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MASTER PLAN FOR THE DEVELOPMENT OF NATIONAL RESEARCH INSTITUTIONS AND THEIR CONTRIBUTION TO THE DEVELOPMENT OF THE INDUSTRY

UC/IRA/93/032/11-02

ISLAMIC REPUBLIC OF IRAN

Technical report: Development of activities related to the agrochemical industry and processing industry*

Prepared for the Government of the Islamic Republic of Iran by the United Nations Industrial Development Organization

Based on the work of Edward Kaminski, expert in food processing and food analysis

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Chemical Industries Branch

* This document has not been edited.

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CONTENTS

I. ABSTRACT

From April 11 to May 11, 1994 a visit to the Islamic Republic of Iran was arranged as part of an assistance and advice mission to the government. The aim was to assess the capabilities of the national research and development institutes and to evaluate possible contributions to the improvement of the industrial sector in the field of food processing and related issues. The mission was organized by technical assistance of UNIDO under project UC/IRA/93/032/11-02.

The main objectives of the visit were:

- Evaluation of present capabilities and future options for the existing research and development institutions;
- assistance to the industry in the improvement of technological processes for the production of food, both in the public and private sectors;
- evaluation of potential of research institutions to contribute to the development of the food industry and indication of specific activities to be performed;
- issuing recommendations to governmental institutions, research and development centers and to a selected number of food processing plants;
- giving advice of possibilities of better utilization of locally produced agricultural products and of research activities into the use of agro by-products for the industrial production of animal food or other industrial products.

The consultant met the representatives of three ministries:

Ministry of Industry (Dr. A.A. Tofigh, Deputy Minister of Research and Training)

Ministry of Jahad (Mr. M.T. Aman Pour, Deputy Minister of Education and Research)

Ministry of Agriculture (Mr. J. Alizadeh Shaegh, Deputy Minister of Agricultural Research Training Extension Organization)

In the course of visit information was gathered from various research institutions. The consultants had discussions with scientist in:

the Pasteur Institute of Iran

the Institute of Standards and Industrial Research of Iran

the University of Teheran - Food Engineering Department

the Food and Drug Control Laboratory, and private research and development institutions (R & D Centers).

Visit to some food processing factories were organized, namely to the Taban Flour Mills Co., the Pars Vegetable Oil Co., the Iran Diary Industries, a diary farm, a fruits and vegetables canning plant, and a starch processing plant.

Suggestions were made and recommendations given during the visits to the Research Centers, R&D-Institutions, and food processing plants. These recommendations are included in the report (General and Sectoral Recommendation).

However, a one month assignment is too short to prepare detailed studies for all items in the job description, but there is no doubt that the scientists in the Iranian institutions will be capable to proceed in such activities.

II. INTRODUCTION

1. A one month consultancy visit was undertaken from 11 April to 11 May 1994 to provide advice and assistance to the government of Islamic Republic of Iran in assessing the present capabilities of the national research and development institutions working in the field of food development to contribute to the improvement of the related industrial sector. The mission was organized by technical assistance United Nations Industrial Development Organization's (UNIDO) under project UC (IRA/93/032/11-02).
2. The consultancy was undertaken by EDWARD KAMINSKI, Professor Dr. of the Food Technology Institute of the University of Agriculture, Poznan, Poland,
3. The specific objectives of the mission were to:
   - Evaluation of present capabilities and future possibilities of the existing research and development institutions to assist the industry on the improvement of technological process for the production of food, both in public and private sector utilizing the locally available indigenous row materials and to indicate those activities which require modernization.
   - Evaluation of possibilities of research institutions to contribute to the development of the food industry and indication of the specific activities to be performed. Advice on the procedures to be followed. Estimated cost and contributions of the parties involved possibilities of better industrial utilization of locally produced agricultural products. Qualified personnel requirements, equipment and infrastructure for the implementation of the recommendations.
   - To assite on the application of FDA regulations.
   - Evaluation all aspects related to the treatment of effluent and environmental protection.

   Research activities on the industrial utilization of agro by-products for the industrial production of animal feed or industrial products.
   - Interrelations of the proposed activities with the industrial infrastructure of the country.

   Possibilities of utilization of locally available indigenous raw materials.
   - Demand of the selected products both in local and International markets.
   - Availability of qualified personal and activities to be under taken for improvement of the level of qualification.
   - Estimated casts for performance of research works and the future industrial application.
   - prepare a terminal report.
4. The first proposition for above project was 1.5 month. Later in January 1994 the duration of the expert mission was reduced to 1 month.

The expert was interviewed in Vienna on the 12 April 1994, and arrive in Tehran on 13 April. Here was introduced by F. Kovats chief Technical adviser project to: Mr. Ali Tofigh - National Project Director, and national counterparts: Mr. Nade Niktabe, Mr. Mir Mohammadi, Mr. Manouchehr Dlizadeh, Mr. M. V,d. Schulenburg, Resident Representative, Mr. Iraj Banatshe, program officer UNDP-UNIDO.

- The job description is given in Annex 1
- A list of the senior counterpart staff is given in Annex 2
- A list of people met is given in Annex 3
- Timetable and a list of research centers and processing plant visited is given in Annex 4

The expert was assigned to Ministry of Industry of the Islamic Republic of Iran.

III. BACKGROUND INFORMATION of Iranian agriculture, research centers and food industry

A. Agriculture

The country has a surface of 164 m.ha, of which only approximately 16,8 m.ha are under cultivation. The area under irrigation is over 7 m.ha; 2,440,428 agricultural units are concerned with arable farming; 1,557,195 with horticulture; 2,280,283 with livestock raising; 256,465 with poultry breeding; 63,100 with silkworm breeding; 1,967 units with flowers and plants. 29 percent of the working population are employed in agriculture. The government has paid special attention to agriculture since the revolution. The basic data of Iran is given in Appendix 1. The principal crops production is given in Appendix 2. The main crops are wheat, barley, rice maize, potatoes, cotton, sugar leafs and tea. The average crops yield per hectare reached 1,082 kg. Through the expansion of irrigation the wheat yield is rise from 1,96 to 3.2 tons/ha. The government subsidized prices for grains and other crops. The biggest subsides have gone to wheat. The country is not self-sufficient for food. A few millions ton of wheat is imported each year, and some other agricultural products and food (cheese beverages, tobacco, oils and fats) (Appendix 2). Some of the agriculture products such as fruits, vegetables, pistachios, almonds, tea; sea products and caviar are exported. The items of exported goods from Iran, and imported agriculture products are given in Appendix 3. Approximately one-third of value added in agriculture is estimated to come from livestock. The data of livestock production and livestock products are given in Appendix 2. The number of livestock throughout Iran is estimated of around to 90 million; 70 million of which are sheep and goats; 10 million cows and calves; 6,7 million natives; 900,000 crosses and 350,000 thorough-bred. Livestock rearing takes two main forms. Animals are kept in considerate numbers on traditional forms for traction milk and meat and second form - there is residual tribal population that is engaged in pastoral nomadism with large herds of sheep and goats, especially in Zagros region.

B. Iranian Food Industry

Industrial foods in Iran are supervised by the Ministry of Industry. All industrial plants are joined to the companies., the companies affiliated to the National Iranian Industries Organization (NIIO) are categorized under six Industrial groups. One of this group is foodstuff.

Foodstuff Industries Group

This group of industries include 928 major workshops which constituted 15,1% of the country's overall industries. The total number of foodstuff beverage and tobacco producing units counted in the 1986 statistics were 61,695 of which 59,920 or 97%, employed between 1 to 9 workers. The number of workshops which employed between 10 to 50 workers was 2,5%. Only 0.5%, or 207 units employed between 50 to 100 workers, which was raised to 278 units in 1990/91. The distributions of this group is as follows:

Dairy Products: The production of milk in 1991 was 3,8 million tons. Milk is processed to liquid milk (pasteurized or sterilized) and condensed milk butter, cream, fermented milk fresh cheese. Monthly production of cheese averaged about 150 tones. Iran imports 70,000 to 100,000 tones of cheese yearly.

Meat and poultry products, around 400,000 - 500,000 tones of red meat is produced domestically, and up to 700,000 tones is imported. The broiler chickens are reared in 14,000 farms with monthly chicken meat output of 1,200 tones.

The production of eggs estimated to 2,735 tones in the year.

Canned Vegetables and Fruits. There are 34 units engaged in the production of canned vegetables and fruits, some 43 thousand tons of tomato paste and 10 thousand tons of various canned fruits are annually produced.

Vegetables Oils, There were 17 major oil processing factories in 1990 with a production value of some one billion dollars. The total production of these processing units in 1990 was 558,000 tons, there are three units which are the largest refineries in the country producing edible oil in liquid and solid state (hydrogenated).

Their production accounts for 97.10 percent of the total production in the country.

Cereal grain products. There are 500 flour mills in which 220 mill are modern. In northern part of Iran there are large and small rice threshing units to process rice.

Machine made Bread. There are 17 major industrial workshops. The production of bread, cookies, confectionery, macaroni, noodles and biscuits are among the most activities of this group.

Granulated Sugars. Sugar industry annually processed of 5 million tons of sugar beet and 1,8 million tons of sugar cane at 40 industrial units.

Starch and glucose. The production of wheat starch glucose and gluten reached 16,399 ton in year 1989.

Root Beer and Malta. There are presently two major units produced root beer (or barley beer) and Malta. Some 37 millions bottles of root bear and Malta with a bottle can volume of 330 cc were marked.

Non-Alcoholic Beverages. The production of various kinds of sherbet and tonic lost popularly with the coming of carbonated drinks. There are presently 22 non-alcoholic units in Iran, producing two millions totals of all kinds of beverage.

Confectionery. There are 11 major chocolate and cookies producing factories and there are many small-scale workshops employing as low as nine people.

There are seven units processing tea leaves, spices natural colors, corn flakes, edible salt, baking powder etc.[1]

C. Industrial Research Institutions.

In Islamic Republic of Iran was established a chain of research centers.

1. Non-Governmental Industrial Research Centers.
2. Engineering Services and Research Companies of Homogenous Industries.
3. Research and Development Units in factories.

   There are 64 non-government engineering research centers which have the license from the Ministry of Industries to offer engineering and research services. There are 11 engineering and research companies of the homogenous industries which have been established with the investment of the relevant factories.

4. The Society of The Centers for Scientific and Industrial Researches of Iran. At the present (1993) the Society follows up its activities with 150 members in the following area: chemicals, pharmaceuticals, pollution control of the environment, electric and electronic metal industries, foodstuffs, non-ferrous minerals, medical, engineering and miscellaneous industry. The objections of the Society are given in Annex 9.

IV. FINDINGS

Visit to Research Institutes, Laboratories, Development Units and Factories.

The Expert during his mission has visited with counterpart the governmental research institutes, non-governmental food engineering research centers, industries laboratory and factories. The list of visited centers and processing plants is given in Annex 4. After visited each R&D unit or plant a brief summary was made which are given in Annexes 5.1 - 5.15.

In each visited center or plant the expert met kindly and hospitality people. The discussion which was provided with the staff of the unit was fruitfully. The remarks, ideas and same recommendation given are described in Annexes 5.1 - 5.15 and in Appendices from to are given data concerning food processing and food control required by Iranian food manufactures.

[1] Source: Export Directory of Iran Industries 1993/94.

1. Research and Development Centers.

- The Iranian research centers such as Pasteur Institute and Institute of Standards and Industrial Research of Iran "ISIRI" are very good establish and organized and they are update equipped in scientific and research apparatus books and periodicals in the library. The scientific and technical staff has a lot of experience in the field they are working. Those centers could provide education and training people from affiliated laboratories and carrying research on high level. However, they needs for research such instruments as combine gas chromatograph with mass spectremeter (GLC/MS), capillary electrophoresis, high performance scanning UV-Visible spectrometers. The GLC/MS equipment alows separation, identification quantification of complex mixture of the organic compounds such as those occuring as:
  - trace organics in foods and water,
  - emissions from industrial stocks and large variety of processes including industrial waste,
  - aroma compounds from the aromatic plants and citrus fruits.

The scientific staff needs to have more contacts with internationals homogeneous institutions and to participate in international congresses and symposiums. Some details concerning Pasteur Institute and ISIRI are given in Annexes 5.1 and 5.2.

- The research and development units affiliated to the industrial branches are well organized and they are very functional for solving practical problems arising in the process of food manufacture, and with food quality. These units could develop a new technics, design, and training people from processing plants.

  The staff working in such units needs equainted with some of the modern scientific and research apparatus such as gas chromatography and mass spectrometry for determination of volatile substances in domestic fruits and spices or toxic components in food. NIR spectroscopy for rapid determination food constituents.

  The people working in such units needs to have more contacts with the some branches abroad and they needs to have scientific and technical information up-to-day.
- The laboratory located in processing plant are sufficiently equipped and laboratory staff could provide necessary examination according Iranian standards.
- The research projects which were elaborated by Iranian research staff are useful for development of industry and they should be introduced in the industrial process (Annex 6).

2. Food industry

The food processing industry make a link in the food chain that extends from the farm to the consumer.

- Dairy Industry

Milk production in the country amounts to 4 millions ton/year. Milk is processed to liquid pasteurized or sterilized milk, butter, cream, fermented milk and fresh salted cheese. The quality of some products is not good enough. The main reason is of lack or no good operating cooling system for raw milk and final products. There is requirement for international assistance, for introduction appropriate cooling system for all chain in milk processing. The white cheese production have a tendency to increases, but the whey as a by-products from cheese making process, mainly is not utilized.

Whey is reach in lactose, proteins, minerals and vitamins, special vitamin B_2 (riboflavin) and is a good nutritive product for food, and for animal feed. Whey should be utilized by use of membrane technique for food, and dryers for animal feed. Some practical suggestion was given during visits (Annex 5.3) and in Appendices 5, 5.1, 5.2.

- Flour Mills Industry.

Flour milling potential is sufficient in Iran. There are 500 operating mills in which 220 mills are modern. In Iran tree types of wheat flour are produced:

75% extraction, 81% extraction and 87% extraction.

Domestic wheat production rounded 5 millions ton, and 2,5 millions ton is imported from Australia, Argentina, Canada and Europe. Flour mills industry needs particular types and varieties of grain for production different kind of flour for bread macaroni and cookies manufacture.

The quality control in grading and bulk handling system is very important within the country. For quality control of cereal grain the ICC (International Association for Cereal Chemistry) - Standards Methods to use were recommended. It is a very big difference between the price of grain and for flour. The Government is paying a big subsistence to the bread There are lot of loses of bread by customers among others in cause of short "Shelf life" of common bread (Lavosh).

The by-products from the milling are germs, which should be separated from the bran and utilized for human consumption, as a reach source of vitamins, special vitamin E (tocopherol). Some practical advise and suggestions concerning quality control of wheat and flour was given during visit Taban Flour Mills Co. in Tehran (Annex 5.4).

The rice-processing plants should establish parboiling process for enrichment product in vitamins. The schema of operation parboiling rice is given in Appendix 6.2.

Parboiling process comes between precleaning and husking. There are numerous advantages to this process; better quality and nutritional value, higher milling yield, better cooking quality and reduced stickness.

Some disadvantages; some consumers don't accept particular yellow color, test and odor of parboiling rice.

- Vegetable Oils Industry

Vegetable oils is a big industry in the country. The total production estimates around 600,000 tons per year. One of the biggest factory Pars Vegetable Oil Co. manufacture 100,000 metric tons per year in which 95% hydrogenated oil for industry. Polyunsaturated fats have become popular in industrialized countries because of the belief that saturated fats contribute to heart disease. Vegetable oils might consider increased production of unsaturated oils. There is requirement for international assistance for the initiate process for margarine manufacture for human consumption. Some brief informations how to start manufacturing are given in Appendices 7 and 7.1.

Special is recommended to increase oil production from the germ of the maize kernel. This oils is highly unsaturated, reach in vitamin E /tocopherol/ and are widely using as a salad dressing, or salad oils. It is also recommended to increase production alive oil from domestic sources which is the most popular of vegetable oils.

Some details and suggestion were given during visiting Pars vegetable oil Co. (Annex 5.5).

- Starch and Glucose Industry

In Iranian food industry the starch is produced from the wheat flour. Starch is used for textile manufacture, for glucose syrup production and for manufacture modified starch (Oxygenated) for mineral oil industry.

Advanced processing methods are needed to industrialize the processing of starchy products, such as different kind of glucose or fructose syrup, and modified starches. A brief informations are given in Appendices 8 and 8.1 concerning production of high fructose syrup and production of starch derivatives.

The by-product from starch manufacture could be utilized as a source of aminoacids for vegetable hydrolyzed protein (VHP) and for production of bullions and seasoning such as "Maggi" - source of sodium glutamate. The schema of VHP processing and aminoacids composition of different kind of protein are given in Appendix 9.

Some practical advises were given during visiting "Vegetable Processing Co. (Annex 5.6) and "Pars-Esta Co." (Annex 5.8).

- Preserved Foods

The canned vegetable and fruit processing industry needs a high quality of agricultural products, special selected varieties of vegetables and fruits suitable for canning. The industry needs modern sterilizing system, such as Stork continous steriliser "Hydromatic". The Stork Amsterdam Co. produce sterilisers handling of 100.000 cans per hour. In a new types the consumption of steam and water is reduced by regeneration.

In Europe is popular also "Hunister" - hydromatic steriliser handling up to 27.000 cans per hour, produced in Hungary.

The Behroos Food Industry which expert was visited is not big factory, but very well organized - processing line, control laboratory and management.

- Non-Alcoholic Beverages

Iran has a lot of natural agricultural products, different kind citrus fruit, apples, cherries for manufacturing healthy natural drinks. The carbonated beverages cola type drinks should be replaced in some amounts by natural juice.

The Sasan Company which produce Parsi Cola drink is a modern good managed factory producing good quality drink.

Water used for soft drink manufacture is well treated (Annex 7).

3. Food quality control

Quality control and sanitation in the food processing industry are of the utmost importance not only to protect consumers but also to retain product quality and avoid losses. Food should be protected from contamination from whatever source (pesticide, heavy metals, unsafe chemical preservatives, mycotoxins and all other contaminants originated from microorganisms, packing materials pest and animals.

The food quality control in the country is executed by plant processing laboratories, in Food and Drug Control Laboratories and Institute of Standards and Industrial Research of Iran (ISIRI)- laboratories acc. Iranian standards.

It is recommended to introduce to food manufacture "Hazard Analysis Critical Control Points" (HACCP).

Some details concerning how to apply this system is given in Appendix 14. In Appendix 13 are given data of microbiological standards for various food products.

V. RECOMMENDATIONS

Suggestions given below classified in "General Recommendations" and "Sectoral Recommendations" are the result of investigations and findings derived from visits organized and selected on the basis of national priorities by the Iranian counterpart.

The "General Recommendations" are supposed to be valid for the whole food processing industry (maybe to other fields of the industry as well), while the Sectoral Recommendations are related to the resp. section, however - mutatis mutandis - may be useful for other sectors of the food industry not covered by this report.

A. GENERAL RECOMMENDATIONS

1. Subsidies

Agricultural production is supported/subsidized in all countries in the world. Iran is not an exception, neither.

However, a revision of the policy and the system of subsidies is recommended. Prices kept low and fixed may be an obstacle for future development in many respects:

- extremely large portion of wasted food
- no incentives for producers to improve the quality or to increase the yield
- no basis for competition on market functions.

2. Privatization

The Iranian government has opened the way for private enterprises. The beneficial effects can be observed even during a short stay in the country.

However, some constraints - due to the transformations of the social/political system and still more to the recent period of war - are still in force.

For example: severe restrictions exist for the owners of operators of milling enterprises to adopt to the market situation or to introduce new techniques and products, because:

- fixed price of wheat
- fixed price of flour
- quantities and product mix stated by the Grain Board
- payment performed on the basis of tonnage - without respect to quality.

A careful but deliberate continuation of the privatization movement is strongly recommended.

3. Flow of information

The places visited (both R&D and production units) are suffering of limited access to information

- between R&D institution and industrial enterprises (a suggestion for Iranian R&D Board for Food Processing follows)
- printed publications (books and periodicals from abroad).

A separated budget in foreign currency - especially for state-owned enterprises - is proposed to be assigned at the disposal of consumers in order to enhance information update, with priority to industry and R&D-institutions, which are oriented towards export activities.

4. Iranian Research & Development Board for Food Processing

For integration and strengthening of all governmental R&D institutions and private R&D units it is proposed to establish a Board for Food Processing R&D, in which scientific personnel, the professional and trade chambers or other special groups should be represented.

This institutions could start issuing a status report of the present situation, collecting data about existing capabilities of R&D institutions already accessible, their current research activities, future potential and needs. The Board should be entrusted to support research work in the most important fields, and to assist in the application of R&D-results through the extension services (See paragraph "Related Suggestions C.1).

The Board should be equipped to sponsor required research at R&D institutes and universities. It should support the national and regional training facilities, thus improving the access to these facilities.

The Board for Food Processing could be one of the branches of the present Society of the Centers for Scientific and Industrial Researches of Iran.

5. Central Service Agency for "Special Instruments"

There is a need expressed by all entities visited dealing with large of expensive instrumentation (Gas Chromatograph/Mass Spectrometer, Atomic Absorption Spectrometers, Nuclear Magnetic Resonance Spectrometer, etc.) for:

- regular maintenance
- reagents or standard kits
- spare parts, accessories
- information on recent new applications, methods, novel modifications.

A central agency entrusted to take care of any such instrumentation and to cope with the demand of the users should be installed.

B. SECTORAL RECOMMENDATIONS

There are many R&D-centers in Iran active in food processing, which could provide know-how, perform research to further the technological progress, and thus contribute to food quality and food safety.

These institutes - be it governmental or private ones - could play an important part in developing novel techniques for food processing.

After some field experience concerning the procedures used in the country and possible improvements the following R&D activities are suggested to be provided in the related branches of the Iranian food processing industry.

In addition to this findings some practical recommendations were given during visits at several research and development centers and food processing plants already. An outline of this recommendation is annexed.

1. Dairy industry

1.1. An immediate chilling process to 4°C as soon as possible after milking should be ascertained and an uninterrupted cooling chain be provided during transportation to the dairies.

Milk is an ideal culture medium for numerous micro-organisms to grow - and thus it is susceptible to rapid decay.

To keep this process from influencing milk quality cooling systems have to be elaborated for:

- the fresh milk at the farms (preferably) and/or at the collecting stations;
- a sufficiently powerful cooling device active during transportation between the farms (collect-points) and the dairies.

In a similar way this recommendation applies also to pasteurized milk and to nearly all of the other dairy products.

1.2. Many processes or methods used abroad could be applied to derive new products. The related procedures should be elaborated or adopted to the local market. This is suggested especially

- for the production of fresh cheese "Philadelphia", "Petit Suisse", or "Kiri" - type.

- for the introduction of ripened cheese (Holland cheese, Cheddar), which could be stored with less risks of rotting.

1.3. Whey as by-product from cheese production should be utilized as well for human consumption (from the first class milk) as for animal feed. The production methods for this are well known. A brief information was given in Appendices 5 and 5.1.

2. Flour Mills and Bread Manufacturing Industry

2.1. The flour mills in Iran produce a good quality flour for bread baking. However, an improvement of the quality of the bread seems feasible, mainly aiming to reduce bread losses on the way to the consumers. Primarily the shelf life of the bread should be extended by the elaboration of - an adequate product formulation and composition of flour;

- an improved packing system;
- better management of storage and distribution of products.

When making low extraction rate wheat flour for bread a restoration of vitamins, especially for vitamin B1 (Thiamin) is suggested.

By-products from the flour milling such as germs should be utilized for human consumption or in biotechnological processes as a source of vitamins - especially vitamin E (Tocopherol).

2.2. In connection with the rice milling process the application of the parboiling process (steaming under pressure) is suggested.

By parboiling soluble vitamins (especially B1) and minerals will be transferred from the bran surrounding the grain into the grain. Thus, valuable vitamins could be preserved in white rice (Details are given in Appendix 2.)

3. Starch and Glucose Industry

3.1. In starch and glucose processing plants Gluten is a by-product from wheat flour. Gluten is a very good source of all aminoacids. There is need to elaborate technical processes to produce hydrolyzed vegetable protein (H.V.P.) as a product to manufacture:

- Flavor seasoning "Maggi" - type;
- additives for bullion processing;
- a source for sodium glutamate (intensifier of beef flavor);
- products to manufacture roasted beef flavor.

Some details of H.V.P. manufacture are given in Appendix 9.

3.2. For better utilization of starch in the process of deriving glucose syrup the enzyme should be applied or combination type enzyme-acid hydrolysis could be used (details are given in Appendices 8 and 8.1.

4. Vegetable Oil Industry

The vegetable oil industries produce hydrogenated oil, which is a main component of margarine. There is need to elaborate a technology for the production of margarine as a substitute for butter.

For that purpose the technical staff of the Pars Vegetable Oil Co. should obtain good manufacturing practice in European Countries. The data how to start manufacturing margarine is given in Appendices 7 and 7.1.

5. Non-Alcoholic Beverages

5.1. The variety of existing carbonated beverages on the market should be increased by the introduction of new products based on flavoring ingredients obtained from natural resources - especially citrus plants.

5.2. Carbonated beverages based on citrus flavor are very popular in all countries. Containing more than 200 compounds citrus oils are very complex in chemical composition. But their extraction from natural raw material is a procedure, which can easily be applied.

6. Food Control and Food Analysis

Since food for human beings has to be 100% safe, it must be prepared with utmost care. To achieve safe and good quality foods the food processing should be controlled and monitored by adequate means. All aspects of the catering process which are essential for food safety, quality and consumptive requirements should be recorded as part of a quality assurance procedure.

To achieve this, objective laboratory staff at processing plants should apply Hazard Analysis Critical Point (HACCP) procedures. This procedures are widely used in relation to microbiological food safety, chemical and physical hazard in food, and in quality aspects of the processes. An example of application of this procedure is given in Appendix 11.

C. RELATED SUGGESTIONS

1. Food Advisory Extension Service

To achieve the objectives related to the project it is recommended

- to establish a Food Advisory Extension Service, providing cross links between R&D-centers and Iranian industries and vice versa (aspects of establishing such a service are cited in Appendix 14);
- to encourage the cooperation of industrial and research entities with institutes and enterprises abroad; and
- to introduce a procedure of assistance in the commercialization of research results, which could be ascertained by
  - : financial incentives
  - : personal (scientific) support for certain times

: (temporary) subsidies for market introduction

: tax excemption of similar aid.

An extension Service is based on four closely interrelated functions: Research - Extension - Education

It should therefore focus on the following three aspects:

- Organization of the task;
- Selection and training of extension service personnel;
- Budgetary support for extension.

Extension services could be affiliated to the Ministry of Industry. They should be under the surveillance of the Iranian R&D Board for Food Processing (See Gen. Recommendation A.4).

2. Research and Development Institutions

The Iranian R&D homogenous institutes such as Pasteur Institute, Institute of Standards and Industrial Research of Iran (ISIRI) have very good educated and experienced staff, are well equipped with scientific and control apparatus, and have access to adequate documentation in books and periodicals.

However, they need for their research contemporary equipment, e.g. gas Chromatograph combined with mass-spectrometer (GLC/MS); high performance scanning UV to visible spectrometer, capillary electrophoresis, and other. The cost of GLC/MS is estimated to amount to roughly US$ 70,000.-

3. Small R&D Centers

Many small R&D centers or unit have a good educated staff of one to four persons. But those centers are not sufficiently equipped as far as scientific apparatus and research infrastructure are concerned. They have to rely on support from the homogeneous R&D institutes and from universities in technical aspects, scientific information, consultancy, and in analyzing capabilities of food products.

To keep in line with the state-of-the-art they also need to have contacts with R&D institutes in Western countries by visits (short or long term) and by access to training opportunities.

4. New Research Tasks

New research activities should be performed in order to introduce of new products derived from domestic raw material (for example: production of new type of cheeses, juices from all types of fruits, essence oils from citrus fruits, etc.).

Priority should be given to childrens' food requirements in terms of proteins and vitamins contents.

Additional suggestions have been made and concrete projects to be performed have been defined in the recommendation for some specific branches of the food industry.

Food processing programs should be outlined on a long-range basis to integrate the efforts of governmental experts in food processing, education centers, engineering organizations, and any other related activities.

D. FINAL REMARKS

Some further technical assistance of UNIDO and other organizations will be necessary, especially as far as contemporary experience is concerned with processes and functions of food processing - such as dehydration, refrigeration, conservation, sanitation, and water and waste management and in manufacture of new food products.

ANNEX 1

UNIDO

M. Sanchez/epg
2 March 1993

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION
UC/IRA/93/032/11-02

Post title	Expert in research, development of activities related to the agrochemical industry and food processing industry
Duration	1. months
Date required	March 1993
Duty station	Teheran, Iran
Purpose of mission	To provide advice and assistance to the government of the Islamic Republic of Iran in assessing the present capabilities of the national research and development institutions working in the field of food development to contribute to the improvement of the related industrial sector.

Duties

The expert is expected to perform the following activities in cooperation with the national counterpart:

1. Evaluation of present capabilities and future possibilities of the existing research and development institutions to assist the industry on the improvement of technological process for the production of food. both in public and private sectors, utilizing the locally available indigenous raw materials and to indicate those activities which require modernization.

2. Possibilities of research institutions to contribute to the development of the food industry and indication of the specific activities to be performed. Advice on the procedures to be followed. Estimated costs and contributions of the parties involved. Possibilities of better industrial utilization of locally produced agricultural products. Qualified personnel requirements, equipment and infrastructure for the implementation of the recommendations.

..../..

3. To assist on the application of FDA regulations.

4. Aspects related to the treatment of effluent and environmental protection. Research activities on the industrial utilization of agro by-products for the industrial production of animal food or other industrial products.

5. Interrelations of the proposed activities with the industrial infrastructure of the country. Possibilities of utilization of locally available indigenous raw materials.

6. Demand of the selected products both in local and international markets.

7. Availability of qualified personnel and activities to be undertaken for improvement of the level of qualification.

8. Estimated costs for performance of research works and the future industrial application.

9. The expert should present the typed mission report including findings, conclusions and recommendations.

Qualifications

Language English

Background information:

The MOI intends to implement a national plan within the overall gamut of the first five-year Plan to establish a linkage between the programmes of the research institutions and the existing industries to upgrade ageing technology and ensure improved production and commercialization of the research findings. This, it is envisaged, will also increase export and encourage the private sector entrepreneurs to invest in industries.

Through the project, the Ministry of Industry of Iran will receive concrete advise on the utilization of existing research and development institutions in the field of chemical research in order to orient these institutions to the planning, organization and execution of their plan of activities addressing them to the development of the chemical industrial sector and improvement of its efficiency. Fulfillment of the project objective will entail an investigation of the means and ways for stronger direct working contacts as well as active promotion of closer working association among different institutions and industry.

The project will allow to define the surplus capacities of the research institutions, high level educational centres, engineering designs and development organization which could be made available for the development of the industrial potential in the country.

List of senior counterpart

name	title	affiliation	adress
Dr.Ali.A.Tofigh	Deputy minister	m.o. Industry	No,10,Kabkanian Lane, Keshavarz- Blvd valey- e- asre sq. TEHRAN- IRAN
Dr.Mohammad Ali Mirmohammadi	Head of the Department of Mining Eng.	M.o.Higher Education	TEHRAN University
Dr.Manoochehr Oliazadeh	Professor, of Mineral processing	M.o.H.Education	TEHRAN UniversitY
Nader . Niktabe	Organizing manager	M.O.I	R&D Department

LIST OF PEOPLE MET

1. Mr. M.V.D. Sehulenburg, Resident Representative UNDP In Tehran.
2. Mr. M.T Amanpour , Deputy Minister of Education & Research Dept. of Ministry of Jahad Sazandegi.
3. Mr. Gh. Chams. Prrofessor, Tehran University.
4. Mr. M. Esteki. Pass Vegetable Oil Co., Utilization Assistant of Managing Director.
5. Mr. F. Jahani, Noosh Pajouh Co., Managing Director.
6. Mr. P. Jahangiri, Pars-Esta Co., President.
7. Dr. K. Nikpour Tehrani, Milad Machine Ind, Des. & Mfg. Co., Research Director.
8. Mr. Mir Ahmad Sadat, ISIRI President.
9. Mr. J. Alizadeh Shaegh, Agricultural Research, Training, Extension Organization, Deputy.
10. Mr. Behrooz Forotan, Behroz Food Industry, Managing Director.
11. Dr. H. Yazdjerdi, Taban Flour Mills Co., Member of the Board of Directors.
12. Dr. Morteza Azarnoush, Pasteur Institute of Iran, Director.
13. Dr. S. Haghighi, Food & Drug Control Labs. (FDCL), General Director.
14. Mr. Ebrahim Azad, Iran Dairy Industries Co. Process Engineer.
15. Mr. A. Taheri, M.SC. Chem. Eng., Alfa Neshasteh Co., Managing Director.
16. Mr. Hamid Tamizkar, Ministry of Agriculture, Bureau of Industries of Agri. Products, Director - General.

MASTER PLAN FOR THE DEVELOPMENT OF NATIONAL RESEARCH INSTITUTIONS AND THEIR CONTRIBUTION TO THE DEVELOPMENT OF THE INDUSTRY (TIME TABLE FOR MR, E. KAMINSKI)

NO	VISITING PLACE	PERSON INCHARGE	FIELD OF ACTIVITIES	RC,R&D,PI	DATE / TIME
1	PASTEUR INSTITUTE	DR. AZARNOOSH	SERUM PRODUCTION & FARMACEUTICAL, RESEARCH CENTER	RC	WED. 13 APR. 9 - 14
2	INSTITUTE OF STANDARD	DR. SADAT	RESEARCH & STANDARDIZATION	RC	THU. 14 APR. 9 - 14
3	IRAN DAIRY INDUSTRIES CO.	ENG. AZAD	DAIRY PRODUCTION	R&D	SAT. 16 APR. 9 - 13
4	TABAN FLOUR MILLS CO.	ENG. KHANLOO ENG. SAMIE	PRODUCTION OF FLOUR	R&D	SUN. 17 APR. 10 - 15
5	PARS VEGETABLE OILS CO.	ENG. MAVEDATI	VEGETABLES OIL PRODUCTION	R&D	MON. 18 APR. 9 - 12
6	FARAYANDHAYE GUIAHY	ENG. TAHERI	VEGETABLE PROCESSING(STARCH PRODUCTION FROM WHEAT)	PRI	TUE. 19 APR. 9 - 12
7	MILAD MASHINE	DR. NIKPOOR	RESEARCH, DESIGN AND PRODUCTION OF MACHINERY, PRODUCTION LINES FOR FOOD, TEXTILE INDUSTRIES	PRI	WED. 20 APR. 9 - 12
8	PARS ESTA INDUSTRIAL RES.	ENG. SEPAHI	PROJECT DESIGN FOR PRODUCTION OF STARCH GLUCOSE, CHEESE AND ADDITIVES	PRI	SUN. 24 APR. 9 - 12
9	NOOSH PAJOUH FOOD INDUSTRIES	ENG. JAHANI	RESEARCH ON PROCESSES AND FORMULATION OF SOFT DRINKS & FRUIT JUICES	PRI	MON. 25 APR. 9 - 12
10	BEHROOZ FOOD INDUSTRIES	DR. MALEKI	TINNED FOOD	R&D	TUE. 26 APR. 9 - 12
11	MINISTRY OF JAHAD	ENG. AMANPOOR	DEPUTY MINISTER AT RESEARCH AND TRAINING	---	SUN. 1 MAY 9 - 10
12	UNIVERSITY OF TEHERAN	PROF.DR. B.H.CHAMS	FOOD ENGINEERING DEPARTMENT	R&D	1 MAY 11 - 13
13	FOOD AND DRUG CONTROL LABS.	DR. S.HAGHIGHI	FOOD ANALYSIS & CONTROL	F&D.C.	2 MAY 10 - 12
14	MINISTRY OF AGRICULTURE	MR. ALIZADEH SHAEGH	RESEARCH, TRAINING, EXTENSION ORGANIZATION	R&D	3 MAY 9 - 11
15	MINISTRY OF AGRICULTURE	MR. HAMID TAMIZKAR	BUREAU OF INDUSTRIES	R&D	4 MAY 10 - 11

ANNEX 4

ANNEX 4

List of Research Centers and
Processing Plants Visited

1. PASTEUR INSTITUTE OF IRAN- Pasteur Av.TEHRAN.
2. INSTITUTE OF STANDARDS AND INDUSTRIAL RESEARCH OF IRAN/ISIRI/ -TEHRAN
3. RESEARCH CENTER FOR FLOUR MILLING AND BAKING INDUSTRIES. TEHRAN.
4. INDUSTRIAL RESEARCH AND FORMULATION CENTER FOR FOODS.- TEHRAN.
5. PARS-ESTA INDUSTRIAL RESEARCH Co.- TEHRAN.
6. MILAD MACHINE RESEARCH Co.- TEHRAN.
7. FOOD ENGINEERING DEP.UNIVERSITY OF TEHRAN.
8. TABAN FLOUR MILLS Co.- TEHRAN.
9. IRAN DAIRY INDUSTRIES Co.- TEHRAN.
10. DAIRY FARM INDUSTRIES Co.- TEHRAN.
11. PARS VEGETABLE OIL Co.- TEHRAN.
12. VEGETABLE PROCESSING Co. OF IRAN FARAYANDHAYE GUIAHY.- TEHRAN.
13. BEHROUZ FOOD INDUSTRIES- KARAJ, Qazvin Rd.
14. FOOD AND DRUG CONTROL LABS- TEHRAN.
15. EDUCATION AND RESEARCH DEPARTMENT MINISTRY OF JAHAD SAZANDEGI- TEHRAN.
16. AGRICULTURAL RESEARCH, TRAINING EXTENSION ORGANIZATION, MINISTRY OF AGRICULTURE- TEHRAN.

ANNEX 5.1.

VISIT TO PASTEUR INSTITUTE OF IRAN

A short visit was made on April 12, 1994 to Pasteur Institute in Tehran with Mr. Kovats and Mr Olizadeh (representing the Iranian counterpart). The Director of the Pasteur Institute introduced briefly to the research and related activities in different departments. There are:

- Microbiology Department
- Pulmonary Disease Research Department
- Parasitology Department
- Mycology Department
- Virology Department
- Rabies WHO reference collaboration center
- Hepatitis and AIDS Department
- Immunology Department
- Biochemistry Department
- Molecular Biology Department

All visited laboratories were found to be equipped with modern scientific apparatus. The discussion held concern parasitology of raw food origin, fungal diseases, viral diseases, immunology and salmonelloses was very fruitful and showed that the staff working at the institute have very good experience in their respective fields of activities.

ANNEX 5.2.

VISIT TO ISIRI - INSTITUTE OF STANDARDS AND INDUSTRIAL RESEARCH OF IRAN, KARADJ.

A one day visit was made on April 14, 1994 together with Mr. Kovats and Iranian counterpart Mr. H. Mohammadi.

The Director of the Institute Mr. Mir Ahmad Sadat introduced to the organization and activities of all branches of the Institute. The historical background of ISIRI and its organizational structure is given in Appendix 15.

ISIRI has a large number of control laboratories:

- 60 laboratories at Karadj
- 60 export control laboratories distributed over different cities
- Hallmarking laboratories

During visits the Expert get acquainted with activities of 15 control laboratories related to food and agricultural products. All visited laboratories are very good equipped with all necessary apparatus. The staff of the laboratories are underwent qualified, have very good experience in their respective fields of activities. The work in the laboratories is very good organized and managed.

The standard which was elaborated by ISIRI for agriculture products, food and beverages are very close to the ISO standards. The copies of Iranian standards for rice are given in Appendix 15.1.

The ISIRI is a member of ISO, and cooperates with agencies affiliated to WHO and FAO.

The library which was visited have all necessary books and periodicals. However some current information concerning new equipments and publications of progress in analytical methods is recommended. For that purpose is given the list of analytical methods published by Hewlett Packard in Vienna which was sent, but not included in this report.

ANNEX 5.3.

VISIT TO IRAN DAIRY INDUSTRY CO. (IDI)

Visit to IDI was made on April 16, 1994 with Mr. Kovats.

Mr. Ebrahim AZAD - Research Development Manager introduced to the situation in milk production and milk processing in Iran. There are small farms with 2-3 cows and big one with 1400 cows. Total amounts of milk production evaluated around 4 million tons per year. Sheep milk around 446510 tons per year and goat milk - 400000 ton/year. The raw milk from the cows is collected at the farm or at the collect station and delivered to dairies for processing.

At the dairy plants milk is processed into: pasteurized liquid milk or sterilized liquid milk by the use of UHT techniques; creame, butter, fermented milk (masst) and fresh salted cheese.

The raw milk is controlled for acidity, fat content, density, sensoric test after milk boiling and bacteria count No test is performed for mastitis (See Appendix 16.2). The bacteria counts in raw milk evaluate from 200000 to 40.000.000.

In Iran is popular molded fresh cheese. There is good equipped pilot plant for providing experiments with fresh cheese manufacture. The whey from the curd as a by-product is not utilized. Only small amounts is used for manufacturing soft drink.

During the visit discussion was held concerning milk quality, utilization of by-products and new products on the market.

Following recommendation was given:

1. Milk after milking is not cooled properly, there is a good condition for microbial growth To prevent micro-organisms grow, milk after milking should be chilling to 4°C and should be ascertained and an uninterrupted cooling chain be provided during transportation to the dairies plant. For chilling milk to 4°C is recommended installation with the plate heat exchanger (See Appendix 4).

2. From the good quality milk /it is recommended to start production new product in Iranian market - a wide variety of cheeses of which the best known are quarq, pâte fraiche, cream cheese, Philadelphia cheese, Kiri cheese. Their common denominator is that they are all made from fresh, cultured skim milk, whole milk or cream and that they are all consumed without any further ripening.

<u>Quarq</u> is produced with total solids (TS) a maximum 2% fat in TS. There are many different varieties: in Germany quarq with a minimum 18% TS; in England - 20% TS; in USA 22% TS; in Poland between 18% and 40% TS and between 10% and 50% fat in TS.

<u>Cream Cheeses</u>:

Cream cheese is normally produced with 45% TS and 70% fat in TS. This kind of cheeses is very popular in developed countries. These fresh cheeses have been produced in nowadays by means of ultrafiltration. Some basic data of milk with using membrane filtration processing are given in Appendix 5.

For providing experiments with membrane filtration for fresh cultured cheese, it is recommended to installed ultrafiltration (modules type 37 size 1,65 or bigger) APV Pasilac system in pilot plant at Iran Dairy Industry Co.

3. The whey from the processing cheese with total solids of 6,0 to 6,5% should be utilized for manufacture whey proteins concentrate and lactose by use of ultrafiltration technique (Appendix 5.1) or could be processed to whey powder by use falling film evaporators and spray dryers. Whey powder could be utilized as a food additives or as a component for animal feed manufacture. Liquid whey has been fed to farm animals, particularly cows, calves, chicken. Fluid whey could be replacement for water consumed by milking cows. (See Literature, Kosikowski, pp.459-460).

For any inquiry concerning all kind of equipments for milk processing could contact with:

1. APV Pasilac AS, Pasteursvej, PO Box 320
   DK-8600 Silkeborg, Denmark
   Telefax +4568156611

or

2. Alfa-Laval, Box 802,
   DK-6000 Kolding, Denmark
   Telefax +4575535222

<u>LITERATURE RECOMMENDED</u>:

1. Frank Kosikowski; Cheese and fermented milk foods. Second Ed. 1977, Edwards Brothers, Inc., Ann Arbor, Michigan.

ANNEX 5.4.

VISIT TO TABAN FLOUR MILLS CO. AND RESEARCH CENTER FOR FLOUR MILLING AND BAKING INDUSTRIES IN TEHRAN.

The visit was made on April 17, 1994 together with M. Kovats and Mr. N. Niktabe, Iranian counterpart.

Director of the Research Center is Mr. Ahmad Khantou, the owner of the Taban Flour Mills

The Research Center has a Board consists of 5 elected members. The Director of the Board is Mr. A. Sai.

Mr. Samii one of the board member introduced us to the center activity and research. All informations, as a results of research and other activities, are published in Farsi language In the country there are 500 mills in which 220 mills are modern. Taban Flour Mills proceed 340 tons/24 h wheat.

Three types of flour are produced: 75% extraction, 81% extraction and 87% extraction.

The Taban Flour Mills which was visited, is very modern. The mill is equipped with Bühler rolls and pneumatic conveying system. In the cleaning house wheat grain cleaned and wet cleaned by washing machine. The manager of the mill was educated in the Milling High School in Germany. During the visit Mr. Khanlou organized meeting with managers and owners from 15 flour mills from the country. A brief discussion was held concerning wheat quality, methods used for testing wheat and utilization of by-products. The method of improving quality of flour from the wheat damaged by bug-wheat in milling process, was also discussed.

During discussion following recommendation was given:

The wheat delivered to the mill should be tested in laboratory for:

- amylolytic activity by use Falling Number Method (Appendix 6)
- proteolytic activity by use Kozmina test for gluten
  Appendix 6.1)
- the germ as by-product should be separated in process from the bran and utilized for human consumption as a source of vitamin E (tocopherol).

The Taban Flour Mills could be as a center for training and education the people from other mills to obtain knowledge and good manufacture practice.

ANNEX 5.5.

VISIT TO PARS VEGETABLE OIL CO.

Visit was made on April 18, 1994 with Mr. Morteza-Ghaffar Pur Iranian counterpart. Pars Vegetable Oil Co. is a Shahid Foundation managed by General Director Dr. Mavadati. Mr. N. Esteki, Utilization Assistant of manager director introduced us to the branch Pars manufacturing groups and its activities. Pars Vegetable Oil is one of the leading manufacturer of vegetable oil in Iran with 100.000 metric tons of production in a year. In those:

95% hydrogenated oil

4% liquid oil for industry

0,5% liquid oil for consumers

0,2% palm oil.

The raw palm oil is imported from Indonesia, sunflower and soya oils are imported from Brazil and Argentina. Domestic oil is produced from soya and sunflower.

