OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

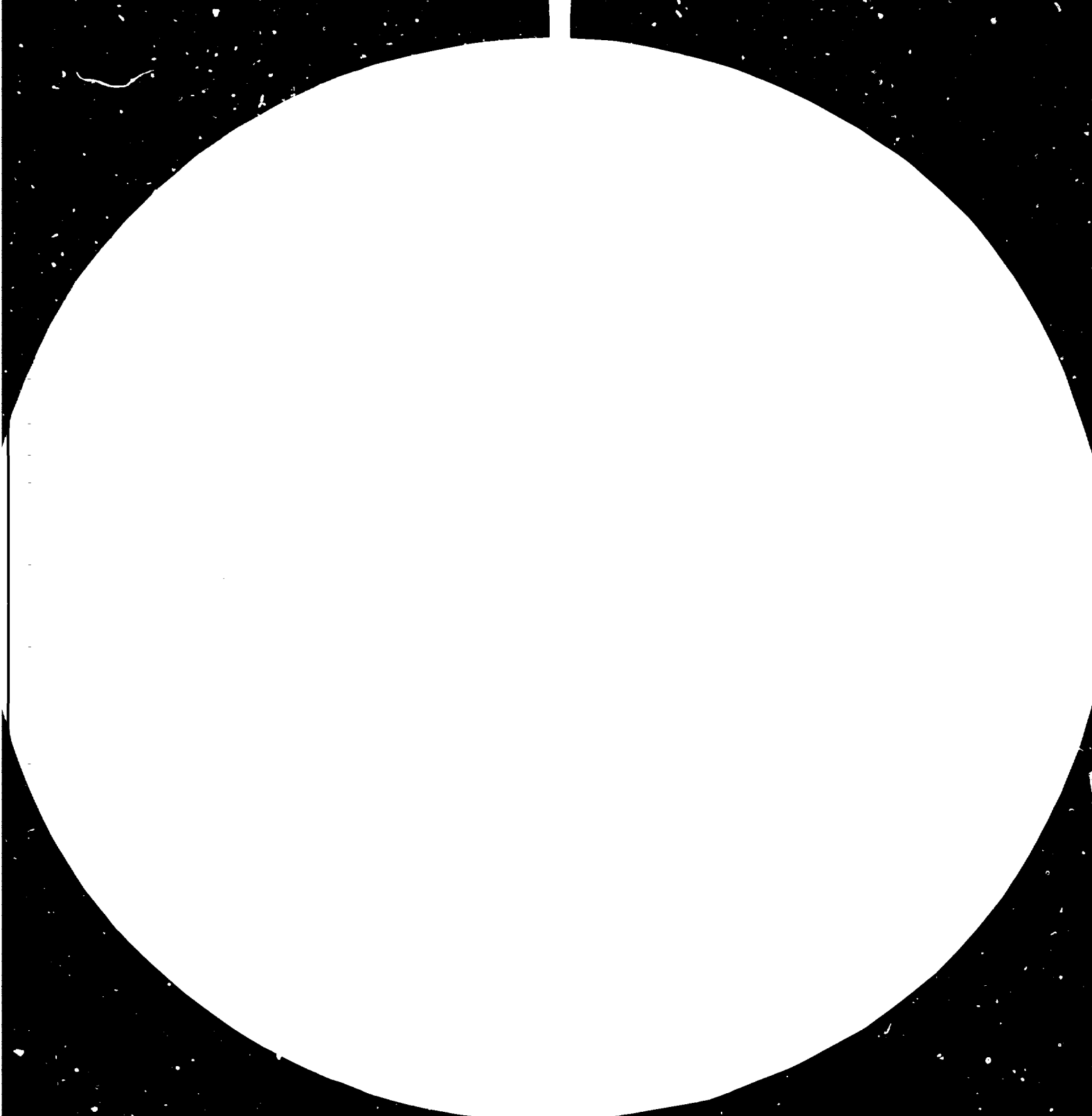
FAIR USE POLICY

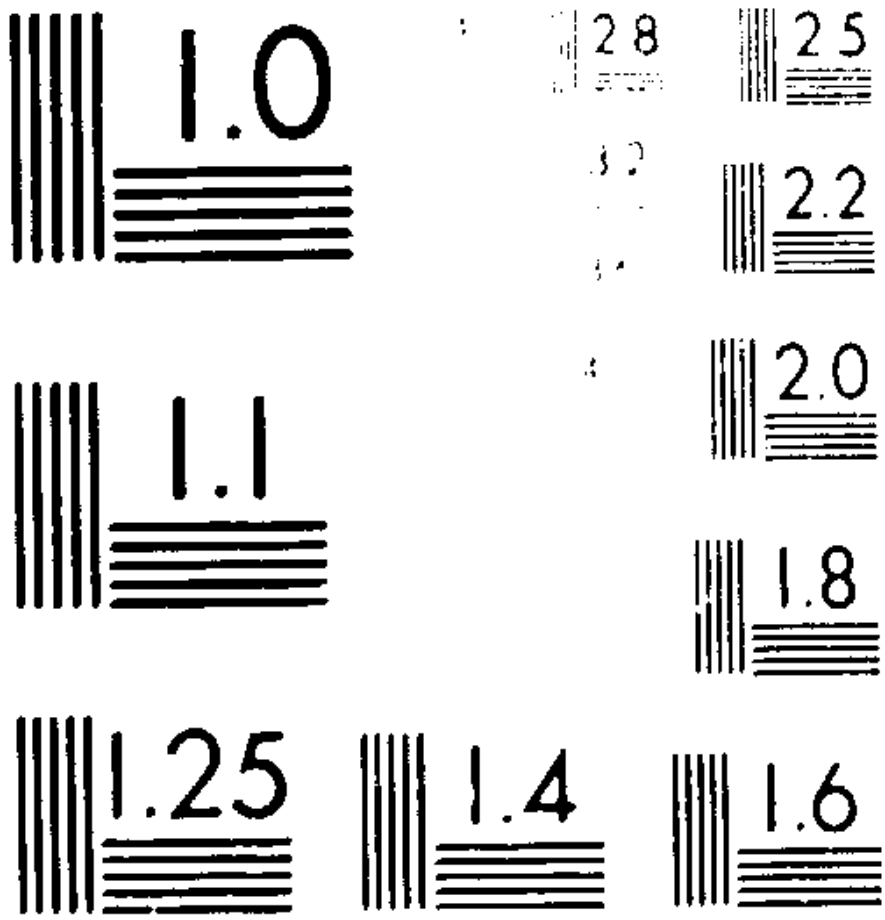
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org




1.0
2.8
2.5
2.2
1.1
2.0
1.8
1.25
1.4
1.6

10834

Distr.
LIMITED

