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TECHNICAL ASSISTANCE TO THE
VITAMINKA FACTORY

Volume I

Management Report
(Draft)

S/F FOOD, FRUIT, VEGETABLES
C/F YUGOSLAVIA

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Prepared for: United Nations Industrial Development Organisation
Lerchenfelderstrasse 1
A-1070 VIENNA
Austria

Prepared by: Agricultural Development Unit
Conrad Jameson Associates Limited
50/51 Wells Street
LONDON W1P 3FD

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C O N T E N T S

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I SUMMARY

1.1 Purpose and scope

1. In June 1975 Conrad Jameson Associates Limited undertook a research programme on behalf of UNIDO to determine the marketing, technical and economic requirements of establishing a new line of baby food products within the Vitaminka factory at Banja Luka in Yugoslavia.

2. The programme of research also provided for a comprehensive examination of the export market potential for a wide range of existing products, namely jams, both high quality and diabetic, fruit juices and frozen fruit and vegetables.

3. As well as reporting on the future requirements of plant and equipment to meet the increased production the consultants were also required to examine and report on the present layout and operation and to note such recommendations and comments as appropriate to increase efficiency and output.

4. Finally, observations and recommendations on the general administration and organisation of the factory were sought with particular reference to the problems of procurement if raw supplies together with the allied problems of transporting them and storing them at the factory.

1.2 Approach

1. The programme of research fell naturally into two distinct channels: commercial and technical. The marketing investigation which is separately reported on in Volume II was undertaken by a consultant working alongside associates in each of the eight countries: Austria, Belgium, Luxembourg, France, Netherlands, Sweden, Switzerland, United Kingdom and West Germany. By combining local market expertise with the broad international overall view a thoroughly objective report has been achieved.

2. On the technical side a different approach was employed in that all the fieldwork took place in the project area. During this period a comprehensive programme of extended interviews were undertaken with the directors of Vitaminka in order to obtain the deepest possible insight into the organisation, method of operation, the thinking behind past decisions and finally the all important future plans for the development of the company.

3. In view of the recent establishment of the regional Kombinat AIPK, headquartered in Banja Luka, which is intended to co-ordinate agricultural development in the area, a short discussion was held with the General Director and the Director responsible for processing development.

1.3 Main recommendations

A. We summarise the main recommendation of the study as follows:

1. Immediate steps should be undertaken to rationalise the current range of products being produced. In order to determine the range of individual product profitabilities the method of costing currently in use will have to be discontinued. Cost centres must be established so that all imports and overheads can be apportioned on the basis of individual throughputs. By determining a range of standard costs a continuous measure of plant efficiency can be obtained.

2. Our most serious criticism is in respect of the low overall standards of plant hygiene and maintenance. We consider this a purely management problem and can be easily rectified providing the will is there to make the improvement.

3. It is essential that a detailed programme of training is drawn up. This should include senior executives as well as workers on the shop floor. Reference is made in the report to suitable guides for the purpose.

4. We have recommended the following new appointments:

- Divisional Director Baby Food
- Operations Research Officer
- Market Research Officer

The latter appointment has in fact been provided for in the new organisation. We have emphasised the need for active field research as opposed to purely desk economic research.

Both the Director in charge of baby foods and the Operations Officer will require training, possibly outside Yugoslavia.

5. The supply of suitable raw materials for processing in adequate quantities is essential if Vitaminka's aspirations for the future are to be achieved. Steps must now be taken to ensure that production is stimulated both on farm and at Kombinat level. Vitaminka should take an active role in extension work and should also consider the possibility of taking over two farms so that the benefits of following the advice given can be seen in practice.

B. We indicate those areas where UNIDO should be invited to give further technical assistance as follows:

1. Production advisor - to help in the programme of reorganisation outlined in this report. The advisor should have had a wide experience of the food processing industry in a management role and have the ability to plan and introduce a system of line costings based on cost centres. The appointment should be of nine months/ one year's duration.

2. Operations Research Officer - a food technology graduate with an interest in agriculture is required for this appointment. He should also be highly numerate with experience of statistics. A training programme is required as follows: six months attendance at a formal O.R. course followed by 3-6 months on site experience in a large food factory. It is unlikely that these facilities will be found in Yugoslavia and therefore study abroad probably in the UK, Germany or Holland will be necessary.

1.4 Summary and conclusions - general background

1. Rationalisation of product lines with concentration on the higher profit lines and those derived from raw materials over which control of production and quality can most readily be achieved.

2. More effective implementation of directives all down the line, with the necessary training of supervisors and operatives to make this possible. The development of a more critical attitude to shortcomings in respect of hygiene and cleansing, maintenance and other engineering, and to raw material selection and product quality - all leading to an informed and critical pride in all aspects of products (including product, packaging, presentation etc) and their means of production.

3. Improvement of structure of factory and general facilities to enable greater general efficiency and hygiene to be achieved - eg tiling of floors; marking out of production lines, transport 'roads', storage areas etc; modifying 'services' lines to be both easily recognisable and to be safe (particularly electricity supplies) and to be fully supporting all hygiene services as well as production facilities per se.

4. A greater measure of factory area division into 'very wet' (ie preparative), wet and dry areas.

5. The immediate provision of filtration and chlorination equipment for treatment of river water and of steam/water lances for cleasing purposes, so providing the two most effective ancillaries to water (heat and chlorine) in maintaining high hygienic standards.

6. The purchase of the necessary equipment for production of exportable products is an essential pre-requisite to the export programme. For example, in the case of apple juice concentrate, both aroma stripper and super D-canter (or equivalent) centrifuge are necessary as detailed later.

7. The adoption of more modern and efficient methods of can and glass jar handling - eg the replacement of cartoned deliveries by palletised deliveries - and the mechanised (eg depalletiser) handling of such palletised supplies. 'Untouched by hand' is a good principle to apply except perhaps in final case packing of finished product in such instances where the quantities involved are too small to warrant mechanical handling.

8. That a training course based on Chapter I of " A Complete Course in Canning' (Pub. The Canning Trade Inc, 2619 Maryland Avenue, Baltimore Md.21218, USA) allied to ' A Laboratory Manual for the Canning Industry', pub. National Canners Assoc, USA, would create the necessary awareness in all personnel of what measures should be taken and methods employed in practically all circumstances encountered in dealing with the handling and preservation of foodstuffs.