A brief discussion was provided with manager and with Dr. Firouz Madad Noee, Iranian expert of food science and industrial consultant. There is a big demand for margarine manufacture. Margarine is essentially produced by mixing the hydrogenated oils with raw oils and fats, water or fermentation milk, monoglyceride, lecithin, aroma ingredients, coloring agents, carotene, antioxidants. The main ingredients for oils are: soya oil, cotton-seed oil, sunflower oil or peanut oil. For fats there are cocoa fat, palm oil. High value oils from fish can also be used for the production of margarine.

Margarine contains polyunsaturated fats which contribute to the reduction of cholesterol level thus also reducing the risk of degeneration of arteries and coronary vessels, which is one of the main reasons of heart attacks and apoplexy of the brain. A two short informations how to start manufacturing of margarine are given in Appendices 7 and 7.1).

The manager staff from the Pars Vegetable Oil Co. needs training in some margarine plant of West European countries to get a good manufacture practice.

The laboratory is equipped with gas chromatcgraph (Varian), but staff of the laboratory needs training how to use that equipment for multi purposes analysis; selection of columns, selection of detectors, sample preparation and others. The method for sample preparation and fatty acids analysis by the use of gas chromatograph is given in Appendix 7.2.

ANNEX 5.6.

VISIT TO VEGETABLE PROCESSING COMPANY OF IRAN (FORAYANDHAYE-GUIANY)

Visit was made on April 19, 1994 with Mr. Nader Niktabe Iranian counterpart. Vegetable Processing Company of Iran is a private enterprise directed by Mr. A. Taheri, chemical engineer. The main activity of this enterprise is producing modified starch for Iranian mineral oil industry and some amounts of glucose syrup for food additives. The by-product of wheat processing is wet gluten which was drying by another company. The Vegetable Processing Company have own mechanical workshop where are produced all necessary equipment for own starch plant.

During visit discussion was held with other partners of Company concerning effectiveness of conversion starch to glucose syrup with acid and enzymes. A brief discussion was provided concerning gluten utilization. Recommendation given are listed below. Mr. A. Taheri was invited by expert to visit starch plant processing in Poland.

Recommendations:

1. The glucose syrup production by use acid (HCl) for hydrolysis given product with low rate starch conversion (around 42 DE).

   The use of enzyme hydrolysis or combination of acid and enzyme permits reaching a high rate starch conversion to dextrose (around 63 DE).

   It is recommended also to manufacture a syrup (42% fructose) with high sweetening power (HFCS) from glucose syrup by means of isomerization by the use of enzyme.

2. The gluten as a by-product of starch processing from wheat flour could be used (utilized) for manufacture of hydrolyzed vegetable protein (HVP). That product contain all aminoacids which are necessary for production dietetic bullions and seasoning "maggi" (Appendices 9 and 9.1).

A brief explanations of process description of starch derivatives production; glucose syrup, dextrose syrup and sorbitol are given in Appendices 8 and 8.1.

ANNEX 5.7.

VISIT TO MILAD MACHINE INDUSTRIAL RESEARCH AND MANUFACTURING CO. TEHRAN

The visit was made on April 20, 1994 with Mr. Nader Niktabe - Iranian counterpart. The General Director and owner of the Company is Mr. Amir Sharifi who was absent during our visit. Dr. K. Nikpour Tehrani - Research Director introduced us to the activity of that Company. Industrial R+M Co (Milad Machine) design and manufacturing industrial factories as turn key with the license from Ministry of Heavy Industry. Milad Machine has an extensive line of products, its own design and engineering department. They have a team of top level consultants and advisors on nutrition, veterinary, business, management and marketing. Milad Machine produced different kind of dryers and lines for:

1. Garlic, onion, potato processing
2. Black cherry, plum, peach dryers
3. Alfa-alfa and corn dryers

A brief discussion was held concerning animal and poultry feed production and utilization of by-product from industry and domestic waste. It was utilized around 500 tons of dry bread and about 7 tons of bones bouches daily. This waste are rendered to top quality animal and poultry feed. It was also utilized by sterilization of slaughter trash and poultry offal and poultry manure. Till now Company not utilized whey from cheese production. Company seeking economical design for evaporation water from the whey. It was recommended for Company to use three or six - effect falling film evaporator with thermal vapour recompression (TVR). Information concerning falling film evaporators could be obtained from:

APV Anhydro A/S, 7 Ostmarken,
2860 Soborg-Copenhagen, Denmark
Tel: 451692811 Telex: 27016

ANNEX 5.8.

VISIT TO PARS ESTA INDUSTRIAL RESEARCH CO.

The visit was made on April 24, 1994 with Mr. N. Niktabe.
The main office of the Company is located at Tehran. The President of the Company is Mr. P. Jahangiri. The Company has three factories which are located outside of Tehran. Starch wheat factory daily capacity estimated cá 6 ton/day, where is produced modified starch for industry (textile industry) and glucose syrup. Gluten as a by-product is utilized by drying as an additives for bread.

Dairy plant produced liquid pasteurized milk (300 tons/day), yogurt (5 tons/day), cream (0,5 tons/day) and fresh cheese. Milk is delivered from the farms and collecting centers The temperature of delivered milk is about 8-12°C.

Whey from the cheese production is utilized in laboratory scale by ultrafiltration for production of whey protein for baby food. Whey is also concentrated by evaporation and dried for confectionery. Utilization of whey estimated cá 200 tons/day. The Company is on the way for production of ripened European type of cheese. The research project is carried out on enzyme processing for manufacture milk without lactose.

The Noosh Co. directed by Mr. A. Etemad produced fruit concentrated juice from oranges, essential oils, from citrus fruits, alcohols, vinegar, natural red colorings from the red beets, in small amounts.

During a visit a several problem was discussed. Lot attention was paid to the quality of the raw milk. There needs to be organize cooling chain from dairy farm to processing plant. The discussion was concerned also gluten utilization for production of hydrolyzed vegetable protein (HVP), and production of spices "Maggi" type. Some advise was done by the expert for manufacture of natural red coloring product from the red beets, some explanation and advise was given to Mr. Sepahi and Mr. Etemad concerning essential oils quality, stability and analysis by the use of gas chromatography and mass spectrometry.

The Pars Industrial Research Company is on the good way to expire their production. The Company needs more information update concerning new technology for new products. Information concerning starch hydrolysis products are given in Appendix 8.
Schema of production HVP is given in Appendix 9. Aminoacid composition of HVP of various protein is given in Appendix 9.1.
Information concerning production of natural coloring pigment "betanin" from the red beet and its stability are given in Appendix 12.

ANNEX 5.9.

VISIT TO NOOSH PAJOUH FOOD INDUSTRIAL RESEARCH CO. and SASAN CO. and PARSI COLA PRODUCTION PLANT

The visit was made on April 23, 1994 with Mr. Niktabe, Iranian counterpart.
The Noosh Pajouh Food Industrial Research Co. is a private company managed by Mr. Firooz Jahani Avval who is the owner of laboratory and pilot experimental plant. The main field of activity is formulation of soft carbonated drinks and fruit juices; application of chemical and microbiological control systems in plants; advisory services and research concerning new products. Pilot plant has facilities for producing beverages and fruit juice. Mr. Jahani is very well educated person in the branch of food technology and food analysis. He has a good knowledge in the field of his activity. He could provide education and training people from the branch of soft drinks and fruit juices analysis.
In Iran there are 23 factories producing soft and carbonated drinks and 3 factories producing cola and orange base drinks.

The discussion which was held concerned application of Hazard Analysis Critical Point (HACCP) in the branches of soft carbonated drinks and fruit juices production. Some recommendation was given concerning analysis of aroma substances by the use of gas chromatography and mass spectrometry. The problem arisen concerning lactic acid contamination in apple juice produced by Fruit Juice Co. at Urmia, Azerbaijan was also discussed.

PARSI COLA

After visiting the Noosh Pajouh Food Co. visit was done to one of the biggest factory producing Parsi Cola in Tehran. Mr. A. Metghalchi - Vice President of SASAN COMPANY Soft Drink Manufacturer introduced us to all process of Parsi Cola production. Company produced one type of carbonated soft drink - Parsi Cola, capacity 600.000.000 bottles per year. The water used for Parsi Cola production is very good treated by chemical and filtered through activated charcoal. The CO_2 used for carbonation of the soft drink is produced in the plant by burning of diesel oil and next by purifying treatment. The purity of CO_2 is 99,97 per cent. The cola flavor was imported.

The Company needs technology for plastic one liter bottles manufacture for packaging carbonated drinks.

Information concerning water quality is given in Annex 7. Information concerning concentrated fruit juice making plant is given in Annex 7.

ANNEX 5.10.

VISIT TO BEHROOZ FOOD INDUSTRY

The visit was held on April 26, 1994 with Iranian counterpart Mr. M. Olizadeh.

The Behrooz food factory is located around 80 km from Tehran. The factory was build in 1977 and belong to the Behrooz Forotan Family. In the factory there are separate lines for production and canning of mayonnaise, tomato paste and green peas, baked peas, cucumbers, onions and fruit jam. The main products:

- mayonnaise	- 8.000 tons/year
- tomato paste	- 5.000 tons/year
- peas and beans	- 2.000 tons/year
- pickles	- 3.000 tons/year
- jam	- 1.000 tons/year

Total production amounts 30.000 tons/year. The main equipment for manufacture of the above items are made in Iran. From 15 to 50% of global production is exported mostly to Arabic countries.

The food factory is very good establish and good managed. The laboratory for microbial and chemical examination of the raw and final products was managed by Dr. M Malaki.

The discussion which was held concerning quality of the raw material and the methods of examination final products according international standards

ANNEX 5.11.

VISIT TO EDUCATION AND RESEARCH DEPARTMENT
MINISTRY OF JAHAD-E-SAZANDEGI
ISLAMIC REPUBLIC OF IRAN

The visit was made on 1 May 1994 with Mr. M.F. Kovats and Mr. M. Olizadeh, representing the Iranian counterpart.

Mr. M.T. Aman Pour - Deputy Minister of Education and Research Department introduced to the links of the Ministry with UNIDO and their requirements. The following projects were proposed in the field of agriculture and food branches with the technical assistance of UNIDO:

- Project for preparation of essence aromatic herbs and related raw materials
- Project to explore the development of edible oil extraction from wild pistachios
- Project on kilka fish processing
- Project for animal feed production
- Request for training courses in the country and fellowships for training abroad

Some information concerning animal feed production are given in Appendix 17.1.

ANNEX 5.12.

VISIT TO FOOD ENGINEERING DEPARTMENT, UNIVERSITY OF TEHRAN

Visit was made on May 1, 1994 with Mr. M. Alizadeh to the Professor Gh. Chams who is the Head of Food Engineering Department, University of Tehran.

Professor Chams introduced to education system of students in Food Engineering and the research which are provided with the students for M.Sc. and Ph.D. degrees. A lot of projects were done concerning food processing or related products. Some of them:

- Investigation of tea fermentation process
- Production of instant tea
- Extraction of eucalyptus oil
- Accelerating of glucose fermentation
- Detoxifying of almonds kernel.

The results obtained are not applied up to now in the practice, or some of them without of profits to University. There are needs to establish a links between the University and industry with the aid of extension services.

ANNEX 5.13.

VISIT TO FOOD AND DRUG CONTROL LABORATORY

The visit was made on May 2, 1994 together with Mr. Kovats and Mr. Niktabe Iranian counterpart.

The General Director of Food and Drug Control Laboratory Dr. Haghighi introduced to the organization and activities carried in the food and drug laboratories. There are two main divisions:

- Division for food and drug legislation and policy
- Division for control foodstuff and drugs

Food and Drug Control Laboratories employed 160 people with M.Sc. and Ph.D. degrees, and are equipped with all necessary apparatus for control food and drugs products. For control beverages and mineral water there is a separate laboratory. Food & Drug Control Laboratory organize courses 4-5 times in the year for employees from the industry. The laboratory provided control all kind of foods from 3000 food manufacturing plants.

Some problems concerning food contaminations by microflora, mycotoxins and heavy metals was discussed in details, as well as introduction of HACCP in food chain (Hazard Analysis Critical Control Point). The data concerning microbiological standards for various products are given in Appendix 13.

An example of HACCP application to catering cold chicken for salad is given in Appendix 14.

ANNEX 5.14.

VISIT TO AGRICULTURAL RESEARCH, TRAINING, EXTENSION ORGANIZATION - MINISTRY OF AGRICULTURE

The visit was made on May 3 and 4, 1994 together with Mr. Kovats and Mr. Niktabe, Iranian counterpart.

Mr. J. Alizadeh Shaegh - Deputy Minister introduced to the organization activity of the Agricultural Research, Training and Extension Services to farmers. There are a lot of farmers with small cultivated area and up to 1000 ha area. The average area of farmers producing rice is 1,5 ha. Discussion was held concerned the use of pesticide for plant protection, grain conservation and processing. There are 5-25% losses of agriculture products during handling and storage.

Mr. Hamid Tamizkar - Director of Bureau of Industrial Products introduced to the activity of food manufactures supervised by Ministry of Agriculture. There are some large Companies as Kesht and Santech Moghan; Jiroft, Haft Tappeh - producers of fruit juices, grape concentrated juice, sugar and meat processing.

ANNEX 5.15.

VISIT TO DAIRY FARM OF DAVOOD AFZALIAN NAINI, located near Tabeyik

The visit was made on April 22, 1994 with Mr. F. Kovats, Mr. A.A. Tofigh and Mr. A. Mirmohamadi.

The visited farm is located around 70 km from Tehran. In the farm there are 800 cows Holstem-Fresian breed, in which 700 cows are milking. In the farm is installed "milking parlon" for mechanical milking. The milk after milking is cooled in the tank to 8 or 10°C.

The feed for cattle is produced on the farm: alfalfa, hay and silage from chopped green maize. The farm is managed and controlled by veterinary service. Mr. Naini is owner next two farms; in one of them there are 1200 cows in which 800 cows are milking and in next farm there are 1400 cows in which 800 cows are milking.

It is recommended to make investment for installation plant for fresh milk making, different types of milk (Appendix 16 and 16.1), or small multi-product dairy plant for processing different kind of cheeses (molded fresh cheese, smoothed fresh cheese). The by-products as a result of the processing of certain products (whey from cheese, skim milk, butter milk) could be utilized in the farm or use for production whey proteins, lactose and other products (Appendix 5.1).

Some information concerning how to start manufacturing and a guide to small multi-product dairy plant are given in Appendices 16 and 16.1.

According the requirement of Mr. Naini in Appendix 18 are given information how to start organize cattle slaughterhouse.

Any inquire concerning to technical - economic guide should be sent to:

- UNIDO, Industrial Investment Division,
  Vienna International Center,
  P.O. Box 300, A-1400 VIENNA, Austria

or

- APV Pasilac AS, Pasteursvej, P.O. Box 320,
  DK-8600 Silkeborg, Denmark
  tel: +456824100 Fax: +456815611

It is suggest also to make a visit to Avonmore Foods plc. Company.
Avonmore Food plc. Ballyraget, Co Kilkeny, Ireland.
tel. (056)33155, Fax (056)33268.

<u>Recommended literature</u>:

1. John R. Campbell, Robert T. Marshall: The Science of Providing Milk for Man. Mc Grow-Hill Book Company, 1975.

ANNEX 6

The list of completed research projects:

1. Replacement of other imported edible oils with palm oil.
2. Manufacturing a chains of conveyor belts of the sugar, cattle feed and poultry industries.
3. Production of the oily acids.
4. Production of lecithin.
5. Make use of the tea wastes to produce cafein.
6. Survey on the possibility of enhancing performance of the calcium converted furnaces for sugar industries.
7. Production of cattle feed from the wastes of dates and third grade dates.
8. Alteration of alcoholic beverage lines to non-alcoholic beverage lines.
9. Reduction of the wastes of vegetable oil processing industries.
10. Replacement of imported chemical dyes by natural edible dyes.
11. Survey on the physical and chemical properties of milk weed and finding out the various applications thereof.
12. Effect of soya beans protein on the length of shortage of machine-made bread.
13. Production and consumption of alfa amilas in flour processing industries.
14. Survey on the possibiligy of replacement of non-alcoholic beverages by the gaseous traditional spirits.
15. Carriage of bulk flour in a correct and hydienig way.
16. Extraction of oily essences from the existing plants in the country.
17. Survay on the enhancement of quality of grape fruit in Iran.
18. Reparation of mono and diglissirides as emulsifiers in the vegetable oil industries.
19. Survay on the varous methods for preservation of all types of oil seeds.
20. Research project on the mode of recovery and use of the oil residue in the bleaching earth and the used catalyte.

ANNEX 7

J. Vet. Fac., Univ. Tehran, Iran
*(1970)***26** *: No. 4*

A Survey on the Quality of Water Used in Food Manufacturing Plants in Tehran

M. Malaki,o DVM and A. Nikforjam,oo MSPH.

Summary

A survey on the quality of water used in manufacturing plants in Tehran was carried out and the following results were obtained:

1- Out of 50 Food Factories, eight use the purified water supply of the city, one uses spring water and the rest use well or underground water. As the factories are mainly using the water from deep or semi - deep wells, the hygienic standards of these wells should be controlled by the authorities concerned.

2- Nearly all the wells contained very hard water and this is not suitable for food manufacturing due to the economical standpoint. Usually the water taken from the wells is not disinfected by the factory men. They believe snch water is already pure and sterile, but this is not so. The examination revealed that nearly all the specimens taken from such

* *Department of Food Hygiene.*

** *Public Health Engineering Division, Ministry of Health, Tehran*

water were contaminated with different types of bacteria.

3- The factory authorities have all the facilities for the chlorination of water disposal and nearly all of them claiming that this operation isa routine and it is daily done. However the results of the chemical analysis of water revealed no traces of chlorine in the water.

Due to the great importance of the hygienic standarnd of water used in food factories, it is recommended that more attention should be paid to the control of the water used.

References

1- Parker, M. E. and Litchfield, J. H. (1962) Food plant sanitation, ed., Chapman and Hall, Ltd., Lonbon, pp. 401.

2- W.H.O. (1963) International standard methods for water. pp, 79.

ANNEX 8

General aspects of establishing Advisory Extension Service

Extension services are based on four closely interrelated functions;

Research - Extension - Education - Marketing.

The research requires a strong links with extension services to carry its findings to the industry or agriculture and bring back their actual problems.

The main key objectives of Extension Service:

Extension service (extension officer) should organize appropriate follow up action strengthening R&D institutions, food processing industries through the integrated development of all sectors of the food processing and marketing.

Extension service should organize and conduct specialized training course to the engineering and management personnel in the food industry and provide technical and scientific information with assistance of national and international experts from different branches.

Extension service should liaise between the food producers and their customers in the retail and catering outlets to keep up to date with whole is happening in the market.

Extension services have to offer a range of services and financial subsides to help producers start-up and develop a new products.

Extension services in some countries are incorporated in one organization, or may be separately controlled by different organization. In USA, extension services are affiliated to the Universities and close cooperates with education and research. In Poland extension services was financed and established by Ministry of Agriculture for integration of educational programs, research and advisory services to the farmers, food producers and householders. In the Universities there are extension services as a part of administration unit to make a links between research, farmers and industry. The key food industry have been established own extension service units to have a link between industry, R&D institutions, farmers and marketing.

In Iran, some R&D units could be included to the chain of extension services, for example Noosh Pajouh Co. directed by Mr. Johani, who was very good links between his R&D unit and food processing plants.

ANNEX 9

THE SOCIETY OF THE CENTERS FOR SCIENTIFIC & INDUSTRIAL RESEARCHES OF IRAN

THE SOCIETY OF THE CENTERS FOR SCIENTIFIC AND INDUSTRIAL RESEARCHES OF IRAN COMMENCED ITS ACTIVITIES WITH APPROXIMATE MEMBERSHIP OF FORTY NON-GOVERNMENTAL CENTERS IN LATE 1365 (1986-87).AT THE PRESENT (SPRING OF 1372 (1993)) THE SOCIETY FOLLOWS UP ITS ACTIVITIES WITH 150 MEMBERS IN THE FOLLOWING FIELDS: CHEMICALS, PHARMACEUTCALS, POLLUTION CONTROL OF THE ENVIRONMENT,ELECTRIC AND ELECTRONICS,METAL INDUSTRIES ,FOODSTUFFS,NON-FERROUS MINERALS, MEDICAL ENGINEERING AND MISCELLANEOUS INDUSTRIES.

THE OBJECTIVES OF THE SOCIETY

1- LEADING AND PROMOTING DOMESTIC INDUSTRIAL RESEARCH CENTERS TO UNDERTAKE SCIENTIFIC AND APPLIED RESEARCH WORK.
2- MAKING EFFORTS TO EXPAND THE NUMBER OF RESEARCH CENTERS IN THE COUNTRY AND PROVIDING NECESSARY FACILITIES FOR THEIR RESEARCH WORK
3- CREATING REQUIRED COORDINATION AMONG THE RESEARCH CENTERS OF THE COUNTRY SPECIALLY AMONG THE LEGAL MEMBERS OF THE SOCIETY OF THE SOCIETY.
4- RENDERING NECESSARY FACILITIES FOR LENDING ASSISTANCE TO NATIVE RESEARCHERS.
5- CREATING LIAISON WITH UNIVERSITIES AND INSTITUTES OF HIGHER EDUCATION IN THE EDUCATIONAL & RESEARCH FIELDS.
6- PROVIDING ALL FACILITIES FOR LIAISON WITH INDUSTRIAL UNITS OF THE COUNTRY AND ALSO CREATION OF CONSTANT LINK WITH CONCERNED GOVERMENTAL CENTERS FOR ELIMINATING THE SCIENTIFIC, TECHNICAL AND INDUSTRIAL PROBLEMS IN INDUSTRIAL PLANNING.
7- PROVIDING LIAISON WITH THE DOMESTIC AND FOREIGN RESEARCH CENTERS THROUGH EXCHANGE OF INFORMATION AND RESEARCHERS,PARTICIPATION IN INTERNATIONAL AND DOMESTIC CONFERENCES , SEMINARS AND WORKSHOPS WITH A VIEW TO ENHANCING THE RESEARCH CAPACITY OF THE MEMBERS AND COORDINATION OF THE SOCIETY.

THE SOCIETY OF THE CENTRES FOR SCIENTIFIC AND INDUSTRIAL RESEARCHES OF IRAN HAS A NEWSLETTER,WHICH IS PUBLISHED MONTHLY.THIS PUBLICATION REFLECTS THE VIEWS OF THE SOCIETY IN ALL THE RESEARCH FIELDS AROUND THE COUNTRY. MEANWHILE, IN ORDER TO INTRODUCE THE EXECUTIVE CAPACITY OF THE MEMBERS,THE SOCIETY HAS ORGANIZED TWO SEMINARS IN LATE 1368 (1989) AND EARLY 1370 (1991)ON "ACQUIREMENTS OF NON-GOVERNMENTAL RESEARCH CENTRES."

APPENDIX 1

Iran STATISTICAL SURVEY

BASIC DATA

Total area

163.6m hectares, including 11% forest and scrubland, 9.2% under cultivation, 27% pasture

Population

57.8 million (1991 census); 61.5 million (1993 estimate)

Main towns

Population in '000 (1986 census)

Tehran	Meshhed	Isfahan	Tabriz	Shiraz	Ahwaz
6,043	1,464	989	971	848	580

Climate

Continental, with extremes of temperature

Weather in Tehran (altitude 1,220 metres)

Hottest month, July, 22-37°C (average daily maximum and minimum); coldest month, January, minus 3-7°C; driest month, July, 3 mm average rainfall; wettest month, January, 46 mm average rainfall

Language

Persian (Farsi)

Measures

Metric system. Some local measures are used including:

area:	1 jerib	=	0.108 hectare
capacity:	1 artaba	=	0.66 hectolitre
weight:	1 rey	=	11.88 kilograms

Calendar

The Iranian year begins on the spring equinox, March 21, and contains 31 days in each of the first six months, 30 days in the next five months and 29 in the 12th month (30 in every fourth year). The system relates to the *hijra*, the Prophet Mohammed's flight from Makkah in AD 622. The Gregorian equivalent can be found by adding 621 to the Iranian date. The Iranian year AH 1372 began on March 21, 1993, and runs to March 20, 1994

Currency

Rial (IR); IR10=1 toman. The government-managed floating rate was IR1,620.29:$1 in mid-June 1993. (On March 21, 1993, the government abolished the old official rate (IR70:$1) and the competitive rate (IR600:$1))

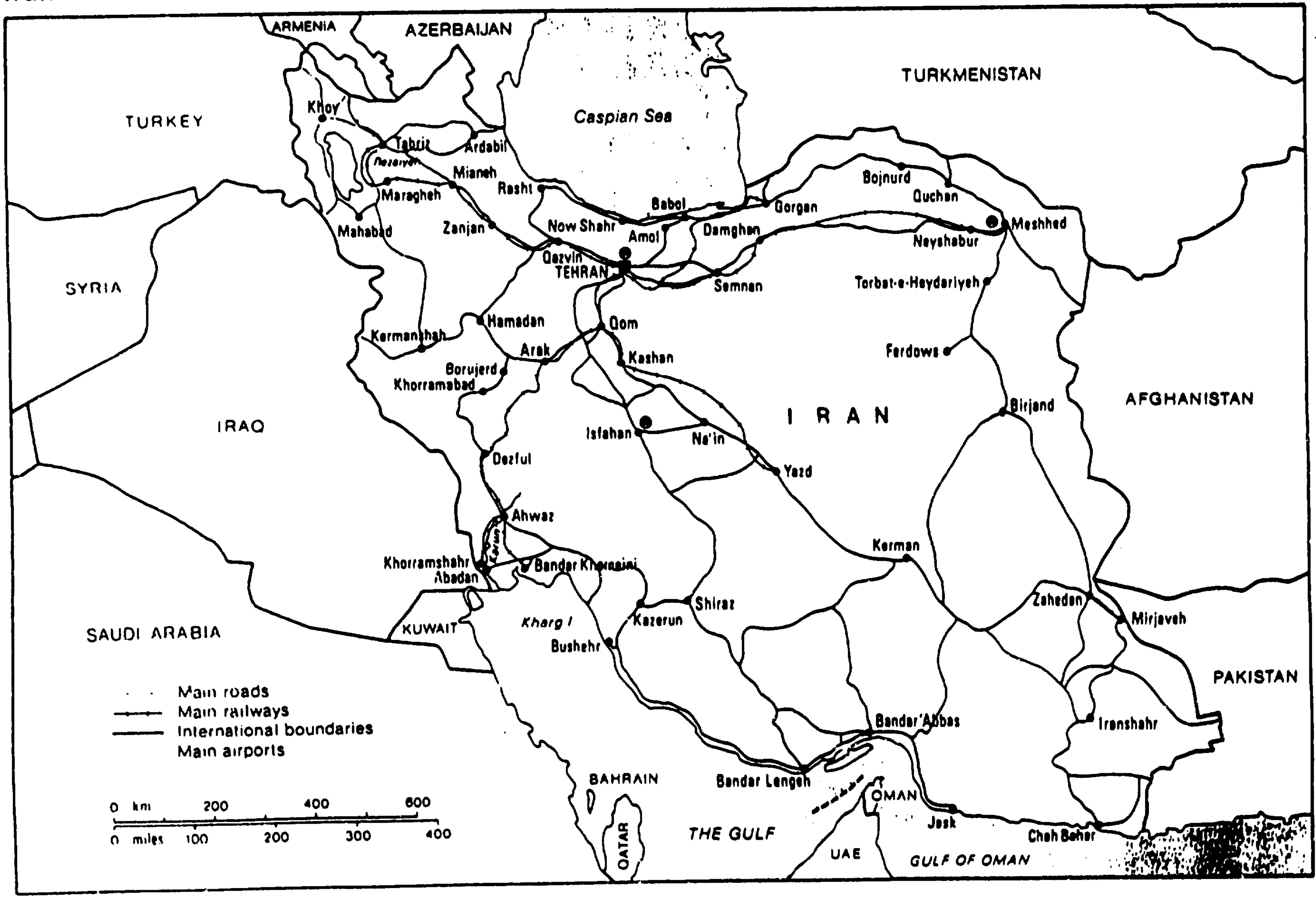
Time

3 hours ahead of GMT

Public holidays

Most holidays are religiously based and subject to change at short notice

Iran


ARMENIA
AZERBAIJAN
TURKMENISTAN
TURKEY
Caspian Sea
SYRIA
IRAQ
I R A N
AFGHANISTAN
PAKISTAN
SAUDI ARABIA
KUWAIT
BAHRAIN
QATAR
THE GULF
UAE
OMAN
GULF OF OMAN
Khoy
Tabriz
Rezaiyeh
Ardabil
Mianeh
Maragheh
Mahabad
Zanjan
Rasht
Now Shahr
Babol
Amol
Gorgan
Bojnurd
Quchan
Meshhed
Neyshabur
Damghan
Qazvin
TEHRAN
Semnan
Torbat-e-Heydariyeh
Hamadan
Qom
Kermanshah
Arak
Kashan
Borujerd
Khorramabad
Ferdows
Birjand
Isfahan
Na'in
Yazd
Dezful
Ahwaz
Karun
Khorramshahr
Abadan
Bandar Khomeini
Kharg I
Shiraz
Kazerun
Bushehr
Kerman
Zahedan
Mirjaveh
Bandar 'Abbas
Iranshahr
Bandar Lengeh
Jask
Chah Bahar
Main roads
Main railways
International boundaries
Main airports
0 km 200 400 600
0 miles 100 200 300 400

STATISTICAL SURVEY

Agriculture

PRINCIPAL CROPS ('000 metric tons)

	1988	1989	1990
Wheat	7,265	5,525	7,000
Rice (paddy)	1,419	1,852	1,400
Barley	3,394	2,750	2,700
Maize	6	7*	7*
Potatoes	1,433	1,295	1,450*
Pulses*	379	386	397
Soybeans	90†	90†	90*
Cottonseed	250	241	307†
Cotton (lint)	121	117	144†
Tomatoes	983†	690*	800*
Onions (dry)	612	635	700*
Other vegetables*	1,201	1,710	1,720
Watermelons	1,961†	925*	950*
Melons	1,307†	440*	450*
Grapes	1,743	1,320	1,500*
Dates	559	539	540*
Apples	1,351	1,246	1,250*
Pears	125	71*	71*
Oranges	1,169†	1,262†	1,262*
Other citrus fruits*	819	885	886
Apricots*	118	57	57
Other fruits*	1,020	734	680
Sugar cane	1,299	1,390*	1,750*
Sugar beets	3,454	3,535	3,535*
Almonds	64.2	60.0*	65.0*
Pistachios	126.3	130.4	125.0*
Walnuts	37.8	30.0*	35.0*
Tea (made)	56	46*	46*
Tobacco (leaves)	21	19*	21*

* FAO estimate(s). † Unofficial estimate.

Source: FAO, *Production Yearbook*.

IRAN

LIVESTOCK (FAO estimates, '000 head, year ending September)

	1988	1989	1990
Horses	270	270	270
Mules	127	126	126
Asses	1,760	1,740	1,720
Cattle	8,350	8,000	8,000
Buffaloes	230	230	230
Camels	27	27	27
Sheep	34,500	34,000	34,000
Goats	13,620	13,500	13,500

Chickens (FAO estimates, million): 110 in 1988; 115 in 1989; 120 in 1990.

Source: FAO, *Production Yearbook*.

LIVESTOCK PRODUCTS (FAO estimates, '000 metric tons)

	1988	1989	1990
Beef and veal	169	180	180
Buffalo meat	10	10	10
Mutton and lamb	234	241	241
Goats' meat	46	46	46
Poultry meat	255	260	265
Other meat	17	18	18
Cows' milk	1,754	1,680	1,750
Buffaloes' milk	38	38	38
Sheep's milk	725	725	735
Goats' milk	270	267	267
Cheese	114.6	112.3	114.7
Butter	73.3	71.2	73.5
Hen eggs	250	260	270
Honey	6.2	6.2	6.3
Wool*:			
greasy	32	32	32
clean	17.6	17.6	17.6
Cattle and buffalo hides	35.3	37.5	37.6
Sheep skins	39.0	40.2	40.2
Goat skins	9.1	9.3	9.3

* Unofficial estimates.

Source: FAO, *Production Yearbook*.

APPENDIX 2

Agriculture

ARABLE FARMING

GENERALS

BARLEY

Barley harvest was 2.719 million tonnes from a total cultiveted area of 2,140,000 hectares in the year ended 20 March 1988 (3.300 million tonnes in the year ended 20 March 1992). Average yield per hectare is 1,291 kilos, 2,200 kilos for irrigated plantatins and 746 kilos for dry farming land.

RICE

Cultivated area is about eight per cent of wheat-cultivated area. But its gross production value is over 20 per cent of the wheat total. Rice harvest was 2,049,000 tonnes in the year ended 20 March 1987. The rising price of rice since 1983 has led to an increase in rice planting. Rice price doubled in 1983 over the preceding year, and the increase in 1985 was 521 per cent as compared to 1979. There were further price rises in 1988 and early 1989. Rice harvest falls short of meeting the national demand by 450,000 tonnes a year, which has to be imported. Average yield per hectare was 2,834 kilos, 3,361 kilos, 3,715 kilos and 3,925 kilos in the years ended 20 March 1984, 1985, 1986 and 1987 respectively.

Iran's yearly imports of rice in 1991 has been 10 times as much as it was in 1971, though domestic production of rice has meanwhile increased by 230 percent. Agriculture experts ascribe the increase in consumption to the wider popularity of rice in Iran, government subsidies on rice, population increase, and an increase in the per capita consumption of rice due to higher wages and salaries in the lower income class. To compensate for the increase in consumption, they maintain, more farmlands should be devoted to the cultivation of rice and cultivation methods should be improved for higher yields and lower waste which happen at the various phases of cultivation and reaping. Rice paddies in Iran have a comparatively low yield because of the inadequate farming knowledge of growers, as well as limited water supplies.

An agriculture survey conducted in the Caspian Province of Guilan in 1990 said

Major Agricultural Items ('000 tns)

	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
Wheat	7556	7600	7765	6010	8547	8900
Barley	2505	2731	3394	2847	3747	3300
Rice	1784	1803	1419	1854	2273	2500
Sugar beets	4965	4456	3454	3535	3641	4900
Cotton	359	341	380	395	437	395
Meat	500	520	515	530	540	575
Chicken	390	390	390	440	416	425

Source: Central Bank of IRI

SOURCE: IRAN YERBOOK

that the province contained 220,000 hectares of rice paddies. The per hectare yield of the better type of indigenous seeds is 3,755 kilograms. In 1990 the total yield of rice paddies in the Guilan Province was upwards of 860,000 tons. The better class seeds produce between six and seven thousand tons per hectare. Experts, meanwhile, are trying to improve on traditional seeds. The 1992's yield for 220,000 hectares of rice paddies in Guilan was 900,000 tons. The total area of paddies in the province now is 600,000 hectares.

WHEAT

Wheat is cultivated in 50 per cent of all farm lands. Total cultivated area is 6,304,043 hectares according to latest statistics. Khorassan province had the highest wheat harvest of the total, 17.49 per cent, and Yazd province had the least, 0.23 per cent. Wheat harvest was 7.55 million tonnes, 7.571 million tonnes and 8 million tonnes in the years ended 20 March 1987, 1988 and 1989 respectively. The average yield per hectare was 1,070 kilos and 1,174 kilos in 1985 and 1986, 2,030 kilos in irrigated plantations and 774 kilos in dry farming plantations. Domestic consumption of wheat amounts to 10 million tonnes a year, the shortage of which has to be imported. Wheat imports amounted to 3,169,000 tonnes, 2,137,000 tonnes and 1,831,000 tonnes in the years ended 20 March 1985, 1986 and 1986 respectively. Consumption has particularly been rising since 1985, owing to rises in prices of potato and rice.

INDUSTRIAL CROPS

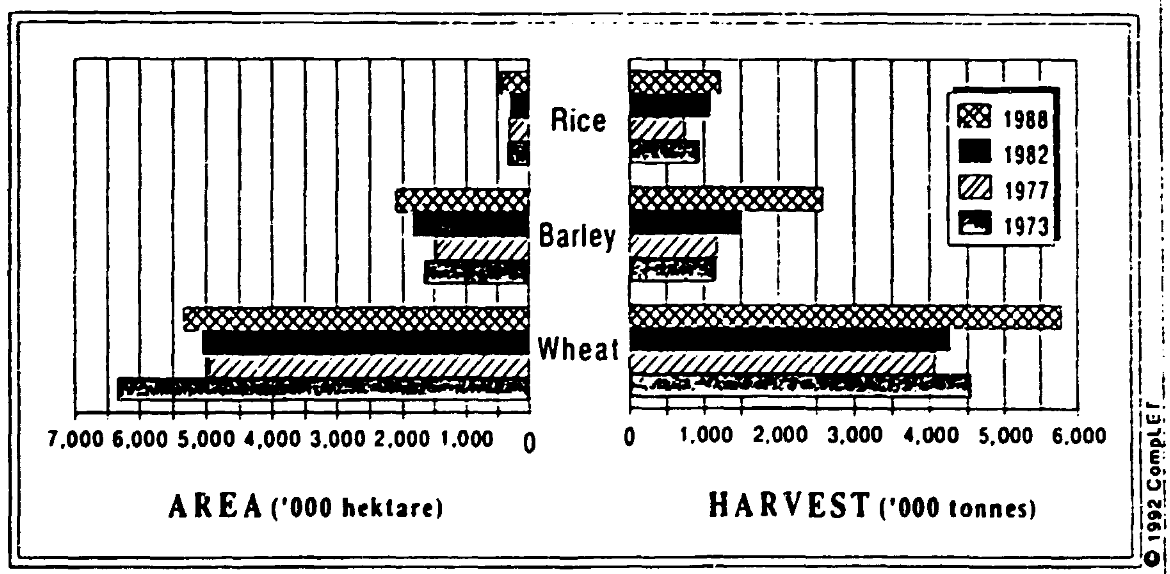
CANE SUGAR

Cane sugar plantations have shrank from 27,000 hectares in 1983 to 20,000 hectares in the year ended 20 March 1988 and the harvest has fallen from 2,174 tonnes to 1,420 tonnes in the period reported . The principal reason for the decrease is that cane sugar plantations are located in the war-hit Khuzistan province. The harvest in 1992 was 4.900 tonnes. Yield per hectare was 7,333 kilos in 1986, compared with 58,554 kilos of world average.

COTTON

Cultivated area was about 192,000 hectares in the years ended 20 March 1988 and 1989

WHEAT, BARLEY, RICE PLANTATION



Source: Statistics Center of Iran

and unginned cotton harvest was 350,000 tonnes. Cotton cultivation reached a peak in 1974-75, 396,000 hectares of plantations and 716,000 tonnes of harvest. Uncertainty about ownership of land pushed down production to as low as 63,000 tonnes in 1981, going up again as the result of government intervention.

Cotton plantations are located mainly in Gorgan, Gonbad, Khorassan, Fars, Dasht Moghan and Kerman. Seventy-five per cent of the cotton planted is of the first and second grade high quality American type, with fibres measuring 27-30 millimetres on average.

Sixty-nine cotton ginning plants are active throughout Iran, which were supplied 291,000 tonnes of unginned cotton in the year ended 20 March 1988. Unauthorised and manually operating plants took delivery of the rest of the harvest. Total output of ginned cotton in the year ended 20 March 1992 was 395,000 tonnes. .

SUGAR BEET

Sugar beet was cultivated in 176,588 hectares of land and its harvest amounted to 4,965,136 tonnes in the year ended 20 March 1988. The area under cultivation in 1989 is 175,679 hectares. The average yield per hectare was 28,051 kilos in 1986. Increased cost of production and the relatively low price paid by sugar factories for sugar beet had raised concern that cultivated area might be reduced. But government measures of supplying the growers with seeds, pesticide and fertilisers, and the rise in factory purchase price resolved the problem.

TEA

Area under cultivation was 32,026 hectares and green leaves harvest amounted to 199,244 tonnes in the year ended 20 March 1988. Tea drying plants, 100 in all, produced 46,000-tonnes of dried tea, 70 per cent of the domestic demand, in that year. Over 36,700 tea growers work on tea plantations in the Guilan and Mazandaran provinces.

TOBACCO

Area under cultivation of hookah tobacco is about 19,000 hectares and the harvest amounts to 23,000 tonnes. Cigarette tobacco is cultivated in 15,000 hectares of land with an annual harvest of 13,000 tonnes. Plantations are located in the Guilan, Mazandaran, Kurdistan and Isfahan provinces. A 1988 legislation has given the government to 20 years to eradicate tobacco growing and the production and distribution of tobacco products.

OTHER CORPS

BEANS AND PEAS

Beans are grown in most areas of the country. Western and north-western Iran however are notable for growing beans. Total cultivated area was 491,486 hectares and harvest amounted to 376,350 tonnes in the year ended 20 March 1988.

MELONS AND CUCUMBERS

Cultivated area was 473,516 hectares and harvest 6,570,723 tonnes in the year ended 20 March 1988. Surplus produce is exported to the Persian Gulf littoral states.

OIL SEEDS

Despite their importance, growing oil seeds has decreased owing to the reduced area of cotton cultivation and lack of sufficient government support. Area under cultivation was 103,305 hectares with total harvest of 137,174 tonnes in the year ended 20 March 1989.

PISTACHIO

Pistachio production amounted to the following figures for the Iranian years beginning 21 March (in tonnes): 1978, 60,000; 1982, 32,790; 1983, 36,000; 1986, 70,000; 1987, 60,000 tonnes; 1988, 65,000. Output began rising in 1989 and last through mid-1990s. Exports amounted to the following (in tonnes): 1978, 15,724; 1979, 4,354; 1982, 8,500; 1983, 12,820; 1984, 7,373; 1985, 17,677; 1986, 37,976; 1987, 54,653; 1988, 56,000.

The estimated area under cultivation in 1982 was 105,000 hectares, which rose to 127,000 hectares in 1984. Planting grows at the rate of 5-10 per cent annually. Kerman province comprises 90 per cent of the pistachio plantations. Qazvin and Damghan account for the remaining 10 per cent. But produce from the latter two is used for domestic consumption and in confectionery, while the Kerman pistachio is exported. The Rafsanjan Pistachio Growers Co-operative (*Ta'avoni Pesteh Rafsanjan*) was set up in 1968 with 200 members. It has 30,000 members now and effectively has absolute reign over the business, determining the domestic and export prices.

POTATO

Potato harvest amounted to 1,800,000 tonnes on average in the years 1985 through 1987, 25-30 per cent being wasted owing to pests, irrigation and storage problems. Potato price has fluctuated almost every year in the past few years, with lower price in a plentiful year followed immediately by higher price in the subsequent year of scarcity.

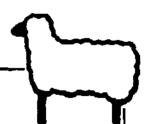
Cultivated area was 144,469 hectares and total harvest 2,348,992 tonnes in the year ended 20 March 1988, but scarcity reigned in early 1989. Average yield per hectare is 16,440 kilos in irrigated lands and 7,018 kilos in dry farming plantations.

SAFFRON

Iran is the biggest saffron growing country in the world. The home of saffron is southern Khorassan, where 6,750 hectares are under cultivation. The harvest amounts to 30,225 kilos, earning Rls 14,000 million in gross income. Average yield of dry saffron per hectare is between 5-10 kilos. But the government has plans to raise the yield and to promote its exports.

LIVESTOCK

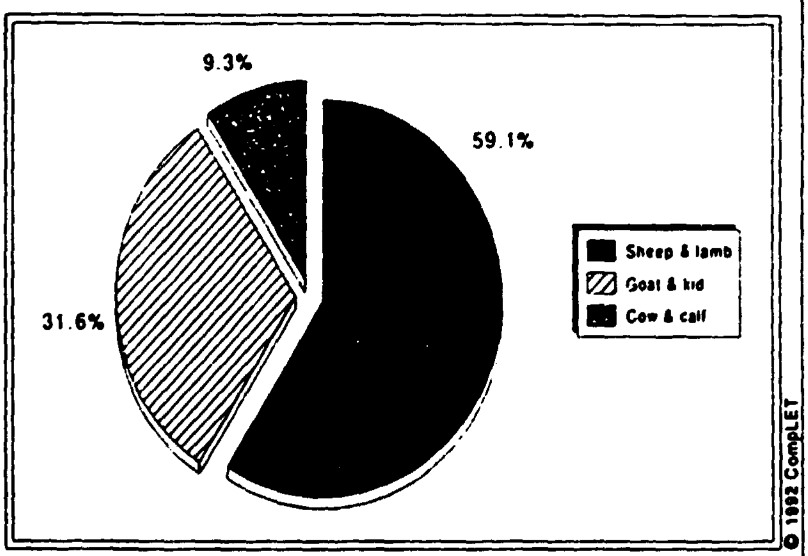
Livestock products form 35-38 per cent of the gross agricultural production value. The number of livestock throughout Iran is estimated at around 90 million, 70 million of which are sheep and goats. There are 10 million cows and calves, 6.7 million natives, 900,000 crosses and 350,000 thorough-bred.



The Agriculture Ministry issued permits for establishment and expansion of units to breed 150,000 thoroughbred cattle in the year ended 20 March 1989. More than 5,000 thoroughbred cattle were also imported and distributed to various provinces.

Several problems hamper the growth of livestock raising industry. These are:

LIVESTOCK



Source: Statistics Center of Iran, 1988 Census

- livestock raising is principally based on traditional methods, and the industrial livestock raising units hold only 1 million livestock;
- vast shortage of veterinary specialists;
- fodder shortage amounts to 20 million tonnes a year. In the year ended 20 March 1988, the area under cultivation of fodder was 740,803 hectares, and the harvest amounted to 5,995,228 tonnes. The government imports the various types of fodder, mainly in the form of concentrates. Fodder imports in the year ended 20 March 1986 amounted to 4,357 tonnes of concentrate, 20 tonnes of complementary nourishment and 10 tonnes of fodder plants.

Total area of pastures is an estimated 90 million hectares. Good pastures, 14 million hectares, have an annual harvest of 4,06 million tonnes (41 per cent of total) of dried fodder. Average and weak pastures, 60 million hectares, account for 5.52 million tonnes (55 per cent) and the remaining salty pastures, 16 million hectares, produce 0.42 million (four per cent). The annual output of dried fodder is about 10 million tonnes. Total output of pastures is sufficient for feeding 16 million livestock, while 60 million livestock (26 million belonging to migratory tribes and 34 million to other livestock breeders) rely on pastures for their feed. The big difference explains increasing ruining of the pastures.