UNIDO/IO.444
29 July 1981

ENGLISH

UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

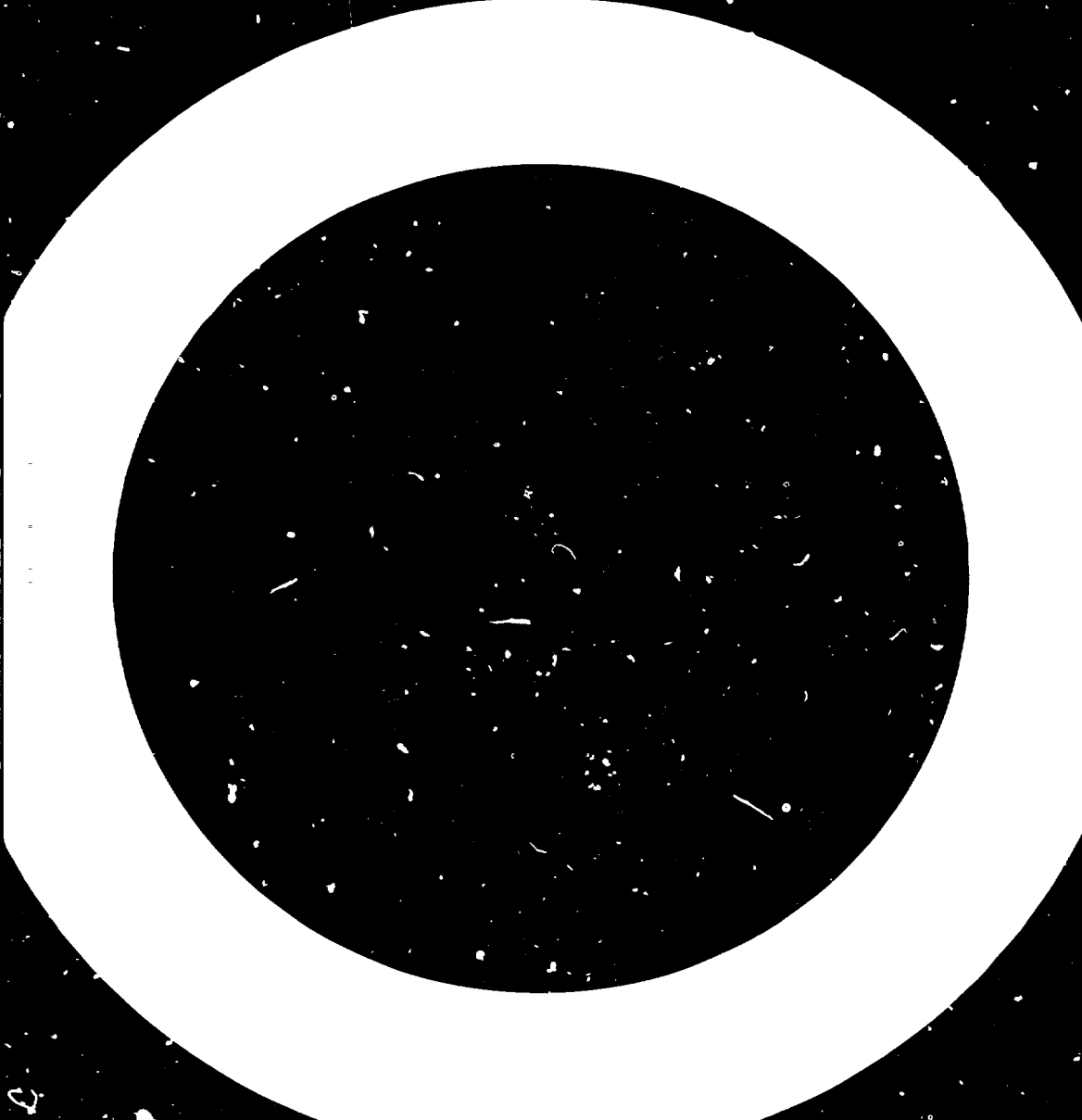
SEMINAR ON INTERNATIONAL CO-OPERATION ON DESIGN,
CONSTRUCTION AND OPERATION OF FRUIT AND
VEGETABLE PROCESSING PLANTS AND
COLD STORAGE FACILITIES
UC/INT/80/115