9. The development of export markets for jam will depend very largely on price; this being the case the high price of sugar in Yugoslavia will make the products uncompetitve. Vitaminka should ask Yugo-Conserve to negotiate with the appropriate Government department to give a rebate of sugar levy on jams exported

10. In the not too distant future new agro-industrial complexes promoted by A.I.P.K, may indirectly compete for the attention and resources of both Kombinets and individual farmers through their Cooperatives. Vitaminka must make its future plans and policies known well in advance.

1.5 Jam manufacture

1. Discontinuance of the use of the pasteuriser in jam manufacture by adoption of one of the alternative processing (boiling) methods as described. The pasteuriser can then be devoted soley to the exact processing of canned fruit. At the same time this measure will remove the current problem of high SO_2 residue when using sulphited pulp.

2. The provision of a 3-pan separate jam production line (but drawing on fruit cleaned and inspected on the existing line) for the production of (a) diabetic jams, and (b) top quality jams. Low-sugar low-calorie jams would be produced on the existing vacuum pan equipment.

3. The packing of diabetic jams (a) in 125g and/or 250g glass jars fitted whitecap closures and (b) in 'Alupak' or similar 30 33g packs, initially using only one Alupak machine.

4. The packing of high-grade jams in ¼ kilo or ½ kilo (approx) jars, these jams being made on the open-pan line using the maximum quantity of top-grade fruit desirable and sucrose only as the added sugar. Provision would be made for fruit addition at almost the termination of boiling to enhance flavour.

5. The production of low-solids, low-calorie jams in the existing vacuum plant, but using this plant in the manner indicated which leads to the production of a 'commercially sterile' product. This product would be packed in pre-sterilised jars under steam flow and with previously steamed 'white cap' closures or alternatively in 'Alupak' or similar unit packs of 30 - 33g.

7. If Vitaminka increases its production especially into frozen peas it will be necessary to speed up the whole of the harvest operation. Agronomic problems especially weed control needs urgent attention.

8. It is recommended that the senior staff of the Kombinets together with the technical and procurement staff of Vitaminka should indertake a study tour of vegetable harvesting, handling and processing in the UK and Holland next year.

1.7 General organisation and administration

1. We agree with the new organisational structure now being introduced by Vitaminka. We have recommended that Baby/Food production should be a separate division. We also recommend the appointment of a suitably trained Operations Research Officer who will be responsible to the Director of Development.

2. UNIDO should be asked to help in the selection and financing of a Production Advisor with wide experience of the food processing industry to give technical assistance in reorganising the production as recommended elsewhere in the report.

3. A continuous programme of market research is recommended and sufficient funds must be made available for the purpose. Field research must be suported by audit date collected from the retail outlets.

4. Directors must adopt a more critical approach in their day to day business relationships with one another. Any failure or shortcoming in one division has a direct effect on the others, - personalities need not be brought into the matter.

1.8 Acknowledgements

1. The Agricultural Development Unit of Conrad Jameson would like to thank the United Nations Industrial Development Organisation for entrusting us with this important study. We would also like to acknowledge the help and guidance given to us both in Vienna and in the U.N.D.P. Office in Belgrade.

2. This study would not have been possible without the full cooperation of the General Director, the Divisional Directors and Staff of Vitaminka. We owe a special debt of gratitude to Mr Rasa Cukovic the Technical Director who so ably guided us in our quest for information.

Metal Box - England
Brierley Collier & Hartley - England
Mather & Platt - England
Lockwoods Foods - England
Ledbury Preserves - England
Peter Holland & Co - England
Alfa Laval - England & Sweden
Westfalia Separator Co - England & Germany
Sharples Corp - England & USA (& Pennwalt Co)
Rossi & Catelli - Parma, Italy
Tito Manzini & Figli - Parma, Italy
Zacmi - Parma, Italy
Ravenna Packaging (& Rockwell Ltd) - England & Germany
Plastimechanique, Courbevoie, France
Bosch Group (Aluseal & Hofliger-Karg) - England & Germany
Herbort Maschinenfabriek, 1 Braunschweig, Germany
Kramer & Grebe K.G. - Braunschweig, Germany
Roure Ltd - Barcelona, Spain
Capsulit SrL - Milano, Italy
Cavanna Ltd - Novara, Italy
Ackerman Rausing Ltd - England & Germany
Cherry Burrell Ltd - USA

II INTRODUCTION

2.1 General

1. In 1947 a fruit and vegetable canning factory was established at Banja Luka. The capacity of this plant was said to be 7000 tons/annum. However, during the earthquakes of 1970 over 80 per cent of the plant was destroyed.

2. Rebuilding commenced almost immediately with an annual capacity of 25,000 tons as the target output. Not only was the output of existing products to be increased but production was also to be increased by diversification into:

- baby foods
- high quality jams
- diabetic jams
- canned peas and beans
- frozen foods

3. By 1974 Vitaminka had achieved a total production of 14,500 tons almost equally divided between vegetable and fruit products. It is now the Vitaminka management's intention to complete their planned development by starting the production of baby foods and also by installing flow freezing and extra cold storage facilities. However, even without these developments if the objectives set in the current production programme are attained 17,500 tons will be processed.

2.2 UNIDO assistance

1. The United Nations Industrial Development Organisation was asked to provide technical assistance to the Vitaminka factory soon after the earthquake and detailed terms of reference for a study were prepared.

2. In the intervening period much of what was originally proposed for investigation has now been put into effect. The actual capacity of the factory is currently about 25,000 tons per annum but by 1980 a 14.5 per cent increase is planned which indicates a total throughput of 34,700 tons. It was therefore necessary to clarify with the Vitaminka management the exact direction the investigation should take and to revise as necessary the original terms of reference as required.

3. It was agreed that the marketing investigation should be carried out as originally planned but that specific export opportunities for the following should be pin-pointed:

- frozen fruit and jams
- high quality jams
- concentrated fruit juice

At the outset it was agreed that baby food would not be exported in the near future but that much useful information could be obtained from other countries on the structure of their markets and the types of product available.

4. The report provides a complete operating programme for the proposed baby food line. Recommendations have also been made on improving the quality and output of other production in the factory particularly the jam process.

5. Both the internal and external organisation of the factory were examined and are reported on. However, the very nature of the increase in the recent production programme dictates that the answer to some of the organisational problems can only be achieved by establishing an in-house programme of research. The report shows the way how best this can be done.

2.3 Report layout

1. It is obvious that with a subject as wide as food processing many aspects are so closely linked that no one format will prevent minor repitition.

2. The main report has been divided into sections relating to each of the main production items in the factory. There is also a section on the general organisation and administration which is based on a management audit technique.