MEAT AND DAIRIES

The problems of livestock raising evidently leave their effect on production of meat and dairies. Around 400,000-500,000 tonnes of red meat is produced domestically, and up to 700,000 tonnes is imported to meet the national demand. A total of 6,683,000 sheep and goats, 824,000 cows and buffalos and 59,000 camels were slaughtered in the official slaughter houses in the year ended 20 March 1987. Corresponding figures for the preceding year were 10,859,000, 1,123,000 and 50,000. Four million tonnes of dairies are produced a year.

Meat consumption in the country will be 760,000 tonnes in the year started March 1992, of which domestic supplies account for 560,000 tonnes,

The government has earmarked $300 million for meat imports for the remaining 200,000 tonnes. The five-year development plan aims to reduce meat imports through supporting local livestock breeders, providing them with banking facilities and guaranteeing the meat price.

Between March and November 1992, the government-run Iranian pasteurized milk plants purchased upwards of 400,000 tonness of raw milk from private dairy farms, up by 18 percent as compared to the same period last year.

The increase in supply of milk to the plants of the dairy industries has also marked a proportional increase in production of cheese. During the Iranian calendar year 1369 (March 21, 1990-March 20, 1991) monthly production of cheese averaged about 150 tonnes, which was improved during March-May by developing cheese processing plants at the neighborhood of milk plants. Since the start of the year 1991 as much as $10 million has been saved in dollar expenditures. Iran imports between 70,000 and 100,000 tonnes of cheese yearly, but the Iran dairy industries has proposed that imports of cheese be reduced and the savings be invested for purchase of cheese processing machinery from abroad. Three cheese processing plants are being built in the provinces of Golpaygan, Mazandaran and Khorassan which will become operational in 1993. The aggregate annual produce of the three plants will be 30,000 tonnes yearly which will help Iran cut down annual dollar expenditures for importing same by as much as about 40 million.

POULTRY

Modern poultry breeding in Iran dates back to 1954. There are 66 progenitor hen farms where the hens laid 84,835,000 eggs in the year ended 20 March 1986, but hatched only 49,916 chickens. Laying hens are bred in 700 farms, the output of which was 2,731 tonnes of eggs in the year reported. Broiler chickens are reared in 14,000 farms with monthly chicken meat output of 1,200 tonnes. One-day chickens are produced in 70 incubation farms, whose output was 25,310,000 chickens in the year reported.

Poultry feed and medicine shortage, imported at the rate of 90 per cent, is the main problem of breeding. A government restriction on imports of feed by official-rate foreign exchange in early 1988, increased the problems and pushed up the chicken meat price. In November however, import of feed using free market-rate exchange was authorised and government control on production and sales were lifted.

APPENDIX 3

STATISTICAL SURVEY

EXPORTS OF AGRICULTURAL AND TRADITIONAL GOODS TO DIFFERENT COUNTRIES

IRAN

Exports f.o.b. (excl. petroleum and gas)	1986/87	1987/88	1988/89
Agricultural and traditional goods	823.1	1,003.6	771.9
Carpets	390.1	484.8	307.8
Fruit (fresh and dried)	292.8	258.0	242.4
Animal skins and hides, and leather	66.6	110.5	77.6
Caviar	17.2	33.6	42.8
Casings	13.6	22.1	28.0
Others	42.4	94.6	73.3
Metal ores	27.2	35.3	29.9
Industrial manufactures	151.7	119.3	219.2
Shoes	1.5	4.3	0.2
Biscuits and pastries	0.7	0.3	0.5
Textile manufactures	41.7	33.7	20.2
Cements	—	—	1.7
Motor vehicles	2.6	2.1	1.9
Others	105.2	78.9	194.7
Total	1,002.0	1,158.2	1,021.1

Exports f.o.b.*	1986/87
France	14.4
German Democratic Republic	15.4
Germany, Fed. Republic	240.9
Italy	58.5
Japan	10.9
Netherlands	17.2
Switzerland	47.2
USSR	18.7
United Arab Emirates	138.9
United Kingdom	17.3
Total (incl. others)	778.7

* Excluding petroleum products and hydrocarb from petroleum.

IMPORTS OF AGRICULTURAL AND INDUSTRIAL GOODS FROM DIFFERENT COUNTRIES

APPENDIX 3a

Appendix 2 Trade of Iran with major partners[a] (continued)

monthly averages

$'000

	Germany[c] Jan-Dec	Jan-Sep	Japan[b] Jan-Dec	Jan-Sep	Italy Jan-Dec	Jan-Sep	UK Jan-Jun		France Jan-Dec	Jan-Sep
Exports to Iran, fob	1990	1991	1990	1991	1990	1991	1991	1992	1990	1991
Dairy products	2,706	2,271	-	-	7	13	15	22	14	237
Cereals & products	262	906	-	-	47	20	1,327	35	2	20
Petroleum products	423	416	584	75	2,511	11,877	481	1,010	2	1,543
Animal & vegetable oils & fats	1,412	905	1	-	116	5	30	112	284	49
Chemicals	34,896	27,572	10,801	9,344	12,666	9,449	9,137	6,912	7,391	8,512
Rubber manufactures	1,615	2,487	8,722	12,419	632	688	340	352	189	1,777
Textile yarn, cloth & manufactures	1,564	2,613	4,989	7,822	640	712	476	610	92	143
Iron & steel	21,151	30,455	27,087	20,203	14,490	12,803	6,087	8,746	4,549	6,408
Non-ferrous metals	2,896	4,368	314	668	1,155	2,768	309	589	63	231
Metal manufactures	5,830	9,178	4,486	7,524	5,519	10,968	1,602	2,994	625	543
Machinery, incl electric	82,507	151,083	54,141	94,956	39,710	69,348	35,346	47,422	11,904	28,270
Road vehicles	24,720	33,637	11,075	25,300	2,498	11,154	4,445	4,054	9,245	18,665
Other transport equipment	3,055	6,619	44	312	60	87	818	1,766	285	343
Scientific instruments, etc	9,276	10,458	4,504	6,670	3,311	4,803	6,190	6,840	1,809	1,725
Total, incl others	**218,161**	**313,097**	**134,769**	**195,058**	**91,015**	**142,317**	**71,879**	**89,889**	**49,753**	**74,203**

[a] Figures from partners' trade accounts. [b] Japanese imports from Iran averaged $254.2 mn and $215.8 mn per month for the period January-June 1991 and 1992. Japanese exports to Iran averaged $174.4 mn and $225.2 mn per month for the period January-June 1991 and 1992. [c] Includes the former East Germany from July 1990.

ALFA-LAVAL

APPENDIX 4

Plate heat exchanger
Type H7-RC

Application

Pasteurization, sterilization and general heating/cooling of dairy products, fruit juices and other food products. Operates with liquid/liquid and steam/liquid.

Working Principle

The heating surface consists of a number of corrugated channel plates clamped together in a frame and sealed at the edges by means of gaskets.

The plates have ports at the corners, and the gaskets are so arranged that the two media of the heat transfer process flow through alternate spaces between plates. The flow pattern is generally chosen so the two media are flowing in opposite directions, countercurrent flow.

One unit housed in a single frame can be made to perform several functions by inserting connecting plates with interchangeable connections into the plate pack to divide it into sections.

The frame consists of a frame head with two adjustable feet, an upper carrying bar, a lower guide bar, and a support column with two adjustable feet. The channel plates are suspended from a rail underneath the carrying bar. The pressure plate and connecting plates are suspended by rollers on the same rail. The plate pack is clamped together between frame head and pressure plate by means of four bolts with ball bearing washers.

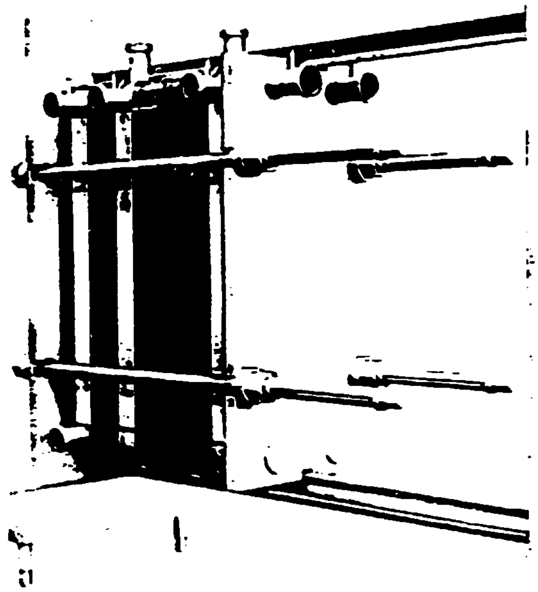
Dismantling and reassembly of the unit can be done by means of a standard wrench. However, the use of a special pneumatic tightening tool (available as optional equipment) makes this operation faster and simpler.

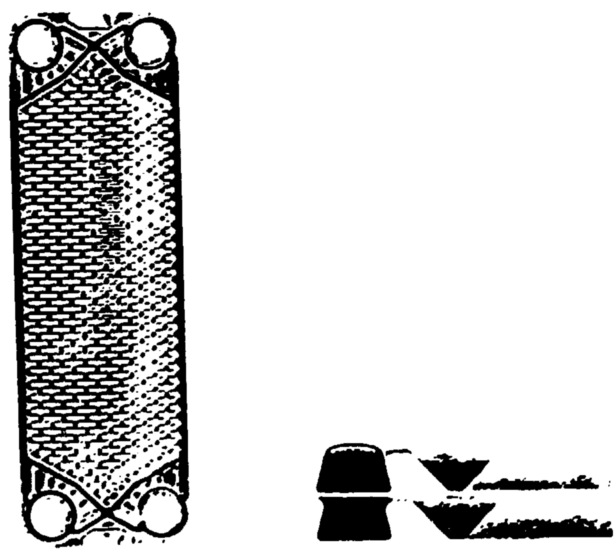
The plate ports are, wherever applicable, sealed by gaskets separated from the plate edge gaskets. There is also a drain arrangement to eliminate accidental mixing of the two media in case of gasket failure.

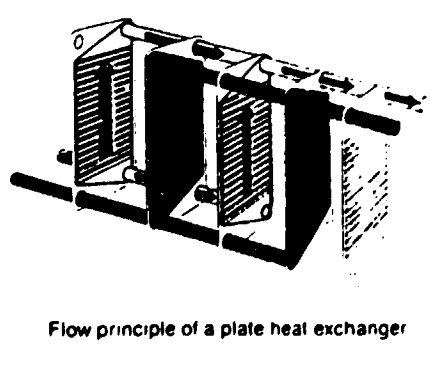
The plates are reversible, i.e. turning 180° (upside down) places their through ports on one side or the other, as required. This means only one type of plate is required. The plates are corrugated in parallel for rigidity and maximum heat transfer efficiency.

The gasket tracks have a dove-tail section, in which the snap-in gaskets are held firmly with no need for glue, and where they are well protected against attacks of aggressive cleaning solutions. Regasketing is fast and simple, done with the aid of a hand tool. (One tool supplied with each unit.)

The unit complies with the German standard for pressure vessels (AD-Merkblätter) or Swedish pressure vessel code.







Flow principle of a plate heat exchanger

Plate Heat Exchanger Type H7-RC

Basic Unit

Plates: Bright-annealed finish stainless steel — AISI 304, or AISI 316.

Gaskets: EPDM (standard) or nitrile (optional).

Frame: Frame head, pressure plate, carrying bar, and support column of mild steel, clad with glassblasted finish stainless steel. Carrying bar suspender rail, guide bar, bolts and washers, connecting plates, and feet of stainless steel.

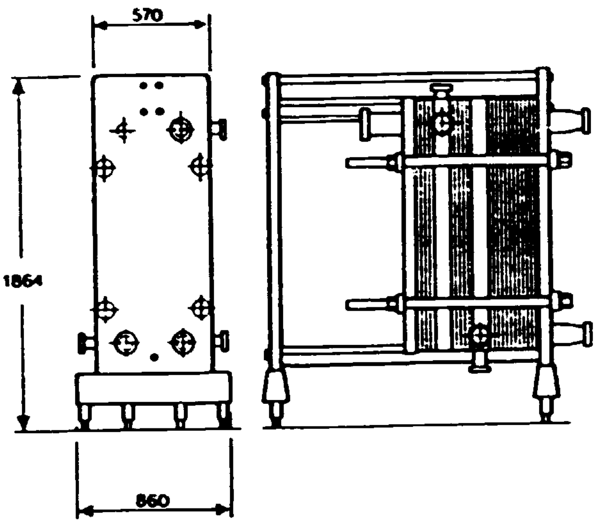
Technical Data

Plates	
Actual heating surface	0.40 m^2
Overall dimensions	1205x394 mm
Thickness (uncorrugated)	0.8mm
Weight, incl. gasket	3.4 kg
Port size	appr. 76 mm
Connections	76 or 63.5 mm, SMS/DIN male part (other union standard on request)

Max working pressure
1.0 MPa over pressure

Capacity	
Heating/cooling	80,000 l/h
Pasteurization	30,000 l/h

Dimensions (mm)



Overall length varies depending on number of plates and connecting plates.
Required free space around the unit is one metre at sides and frame head end.

Optional Equipment

Standard wrench
Pneumatic clamping tool, continuous torque type
Gasketing tool
Thermometers (through passes in connection plates)
Protective shielding
External holding cell, spiral type
External holding cell, tubular type

APPENDIX 5

MEMBRANE FILTRATION

By Werner Kofod Nielsen, APV Pasilac AS

INTRODUCTION

For many years, membrane filtration and membrane filtration processes separating molecules and ions of various sizes were regarded as a laboratory rarity.
In fact, membranes for dialysis and osmosis have been known since 1877 when Pfeffer demonstrated the semi-permeability of a hog's bladder, thus illustrating the principle of osmosis. Later on, cellophane and collodium membranes came to be used in dialysis. As early as 1863, the dialysis process was used in the sugar industry for removal of salt from molasses. However, this proved not to be profitable and it was not until the 1950s when pressure-driven membrane processes were considered to be viable that the development of membrane filtration processes began in earnest.
In 1953, C.E. Reid [1], professor of the University of Florida, suggested to the Department of the Interior that part of the US programme for desalination of sea water should be directed towards the study of reverse osmosis. However, the problem was that, even with pressure-driven reverse osmosis, the process was still not profitable because the fluxes were very low.
But in the early 1960s, Loeb and Sourirajan [2], [3] at the University of California, Los Angeles, produced the first membrane based on cellulose acetate which had reasonable fluxes and which provided for a reasonable degree of salt rejection.
After this great step forward, the US government, through the Office of Saline Water, strongly supported the development of processes for desalination of sea and brackish water.
Considerable progress was made during these first years, but it also became apparent that the difficulties were greater than first expected. The main problems were to obtain a reasonable lifetime of the membranes and to avoid severe fouling. This problem was investigated by Merten [4] during the 1960s.
During the same period, the groundwork was laid for the various membrane system designs such as plate-and-frame, spiral-wound, tubular, and hollow fine fibres, and on the basis of Loeb and Sourirajan's work, the concept of asymmetric membranes was further developed.
All this development work was carried out in the US, supported by government grants to promote the development of processes that would turn sea water into fresh water.
In Europe, a number of commercial enterprises became interested in the reverse osmosis process, one of them being DDS (The Danish Sugar Corporation). In 1969, Madsen and Olsen

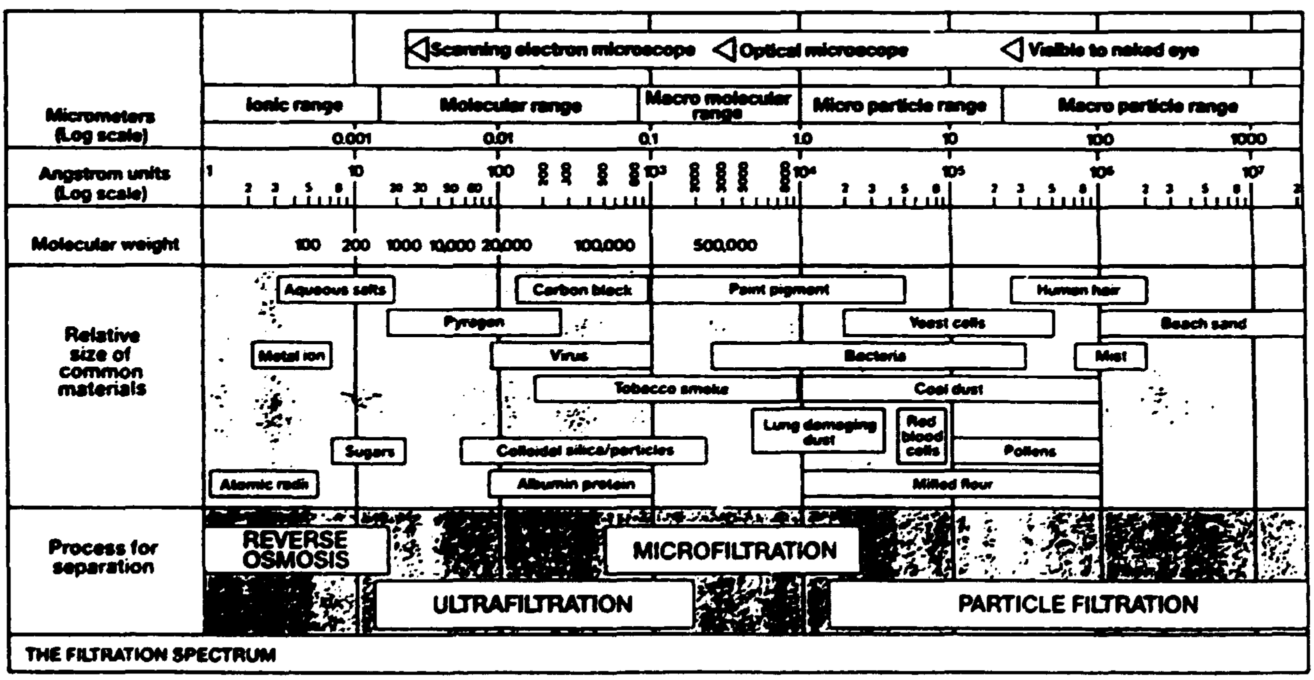


Fig. 1. "The Filtration Spectrum" illustrating the size and character of a number of particles which can be separated by filtration processes.

Membrane filtration processes are rapidly becoming increasingly interesting to a wide variety of industries: from the food and beverage industries to entirely new biotechnological industries.
Today, membrane filtration is a far cry from the laboratory rarity that it was long considered. The past 25 years have seen a very successful development of membrane filtration equipment and processes, not least in the dairy industry, which was one of the first industries to realize the potential of this technique.
Today, the two most important filtration processes are *ultrafiltration* (UF) and *reverse osmosis* (RO). In the dairy industry, the primary raw materials are *milk* (whole milk or skimmilk) and whey, and both types of filtration processes may be applied to both kinds of raw materials. Typically, however, the following combinations apply:

- MEMBRANE FILTRATION OF MILK:
  Ultrafiltration for protein standardization, for production of cheese and protein powder, or for concentration of buttermilk.
  Reverse osmosis for concentration of milk and buttermilk.
- MEMBRANE FILTRATION OF WHEY:
  Ultrafiltration for production of whey protein concentrate.
  Reverse osmosis for concentration of whey.
  Nanofiltration (NF) (reverse osmosis with a more open RO membrane) for concentration and demineralization of whey.

For both types of raw materials, the question of the best possible utilization of the permeate is also important.

- The UF PERMEATE may be used for concentration by RO, for demineralization by NF, for production of all grades of lactose or for hydrolysis of lactose (sweeteners). It may also be used for fermentation (ethanol/methane production), or for feed.
- The RO PERMEATE may be used directly for CIP.
- The RO PERMEATE may also be subjected to further treatment by reverse osmosis for production of CIP water, etc. The EVAPORATOR CONDENSATE and RINSING WATER from the CIP unit, too, may undergo further treatment by means of reverse osmosis, ie, for production of CIP water and reduction of the BOD load. These processes are examples of reverse osmosis for environmental purposes.

In all these areas, the expertise of APV Pasilac AS is among the best in the world, and therefore we have decided to issue a series of *Marketing Bulletins* describing the present state of development of membrane filtration.
In the current issue, we trace the development of membrane filtration processes and equipment. What exactly is understood by the general concept of membrane filtration, and by specific concepts such as osmotic pressure, transport properties and concentration polarization? What exactly characterizes the different filtration processes?
As far as equipment is concerned, we look both at the membrane side, including aspects of membrane structure and materials, and at the many possibilities that exist as regards modules – both in the plate-and-frame system and with spiral-wound elements.
Furthermore, we discuss some of the basic aspects of general plant design, modern control systems and, above all, of correct cleaning of membrane filtration plants.
Finally, we look at some of the areas of application that exist for membrane filtration processes in the dairy industry.
The discussion in the following pages demonstrates that the role of APV Pasilac AS as a pioneer of both processing equipment and processing methods in relation to membrane filtration is as significant as ever.

Aarhus, June 1990

Per Nielsen

APPENDIX 5

MEMBRANE FILTRATION FOR FRESH CULTURED CHEESE

By P. Sæderup Nielsen, APV Pasilac AS

INTRODUCTION

In traditional cheesemaking, the milk is first coagulated by addition of starter culture and rennet. The concentration takes place when the whey is drained off and the curd forms. This whey contains approximately 25% of the protein content and approximately 10% of the fat content of the milk. This means that, in traditional cheesemaking, only about 75% of the protein content and about 90% of the fat content of the milk is utilized.
For most cheesemaking by means of ultrafiltration (UF), the milk is first concentrated by ultrafiltration and only then follows the starter culture and rennet-induced coagulation. In a total concentration process this means that the following utilization of the feed-product is obtained: a 100% utilization of the fat content and a 95% utilization of the protein content of the milk.
In addition to large savings in milk consumption, UF-based cheesemaking also entails considerable starter culture and rennet savings. Furthermore, with ultrafiltration it is possible to produce a number of products that cannot be produced by means of traditional processes.
There are a number of different ways of using the UF technique in cheesemaking.

- *Protein standardization* to 3.6 - 4.0% protein. This technique entails that, all the year round, a more homogeneous and constant cheese quality is obtained and that the loss of casein fines is reduced.

- *Pre-concentration* prior to traditional cheesemaking. This technique can be used for a wide variety of cheeses, and the typical pre-concentration is twofold concentration. Twofold pre-concentration means that the capacity of the traditional cheesemaking equipment is doubled and that the consumption of starter culture and rennet is halved.

Fig. 1. Examples of fresh cultured cheese and quarg dessert produced by ultrafiltration

- *Part-concentration* to between 20% and 40% total solids. This technique is mostly used for open-structure cheeses and requires untraditional cheesemaking equipment such as dosing, mixing, coagulation, cutting, and continuous after-treatment equipment.

- *Total concentration* to a total solids level which is identical or almost identical with the total solids content in the final cheese. This technique is the most profitable as the whey proteins are fully utilized. It is mostly used for closed-structure cheeses. In this case, too, untraditional cheesemaking equipment is required: dosing, mixing, coagulation, and moulding equipment.

This issue of the *Marketing Bulletin* is devoted to a discussion of the production of fresh cultured cheeses by means of ultrafiltration for which the *total concentration* technique is the most immediately interesting.

PRODUCTS

The concept of *fresh cultured cheese* as discussed in this *Marketing Bulletin* covers a wide variety of cheeses of which the best known are *quarg, baker's cheese, pâte fraiche*, and *cream cheese*. Their common denominator is that they are all made from fresh, cultured skimmilk, whole milk or cream and that they are all consumed without any further ripening. Instead, they are used directly for consumption, for domestic and industrial cooking and baking, or as a raw material for dessert production. Although the basic products are more or less the same, they are produced with large variations in their contents of non-fat milk solids and fat. These variations are usually determined by the geographical origin of the product in question.

Fresh cultured skimmilk cheese

This type of cheese (TS with a maximum of 2% fat in TS) is produced in many different varieties and under a variety of names:

West Germany:	*Quarg* with a minimum of 18% TS
Austria:	*Topfen* with a minimum of 20% TS
England:	*Skimmilk soft cheese* with a minimum of 20% TS
United States:	*Baker's cheese* with a minimum of 22% TS
France:	*Pâte fraiche* with a minimum of 14-18% TS
Soviet Union:	*Tvorog* with a minimum of 20% TS
Denmark:	*Quarg* with a minimum of 16% TS
Iceland:	*Skyr* with a minimum of 18% TS

Fresh cultured cheese with fat

These cheeses vary greatly as regards their contents of total solids and fat in total solids: They are produced with

- between 18% and 40% TS and between 10% and 50% fat in TS.

In traditional production, the starting point for all such cheeses is normally the skimmilk products listed above to which the necessary quantity of cultured cream is added. UF products can also be made by this process, but normally their production will be based on concentration of cultured, standardized whole milk, which gives a more homogeneous product.
Other varieties include products to which fruits, vegetables, flavours, etc. are added or products which are whipped with N_2 or CO_2 for production of desserts.

Cream cheese

Cream cheese is normally produced with the following composition:

- 45% TS and 70% fat in TS

However, in spite of all the many variations, all these cheeses - be they skimmilk cheeses, cheeses with fat or cream cheese - share a number of characteristics: their colour is white to yellowish, their consistency smooth and pasty without being too dry and grainy, and they are easy to spread. Finally, their flavour is fresh and acidic and their pH-value normally lies between 4.5 and 4.6.

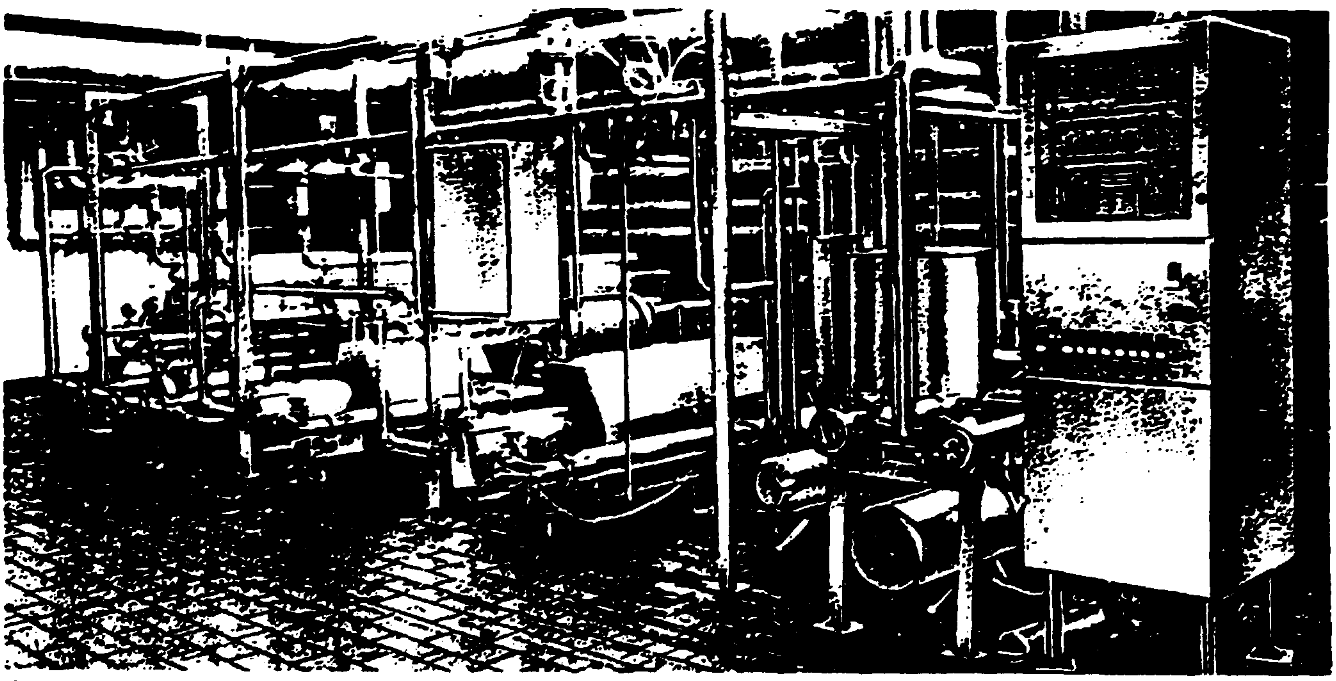


Fig. 2. Ultrafiltration plant at Moha, West Germany.
Products: quarg (18% MSNF), quarg desserts, and quarg with fat. Capacity: 1,700 kg/h

Fig. 3. Module 37 with intermediate flange.

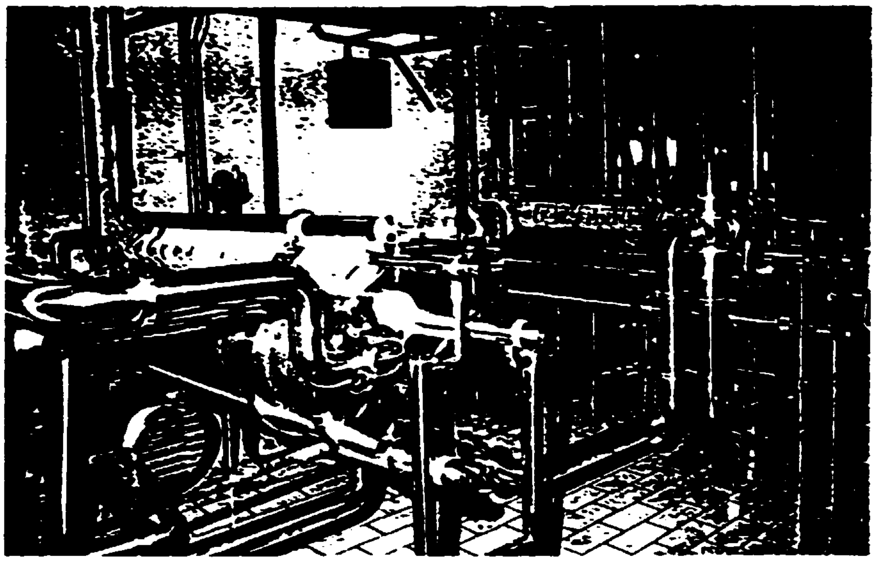


Fig 4. Ultrafiltration plant in France for production of pâte fraîche and protein standardization (camembert and liquid milk).

PROCESSING

Before the ultrafiltration process was developed, these fresh cheeses were produced either by means of the traditional separator process or by means of the traditional separator process with heat-treatment of the feed.
However, since the ultrafiltration process was introduced into the dairy industry around 1971, these fresh cheeses have been an obvious choice for production by means of ultrafiltration. Over the years, various methods have been tried:

- Total concentration of fresh or slightly pre-ripened milk or cream with subsequent culturing of the retentate.
- Recovery of whey proteins by means of ultrafiltration of acid whey with subsequent re-dosing of the proteins into the cheese.
- Total concentration of cultured milk or cream at pH 4.5-4.6 to the final total solids content in the cheese.

Concentration of fresh milk or cream

Concentration of *fresh* milk or cream with subsequent culturing of the retentate results in a cheese with the so-called "UF taste" a bitter taste which is caused by the concentration of calcium salts. This cheese also has a more greyish colour.
If the milk or cream is *slightly pre-ripened* (to pH 5.8-5.9), a larger part of the calcium salts become soluble and can be removed with the permeate. It is also possible to use electrodialysis for calcium removal, or to add citric acid and NaOH to the milk for the formation of calcium-citrate complexes which can then be removed with the permeate.
The cultured retentate has a very high viscosity, and therefore special fermentation tanks and agitators are required for the cultured cheese to be stirred and packed.
With the introduction of additional types of machinery such as special fermentation tanks and, possibly, electrodialysis plants, products of reasonably good quality were obtained. However, this also meant increased investments and, even then, the quality never came up to the standard of the cheese manufactured by means of the traditional separator process. The cheese still had a greyish colour and a bitter taste.

Concentration of whey

The second method entails that the lactic acid whey produced by means of the traditional separator process is concentrated by ultrafiltration to the total solids content in the cheese and then dosed back into the cheese, possibly also with addition of stabilizers.
With this method, the quality of the finished cheese is almost identical with that of traditionally produced cheese.
This method, too, requires that considerable investments are made. In addition to the investment already made in a separator processing line, the concentration of the whey also requires investment in an ultrafiltration plant. Moreover, the necessary pasteurization, homogenization and dosing equipment must be available for treatment and dosing of the whey retentate in order to obtain the right consistency in the finished cheese.
Finally, it should be noted that, to prevent the finished product from becoming too soft, only 50% of the treated whey retentate can be dosed back, and that this process has not been used for the production of cream cheese.

Concentration of cultured milk or cream

This method overcomes the problems of the first two methods. Above all, basing the production of fresh cheese on ultrafiltration of cultured milk or cream means that the flavour and consistency problems can be avoided. Indeed, through a change in the processing parameters during pre-treatment and/or after-treatment, it is possible to obtain exactly the required flavour and consistency in the finished product.
Furthermore, with this method, a considerable additional yield is achieved and it is possible to base the production of these cheese types on skimmilk powder and butter oil in the shape of reconstituted skimmilk or recombined whole milk or cream. Acid buttermilk can also be used for production of, eg. buttermilk quarg.
Quarg made by ultrafiltration is more smooth and creamy than traditional quarg. It creates the impression that it contains more fat than traditional quarg with the same fat content. In fact, most people consider both the taste and the overall impression of UF quarg to be better than that of traditionally produced quarg.

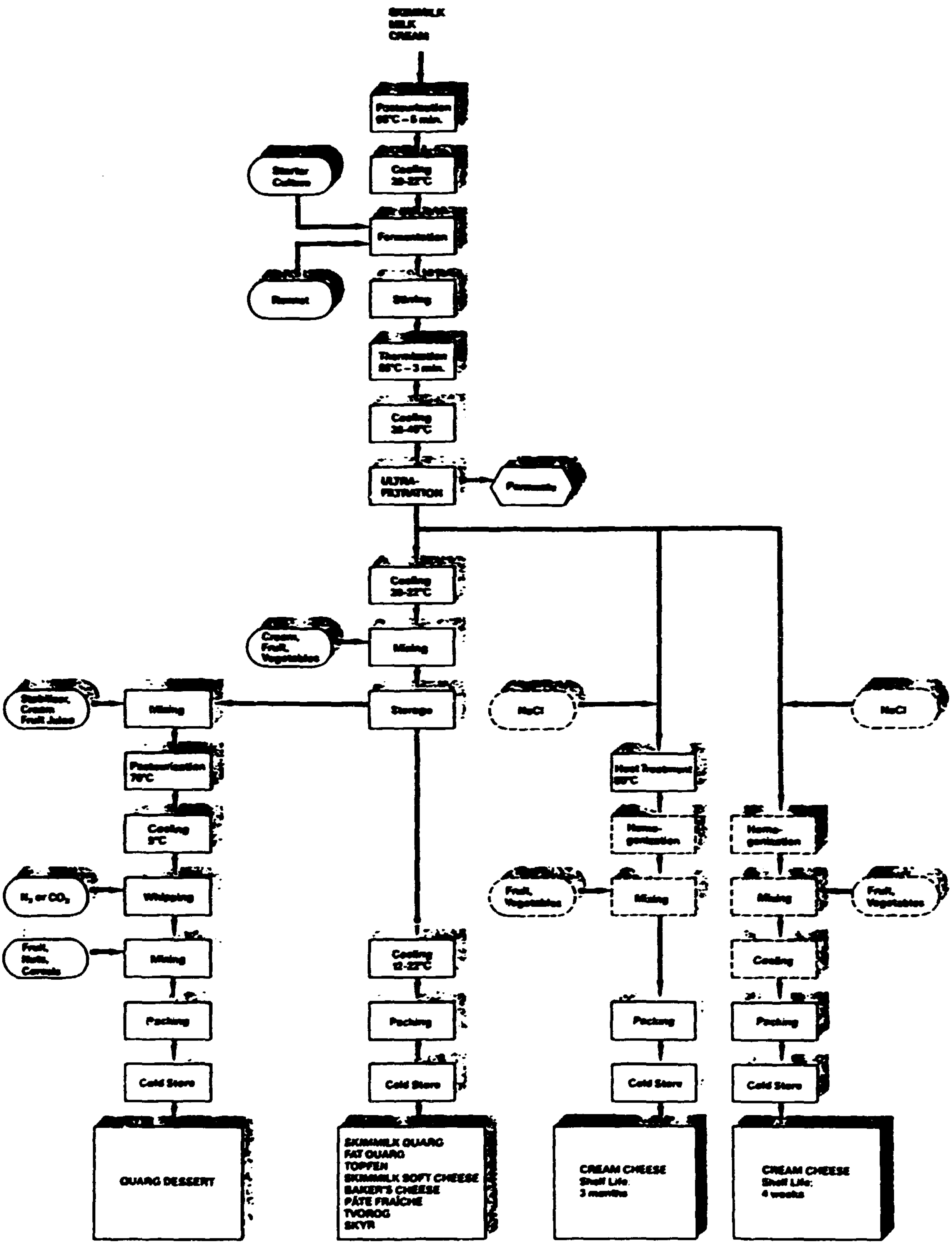


Fig. 5. Production processes for skimmilk and fat quargs, quarg desserts and cream cheese.

Figure 5 shows the processes that are involved in the production of *skimmilk and fat quargs, quarg desserts*, and *cream cheese* by means of ultrafiltration. The figure shows that the processes are largely identical for the various products - only during after-treatment will there be a difference in the required processing.
Fresh cheese with fat can be produced - as it is done by the traditional method - by dosing cultured cream into the skimmilk retentate, or it can be produced by concentration of cultured whole milk. For cheeses with fat that are to be manufactured by ultrafiltration of cultured whole milk or cream, the fat percentage should be standardized in relation to the protein percentage in order to obtain the correct solids and fat content in the final cheese.
Skimmilk, standardized milk or cream is pasteurized at 95°C with a holding time of 5 minutes. This high-temperature treatment improves the stability of the finished product. After pasteurization, the feed-product is cooled to the incubation temperature of 20-22°C. Starter culture and rennet are added, and after about 16-18 hours, the pH value of the feed-product will be 4.5-4.6. The coagulum is then stirred to a smooth and homogeneous product.
Next, the cultured product is thermized at 55°C for 3 minutes. This thermization serves partly to improve the shelf life of the finished cheese, partly to increase the capacity and partly to obtain a constant flux in the ultrafiltration plant.
Further, the feed-product must be cooled to 38-40°C, at which temperature it is led to the ultrafiltration plant where it is concentrated to the desired total solids content.
As far as cream cheese is concerned, it should be noted that one of the advantages of using the ultrafiltration process is that this process is much less sensitive to variations in the pH-value of the cream than the traditional separator process. No pH adjustments or deaeration are needed.
When the retentate leaves the ultrafiltration plant, the after-treatment will, as shown in figure 5, vary according to whether the end product is going to be *quarg or similar products, quarg desserts* or *cream cheese*

After-treatment of quarg or similar products

If the production of quarg or similar products with fat is based on concentration of skimmilk, the desired amount of cream must be added to the skimmilk retentate before the final cooling.
By subjecting the retentate to different kinds of temperature treatment before storage, it is possible to control the texture and stability of the final cheese. Usually, the cheese is cooled to 12-14°C and then packed at this temperature. The final cooling takes place in the package in the cold store. If, however, the cheese is packed at 20-22°C and subsequently cooled slowly in the cold store, the result is a firmer product which is used by, for instance, bakeries. Various flavours, fruits or spices can be added before the final cooling and packing.

Production of quarg desserts

The presence of water-binding and stabilizing whey proteins in UF quarg makes this product very suitable for production of whipped quarg desserts with different additives such as fruits, spices, cereals, etc.
After the first cooling to 20-22°C, the quarg is mixed with stabilizer and, if desired, with cream, fruit juice, etc, and then it is pasteurized at 70°C. The quarg is cooled to 5°C and whipped with N_2 or CO_2 to an overrun of 30-50% in a special product/air mixer. Before packing, the whipped quarg can be mixed with fruit, nuts, cereals, etc.

After-treatment of cream cheese

Cream cheese can be subjected to various kinds of after-treatment depending on the required texture and shelf life of the finished product.
The most simple after-treatment consists of packing the cream cheese directly from the ultrafiltration plant with subsequent cooling in the package. This type of after-treatment gives a cream cheese with a very short body and a shelf life of about four weeks.
The cream cheese can also be heated to 80°C in a scraped surface heat exchanger and packed at this temperature. This process will increase the shelf life to three months.
If a more firm and homogeneous cheese is wanted, it is necessary to homogenize the cheese

PROCESSING PLANT

When fresh cheeses such as quarg, baker's cheese, pâte fraiche and cream cheese are to be produced by means of ultrafiltration, the first requirement of a successful production is that the correct ultrafiltration modules and membranes are used
In the APV Pasilac system, the UF module, type 37, is used (Figure 6) This module has been developed specially for high-viscosity products and has been

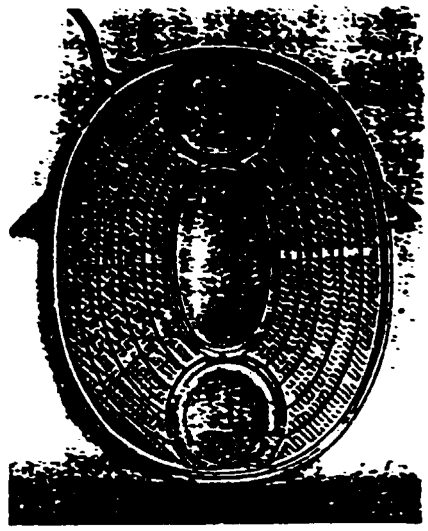


Fig. 6. Support plate for module 37

fully commercially tested. It is manufactured in a variety of sizes from 1.65 to 2? m^2 membrane area.
In module 37, the middle part of the plate has been removed so that the product flows in only 10 channels on either side of the plate. The channels have different heights: the inner channels are 1.1 mm high and the outer channels are 1.8 mm high. These channel heights have been chosen on the basis of a study of the rheological properties of different high-viscosity dairy products, including the fresh cheeses that are discussed here. Thus, the channel heights of module 37 give almost the same flow in all channels at the same pressure drop and prevent blocking of the flow channels.
The type of membrane used for these products is the GR 60 PP type, which is made of polysulphone and cast onto polypropylene paper. This membrane has high mechanical strength as well as a high temperature (0-75°C) and pH (1-13) range. Two membranes, each of 0.055 m^2, are fitted on each support plate. This means that visual inspection of a membrane area of 0.11 m^2 is possible during production and that, in case of a leaking membrane, it is only necessary to replace an area of 0.22 m^2
The same modules and membranes are used for production of all fresh cheeses that are based on ultrafiltration of cultured milk or cream. Both modules and membranes have been approved by the health authorities in a great many countries
Module 37 can be divided by intermediate flanges with inlets and outlets in such a way that the whole module is used for concentration of low-viscosity products. When high-viscosity products are concentrated, only the first part of the module is used (Figure 3)

This means that the ultrafiltration plant can be dimensioned and constructed in such a way that it is possible to make all fresh cheeses on the same ultrafiltration plant.
Because of the high viscosity of these products, the ultrafiltration plant is normally equipped with positive pumps as booster pumps in the last part of the plant. The high viscosity also entails that the continuous control of the total solids content takes place by measuring the electricity consumption of the positive pump at the last module.
The equipment for pre-treatment and after-treatment normally consists of plate or tubular heat exchangers, tanks, dosing pumps, etc, except in the case of cream cheese and other products with a high fat content for which a scraped surface heat exchanger is needed for heating and cooling. For the production of whipped desserts, a product/air mixer is needed.
Finally, the high flexibility in module size and number and the possibility of reducing the operating area of the module by means of an intermediate flange mean that it is possible to build just one ultrafiltration plant for all desired capacities and product varieties.

PROCESSING ECONOMY

On the question of processing economy, comparisons between the traditional separator process and the ultrafiltration process are usually based either on the savings in skimmilk and fat or on the extra yield that may be obtained.
The consumption of skimmilk or the yield of quarg depends on the protein content of the skimmilk. *Figure 7* shows the relation between the *protein content in the skimmilk* and milk consumption. The lower the protein content, the higher the milk consumption and vice versa.
The required total solids percentage in the quarg is also important for the yield. *Figure 8* shows the relation between the *total solids content in the quarg* and milk consumption. The higher the total solids percentage in the quarg, the higher the milk consumption at a specific protein content in the skimmilk.
The consumption of milk also depends on the required fat percentage in the quarg. *Figure 9* shows the relation between the *protein content in the milk* and milk consumption at three different levels of fat content and a constant level of total solids. The figure also shows the fat content in the standardized milk before ultrafiltration. With increasing fat content in the quarg, the milk consumption decreases, but, at the same time, the fat content in the milk must be raised

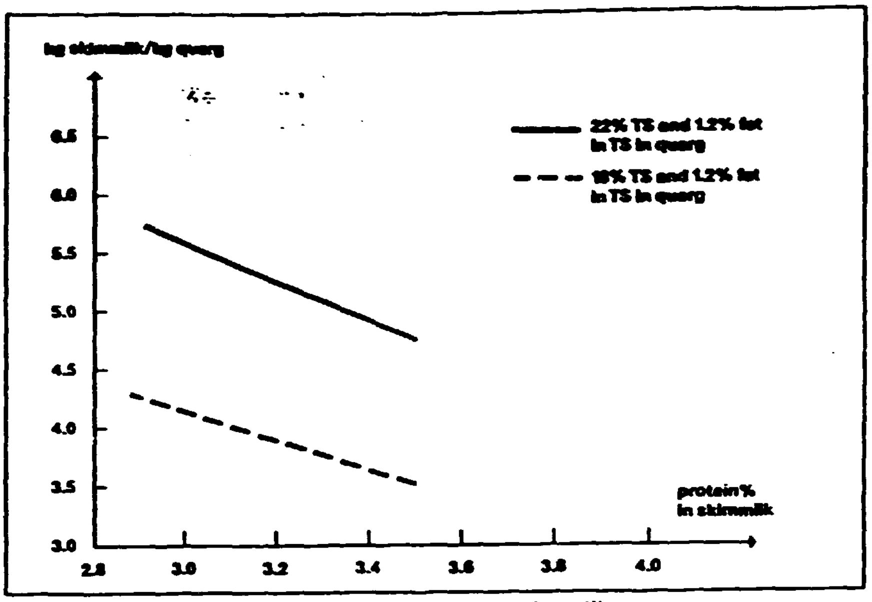


Fig. 7. Milk consumption at various protein percentages in skimmilk.