Trends in design, construction and operation of plants for industrial processing of fruit and vegetables [1]

Technoexport, Sofia
Bulgaria

1/ The views and opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the secretariat of UNIDO.

V.81-28029



CONTENTS

I. INDUSTRIAL RPOCESSING OF FRUIT AND VEGETABLES

Canning is a growth industry for three reasons: because of the constant introduction of industrial technologies into agriculture (which in turn means fast raw material processing), because of the related industrialization of public catering establishments and because of advancing science and technology of canning itself.

Today's technology has paved the way for complete industrialization of the canning industry. Almost all its production processes are mechanized, a large part of them fully automated. In practical terms this means modern systems engineering and instrumentation both for in-plant process control and for quality control.

A. General scheme of canning

The common features of industrial fruit and vegetable processing can be represented by four basic stages:

(a) Delivery and reception of raw material;
(b) Primary (preliminary) processing;
(c) Main processing (canning);
(d) Packaging and storage.

Those four stages both determine and depend on the particular end product and on the peculiarities of separate technological processes involved.

Delivery and reception of raw material

This stage includes harvesting, transportation, intermediate preservation and delivery of the raw material for production. All will influence the organization of further processing and quality of the end product. Reception of the raw material should conform to the agricultural technology involved, i.e. application of chemicals, mechanized harvesting, loose gathering, transportation etc.

Transportation. In order to exclude mechanical damage to fruit and vegetables, this should be as fast as possible and in proper containers. Transport may be by truck, rail or sea, preference being given to trucking. The related packaging includes: crates, small boxes (cassettes), plates and large pallets, gondolas and tanks. Raw materials may also be carried loose.

The factors to be considered in the choice of packaging are the organization of agriculture, the raw material properties, its destination and economic criteria.

Intermediate preservation in fruit storage extends the processing season. It is, however, short-term (not over 50 to 60 h) and is carried out under normal climatic conditions. Any prolongation therefore determines the waste (loss) and the quality (withering) of raw material. The preservation may be carried out in transport packaging, on horizontal or inclined platforms and in bunkers, or in water tanks inside cages.

Delivery of the raw material for processing mainly uses trucks, electric vehicles and hydraulic transport. The delivery and reception of the raw material should also be mechanized, different equipment and systems being used according to the kind of raw material and its destination. It should be organized under local process management, but with quantitative reports giving centralized automated control.

Primary processing

The task of preparing the raw material for canning begins with two essential processes - washing and sorting.

Washing. This has to take account of the chemicals used in the agricultural stage. It should be accomplished with minimum water consumption and high efficiency. A variety of universal and specialized washing machines are available for the purpose.

Sorting (inspection) for acceptability. Separating decayed, rotten and unsuitable fruit and admixtures, calibrating and sorting for quality and size are the key processes that influence the quality and appearance of the finished product. This can be achieved using a variety of equipment.

Further primary processing, depending on the end products, depends on the need to preserve raw material appearance and consistency.

Primary processing to preserve appearance and consistancy. This features in the production of sterilized, dried, chilled, frozen and canned goods, as well as those prepared by chemical and biochemical means. Its purpose is to separate useless and unsuitable components, e.g. skins, stones, stems, seeds, from the raw material. Fruit may either stay whole or be divided into several (e.g. two to six) equal parts (slices).

The main mechanical processes at this stage are peeling, stone, stem and seed separation, shelling of leguminous raw material and cutting. The fruit is simultaneously subjected to thermal treatment, i.e. blanching with hot water or steam.

These processes frequently involve considerable loss of raw material - the extent depending on the sophistication of the technology, the freshness of the fruit and whether it is processed individually or in batches. The processes are mostly mechanized, but not always to a high level. Their efficiency is then well under 100 per cent. Because of this, such processes should be accompanied by intermediate inspection with a view to separating non-processed material.

In this connexion research work is aimed at selecting fruit that have both high nutritive qualities while being mechanically managable, and at improving and developing new methods of raw material cleaning.

Primary processing with altered appearance and consistency. This occurs in production of clarified and non-clarified juices, concentrates, preserves, natural aromatic substances, strong fruit drinks, and dried powdered fruits and vegetables. The main technological processes involved are as follows: crushing, straining, homogenizing, pressing centrifuging, extraction, filtration, enzyme treatment, clarifying, and [illegible] treatment.