3. In principle each section starts with a description of the present situation, goes on to outline what improvements or developments should be undertaken and finally the potential benefits that are likely to accrue.

2.4 General background

1. When a food factory of the Vitaminka type is first conceived a factory dependent on seasonal crops and devoted basically to fruit and vegetable preservation, the siting of the factory is particularly important in relation to what is intended to be produced and in what quantity and in what quality.

2. The consdierations usually taken into account in planning the site of such a factory and establishing its feasibility are:

- availability of raw materials at a realistic price of the right quality, variety and quantity in the vicinity of the site
- availability of cans, glass containers and other packaging materials at realistic prices and at not too great distance
- minimal transportation and distribution costs for finished products to potential markets with adequate local roads and preferably also rail
- adequate and suitable services - power, water, effluent disposal, etc
- availability of suitably qualified labour force in sufficient numbers

No site is ever completely ideal but the best possible compromise is sought.

3. Insofar as any of the above factors cannot be met or can only partially be met, the scales are loaded against the potential competitiveness of the factory both in domestic and, particularly, in overseas markets where large and specialised factories sited in the centre of areas noted for the particularly economic production of certain crops and with can-making facilities nearby provide very significant competition.

4. In Banja Luka the factory is already extant with its inbuilt 'feasibility' pluses and minuses. The factors arising from the location naturally affect competitiveness in various ways, apart altogether from within-factory efficiency and standards but have to be accepted as, to some extent, an unchangeable status quo.

2.5 Basic raw materials

1. General

It is appropriate to start with a consideration of Vitaminka raw material supplies in view of the fact that the primary limiting constraint on the quality of whatever is produced lies in the quality of the raw material on arrival at the factory.

2. It is axiomatic that the shorter swifter and smoother the journey from field to factory, the better the potential quality of fruit or vegetable intake; also minimising handling and storage, dwell en route, and temperature are pertinent factors, as are considerations of size, depth, cleanliness etc of containers used for transport and of the means of transport.

3. It was stated that the normal catchment area for the Vitaminka factory is a radius of 40 km around Banja Luka. This, because of geographical constraints, in fact means not a full circle but a semi-circle, but such an area should be well able to supply very much more than the material necessary for the currently projected maximum output of 25,000 tons of final product. The area is in fact approximately 0.25M hectares, and very much less than an average of 0.1 tonne or 100 kilos (depending on product mix) of raw material only, per hectare, from the whole area would supply Vitaminka's projected needs. Even with the necessity for choosing suitable land for certain crops it should, in course of time, be possible to reduce the catchment area to less than a quarter of its present stated dimension, so halving the collection radius to less than 20km. This would the correspond more nearly to normal current Western practice and could contribute markedly to improve raw material intake quality.

4. This point is made first because during the stay at Banja Luka, the only crops being handled were strawberries, cherries and peas. The strawberries had come from a distance of 400 km - from Beograd,- and this long long journey on roads which are sometimes unkind to delicate fruits however thinly they may be spread in containers, is quite inimical to the eventual production of the highest class of final product, but particularly jams and 'canned in syrup'. It is appreciated that steps are currently being taken to arrange the growing of strawberries locally: the point which is being made is that not only is it economically unsatisfactory to transport delicate raw materials over such distances but it is also a very major constraint on the quality of the potentially more valuable final products. The policy of long distance transport needs close examination.

5. <u>Transport</u>

Cherries present no problem being produced in adequate quantity locally. The detail of raw material transport - even if it is short - in relation to quality is also important.

6. When picked fruit is left for a few hours in fairly high ambient temperatures and in (largely self-generated) high humidity, microbiological damage of various kinds (mould growth, fermentation etc) is liable to occur and leads to high losses on the inspection tables, during washing etc and/or significant lowering of final product quality. Vitaminka rightly supplies appropriate plastic crates to producers into which picked fruit is placed and in which it travels and is received at the factory. However we saw no facility for automatic crate washing and sterilisation - the crates we saw were far from clean and could form a fertile source of infecting fruit put in them. An immediate necessity is for a crate washer and sterilizer placed, under cover but in the open air, close by fruit reception so that on empyting the crates they are immediately placed on a conveyor which takes them to the washer/sterilizer. On emerging from this machine they should be stored in an area where minimal re-infection from air-borne organisms - and dust etc - can be confidently expected. And finally, when they are to be re-used, the vehicles on to which they are placed should have been throroughly washed down - in particular the payload area - and be very clean. Microbiological load affects ultimate processing.

7. **Supply contracts**

There is a further area in raw material procurement which is most germane to quality and requires reference - it does not apply to the pea and bean arrangements which are and have to be on a contract basis.

8. Fruit and most vegetables, we learn, come almost entirely from the small farmers (10 hectare maximum size of farm) via their co-operatives. The basis on which this arrangement operates is one which provides Vitaminka with produce which is surplus to the 'fresh' market - if the 'fresh' market takes it all then there is none for Vitaminka. The non-quality factors of this situation will be dealt with elsewhere; in terms if setting and maintaining quality standards for raw materials it poses problems which are exceedingly difficult of solution.

9. It really amounts to the totally untenable hypotheses that, for producing high quality products,

- the surplus on a fruit/vegetable market will be of top or even average quality, and

- that an economically sound and technically efficient preservation operation (jams, compotes, etc) can be programmed and carried out based on availabilities of surpluses.

Experience shows that surpluses almost invariably are of basically lower quality and involve greater inspection and other losses than the material which has been sold for consumption fresh on the retail market. This is quite apart from the additional quality problems introduced by reason of the fact that the preferred varieties grown for 'fresh' consumption are by no means always the preferred varieties for preservation.

10. In the long term, the only effective way of overcoming this situation is for contract production of all non-wild fruit and vegetables, such contracts including provision for varietal control and the supervision and control of those agronomic factors which are controllable (fertiliser, irrigation where applicable, cultivations, etc).

The foregoing strictures on raw material quality and methods of obtaining it apply wholly when the ultimate aim is to produce high quality end products (jams and bottled and canned fruit particularly); in terms of hygiene they apply in all areas, but as and where lower quality is acceptable (in marmelada, nectars, fruit pulps etc) naturally it is possible and may only be economic to accept lower quality raw material. In this context, the softness of the varieties of apricots produced in Yugoslavia in comparison with - for example - Spanish equivalents makes the possibility of production to high quality textured apricot products problematic to say the least.

2.6 Factory hygiene and methods

1. General

Whilst the principles of factory (and in fact processing also) hygiene are well known and appreciated by the factory directorate, on the factory floor these principles appear to be very much more honoured in the breach than in observance. Brief observation of this situation indicates these following possibilities.