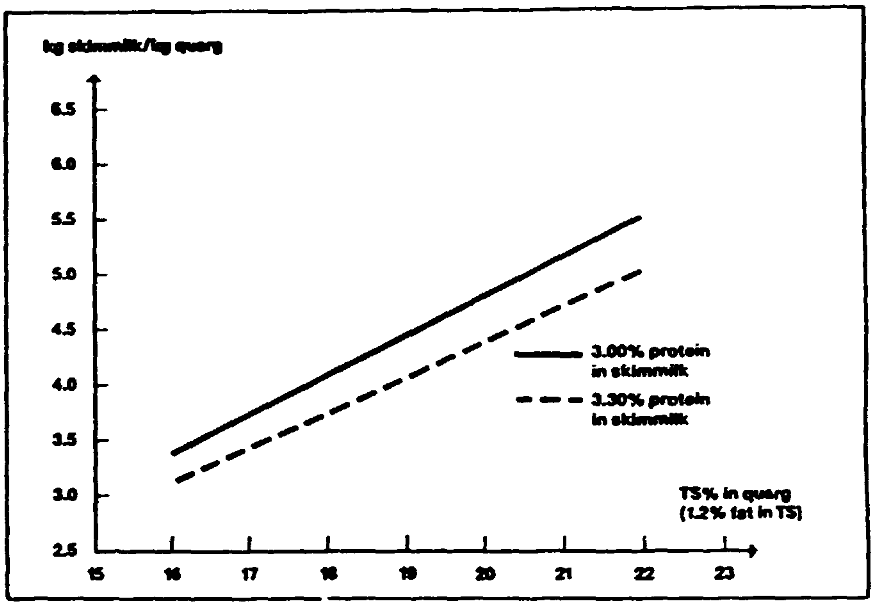


Fig. 8. Milk consumption at various total solids percentages in quarg.

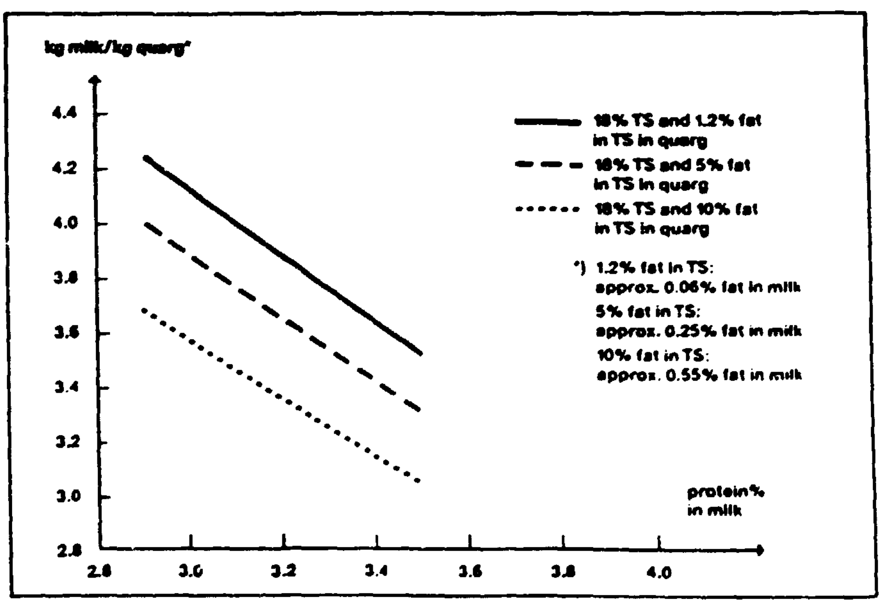


Fig. 9. Milk consumption at various fat percentages in quarg

Quarg process	Traditional	Thermo	UF
Quarg, TS%	18.0	18.0	18.0
Skimmilk pH 4.5, TS%	8.7	8.7	8.7
Skimmilk, protein%	3.22	3.22	3.22
Whey/permeate, TS%	6.2	5.9	5.4
Skimmilk/quarg, kg/kg	4.7	4.3	3.8
Milk savings, %	0	8.5	19.1
Extra yield, %	0	9.3	23.7

Table 1. Comparison between milk consumption and extra yield in quarg production.

Product			Quarg with fat		Cream cheese	
Process			Thermo	UF	Tradition	UF
Product:	TS	%	18.0	18.0	45.0	45.0
	fat in TS	%	30.0	30.0	70.0	70.0
Feed:	TS	%	9.2	11.5	18.1	18.3
	fat	%	0.06	2.55	9.85	10.10
Cream:	TS	%	43.7	-	-	-
	fat	%	38.0	-	-	-
Whey/permeate:	TS	%	6.04	5.63	5.90	5.75
Consumption:	milk/product	kg/kg	2.12	2.12	3.23	3.13
	cream/product	kg/kg	0.141	-	-	-
Savings:	skimmilk	%	0	6.0	0	3.7
	fat	%	0	1.5	0	0.6
Extra yield:		%	0	6.7	0	3.2

Table 2. Comparison between milk consumption and extra yield in fat quarg and cream cheese production.

Table 1 shows a comparison between *traditional quarg* without heat treatment, *thermo quarg* and *UF quarg* based on the same skimmilk composition and the same total solids percentage in the quarg (1.2% fat in TS). Compared with the traditional method, the UF method entails savings in skimmilk of 19.1% or an extra yield of 23.7%. A direct comparison between the thermo and ultrafiltration processes shows skimmilk savings of 11.6% or an extra yield of 13.2% in favour of the UF process. Provided that the relation between the different solids components in the skimmilk is the same, either the milk savings or the additional yield expressed in percentages will be approximately the same at different total solids contents in the skimmilk or at different total solids contents in the quarg.
In the traditional process with recovery of the whey proteins by means of ultrafiltration of the quarg whey and re-dosing of 50% of the whey proteins into the cheese, the milk savings or extra yield are identical with those of the thermo process.

Table 2 shows a comparison between *quarg with fat* produced by the *thermo process* with subsequent addition of fat, and *quarg with fat* produced by the *ultrafiltration process* on the basis of concentration of cultured, standardized milk. The table also shows a comparison between *cream cheese* produced either in *the traditional way* or by means of *ultrafiltration*. When either *quarg with fat* or *cream cheese* is produced there will be savings in both skimmilk and fat. For quarg with fat produced by the ultrafiltration method, the savings in skimmilk are 6.0% and in fat 1.5%, or the extra yield is 6.7%. For cream cheese, the savings in skimmilk are 3.7% and in fat 0.6%, or the extra yield is 3.2%.

The values of the above figures and tables may vary considerably depending on changes in milk composition, milk quality, manufacturing, product composition, etc.
Finally, it is important that comparisons between traditional processing methods and ultrafiltration are not restricted to comparisons between savings in milk and fat on the one hand, and additional yields on the other. Ultrafiltration offers further advantages:

- With the separator process, the maximum TS for thermo skimmilk quarg is approx. 18%.
- With the separator process, the maximum TS for traditional skimmilk quarg is approx. 22%.
- With ultrafiltration, the maximum TS for skimmilk quarg is 22%.
- UF quarg is more suitable for production of whipped quarg desserts.
- Traditional production of skimmilk quarg and cream cheese requires two different separators.
- With ultrafiltration, the same UF plant can be used for production of skimmilk quarg, quarg with fat and cream cheese

CONCLUSION

Compared with the traditional separator process or other similar processes, the APV Pasilac UF process for production of fresh cultured cheeses like ***quarg, baker's cheese, pâte fraîche*** and ***cream cheese*** has several advantages.
By way of conclusion, some of these advantages may be summarized as follows:

- *Feed-related advantages.* Above all, ultrafiltration means reduced consumption of milk, starter culture and rennet (3% to 19% depending on cheese type), reduced butter fat consumption (0.5% to 1.5%) or an increased yield (3% to 24% depending on cheese type).

- *Product-related advantages.* First of all, ultrafiltration ensures a uniform and constant product quality. Secondly, ultrafiltration provides for production of both products with up to 22% non-fat TS or 45% TS with 70% fat in TS and products which are suitable for production of whipped desserts. Furthermore, the fact that all the whey proteins remain in the cheese ensures a higher nutritive value of the final product, and because of the high sanitary standards that can be observed, the products have a longer shelf life.

- *Process-related advantages.* The ultrafiltration process is much simpler and more flexible than traditional processes and it is far less sensitive to pH variations and no deaeration of the feed is necessary. Only one UF plant is needed for the production of skimmilk quarg, quarg with fat and cream cheese, and it is constructed in such a way that visual inspection of each two membranes is possible during production. This construction principle also entails that only 0.22 m^2 membranes need to be replaced in case of leaking membranes.

In other words, the APV Pasilac UF process occupies a unique position on the market, which is above all the result of extensive research and development activities.

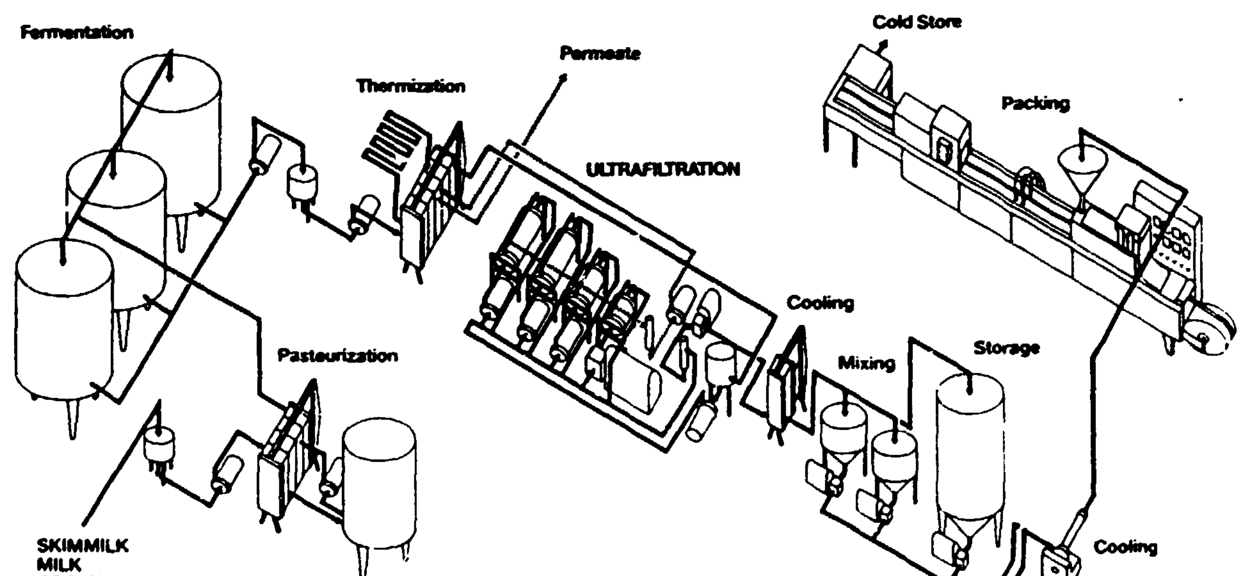


Fig. 10. Production of fresh cultured cheese by means of ultrafiltration.

APPENDIX 5.1

Applications of Whey Proteins in the Food Industry - A Review

Introduction

Whey proteins have many important properties that have encouraged their use in the food industry. Amongst the functional properties can be included water binding, emulsification, the ability to coagulate protein at low temperature and gel formation. These properties have enabled whey protein concentrates to be used as low-cost ingredients in products, such as fishballs, fishburgers, cooked ham meatballs, patés, hamburgers and other meat products (Battermann, W. (1990)).

Developments in the technology of membrane separation processes has extended the range of retentate compositions that have become available as food ingredients. Microfiltration (0.1 to 10μm) can be used to remove large particles (casein fines, micro-organisms or microbial spores, fat globules, somatic cells, phospholipo proteins etc) from whey or milk. Nanofiltration (0.0001 to 0.001 μm) can be used for the selective rejection of ions based on their charge. A major application in the dairy industry is the partial demineralisation of whey and similar liquids (Jelen, P. (1991)).

Ion exchange processes used for many of the commercially available whey protein isolates (WPI's) results in products with very low mineral, lactose and lipid contents. As a result (WPIs) are often excellent with respect to heat stability and foaming in aqueous media and perform well in high mineral salt concentration conditions (Harper, W.J. (1991)).

Applications

(a) Nutritional

Cheese whey has been traditionally used as a low cost pig feed and a source of protein in calf milk replacers. The Volac company has invested £6 million in a former skim milk and butter producing factory at Lampeter in Wales to separate protein from cheese whey by ultrafiltration. The concentrated protein comprises virtually 100% usable amino acids. By comparison conventional milk protein contains about 15% non-protein nitrogen, which cannot be utilised by the calf until it is weaned. Feeding trials with the concentrated protein calf milk replacer resulted in 10% higher growth rates compared with skim milk-based calf milk replacers. Other advantages claimed were the retention of active immunoglobulins and a reduction in mineral levels, producing a balance similar to that of bovine milk, thereby slowing down the passage of food into the gut and raising material digestibility and utilisation. (Anon, 1992).
Ault Foods Ltd of Canada have created a milk protein concentrate from sweet whey which can be used to manufacture a 1% fat ice cream. Initially, Dairy-Lo is derived from high quality sweet whey containing a substantial level of undenatured whey proteins. Following ultrafiltration, the retentate is heat treated to give a controlled denaturation of the protein resulting in:

(a) Protein unfolding and swelling to expose hydrophobic sections of the polypeptide chains;
(b) protein-protein interactions through sulphydryl and disulphide bonds; and
(c) self aggregation.

The unfolding of the whey protein chains imparts an amphiphilic nature to the product improving the emulsifying power at air cell interfaces in ice cream. The self aggregation results in the protein hydrating and swelling with a consequent decrease in iciness and an improvement in the creamy mouthfeel of a frozen dessert (Mitchell, H.L. (1993)).

Whey protein concentrates are now being used commercially as the raw material for the manufacture of all-dairy fat replacers. The Nutra Sweet Co have marketed a product called "Simplesse 100" which is made from whey protein concentrate that is cooked and blended to create tiny round particles similar to fat globules in stable oil-in-water emulsions. This smooth, viscous fluid provides the creamy taste and texture of fat, but at a much reduced calorific value. The FDA has given the product GRAS (Generally Recognised As Safe) approval. Simplesse has been used in products such as mozzarella cheese for pizza toppings (Anon, 1991).

Whey proteins have excellent nutritional properties and have been used as a protein supplement in a process for the manufacture of an enteral diet product for patients with pulmonary disease (Trimbo, S.L. et al (1992)). The diet obtains some of its energy content from high-quality protein sources such as whey protein. Approximately 20 to 50% of the energy content comes from a slowly metabolizable carbohydrate source derived from maltodextrin or other partially hydrolysed polysaccharides. A mixture of lipids comprising medium- and long-chain triglycerides provides 40 to 55% of the energy and milk phospholipids are used as surfactants in the product.
Whey proteins have also been used in the formulation of dietetic foods for patients with renal insufficiency. Such a German product, comprising proteins, fats, carbohydrates and mineral substances, resembles cow's milk sensorially and in its processing characteristics. The formulation has been the subject of a European patent application (Behr, H. and Manz, F. (1991)). The albumen content of the product is derived from whey protein and the energy value ranges from 50 to 500 calories per 100 ml.

The proteins and other constituents in cheese whey have been used as a nutrient source for animal feeding for many years. A Polish study (Flis, M. and Lewicki, C. (1991) compared the effect of various protein feeds (supplementing field bean in diets for fattened pigs) on nutrient digestibility and nitrogen utilisation. The basal diet contained 26% field bean as the only protein component or with field bean partially replaced by fish meal, soya bean, oilmeal, rape seed (00 Jantar variety) oilmeal, skim milk or whey. The highest ($P<0.01$) protein digestibility and nitrogen utilisation were obtained when the field bean was replaced by skim milk or whey.

Enzymes derived from Pineapple pulp have been used to improve the digestibility of milk proteins (Giangiacomo, R. et al (1991)). Partial hydrolysis of casein was from 12% for the beta-fraction to 50% for the Kappa fraction. Hydrolysis of the whey proteins was about 10% for bovine serum albumin and lactoglobulin and 3% for lactalbumin.

(b) Gelation

Kessler et al (1990) have emphasised the importance of β-lactoglobulin (β-LG), and the effects of heat denaturation on functional properties by mechanisms such as complex forming reactions with itself, α-lactalbumin and casein. They have provided detailed information on the flow properties of a whey protein solution as a function of the degree of β-LG denaturation. Data on the effect of denaturated whey protein content on gel rigidity has also been provided.
The gelling properties of whey protein concentrate have been compared with those of chicken salt-soluble protein, (Beuschel, B.C. et al (1992)). Five whey protein concentrates (WPC) with protein solubilities ranging from 27.5 to 98.1% in 0.1 M Na Cl, pH 7.0, chicken breast salt-soluble protein (SSP) or a combination of SSP and WPC at pH 6.0, 7.0 or 8.0 were compared. WPC did not form gels when heated to 65°C. SSP gels heated to 65°C were harder than those heated to 90°C at all pH levels and hardness decreased as pH increased. Hardness of combination gels heated to 65°C increased as WPC solubility decreased at all pH levels. However, the opposite trend was observed at 90°C. Combination gels of the same WPC solubility at 65°C were more deformable than those heated to 90°C.

The effect of removing low-molecular weight components on the gelling properties of commercial WPCs' has been investigated (Brandenburg, A.H. et al (1992)). Low-molecular weight solutes were removed from reconstituted commercial WPC's and whey protein isolate (WPI) by centrifugal gel filtration. Effects on gelation properties were investigated as a function of pH, protein concentration and mineral ion addition by least concentration end-point (LCE) and uniaxial compression testing. Partial removal of low-molecular-weight solutes had little effect on WPC and WPI gelation. Lowest LCE values were obtained at pH 6, 0.2 M ion addition, and with KCl and $CaCl_2$ addition. Highest gel firmness values were at pH 6 and 7.5, and at 0.1 M ion addition.. WPI functioned better than WPC by both test procedures.

(c) Emulsification

The functional properties of whey proteins are very important. In one study (McNeil, V.L. and Schmidt, K.A. (1991), whey protein isolate and sodium caseinate from commercially prepared isolates were dissolved in deionized, distilled water and subjected to various heat treatments. Results indicated that the caseinate solutions were more viscous and had greater foam capacity but lower emulsifying ability than the whey protein isolate solutions.

A technique has been developed for the manufacture of processed cheese in which 20% of cheese solids was replaced by whey protein concentrate (Gupta, V.K. and Reuter, H. (1992)). Trisodium citrate at a level of 2.5% was used as an emulsifier. A moisture content of 45.2% in the processed cheese resulted in the best sensory characteristics. Concentration of whey protein concentrate (WPC) by ultrafiltration to 26.1% DM and a low calcium content of 0.7% of DM improved the incorporation of WPC into processed cheese. Diafiltration of WPC had a negative effect on suitability for the product. The technique developed for process cheese manufacture involved mixing 25% of 6.5 to 7.5 month-old and 55% of 2 to 3 month-old grated Cheddar cheese, WPC equivalent to 20% of cheese DM, dry salt and water. The mixture was heated thoroughly using stirring and indirect steam heating. At a temperature of approximately 49°C, 2.5% dry trisodium citrate was added and the heating continued until the temperature reached 82°C at which it was held for 3 to 4 minutes.

(d) Texture

The texture and ultrastructure of process cheese spreads has been modified by using heat precipitated whey proteins. Hill, A.R. and Smith, A.K. (1992) used whey protein precipitates prepared by heating reconstituted whey powder (WP-PPT) and reconstituted 35% whey protein concentrates (WPC-PPT) at 85°C for 15 minutes followed by acidification to pH 5.2 - 5.4. Process cheese spreads (56% H_2O, 22% fat and pH 5.3 - 5.5) were prepared from the precipitates and 3-month old Cheddar cheese using a Model UM 40E Stephan cooker and two stage homogenisation (14.0 Kgf/cm^2 and 3.5 Kgf/cm^2). Compared to normal processed Cheddar cheese spreads, both precipitates produced spreads with short body but the spreads using (WPC-PPT) were much firmer and imparted a chalky 'mouthfeel'. However, it was concluded that (WP-PPT) could be used as an extender in process cheese spreads.

A European patent application (Hakkaart, M.J.J. et al (1992)) describes the isolation of an enriched fraction of denatured alpha-lactalbumin via heat treatment at neutral pH which, due to specific pH setting and cooling conditions after heating, gives a fatty mouthfeel. It has a consistency similar to spreads and can be used as a texturising agent in emulsion type food such as ice cream, salad dressings, cheese, yoghurt, spreads, cream and even cosmetic lotions, when applied as a wet fraction.

(e) Health - Animal & Human

Various investigators have pointed out the potential usefulness of minor whey proteins such as lactoferrin and enzymes such as lactoperoxidase. These compounds are metalloproteins which are found in all mammary secretions and are believed to provide non-immune protection for the neonate against infection (Smithers, G. (1991)).

The lactoferrin concentration in whey is about 100 mg/l and lactoperoxidase about 30 mg/l. Semi-commercial isolation of these proteins from cheddar and mozzarella cheese whey has been undertaken at the International Food Institute of Queensland (Dionysius, D.A. & Grieve, P.A. (1990)). Cation exchange chromatography was used to isolate the proteins in a highly purified state. Lactoferrin and lactoperoxidase are both thought to possess antibacterial properties under appropriate conditions. Various research workers have investigated the potency of the lactoperoxidase (LP) inhibitory system in milk, which can be activated by the presence of hydrogen peroxide and thiocyanate (SCN), with hypothiocyanate (OSCN) as the active radical. This system has been extensively evaluated as a means of reducing calf mortality rates (Mullan, W.M.A. et al (1982)). The LP system attacks gram negative bacteria such as coliforms and salmonella but does not kill useful lactic acid bacteria. Commercial interest has also been concerned with the activation of the indigenous enzyme for the cold sterilisation of milk or as a protection against mastitis in the mammary gland (Fox, P.F. & Mulvihill, D.M. (1992).

Lactoferrin may have potential as an iron delivery system for the new born and as an anti-inflammatory agent. Another area in which the minor protein fractions of cheese whey may have a role to play is in cell growth promotion. Milk, colustrum and cheese whey contain a number of protein and peptide factors that markedly influence cell growth by promoting protein synthesis and inhibiting protein degradation. Work has been carried out at the CSIRO Division of Human Nutrition [illegible] Animal Production on the use of chromatographic techniques to isolate these factors from colostrum and cheddar cheese whe[illegible] [illegible] rotein fractionation technology is now being developed commercially by United Milk Tasmania Ltd in Australia. Pilo[illegible] quantit[illegible] of product are available from the company and commercial scale production is anticipated in about one year (Pearce, R [illegible]).

Fox, P.F. and Mulvihill, D.M. (1992) have reported that human colostrum and mil[illegible] [illegible] g/ml and 2-4 mg/ml lactotransferrin, respectively, representing about 25% of the total protein in the latte[illegible] By contrast, bo[illegible] [illegible]rum and mil[illegible] contain about 1 mg/ml and 0.02 - 0.35 mg/ml respectively. This difference underlines the [illegible]erest in supplementing bovine milk-derived formulations with lactoferrin. They have also pointed out that the concentration of lactotransferrin in human milk decreases slightly during lactation but appears to increase slightly in bovine milk, particularly during the dry period. Increases in the concentration of lactoferrin in bovine milk during mastitis suggests that is has a protective function in the mammary gland.

The SMR Laboratory in Malmo (Sweden) has reported some interesting developments in lactoperoxidase and lactoferrin extraction from whey on a commercial scale (Borgström, U. (1990)). Somewhat lower contents of lactoferrin (30 mg/l) and lactoperoxidase (20 mg/l) in the whey were reported, compared with the figures provided by Smithers, G. (1991). Unsalted, pasteurised whey is supplied from the cheese plant at Skånemejerier in Kristianstad and fed to an ion exchange filter followed by subsequent separation, concentration and drying to a powder. It was pointed out that lactoferrin is widely used for the enrichment of infant formulae and potential applications in cosmetics and toothpaste were also recognised. The extraction of lactoperoxidase and lactoferrin was quoted as yielding an additional income of SEK 0.10 per litre of whey giving a potential profit of SEK 100 M per year.

Bovine colostrum contains about 10% immunoglobulins (Ig's) and this level decreases to approximately 0.1% about one week from birth. The milks and colostra of those animals (e.g. human, rabbit) that transfer Ig *in utero* contain mainly Ig A, while those (e.g. cow, horse, pig) that transfer immunity via colostrum secrete mainly Ig G_1. (Fox, P.F. & Mulvihill, D.M. (1992)).

Ruminants are born without blood antibodies and are, thus, very susceptible to infection. Ig's can be absorbed through the intestine of young ruminants for about 3 days after birth. Where it is not possible to feed colostrum to transfer temporary immunity from cow to calf, the use of calf-milk replacers enriched with Ig's is an alternative.

Cheese whey often contains casein-derived peptides (CDP) which can amount to 20% of the total protein in the whey. Pearce, R.J. *et al* (1991 b) have suggested that CDP might represent a valuable source of protein for patients suffering from phenylketonuria or forms of hepatic disease.

(f) **Manufacture**

Recently an excellent two-part review of Whey Utilisation has been reported (Mann, E.J. (1993 a and b)). This review mentions the development by a Danish Company of a range of whey protein isolates and modified whey protein concentrates containing 60-85% protein. The functional properties of these products were compared to those of casein, (Wilmsen, A. (1992)). It has also been reported that interest has been shown in Australia in the separation of the principal whey proteins into various constituents such as α-lactalbumin, β-lactoglobulin and the minor constituents such as lactoferrin, lactoperoxidase, growth factors and immuno regulatory constituents (Smithers, G. (1991).

Microfiltration technology has been applied to achieve low-temperature sterilisation of whey (Pearce, R.J. et al (1991 a)), producing a product of good microbiological quality for the food industry. The reported process also reduces residual fat levels in whey protein concentrates with a consequent increase in protein and improved functional properties. An Alfa Laval MFS-7 unit fitted with Ceraver ceramic membranes of 1.4 μm porosity has been used to remove up to 30% of the residual milk fat from Cheddar Cheese whey (Pearce, R.J. et al (1992)). The level of residual milk fat removed could be raised to 80% by using a membrane of 0.8 μm porosity. When the whey protein concentrates were used to manufacture dairy products, significant improvements in foaming and meringue forming properties were achieved. These properties improved with the increasing amounts of milk fat removed.

Whey protein concentrate has been used in Egypt in the manufacture of Labneh (Mahfouz, M.B. et al, (1992)). WPC with 20% TS (prepared from de-salted Domiati cheese whey and Ras cheese sweet whey) was added at 0, 5, 10 or 15% to ultrafiltration (UF) retentate (22% TS) of cow's whole milk. The mixture was heated at 80°C for 1, 5 or 20 minutes, and cultured with 2% yoghurt starter to form labneh. The total solids content of the labneh decreased slightly with increasing level of WPC and increased slightly with duration of heating. The titrable acidity increased with increasing level of WPC ($P < 0.01$) but intensity of heating had no significant effect. Heat treatment was sufficient to denature most of the whey protein. WPC addition and heating had little effect on flavour scores of labneh, but addition of WPC improved the scores for wheying-off and smoothness ($P < 0.01$). It was concluded that WPC can be added at up to 15% (on a total nitrogen basis) to UF retentate for production of labneh of acceptable quality and composition.

There are sometimes legal limits to the addition of whey proteins in food. Whey and whey products have been used in ice cream (Lechner, E. (1991)). Polarographic determination of cystine was used to investigate the whey content of a variety of ice creams. Since whey proteins (WP) contain a relatively higher proportion of cystine than casein, cystine values (μg cystine/mg protein N) increased with increasing proportion of WP in the product. As 50% of total protein is the maximum amount for WP in German ice cream, cystine limiting values of 128 and 120 μg/mg protein N were suggested for ice cream and chocolate ice cream respectively, as a means of monitoring the level of added whey protein.

A recent patent (Hup, G. (1991)) describes a process for the preparation of a fat emulsion. The aqueous phase contained 0.1 to 3% of predominately undenatured whey protein. The oil-in-water emulsion is intended for use in the manufacture of Edam, Gouda and Camembert - type cheeses, yoghurts and custards. Whey protein concentrate has been used in the manufacture of mayonnaise (Dudina, Z.A. et al (1989)). A recent article (Duxbury, D.D. (1992)) refers to the use of whey protein concentrates in baked goods, beverages, canned foods, cereals, cheese products, confections, milk products, dry mixes, frozen desserts, frozen foods, processed meat products, pasta products and salad dressings.

(g) **Other**

Although not specifically the subject of this review, it should be mentioned that there are uses for proteins in the non-food sector. Milk proteins, particularly, casein, used to be used as a raw material for industrial products such as clothes buttons prior to the advent of alternative raw materials becoming available from the chemical processing and petro-chemical industries.

Some of these products were of excellent quality. A few years ago the author was shown an early ball-point pen the body of which had been manufactured from casein resulting in a beautiful, translucent pale-green pen ranking in quality with many of today's similar products.

Within the European Community, surpluses in dairy products having been a problem in the last decade which has been tackled by the imposition of quotas and set-aside schemes. It is not surprising, then, to find some attention being given again to the use of milk proteins for non-food industrial applications. A project (Kohler, A. (1992)) at the Technical University of Munich at Weihenstephan in Germany was concerned with the non-food applications of milk fat, casein, whey protein, lactose and whey minerals that had been reported in the literature. Whey proteins were considered to have a potential for use in the pharmaceutical and the cosmetic sectors.

The uses for whey proteins continue to multiply and it will be interesting to see how consumer demands and technological development will influence the changes in the utilisation of these versatile milk components in the future.

V N Wade

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This paper was presented by Dr N.Wade at the European Alliance of Dairy Teachers Conference Milk Protein'94,which was held in La-Roche-Sur-Foran-France,November 1993.

Wet oxidation of dairy waste is one of the most difficult tasks that microorganisms are required to do. The microbiological system must oxidize the carbon and hydrogen of organic compounds to carbon dioxide and water, respectively, and must at the same time conserve its own mass. In other words, the cellular mass must neither increase nor decrease over long periods. That this ultimate objective is closely approached in practice testifies to the remarkable power of the metabolic capacity of microorganisms.

Dairy wastes fall into two categories, one of which may be described as an intrinsic waste, and the other as a conditional waste. All dairy factories experience losses that are intrinsically a part of factory operation. For example, a dairy factory that receives 10,000 lb of milk daily may produce each working day about 1250 gal of waste with a milk solids concentration of 0.1%. Cheese plants, on the other hand, produce whey as a by-product of cheesemaking; although whey contains half the nutrients of the milk from which it was derived, it must be treated as a conditional waste—conditional upon the absence of a suitable market for its use. A more detailed discussion on disposal of dairy wastes can be found in a review by Arbuckle (1970).

Treatment of Dairy Waste by Aeration

The magnitude of the chemical or biological oxygen demand of solutions of organic matter determines whether or not these solutions may be safely added to bodies of water. Chemical oxygen demand (COD) is the amount of oxygen, determined chemically, necessary for complete oxidation of an organic substance, and is usually reported in parts per million (ppm) (Porges *et al.* 1950). For milk wastes, biochemical oxidation demand (BOD) and COD are practically equal.

As oxidants, either permanganate or dichromate may be employed under standard conditions of concentration, temperature, and time. These reagents have been studied critically; only the results with dichromate were found to reflect accurately the BOD of dairy wastes (Fritz 1960A,B).

Aeration techniques are successful only if oxygen can be supplied at a sufficiently high rate to lower the COD to an acceptable value. Extensive investigations on the biochemical and chemical oxidation of dairy wastes have shown that each pound of dry organic matter in dairy waste requires about 1.2 lb of oxygen for complete oxidation (Hoover and Porges 1952; Hoover *et al.* 1952A; Porges 1956). During the period of rapid assimilation, bacteria need about 37.5% of their complete oxygen requirement, or 0.45 lb; and in the process, 0.52 lb of new cell material is formed per pound of waste solids. To oxidize this newly formed sludge, 0.75 lb of oxygen is required, the difference between the oxygen required for complete oxidation of 1 lb of waste solids and that required for assimilation. During endogenous respiration at 32.2°C, sludge is consumed at an hourly rate of approximately 1%. Thus, if an amount of sludge equal to 0.52 lb of newly formed cells is to be oxidized in time t_1, no less an amount of sludge than that given below would be required to maintain this condition: equilibrium weight of sludge per pound of organic matter = $52/t_1$. If the parts of oxygen required to oxidize the organic matter in 1 million parts of waste volume—the ppm COD—is known, the total oxygen requirement in pounds for any given waste volume, V, in gallons is easily calculated. The weight of organic solids is equal to 83.3% of the total oxygen requirement (COD), and hence the equilibrium sludge weight is given by the following equation: sludge = $(52 \times V \times \text{ppm COD} \times 8.34 \times 0.833 \times 10^{-8})/t_1$.

If, for example, a waste volume, V, of 10,000 gal with a ppm COD of 1500 is processed in $t = 20$ hr, the equilibrium sludge weight is 270 lb. The calculation is oversimplified and is about 10% too low, assuming, as it does, that endogenous respiration and assimilation occur simultaneously during the entire operation. Actually, there is always a retention time during which cellular substance is consumed without replenishment.

The hourly oxygen requirement for sludge respiration is equal to the sludge dissipation rate multiplied by the pounds of oxygen (1.44) required for oxidation of each pound of ash-free sludge. The hourly oxygen requirement for assimilation is given by the quotient of total oxygen required for assimilation and the time required to introduce the waste. The hourly oxygen requirement during assimilation is equal to the sum of the two aforementioned requirements, and may be expressed in terms of the volume, V, of influent, the ppm COD, the feed time, t_2, and the endogenous respiration time, t_1, thus: O_2 (lb/hr) = $(5.2V \times \text{ppm COD} \times 10^{-6})t_1 + (3.13V \times \text{ppm COD} \times 10^{-6})/t_2$.

This equation summarizes some of the arguments and data contained in the literature (Porges *et al.* 1960). The aeration device must be designed to furnish the solution with oxygen at the required rate. The tank must be designed to accommodate milk waste and sludge. Allowances must be made for a certain proportion of free space (freeboard), and settling space. The design, construction, and operation of dairy waste disposal units have been described (Porges 1958; Porges *et al.* 1960).

Processing of Whey Wastes

Whey solids compared with milk solids contain a greater proportion of lactose and a much smaller proportion of nitrogen. Consequently, in the processing of whey wastes even under conditions of adequate aeration, the rate of assimilation may be limited by the COD-nitrogen imbalance. Jasewicz and Porges (1958) observed that when sludge (2000 ppm COD) was used to treat dilute whey waste (1000 ppm COD) under highly aerobic conditions, no additional nitrogen was necessary for complete whey removal, since the essential nitrogen was supplied during endogenous respiration. Addition of ammonium sulfate to aerators was recommended to compensate for the additional load imposed on them when whey is wasted along with the normal load. In studies using whey, it was found that under the laboratory schedule of daily feedings, both supplemented and unsupplemented sludges gradually deteriorated and presented serious bulking problems after three months. This suggested that supplementation with nitrogen alone was not enough. In a 61-day study of the COD balance in a system to which whey was added 48 times to aerated sludge, it was observed that whey wastes may be readily treated under certain conditions without nitrogen addition. An average of 75% of the influent whey COD was relieved when no provisions were made for removal of sludge from the effluent. The sludge accounted for all but 2 to 3% of the effluent COD. Calculations based on a sludge oxidation rate of 6.3% per day showed that dynamic equilibrium would be possible if 100 units of sludge were used to treat 10 units of whey.

APPENDIX 6

International Association for Cereal Chemistry (ICC)

ICC-STANDARD No. 107

Approved: 1968

1. Title

Determination of the "Falling Number" according to Hagberg – Perten as a Measure of the Degree of Alpha-Amylase Activity in Grain and Flour

2. Scope

Applicable to grain, flour and other starch-containing products. By converting the falling number into the liquefaction number it is possible to calculate the composition of flour mixtures of desired falling number.

3. Definition

The falling number is defined as the time in seconds required to stir and to allow a viscometer stirrer to fall a measured distance through a hot aqueous flour gel undergoing liquefaction.

4. Principle

The falling number method determines alpha-amylase activity using the starch in the sample as substrate. The method is based upon the rapid gelatinization of an aqueous suspension of flour or meal in a boiling water bath and the subsequent measurement of the liquefaction of the starch paste by the alpha-amylase in the sample.

5. Reagents

Distilled water.

6. Apparatus

Falling Number Test Equipment; obtainable from Falling Number AB, Norrlandsgaten 16, Stockholm C, Sweden. The equipment consists of:

6.1.

Standardized water bath with a diameter of 15 cm, equipped with a lid with viscometer tube holder, a clip to secure the viscometer tube after insertion and a condenser to reduce the escape of steam.

6.2.
Standardized 600 W electric heater.

6.3.
Standardized viscometer stirrer with a bottom wheel and 2 stops. The distance from the bottom of the wheel to the top of the lower stop ist 115 mm. and from the top of the lower stop to the bottom of the upper stop 103 mm. The stirrer shall run smoothly in an ebonite stopper, and its weight without stopper is 25.00 ± 0.05 g.

6.4.
Standardized precision viscometer tubes of special [illegible] [illegible]ances inner diameter 21.00 ± 0.02 mm, outer diameter [illegible] ± [illegible] ± 0.3 mm.

6.5.
Standardized rubber stoppers for the viscometer tubes.

6.6.
Pipette delivering 25 ± 0.2 ml.

6.7.
Automatic timer with signals to obtain the correct stirring rhythm (or stop-watch).

6.8.
A balance with an accuracy of ± 0.05 g.

6.9.
An approved mill (the standard mill is Kamas 200-A).

7. Sampling

A representative sample should be taken according to the ICC Standard Method for sampling no. 101.

8. Procedure

8.1.
Preparation of grain sample
Dust and coarse impurities should be eliminated from the whole grain. Approximately 300 g. of the grain should be prepared for grinding. If less than 200 g. of grain is prepared, results may be misleading.

8.1.1. Grinding of grain
The falling number values are affected by the particle size of the ground grain.

Therefore a meal of particle size corresponding to that of meal ground on the standard mill is required.
The ground grain should comply with the following specification:

Aperture of sieve	% of sample passing through sieve
710 microns	100
500 microns	94 – 98
210 microns	55 – 70

The sieving test can be made as follows:
Sift 100 g of the mixed ground grain through a round sieve of approx. 22 cm diameter. Shake the sieve by hand in a horizontal plane for three minuntes, tapping the sieve against the table every fifteen seconds.
Meal of the required particle size may be obtained by using a hammer type laboratory mill, equipped with a sieve with 0.8 mm openings. (In the standard mill it is possible to grind grain of moisture content up to 30%). The mill must be fed carefully with grain in order to avoid heating and over-loading. Grinding should be continued for 30–40 seconds after the last of the sample has entered the mill. Small quantities (up to 1% of the grain taken for grinding) of bran particles remaining on the sieve may be discarded. The ground grain should be carefully mixed. For accurate results, the falling number should be determined on ground grain at 15% moisture content. The quantity of sample to be taken when its moisture content differs from 15% is given in the table in 10.1. Rapid electrical moisture determination apparatus may be used for determining the moisture content of the meal.

8.2.

Preparation of flour sample

Flour should be sifted through an 0.8 mm mesh sieve in order to separate lumps, and the sample weight is to be based on 15% moisture basis.

8.3.

Determination of falling number by the standard method: 7 g flour/25 ml water

The water bath should contain distilled water, the level of which is adjusted to approx. 2–3 cm below the top edge of the container. The water is heated to boiling point and must boil vigorously during the test. Place 25 ml distilled water at 20°C. in a viscometer tube.
Weight out 7.0 ± 0.05 g of the ground grain or flour (at 15% moisture content) and transfer it into the viscometer tube.
Fit the rubber stopper into the top of the viscometer tube and shake vigorously 20–30 times, or more if necessary, for obtaining a uniform suspension.
Remove the stopper and, with the viscometer stirrer, scrape down into the suspension any flour adhering to the sides of the viscometer tube.
Place the viscometer tube together with the viscometer stirrer in the boiling water bath through the hole in the lid.
Start the timer or the stop-watch immediately the viscometer tube touches the

bottom of the rack. Secure the viscometer tube with the clip.
Exactly five seconds after the immersion of the viscometer tube, commence stirring the suspension by hand at the rate of two stirs per second. (1 stir = 1 up movement and 1 down movement), i.e. 4 movements per second. The automatic timer gives two signals per second in order to faciliate the stirring rhythm. The lenght of the stirring movement is regulated by the lower stop of the stirrer and the bottom of the viscometer tube, and the stirrer should lightly touch them at the end of both the up and down movements. It is important to keep to this exact speed of stirring. After a total of 59 seconds, the stirrer is lifted to the uppermost position, i.e. with the lower stop touching the stopper which is kept firmly on the viscometer tube by the clip. The stirrer is held for a moment in its uppermost position and, exactly sixty seconds from the start of the timer, the stirrer is released. When using an automatic timer the microswitch for time-measurement is turned into position beside the viscometer stirrer.
When the stirrer has dropped by its own weight so that the lower edge of the upper stop is at the same level as the top of the stopper, the timer is stopped [illegible]ly and the alarm buzzer sounds. If a stop-watch is used, this is stopped manually.

9. Presentation of results

9.1.
Method of calculation
The total time in seconds counted from the immersion of the viscometer tube into the water bath until the viscome[illegible] has dropped down into the gelatinized suspension, is the falling number. The stirring time is thus included.

9.2.
Accuracy of determination
Repeated tests on the same sample should give results within ± 5% of the average falling number value. The importance of correct sampling is emphasized, since differences between the alpha-amylase activity of subsamples may occur if the sample is not well mixed.

10. Remarks

10.1.
Correct sample weight at different moisture content
The following table shows the required sample weight, at different moisture contents, corresponding to 7 g at 15% moisture — no change is made in the quantity of water used.

Moisture content %	Weight of sample (15% m.b) g	Moisture content %	Weight of sample (15% m.b) g	Moistrue content %	Weight of sample (15% m.b) g
9.0	6.42	12.0	6.70	15.0	7.00
.2	6.44	.2	6.72	.2	7.02
.4	6.46	.4	6.74	.4	7.04
.6	6.47	.6	6.76	.6	7.06
.8	6.49	.8	6.78	.8	7.09
10.0	6.51	13.0	6.80	16.0	7.11
.2	6.53	.2	6.82	.2	7.13
.4	6.55	.4	6.84	.4	7.15
.6	6.56	.6	6.86	.6	7.17
.8	6.58	.8	6.88	.8	7.19
11.0	6.60	14.0	6.90	17.0	7.22
.2	6.62	.2	6.92	.2	7.24
.4	6.64	.4	6.94	.4	7.26
.6	6.65	.6	6.96	.6	7.29
.8	6.68	.8	6.98	.8	7.31

10.2.

Importance of stirring

The stirring is the most important phase of the determination of the falling number. Great care must be taken to stir with the correct rhythm as experience has shown that different rhythms may lead to considerable variations in results. Errors from this source are reduced by using an automatic timer, which, by means of sound and light signals, indicates the correct rhythm. The method is greatly simplified by mechanical stirring. Bot semi-automatic and fully automatic equipment being available.

10.3.

Typical results (wheat flour)

Falling number value:

Less than 150	– sprouted wheat, high amylase activity, danger that the bread crumb is likely to be sticky,
200 – 250	– unsprouted wheat, normal amylase activity,
300 – and more	– unsprouted wheat, amylase activity too low, risk of diminished bread volume and bread crumb that is too dry.

10.4.

Preparation of flour mixtures with a desired falling number

The falling number values are not suitable for the calculation of the composition of flour mixtures since the relationship between falling number and alpha-amylase activity is curvilinear. This relationship can be expressed as a straight-line function by converting falling numbers into liquefaction numbers (LN) according to the empirical formula:

$$\text{Liquefaction Number} = \frac{6000}{\text{Falling Number} - 50}$$

In this equation 6000 is a constant. The number 50 approximately corresponds to the time in seconds required for the flour starch to gelatinize sufficiently so that it will be available for attack by enzymes. The LN is proportional to the alpha-amylase activity over the range encountered in commercial flours. This linear relationship makes it possible to calculate arithmetically or graphically the composition of flour mixtures with a desired falling number. To obtain correct results, however, the components of each mixture must be ground equally fine. The linear relation between the liquefaction number (LN) and malt addition also makes possible a graphical determination of the amount of malt supplement required for balancing the alpha-amylase activity in flour. (See article by H. Perten "Application of the Falling Number Method for Evaluating Alpha-Amylase Activity", Cereal Chemistry 41: 127–140, (1964).

10.5.
Falling Number – 9/25
Falling Number 9/25 is determined on 9 g sample instead of 7. It gives a more pronounced differentiation of samples with very high amylase activity. Otherwise the procedure is the same as for falling number 7/25.

Study Group: Determination of Amylase Activity
Chairman: Dipl.-Ing. H. Perten, Khartoum, Sudan

APPENDIX 6.1

DETERMINATION OF GLUTEN QUALITY BY KOZMINA TEST

Gluten is washed from a dough containing 20 g of flour and about 15 ml of water.

The doughs, made with tap water, were rested under water for 20 min after mixing and then kneaded under a stream of water in a Simon gluten washer. Washing was completed by hand kneading under water until no further starch could be removed.

The wet gluten was rolled between the hands to remove excess water and weighed. A 2.5 g portion was cut off, moulded into a ball with the fingers and then rested for 20-25 min under distilled water at 30°C. It was then threated on to a wire hook attached to a cork. A second wire hook, which with its attached load weighed 5 g, was then threaded through the gluten and the whole, except for the supporting cork, put into a 1-litre cylinder which was filled with distilled water at 30°C. The level of the bottom of the weighted hook, relative to a scale attached to the outside of the cylinder, was noted at the start of the test and after intervals of time (see fig. I).