The characteristic feature of these processes is that they are largely mechanized and automated and the corresponding equipment has a high output, while being reliable and safe. Raw material losses are negligible.

There are various possibilities for fully utilizing the raw material. Since several of the above processes have almost reached maturity - such as draining and pressing - any new findings can hardly change their character and prospects.

Main processing (canning)

This step depends on the required end products and their method of canning.

Sterilization. Canning is preceded by heat sterilization of the raw material, which is assumed to be primarily processed. After processing, the material is filled into glass or metal containers and hermetically sealed. Sterilization destroys the micro-organisms in the product or reduces them to a non-noxious state. It is carried out under special conditions of temperature, time and

pressure, in sterilizing equipment of various designs, e.g. static- or rotary-pressure boilers, steam-, flame- and gas-sterilizers or protected (covered) rotor-, chain- or hydro-static sterilizers featuring continuous operation. The latter are characterized by high productivity and economical heat, energy and water consumption.

Sterilized production accounts for the largest share of the canning industry because it offers full food value while being handy for use in the home and in public catering establishments and shops, and being easy to transport.

The system needs only minimal care during preservation and requires almost no culinary treatment. The range of applications is broad, but can be divided in four groups:

(a) Canned vegetables (semi-finished products): this group is represented by French beans, string beans, cucumbers, peeled and unpeeled tomatoes, vegetable salads and composites, and potatoes;

(b) Fruit compotes: mainly peaches, strawberries, apricots, cherries, pineapples, plums, mixed compotes, fruit salads, cocktails etc.;

(c) Baby foods: this is notable for its variety and formula changes according to the physiological development of the consumer. Canned baby food is made using automated, high-efficiency and high-speed equipment, improved sanitary conditions, and strict chemical, technological and microbiological control. The main components of baby food are mashed fruits, vegetables and meat, which are often enriched with vitamins, mineral salts and proteins;

(d) Ready-made food: this group includes classical canned foods, natural dishes and specialities. It is produced both in small quantities for individual consumers and in larger packaging for public catering. In the Finesco system, components of a whole dish are canned separately. Separation of the main dish components in the packaging is also carried out.

Concentrate and jam production. This approach employs osmoanabiosis - reducing the water content in the crushed raw material and mixing in additives (e.g. sugar or salt) so that the osmotic pressure in the raw material increases, thereby supressing micro-organism activity.

Concentrates are processed in continuously operating multiple-effect vacuum evaporators with capacities up to 900 tons/day. Their operating temperature is low (40° to 60°C) but special low temperature equipment for citrus juices operates at 15° to 25°C.

Applications are mainly:

(a) Tomato concentrate with a dry matter content of 30–40 per cent, used as spice, for direct consumption and as a semi-finished product for various foods and sauces. It can be packaged either in small or large (5 kg) cans. Semi-finished concentrate product is packed in tanks of 200 kg capacity or preserved aseptically in 300 kg tanks, after being sterilized at high temperature;

(b) Mashed red pepper is produced in small quantities but it is highly esteemed due to its high vitamin content;

(c) Fruit concentrates from clarified and non-clarified juices; apple, grape and citrus concentrates dominate;

(d) High-concentration natural fruit aromas; these are separated during concentration of fruit juices and, if required, may be recovered in aroma traps on the evaporators. They are used in production of juices and soft drinks.

Jams are produced by boiling at a temperature of 100°C in batch or continuously operating vessels with addition of sugar or gelatinizing substances (pectin).

Three types are produced:

(a) Jams - a non-homogeneous product, containing whole fruits, boiled in sugar syrup with addition of gelatinizing substances (pectin), which, after cooling, acquires gelatinous consistency;

(b) Jellies - a homogeneous product, in which the fruit is substituted by natural fruit juice or concentrate;

(c) Jellies in which fruit is crushed.

Juice and pectin production. Consumption of fruit juices is growing at accelerating rates and demand exceeds that of both soft drinks and mineral water. In a number of countries, e.g. France, the Federal Republic of Germany, the Union of Soviet Socialist Republics and the United States of America, it has developed into a major industry.

Juice production can utilize fruits and vegetables, the appearance, form and size of which are not suited to direct consumption or other type of production. Complete utilization of the raw material is quite feasible since the waste serves to produce pectin, spirits and, finally, fodder. The production processes are largely mechanized and automated, and they are carried out on modern plant.

Fruit juices are divided into two main groups: clarified and non-clarified.

Clarified juices contain no fruit matter. In this group apple and grape juices are dominant but quince, rasberry, strawberry, black currant, cherry and morello cherry juices are also used. The juices are produced by pressing

the primary processed raw material i.e. after washing, sorting, crushing. Pressing can produce around 80 per cent of the available juice; the average yield, however, is about 75 per cent.

Until recently pressing has been effected with batch-operated packing and basket presses. These require heavy manual labour and are characterized by poor sanitary conditions and low efficiency. Modern pressing equipment is greatly improved. Wide use has been made of inner drainage presses, portional presses, continuous belt presses, all of which exclude manual operation. But while clarified juice production can thus be rationalized, the economic problem remains: the new presses are very expensive.