2. Factory housekeeping

The factory is very untidy and whereas orderly chaos is frequent in canning and jamming factories, disorderly chaos is unacceptable. The impression gained is that a great deal of training, first of supervisors and then of workpeople, will be necessary before a better situation is reached. Factory staff do not seem to appreciate (or are not encouraged or allowed to appreciate) that things are not as they should be. Such simple principles as a place for everything and everything in its place do not appear to be understood, and aids to better efficiency and orderly flow of materials and work even when available (eg the hand-pack fill table and the Busse-type crate loader and unloader reportedly in engineering stores) are not used. Waste material is allowed to build up and to lie around without any routine procedure for its orderly removal. Permanently installed plant in use is, despite all the rules, left dirty in many instances which were observed - in one very obvious case over a 12-day period. Non-electrically-driven fork-lift trucks are allowed in the factory, emitting fumes - the basic rule is electric trucks only in a food factory. The surface of the floor does not lend itself to thorough cleansing in the canning and jamming area - this floor should be tiled. Coving should be introduced as and where necessary to facilitate cleansing. Hosing down is made hazardous by the type of electrical installation. There appears to be no provision for insect control.

3. **Factory design**

In fact the whole hygiene situation is made more difficult by reason of the fact that the basic factory design is for the main part that of a general-purpose factory - satisfactory for warehousing, or making furniture, textiles or electrical goods with little change, but, apart from the grid-covered floor channels, unsuitable in very many ways for this type of food factory. Even in non-refrigerated areas where storage of non-perishable materials took place, eg packaging materials, finished goods, etc, the storage appeared to be very haphazard and proper rotation of inventories would be difficult if not impossible. The water used for wash-down and cooling - for which basically river water is satisfactory - should at least have been filtered and chlorinated; at present it is neither. For a thorough and efficient cleansing job on plant and other difficult areas, high pressure steam/water lances should be regularly used; they are not at present provided.

4. **Operation research**

In other words there should be a thorough overhaul of factory house-keeping and hygiene by an operations research specialist well acquainted with food plants of this type together with a training programme for factory personnel integrated with the introduction of the organisation and hygiene methods.

5. The provision of white coats etc, of cloakrooms and lockers and of medical checks is all very laudable but is largely nullified by the factory conditions.

6. In Western Europe there is a large retailing operation with a very sizeable food section which has all its products manufactured for it by a variety of specialist producers. It has established a reputation for quality and hygiene second to none and is jealous of this reputation. It has hygiene inspectors who go round its supplier factories to ensure that first of all the factory set-up permits of their standard being established and then that these standards are maintained. I have no hesitation in saying that any or all of Marks & Spencers hygiene inspection staff would need to spend no more than five or ten minutes in the Vitaminka factory before refusing to do business with it. This situation needs to be changed.

7. <u>Maintenance and preventive maintenance</u>

Three quite extensive tours around the factory were made, and in the course of these not once was an engineer seen. What was seen frequently was maladjusted machines - eg glass jar and can feed scrolls on slow (60/min) lines tipping and jarring filled containers to such an extent that product loss and a continuing mess on machines, containers and floor was inevitable before capping or seaming. The engineering foreman should have seen, notedm and rectified such a fault long before it had reached the stage at which it was observed. Likewise, lack of maintenance had led to small items of ancillary equipment most desirable for efficient operation - eg photo-electric cells - being left un-wired and dangling from a machine. Various expensive pieces of plant which should have led to labour-saving, eg case packers and sealers, were not in use whilst cases were being sealed by hand. It may be true that short runs are un-economic on such machines but factory organisation should be such that long enough runs are the rule to allow proper plant utilisation and minimising of labour - the plant has been bought and is just unproductive capital investment if unused.

One of the principal evidences of the implementation of planned preventive maintenance is that, after seasonal use of a piece of plant, it is thoroughly cleaned, all necessary parts (eg bearings and other wear areas) replaced or built up, is lubricated and all bare metal covered with a protective coating, and then it is finally painted. Of all these criteria the one must easily observed and checked is painting, and on the evidence of what was seen it would not appear that very much preventive maintenance actually took place.

8. This is an area in which more lengthy probing would be necessary than was possible during the time spent at Banja Luka in order to establish the total spectrum of facts. We were told that a very complete system of preventive and current maintenance was in operation: of this system we saw no evidence in actual practice. It could be either non-implementation of a laid-down plan, or very inefficient implementation of the plan, or else wishful thinking by an individual who knew very well what should be happening but had no power to cause it to happen. The same comment is equally applicable to what was found on the hygiene fromt and that which was stated to be the case.

9. The strong impression gained in this as in several other areas of the factory operation was that whilst the theory of operations was well known and appreciated there is a failure to apply this knowledge down the line.

10. Spoilage

One of the most illuminating pieces of information concerning the overall efficiency of a canning and glass-packaging factory is that concerned with losses of product however caused.

In canning circles the maximum amount of spoilage which is at all permissible is 1 in 10,000. Many canneries set and maintain a standard of better than 1 in 100,000.

The Vitaminka achievement is by no means even up to the 10,000 standard and this need rectifying.

When it comes to incidental and casual loss by breakage or deformation of glass and steel containers, loss of glass in particular appeared to be excessive - both plain cullet and cullet mixed with product was in piles on bays and floors. Furthermore there did not seem to be very much concern that this was happening - or there was even a lack of awareness that it was happening. It is suggested that to minimise losses, all causes should be itemised and records kept of incidence under each cause. This would provide data on which remedial action could be taken (eg losses on filling, palletisation, retorting etc etc etc).

11. Number of product lines

A relatively brief inspection of the list of products made at Vitaminka (we were not provided with a complete list and therefore a very detailed critique on this point is not possible) indicated that the number of actual products was possibly - or even more than - fifty, and that raw materials (fruits and vegetables) alone were more than 20. When variable size of pack is taken into account, the total number of lines must be well over 100. The production of some of these lines appeared to be very small indeed and the utilisation of some of the raw materials also very small.

12. In the interests of profitability, of effective organisation, of effective maintenance of quality and quality control, and of minimising interference with the main 'bread-and-butter' lines of the factory it is highly desirable to rationalise and to reduce the number of product lines to manageable proportions.

13. The comment made above (Factory Hygiene and Methods: General) of unacceptable 'disorderly' chaos may in fact only be convertable into the acceptable 'orderly' chaos if and when the number of product lines matches the capability of effectively organising their production within the existing parameters of factory size, equipment and staffing.