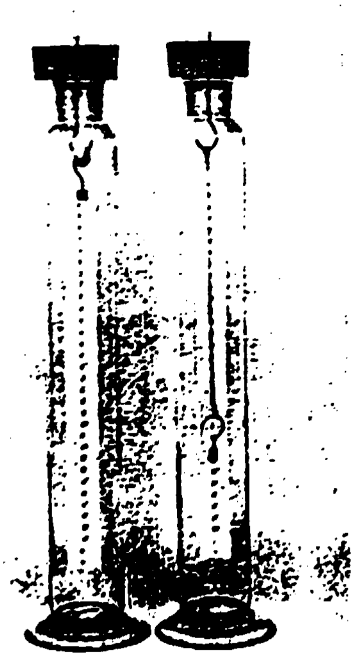


FIG. 1.—*Stretching of gluten at the start of the test* (left) *and 60 min. later* (right)

Quality of gluten is measured by the streching rate cm/min. Low streching rate indicate stable, hard or strong gluten, high streching rate indicate weak gluten.

Rapidly increase of streching may indicate that wheat grain was damaged by wheat bugs.

Lit: E.Kaminski, P.Halton "Streching characteristics of gluten washed from air-classified fractions of English and Manitoba wheat flours", J.Sci.Food Agr. 15 (1964), p.625-629.

RICE MILL PARBOILING RICE PROCESSING

ALTERNATIVES AND CONSTRAINTS

Alternatives :

-The objectives of the grinding are to separate the grain from its husk and to remove the bran and the germ which contain vitamins, protides, and lipids. Apart from white rice, semi-blanched rice and parboiled rice (see infra) are produced.

- Very small units do not separate the bran from the husk and devalorize the by-products.

Constraints :

- The unit's success depends on transportation and storing as well as financing of stock.
- The unit should be located near growing sites (Paddy is voluminous and weighs 50 % more than the rice).
- By-products should be valorized : husk, (fuel, litter ...), bran (animal feed).

OPERATIONS	FUNCTIONS	POSSIBLE CHOICES OF TECHNOLOGY
Straining Aspiration	Remove dust and foreign bodies.	
Parboiling	Parboiling of paddy allows for: - better preservation of vitamins in white rice - diminishment of losses in cooking and cleaning water - hardening of grains and diminishement of breakage	- in open air or under pressure - fixed or rotating container
Dryers Drying	Optimize water content in the paddy	- Artificial or natural - Use of vacuum during first phase.
Husking	Remove husk	Steel or rubber rollers, or abrasive discs.
Grading	Homogenize grain size to reduce breakage.	Rotary cylinders or vibrating sieves
Blanching (polishing)	Remove pericarp and germ.	- Blanching more or less advanced - There exists a process for humid grinding which reduces heating and breakage - Extraction of oil from resulting bran.
Packaging		

APPENDIX 7

FILE: A13
ISIC 3115

How To Start Manufacturing Industries

Margarine Making Plant

Margarine was first made by a Frenchman; Monsieur Mege Mauries in 1869 for use as a substitute of natural or genuine butter.

In the rudimentary stage of the manufacture of margarine, it was impossible to use all kinds of oils and fats as raw materials of margarine due to primitive oil refining techniques.

Later, it became possible to produce high quality oils and fats having suitable melting points and viscosities from various kinds of liquefied oils owing to the development of the vacuum deodorization technique in the U.S.A. as well as the development of manufacturing the hardened oil in Germany.

Consequently, so many kinds of oils and fats from animals, fishes and vegetables which could not be used as raw materials of margarine in the past, have become available for the manufacture of margarine.

Furthermore, according to the improvement in the technique of oil refining, the quality of margarine has become so high as that of natural or genuine butter.

On the other hand, when we appreciate the efficacy of the margarine for physical health as a foodstuff, oils and fats have twice calorie as the amount of sugar and have high unsaturated fatty acids called the indispensable fatty acid or vitamin F and oil-soluble vitamins such as vitamin A, D, E, etc.

Margarine is essentially produced by mixing the oils and fats described above (at a ratio of roughly 80%) with other materials such as water and lactic products (at a ratio of roughly 20%). The larger proportion of oils and fats, the principal ingredient, consists of hardened oil.

While the kinds of hardened oils (raw oils and fats) used for the manufacture of margarine differs by countries very much. In America the principal raw oils and fats are soybean oil, cottonseed oil and their hardened oils. In Europe oils and fats produced in each country and imported ones are available. In Japan principal raw oils and fats are vegetable oils such as cottonseed oil, soybean oil, corn oil, coconut oil, palm oil and rapeseed oil, and fish oil, beef tallow and lard.

A typical example of blending of raw oils and fats for the manufacture of industrial margarine in Japan is the following;

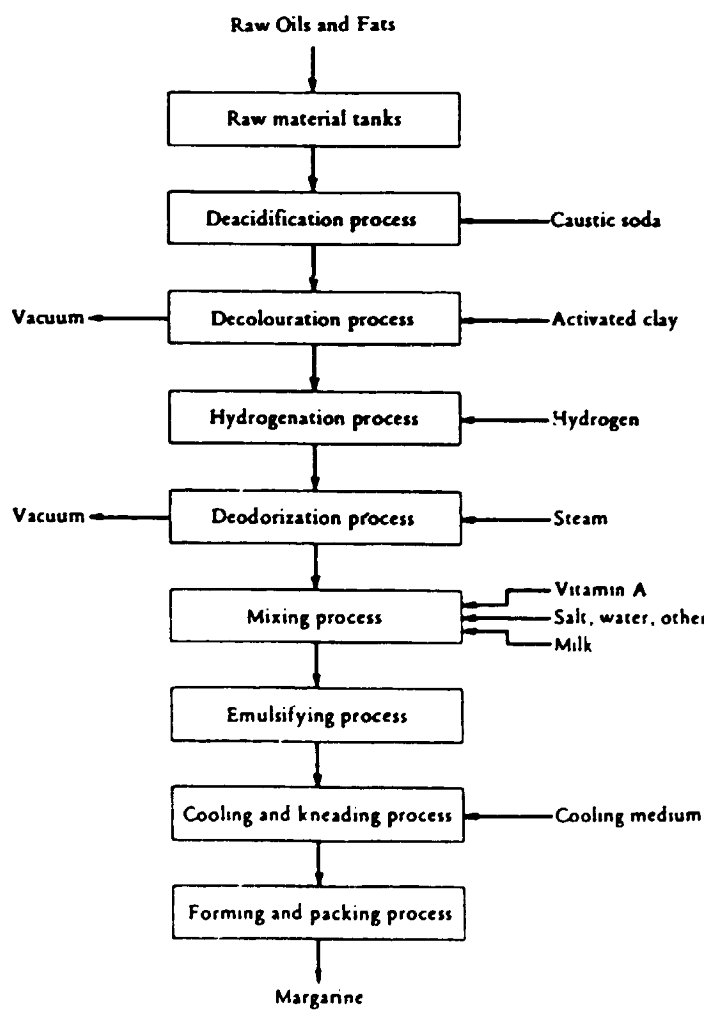
Raw oils and fats	Blending ratio
1) Fish oils	45%
2) Beef tallow	10%
3) Soybean oil	15%
4) Cottonseed oil	1%
5) Coconut oil	2%
6) Palm oil	15%
7) Lard	8%
8) Others	4%

The auxiliary and sub-materials, which are blended with the ingredients mentioned above, may consist of the following;

Materials	Blending ratio
1) Raw oils and fats	80%
2) Water or fermentation milk	16 ~ 18%
3) Salt	2 ~ 3%
4) Monoglyceride	0.2 ~ 0.5%
5) Lecithin	0.1 ~ 0.3%
6) Antioxidant	$1 \sim 2 \times 10^{-4}$%
7) Antiseptic	$1 \sim 5 \times 10^{-4}$%
8) Aroma ingredients	$1 \sim 2 \times 10^{-5}$%
9) Colouring agents	$2 \sim 3 \times 10^{-5}$%
10) Vitamin A	15,000 ~ 30,000 units/lb

As raw oils and fats to be used for the manufacture of margarine are refined to colourless and odourless level, margarine may be manufactured to

Process Flow Sheet for Margarine Making Plant



feature a number of qualities such as enticing colour, good luster, lactic appearance and good flavour by blending auxiliary, or sub-materials above mentioned.

Today, margarine is used widely on the table, also for cocking and for making bread and pastries. That is, margarine is used not only as a substitute for genuine butter but also as a vital source of edible oils and fats.

Process Description

A margarine plant comprises two principal processes. One is the process for refining the raw oils and fats by deacidification, decolouration, hydrogenation and deodorization. The other is for producing margarine by blending auxiliary materials to the refined raw materials, which can be broken into mixing process, emulsifying process, cooling and kneading process and forming and packing process.

1) Deacidification process
Free acids, proteins and other impurities or organic substances contained in raw oils and fats are removed in this process by means of alkali and other treatments.

2) Decolouration process
Undesirable colouring matters contained in raw material oils and fats are removed by the adsorption to activated clay in this process.

3) Hydrogenation process
Unsaturated fatty acids in material oils and fats are converted to saturated fatty acids by reaction with hydrogen under the existence of catalyst such as reducing nickel, etc. This treatment serves to raise the melting temperatures of these oils and fats to desirable levels, and to improve the stability of quality.

4) Deodorization process
The oils and fats subjected to deacidification, decoloration and hydrogenation still have their inherent odours and the ones created by oxidation or decomposition, and these odours are generally disagreeable. The substances giving off these odors are removed by blowing steam through oils and fats heated up to the temperature of 200°C ~ 250°C under several mmHg absolute pressure.
The refined oils and fats treated in the above mentioned processes are stored in each tank and then sent to the margarine producing process.

5) Margarine producing process
Raw oils and fats are melted and blended with salt, water, lactic substances, vitamins, colouring agents, aroma and other ingredients, and then mixed, emulsified, sterilized, cooled rapidly and kneaded. The mixture is, after being aged for a while, formed into the prescribed shape to be obtained as finished product.

Example of Margarine Making Plant

1) Production Scheme
Production capacity: 1,000 tons/month as table or industrial margarine
Working hours: 24 hours/day
25 days/month

Note: Tables 1 – 5 are based on the above scheme.

Table 1: Required Machinery and Equipment

(The main machinery and equipment within the battery limit of the plant which compose the above mentioned processes are as follows:)

1) Deacidification tanks with accessories
2) Decolouration vessels with filters
3) Hydrogenation equipment
4) Deodorization equipment with boiler
5) Mixing tanks
6) Emulsifying tanks
7) Continuous sterilization equipment
8) Continuous cooling and mixing equipment with a resting tube
9) Forming and packing machines

FOB price of machinery and equipment . . . . (approx.) $US 2,381,000

In addition to the above machinery and equipment, the followings are required to construct the plant:

– Machinery and equipment:

1) electric power receiving and supply system
2) process water receiving, treating and supply system
3) steam generating equipment
4) cooling water supply system
5) waste water treatment system
6) field storage and loading/unloading facilities of raw materials and product
7) laboratory and maintenance apparatuses

– Buildings, foundations, structures, paving and other civil works.

– All the works such as erection, piping, wiring, painting, insulation and others at the plant site and materials for the aboves.

Table 2: Required Raw and Subsidiary Materials

Item	Quantity
Raw material oils and fats	900 kg/ton of margarine
Water and fermentation milk	170 kg/ton of margarine
Salt	25 kg/ton of margarine
Hydrogen	70 $N\text{-}m^3$/ton of margarine
Monoglycerides, aroma ingredients, anti-oxidant vitamin, etc.	small amount

Table 3: Required Utilities

Item	Quantity
Electricity	210 kWh/ton of margarine
Steam	2,000 kg/ton of margarine
Process water	20 m^3/ton of margarine
Fuel	10 ℓ/ton of margarine

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Required Area

Production building	150 sq.m
Cold storage building	100 sq.m
Facilities	100 sq.m
	350 sq.m

Required Power and Utilities

1.	Electrical Power	55 kW
2.	Steam	250 kg/h at 10 bar
3.	Water	1 cu.m/h

Required Manpower

Management and administration	4
Technical manager engineer	1
Foremen	2
Skilled workers	3
Quality control	1
Mechanic technician for maintenance	1
Eletrician for maintenance	1
Helpers	5
	18

Required Raw Material

Base recipe margarine	
Oils and fats (separated or composition)	78–80%
Emulsifier	0.3%
Lecithin	0.2%
Beta carotene	0.1%
Salt	0.5%
Sorbic acid	0.15–0.3%
H_2O	16–20%

This information has been prepared by UNIDO as a result of the financial contribution to UNIDO from the Government of the Federal Republic of Germany and the close co-operation extended to UNIDO by the relevant industries in the Federal Republic of Germany.
Any inquiry should be sent to Registry file no. 312/07 (003), UNIDO, P. O. Box 300, A-1400 Vienna, Austria.

APPENDIX 7.1

File: A 47
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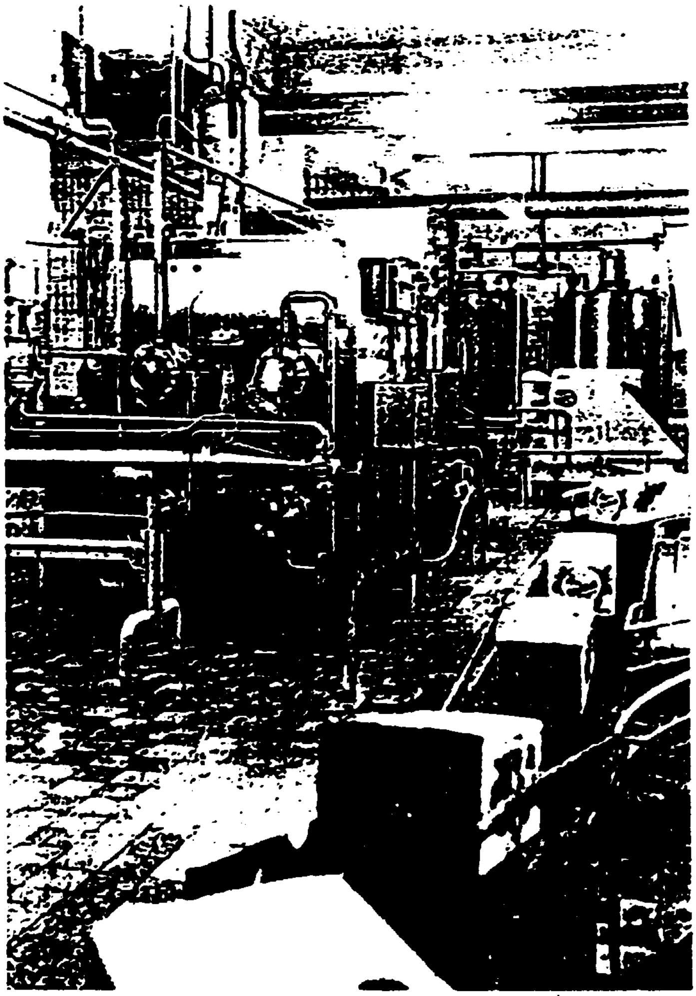
How To Start Manufacturing Industries

Margarine



Introduction

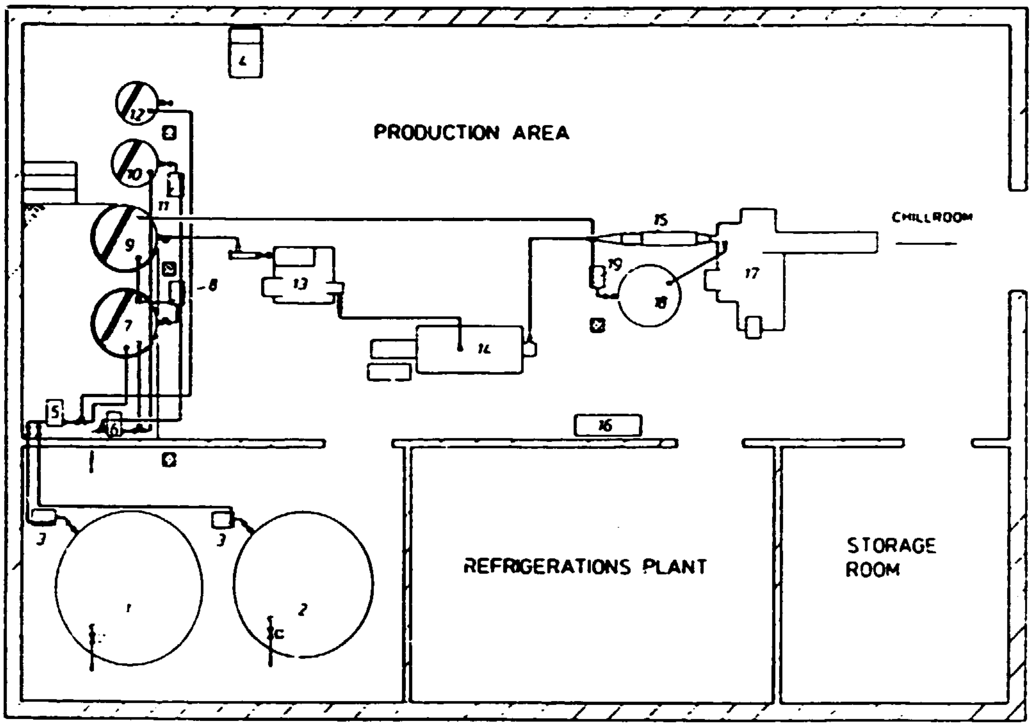
In the course of the past 50 years margarine has been developing steadily into a nutrient fat of high dietetic value that in many cases is even preferable to butter. It is spreadable, an emulsion of certain oils and fats. For oil, soya oil, cotton-seed oil, sunflower oil or peanut oil are the main ingredients; cocoa fat, palmoil or palmkernel fat the main fats. Apart from these vegetable raw materials, high-value oils from mammals or fish can also be used for the production.

Margarine contains polyunsaturated fats which contribute to the reduction of the cholesterine level thus also reducing the risk of degeneration of arteries and coronary vessels, which is one of the main reasons for heart-attacks and apoplexy of the brain.

Hence margarine also has become an important component of a healthy diet increasing its appeal to all those who want 'to lead a healthy life'.

The described plant has been designed for the production of table margarine with a capacity of 500 kg/hour.

Layout of the Production Plant



Description of the Production Process

Oils and fats in the required quantities are conveyed from the storage tanks 1+2 via the volumetric meter 5 into the stirring vessels by means of centrifugal pumps 3. Whilst in the stirring vessel 7 the margarine consisting of oil, hydrogenated fats, emulsifier, lecithin, water, salt and other ingredients, is formed. The stirring vessel 9 is used as buffer vessel. The emulsifier/lecithin phase is formed in the stirring vessel 12 and manually led to the stirring vessel 7. The water/salt phase is formed in the stirring vessel 10. The necessary water quantity for the batch is added via the volumetric meter 6. By means of the centrifugal pump 11 and again via the volumetric meter 6 the water/salt phase is led into the stirring vessel 7. Until the margarine emulsion is pumped into the buffer vessel 9 by means of the centrifugal pump 8, the emulsion is kept circulating in the stirring vessel 7 by the same pump to guarantee a steady and continuous mixing procedure.

A gear pump 13 pumps the margarine emulsion to the Kombinator. This Kombinator is a permanently operating heat-exchanger in which internally rotating knives keep on scraping the product from a cylindrical heat transmis. on surface. From the Kombinator the product is conveyed via the resting implement 15 to the packing station 17.

In case of any faults in the production the margarine can be conveyed to the remelting vessel 18 to be liquefied again and conveyed back to the buffer vessel 9 by the centrifugal pump 19.

In the packing station the final product is automatically filled into the containers.

Example of the Plant

Required Machinery and Equipment

Item	*Description*	*Pieces*
1	Storage tank, heatable	1
2	Storage tank, non heatable	1
3	Centrifugal pumps	2
4	Balance for ingredients	1
5	Volumetric meter (heatable)	1
6	Volumetric meter (non heatable)	1
7	Fat blend tank (mixing)	1
8	Centrifugal pump	1
9	Fat blend tank (buffering)	1
10	Stirring vessel	1
11	Centrifugal pump	1
12	Stirring vessel	1
13	Gear pump	1
14	Kombinator	1
15	Resting implement	1
16	Electrical control panel	1
17	Packing machine for cups	1
18	Remelting vessel	1
19	Centrifugal pump	1
20	Refrigeration plant for Kombinator	1
21	Refrigeration plant for the cooling chamber	1
22	Piping system	1
	FOB-price for machinery and equipment approx.	US$ 450.000.00

APPENDIX 7.1.

Analysis of fatty acids as fatty acids methyl esters

Performed at Agricultural University of Poznan, Institute of Food Technology of Plant Origin, Food Concentrates Laboratory

SAMPLE PREPARATION:

Approximately 100 mg of fat (plant oil or fat extracted from food material) is to be dissolved in 1 ml of hexane. Subsequently 1 ml of 0,5M CH_3ONa is added and the mixture is left for ≈20 min. After that time ≈10 ml of distilled water is added and from the upper (hexane) layer 0,1 µl is taken with a syringe and injected into GC.

GC ANALYSIS of fatty acids from milk and food concentrates with milk added:

EQUIPMENT:

Hewlett Packard HP 5890II with FID detector
Column Supelco Wax-10 (30 m x 0,25 mm x 0,25 mm)
Carrier gas: He 1,5 ml/min, split 1:40
Injector temperature 250°C
Detector temperature 260°C
Oven program: init. temp. 90°C
90°C to 170°C, 6°C/min
170°C to 240°C, 2°C/min
Correction factors (Die Nahrung 25(6), 591-603)

Fatty acids determined with this method:
C4:0, C6:0, C8:0, C10:0, C12:0, C14:0, C14:1ω5, C15:0i, C15:0ai, C15:0, C15:1, C16:0, C16:1ω9, C16:1ω7, C17:0, C17:0ai, C17:1, C18:0, C18:1ω9, C18:1ω7, C18:1ω6, C18:2ω6, C18:2ω9, C20:0, C20:1ω9, C20:1ω6, C22:0, C22:1, C24:0.

For analysis of plant oils sufficient is the program beginning at 170°C to 240°C in 2°C/min.

RECOMMENDED LITERATURE:

W.W. CHRISTIE. Gas Chromatography and lipids (1989). The Oily Press Ltd. Ayr, Scotland.

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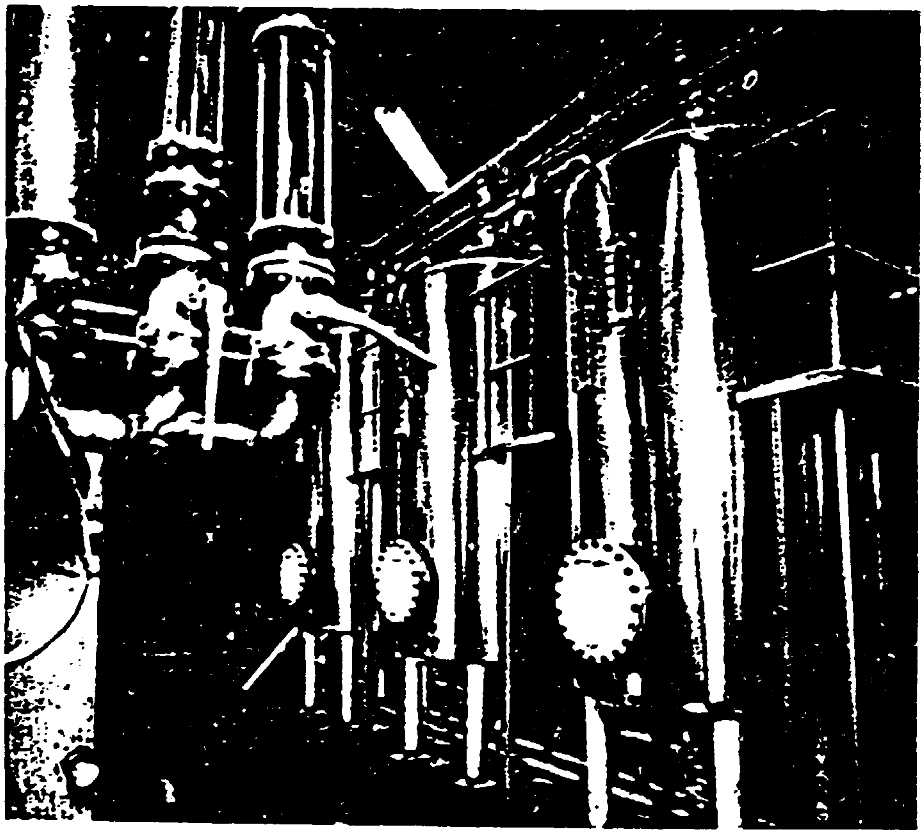
ISIC 3510

APPENDIX 8

Starch Hydrolysis Products Plant



View of Isomerization Column

The products which can be produced through saccharification of starch are glucose syrup, dextrose syrup or crystal dextrose, 42% fructose syrup and 55% fructose syrup

These products can also be selectively produced according to needs Especially, fructose syrups are very good products and can partially replace the sucrose being imported by many countries 55% Fructose syrup which was developed in the 1970s all over the world can be supplied at lower prices and with better sweetness than surcose as new product In general, these products are used in foods confectionery, beverages, etc

The plant introduced here is the same as those in America and Japan in the aspect of yield, consumption of secondary raw meterials and energy while its equipment for production can be supplied at lower prices The full technology, consultation services and information and advice relating to the operation and management of their plant can also be supplied

The services and information which can be supplied is for the purpose of helping to reduce costs of production, improve the efficiency and operation of the plant as well as the quality of the products

Products and Specifications

The products currently produced by this plant include glucose syrup dextrose syrup or crystal dextrose 42% high fructose syrup and 55% high fructose syrup based on the saccharification of starch

Detailed specifications of typical products are as shown in table 1

Table 1. Specifications of Glucose Syrup, Dextrose, High Fructose Syrup

o Dextrose

Classification	Item	Package	Specification		Special feature	Use
			Common	Item		
Refined powder dextrose	Special A 1A 1B	20 kg Paper bag	DE 96 ↑ Mo. 9% ↓	Particle size +60 mesh ↓ Particle size +30 mesh ↓ Particle size +20 mesh ↓	· sanitary products of spray dried. · restraint of microorganism's growth is superior due to high osmotic pressure. · change of particle size is possible by order.	confectionary, bakery, dairy products, beverage, canning, ice cream, leather etc.
Dextrose monohydrate	Regular	20 kg Paper bag	DE99.5 ↑ Mo. 9% ↓	Particle size +30 mesh ↓ Particle size +80 mesh ↓	· pure crystal of monohydrate · mouth feeling is good due to quick solubility. · price is cheaper than crystal products.	confectionary, beverage, cosmetic, ice cream nutrient agent for medicine, brewing industry etc.
Dextrose anhydrous	Regular Powder	20 kg Paper bag	DE99.5% ↑ Mo. 0.5% ↓	Particle size +24 mesh ↓ Particle size +80 mesh ↓	· crystalline without hydration. · Stable to heat than dextrose monohydrate.	antibiotics, injection, cosmetic, tea binder high grade liquor etc.
Liquid dextrose	G-60	Tank lorry	Mo. 40% ↓	DE 96.0 ↑	· Price is cheap · easy handling because of liquid phase. · adjustrable D E and Moisture content by order	confectionary, bakery, canning, leather, dyestuff, beverage, fermentation.

o Glucose syrup

Classification	Package	Specification	Special feature	Use
Medium D.E. glucose syrup	24 kg can, tank lorry	Mo. 18-25% DE 90-95	· stable to long period storage and hardly colored with high temperature.	candy, confectionary, dairy products, bakery, meat processing, canning, ice cream, cooking for home etc.
High D.E. glucose syrup		Mo. 18% ↓ DE 50 ↑	· adjustable DE and moisture content by order.	
Malto dextrin syrup	23 kg can, tank lorry	Mo. 29.5% ↓ DE 20-35	· can reduce retrogradation of starch in food. · High viscosity and coagulating power	coffee cream, canning, candy, confectionary, dairy products, ice cream.
Maltose syrup	5 kg 24kg can, tank lorry	Mo. 18% ↓ Maltose 40-50%	· glossness is good and hard to coloring and moisturing of processed food. · have mild sweetness and good application in surface coating of food.	candy, confectionary, caramel, meat processing, canning, beer, preservative improver for fast type food.

o High Fructose Corn Syrup

Classification	Package	Specification	Special feature	Use
42% High fructose syrup	25 kg can, 1000kg container tank lorry	Mo. 25% ↓ Fructose 42% ↑ Glucose 50% ↑	· have good fluidity · similar sweetness with sucrose by dry basis. · good resistance of microorganism's growth.	beverage including coke, confectionary, bakery, ice cream, canning, fish processing, medicine, substitution for sugar and treacle (or molasses)
55% High fructose syrup		Mo. 23% ↓ Fructose 55% ↑ Glucose 39% ↑	· have same or more sweetness with sucrose by dry base · can store long period in relatively low temp. (no crystal formed)	

2) Equipment and Machinery

Liquefaction and saccharification section
- Starch slurry tank
- Control tank
- Service tank
- Reactor
- PH control tank
- Enzyme tank
- Saccharifying tank

Decolorization and filtration section
- Decolorization tank
- 1st Activated carbon tank
- 2nd Activated carbon tank
- Carbon injection pump
- Feed pump

Refining section
- Receive tank
- Feed pump
- Plate heat exchanger
- Ion exchange resin tower
- Refined hydrolysate storage tank
- Refined hydrolysate pump

Isomerization section
- Dextrose storage tank
- Dextrose feed pump
- Vacuum pump
- Plate heat exchanger
- Syrup receive tank
- Syrup pump

Evaporation Section
- Feed tank
- Feed pump
- Evaporator

Fructose, Glucose Separation Section
- HFS storage tank
- HFS pump
- HFS control tank
- F/G separation column
- Fructose rich receive tank
- Fructose rich pump
- Glucose rich pump

3) Raw Materials and Utilities

Raw materials and utilities	Requirement (per ton of product)	
	Dextrose monohydrate	55% HFS
Corn starch Tapioca starch	1.1 m/t-D.S	0.965 m/t-D.S
Calcium chloride ($70\% CaCl_2$)	0.3 kg	0.3 kg
Sodium hydroxide (40% NaOH)	12 kg	18 kg
Hydrochloric acid (35%-Hcl)	12 kg	20 kg
Activated carbon	1.5 kg	2 kg
Steam	2.3 m/t	1.3 m/t
Electric power	120 kwh	90 kwh
Water	8 m^3	12 m^3

Example of Plant Capacity and Construction Cost

1) Plant capacity : 70 m/t/day
   - Basis : 10 hrs/day

2) Example of construction cost (as of 1983)
   - o Equipment and machinery : US$4,500,000
   - o Material cost : US$1,500,000
   - o Installation cost : US$1,200,000

   Total : US$7,200,000

3) Required space
   - o Site area : 15,000 m^2
   - o Building area : 3,000 m^2

4) Personnel requirement
   - o Manager : 10 persons
   - o Engineer : 10 persons
   - o Operator : 40 persons
   - o Others : 20 persons

   Total : 80 persons

Contents of Technology

1) Process Description

Liquefaction section

PH and concentration of the refined starch slurry are adjusted at room temperature, and then enzyme co-factor is added. The starch slurry is passed through a high temperature holding cell. The slurry is fed into reactors for proper retention. In the reactors the product is fully liquefied and transferred to the saccharification section.

Saccharification section

The hydrolysate coming from the liquefaction reactors is cooled by means of heat exchanger. The hydrolysate pH is adjusted and enzyme is automatically and continuously dosed into the hydrolysate. The saccharification takes place in the saccharifying tank and after proper retention time the final DE is obtained.

Decolorization and filtration section

After saccharification the color bodies are removed and then non-soluble part of the protein and fats are separated from the hydrolysate in this section.

1st Refining section

The clear and decolored hydrolysate is led to the 1st refining section consisting of cation, anion and mixed bed exchangers. In the cation exchangers, sodium, calcium, iron, copper, etc. are removed. Some amino acids are also removed. The anion exchangers remove chlorides, sulphates, phosphate and most of the remaining soluble amino acids. The mixed bed tower also reduces dissolved solids to maximum extent.

Isomerization section

By continuous enzymatic conversion, part of the liquid dextrose is made into fructose syrup and then isomerized fructose syrup is obtained.

2nd Refining section

After the isomerization the syrup is led to the 2nd refining section where the syrup is subjected to a second demineralization.

Evaporation section

The evaporation takes place in a double-stage evaporator according to the falling-film principle where the product flows from the top to the bottom of the inside wall of vertical heating tubes as a thin boiling film. After the evaporation, part of the product is pumped into F/G separation system.

F/G Separation section

The purpose of this system is to obtain higher fructose syrup by the chromatographic separation technique. After the F/G separation the high fructose syrup is demineralized again in a mixed bed ion exchanger.

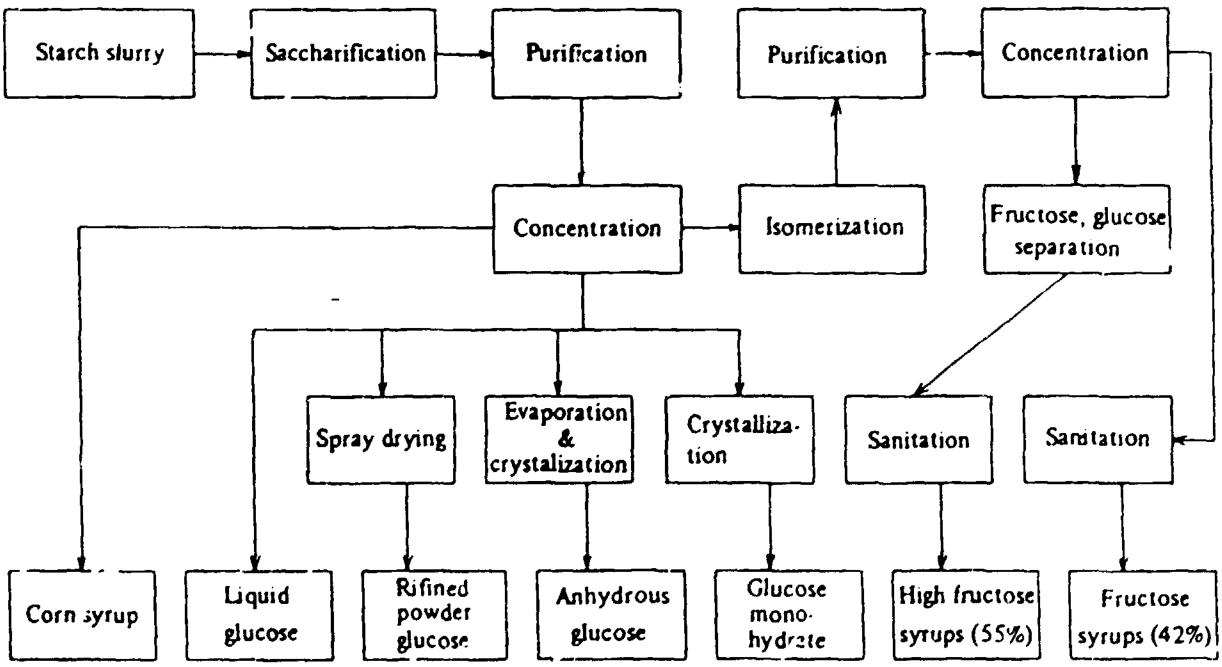
Sanitation section

Produced high fructose syrup is filtered to remove micro-organisms and fine insoluble impurities and then sterilized and cooled by plate type heat-exchanger.

Final product

Final product is thus produced by these processes.

Dextrose and High Fructose Syrup Manufacturing Process Block Diagram



APPENDIX 8.1

File: A 44
ISIC CODE 3121

How To Start Manufacturing Industries

Starch Derivatives Production

Introduction

For many years starch and starch containing materials have been converted by means of high temperatures in the presence of catalysts into soluble sweet products.

Early in the last century it was discovered that, if potato starch slurry is treated with acid, a sweet tasting syrup was produced, from which dextrose crystallized.

Since that time starch production from amylaceous raw materials and starch processing into high-quality starch derivatives has made enormous technological progress, especially over the past thirty years.

In general large amounts of starch are processed into starch sweeteners. Any purified starch extracted, for example, from maize (corn), millet, wheat, rice, potatoes, or from tropical roots such as manioc, tapioca, cassava and yucca, can be used for this purpose. It is hardly often that these raw materials are processed directly into starch sweeteners without starch as an intermediate.

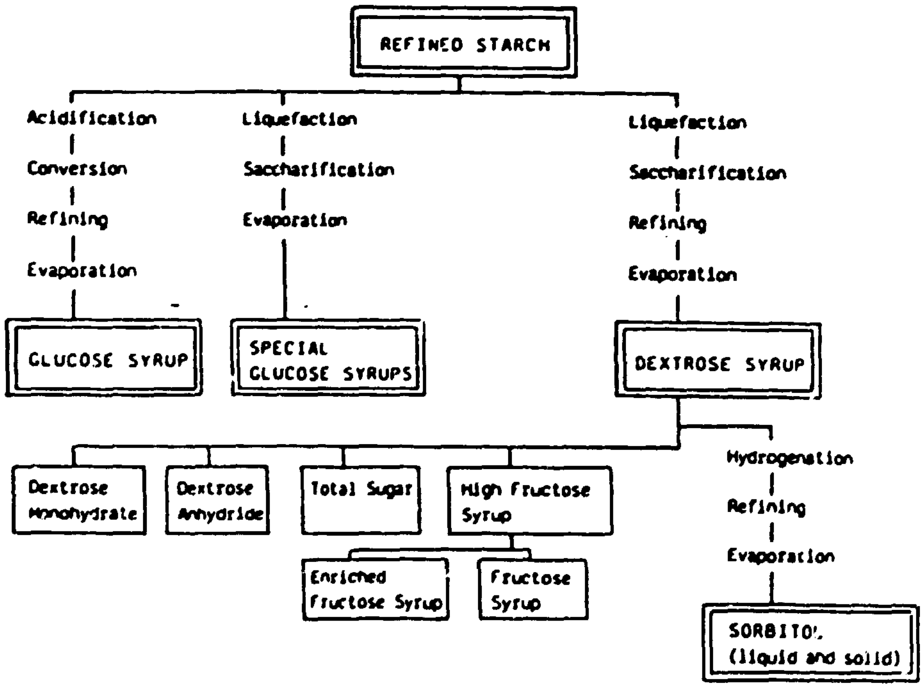
Starch sweeteners/derivatives are primarily subdivided into glucose syrup (including the "family" of special glucose syrups) and dextrose syrup (as base for subsequent forms of dextrose).

Process Description

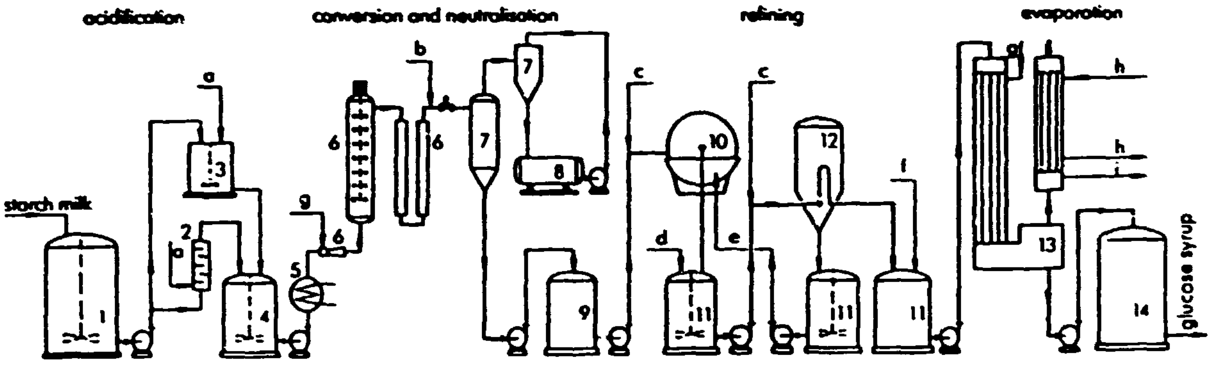
The process descriptions hereafter refer to the production of:

1. Glucose syrup
2. Special glucose syrups
3. Dextrose syrups
3. Sorbitol (one of the subsequent products out of dextrose syrup)

Synoptic Chart of Starch Derivatives



Process Flow Diagram for Glucose Syrup



1 starch milk tank
2 continuous acidification
3 batch acidification
4 acidified starch milk tank
5 heat exchanger
6 continuous converter
7 flash cooling
8 hot water aggregate
9 neutralisation tank
10 filter
11 tanks
12 candle filter
13 evaporator
14 product tank

a HCl
b Na_2CO_3
c filter aid
d activated carbon
e used activated carbon
f $NaHSO_3$
g steam
h cooling water
i vapour condensate

1. Glucose Syrup

Glucose syrup is used in the food industry not only because of its sweetness and its nutritive value, but in particular for its functional properties (stabilization of moisture, softening ability, build-up of texture, prevention of crystallization of other sugars, formation of film and body). In the first place it is used for sweets and confectionery, ice cream, pastries, preserves and liqueurs.

Glucose syrup is a sweet, colourless, highly concentrated solution of a mixture of easily digestible sugars. Glucose syrup produced by the standard method, i.e. single-stage hydrolysis of starch with acid, has a DE between 32% and 55%. A DE of approx. 42% (which is the most common syrup) goes with a constant sugar spectrum of about 19% glucose, about 14% maltose and about 67% oligosaccharides. This syrup is concentrated to 43–45% Baumé equalling 81–85% dry substance, and at 45% Bé it is a very viscous product.

To produce glucose by acid hydrolysis, purified starch milk is acidified (commonly in the presence of hydrochloric acid as a catalyst) to an acidity of 0.03 n HCl. In a converter the acidified starch is converted at high temperature into a mixture of glucose, maltose and higher saccharidies. With the aid of such process parameters as temperature, pH value, concentration and residence time (which have to be checked very carefully) it is possible to choose a degree of saccharification (DE) being equivalent to a defined sugar spectrum.

After hydrolysis, the hydrolysate is cooled down, and soda is added for neutralization in order that the impurities in the starch (protein, fat) flocculate can be removed by mechanical means, either by separators or by rotary precoat filters.

In general, decolourization of the hydrolysate proceeds in two stages in the presence of activated carbon. The filters (rotary filters, candle filters, filter presses) required to filter the juice and to separate the activated carbon are of the precoat type. If need be, ion exchangers can be employed to demineralize the glucose. Finally, the purified glucose is evaporated in a vacuum to the final concentration of 81% to 85% dry substance.

The starch generally used for acid hydrolysis is corn starch or root starch which has to be purified very thoroughly. Since starch to be hydrolyzed has to be suspended in water, a glucose factory quite often is combined with a starch factory so as to avoid the necessity of drying the

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* DE: Dextrose Equivalent, expressing the degree of hydrolysis (conversion) and, consequently, the breakdown of the glucose chains in the starch.
Since glucose and maltose-type sugars, unlike the starch molecule, have reducing aldehyde groups, this reducing property can be utilized to define the DE. The DE is the percentage of reducing sugars (in terms of glucose) in the dry substance of the product concerned. The DE of starch is 0% and that of pure glucose is 100%. The DE is just a measure of the number of reducing groups present, but does not disclose any details about the sugar spectrum, i.e. the percentages of glucose, maltose and higher saccharides.
The acid hydrolysis, acid-enzyme breakdown and double-enzyme process makes it possible to produce substances having different DEs and a different sugar spectrum.

starch first and then re-dissolving it in water. For another thing, the factory should be located in the centre of its market area in order to minimize syrup transport costs. For root starch which in most cases is produced in places far away from the centres of glucose consumption, it might therefore be expedient to use dry starch.

2. Special Glucose Syrups

Maltose syrup and high-DE glucose syrups can be produced by two-stage acid/enzyme or enzyme/enzyme saccharification. Though their DE is the same as that of standard glucose syrup, these syrups have a different sugar spectrum and, as a result, specific properties such as more sweetness, a better crystallization-inhibiting effect upon sucrose, and less hygroscopicity.

The applications of these syrups are the same as those of standard glucose syrup, and owing to their favourable properties they are being used to an increasing extent – in spite of the fact that their price is higher.

Generally speaking, low-DE syrup is highly viscous and imparts texture and body to the product; high-DE syrup is used for its sweetness.

The principal fields of application of these glucose syrups are as follows:

- Low-DE syrup, 20–38 DE:
  Frozen dairy products, beer;
- Normal-DE syrup, 38–58 DE:
  Confectionery such as drops, gelatine and jelly sweets, chewing gum, marzipan, etc., beverages, frozen dairy products;
- High-DE syrup, 58–70 DE:
  Soft drinks, jams, pastries, ice cream.

Special glucose syrups can be produced at a normal glucose factory practicing the acid hydrolysis technology, provided the plant is supplemented by the equipment required for enzymatic saccharification.

Table of Typical Sugar Spectra of Glucose Syrups

DE	*Process*	*Sugar spectrum (%)* glucose	maltose	oligo-sacch.	*Glucose variety*
32	Acid	11	10	79	low-DE
42	Acid	19	14	67	normal-DE
55	Acid	31	18	51	normal-DE
47	Acid/ enzyme	12	50	38	maltose syrup
63	Acid/ enzyme	37	31	32	high-DE
97	Enzyme/ enzyme	96	3	1	dextrose syrup

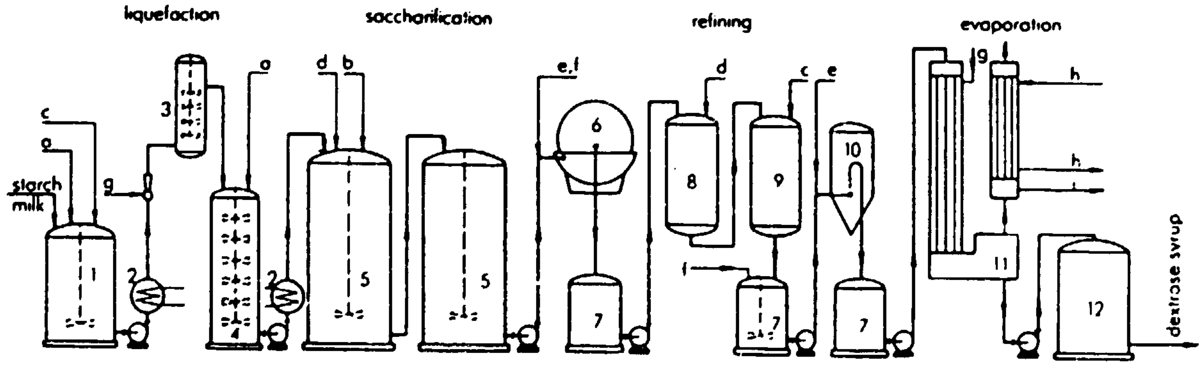
Some maltose syrup varieties are made by the enzyme-enzyme process, but this process requires the same equipment as dextrose syrup production.