A development receiving close attention during last 10 to 15 years in France, the Federal Republic of Germany and the Union of Soviet Socialist Republics is the production of fruit juice by extraction. While still the subject of heated arguments on the naturalness and qualities of the extracted juice, this approach increases fruit juice yield from approximately 75 per cent to 95 to 99 per cent.

The current problem is its technical realization The above countries have worked out two methods:

(a) Hot extraction in a counter-current mixing extractor, borrowed from sugar industry;

(b) Using a cold sprinkling extractor, borrowed from fruit wine and butter industries.

Both methods betray a number of the imperfections and drawbacks reflecting their adaption to fruit and vegetable raw materials.

The best solution in this case would be a combined approach. Continuously operating presses - screw presses, for example, which are high-through-put, cheap and easily serviceable - would operate with a yield of about 60 per cent; the remaining 35-39 per cent would then be extracted using extractors designed specially for the purpose. Juice plants in the near future will work on this principle.

After extraction, the juices are clarified using pectolitic enzyme preparations, tannin and gelatine. After passing through continuous line sterilization, the clarified juices are bottled or canned, depending on trade

requirements; they may be also preserved in aseptic conditions as semi-finished products.

Non-clarified juices, i.e. juices containing fruit particles, include both natural opalescent juices with a low percentage of particles (obtained by pressing) and non-natural juices (nectars), which contain all the components of the fruit and are mixed with sugar syrup and acid.

Opalescent juices occupy a special place in juice production, the main share being citrus juices (orange, grapefruit and tangerine juices), followed by apple and grape juices. Obtained by centrifuging the juices received after pressing in order to separate the solid component, they are of great agricultural importance for a number of Southern countries.

Nectars are obtained by separating unwanted components (skins, seeds, stones) from crushed raw material by straining, after which they are mixed, finely homogenized, deaerated and processed like clarified juices. The nectars are then bottled in appropriate containers or perserved as semi-finished products. Non-clarified vegetable juices are natural juices represented mainly by tomato juice and to a lesser extent by other single-vegetable or mixed juices.

Pectin is an important, high demand product, with applications in the food and textile industries and in pharmaceuticals. Its availability in fruit juice residues accounts for the fact that the juice and pectin production are often combined. The most widely used raw materials are apple pressings and the skin of citrus fruits. Sunflower heads and stems can also be used.

Pectin is produced by an extraction process that is complicated and therefore usually carried out in batches under difficult conditions. The extract may be clarified and concentrated to a semi-finished product which can be used directly. More often it is coagulated by one of several methods and cleaned by washing. The cleaned pectin is then dried under vacuum, homogenized and packaged for distribution.

Dried products. Preservation of fruits and vegetables by anabiosis gives an end moisture content of less than 10 per cent, rendering unnessary any additional measures to prevent decay. The low moisture content of dried fruit and vegetables together with their mass leads to economies in packaging, storage and transport. However, although their preparation before consumption is quick and easy they are not in great demand and their share in the canning industry is low.

All fruit and vegetables can be dried, but the most industrial important are dried red pepper, onion, garlic, french beans, apples, plums, figs, tomatoes, fruit pulp and purées.

Drying of whole and cut fruit is carried out with hot air in convection chamber-, tunnel- and belt-driers. Crushed fruit - in the form of pulp and purées are dried after concentration (which is cheaper) in pneumatic dispersing driers. The process takes only a few seconds to produce powdered product in the form of fruit and vegetable flours. The pulp and purées may also be dried as thin layers in contact driers.

Newer driers with limited application in food processing feature sublimation and foam drying, extrusion, infra-red and dielectric drying.

Packaging and storage

This stage includes various mechanical finishing processes connected with transportation and distribution of the finished product. The processes are as follows:

(a) Metering, during which containers are filled with a specified quantity of product;

(b) Capping, when the opening through which the container has been filled, is closed with a cap and hermetically sealed;

(c) Marking and labelling, during which the container is provided with technical advertising and commercial information;

(d) Wrapping of one or more containers in paper wrapping materials;

(e) Grouping, during which a number of single containers are packaged into a larger group (e.g. cases, crates etc.);

(f) Palletizing and depalletizing, during which the single or grouped containers are assembled on pallets for mechanical handling and transport.

The above operations are characterized by a high level of mechanization and automation, including automatic control, safety and signalling devices. Complete process lines are in operation that, according to the nature of the product, involve all or part of the specified processes.

Packaging and packaging materials

Packaging is nowadays an important factor influencing the structure and assortment of production, production capacities and organization, storage at the farm, transport, distribution and retailing. The packaging has to be attractive, informative, easy to use, stable, appropriate to the product,

economically profitable, and in conformity with sanitary requirements.

The containers in the canning industry are mostly metal, glass and, to a lesser extent, plastic. The metal containers are produced from low-carbon steel sheets with a protective covering of tin, chrome, aluminium, plastics, bimetals (steel, aluminium), or aluminium alloys. They offer major advantages in capacity, form, weight, hardness and further decoration. Glass containers on the other hand, are entirely resistant to corrosion as well as being transparent, and available for re-use. They are also produced from practically inexhaustable raw materials. The problem of choosing cap material and design together with the system of capping admits various solutions.