14. Additionally, having too many lines means that marketing effort is excessively dispersed and not concentrated on disposal of the lines which really are profitable to the company - and of course the profitability of each line must be known or there is no sound basis on which rationalisation can take place.

In view of the number of lines now produced, and with possibilities arising of adding to the list (such as are dealt with in this report) it is unfortunate that certain plant choices have already been made. For example that vacuum pan jam manufacture was decided on and implemented, because the main reason for its abandonment in Europe generally was its lack of flexibility. This was obtained even with very large scale jam manufacturers in factories producing 30,000 tons of jam a year and more. Also, and as referred to later, the pasteuriser could have been of a multi-entry type able to accept various sizes and types of pack without belt speed change and able to handle a considerable variety simultaneously, giving each size and type its appropriate treatment.

2.7 Utilisation of labour

1. General

Labour once engaged for work at Vitaminka must be employed throughout the year. This is an excellent principle but provides difficulties and a big challenge to management, particularly as a great deal of work is seasonal/variable in nature. It is tantamount to a situation where the only way of maintaining a reasonable level of labour cost (regarded here as a continuing overhead) is to be certain to have those machines available in the necessary quantity which can minimise the employment of manual labour at times of peak demand, ie during harvesting/processing of fresh raw materials.

2. Planning of production and of crop intakes so that highly labour-intensive and less labour-intensive materials come in at the same time is also helpful. But broadly it means that if there is a machine which will do a job as well as an employee, or if one employee + machine can do a job as well as three or four employees, then it is most unlikely that the cost of that machine when amortised over its life will be greater than the cost of human labour.

3. It therefore becomes highly desirable to review labour usage in every department quite frequently and to introduce and make use of machines particularly when natural wastage leads to possibilities of reduction in work-force. Parallel with this could be an up-grading of work-force in terms of skills - higher competence brings savings all round both in numbers of employees, in quality of produce, in reduction of losses and mistakes, and in general efficiency. The absence of an internal seasonal labour availability makes measures of this sort doubly important if costs are to be kept competitive. The impression gained during factory visits at Vitaminka was that there was a very liberal use of labour, frequently employed on manual operations which could better have been done by machine. On the other hand, much too little labour utilisation was evident on general cleansing, maintenance, etc.

III FACILITIES AND CURRENT PRODUCTION

3.1 Banja Luka

1. Banja Luka is almost in the centre of the Republic of Bosnia. The town itself straddles the Vrbas river where the blue waters of the rapids and soft green tree-covered gorges give way to the fertile plains of the Sava river. Throughout the ages Banja Luka has been of considerable strategic importance to invaders and defenders alike.

2. Topography

The topography of the area is quite striking. To the south and west lie some of the most beautifully-wooded hills in Europe, rich in wild fruit trees and wild berries. To the north the countryside is very much less striking as the plain widens out. This is the area for large-scale arable farming on the rich alluvial soil.

3. Climate

Unfortunately climatological data for the Banja Luka area was not available as records have only just started being kept. Banja Luka has the invidious reputation of being the coldest town in Yugoslavia with winter temperatures in the order of -15 to -20°C. In the town snow falls most years and usually reaches a depth of about one metre. During spring there is usually a plentiful supply of rain - not big showers but little and often. June and July are normally considered dry months - 1975 being an exception.

4. **Communications**

Banja Luka is well connected by roads and is only some 70 km south of the main Zagreb-Beograd road, taking three and five hours respectively to reach. To the south lies the port of Split and to the south east Sarajevo.

5. **Population**

In the last few years there has been a steady growth in population which in 1974 nearly reached 170,000. The population is almost equally divided between Muslims, Serbians and Croatians, and all races whatever their ethnic origin seem to work harmoniously together. The population is also inflated by a very large student population said to be more than 7000 strong. Social, sporting and cultural activities are well organised and help to provide a happy and contented environment in which to live.

6. **Earthquake**

In October 1969 an earthquake of great severity destroyed much of the town - shops, factories and homes alike. With the help of a reconstruction fund new buildings have sprung up, and while a great deal has been accomplished the work of rebuilding still continues. However, the worst scars of the earthquake have healed over and it becomes increasingly difficult to tell the difference between reconstruction and new buildings as a result of organic growth.

7. **New building regulations**

All new building is now carefully controlled to ensure that designs include safety factors to withstand an earth tremor of 0.9 on the Richterscale. Generally speaking, most designs provide for individual pad foundations which give the necessary flexibility of movement.

3.2 Vitaminka

1. The majority of the new industrial activity, including the Vitaminka food factory, has been located to the north of the city. The industrial area is divided by the Vrbas river. As a result of the rapid increase in industrialisation the river has become seriously polluted by both chemical and organic contamination. Expansion in this industrial area has been such that land for development is at a premium. At Vitaminka only limited expansion can now take place which precludes the possibility of a major processing development.

2. **Rebuilding**

Like many other factories the 1969 earthquake totally destroyed the Vitaminka factory. However, a great deal of the original plant was recovered. The factory as it stands today is therefore new since 1969 and has not only replaced the original buildings but provided new facilities by which the factory's production has been increased.

3. **Investment**

In 1974 the total value of the buildings and plant stood at 100 million dinars ($5.9 million). Working capital stood at 30 million dinars ($1.8 million) but this is being increased to 40 million dinars ($2.4 million) in the current year. The investment is almost equally divided between plant and machinery on the one hand and buildings and facilities on the other. Since the first buildings were erected in 1970 building costs have increased by a least four times and the current cost of building inclusive of services is about 4000-4500 dinars ($235-264) per square metre.

4. **AIPK**

In the future all further agro-industrial development in the Repulic of Bosnia will be co-ordinated through Agro-Industriski i Prometni Kombinat - "Bosanska Krajina". The headquarters of this new organisation, whose formation was recommended as a result of an FAO/World Bank mission, is situated in Banja Luka. It is already apparent that close ties at all levels are being forged between AIPK and Vitaminka.

5. AIPK's very function will be to promote agricultural production in the area as part of the "Government Green Plan". Essentially this will involve a two-pronged attack - first to increase the productivity of the Kombinats and secondly through the farm co-operatives help to promote greater prosperity amongst the local farmers. In this respect the migration of young people of farming backgrounds is causing major concern. Unless the present trends can be reversed many of the hill villages will cease to exist. AIPK will next year take over responsibilities for agricultural extension work, working closely with the co-operatives.