3. Dextrose Syrup

Dextrose syrup is a sweet, colourless, concentrated solution having a DE of 97–89%, a typical sugar spectrum of 96% glucose and 4% maltose and oligosaccharides, and a concentration of 71% dry substance. It is made from starch milk by two-stage enzyme-enzyme liquefaction and saccharification.

Very high DE dextrose syrup is used for pastries, soft drinks, etc. In general, however, dextrose syrup is an intermediate which quite often the producer himself tranforms into high fructose syrup, dextrose monohydrate and sorbitol.

Process Flow Diagram for Dextrose Syrup



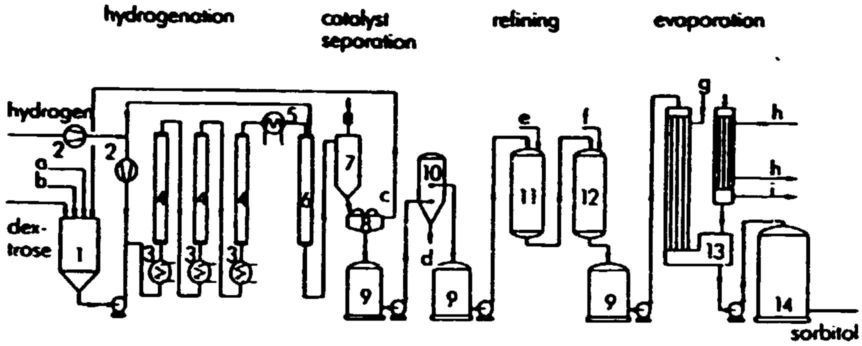
1 starch milk tank	7 tanks	a α-amylase	f activated carbon
2 heat exchanger	8 cation-exchanger	b amyloglucosidase	g steam
3 preliquefaction	9 anion-exchanger	c NaOH	h cooling water
4 liquefaction tank	10 candle filter	d HCl	i vapour condensate
5 saccharification tank	11 evaporator	e filter aid	
6 filter	12 product tank		

Examples for the Different Production Plants

Designation	*Dimensions or Quantities*	*Final Products*: *Glucose Syrup*	*Special Glucose Syrup*	*Dextrose Syrup*	*Sorbitol*
Capacity min. approx.	t/d	5–10 t/d batch wise 10 t/d continuously	5–10 t/d batch wise 10 t/d continuously	5 t/d	5 t/d continuously
working time	h/d	24	24	24	24
Production equipment for process plants	see process flow diagrams				
Production material	kg per 1,000 kg DS final product	refined starch 1,000 kg DS	refined starch 1,000 kg DS	refined starch 967 kg DS	dextrose syrup 1.05 kg DS
Chemical and other additives	kg per 1,000 kg final product based on DS	Batch Cont. HCl (30%) 7 7 Na_2CO_3 (100%) 2.5 2.5 filter aid 6 6 activated carbon 6 6 $NaHSO_3$ – 0.18	Batch Cont. 7 7 2.5 2.5 6 6 6 6 – 0.18	-amylase 0.6 amyloglucosidase 0.8 NaOH 4 HCl (30%) 6 filter aid 3 activated carbon 3	catalyst 8.5 NH_3 3–4 HCl (30%) 38 NaOH 17 hydrogen H_2m^3 134
Approx. FOB price for the process plants	US$	5 t/d batch 0.7 Mill. 10 t/d cont. 0.9 Mill.		5 t/d 74% DS 1.0 Mill.	15 t/d cont. 70% DS 1.8 Mill.
Utilities for main production plants:	based on 1,000 kg DS	Batch / Cont.	Batch / Cont.		
Electrical power	kWh	120 / 70	120 / 70	110	155
Steam bar	kg/h	8 bars 1,000 / 1,200	1,000 / 1,200	10 bars 600	12 bars 3,200
Process water	m^3/h	0.25 / 0.25	0.25 / 0.25	1.2	2.8
Cooling water via cooling tower	m^3h	0.6 / 1.4	0.6 / 1.4	2.5	4
Manpower requirements	per shift	Batch / Cont.	Batch / Cont.		
Chemist		1 / 1	1 / 1	2	1
Foreman		1 / 1	1 / 1	2	1
Workers skilled		2 / 3	2 / 3	4	2
Workers skilled		4 / 4		6	2
Laborant		2 / 2		3	1
Space requirement (main prod. + aux. plants)	m^2	480 / 600 ÷ 800	480 / 600 ÷ 800	2,400	at 10–30 t/d production 1,200
Open area	m^2	depending on storage possibilities			

File: A 44

Process flow Diagram for Sorbitol



1 feed tank
2 HP-compressor
3 HP-heat exchanger
4 HP-reactor
5 HP-cooler
6 HP-gas/sorbitol separator
7 LP-gas/sorbitol separator
8 separator catalyst/sorbitol
9 tank
10 candle filter
11 cation-exchanger
12 anion-exchanger
13 evaporator
14 product tank
a catalyst
b NH_3
c recycled catalyst
d non-active catalyst
e HCI
f NaOH
g steam
h cooling water
i vapour condensate

This intermediate should contain a very high percentage of glucose and the least possible amount of other saccharides: this can be achieved by using enzymes specifically breaking the starch molecule in both liquefaction and saccharification.

Usually, starch liquefaction proceeds in two stages in the presence of thermostable alpha-amylase. In this case, part of the enzymes is added to the starch milk, and the starch is preliquefied in a steam-heated converter. Liquefaction to the required DE of approx. 12 then proceeds in a retention zone at a temperature of 95°C for a period of 90 to 120 minutes.

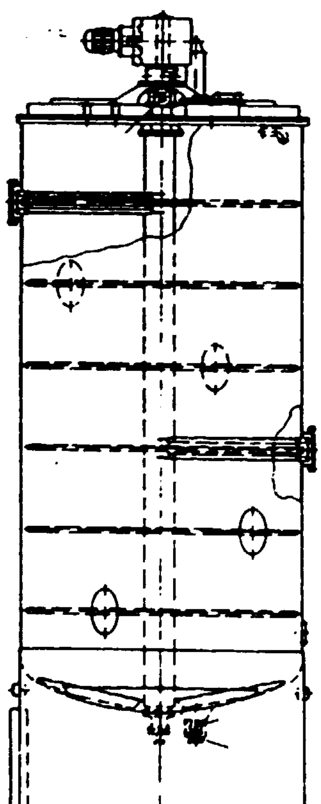
Starch liquefaction is followed by saccharification in the presence of amyloglucosidase. Saccharification is a slow process which takes about 48 to 72 hours. A larger amount of enzymes reduces the reaction period. Saccharification takes place in tandem-arranged tanks ensuring a continous flow. Prior to saccharification, the hydrolysate has to be cooled to approx. 60°C and set to a pH of 4.5.

This is followed by multi-stage purification of the thin dextrose juice to give the required product quality. The purification process comprises: separation of insolubles such as protein, fat, etc., decolourization with the aid of activated carbon, and elimination of all salts in ion exchangers. Finally, the demineralized product is evaporated in a multi-effect evaporator plant to the degree of concentration required for further processing.

4. Sorbitol

Sorbitol is a hexahydric alcohol (sugar alcohol) and is a resultant product of dextrose. It is available in liquid form containing 70% dry substance and in solid form (granular or powdered).

In the food industry sorbitol is used as a substitute of sugar for diabetics' food. Today sorbitol is the only raw material that permits econom-



Continuous Dextrose Crystallizer

ical production of ascorbic acid (vitamin C). In the cosmetics industry it is an essential consistency-stabilizing constituent of toothpastes and creams. Moreover, sorbitol is used for tobaccos and in the chemical industry for plastics, resins, adhesives and plasticizers (paper, leather, textiles).

Sorbitol is produced by catalytic hydrogenation of dextrose (glucose) at an increased temperature by the following empirical formula:

$$C_6H_{12}O_6 + H_2$$

$$\downarrow$$

catalyst

$$\downarrow$$

$$C_6H_8(OH)_6$$

For sorbitol production a continuous high-pressure hydrogenation process is applied, proceeding at 150 bar and 180°C, its special Raney nickel catalyst being continuously separated from the sorbitol solution after hydrogenation and being recycled.

After hydrogen removal, the sorbitol/catalyst mixture is reduced to normal pressure and the catalyst is separated from the sorbitol in such a way that the active particles only are recycled for re-use. The inactive particles are filtered off and can be regenerated.

The sorbitol is decolourized and demineralized in ion exchangers and then evaporated to a dry substance content of 70%.

Dry sorbitol can be produced from liquid sorbitol either by crystallization or by drying.

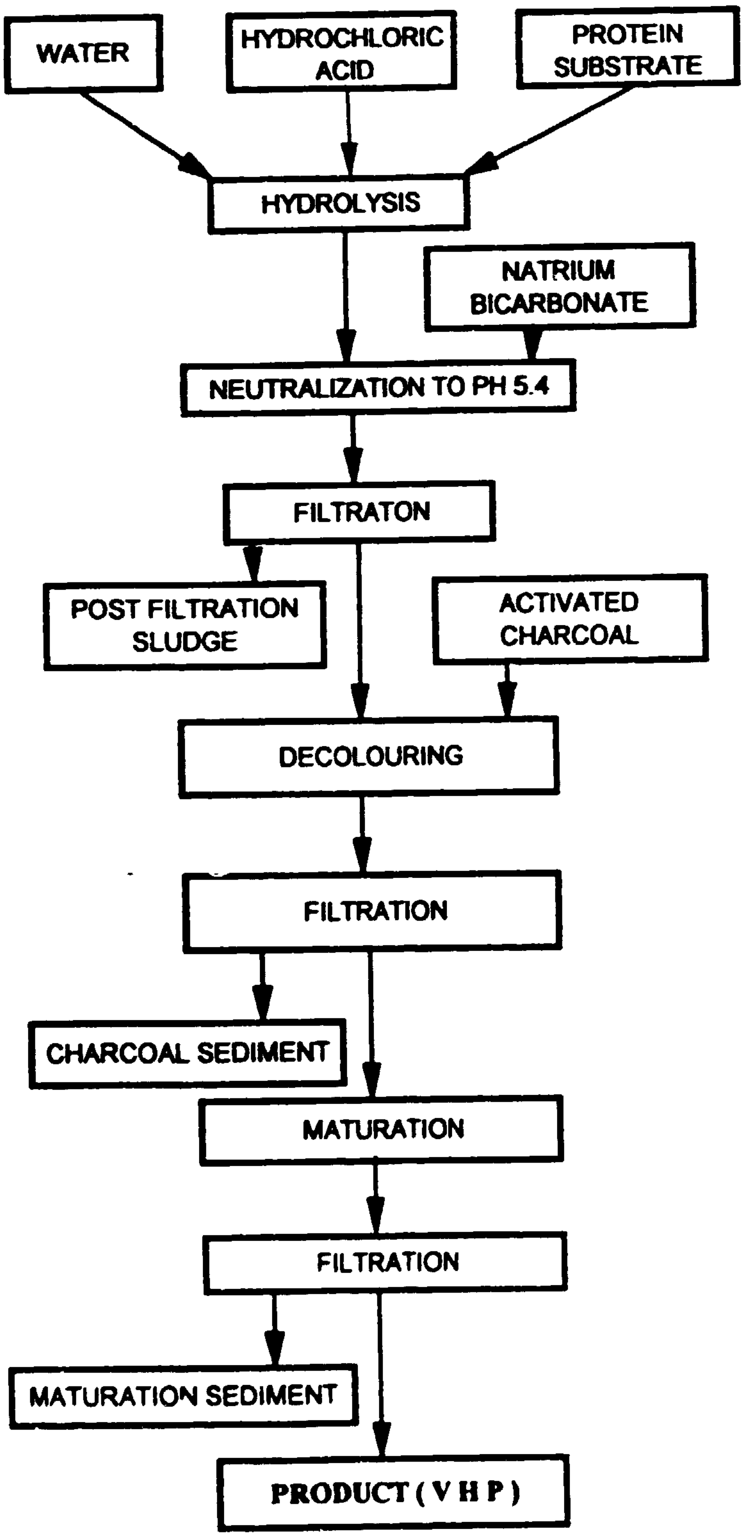
Either dextrose monohydrate dissolved in water or dextrose syrup may be used as a starting material. The syrup is mixed with the recycled catalyst and pumped into the high-pressure hydrogenation reactor with hydrogen gas being added at the same time. The heating and reaction processes proceed in several steps in order to prevent side reactions. When hydrogenation is finished, the mixture is cooled and the hydrogen gas is separated from the sorbitol/catalyst mixture.

Since the hydrogenation process requires hydrogen, this hydrogen has to be produced by electrolysis of water or has to be made available from another process source. A compressor keeps this gas and the recycled hydrogen at an operating pressure of 150 bar.

This information has been prepared by UNIDO as a result of the financial contribution to UNIDO from the Government of the Federal Republic of Germany and the close co-operation extended to UNIDO by the relevant industries in the Federal Republic of Germany.
Any inquiry should be sent to Registry file no. 312/07 (003), UNIDO, P. O. Box 300, A-1400 Vienna, Austria.

APPENDIX 9

SCHEME OF PRODUCTION OF VEGETABLE HYDROLIZED PROTEIN(VHP)



LIST OF EQUIPMENT

PANEL HEATER WITH FLOW CONTROL

MEASURMENT DESIGN FOR HYDROCHLORIC ACID

CONTAINER FOR PROTEIN SUBSTRAT

AUTOCLAVES

MEASURMENT DESIGN FOR BECARBONATE

NEUTRALIZERS

FILTER PRESS

CONTAINER FOR DECOLOURING (HEATED)

FILTER PRESS

MATURATION TANKS

FILTER PRESS

STORAGE TANKS

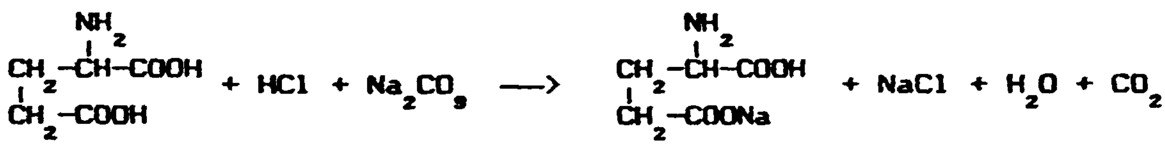
OPTIMUM HYDROCHLORIDE ACID AMOUNT ADDED FOR ACID HYDROLYSIS OF GLUTEN

$$Z = \frac{C_{HCl}}{C_N} * Q_N * f = \frac{36,465}{14,008} * Q_N * f$$

where:

- Z - optimum of hydrochloride amount for protein substrate proccessed,
- C_{HCl} - hydrochloride molecular weight,
- C_N - nitrogen atom weight,
- Q_N - amount of total nitrogen introduced as a protein substrate,
- f - coefficient characteristic for the protein substrate processed.

CHEMICAL REACTION FOR THE NEUTRALIZATION OF HYDROCHLORIC ACID BY SODIUM BICARBONATE IN VHP MEDIUM AND FORMATION SODIUM GLUTAMATE.



AMINO-ACID COMPOSITION OF HUMAN BREAST MILK

CASEIN, WHEY PROTEIN, EGG, BEEF, WHEAT GLUTEN

(mg amino-acid per g total nitrogen)

Amino-acid	Human breast milk	Casein	Whey protein	Egg	Beef	Wheat (whole grain)
Isoleucine	254	345	476	393	301	204
Leucine	471	607	736	551	507	417
Lysine	337	518	704	436	556	179
Methionine	78	178	151	210	169	94
Cystine	114	23	174	152	80	159
Phenylalanine	171	334	224	358	275	282
Tyrosine	223	371	214	260	225	187
Threonine	228	297	527	320	287	183
Tryptophan		103	147	93	70	68
Valine	296	430	449	428	313	276
Arginine	171	239	175	381	395	288
Histidine	114	186	144	151	213	163
Alanine	166	196	341	370	365	226
Aspartic acid	451	455	766	601	562	308
Glutamic acid	1000	1406	1231	796	955	1866
Glycine	98	126	126	207	304	245
Proline	513	738	450	260	236	621
Serine	228	385	374	478	252	287

Tomato Ketchup Making Plant

Tomato ketchup, tomato juice and tomato purée, the secondary processed products of fresh tomato, have come to be consumed in vast amounts today in our homes as well as in restaurants and other places as an indispensable food in our daily living.

Tomato has long been processed into tomato ketchup in Italy, Greece, the West Coast of the U.S. and other parts of the Western World, where tomato is suited for cultivation on a large scale.

It was some 80 years ago that tomato was first cultivated and placed on local markets in Japan. In those days, with the Japanese people still quite unfamiliar with tomato, it failed to gain consumer acceptance and naturally tomato growers were distressed with the problem of how to move the product on vegetable store shelves.

It was only a few decades ago, when imported tomato ketchup paved the way, that the manufacture of tomato ketchup came to be undertaken in Japan as a home industry. And today, the most modernly equipped tomato ketchup making plants are in operation to meet the large national demand for the product.

The manufacture of tomato ketchup can be undertaken only when two basic conditions are met – the availability of a large and stable supply of fresh quality tomato, and the availability of a vast supply of water.

While tomato is an annual plant, its method of cultivation will differ according to the soil. An ideal environment for tomato cultivation would be a place having sharp temperature difference – warm in the daytime and cool in the nighttime, and the soil should preferably be dry rather than moist.

In most regions, letting the tomato plants to trail on the ground would cause ripened tomato to be covered with dirt or other foreign matter, so to prevent this the plants are normally supported with thin bamboo stalks or other kinds of rods. In arid regions, the plants may be left to trail on the ground since there would be no such anxiety.

Since the quality of the ketchup that is produced will be determined largely by the quality of the tomato used as raw material, a great importance is attached particularly to tomato cultivation itself. For example, while Japanese tomato processors purchase their tomato by quantity or by cultivated area, they make it a point to offer technical guidance to tomato growers. This is done primarily to improve the processability of the tomato they purchase.

Now, as pointed out earlier, a large amount of water will be necessary for a tomato processing plant. Namely, since the peak tomato harvesting time is generally concentrated over a period of only about a month to 45 days, it will be necessary to process a huge amount of tomato quickly in a very short period to time. And as the same amount of water as the amount of tomato collected will be necessary for washing, a vast volume of water will be required by the plant.

Accordingly, when constructing a new tomato processing plant, the processing capacity of the plant will be determined not by the quantity of tomato available, but rather by the amount of water available with ease.

The tomato ketchup making plant, therefore, may be regarded as a typical seasonal industry, and one that is inalienably related to agriculture.

Process Description

The processes involved in the manufacture of tomato ketchup are indicated in the accompanying process flow sheet, a description of which follows:

Fresh tomato shipped to the plant is first of all washed clean with water. For this, a special washing technique has been developed that allows for preservation of the fresh, natural qualities of ripened tomato.

Washed tomato is crushed into tomato pulp, which is strained and filtered. This is followed with preheating and concentration to about one-third of its original volume by means of a continuous concentrator, for which boiler heat is used. Since the concentration should necessarily be achieved in very short time, each tomato ketchup manufacturer uses a special technical know-how.

Instantaneous concentration is necessary since, otherwise, heating the tomato pulp would cause it to be oxidized and discoloured into a dark-reddish, disagreeable colour, losing the savory, delightful colour of natural tomato.

Concentrated tomato pulp is homogenized, then given an addition of salt, sugar, spices and other ingredients in the Seasoning room, to give the tomato pulp the flavour associated with tomato ketchup. The product is next filled into bottles, then packed into dozen or gross cartons for shipment.

The description given above generally summarizes the processes involved in the manufacture of tomato ketchup. But while some manufacturers may process their entire stock of tomato into ketchup at a stroke, some may process a part or all of their tomato into primary paste, tomato pulp or tomato purée, and further process these stocks into tomato ketchup in accordance with market demands.

The entire process, from the charging of tomato into the Washing and Sorting Machine to the bottling of ketchup, is consummated in a processing cycle requiring only about 30 minutes. And to process fresh tomato into ketchup by the process described above, the plant will operate for about 40 days/year, of which roughly 10 days will require plant operation for a full 24 hours/day.

1) Collection
   Ripened tomato is harvested and collected at the plant during the day.

2) Charging
   Collected tomato is charged into the washing line.

3) Washing
   Dirt and other foreign matter are removed from tomato by washing and bubbling.

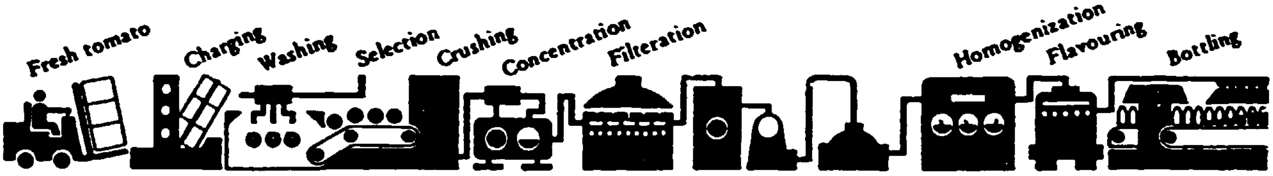
4) Sorting
   Good tomato is selected by removing rotten, crushed or unripened tomato

5) Crushing
   Tomato is crushed whole.

6) Concentration
   Tomato pulp is concentrated instantly by one third its volume, to the prescribed density.

7) Filtration
   Tomato peel and seed are removed here.

Process Flow Sheet for Tomato Ketchup Making Plant



8) Homogenization
Tomato pulp is homogenized.

9) Flavouring
Salt, sugar, distillation vinegar, spices, etc., are added.

10) Bottling
Ketchup is filled into bottles.

11) Cooling
Quick-cooling is done to inhibit quality deterioration due to temperature changes.

Example of Tomato Ketchup Making Plant

Production Scheme

Here, an introduction shall be given of a tomato ketchup making plant having a production capacity of 400 tons/day.

This plant is designed to operate about 40 days a year, with 10 days of work done continuously round the clock and the remaining 30 days of work done, under a 12 hours/day schedule.

Tables 1, 2, 3 an 4 show respectively required machinery and equipment, raw materials and utilities, manpower, and area for plant site.

Table 1: Required Machinery and Equipment

Item	No.
Tomato charging machine	1 set
Tomato washing and sorting machine	1 set
Continuous concentrator	1 set
Filter	1 set
Homogenizer	1 set
Seasoning mixer	1 set
Bottling machine	1 set
Cooler	1 set
Labeler	1 set
Packing machine	1 set
Water treatment facility	1 set
Boiler	1 set
FOB price . . (approx.)	$US 1,905,000

Table 2: Required Raw Materials and Utilities

Item	Quantity
Fresh tomato	500 tons/day
Sugar	small amount
Salt	small amount
Distillation vinegar	small amount
Spices	small amount
Bottles (400 g container)	13,250,000 pieces/year
Electric power	2,000 kWh/day
Water	500 tons/day
Fuel for boiler	5 tons/day

Table 3: Required Manpower

Item	No.
Engineer	1
Skilled worker	5
Unskilled worker	20
Total	26

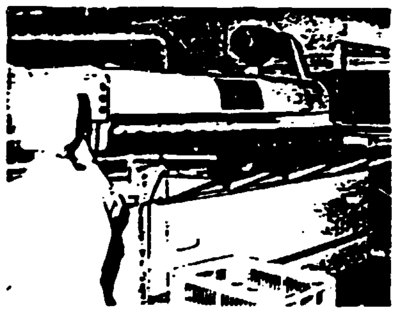
Table 4: Required Area for Plant Site

Item	
Buildings	2,720 m^2
Plant building	45 m x 50 m = 2,250 m^2
Product warehouse	20 m x 20 m = 400 m^2
Boiler room	10 m x 7 m = 70 m^2
Land	6,600 m^2

Locational Condition

For the reasons described earlier, the plant should be constructed as close as possible to a tomato cultivation centre, and at a place affording an ample supply of good water. And since the plant, by its very nature, is operated at full blast for a short span of time at a specific season, the location should permit easy procurement of cheap labour. In addition, it should be situated as close as possible to consumer markets, although this may be unnecessary in countries where transportation facilities are advanced, for the product withstands long preservation.


Bottling


Cooling

APPENDIX 10.1

FILE: 03
ISIC 3819

How To Start Manufacturing Industries

Canning Plant

Preservation of foodstuffs has been conceived as an art of living ever since the dawn of human history. At present, various methods of preserving food can be cited, such as canning, refrigeration, drying, salt-pickling, sugar-preservation and smoking. However, from the viewpoint of preservation, transportation, sanitation and economy, canned food can be said to be the most ideal as compared with food prepared by other methods.

The canner is defined as a person who manufacures canned food for sale. In actuality, however, canners do not manufacture the food contents of cans nor do they sell the containers. What they produce is quite different from food which is merely put into cans. In other words, they incorporate the contents with the can by a special process to produce merchandise known as canned food, which is different from the mere food contents or the containers.

Manufactured goods represent a special function created by a new combination. What is sold as canned goods is nothing but the result of the function.

The main features of canned merchandise are: (1) ability to withstand long term preservation and transportation; (2) simplification and sanitation of cookery and (3) processing feasibility (canning adds to the taste of food, i.e., fruits, syrup-preserves).

In laying down the conditions for determining the scale of the plant, the following points should be taken into consideration.

(1) Whether the product is suitable for mass production from the technical viewpoint.
(2) Whether the purchase of the same or similar product can be carried out continuously and in a large quantity.
(3) Whether the sale of the same or similar product can be realized continuously and in a large quantity.

General Process

The canning process begins with the filling of food into a tin-can followed by the seaming of these containers, and the final process of sterilization under heat. In other words, seaming is done to prevent air-flow between the outside and the inside of the can, thus preventing bacteria from getting into the can. Whereas, sterilization under heat is designed to decimate any bacteria inside the can, thus repressing the action of bacteria in and out of the can, which causes decomposition of canned food. In the case of canning, air exhaust is a normal process interposing between the seaming and sterilization processes. In the case of bottling by machines, exhaust, heating and sterilization operations are done separately, while simplified bottling adopts, in normal cases, a single heating method in which air exhaust and sterilization are done at the same time. It is to say that the main process in canning and bottling can be summarized in the three processes of exhaust, seaming and sterilization.

The manufacturing process of canning is uniform except for some difference in the cooking process resulting from the kind of raw materials used.

Raw Materials

In manufacturing canned food, a wrong selection of raw materials may affect the final product, no matter how carefully the subsequent process is executed. In using marine food, it is necessary to judge the degree of freshness when processing because of the easy deterioration of the material.

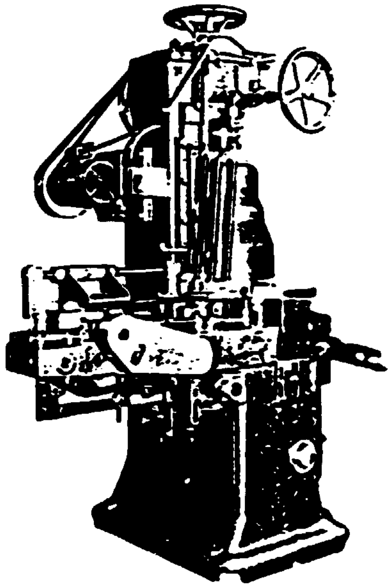
To cope with this, various physico-chemical studies have been conducted, such as refractive index measurement of the fixed quantity of decomposed product of meat albumen or eye-bal liquid.

With regard to agricultural raw materials such as fruits and vegetables materials of proper maturity must be used as they are indispensable for processing.

Example of Canning Plant

There are numerous kinds of canned foods, such as sea-food, fruits, vegetables, live stock products, soups and others. However, an example plant with a daily output capacity of 450 cans of boiled sardine (No. 4 can x 4 dozen) is taken up in view of the raw material collection situation.

The first factor which must be taken into consideration in the installation of a plant, is the collection of raw materials, and in particular, whether a supply of identical or similar types of fish can be obtained. It goes without saying that the supply and purchase of empty cans at a distant location is uneconomical in regard to freightage. In the case of a cannery, a plant having a production capacity of 450 cases per day falls in the medium and small-scale category.



Vacuum seamer

Process Description

1. Adjustment of Materials

1) Cooking

Cut off the fish-head and pectoral fin along the dirsiventral line diagonally with a small carver, and take out the bowels gently so as not to tear off the bowel tip. Cut the fish from into 9–10 cm length for the No. 4 can, 8 cm for the small No. 1 can, 11–14 cm for the oval can starting from the neck.

2) Washing

After cooking, the fish is washed to remove blood and scales. Washing is done by water chute or a tank.

3) Salting

The fish is then drained, and soaked into salt water of B 18 . Fatty fish of 90 g in weight are soaked for about 25 min., while thin fish must be taken out of the water in good time. Salting has the effect of giving fish a salty taste, strengthening the skin, removing blood, and preventing the growth of curd in the product. After having been salted, the fish undergoes rough washing with plain water or weak salt water.

2. Filling

Prior to filling, the fish is weighed. When filling half-cut fish as in the case of the small No. 1 can, it is desirable to put in an equal quantity of head and tail, or to fill more head than tail.

When there is direct filling without undergoing the salting process, refined salt is added to the amount of 2–2.5 g for the small No. 1 can, on condition that the degree of freshness of the raw materials is exceedingly high. If freshness is low, salt water will tend to cause contamination.

3. Steaming

Materials seamed by a vacuum seamer do not usually go through this process, though many plants are accustomed to employing this process. Filled can are arranged in a steaming basket with an open work bottom. Baskets are piled one on top of the other in several layers, placed on a small rack, and then sent into a tunnel-like exhaust box. Most of the steaming baskets in use are made of wood, the size measuring 47 x 47 cm, and capable of accomodating 36 No. 4 cans or 725 small No. 1 cans. It is preferred that the edge of the steaming basket has a height about 1 cm higher than that of an oval No. 1 can.

4. Seaming

Before seaming, each can must be weighed in order to prevent shortage of weight.

After seaming, the cans are fed into a jet-spraying can washer for cleansing with a neutral cleanser. Then they are rinsed with plain water to be transferred to a basket type retort.

5. Sterilization

Seamed cans undergo sterilization immediately. Unsteamed cans must not be left untouched for long, because the quality of the product will deteriorate.

Sterilized fish is cooled in the water, and is filled in a clean-wiped can.

Table 1: Standard of Canning Boiled Sardine

Can type	Sardine weight (g)	Gross weight (g)
No. 4	350	425
Small 1	125	155
Oval 1	320	425
Oval 3	150	215

Required Amount of Raw Material

The required amount of raw material varies according to the size of the fish and the dehydration amount. The standard amount is as shown in Table 2.

Locational Condition

The cannery plant is usually built where raw material is produced. In any case, the site must have the condition of availability, in necessary amounts, of a cheap supply of high quality raw materials in terms of both freshness and maturity. However, as compared with perishable foods, canned-food products can be easily preserved and transported.

Factors constituting locational conditions can be roughly divided into natural, economic and other factors.

The total requirement of the plant site area is 4,180 m^2 including 1,913 m^2 of floor area.

Table 2: Required Amount of Raw Material

Can type	Raw material (kg)	Table salt (kg)
4 doz. of No. 4	30 – 32	0.3
100 cans of small No. 1	24 – 26	0.15
4 doz. of oval No. 1	30 – 32	0.3
4 doz. of oval No. 2	15 – 16	0.15

Table 3: Required Machinery and Equipment

Item	No.
[illegible]	[illegible]
Washing tank	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Tray	300
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
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[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	40
[illegible]	[illegible]
[illegible]	[illegible]
Gear pump	[illegible]
[illegible]	[illegible]
Balance	15
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	10
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	10
[illegible]	[illegible]
[illegible]	[illegible]

[illegible] 38 pieces of machinery and equipment . . . (approx.) $US 476,[illegible]

Process Flow Sheet for Canning Plant

Cooking (head cutting, disposal of guts)
↓
Washing
↓
Salting
↓
Filling ←······· Empty can
↓
Liquid filling
↓
Seaming ←····· Marking ← Can ends
↓
Sterilization

Raw Materials and Utilities

Raw material fish should be delivered to the plant whenever they are used. When they must be stored, they are put into a freezer. It is desirable that the empty cans to be used should be supplied at the desired time. If they are not, however, it is desirable to maintain a close contact with the can making factory so that cans may be delivered on the previous day for storage in the cannery plant. Required amount of raw materials and utilities is shown in Table 4.

Table 4: Daily Requirement of Raw Materials and Utilities

Item	Quantity
Materials	
Sardine	15 tons
Table salt	500 kg
Empty can (No. 4)	450 c/s
Utilities	
Electric power	75 kWh
Fuel (C standard)	200 ℓ/hr.
Water	150 tons

Table 5. Required Manpower

Item	No.
Technician	3
Male worker	25
Female worker	80
Senior clerical worker	1
Assistant clerical worker	2
Total	111

PASTERIZATION PROCESS

TABLE 158

CANNED FOODS WITH A pH OF LESS THAN 4.5 (ACID FOODS) AND THEIR pH VALUES

Canned Product	pH Value Ave.	Min.	Max.
Apples	3.4	3.2	3.7
Apple sauce	3.6	3.2	4.2
Apricots	3.9	3.4	4.4
Blackberries	3.5	3.1	4.0
Blueberries	3.4	3.3	3.5
Cherries, black	4.0	3.8	4.2
Cherries, red sour	3.5	3.3	3.8
Cherries, Royal Ann	3.8	3.6	4.0
Cranberry sauce	2.6	2.4	2.8
Grape juice	3.2	2.9	3.7
Grapefruit juice	3.2	2.8	3.4
Lemon juice	2.4	2.3	2.8
Loganberries	2.9	2.7	3.3
Orange juice	3.7	3.5	4.0
Peaches	3.8	3.6	4.0
Pears, Bartlett	4.1	3.6	4.4
Pickles, fresh cucumber	3.9	3.5	4.3
Pickles, sour dill	3.1	2.6	3.5
Pickles, sweet	2.7	2.5	3.0
Pineapple juice	3.5	3.4	3.5
Plums, Green Gage	3.8	3.6	4.0
Plums, Victoria	3.0	2.8	3.1
Prunes, fresh prune plums	3.7	2.5	4.2
Raspberries, black	3.7	3.2	4.1
Raspberries, red	3.1	2.8	3.5
Sauerkraut	3.5	3.4	3.7
Strawberries	3.4	3.0	3.9
Tomatoes	4.3	4.1	4.6
Tomato juice	4.3	4.0	4.4
Tomato purée	4.4	4.2	4.6

STERILIZATION PROCESS

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CANNED FOODS WITH A pH GREATER THAN 4.5 (LOW ACID FOODS) AND THEIR pH VALUES

Canned Product	pH Value Ave.	Min.	Max.
Asparagus, green	5.5	5.4	5.6
Asparagus, white	5.5	5.4	5.7
Beans, baked	5.9	5.6	5.9
Beans, green	5.4	5.2	5.7
Beans, lima	6.2	6.0	6.3
Beans and pork	5.6	5.0	6.0
Beans, wax	5.3	5.2	5.5
Beets	5.4	5.0	5.8
Carrots	5.2	5.0	5.4
Corn, w.g., brine packed	6.3	6.1	6.8
Corn, cream-style	6.1	5.9	6.3
Figs	5.0	5.0	5.0
Mushrooms	5.8	5.8	5.9
Olives, ripe	6.9	5.9	8.0
Peas, Alaska	6.2	6.0	6.3
Peas, sweet wrinkled	6.2	5.9	6.5
Potatoes, sweet	5.2	5.1	5.4
Potatoes, white	5.5	5.4	5.6
Pumpkin	5.1	4.8	5.2
Spinach	5.4	5.1	5.9

Concentrated Fruit Juice Making Plant

Modern commercial production of fruit juice first began in Switzerland in 1800. Great development began in 1918 after World War I. The importance of fruit juice as military food supply was recognized from the war experience, and interest in fruit juice heightened in the U.S.A. and Europe.

From 1925, mass production of fruit juice began in the U.S.A., and since then, both technology and volume of production greatly exceeded that of Europe. Almost all production technology being used today have been developed in the U.S.A.

In 1928 the hot packing method, whereby juice is sealed in cans and then pasteurized by heating, was developed in the U.S.A. Grapefruit juice and grape juice appeared in the market; then, tomato juice and orange juice also appeared in the market. This method of pasteurizing continued up to 1937 when World War II was broken out. Up to this time all juice products were treated at the state of natural concentration, but in 1940 canned concentrated orange juice and grape juice appeared in the U.S.A. market. Concentrated fruit juice was packed in containers and pasteurized by heating. In 1945 frozen concentrated orange juice (FCOJ), which was developed and popularized rapidly, appeared sucessively.

In 1974 there were 24 plants in Japan operating on internationally industrial scale. At present, Japan is second only to the U.S.A. in production of FCOJ. However the consumption of FCOJ in the U.S.A. is 21.8 kg per capita, whereas the consumption in Japan is 3.6 kg (one-sixth of the U.S.A.).

Table 1: Production of Orange and FCOJ in Japan

Year	Orange (ton/year)	FCOJ (ton/year)
1965	1,330,000	3,213
1970		7,507
1975	3,670,000	46,644
1978	3,500,000	65,000

The consumption of natural fruit juice and fruit drinks in Japan in 1970 compared with that of 1975 shows that the former increased by 23 times while the latter increased by 14 times. The remarkable advance of manufacturing technology, the use of composite cans, and the appearance of chilled juice filled in pure pack paper containers also helped promote the growth of fruit juice. On the other hand, the methods of cut-back and add-back were employed to improve the quality of fruit juice. The technology of storing FCOJ in huge tanks and the use of containers for transporting at normal temperature also helped promote the development of the fruit juice industry.

Example of Concentrated Fruit Juice Making Plant

Generally there are two kinds of fruit juice treating plants: frozen concentrated fruit juice manufacturing plant and fruit drinks manufacturing plant. In the former, juice is squeezed out from fruit; this juice is concentrated to one-fifth by a vacuum concentrator; the juice is cooled down to -8 degrees C; the sherbet-like fruit juice is packed in composite cans or large cans and further cooled down to -20 to -30 degrees C to produce frozen concentrated fruit juice. Frozen concentrated fruit juice in composite cans is sold, and frozen concentrated fruit juice in large cans is used as raw material for fruit drinks. In the latter, frozen concentrated fruit juice is used as raw material, and syrup, citric acid, colouring matter, pulp, and carbonic acid gas are added, as required, to produce various kinds of fruit drinks. These drinks prepared are packed in bottles, plastic and paper containers and sold as products.

A description will be given for FCOJ. However, it must be understood that there are all sorts of fruit: orange, apple, grape, tomato, pineapple, passion fruit, banana, etc. The ingredients of juice are different according to the kind of fruit, and so, as a matter of course, the treating processes are different. It is difficult to describe each process, so description will be limited to the most representative orange fruit and juice treatment.

The plant given in this description is capable of treating 6,000 kg/hour of orange fruit. The production of juice 55° Brix FCOJ is 552 kg. Also 1,500 kg/hour of peel and 1,462 kg of pulp can be produced. Reprocessing of the latter by-products can be utilized for production of cattle feed and for others.

Manufacturing Technology

The most important technological point in fruit juice manufacturing is how to treat the fruit without losing the natural flavour, colour, and taste of the original fruit. From this viewpoint an explanation will be made concerning the superior points of FCOJ product, the cut-back method, the add-back method, and the vacuum concentrator.

1) Pasteurized concentrated fruit juice and frozen concentrated fruit juice

The manufacturing of pasteurized concentrated fruit juice and frozen concentrated fruit juice are carried out by almost same process. There are some differences, however, in the storage temperature, the concentration temperature, and the number of times of heat treatment.

In the former, enzym which decomposes pectin is thoroughly inactivated and sufficient pasteurization by heat treatment is done to sterilize harmful microorganisms. Since pasteurized concentrated fruit juice is stored at around 4 degrees C, higher than its own freezing temperature given, treatments should be done for the preservation of the quality of fruit juice. Therefore deairing and pasteurizing before concentration are of course necessary, and also pasteurizing again after concentration is necessary.

The latter, on the other hand, does not require repasteurizing after concentration because the storing temperature (-24 degrees C) is lower than its own freezing temperature. Accordingly, there is no deterioration in quality due to the above heat treatment. At frozen storage at the lower temperature than -18 degrees C, there are no fading and change in colour tone, no change in flavour, no loss in vitamin C, etc. According to a report from the U.S.A., the stability of flavour lasted for 750 days, and the stability of colour lasted fo 275 days.

2) Cut-back and add-back

During the vacuum concentration at low temperature, the fresh flavour of raw fruit juice tends to be lost because of the loss of volatile aroma. It has been discovered that this can be restored sufficiently by adding a suitable amount of fresh raw fruit juice. This is the cut-back method which is covered by 1948 American patent (U.S.P.) No. 2.453109.

According to this method, fruit juice is concentrated to 55 – 65° Brix; then, 7 – 10 wt% fresh raw fruit juice is added to make 42° Brix. At this Brix, the whole fruit juice will not be frozen necessarily at –18 degrees C. By adding as much approximately three time quantity of water, sucrose will become 12%. Ice crystal will dissolve in the water, and the feeling of coolness at this temperature will be just right for drinking. In the U.S.A. 170 cc cans and 355 cc cans are produced for home use. Housewives purchase huge quantities from super markets and always keep a stock in the home freezer-refrigerator. The fruit juice is diluted to three times by water and served when needed.

In the add-back method, late season fruit is kept in cold storage and mixed with new crop the following year to restore the flavour and to adjust the ratio of sugar to acid and the tone of colour. Generally, FCOJ is defrosted by a defroster and mixed in the concentrator. Another method is to recover essence and return it to the concentrator.

3) Vacuum concentrator

Almost all concentrators used are of the vacuum type. There might be some deterioration in colour, flavour, taste, etc. of fruit juice even in a heat treatment at the reduced pressure by the vacuum concentrator. Therefore, the requisites of a concentrator are that the evaporating temperature must be low and that the time required to pass through the concentrator must be short.

There are various types of concentrators, but the most widely used types at present are the plate type and the falling film type. Both are high temperature short time distillation types. The evaporating temperature at the inlet is 70 – 80 degrees C, and the temperature at the outlet is 45 – 50 degrees C. The time required for full concentration is within three minutes. The time is short, and so there are no loss of flavour, loss of vitamin C, and change in colour caused by microorganism.

In the plate type there is some scorching when the fruit juice contains abundant pulp, and it is disadvantageous for long running. The falling film type can be run for long hours and the thermal efficiency is somewhat superior.

Process Description

A general outline of the manufacturing process including FCOJ is given in Fig. 1.

1) Raw material intaking

The raw material is transported to plant and weighed on a scale.

2) Storage

The raw material is kept in storage and, when necessary, it is sent to the succeeding process by way of a stream of water. Earth, sand, and other foreign matters are washed off at this time.

3) Washing and brushing

The raw material fruit which has travelled through the stream of water and which has been lifted up by the bucket conveyor is sent to the first washing tank. The coated wax and chemical onto the surface of the peel are washed off with detergent, and the fruit is sent to the second washing tank. The raw material fruit is washed with detergent again in the second washing tank; then, it is transferred by the bucket conveyor and sent to the brushing conveyor. And then brushing is carried out by a revolving brush of roll type, there.

4) Screening

The fruit which is carried on the screening conveyor is sprayed with fresh and clean water at the inlet of the conveyor, and diseased fruit, green fruit, old fruit and damaged fruit are taken away by workers lined along the conveyor on both sides.

5) Scalder

The raw material fruit from preceding process is transferred to the scalder by the bucket conveyor. The scalder is a horizontal type cylindrical revolving drum, and the raw material fruit is heated in this drum by steam for approximately one minute. Thus, the peel is softened to make peeling easy.

6) Peeling

The raw material fruit which has left the scalder is sent to the peeler mounted on a stant by the bucket conveyor. Here the raw material fruit is classified into large, medium, and small sized fruit; then, they are separated into peel and peeled fruit. The peel is sent to the hopper by the conveyor, and the peeled fruit is dropped into the hopper of the juice extractor by a separate conveyor.

7) Juice extraction

The peeled fruit is charged into the chopper-pulper. The fruit is chopped into small pieces by the chopper. The pulper consists of a cylindrical screen with 1.5 mm perforations and three paddled rotating inside. Here the peeled fruit is crushed and, with centrifugal force, it is filtered through the screen and separated into fruit juice and pulp. The fruit juice is sent to the finisher, and coarse pulp, fibre, and seed are removed by a 0.5 – 0.8 mm screen to produce clear fruit juice.

8) Deairing

The air and gas mixed in the fruit are eliminated by spraying the fruit juice in a vacuum chamber of the deaerator. The objective is to prevent breeding of microorganism, to prevnet oxidation of the oil in juice, and to prevent the loss of vitamin C, flavour, and colour.

9) Pasteurization

Instantaneous pasteurization is done by heating in a plate heat exchanger at 93 – 95 degrees C for about 15 – 20 seconds. Microorganism is pasteurized and at the same time, pectin decomposing enzym and vitamin C oxidizing enzym are deactivated to prevent deterioration of the quality.

10) Separation

Fine pulp is separated by a centrifugal separator to produce clear fruit juice.

11) Concentration

Vacuum concentration is done up to 55° Brix by the vacuum evaporator to get fruit juice concentrated to one-fifth. The evaporation temperature is 66 – 43 degrees C.

12) Blending

The 55° Brix concentrated fruit juice is put into the blending tank and, in order to restore the flavour and colour as mentioned earlier, 7 – 10% of raw fruit juice is added as cut-back to get 42° Brix fruit juice.

13) Cooling

The blended fruit juice is sent to the slush freezer immediately and is cooled down to –8 degrees C by the cooling medium of a freezer and is made into sherbet-like juice frozen. The freezer has a freezing jacket on the outside of the horizontal cylinder and a revolving rotor and scraper on the inside of the horizontal cylinder. The fruit juice frozen by the medium in the freezing jacket is scraped off from the inside wall of the cylinder by the scraper.

14) Filling

Generally, the piston type filler is used most widely for filling of juice into cans. Composite cans, 18 liter metallic cans or drums which are lined with double polyethylene inner bags are used as containers. These containers should be decontaminated by thorough cleaning or ultraviolet ray radiation.