The plastics are comparatively new packaging materials. They are of limited application and one-time use, the main problem being contamination of the surroundings.

Cellulose materials (paper, cardboard, corrugated cardboard) are becoming more and more scarce, and their application therefore, is limited to external use during transport.

Discussion

This description of canning operations gives the general outline without covering some less essential elements such as chemical and biochemical canning. It gives, nevertheless, a general idea of the significance of each element and the complexities involved. The modern canning plant is a complicated assembly of equipment, services and supporting activities. Achievement of good and efficient production requires proper planning, erection, organization, operation and management.

B. Trends in canning

Attaining high productivity and high efficiency means solving a number of agricultural, economic, chemical, technical, organizational and commercial problems. Always interconnected and interdependent, these are sometimes hard to distinguish.

Technical and technological trends

The raw material is the basis on which the entire canning process is built up. It is the raw material, therefore, that to a large extent, determines its efficiency, i.e., the quality, cost price, labour, consumption etc.

Close relations and integration between the canning industry and the agricultural sector can permit such improvements as seed selection, organization of the most rational way of delivery, introduction of industrial methods to agriculture to ensure regular delivery; elimination of losses during transportation, proper preservation and delivery of the preserved raw material for processing.

The technology of canning has been well worked out. It is tested, proven and scientifically based. The basic orientation of development trends is therefore the improvement of existing canning methods, creation of more effective and cheaper ones, optimizing of technological processes, improvement of intermediate and final control, increasing of product biological values, broadening the range and reducing energy consumption.

The main trends in sterile production aim at intensifying the sterilizing process with a view to decreasing processing time, creating further varieties of ready-made dishes and semi-finished products, improving canned baby foods by enriching them with biogically active and other nutritive additions, satisfying the requirements of public catering, developing aseptic preservation of non-homogeneous semi-finished products, overcoming seasonal problems, increasing production flexibility and increasing the range of packaging containers.

The main problem in production of concentrate is energy consumption: this can be solved by introducing three to five-effect tube evaporators. Other trends include aseptic preservation of the semi-finished product in large tanks up to 600 tons, application of reversive osmosis for concentration, and increasing the assortment of jellies and jams with low sugar content.

Juice production requires the introduction of continuous presses, extraction systems and their combined utilization to create rapid continuous clarifying systems. Also needed are continuous filters, better bottling and packaging processes, a wider product range - with new mixed juices and drinks - and rationalized production of pectin.

Trends in dehydration focus on rationalization of the drying process with respect to the efficiency and cost of drying, including the widest possible use of preliminary solar drying. Product developments include dried soups, breakfasts and semi-finished products, and improvement of the properties of dehydrated ready-made products.

On the canning line, developments are oriented towards solving problems in mechanizing the remaining manual processes and operations. These include can filling with sizeable loose products, cleaning of strawberries, intermediate inspection, automation, unification and aggregation of separate machines, and utilization of corrosion-resistant materials for plant stability, reliability and safety.

In packaging the trend is to lighter containers by reducing material thickness and increasing its strength. At the same time containers come in more diverse forms with a view better to utilization of storage areas and transport systems. Designs are being improved with wider use of lithography.

Control of production influences raw material utilization, provides for more economic usage of energy and materials and governs the quality of the manufactured product. Such controls include:

(a) Incoming (preliminary), inspection exercized over all primary and auxiliary raw materials. These are classified according to existing standards and prearranged indices;

(b) In-plant control - exercised over all main production sections in order to determine the parameters of the process as well as the technological, physical and chemical indices of the product needed to ensure a high and durable quality;

(c) Final inspection - to determine the quality of the end product or semi-finished product, in accordance with already established rules and norms.

Organizational and economic trends

The organizational forms found in canning production vary, but in all cases - even at minimal capital intensify - there should be provision for low prime cost, maximum productivity and high quality. The main ways to obtain good economic results are as follows.

Production lines featuring continuous operation and that are largely mechanized and automated, assure rapid quality processing. The linear, horizontal high systems adopted recently should be analysed in terms of their size and assembly area, the distribution of their components and their stretched out communications. In some cases, they could possibly be replaced by variants such as, for example, vertical ring designs that avoid the drawbacks of linear systems while economizing on transportation energy and affording better opportunities for operator control and supervision.

Extension, concentration and specialization. These are the conditions for introducing highly productive equipment and full utilizing its production capacity.

Complete utilization of raw materials. This is achieved by reducing losses during processing, utilizing waste and creating new assortments. It should be mentioned that canning waste contains a number of nutritive substances such as fats, pectins, organic acids, dyes, spirits, enriched fodder and others. These can be used in other plants. Their usage will increase overall efficiency and help to preserve the environment.

Power consumption and power economy. The modern food industry consumes nearly 12 per cent of total industrial power. Ways to reduce specific power consumption are as follows:

(a) Determination of conditions for economical power consumption;

(b) Analysis and selection of measures for rational power economy;

(c) Process rationalization by introducing multiple-tube evaporators, regeneration of heat during blanching, sterilization, drying etc., utilization of waste energy, use of natural or low-temperature sources etc.