6. AIPK is also investigating a number of other major developments covering both livestock and industrial areas. At the present time there are no meat processing facilities in the area and a fully integrated complex is under consideration. Other projects of interest include a soya bean oil extraction plant, various poultry and duck enterprises, a potato processing complex and a barley maltings.

All this would indicate that with so much activity going on Vitaminka should ensure that the company's attitudes and future policies are well-known and should do all it can to promote its own interests, particularly in regard to on-farm production facilities.

3.3 Production and output

1. General

Vitaminka is the largest food processing company in Yugoslavia and specialises in the processing of fruit and vegetables which are cultivated or picked wild in the Banja Luka region.

2. Sales and production for the last three years are set out overleaf (table 3.1). From 1972 to 1974 it will be seen that the actual quantity of processed product rose by 41 per cent to around 14,500 tons. However, during that period the value of sales decreased sharply, reflecting the problems which have been facing European processors in recent years. It should be appreciated that sales figures have not be adjusted for stocks which rose during 1973 and therefore unrepresentative unit values are given for this year.

3. In terms of selling value, vegetables have fallen from 49 per cent of sales to 38 per cent in the period, but in quantity they remain the greater. There are indications that fruit will become more important during the next few years.

4. Vegetable production

Details of the production of processed vegetables are set out in table 3.2. It can be seen that four major products account for 82 per cent of the total - namely:

canned peas
cucumbers/gherkins
capsicums
ajvar

Table 3.1

Total sales and Production 1972-1974

Value = '000 $
Quantity = tons

	1972			1973			1974		
	Vegetables	fruit		Vegetables	fruit		Vegetables	fruit	
Total sales ($)	3855.8	4084.7	7940.5	2280.3	3171.5	5451.8	2893.0	4646.9	7539.9
Total production (tons)	5617	4644	10261	6112	6875	12987	7220	7250	14470
Unit value $/ton	686.5	879.6		373.1	461.3		400.7	640.9	

Table 3.2

Production of vegetable products for 1972 - 1974

(tons)

	1972	1973	1974
Peas	1590	1417	2007
Peas and carrots	31	34	159
Green beans	994	1352	871
Mixed vegetables	637	-	-
Ajvar	639	1030	1207
Cucumber/gherkins	678	507	1362
Capsicum	477	1477	1309
Pepperoni	16	-	59
Other capsicum	-	-	55
Carrots in water	-	4	30
Red beet	459	147	-
Tomato puree	96	144	57
Green tomato	-	-	104
Total vegetables	5617	6112	7220

Ajvar is a paste made out of tomatoes and red capsicum. It is very popular in Yugoslavia and is freely exported to those countries where there has been a substantial Yugoslavian immigration. In the future we understand that the production of all products will be increased, particularly those mentioned above. Emphasis is also likely to be placed on tomatoes and red beet.

5. Fruit production

The production of processed fruit products for the last three years is given in table 3.3. Jams and 'marmalada' (a fruit 'cheese') which accounted for nearly 59 per cent of production in 1972 have recently declined in importance and now account for only 40 per cent. The reason for this has been the large increase in fruit juice production together with the introduction in 1973 of bulk frozen fruit for reprocessing. In the future, it is hoped that the production of all the main products will be increased.

Table 3.3

Production of jams and other fruit products for 1972 - 1974

(tons)

	1972	1973	1974
Marmalade	1671	2449	1737
Jams	1081	1182	1102
Fruit compote	-	306	266
Fruit syrup	571	758	584
Fruit juice	1125	1326	2785
Fruit in heavy syrup	154	147	190
Frozen fruit	-	396	466
Fruit pulps	42	311	120
Total fruit products	4644	6875	7250

3.4 Product range

1. In appendix III details of sixty or so more popular product packs have been set out. In terms of actual products numbers are equally divided between fruit and vegetable products.

2. Overall the total number of packs (determined by size/capacity; material - can/jar/bottle; process treatment and base product) possibly approaches 100 different types. However, within this number would be included bulk packs of frozen products suitable for reprocessing.

3. As can perhaps be anticipated some of the individual product lines represent very small sales levels. Unfortunately although this data is available there was not sufficient time to analyse it. However, in 1974 there were nine fruit and four vegetable products with less than 500,000 dinars ($29,000) selling value; of these only four had been introduced during the previ two years. Further investigation showed that 13 fruit products and 7 vegetable products had sales below 750,000 dinars ($44,000); again there were only four new introductions during the previous two years.

4. This brief analysis immediately raises the question of the individual profitability of each product. What contribution does each product make to profits? Are some products more profitable than others? We comment on these aspects in greater detail elsewhere but from our discussions and study of the information given to us it would appear that the current systems of product line costings installed in the factory would not be able to give an accurate indication of individual product profitability, let alone even groups of products.

5. We must emphasise that without this essential information it becomes difficult if not impossible to make rational decisions on such matters as new product development, marketing development and indeed on such organisational matters as plant layout and utilisation.

3.5 Plant capacity

1. The following figures give an indication of the operating capacities with different products:

Vegetables	Labour unit	Tons/8hr* shift
Peas	39	18
Green beans	39	18
Cucumbers/gherkins	64	10
Capsicum	50	10
Red beet	37	8
Carrots	37	8

* 1 kg cans

Fruit (½kg jars)		
Strawberry jam	21	6
Cherry jam	22	6
Compôte of cherry	28	8
Fruit juice	18	14*

* bottle 1 litre

2. It should be noted that when sulphited fruit is used the cooking process has to be extended. There are some savings in the time taken in preparation but the net result is an extension of the cycle time from 1 hour to 1½ hours.

3. **Period of operation**

From 1 June to 15 October (1975) the plant operates 21 shifts per week and ten shifts per week for the remainder of the year. The company calculates on the basis of 250 working days in the year. Eight days are lost through national holidays but there is no extended period of factory close-down. Generally there is a long break just before the New Year but this coincides with the Christmas Holiday.

4. **Theoretical capacity**

Vitaminka state that with the equipment already installed in the plant the theoretical annual output would be 25,000 tons of finished product. It is in fact 10-15 per cent higher, say 28,000 tons. The plant utilisation for 1974 and 1975 is as follows:

	Output	Percentage utilisation
1974	14470	50%
1975	17500 (estimated)	61%

5. We consider that 70-80 per cent utilisation should be aimed for. At the present time the reasons for low utilisation are as follows:

a. insufficient supplies of raw materials

b. difficulty in finding markets for finished products

To these two could be added: low plant efficiency and plant wastage, but these are the responsibility and under the direct control of Vitaminka management and can theoretically be resolved given the determination.