15) Freezing

After filling in containers, the concentrated juice is sent to the freezing unit. The concentrated juice is frozen to –20 degrees C or less in approximately 10 minutes. If necessary, freezing temperature may be decreased to approximately –30 degrees C.

16) Storage

The product which has been frozen to sufficiently low temperature is sent to the storage where the temperature is kept at –24 degrees C and served when needed.

Table 2: Required Machinery and Equipment

Item	Specification	No.
Truck scale		1
Storage		1
Bucket conveyor	0.4 kW each	5
Primary washing tank	fresh water consumption 4,000 ℓ/hr	1
Pump	total of 6.6 kW	3
Ultra screen		3
Water tank		3
Circulation pump	total of 4.5 kW	3
Secondary washing tank		1
Roots blower	1.5 kW	1
Brushing conveyor	0.75 kW, fresh water consumption 16,000 ℓ/hr	1
Screening conveyor	1.9 kW, fresh water consumption 8,000 ℓ/hr	1
Motor-switchboard	total of 2 kW	3
Scalder	1.5 kW, steam consumption 200 kg/hr	1
Screener	1.2 kW	1
Peeler	total of 10.6 kW	4
Peeled peel conveyor	1.15 kW	1
Peeled peel conveyor	1.2 kW	1
Segment conveyor	2.2 kW	1
Stand		1
Screw conveyor	14.4 kW	1
Peeled peel hopper		1
Pulper	11.0 kW	1
Pump with hopper	total of 1.5 kW	2
Balance tank	total of 0.75 kW	4
Juice circulation pump	6.75 kW	7
Finisher	7.5 kW	1
Deaerator	5.9 kW, fresh water consumption 15,000 ℓ/hr, air consumption 100 ℓ/hr	1
Plate type heat exchanger	0.75 kW, steam consumption 480 kg/hr, fresh water consumption 10,000 ℓ/hr, 1 degree C chilled water consumption 5,000 ℓ/hr	1
Automatic controlling panel for plate heat exchanger	1.0 kW, air consumption 100 ℓ/hr	1
Surge tank	0.75 kW	1
Centrifugal separator	30.0 kW, fresh water consumption 2,000 ℓ/hr	1
Square hopper		1
Pulp circulation pump	0.75 kW	1
Storage tank	total of 2.25 kW, chilled water consumption 9,000 ℓ/hr	3
Blending tank	total of 2.25 kW, chilled water consumption 3,000 ℓ/hr	3
Quick freezer	0.75 kW	1
FOB price of machinery and equipment	$US 1,082,000	

Fig. 1 Frozen Concentrated Orange Juice Manufacturing Process

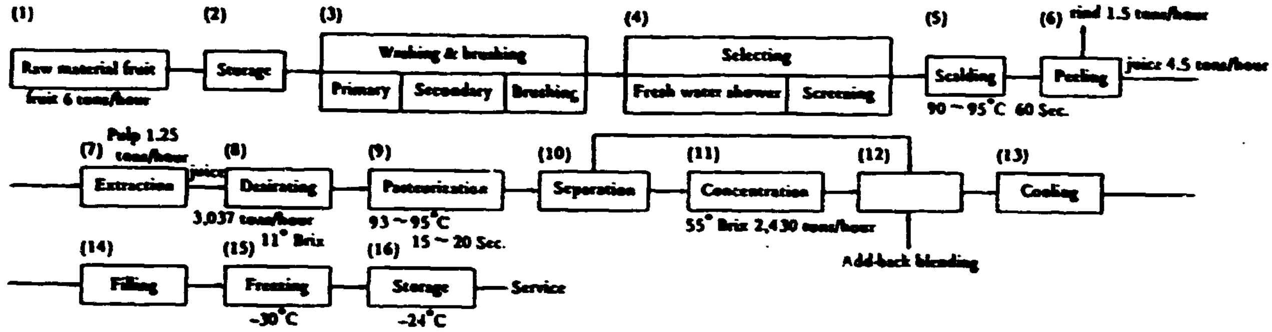
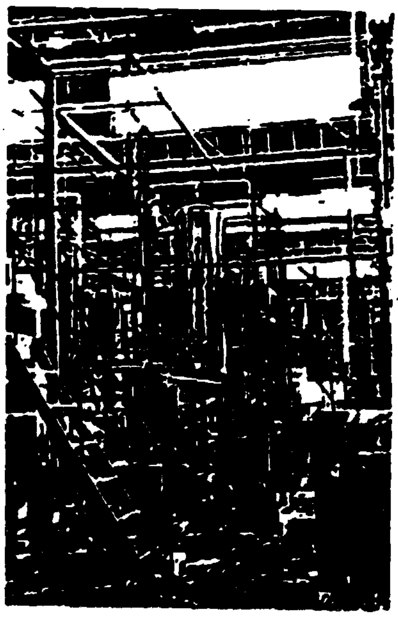


Table 3: Auxiliary Machinery and Equipment

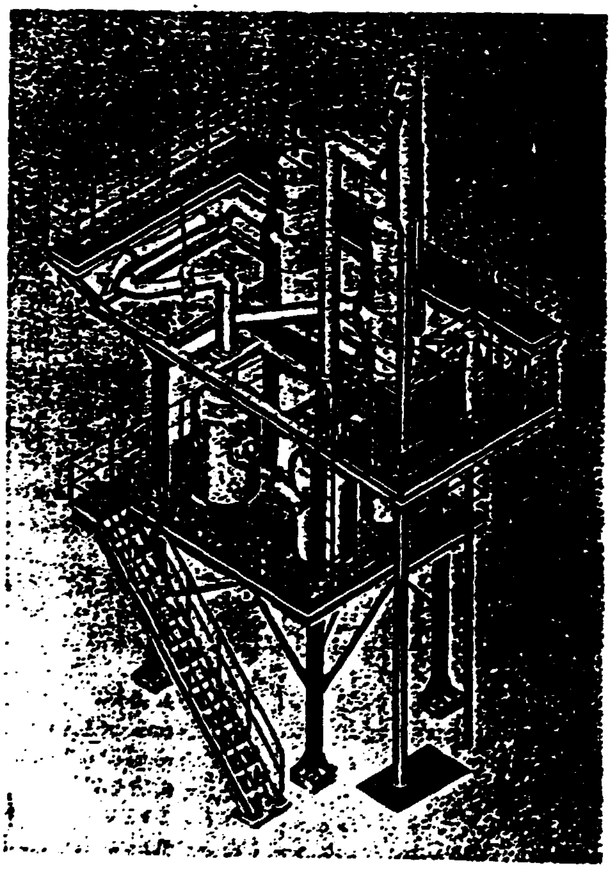
Boiler
Freezer and equipment for freezing facilities
Facilities for receiving and delivering electricity
Facilities for receiving and delivering water
Testing equipment

Table 4: Required Raw Materials and Subsidiary Materials

Orange fruit
Citric acid
Machine oil
5 gallon cans



Deaerator



Falling film type, double effective evaporator

APPENDIX 12

FOOD COLORANT PRODUCTION FROM BEETROOTS

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In the last decades the interest in natural pigments for food coloring increases as much, as the artificial dyes are banned. Several beneficial attributes predestine beet root (Beta vulgaris L., ssp. vulgaris var. conditiva Alef) as a good source of industrial produced red pigment for food.

The pigment is composed of two groups of related substances: violet - red betacyanins and yellow betaxanthins, which form together the group of betalains. The main betacyanin of beet root juice is betanin, amounting about 95% of all red components. Among betaxanthins this position is occupied by vulgaxanthin. The hue of reed beet juice depends on the proportion of these two components. In contrast to widely spread in plant kingdom anthocyanins, betalains occurence is limited to the species belonging to Centrospermae.

Solutions of betanin exhibit maximum light absorbance in the visible region at 537 - 538 nm, whereas vulgaxanthin at 476 nm with a shoulder at 460 nm. This is the basis of analytical methods of estimation of betalains content. The maximum peak of absorbance is identical in the range pH 3.5-7.0 for betanin, and 4.5-8.5 for vulgaxanthin. It makes that the hue of betalains (in contrast to anthocyanins) is unaffected at pH value of most food.

The red-violet colour of juice occurs, when the proportion of betanin is high. The hue turns to bloody-red if the amount of vulgaxanthin rises. Usually, the proportion of betanin to vulgaxanthin is in the range 1.2-2.0. However, vulgaxanthin is a more labile partner. Therefore the domination of betanin is highly desired. In a good beet root variety the ratio of betanin to vulgaxanthin, or more generally, of red to yellow pigments should be at least at the level 1.5-1.8.

As with many natural pigments, stability of betalains is affected by heat. During processing and storage the degradation of pigment occurs, giving shifts toward a shorter wavelength.

Visually, browning of the red colour is observed. Analytically, the absorbance in the region of yellow pigments rises, resulting in the reduction of the calculated betanin to vulgaxanthin ratio to the level below 1.

The range of the degradation depends also upon the amount of pigment and on the initial ratio of betacyanins to betaxanthins (ref. 6). At the high level of pigment and distinct domination of betanin the hue is not so strong affected, and the degree of degradation is not so high.

Keeping in mind the features of betalains, two main problems should be considered in order to obtain a good colorant:

- an aboundant source of pigment, i.e. a good variety of beet root,
- an effective technological process, based on the knowledge of betalains stability.

In both these directions our works were involved.

BEET ROOT AS MATERIAL FOR DYE PRODUCTION

Climatic condition of Poland, and generally, of the northern part of the moderate climate area, are favourable for beet root cultivation. However, the betalain content in beet root is influenced by several factors, such as variety, weight and shape of the root, its age (time from sowing to harvesting), the weather during vegetation and at the time when roots mature, as well as by the horticultural practices. Much work of many authors was done in these problems (ref. 7, 12, 15, 18). One is evident: the quality of the beet root preparation and the economy of production depend strongly on the betanin concentration in juice and on the agricultural pigment yield.

These problems were also the aim of our several years experiments, carried out in collaboration with three Vegetable Breeding Stations (Nochowo, Baków and Dziekanowice), situated in different regions of Poland. The subjects of investigation were the breeding objects of beet root from the collections of these Stations, coded with symbols N, B and D, respectively. As the result of experiment, the objects were selected with favourable pigment characteristics. Four of them, from the collection of Nochowo breeding lines, are registered as new varieties, Nochwoski Chrobry, Poznanski and Batory well adapted for colorants production. They meet the demand of high and stabile pigment concentration in juice, enough efficient yield and good relation of betacyanins to betaxanthins.

PIGMENT CONCENTRATION IN JUICE

At the time of harvest the betanin content in juice varies in wide range: from 23 to 180 mg per 100 g of fresh weight (ref. 12, 18), depending on variety. According to Elbe (ref. 7), the average content of betacyanin in two varieties, W279X W300C and Ruby Queen is on the level 158 and 117 mg per 100 g of fresh weight respectively, whereas the Egyptian (ref. 12) contains only the half of the latter amount.

The pigment content is usually much higher in beet roots from experimental culuvations than from normal horticultural production. This is due to the fact, that farmers are interested in high yield of beets of good quality for fresh market and canning industry, therefore the breeding selection is also directed on high crop yield and morphology of root. However the relation between root weight and betanin content is negative, as it can be seen in table 1. In consequence usually processed beet roots containing no more, than 40 - 60 mg of betacyanins per 100 g. After processing, the concentrated juice contains not much more pigment, owing to processing losses.

In our inter-stations experiment it was possible to select the breeding objects (from the N-collection) in which the betanin content was steady higher than in standard varieties (table 2).

Table 1 Red pigments (expressed as mg of betanin) and extract content in relation to the weight of the beetroot (breeding object from the N-collection, 1990 crop)

No	Weight of the beet /g/	Extract /%/	Red pigment mg/100 ml of juice
1	64	16,4	260
2	161	14,0	206
3	166	16,0	209
4	170	16,0	172
5	190	12,6	176
6	197	14,0	135
7	217	13,0	219
8	219	14,6	213
9	248	14,2	134
10	276	13,0	177
11	282	12,0	156
12	287	13,0	178
13	317	12,0	176
14	320	12,8	139
15	440	12,0	88

Table 2 Average content of red pigments (expressed as mg of betanin) in breeding objects of the collection lines of three Vegetable Breeding Stations during three years of inter-station experiment

Sample	Red pigment content, mg/100 ml of juice								
	Dziekanowice			Baków			Nochowo		
	1987	1988	1989	1987	1988	1989	1987	1988	1989
Standard varieties									
Okragly ciemnoczerwony	105	91	118	105	104	111	111	125	135
Czerwony kula	117	114	88	154	115	117	140	147	95
Breeding objects									
B-1	–	78	104	129	98	95	106	108	100
B-2	96	89	86	131	88	134	104	119	87
B-3	99	91	95	122	98	126	113	94	96
N-1	167	140	150	162	162	154	202	178	164
N-2	147	120	127	147	154	132	169	131	118
N-3	151	137	102	186	155	138	134	214	138
N-4	187	157	153	191	130	204	215	167	172
D-1	105	79	84	121	97	117	106	105	82
D-2	109	83	88	116	98	98	109	125	99
D-3	114	87	89	116	106	91	118	106	98

Table 3 Average crop, pigment and sugar yield per hectare obtained in the inter-station experiment (see table 2)

Sample	Yield per hectare		
	Beetroot of trade class /q/	Red pigment[x] /kg/	Sugars[x] /q/
Standard varieties			
Okragly ciemnoczerwony	531 ± 29	59	53
Czerwona Kula	505 ± 90	61	52
Breeding objects			
B-1	551 ± 35	56	53
B-2	574 ± 70	60	52
B-3	525 ± 88	54	53
N-1	463 ± 50	76	55
N-2	498 ± 74	69	58
N-3	437 ± 88	66	51
N-4	465 ± 27	84	57
D-1	556 ± 35	55	59
D-2	533 ± 42	55	54
D-3	451 ± 98	46	46

x The yield of pigment and sugars were calculated on the content in juice basis

Table 4 Six months storage losses of red pigments (expressed as mg of betanin) and changes of the ratio of red to yellow pigments (expressed as mg of vulgaxanthin) - average value of the inter-station experiment (see table 2)

Sample	Red pigments			Ratio of red to yellow pigments	
	after harvest mg/100 ml	after storage mg/100 ml	losses %	after harvest	after storage
Standard varieties					
Okragly ciemnoczer-wony	112	84	25	2,2	2,0
Czerwona Kula	121	79	34	2,2	1,7
Breeding objects					
B-1	102	80	21	2,1	1,9
B-2	104	74	29	1,8	1,7
B-3	104	78	25	1,9	1,7
N-1	164	111	32	2,2	1,7
N-2	138	93	33	1,9	1,5
N-3	151	106	30	2,3	1,8
N-4	174	121	30	2,1	1,7
D-1	100	70	29	2,3	1,8
D-2	103	78	24	2,3	1,8
D-3	103	75	26	2,1	1,8

PIGMENT YIELD PER HECTARE

Pigment content in juice is only one of the problems. Another one is the yield of pigment per hectare of field. The breeding objects of the N-collection are characterized by relatively small, rounded roots. Therefore the crop yield was lower than in standard varieties. Nevertheless, because of high betanin content, the pigment yield was higher (table 3)

BETANIN TO VULGAXANTHIN RATIO

The data listed in table 4 show, that the pigment composition in all tested objects is favourable for colorant production. The high ratio of betanin to vulgaxanthin remains on the desirable level even after six months keeping in field storage. The pigment content dropped at this time in about 30%, but the level in objects of the N-collection is still higher than in standard varieties at the time of harvest.

BETANIN STABILITY

Technological process of beet root colorant production involves several steps of heat treatment, such as pasteurization, concentration and drying. Therefore the thermostability of betanin influences both the yield and the quality of obtained colorant.

The thermostability of betalains is limited and depends on such factors as pH, presence of oxygen and light, and others.

Betaxanthins are the more labile component, therefore, as it was said before, their low contribution in pigment composition is desired. But, not much data on their stability is available.

Betanin, on the other hand, was the object of intensive investigations, referred in several publications (ref. 4, 13). Ten years ago an interesting feature of this pigment was stated by Elbe et al. (ref. 8). After thermal decomposition, partial reconstitution of betanin occurs from the components appearing during heating process i.e. betalamic acid and cyclodopa glycoside. The regeneration is visually noticed as intensification of red colour in few hours, or even few days after thermal treatment. The degree of resynthesis is influenced by many factors (ref. 3).

Betanin undergoes also enzymic degradation. It was observed that the colour of crude juice fades quickly after lowering the pH to 3.4. Kaczmarek (ref. 9) stated that native peroxidase of beet root is responsible for this process. The reaction is also catalyzed by horseradish enzyme.

The oxidative way of destruction of betanin paid our attention on the role of oxygen in the thermostability of betanin (ref. 4). It was stated that metal complexing agents, such as EDTA, inhibited the rate of thermal destruction, whereas some metal ions strongly prompted it. The accelerating effect of Fe (III) ions is evident mostly at pH 4.0, and Cu (II) ions at pH 6.0. Chelating agents protect betanin against thermal decomposition at pH 4, and rise the postthermal resynthesis at pH 6.0.

THE PROCESSING TECHNOLOGY OF PIGMENT PREPARATIONS

Betalains are water soluble and the simplest way of their isolation is pressing of disintegrated beets. The concentrated or dried juice is widely used as colorant for soft drinks, dessert powders and many dairy, confectionery and meat paroducts. Such a colorant shows, however, many imperfections and does not meet the demand for a high quality preparation. They would be characterised by:

- the absence of own taste and smell,
- high colouring power,
- desired hue of coloured food,
- acceptable price.

The substance responsible for characteristic taste and smell of beet root is geosmin (ref. 1, 11). The crude juices, after concentration and/or drying, retain much of this odour.

The limited factor of colouring strength of betalain preparations is the imperfect technological process. Therefore, after processing, only dropping of the proportion of pigment in the dry substances of juice, can be expected. In consequence, the cost of application of red beet colorant in food is higher than for artificial dye, although the colouring strenght of betanin is about twofold higher (ref. 13).

Our efforts are then directed to:

- improving the technology of concentrated juice production,
- raising the betanin content in the dry matter of juice.

THE IMPROVEMENT OF TECHNOLOGY

Betanin is most stable at the pH 4 - 5, the natural pH of beet root juice being much higher, i.e. pH 6.0 - 6.4. Lowering this value in disintegrated beet root mash, before juice pressing, provokes, however, the harmful enzymes action (ref. 9). But the addition of acid to pressed juice before pasteurization is beneficial, causing:

- protection of betanin during heating treatments,
- partial destruction of vulgaxanthin, which makes the dye more stable and of desired hue,
- discarding the coloidal substances: this prevents foaming of the juice, as well as precipitate formation in an evaporator and in the stored concentrate

Details of such treatment were discussed in an earlier publication (ref. 5).

RAISING OF BETANIN CONTENT IN THE DRY MATTER OF JUICE

The dry matter of beet root juice consists in 80% of sugars, the rest being mainly protein and ash. The pigment proportion is low and ranges only about 1%. Two possibilities can be considered in effort to improve this bad relation: biological and technological. Both together can lead to the desired effect.

The biological way offers the possibility to increase the betacyanins proportion in dry matter of juice from 0.4 to 2.0 % by breeding methods and good horticultural practice. Technologically, the aim can be achieved either by elimination of balasting substances, or by isolating the pigment from juice.

Since as much as 80% of dry matter consists of fermentable sugars, they can be removed by fermentation. Adams et al. (ref. 2, 10) developed a method of fermentation in aerobic condition (with aerating) at pH 5.0 and temperature 30°C, with Candida utilis. The pigment content can be raised to 3-8% of dry matter. The main by-product is the biomass of yeast cells, which can be used for feeding of animals. Disadvantage of this method is, that in the final concentrate of fermented juice the ratio of betanin to vulgaxanthin is

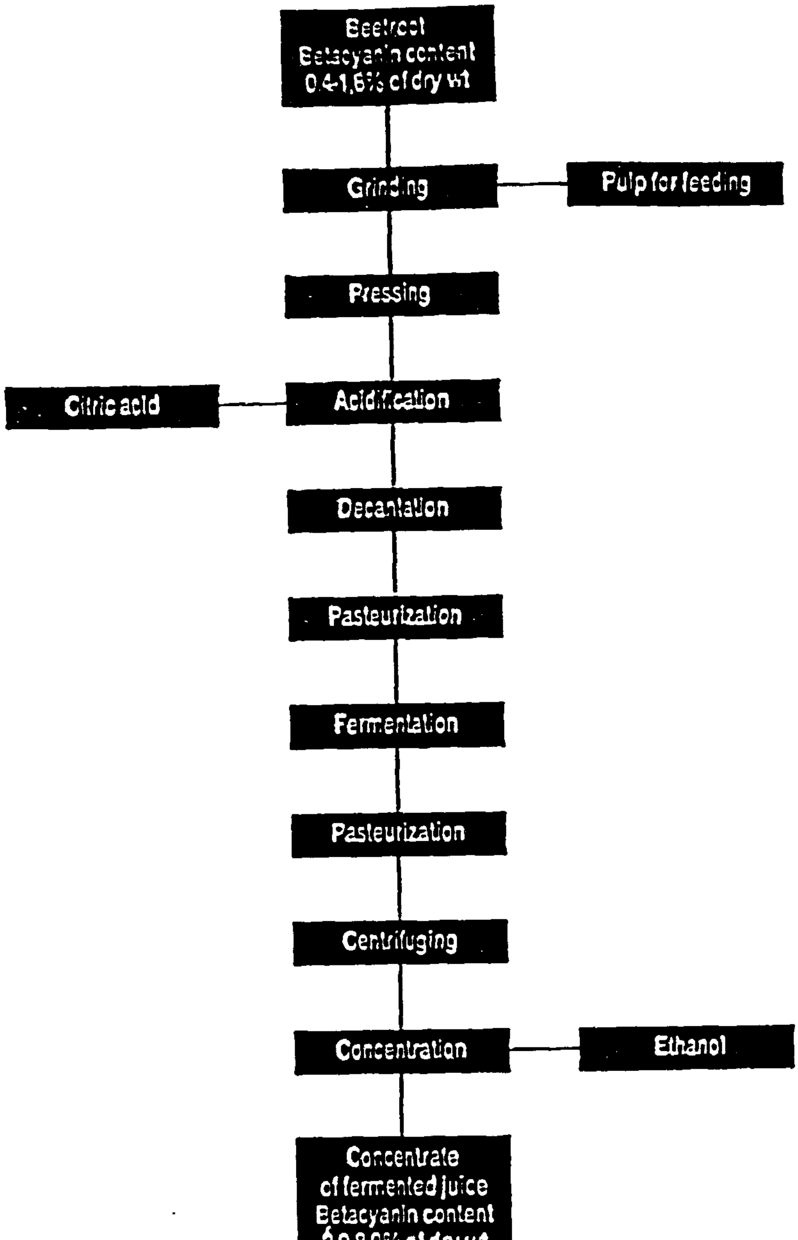

Figure 1. Manufacturing process of concentrate of fermented beetroot juice

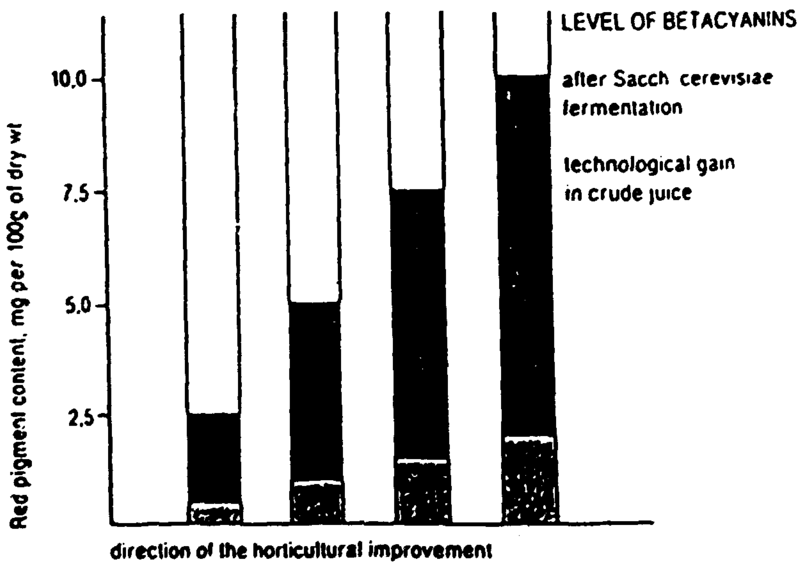

Figure 2. The effect of horticultural and technological improvements on the level of red pigment content in the dry matter of beetroot juice

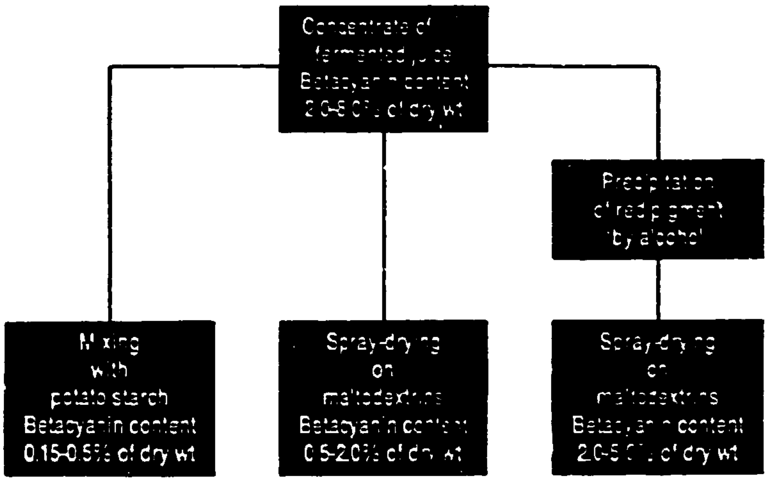

Figure 3. Colorant preparations of the concentrate of fermented beetroot juice.

not improved (in relation to crude juice), which raises the risk of poor stability of the hue of coloured products. The technology needs the use of fermentors equipped in facilities for air-flow and agitation.

TECHNOLOGY OF FERMENTED JUICE CONCENTRATE PRODUCTION

In the technology developed in our laboratory (figure 1), the yeasts for wine and/or alcohol production are used, i.e. appropriate strains of Saccharomyces cerevisiae. This organism was chosen because it ferments sugar to ethanol in anaerobic conditions which makes possible to use the ordinary distillery tanks for fermentation. This is much easier for the juice producing plant and does not need the new, expensive installation. The process can be carried out on a line for concentrate juice production with a short time evaporator (e.g. Unipektin station), additionally equipped with tanks for fermentation. The main by-product, ethanol contribute also in the reduction of costs of colorant production.

The betanin content in the dry matter of fermented juice vary from 2 to 8 percent, depending on the quality of beet root used (figure 2). The ratio of red to yellow pigment is raised in the final concentrate to the value about 3, which makes the hue of coloured products more stable. The effective reduction of beet odour takes also place.

The technology is patented under Polish Patent No. 136435.

DRY COLORANT PREPARATIONS

Further processing of concentrate gives the possibility to produce stable colorants, which pigments do not undergo changes for a long time of storage. The coloured food retains also the hue in the acceptable time of shelf-life, i.e. during the guaranteed time of high quality.

Three kind of dry colorants were obtained, differing in colouring strength, price and application range (Figure 3).

1. Dry Concentrate of Fermented Beet Root Juice
   Preparations are obtained by spray-drying of the fermented juice concentrate, using maltodextrins. The colorants contain 0.5-2.0% of red pigment and are easily soluble in water. Their hygroscopicity rather high, depends on the kind of carrier used. Colorants are well adapted for food of low water activity, not higher than 0.35. When higher, the premix preparation is advised.
   Since two years these colorants are produced, under our licence, in a food processing plant in the district of Poznan. This preparation is applied by the producers of soft drinks, ice-cream and dry desserts.

2. Pigment Concentrate Adsorbed on Potato Starch
   In this preparation the problems of hygroscopicity and cloud formation were soluted by appropriate technology of mixing the concentrated juice with potato starch. Owing to omitting the additional heat treatment (drying), losses of betanin are very small. The preparation is suitable for non-transparent food. It remains dry and pulverized for a long time, even in open packages. The red pigment content is rather low, 0.15-0.5%, but high enough for dyeing such products, as starch desserts.

3. Enriched Colorant Preparation
   The enrichment in pigment content is achieved by precipitation of the betanin from the fermented juice concentrate with such solvents, as ethanol or acetone. The approximate price, calculated on betanin content basis, is on acceptable level, if precipitation is efficient, and only about 15% higher than for the colorant on maltodextrins. Its exceptional worth is connected with colouring strength and absence of beet flavour. It is of universal use adapted also for special purposes.
   The technology is submitted to patent. The industrial production is under training time.

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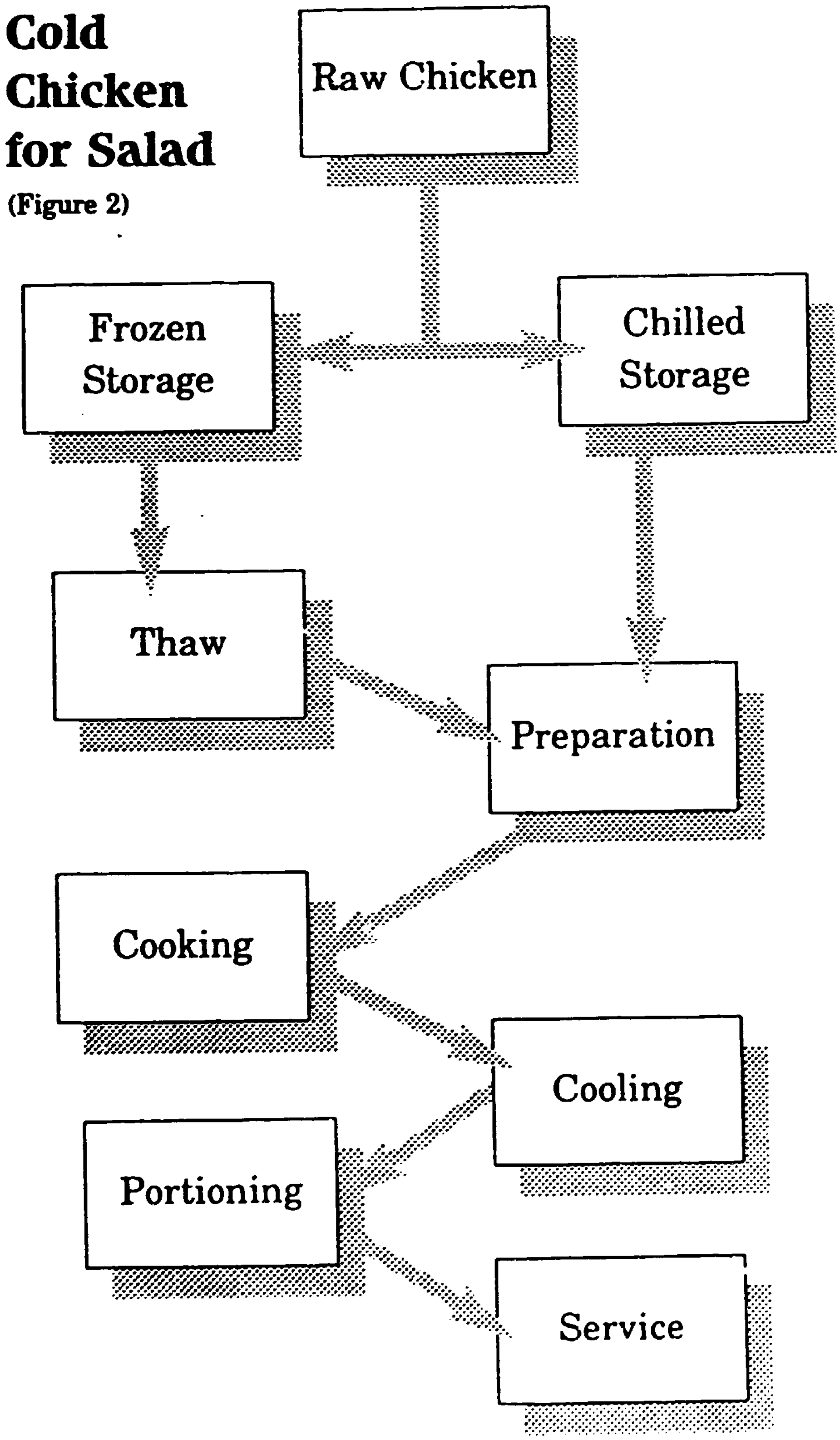
TABLE 15-7. Microbiological standards for various food products (compiled from ref. *1, 26, 32, 48*).

Food Products	*APC/g*	*Coliforms/g*	*E. coli/g*	*S. aureus*	*Salmonellae*	*State/Agency*
Raw, fresh, frozen meats	5,000,000	—	Not > 50	—	—	Oregon law, 5/73
Raw, fresh, frozen meats	5,000,000	50	—	—	—	Proposed, North Dakota
Raw, fresh, ground meats	1,000,000	250	—	—	—	Administrative guidelines, Rhode Island
Raw meats	100,000	100	—	absent	absent	Guidelines, Massachusetts
Heat-processed, smoked meats	1,000,000	—	Not > 10	—	—	Oregon law, 5/73
Heat-processed, smoked meats	1,000,000	10	—	—	—	Proposed North Dakota
Heat-processed, smoked meats	<50,000	10	—	absent	absent	Massachusetts law, 1959
Heat-processed, smoked meats	100,000	100	—	—	—	Admin. guidelines, Rhode Island
Precooked frozen meat, poultry, and seafood products	100,000	100	absent/g	—	absent/25g	Military & federal specifications
Ice cream and related products	50,000	20	—	—	—	Military & federal specifications
Ice cream and frozen dessert products	500,000	—	—	—	—	Boston, 1906
Ice cream and frozen dessert products	100,000	—	—	—	—	California
Ice cream and frozen dessert products	—	10	—	—	—	20 States
Dry gelatin	3,000[1]	10 (MPN)	—	—	—	Proposed FDA
Frozen cream-type pies	50,000[1]	50 (MPN)	—	—	—	Proposed FDA
Whole dry milk[2]	30,000–50,000	90	—	—	—	Military & federal specifications
Nonfat dry milk	50,000	—	—	—	absent/100 g	Military & federal specifications
Malted milk	30,000	10	—	—	—	Military & federal specifications
Cottage cheese[3]	<100[4]	10	—	—	—	Military & federal specifications
Precooked frozen meals	50,000	10	—	absent	absent	Massachusetts
Precooked frozen meals	100,000	100	—	—	—	Rhode Island
Precooked frozen meals	100,000	10	—	—	—	Armed Forces
Dehydrated cooked beef	150,000	40	—	—	—	Military & federal specifications
Dehydrated cooked beef stew, chicken, chili con carne	75,000	—	absent	—	—	Military & federal specifications
Dehydrated cooked tuna and turkey	200,000	40	—	—	—	Military & federal specifications
Crab meat[5]	100,000	100	—	100	—	New York City
Custard-filled items	100,000	100	—	—	—	New York City

[1]Geometric mean
[2]DMC < 40,000,000 or 75,000,000 depending upon grade
[3]Not > 10 yeast and mold/g
[4]Psychrotrophs
[5]Not > 1,000 enterococci.

APC-Aerobic plate counts

APPENDIX 14


Cold Chicken for Salad
(Figure 2)
Raw Chicken
Frozen Storage
Chilled Storage
Thaw
Preparation
Cooking
Cooling
Portioning
Service

COLD CHICKEN FOR SALAD

Microbiological safety of this product depends on effective cooking of a raw material which is likely to be contaminated with foodborne illness causing bacteria (especially Salmonella and Campylobacter). Subsequent handling of the cooked carcase when it is portioned must not allow recontamination and effective chilled temperature control must be maintained after cooking until display for sale.

Absolute segregation of raw and cooked processes presents practical difficulties. Monitoring systems used in factories may not be used in a restaurant kitchen where automatic controls may not be available. Display of open foods for customer self-service is rarely found outside of catering operations and may present risks of contamination.

STEP	IMPORTANCE	HAZARDS	PREVENTATIVE MEASURE (CONTROL)	MONITORING
1. Product raw materials	CCP	Foodborne illness - causing bacteria in ingredients.	Purchasing specifications for raw materials. Design of storage facilities and specification of storage conditions. Stock control.	Compliance with specifications. Time (and temperature) of storage of raw materials. Hygiene of storage areas.
2. Raw material preparation		Failure to control preparation procedures may lead to significant microbial growth.	Hygienic design of preparation equipment and preparation area. Cleaning and disinfection schedules for equipment and area. Time and temperature control of perishable materials. Controlled thawing of raw, frozen ingredients.	Hygiene of equipment. Hygiene practices of operatives. Times, temperatures and conditions for holding products during preparation. Storage of prepared materials.
3. Cooking	CCP	Survival of infectious foodborne illness - causing bacteria if cooking is not properly controlled. Prevention of contamination post-cooking.	Design of cooking equipment including ability to control cooking temperature; cleanability. Use of a cooking procedure that ensures that all ingredients receive a minimum heat treatment 2 minutes at 70°C or an equivalent thermal process. Separation of cooked and raw processes. Protection of product from contamination post-cooking. Cleaning and disinfection of surfaces after their use for preparation of raw food and before their use for cooked foods.	Check cooking procedure (time and temperature). Hygiene of cooking vessels and other containers. Staff and equipment movements.
4. Cooling	CCP	Contamination and growth of microorganisms.	Hygienic design of chiller. Adequacy of cooling capacity. Specification of cooling rate (to prevent growth of microorganisms surviving cooking) and exit temperature of product from chiller. Protection of product from contamination during cooling. Cleaning and maintenance of chiller.	Check product cooling rates and performance of chiller. Hygiene of chiller.
5. Portioning the carcass*	CCP	Contamination with foodborne illness-causing bacteria. Microbial proliferation.	Hygienic design of portioning area and equipment. Effective cleaning. Good personal hygiene. Effective separation from 'dirty' processes*. Minimising time product kept above chilled temperature. Chilled ambient conditions if possible. Staff training.	Visual monitoring of cleanliness. Check product temperature. Check practices, especially effectiveness of separation from raw processes. Visual check of personal hygiene standards.
6. Storage	CCP	Microbial growth.	Adequate chilled storage capacity. Capable of achieving 5°C or colder. Stock control.	Check temperature of product and storage unit. Visual check on cleanliness.
7. Display and service	CCP	Microbial growth and contamination with foodborne illness-causing bacteria.	Hygienic design of display equipment. Effective cleaning of display equipment. Temperature control. Control of display period. Packaging or design of display unit, appropriate to minimise contamination (especially in self-service situation). Provision of suitable and sufficient	Check serving utensils available. Replace with clean ones periodically. Check temperature.

CONTROL POINTS

for Figure 2

Raw Chicken
- Check the supplier
- Check delivery temperature against specification
- Check quality

Frozen Storage
- Keep frozen, below −18°C
- Use within 4 weeks of delivery

Chilled Storage
- Keep chilled, below 5°C
- Use within 3 days of delivery
- Keep away from prepared foods
- Keep storage equipment clean and disinfected

Thaw
- Thaw in fridge, maximum 5°C
- Keep away from prepared foods
- Contain any liquid produced
- Check completely thawed

Preparation
- Wash chicken
- Use separate equipment and work surfaces
- Thoroughly clean and disinfect them before and after use
- Wash hands after handling and before touching any other food or equipment

Cooking
- Roast at specified oven temperature, e.g. 180°C
- Check thigh core temperature has reached 80°C and that juices run clear

Cooling
- As rapidly as possible, ideally to below 5°C within 2 hours of removing from the hot oven
- Keep away from other foods to avoid cross contamination
- When cool, keep refrigerated at below 5°C

Portioning
- Wash hands before starting
- Clean and disinfect equipment and work surfaces
- Keep out of fridge for as short a time as possible
- Cover and keep refrigerated at below 5°C
- Use within 24 hours of cooking

Service
- Cover and display at below 5°C
- Serve within 2 hours

INSTITUTE OF STANDARDS AND INDUSTRIAL RESEARCH OF IRAN

The Institute of Standards and Industrial Research of Iran which has been established in accordance with the law dated 17th Khordad 1339 (June 1960) is a profiting institute and has a legal personality which, in accordance with commercial principles it is administered with due observance of the stipulations of its Articles of Association.

The main duties and objectives of the Institute are as follows:

Coordinating the efforts of producers and consumers towards completion, uniformalization and simplification of raw materials and agricultural and industrial goods; research regarding the methods of production and distribution for their promotion and simplification; creating economy in time and materials by the way of reducing varieties of unnecessary schemes and sizes of similar commodities; determining the standards for commodities and various procedures from the quantity and quality point of view on the national and international basis; making efforts in promoting and generalizing the Standards of Iran; conforming the samples of commodities to the determined standards and issuance of compliance certificates; supervision in determining the criterion of precious metal manufactures and marking them; supervision over weights and measures for their uniformalization and issuing permits for obtaining and producing measuring means.

The use of the Institute of Standards' symbol will be authorized for commodities which conform to the Standards of Iran and that the producers carry out a supervision by a reliable method regarding their quality and make, and to provide the necessary facilities for inspection by the Institute of Standards. In this connection the general policy of the Institute of Standards is based on non-profiting.

In implementing its duties the Institute of Standards endeavours to attract the full attention of the people of Iran with respect to their general conditions and special requirements, also to see that the views of all the interested technical personalities, experts, persons and institutes are adequately secured.

The observance of the Standards of Iran and the supporting of the Institute of Standards is in the interest of all classes of the people and the economy of the state; it causes an increase in exports and internal sales. It gives rise to economy in time and expenses and consequently an increase in national income and social welfare and a reduction in prices.

BENEFITS OF STANDARDIZATION

Standardization has numerous benefits for producers as well as consumers.
The most important benefits gained by observation of standards by the producers are:

- *reduction of unnecessary varieties.*
- *increase in production.*
- *saving in materials, energy and man power.*
- *reducion of wastes.*
- *upgrading the quality of products.*
- *facilitation storage and transport of goods.*
- *promotion of internal and external trade.*

The most important benefits gained by the consumers are:

- *having access to better quality goods.*
- *assurance in respect of quality, durability, safety and efficiency of products.*
- *easy ordering of goods and reliable of them.*
- *decrease in purchasing expenses.*
- *having easier access to the accessories and interchangeable parts when required etc.*

HISTORICAL BACKGROUND OR ISIRI

Early in 1954 a plan was approved by the Ministry of Commerce to set up a standard institution in Iran, and a few months later the construction of building for such institution began and a bureau of standards was set up.
In 7 June 1960 the law pertaining to the establishment of Institute of Standards of Iran as one of the affiliated institutions to the Ministry of commerce was enacted by the parliament.
In 1960 ISIRI became a member of the International Organization for Standardization (ISO) and in 1965 obtanied membership in the International Electrotechnical Commission (IEC) which is affillated with ISO and is responsible of standardization in the fields of electricity and electronics on international level.
In December 1970 the law of Appended Articles to the law Establishing ISIRI was enacted by the parliament. According to this law for the consumer protection ISIRI is permitted to announce the implementation of any product standards as compulsory if it is significant with regard to the public safety or health.
Until 1971 ISIRI was legallly a profit-making institution but in that year its status was changed and became a government institution under the jurisdiction of the public accountancy regulations.
In 1974 ISIRI became affiliated to the Ministry of Industries and Mines which was set up according to the law enacted in 23 July that year.
After the Islamic revolution of Iran when the Ministry of Industries and Mines was divided into three different ministries i.e. Ministry of Industries, Ministry of Heavy Industries and Ministry of Mines and Metals ISIRI remained under the Ministry of Industries with autonomy in administrative organization and finance.

ISIRI ORGANIZATION STRUCTURE

The highest functional body of ISIRI is the ISIRI Supreme Council which is the policy making body and determines the main technical, financial and administrative guidelines, it consists of the following members:

a) Minister of industries who presides over the supreme council
b) Minister of Heavy industries or his representative.
c) Minister of Mines & Metals or his representative.
d) Minister of Agricutture or his representative.
e) Minister of Health, Treatment and Medical education or his representative.
f) President of the chamber of Commerce, Industries & Mines.
g) Three experts appointed by the Minister of Industries.

Minister of industries also appoints the president of ISIRI who is responsible for all administrative and technical affairs of ISIRI and carries on his function with the help of three technical deputies and an amdinistrative and financial deputy together with 22 different directors in various fields in karadj and 20 directors in different provinces

2. IMPLEMENTATION OF STANDARDS

a) Mandatory Standardization:

According to the laws ISIRI can announce the implementation of standards and codes of practice as compulsory provided that the High Council of ISIRI approves and that the standards have some bearing on the public health or safety or on quality of the generally used goods or on the protection of the consumers interest.

For this purpose ISIRI should take regular supervisional action for due implementation of standards. This action include sampling and testing of products, advisory and consultancy services to industries, confiscation of non-standard products and persecution of the offenders of the laws and regulations through juridical authorities.

b) Voluntary Standardization

In cases where the producers realizing the improntance of standardization refer to ISIRI for voluntay implementation of standards ISIRI after having ascertained that their production constantly conforms to the related standards will issue.

Then a licence permiting them to apply ISIRI mark on their products.

ISIRI will control the compliance of the production and when insures the regular quality of the goods takes all the actions to support them.

3. INDUSTRIAL RESEARCH

ISIRI for the fulfilment of its first and for most duty i.e. standardization has to make regular research work and study both in order to base the specifications, test methods and other standards on the factual and applicable principles and to help the industries overcome their technical problems and improve the quality of their goods or substitute more economical domestic materials for the imported ones.

4. OTHER FUNCTIONS

ISIRI has other duties and functions the most important of which are:

-Documentation and documentary services to domestic industries with regard to the technology and technical aspects of industrial or agricultural products.

- Testing of products for determining the characteristics and their compliance with standards.

- Extension work on Q.C. techniques by promotional and publicity actions, training and education.

- Assistance to the industries for setting up Q.C. systems in plants.

- To encourage the producers to use ISIRI mark.

- Hallmarking of precious metals.

- Calibration of measuring instruments.

- Inspection and sampling of export products and certification of their compliance.

- Testing of imported goods to prevent import of non-standards product in case of compulsory standards goods.

- Training and advising the producers and consumers in standardization and its related fields.