Semi-finished products. Production of semi-finished products is a way to overcome seasonal supply variations. It provides for almost year-round operation of the plant and opens the possibility of combining and preparing the product range according to consumer demand. It also economizes an investment and storage area.

The products are canned and preserved in large tanks. From there they are either filled into small consumer packaging or used in production. Aseptic preservation is used for both homogeneous and non-homogeneous products - pulps, purées, crushed-, cut- or whole fruits and vegetables.

Marketing. Canning production should always relate to the requirements of the market - local, international, present and future. The market determines the production programme in terms of assortment, quantities and packaging. Proper organization of marketing and the adaptability of its application are important conditions for the development and success of the canning plant.

General trends

Preservation of the environment. Sources of environmental contamination from a canning plant are as follows:

(a) Chemical - detergents, salts, alkalis, agricultural chemicals;
(b) Physical - dyes, fats, heat, slime;
(c) Biological - from the auxiliary farms.

The main carrier is waste water containing soluble and non-soluble alimentary components. They are not harmful for life, but present a favourable growth medium for algae which leads to the change of the water oxygen levels. The waste water contamination basically originates from the application of chemicals in production, i.e., detergents, washing machines, chemical peeling of fruit etc.

The way to overcome it is proper organization of treating stations to remove the unwanted components or reduce them to a minimum with mechanical, biological and chemical methods such as neutralization and disinfection.

II. DESIGN OF FRUIT AND VEGETABLE PROCESSING PLANTS

Plant design usually features four stages:

(a) Premliminary studies and design parameters;

(b) Feasibility studies;

(c) Preliminary design;

(d) Working design.

Preliminary studies - design parameters

Preliminary studies include gathering of information on working conditions, the formulation of the main design criteria and preliminary conclusions. The report should cover the results of studies of raw materials, transportation, energy, materials, energy supply possibilities, manpower, erection, marketing and climatic conditions. Choice of the construction site is the most important task during this phase and may be carried out in two basic ways:

(a) Creation of industrial areas to allow setting up of joint power supply to farms, treating plants, transportation networks, underground construction and public works. This solution is applied where arable land is scarce and there is a high level of urbanization;

(b) Establishing agro-industrial complexes to integrate the raw material production area with the food processing capacity. This solution offers several advantages: minimal transport outlays, possibilities for better organization of manpower, creation of joint auxiliary farms, more rational utilization of production waste, and increased production flexibility.

The choice of plant site should reflect the prospective development of the plant and result from studying several possible sites.

Raw material. The composition of seeds and the quantity needed are key prerequisites when establishing a new canning plant. Studies usually reveal one of two different situations:

(a) Availability of a raw material base; all information should be gathered for an input diagram;

(b) Absence of raw material base, but availability of the means for creating it, e.g. simultaneous creation of the canning plant and the raw material base. In this case agrotechnical, hydrographic and technological studies of the climatic data, soil, water resources, transport possibilities, manpower and power supply should be carried out. After exploring different areas, the one most suitable is singled out. Requirements for the raw material base and canning plant should be co-ordinated so that they start up simultaneously and grow by suitable stages.

Marketing. This means that all activities of the plant - its production programme, capital investments, finances, manpower, scientific and technical activities, sales and technical service are determined by present and future consumers demand.

The main task of marketing is to study the state of the market and introduce a market strategy for the plant.

Market research. This covers:

(a) The overall capacity trends and the number of companies already in the business;

(b) The preferred product range, which is a function of the eating habits and climatic peculiarities, the way of life and social employment of the population, the level of public catering development, the available transport and refrigeration networks, the presence of competing companies and the adequacy of market supply;

(c) The preferred packaging - container appearance, size, form, way of opening, frequency of use. This task is not easy: there is a great variety of containers and, depending on their capacity, they may be individual or family packs (up to 1 kg), for public catering (5 to 10 kg) and for the army (from 200 to 500 kg).

(d) Requirements regarding product naturalness and admissible additions, and the labelling requirements and obligatory information lables have to bear. These are usually regulated by special standards and most countries have special technical standards as well;

(e) Eating traditions - these determine the acceptance of canned food;

(f) Trends in consumer demand, as influenced by the way of life, advertisements, popularization of the scientific and technical achievements etc.;

(g) Market prices and their formation.

Researching the marketing possibilities and local markets in a number of countries from the third world may reveal additional possibilities for developing the national economy, providing the population with a year-round supply of cheap foodstuffs, utilizing raw materials, employing local manpower and exporting canned food.

Construction works. Attention should be given to the conditions for future construction works (site, terrain, building materials). This includes the possibilities for using standard industrial construction techniques, light structures, mechanization and joint execution by client and supplier.

Economic efficiency. The aim of this is to work out a preliminary efficiency figure for the plant to be designed. The economic efficiency reflects the final result of exploiting the plant, the expected production quantities, the product range and production expenditures as well as the anticipated profit.