6. It is therefore of paramount importance that Vitaminka carefully appraises the future prospects of increasing raw material supplies and investigates market opportunities for both existing and new products.

3.6 Marketing and distribution

1. Vitaminka has total responsibility for its own marketing effort - ie from point of market identification through to product development, market planning and sales. While home sales are dealt with internally, exports have to be directed through a national exporting company, although the sale itself most probably would have been ovtained by the company's own sales activity.

2. Home sales

While 64 per cent of Vitaminka's home sales are in Bosnia, 19 per cent are in Croatia. Slovenia is also of some importance. Serbia is of little importance while Macedonia is not only a lower priced market but is so distant that transport costs become excessive. It is said that there is no restriction of trade between the different repuhlics in Yugoslavia but at times the impression is given that some republics try to protect home industries. However, it is unlikely that this situation has much interrupted Vitaminka's progress.

3. Purchasing for the retail outlets is undertaken by a relatively small number of wholesalers, so therefore, Vitaminka has very little contact with the retail industry. Selection of what products go on the shelf of a shop is largely dependent on the wholesaler's original choice. Few retail shops for instance will stock more than one brand of any given product. In other words on the jam shelf there may be a number of jam varieties made perhaps by different companies but there will only be, for example, one apricot jam. In this respect the consumer has little choice.

4. Distribution

To overcome this problem and also to improve distribution Vitaminka has established warehouses in Zagreb and Rijka, where it is possible for retailers to come and buy what they want. In Zagreb the warehouse, together with the employment of a travelling salesman, has seen turnover increase five-fold in the area.

5. Transport

Vitaminka uses its own lorries to deliver its produce and on average distribution is said to cost 0.25 dinars/kg of produce (ie just over one US cent). This charge is considered to be highly competitive and indicates the efficiency of the external transport service. This statement presupposes that the products have been delivered to customers as ordered and in the correct quantities.

6. Future prospects for home market

In view of the high price of jams it is felt that some stagnation or even decline in the market will occur. Vitaminka does not wish to reduce quality so that a lower selling price can be achieved. In the past Yugoslav buyers have shown that they are prepared to pay a 30 per cent premium for Yugoslav jams rather than buy from Eastern Europe. Fruit juices will continue to show promise while the past trends for canned vegetable and fruit products are likely to continue.

7. **Export sales**

All export sales are handled by an export agency (Jugo Export) but Vitaminka has to be responsible for obtaining the order in the first place. However, over the last three years exports have started to pick up and in 1974 just under $½ million worth left the factory for overseas destinations - a four-fold increase over the two years. The "traditional products" have shown little increase while the greatest expansion was for bulk frozen fruit, having started production in 1973.

8. Amongst the vegetables produced ajvar is popular in the UK and Sweden, but overall fruit products are of much greater importance, particularly fruit for reprocessing. The UK and West Germany are the two most important markets.

9. A number of years ago jam was a popular export to the UK and some of the Arab countries. However, over the years it has priced itself out of the market. The main reason for this is the price of sugar in Yugoslavia which is currently 1120 dinars per 100 kg ($65.9), whereas the equivalent price in the UK is 630 dinars ($37.06). At the present time jams from Bulgaria and Romania are on the market at half the price, albeit that they are of an inferior quality.

Table 3.4

Exports sales 1972 - 1974 of (a) Canned and bottled products and (b) Frozen products

(units / $)

	1972	1973	1974	
(a) Canned and bottled products				
United Kingdom	82225	58143	94667	(canned cherries, ajvar)
Canada	4624	7370	6532	(rose hip juice)
Sweden	1348	5987	-	(ajvar)
West Germany	2227	5926	94482	(Morello cherries for re-processing)
Australia	22322	30830	22282	(raspberry syrup)
USSR	-	-	11302	(green beans)
Sub total	112746	109256	229265	
(b) Frozen products *	-	171853	257647	(plums and blackberries)
Total Value exported	112746	281109	486912	
Approximate percentage of total sales	0.01	0.05	0.06	

* destination not given

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10. Vitaminka is currently trying to develop the production of molasses to replace sugar but this is likely to take some time before sufficient quantities are available. Unless, therefore, the basic price of sugar can be reduced it is difficult to see how its jams can be competitive, The domestic price of sugar has been inflated to promote a stronger sugar industry in the country. It is anticipated that by 1980 the country will be 90 per cent self sufficient. If it is the Yugoslav Government's wish to promote the export of jams and other products containing sugar, either exports will have to be subsidised or some means found to rebate the sugar levy. We consider this matter should be referred to Yugo-Conserve for discussion with the appropriate government department.

11. Having made this point we feel that nevertheless there are opportunities for the export of jams of very high quality and with a specialist "up market" appeal. For example, apricot jam and almond nuts, cherry and brandy jam or blackberry and apple jam. The quantity sold would not be large but the gross selling value could be quite high. Initially a premium market should be sought - say small gift packs for Christmas time.

12. In Volume II details of the various market opportunities have been set out together with the background to each market situation. The opportunities for juice are considered to be negligible but potentially a market could exist for high quality concentrated juice. As yet Vitaminka could not produce this product as no aroma stripping facilities are available.

13. Bulk frozen fruit - cherries, blackberries, plums, etc would appear to offer a good export potential. There is little doubt that flow freezing would greatly improve the quality and this alone could well increase market opportunity. We understand that it is hoped to install a 2 ton per hour flow freezer next year. Cold storage is also to be expanded but some of this will be taken up by the requirements of the baby food line.

3.7 Site and Buildings

1. Site layout

A plan of the Vitaminka site is given at Figure 1, from which it will be seen that the northern boundary is beside the Vrbas river. While land was available across the service road to the east for the office block and canteen, no further space is available on this side of the road for further building.

2. Buildings

There are essentially three main process units:

- Cold Store
- Fruit and vegetable processing
- Fruit juice plant.

The Cold store is of sufficient area to accommodate 2-ton per hour block freezing line. While the plant room capacity is sufficient for the planned expansion of cold storage space to 2,000 tons, it will be necessary for the block freezer to be provided with its own plant.

3. Construction

The method of construction varies from building to building - the cold store is of reinforced in-situ cast concrete, while the main process building is of a steel frame construction.

4. Floors

Work floors have poorly set levels, particularly in wet areas, and as a result too much water is left standing around. The floor surfaces themselves have been primed with a bituminous coating which, when combined with water, becomes very slippery to walk on. Ideally all floors should be finished in Granolithic or tiles in those areas which will have to withstand particularly hard conditions.