- Liaison with international standard organizations and national standards bodies of other countries and internal scientific, cultural and technological institutions.

HOW IRANIAN NATIONAL STANDARDS ARE PREPARED

For the formulation of standards ISIRI set up committees or sub-commissions as they are called in persian which consists of the representatives of all interested organizations such as producers, consumers, importers, exporters and distributors, universities, research organizations etc. these representatives who are invited by ISIRI may select a working group from among themselves to work out a draft standard for consideration.

The draft which is so prepared will be considered by the mother commission taking into account the available foreign standards and technology as well as native requirements.

When the draft is finalised by the concerned commission it has to be approved by National Standards Committees which are composed of higher authorities in the field.

The members of the National Standards Committees are selected from among the following representatives of the following organizations and authorities:

- Producers and entrepreneurs
- Consumers and purchasers
- Research and technical organizations and labs
- Consumers and producers protection organization
- Chambers of Commerce, Industries & Mines
- Ministries and government institutions
- Experts, university professors, researchers and scientists
- Vocational institutions etc.

Till now thirteen different National Standards Committees (N.S.C) have been set up which are as follow:

1- N.S.C. for electrotechnical industries.
2- N.S.C. for building materials and construction.
3- N.S.C. for minerals.
4- N.S.C. for agricultural and food products.
5- N.S.C. for animal products and footwear.
6- N.S.C. for chemical industries.
7- N.S.C. for cellulosic and Packaging industries.
8- N.S.C. for mechanical and metallurgical industries.

D- AGRICULTURE & FOOD PRODUTCS

1- Hydrogenated Vegentable Oil (Shortening)
2- Cold Stores
3- Non-alcoholic Beverages
4- Canned Fruits
5- Biscuit
6- Wafer Biscuits
7- Sausages and salami
8- Canned baked pinto beans in tomato sauce
9- Canned green pea
10- Tomato Juice concentrated
11- Non-Alcoholic beer
12- Edible Olive Oil
13- Pasteurized Milk
14- Edible Olive
15- Orange Juice
16- Macaroni
17- Tomato Cans
18- Baked Broad Beans Cans
19- Beans Cans
20- Spinach Cans
21- Cabbage Cans
22- Asparagus Cans
23- Pickled Cucumbers
24- Tomato Sauce (ketchup)

E- MEDICAL ENGINEERING PRODUCTS

1- Elbow Crutches
2- Wooden Axilla Crutches
3- Walking Sticks

F- TEXTILE PRODUCTS

1- Cotton Wool
2- Cotton Sewing Threads
3- Paper Tissues
4- Pads and briefs
5- Sanitary pads
6- Blended Worsted Fabrics (45% wool, 55% polyester)
7- Toilet Paper
8- Towel Paper

G- PACKAGING PRODUCTS

1- Plastic trash bags
2- Metal cans for preserved foodstuff
3- Safety Glasses for land transport vehicles

I- HALLMARKING

1- Specifications for Grades and Method for Assaying Gold.

ISIRI also has taken measures for the implementation of the satndards for the goods intended for export. In this connection the following items are controlled before their shipment:

A- AGRICULTURAL PRODUCTS

1- Dates (Sayer)
2- Dates (Industrial Use)
3- Dates (Mazafati)
4- Dates (Rotab)
5- Dates (Kabkab)
6- Dates (shahani)
7- Biscuit
8- Macaroni
9- Pomegranate
10- Dried Fig
11- Sunflower Seed
12- Garlic
13- Hazelnut
14- Walnut
15- Shelled Kernel Apricot
16- Shelled Kernel Peach
17- Shelled Kernel Amygdalus Eleagnifolia Spach
18- Liquorice
19- Liquorice extract
20- Henna
21- Barijeh
22- Rosewater
23- Saffron
24- Grape
25- Dried Plum
26- Asafoetida
27- Unselled Sweet Almond
28- Broad Beans

APPENDIX 15.1

THE COMMITTEE FOR THE STANDARD OF RICE

Chairman	Representation - Designation
Ali Akbar - Agah (Doctor in Anti-botanical pests)	Institute for the Investigation of Botanical pests and Diseases

Members

Baghaee - Hosain (Agricultural Engineer)	In charge of the Cereals Laboratory of the Institute
Tootoonchi - Mehdi	Ministry of Agricultural Products and Consumer Goods
Tahmasbi - Ghasem	Army Supplies Department
Ameli - Parviz (Agricultural Engineer)	Export Promotion Center of Iran
Enayat - Amir Mansoor (Agricultural Doctor)	Standards Office of the Central Province
Ghazavi - Kazem (Chemical Engineer)	The Department for the Compilation of Commodities Standards
Ghahhari - Mohd. (Nutrition Lincentiate)	The Department General for Supervision Over Foodstuffs, Drinks, Cosmetics and Sanitary Materials
Ganjeiee - Nosratollah	Managing Director of the Rice Company of Iran
Lailabadi - Mohd. Ali (Army Colonel)	Sepah Cooperative Super-market
Hedayatpoor - Mahmood	Forooshgah Ferdowsi

Secretary

Jamshid Soofi (Agricultural Engineer)	Expert of the Institute of Standards and Industrial Research of Iran

FOREWORD

This Standard was first prepared in the year 1345 (1966) by the Committee for the Standard of rice under the supervision of the National Committee for the Standard of Foodstuffs and Agricultural Products of the Institute of Standards and Industrial Research of Iran. Based on the proposals received from interested persons as well as the investigations and surveys carried out by the experts of the Institute, it was revised in the year 1348 (1969) by the relevant committee. It is now published on the strength of Article (1) of the law granting permission for the establishment of the Institute of Standards of Iran approved on 17/3/1339 (1960), and Article (3) of the Articles of Association of the Institute of Standards and Industrial Research of Iran approved by the Joint Finance Committee of the two Houses of Parliament, dated 9/4/1344 (1965).

In order to keep pace and harmony with the national and universal developments in industries and sciences this Standard will be revised again when deemed necessary. Any proposal received for amending this pamphlet, will be considered in the course of the next revision.

After every revision, the previous pamphlet shall be annulled and shall be superseded, officially, by the revised pamphlet.

Therefore it is the revised pamphlet which should constitute the basis for concluding agreements and ordering commodities.

Iranian Standard for Rice

1. Scope

This standard covers specifications, grading and methods of testing and packaging of rice.

2. Field of Application

This standard covers the rice produced in Iran of the following varieties:

i) Dom-Siah
ii) Sadri
iii) Champa
iv) Gerdeh

3. Definitions

3.1. Rice is a one-yearly plant of the graminae family and the Oryza genus.

3.2. Dom-Siah is that variety of rice which:
a) the length of its grains is not less than 6mm and
b) the ratio of the length of its grains to their diameter is more than 3.

3.3. Sadri is that variety of rice which:
a) the length of its grains is not less than 6mm and
b) the ratic of the length of its grains to their diameter is between 2.4 and 3.

3.4. Champa is that variety of rice which:
a) the length of its grains is not less than 5.5 mm and
b) the ratio of the length of its grains to their diameter is between 2 and 2.4.

3.5. Gerdeh is that variety of rice which:
a) the length of its grains is not less than 5mm and,
b) the ratic of the length of its grain to their diameter is between 1.6 and 2.

NOTE: the diameter of the rice is measured on the thickest part along the grain

4. Terminology

4.1. Foreign matter: any thing other than the rice grains themselves such as insects, rice hulls, rice powder, stubble, etc.

4.2. Pest presence: presence of any variety of live insects and parasites which infest stored grains.

4.3. Pest damage: effects of insect or parasite infestation

4.4. Moisture: the amount of separable water in rice grain that if raparated there will be no change in the nature and quality of the rice.

4.5. Broken grain: grains the length of which is between 1/2 and 2/3 of the original rice grains.

4.6. White spotted grains: grains which have white spot(s) especially on the middle part.

NOTE: In varieties of rice where white spot is a general characteristics these spots are not regarded as a defect.

4.7. Yellow grains: grains which have undergone discolouration and have turned to yellow colour.

NOTE: Yellowness will not be regarded as a defect in those varieties which are generally yellow.

4.8. Out of variety grains: grains which are not of the same variety as that of the tested rice.

4.9. Pesticide residue: the amount of pesticide which is remained in rice due to pest control activities in the field or in the stores.

NOTE: Pesticides residue should not exceed the amount specified by the Institute of plant pest and Desease Contorl.

5. Specifications.

Different varieties of rice shall meet the requirements specified in the following table in accordance with the effective factors in the quality of rice.

Varieties Effective Factors	D Dom-Siah	Sadri	Champa	Gerdeh
Moisture	Max. 12%	Max. 12%	———	———
White-Spotted grains (per Weight)	Max. 2%	Max. 12%	M 20%	Max. 20%
Out-of-Variety grains	Max. 2%	———	———	———
Pest damaged grains (Per weight)	Nil	Max. 5%	Max. 2%	Max. 3%
Yellow grains (Per weight)	Nil	Max. 1%	Max. 2%	Max. 1%
Foreign matter (Per weight)	Nil	Max. 6%	Max. 6%	Max. 5%
Grain length	Min.6 mm	Min.6.mm	Min.5.5. mm	Min.5 mm
Ratio of length to diameter	Min. 3	2.4 to 3	2 to 2.4	1.6 to 2
Pest Presence	Nil	Nil	Nil	Nil

6. Grading

6.1. Principle of grading: grading is on the basis of positive points gained after test. The positive points are calculated in the following manner. For each effective factor a negative point will be deducted from 100. the resulting number indicates positive points which are the basis of grading.

6.2. Grading of Dom-Siah:

A. Calculating the negative points:

i) For each 0.1% of moisture over 10% one negative point will be given. For 12% of moisture 20 negative points will be counted.

ii) For each 0.% white-spotted grains one negative point will be given. For 2% of white spotted grains 20 negative points will be counted.

iii) For each 0.2% of broken grains one negative point will be given. For 2% of broken grains 10 negative points will be counted.

iv) For each o.% of out-of variety grains one negative point will be given. For 2% of out-of-variety grains 10 points will be calculate.

v) For each 10% of grains between 7 and 7.5 mm one negative points, for each 5% of grains between 6.5 and 7mm one negative point and for each 2.5% of grains between 6 and 6.5 mm one negative point.

B. Grades:

i) Grade one: over 70 positive points.

ii) grade two: over 30 positive points

6.3 Grading of Sadri

A. Calculating the negative points:

i) For each 0.1% of moisture over 10% one negative point will be given. For 12% of moisture 20 negative points will be counted.

ii) For each 1% of white-spotted grains one negative point will be given. For 12% of white spotted grains 12% negative points will be counted.

iii) For each 1.5% of broken grains one negative point will be given. For 12% of broken grains 8 negative points will be counted.

iv) For each 0.2% of pest-damaged grains one negative point will be given. For 5% of pest-damaged grains 25 negative points will be calculated.

v) For each 0.2% of yellow grains one negative point will be given. For 1% of yellow grains 5 negative points will be counted.

iv) For each 0.2% of foreign matter one negative point will be given. For 6% of goreign matter 30 negative points will be calculated.

B. Grades:
  i) Grade one: over 85 positive points
  ii) Grade two: between 70 and 85 positve points
  iii) Grade three: between 45 and 70 positive points
  iv) Grade four: over 15 positve points

6.4. Grading of Champa:

A. Calculating the negative points:

i) For each 0.1% of moisture over 10% one negative point will be counted.

ii) For each 1% of broken grains one negative point will be given. For 20% of broken grains 20 negative points will be counted.

iii) For each 0.1% of pest-damaged grains one negative point will be given. For 2% of pest damaged grains 20 negative points will be counted.

iv) For each 0.2% of yellow grains one negative point will be given. For 2% of yellow grains 10 negative points will be calculated.

v) For each 0.2% of foreign matter one negative point will be given. For 6% of foreign matter 30 negative points will be calculated.

B. Grades:
  i) Grade one: over 75 positve points
  ii) Grade two: between 50 and 75 positve points
  iii) Grade three: over 15 positve points.

6.5. Grading of Gerdeh:

A. Calculating the negative points:

i) For each 0.1% of moisture over 10% one negative point will be given. For 12% of moisture 20 negative points will be counted.

ii) For each 1% of broken grains one negative point will be given. For 20% of broken grain 20 negative points will be counted.

iii) For each 0.1% of pest-damaged grains one negative point will be given. For 3% of pest-damaged grains 30 negative points will be counted.

iv) For each 0.2% of yellow grains one negative point will be given. For 2% of yellow grains 10 negative points will be calculated.

v) For each 0.25 of foreign matter one negative point will be given. For 5% of foreign matter 20 negative point will be calculated.

B. Grades:
  i) Grade one: over 75 positive points
  ii) Grade two: between 50 and 75 positive points
  iii) Grade three: over 15 positive points

7. Sampling method

7.1. This method applies to sampling of rice which is packed in sacks

7.2. The required number of sacks as detailed in the table below should be selected in random from among the consignments or stored sacks of rice.

Samples from each selected sack amounting from 100 to 500 g.- depending on the number of sacks - should be taken through the special standard sampler. The samples should be taken from different sides of the sacks and then all the samples should be mixed to make a mixed sample. This mixed sample shall be sent to laboratory for tests.

No. of Sacks:	No. to be selected:
3 to 10	2
11 to 25	3
26 to 50	4
51 to 100	5
101 to 200	6
201 to 350	7
351 to 500	8
501 to 700	9
701 to 1000	10

NOTE: If number of sacks exceed 1000 then it should be divided into 1000 and for each division the above table should be followed.

8. Test method

8.1. First of all the samples should be searched for any live insect in any stage of life. If there are not any live insects in the samples then they should be tested for other factors.

8.2. Determination of variety: From the well-mixed sample a specimen having at least 200 unbroken grains should be taken. The length... and the diameter of each grain of this specimen should be measured by a micrometer or any other precise device. Then the values indicating the length of the grains should be divided by the values indicating the diameter of the grains to obtain the ratio of length to diameter for each grain, then:

a) If the length of 95% of grains is not less than 6 mm and the ratio of length to diameter of each grains is not less than 3 the rice will be identified as Dom-Siah.

b) If the length of 95% of grains is not less than 6 mm and the ratio of length to diameter of each grain is not less than 2.4 the rice will be identified as Sadri.

c) If the length of 95% of grains is not less than 5.5 mm and the ratio of length to diameter of each grain is not less than 2 the rice will be identified as Champa.

d) If the length of 95% of the grains is not less than 5 mm and the ratio of length to diameter of each grain is not less than 1.6 then the rice will be identified as Gardeh.

8.3. Determination of moisture content of rice: Grind a small specimen from the mixed sample to obtain rice flour. Weigh 5 g. of this flour into a crucible of a predetermined weight. Put the crucible in autoclave of 10˚5 + 5 for a period of 3 to 3.30 hours until it comes to a constant weight. Then take out the crucible from autoclave and put it in a desicator until it reaches to the laboratory temperature and then weigh it. Calculate the difference of original and the resulting weights accurately and multiply it by 20. The resulting value will be the percentage of moisture content.

8.4. Determination of foreign matter, pest-damaged grains, broken grains, white-spotted grains, and yellow grains: Weigh a specimen of at least 200 g. of the mixed sample. Pass this specimen through a No. 1 sieve of one milimetre mesh. Weigh the part that has passed through the sieve and note down the weight. Spread the rice which has remained on the sieve over a black plate. Separate and weigh all foreign matters observed in the irice on the black plate. Add this weight of separated foreign matter to the weight of the part passed through the sieve. This will be the amount of foreign matter in the specimen of rice. Separate in the same way all the broken, white-spotted, yellow and pest-damaged rgrains from the specimen and weigh them separately. The resulting values should be expressed in percentage.

9. Packaging and Marking

9.1. Packaging: For export, rice shall be packed in new jute bags or course linen sacks having two layers. The net weight of the rice packs intended for export shall be 15, 30, 60, or 100 kg.

9.2. Marking: The following information shall be marked in English or the language of the importing country:

- i) Variety of the rice
- ii) Grade of the rice
- iii) The phrase: "Produce of Iran"
- iv) Net weight in kg.
- v) Name or the trade mark of producer or exporter.

Fresh Milk Making Plant

Milk, as a highly nutritive drink, has today become indispensable for our daily living, and its demand continues to increase steadily from year to year for consumption by general households, hospitals and schools.

Milk available on the market may be obtained in the form of plain milk that is simply pasteurized, processed milk that is added with vitamins, minerals or other nutrients, or in a mixture with fruit juice, coffee, chocolate or other ingredients. Whatever the form in which milk is available, the basic processes involved in its preparation are generally the same, the essential difference lying in the processes preceding pasteurization.

Milk available to end consumers, particularly ordinary milk, usually comes in 200 cc, 500 cc or 1 liter containers. These containers may be made of glass, but the more general trend today is to market milk in paper or polyethylene containers which dispense with the need to recover the bottles. Naturally, the milk filling process will differ according to whether a bottle or other form of container is used.

Since milk distributed to general consumers constitutes a typical product that is produced daily and consumed more or less the same day, the milk making business may be regarded as a stabilized one closely linked to our daily living.

The milk making plant to be introduced here is designed with a minimum economic production scale, or a production capacity of 6,000 liters/day. For container is used paper container of 200 cc.

Process Description

Raw milk, stored cool and inspected for quality, is treated by clarifier and its microscopic impurities completely eliminated. The milk is then preheated by ultra high temperature sterilization and its fatty ingredient homogenized by means of a homogenizing system. This is followed with ultra high temperature sterilization at 135°C for about 2 seconds, after which the milk is cooled, then filled into paper containers.

In further details, milk making is achieved by the following processes. Raw milk conveyed by milk cans or tank lorries changed into the weighing tank by a conveyor belt for weighing, after which a prescribed volume of milk is charged into the receiving tank.

From here, the milk is pumped to the clarifier by means of the milk pump, where it is removed of microscopic impurities. Clarified milk is next sent to the plate cooler where it is cooled to about 2 – 5°C, then pumped to the storage tank

Stored milk is preheated to about 80°C by heat exchange with pasteurized milk in the ultra high temperature sterilizer and its fatty ingredient homogenized in the homogenizer, then further recycled to the ultra high temperature sterilizer where it is pasteurized instantly in about 2 seconds at a high temperature of 135°C.

Here, the pasteurized milk is subjected to heat exchange with incoming raw milk, whereupon its temperature is gradually lowered. Final cooling is achieved by means of chilled water to lower the temperature to 3°C, after which the milk is stored in the surge tank for subsequent filling into paper containers by means of the filling machine.

For pasteurization of milk may be adopted either the high temperature sterilization system or the ultra high temperature sterilization system. The high temperature sterilization system involves pasterization at a temperature of about 85°C, while the ultra high temperature sterilization system achieves pasterization at a high temperature of about 135°C.

Today, the ultra high temperature sterilization system is more popularly adopted since it lends itself to killing escherichia coli and other heat resisting bacteria, in addition to permitting longer preservation of milk.

Example of Fresh Milk Making Plant

1) Production Sheme

Table 1: Required Machinery and Equipment

Item	Capacity	No.
Weighing tank	200 kg	1
Receiving tank	500 kg	1
Milk clarifier	3,000 liters/hour	1
Milk pump	3,000 liters/hour	1
Plate cooler	3,000 liters/hour	1
Storage tank	6,000 liters	2
Milk pump	1,000 liters/hour	1
Pasteurizer	1,000 liters/hour	1
Surge tank	1,800 – 2,000 liters	2
Filling & packaging machine	3,400 pcs./hour	1
Boiler	300 kg (evap.)	1
Chiller	40,000 Kcal/hour	1
Power receiving facilities	30 kVA	1
FOB price of machinery and equipment	(approx.) $US 286,000	

Table 2: Daily Requirement of Raw Materials and Utilities

Item	Quantity
Raw materials	
Raw milk	6,000 liters
Paper container (200 cc)	30,000 pieces
Utilities	
Electric power	162 kWh
Water	28 kiloliters
Fuel (light oil)	200 liters

The plant is designed for operation under an 8-hour day system, with 2 hours expended for preparations and after cleaning. That is, the machines are actually operated for 6 hours daily. The standard plant operation schedule is as follows:

8 hours/day
25 days/month
300 days/year

2) Required Machinery and Equipment (Ref: Table 1)
The principal machinery and equipment required for a 6,000 liters/day milk making plant will be as listed below. The cost of machinery and equipment for a 10,000 liters/day plant will not differ much as for a 6,000 liters/day plant, although it will be necessary to operate the packaging section under a 2-shift work system.
The cost indicated above is based on current values and includes installation as well as plant operating guidance expense.

3) Required Area for Plant Site
The land area required constructing the plant and its buildings will be as follows:

Land 40 m x 50 m = 2,000 m^2
Building 18 m x 35 m = 630 m^2

The buildings shall be of formed steel structure with slated roofing, and will consist of the plant building proper, office, chiller housing, power room, boiler room, paper container warehouse and others.

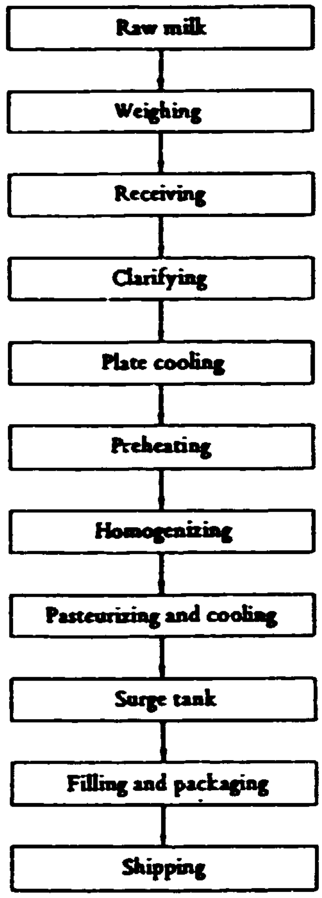
Tables 1, 2 and 3 show respectively the machinery and equipment, raw materials and utilities, and manpower required for the above plant.

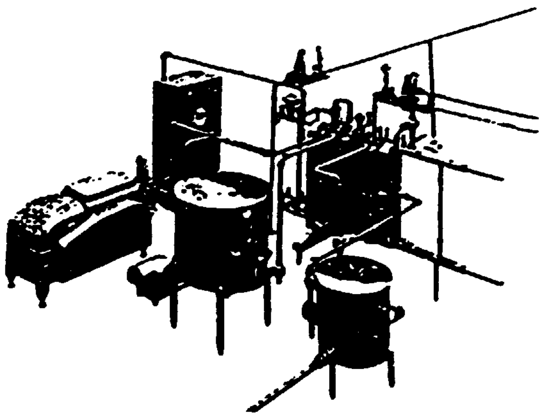
Table 3: Required Manpower

Item	No.
Plant manager	1
Engineer	3
Worker	7
Total	11

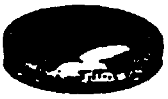
Locational Condition

For a milk making plant catering to general consumers, the primary locational condition for selection of plant site will be its proximity to milk producing centers and to a source of easy water availability. The location would be ideal if, in addition, the site is situated near consumer markets, but this condition will be of secondary importance since good product transportation facilities are generally available today.





DIFFERENT TYPES OF MILK

Type of Milk	Description	Characteristics	Foil Caps	Keeping Qualities
Untreated 	Raw milk which has not been subjected to any form of heat treatment. It may be produced and bottled by a farmer who holds a special licence from the Ministry of Agriculture, Fisheries and Food. This milk must be clearly labelled 'Raw Unpasteurized Milk'.	Very apparent cream line. Vitamin C content slightly higher than milk which has undergone heat treatment.	Green	1 day in a cool place or 3-4 days in a refrigerator.
Pasteurized 	Milk which has been subjected to the pasteurization process of heat treatment (see page 6).	90 per cent of thiamin and vitamin B_{12} and up to 80 per cent of the other vitamins, minerals and protein are virtually unchanged.	Silver	2-3 days in a cool place or 4-5 days in a refrigerator.
Ultra Heat Treated	Milk which has been subjected to the ultra heat treatment (UHT) process (see page 7).	The treatment changes the flavour of the milk slightly.	(Sold only in cartons)	Unopened it will keep up to several months without refrigeration. Once opened it will keep as long as pasteurized milk.
Sterilized 	Milk which has been subjected to the sterilization method of heat treatment (see page 7).	The high temperature causes slight caramelization of the lactose (milk sugar) producing a 'cooked' flavour and more creamy appearance. There is loss of about 50 per cent of the vitamin C and vitamin B_{12} and 30 per cent of the thiamin. There is also a slight reduction in the biological value of the protein.	Blue (for plastic bottles only; otherwise sold in long-necked glass bottles with a crown cap)	Unopened it will keep for at least 2-3 months without refrigeration. Once opened it will keep as long as pasteurized milk.
Homogenized 	Milk which has been subjected to the homogenization process (see page 7).	Homogenized milk has no cream line, but tastes smooth and creamy. It is more readily digested partly because of the small fat globules and partly because the process lowers the curd tension which results in the formation of a softer curd during digestion.	Red	2-3 days in a cool place or 4-5 days in a refrigerator
Channel Islands 	Milk from the Jersey or Guernsey breeds of cow. Available as untreated or pasteurized.	It must contain a minimum of 4 per cent fat but often the average is nearer to 4.8 per cent as opposed to other whole milks which have a minimum of 3 per cent with an average of 3.8 per cent. Because of its high fat content it has a rich creamy taste and a definite cream line.	Untreated: Green with a gold stripe; Pasteurized: Gold	2-3 days in a cool place or 4-5 days in a refrigerator
Semi-Skimmed 	Milk from which some of the fat has been removed. Available pasteurized, sterilized and UHT.	Semi-skimmed milk contains 1.5-1.8 per cent fat.	Not prescribed by legislation. It has been recommended that pasteurized semi-skimmed milk should have a red and silver striped cap and pasteurized skimmed milk, a blue and silver checked cap	2-3 days in a cool place or 4-5 days in a refrigerator (pasteurized)
Skimmed 	Milk from which virtually all the fat has been removed. Available pasteurized, sterilized and UHT.	Skimmed milk contains less than 0.3 per cent fat.		

Mastitis and its Control

Mastitis is a disease which was and is a major problem on dairy farms. This disease is usually caused by bacteria but it can be caused by trauma, particularly by a malfunctioning milking machine. *Staphylococcus aureus* is the main bacterium associated with increases in SCC[1]. It causes increased levels of subclinical (hidden) mastitis and is spread in the herd with faulty milking equipment and a lack of hygiene at milking time. Since often as many as 50% (sometimes even more) of the cows in some herds are affected by this "silent" condition and it causes a reduction in milk yield of some 10%.

Because subclinical mastitis is so common and it causes such losses of milk and money it is very important that the people who are looking after and milking the cows should do everything possible to lower its incidence. A guide to the level of subclinical mastitis can be gained by the study of the bulk milk cell count. There are few methods of estimation of somatic cells in milk. One of them, known as a Whiteside test, is given below. European Community Standards now require that SCC should remain below 400.000/ml in bulk herd milk.

In many countries, on farms has been started programmes of practical control mastitis. The rules set out below are a base of all those programmes.

1. Proper management and hygiene (and the first of all it means clean cows, equipment sterilisation, udder wash, teat dip and udder spray after milking, washing of hands by milkers between cows and well serviced and looked after machine).
2. Good milking techniques and efficient milking equipment.
3. Treatment of clinical mastitis.
4. Therapy of dry period.
5. Spraying of dry cows and in-calf heifers with a fly repellent.
6. A selection and culling policy.

Whiteside test

The test is based on the chemical reaction between sodium hydroxide (NaOH)and DNA which is present in cell nucleus (1 million somatic cells contain ca. 7 ug of DNA). In the case of milk obtained from cow or cows with mastitis, jollification takes place after mixing sample of milk with NaOH.

Method of testing

Transfer 5 drops of milk into watchglass (sometimes Schalma's plate is used). Add 1 drop of 1N NaOH. Mix the milk and sodium hydroxide, than observe appearance of the sample in reflected light on dark green background.

There are 6 levels of detected mastitis. The levels are as follows:

+-; +-+; +; ++, +++; ++++

+- level is the lowest level (almost invisible)

++++ level is the highest level (strong jollification)

[1] Somatic Cell Count

How To Start Manufacturing Industries

Assorted Animal Feed Making Plant

Assorted animal feed industry is gaining rapid worldwide attention in recent years as the need grows ever more critical to supply animal protein to the chicken, hog and cattle raising industries.

The transformation of these industries from small-scale operations to large-scale operations which promise profitability with greater stability, has brought about a change even in the system of supplying feed to grass-eating, herbivorous animals, and the demand for assorted animal feed has continued to grow at a sharp pace from year to year.

In Japan, for example, the output of assorted animal feed during fiscal 1977 was about 20 million tons, of which 50% was consumed for poultry raising, 28% for hog raising, 21% for cattle raising, and 1% for other purposes.

The use of 50%, or one-half of total assorted animal feed output for poultry raising, is characteristic of the Japanese assorted animal feed industry. Perhaps this situation well underscores the great suitability of assorted animal feed to the poultry raising industry.

The demand for assorted animal feed is believed to be increasing at the rate of some 1 million tons annually. In fact, today the volume of assorted animal feed utilized by various industries reportedly runs up to about 80% of total feed consumed in the country, indicating the vital importance which assorted animal feed plays in animal raising industries.

Bullish demands have triggered a rush toward scale upping of assorted animal feed plant capacities. For instance, the minimum monthly production capacity of a plant newly constructed in fiscal 1978 was 5,000 tons, and the plant in Japan having the maximum monthly production capacity is 30,000 tons.

A wide variety of materials is employed in the manufacture of assorted animal feed, the more general ratio being maise 36.8%, milo 25.2%, wheat bran (mash) 2.6%, molasses 1.9%, soybean grounds 11.1%, fish meal 3.3% and others.

As for the breakdown of production costs in Japan the cost of raw materials assumes a very high ratio of 86 – 90% since most raw materials are imported, while other principal cost items are labour 2%, production cost 2.5 – 2.8% and sales cost 7%.

The processes involved in the manufacture of assorted animal feed are indicated in the attached process flow sheet. Briefly described, the following processes are involved.

Process Description

1) Raw materials facilities
The supply of principal raw materials and sub-materials are charged into silos and tanks, where these materials are mixed with additives.

2) Primary crushing
The raw materials stored in silos, tanks and warehouses are processed by primary crushing. Crushed materials are further separated by means of a sifter, then stored in assorting tanks (hoppers) according to the kind of raw material.

3) Assorting and measuring
Small amounts of additives are charged into the bins containing different assortments of raw materials. The raw materials stored in the assorting tanks are measured in accordance with their use as poultry feed, hog feed, cattle feed and others.
Raw materials of large particle size are generally used as feed for poultry, while raw materials of fine particle size are mostly used as feed for hogs.

4) Mixing
The raw materials thus weighed according to the kind of feed to be produced, are then mixed by means of a mixer. In this process, fatty ingredients are added to the materials in order to raise the nutrient value of the feed.

5) Molasses mixing
The feed obtained from the mixer is added with molasses whereupon assorted animal feed is obtained in bulk.

6) Fine crushing
After the feed is mixed with molasses, it is further crushed by means of the 2nd crusher in the event the feed is used for hog raising. The feed is crushed to particle sizes of about 1 mm diameter in this process, and may be used as assorted animal feed at this stage.

7) Pellet making
Assorted animal feed that is crushed into fine particles is further formed into pellets. These pellets, which are cylindrical type and come in sizes measuring 6 mm in diameter and 2 cm in length, are then dried.

8) Packaging
The assorted animal feed having been produced by the processes described above, the product is next accommodated in the product tanks, then weighed and packaged.
The mechanical facilities required for the assorted animal feed plant consist of the following:
(1) Raw materials storage tank and other facilities
(2) Crushing facilities
(3) Assorting facilities
(4) Processed feed facilities
(5) Transportation facilities
(6) Dust collection facilities
(7) Packaging and bulk shipment facilities

Example of Assorted Animal Feed Making Plant

Here, a description shall be given of an assorted animal feed plant having a monthly production scale of 5,000 tons, which is a most economical scale.

Operation hours:
8 hours/day
25 days/month
300 days/year

Tables 1, 2, 3, 4 and 5 are based on the above plant.

Required Raw Materials and Subsidiary Materials

The quantities of raw materials and sub-materials required to produce assorted animal feed are indicated in the following table.

Accordingly, the kinds of raw- and sub-materials as well as their mixture ratio can be determined as long as the specific application of the assorted animal feed in known.

As we are concerned here with a plant capable of producing 5,000 tons of assorted animal feed monthly, the principal raw materials required per month will be described in Table 2.

Table 1: Required Machinery and Equipment

Item
Raw material silo
Sub-material tank
Pre-mixer
1st crusher
Sitter
Assorted tank and hopper
Hopper scale
Mixer
Fat tank
Molasses tank
Molasses mixer
2nd crusher
Pellet manufacturing equipment
Product tank
Product measuring scale
Packing machine
Boiler
Dust collector
FOB price of machinery and equipment .... (approx.) $US 5,238,000

Table 2: Monthly Requirement of Raw Materials and Subsidiary Materials

Item	Quantity
Maise	1,875 tons
Milo	1,095 tons
Other grains (wheat, barley, etc.)	120 tons
Mash	200 tons
Rice bran oil lees	175 tons
α-meal pellet	135 tons
Others	140 tons
Soybean oil lees	460 tons
Other vegetable oil lees	475 tons
Fish grounds, meal	185 tons
Oil and fat	25 tons
Molasses	100 tons
Additives	15 tons

Table 3: Required Utilities

Electricity	1,600 kWh
Water	2 tons/hour
Fuel	156 kg/hour

Table 4: Required Manpower

Item	No.
Manager and chief engineer	1
Total machine operator	2
Packing operator	2
Crushing operator	1
Adding agent	1
Maintenance and supervision	2
Pellet operator	1
Shipment	1
Boiler	1
Pre-mixer	2
Raw- and sub-material warehouse	2
Electrical engineer	1
Mechanical engineer	1
Odd job man	7
Total	25

Table 5: Required Area for Plant Site

Plant building	1,200 m²
Raw material warehouse	1,000 m²
Product warehouse	1,000 m²
Land	15,000 m²

Locational Condition

The plant location will depend largely on how the raw materials are obtained. In a country where most of the raw materials are available locally, a location near the raw materials producing centers would be the most ideal. On the other hand, if the larger proportion of the required raw materials are imported, then a location near a seaport will be more advisable.

However, since some kinds of raw materials such as fish powder may generate foul odor, it may me necessary to construct the plant at some place away from general residential areas and away from city or town areas.

Table 5: Raw Materials for 1,000 Tons of Assorted Animal Feed

Raw- & Sub-Material	For Dairy Cattle	For Beef Cattle	For Poultry	For Other Purposes	Average
* Maise	7.7%	12.9%	47.7%	34.7%	35%
* Milo	19.6	28.5	18.0	12.4	21.9
Wheat	0.2	–	0.2	0.3	0.3
Barley, naked barley	1.4	7.5	–	0.8	0.8
Other grains	2.9	4.8	0.3	4.2	1.3
* Mash	11.7	7.8	1.3	2.5	4.0
* Rice bran	1.8	3.8	0.6	0.8	1.0
* Rice bran oil lees	5.3	2.5	1.6	2.3	2.5
* α-meal pellet	2.1	4.5	2.6	1.7	2.7
Other	12.0	3.2	1.1	3.7	2.8
* Soybean oil lees	10.5	8.0	9.7	5.6	9.2
* Other vegetable oil lees	13.4	7.2	3.0	4.5	9.5
* Fish grounds, powder	0.3	0.2	4.8	4.5	3.7
Adsorbent feed	0.1	–	1.1	0.6	0.7
Skim milk powder	0.7	–	0	3.7	0.3
* Fat & adsorbent feed	0.1	0.2	0.7	0.3	0.5
* Molasses	5.8	3.8	0.4	7.6	2.0
* Additive	0.1	0.2	0.3	0.3	0.3

Note: Items affixed with * are essential raw materials.

FACTORY FOR CATTLE FEED

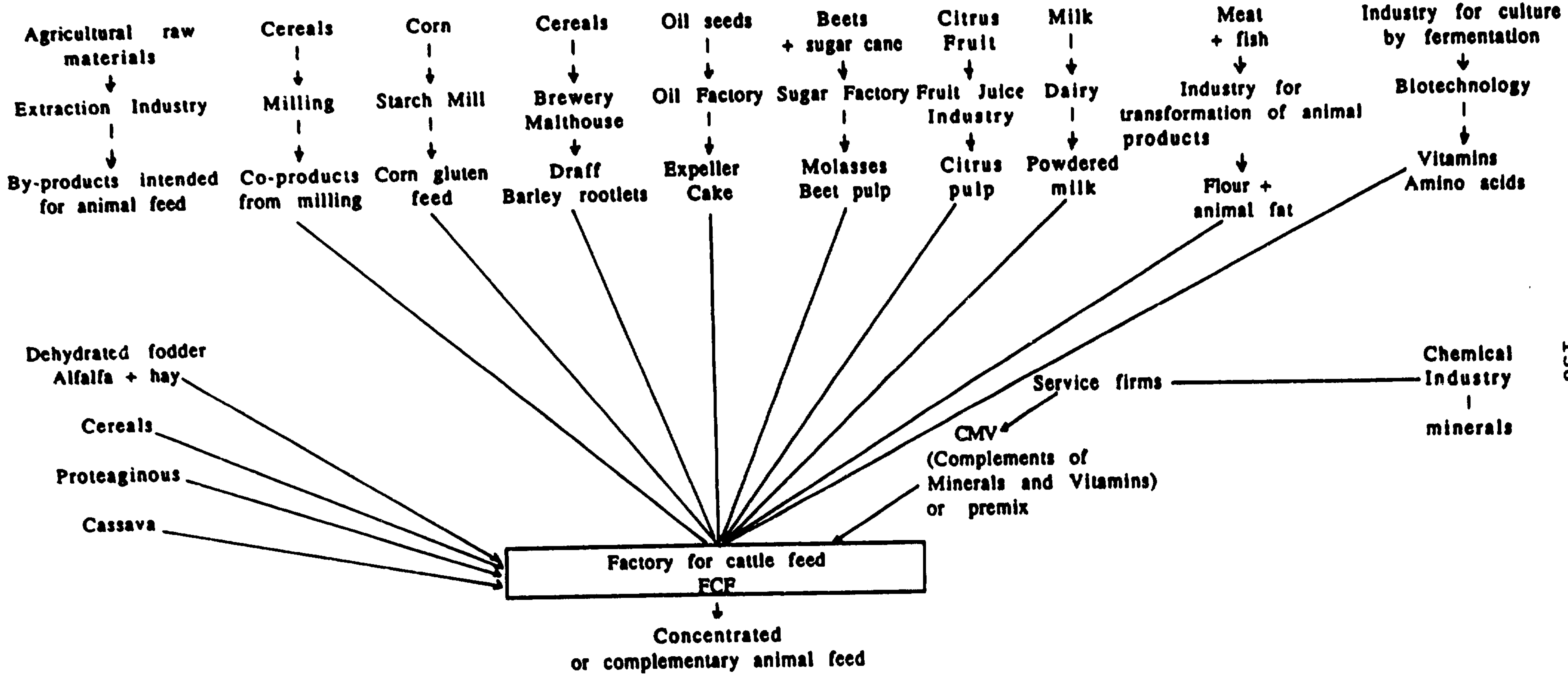
ALTERNATIVES AND CONSTRAINTS

Alternatives :
The operation of the purchasing of raw materials is essential in the production of cattle feed. Of primary importance is the satisfaction of the nutritional needs of the animal, by means of a composed product which is the result of the combination of raw materials of different origins (over 400 eventually listed in France). (Possible origin of raw materials: agriculture, agro-food industries, chemical industry.)

Constraints :
- Energy needs are significant (foresee electrical service or possible generating set)
- Possible pollution problems due to fine particles (notably of flour) which can be resolved by installing filters.
- Risks of disintegration or separation of the feed mixture, especially during bulk transport : possible use of binding agents.
- Necessity of constant link with trading companies (telecommunications, telex), in order to be constantly aware of the price of raw materials freight included and to define the most efficient and economical formulas for raising of livestock in a given region.

OPERATIONS	FUNCTIONS	POSSIBLE CHOICES OF TECHNOLOGY
Reception, Weighing of Raw Materials		Swinging bridges
Mixing	Preparation of the mix	Mixers : double screw; - horizontal : rapid, equipped with "Nauta" blades with endless screws for mixing. - vertical : with "Simon Hersen" screws.
Grinding	Obtaining of a flour	Hammers grinders. Each raw material may be ground before mixing.
Granulating	Improvement of the use by animals	Press with channels
Drying and/or cooling (Crumbling) Dosage bagging In bulk Composed Feed	Breaking down of lumps	Vertical refrigerator unit Dryer - refrigerator unit - turning or rotary - with hoppers - with bands

INDUSTRY BRIEFING PAPER: ANIMAL FEED



SYNOPSIS

SERVICE FIRMS

Manufacture of CMV (Complements of Minerals and Vitamins) or premix.
This activity is not easily performed by small and medium-sized firms due to the veterinary research required for the adaptation of the premix to each feed.
The CMV supplied to manufacturers of cattle feed is a product which often covers the whole range of the animal's needs for minerals, trace elements, vitamins, and growth factors.

Manufacturing constraints

1) Stability of the vitamins
Certain substances in the CMV can reabsorb water when they come into contact with the free water contained in salts. A reaction occurs, causing an amalgam of the mixture and a release of heat, which alters the vitamins.
A premix should contain a sufficient quantity of absorbant nutritive supply to avoid this problem.

2) Flow of CMV

The CMV often does not flow easily. Certain agents such as silicic acid can be added to increase its "flowability". However, if certain limits are not respected, the premix may separate.

Composition of CMV:
Minerals g/kg dry matter P, Ca
Trace elements mg/kg dry matter and micro g/kg dry matter
Vitamins A, D, E, K, thiamine, riboflavin, vitamin B9 (ppm),
micro g/Kg dry matter
Growth factors: antibiotics + AA methionine, choline, lysine
Recently: probiotic, still not utilized and little known

Origin of the raw materials making up CMV:
Vitamins and growth factors: biotechnology
Ca <- calcium carbonate <- chalk
P and Ca <- bone meal
Dicalcium phosphate
Minerals chemistry
Trace elements

CATTLE SLAUGHTERHOUSE

Small slaughterhouses equipped for complete processing are well suited for small towns and daily supply of the population with fresh meat in countries with extensive cattle breeding.

Generally such slaughterhouses can only be built on well drained terrain which is not susceptible to floods and pollution from other sources. Care must be given to the pens and sheds in the slaughterhouse which must be easy to clean and disinfect. Main and other buildings must be fenced to prevent the uncontrolled entrance of animals and must be located in such a way that the paths in the clean and nonclean areas do not intersect. Lastly, slughterhouse refuse must be eliminated and passed into adequate vessels and containers.

The slaughterhouse for the slaughter and processing of cattle described here is of medium capacity.

The technological process and operation guarantee maximum sanitary conditions.

The process alllows for the organized input of cattle, slaughtering, storage and output of finished products. Besides buildings the slaughterhouse also requires electrical energy and clean water. A small quantity of the clean water is heated for cleaning and washing purposes.

PROCESS DESCRIPTION

The slaughtering line is designed to provide for complete processing of cattle in a suspended position. The small capacity of the line does not require the incorporation of conveyers and transportation at the lines is done manually. For the same reason blood processing is not included.

Cattle supplied to the slaughterhouse are weighed on a cattle balance and then unloaded along the reception ramp into pens for rest.

They are stunned by a gun in a box and afterwards slaughtered and removed to the bleeding line where blood is collected in a basin. The carcasses are loaded by electric

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This information has been prepared for UNIDO by the Institute for Developing Countries, Yugoslavia. Inquiries should be addressed to: IPCT/II/PROM, Registry file No. ID/562/12, UNIDO, P.O. Box 300, A-1400 Vienna, Austria.

hoist from the slaughter line to the processing line. Loading, spreading of rear legs and dehiding are carried out on a three level platform, and final dehiding done on a two level platform by means of a pneumatic knife.

The horns are removed by electric saw, and the heads inspected and washed. The brisket is opened by electric saw, the entrails inspected and extracted. Inspection takes place on an inspection table. Stomach and casings are transported for cleaning. Carcasses are split into halves which are washed and inspected by a vet. After inspection the halves are quartered and transferred to a low rail. Before transfer to the storage room the meat is weighed on a suspended rail balance.

Hides are transported to the hide storage from where they are despatched to the processing hall or casing room, depending on the kind of hide.

The meat is cut on tables in the cutting room by means of electric or hand operated saws and knives. Cold storage then provides for the complete cooling of the meat at 0°C, while half the capacity may be frozen at -35°C. Meat from 500 cattle can be frozen.

Staughter and processing of cattle is a continuous process.

PRODUCTION CAPACITY

On the basis of an eight hour day the capacity of the slaughterhouse is 60 cattle a day.

REQUIRED MACHINERY AND EQUIPMENT

I t e m	No.
Electric hoists	4
Stunning box	1
Stunning gun	1
Platforms for cattle processing	7
Electric saws for cutting and splitting	4
Pneumatic knive	1
Hooks for various purposes	260
Pneumatic spreader	1
Carts for various puposes	26
Stand by spreader	1
Sterilizers for slaughtering tools	5
Processing and inspection tables	13
Pipe rail with supporting construction	650 m
Rail balances up to 500 kg	2
Cattle balance up to 2 000 kg	1
Floor balances up to 200 kg	5
Machine for washing and cleaning of stomach	1
Device for casing processing	

Wash basins for washing hands	5
Hand sprayers	12
High effect pumps for washing	2
Pumps for discharging manure	2
Laboratory equipment	1 set
Other slaghtering equipment	1 set

FOB price of equipment and project is 180 000 US dollars (in 1985).

REQUIRED RAW MATERIALS

Cattle .... 60 per day
Salt .... 10 kg per day

REQUIRED MANPOWER (for two shifts)

Qualification	No.
Veterinarians	2
Butchers	37
Workers	10
Clerks	1
TOTAL:	50

REQUIRED UTILITIES

Electric power .... 5 kWh per animal
Water .... 2 tons per animal

REQUIRED AREA OF PLANT SITE

The area of the building and cold storage area is 2,450 m^2.

FLOW SHEET FOR CATTLE SLAUGHTERHOUSE