Feasibility study

The feasibility study pulls together the results of preliminary studies and includes all the data, all generalized, technical, and economic evaluations and suggestions, and all calculations of specific indices, finances and capital flows. It has to estimate future possibilities, the directions for extending production, as well as ways to reduce expenses and increase plant efficiency. There should be specified well-grounded conclusions with respect to the following: a site for plant construction; a plant production programme, the economic effectiveness of the plant, the most appropriate building construction, necessity of auxiliary farms and power supply, and the need for raw material and manpower.

Preliminary design

Preliminary design is the continuation of the study after acceptance and confirmation of the feasibility study. It comprises the following:

(a) An explanatory note describing the raw material, its method of delivery and reception, the technological processes and production lines, storage, inner plant transport, laboratory control, auxiliary buildings, means of construction and erection, tests, project acceptance tests, organization of the repair works and maintenance of the production equipment, technical safety measures, environmental protection and fire prevention;

(b) Technical estimates of machinery, equipment and production lines, material and energy balance with a view to determining expenditures for raw materials, energy, other materials and manpower; specific technical and economic indices (in relation to unit production); total installed power; annual expenditures on materials; use of personnel, administration etc.;

(c) Specification of product, construction and erection;

(d) Graphic materials - project drawings with general layout, production lines, communications and plant transport.

The preliminary design is worked out for all sub-units and the design itself has three main parts:

(a) Architectural engineering - concerned with the architectural features of the project, the buildings and the building structures;

(b) Erection and production equipment - its distribution and composition;

(c) Essential services - concerned with power supply, the treating plants, heating and ventilation.

Working design

The last design is the working design on which plant construction is based.

The working design contains the finalized technical specifications together with all the data and information necessary for its fulfilment. Its contents, i.e. text, tables, drawings, instructions are presented in the order of its execution by project management and operating staff.

The design contains a precise technical description, technical and economic indices, detailed specification of the main processes and a fundamental specification for the erection. It also covers all sub-projects and the organization plan for construction and erection.

Trends in canning plant design

The number of design stages needed relates to the specific conditions. In order to reduce the period between the time of assignment of the project and the start of construction the trend is to cut down the two intermediate stages - feasibility studies and preliminary design. What frequently occurs is that the feasibility study and preliminary design are done simultaneously, this being followed by work on the working design.

III. TRENDS IN CONSTRUCTION AND USE OF FRUIT AND VEGETABLE PROCESSING PLANTS

Plant construction

From the investment point of view, construction of the fruit and vegetable processing plant may be accomplished in three different ways:

(a) The client assigns the construction of the project as a whole to another company, organization or party;

(b) The client partly participates in construction of the plant. For example, the construction, the delivery or the erection of the equipment, could be assigned to another company, organization or party; the rest would remain with the client;

(c) The client undertakes sole construction of the project.

Mostly clients prefer to execute the project by assigning it entirely elsewhere. This is increasingly the case because of the complexity of modern processing and the demand for shorter plant construction times.

Construction of a plant or a complex is preceded by:

(a) Establishing the power supply base at the construction site. This precedes the basic construction and provides the required electrical power, air, water and steam;

(b) Organization of auxiliary buildings. This depends on the kind of construction and the type of machinery involved, the supply of the building materials and the organization of the in-plant transport during construction;

(c) Provision of accomodation and related facilities to be used during construction.

IV. ENGINEERING

In Bulgaria, the above activities are all included in our concept of "engineering", which in its modern form involves the integration of a number of disciplines:

(a) Scientific, technical and economic research, preceding and determining the evantual design;

(b) Analysis and justification for choosing the optimal variant and the size and form of the capital investment;

(c) Developing the preliminary design;

(d) Organization and presentation of tenders (on client request);

(e) Evaluation of licences, know-how and technology;

(f) Developing the final design;

(g) Site preparation (temporary construction, sub-project premises);

(h) Organization of delivery and inspection of machinery, equipment and materials;

(i) Carrying out of construction, erection and plant commissioning;

(j) Liaison with the investor (employer) and consultant (designer) during construction;

(k) Training of specialists;

(l) Engineering assistance (services) in organization and management.

Modern engineering organizations carry out part or all of these activities. Organized into groups of qualified specialists, they are able to take a given task either to completion, or to some stage where it can be finished by another similar firm. Engineering establishments render two main types of assistance: the preliminary and the main engineering.

Preliminary (consultative) engineering

Assistance of this type features: consultation and design evaluation. It does not cover construction of new projects, and confines itself to:

(a) Research into the economic, financial and social conditions in a given country, area or enterprise, to determine the different supply possibilities for energy, raw material, manpower etc.;

(b) Preliminary study of the problems connected with investment planning together with the characteristics and expenses for announcing tenders;

(c) Comparative analysis and evaluation of the results of the submitted offers; control (on behalf of the investor) over erection, construction and plant commissioning.

Basic engineering

Basic engineering includes designing, construction, delivery of machinery, equipment, erection, plant commissioning, training of personnel and economic studies.

V. SUMMARY

This paper has attempted to summarize in general terms most of the problems facing the canning industry - the majority of them not having been discussed until now.

Technoexport specialists are at your disposal to discuss questions and problems of technology, organization, and engineering activities arising in the canning sector.