5. Electrical installation

The electrical installation is on the bus-bas system in the main process area, which permits a free interchange of equipment. In the juice plant an individual switched fused system has been installed. Unfortunately the fuse boxes and control panels have been badly sited and are not of sufficient specification to withstand the working conditions. A number of electrical control panels and fuse boxes had not had their doors closed, allowing the ingress of dirt and other extraneous matter.

3.8 Services

1. In this section we describe very briefly the services which are on site at the present time and then go on to outline what improvement or additions are likely to be made in the future.

2, **Water**

Water for cooling purposes is drawn direct from the river. Although it is passed through a sand filter there is no other purification whatsoever. There is a high level of chemical pollution in the water caused by a cellulose plant upstream. As a result it becomes necessary to hand clean the cans before labels are fixed. We suspect that there must be a measurable level of bacterial contamination in view of the fact that some open drains run into the river at the present time. Also all fish life below the town is non-existent. This is a most unsatisfactory position. Either the water should be purified or shell and tube heat-exchangers should be inserted into the cooling circuit and recirculated water used instead. The latter is possibly the cheaper solution.

3. Fresh water is supplied from the main through 300 mm pipe at 3 atmospheres pressure. This would seem to indicate a plentiful supply, the water itself is slightly chlorinated. The cose is 2.10 DN ($0.12) per cubic metre.

4. **Effluent**

Up to the present time all water has been returned to the river, but as from next year stringent new control measures are being introduced. As a result, all water being returned should in future be of a higher quality than that taken out. Vitaminka is currently constructing a new sediment/sludge plant and all the unpurified liquor will then be discharged into the public sewer. The local authority is currently constructing a new sewerage plant and laying the necessary pipes. Vitaminka will then be charged an appropriate fee by the local authority for accepting the effluent. This will be based on the remaining solid content and B.O.D. The current charge is 0.010 DN per cubic metre.

5. **Steam**

Vitaminka has its own powerhouse which is fitted with three boilers of 5, 8 and 10 tons/hr nominal evaporative capacity. At the present time the normal operating requirement is 15 tons/hr, but this will rise to 18 tons/hr in the future. The feedwater is purified, the plant having a capacity of 24 tons/hr. Factory steam pressure is 11/12 atmospheres at point of delivery. The boilers are fed 960 sec heavy oil, 500 tons of which is stored on site. All oil is delivered by lorry. The cost is 1.35 DN ($0.078) per kg.

6. **Electricity**

There are two independent supplies of electricity on site (3 phase 380v) each having its own 10,000 volt transformer and being connected to the main factory bus-bar. There are no area supply problems and the present installation can take a further 30 per cent capacity. The cost is 0.48 DN ($0.028) per KW/hr.

7. **Factory heating**

The main buildings are heated by steam/hot air units. Few of the main work areas are insulated and Vitaminka is aware of the extent of present heat losses in the winter. An attempt is being made to concentrate all labour into confined areas which can be adequately heated.

3.9 Packaging

1. The following types of packaging materials are used.

Cans	Capacity	Diameter
	½ kg	73 mm
	1 kg	99 mm
	3 kg	163 mm
	5 kg	163 mm

All cans are lacquered and those used for blackberries are double-treated. Normally 8/8 tin plate is used, all of which is imported into Yugoslavia. The cans are purchased 300 km away and delivered in non-returnable cartons.

2. For large runs of cans - mainly vegetable - litho printing is used, otherwise paper labels are affixed. Costs of cans are as follows:

Size	Unprinted Dinars ($)	Printed Dinars ($)
250 gm	-	1.27 (0.07)
½ kg	1.54 (0.09)	1.68 (0.10)
1 kg	2.10 (0.12)	2.31 (0.14)
5 kg	8.67 (0.51) (with handle)	8.61 (0.51)

It would appear that very large quantities of cans are delivered before the start of the season, which undoubtedly takes up much valuable manoeuvring space. Some form of contracted delivery would seem preferable.

4. **Glass jars**

Only two types of glass jar are used - ½ kg and 1 kg nominal capacity. The current design has a heavy flared bottom to provide easy handling characteristics. An earlier type with a tapered base was discontinued because of a high level of line breakages, although in our opinion it is of better appearance.

The jars are moulded, but it is understood that vacuum moulding facilities will be available in the not too distant future ; thus much lighter-looking jars can then be made.

Jars	Capacity	Glass Weight	Contents Weight	Price Din($)
	½ kg	185 g	420 g	1.10 (0.06)
	1 kg	380 g	850 g	1.23 (0.07)
Caps	½ kg			0.042 (0.0025)
	1 kg			0.048 (0.0028)
Glass bottles	½ litre			1.20 (0.07)
	1 litre			1.74 (0.10)

5. **Outer fibreboard containers**

The cost of fibreboard containers ranged from 4 - 5 dinars ($0.24 - 0.29) per case. The quality of the board was adequate but not good. More attention should be given to closure; in some instances tape was being used, which did not add to the already untidy appearance.

6. **Labels**

All labels were of a highly distinctive appearance and no doubt are suitable for the Yugoslav market, about which we do not have much experience. We suggest, however, that a number of new designs should be introduced for exported products. Ideally the labels should be designed by a national of the country where the produces will be on sale.

7. The Vitaminka trade mark is distinctive, and we think very good for the purpose intended.

IV PRODUCTION OF BABY FOODS

4.1 General

1. It is first necessary fo define in broad terms the kind of baby foods appropriate to Vitaminka's operations. These are not of the milk, or modified milk, or milk substitute type used during the first 9 months (approx) of the baby's life as the regular basic feed to replace breast milk. The products appropriate to Vitaminka are of two kinds:

(i) those now very widely used as a supplement to the milk feed from 3 months of age to about 9 months, and

(ii) those feeds, which at about 9 months, totally replace milk, and are transitional to the time (2 years old or so) when the child eats with the family. These latter are usually known as 'junior' foods and differ in character from the first type in that

- particle size is larger and the texture changes from a fine smooth puree to a less fine puree base frequently with discrete larger pieces in it, and
- nutritionally the product has to stand largely alone as it is no longer a 'supplement' to milk.

2. Consumption

The extent to which such products as these are currently used is exemplified by the fact that in the USA about 600 varieties are currently available (a country where around 75% of all babies are bottle fed) and in Sweden about 125 varieties are on sale.

The consumption in USA was, in 1968, 600 jars/baby/year and in Sweden was 450 jars/baby/year (jar size not specified but mostly, one presumes, the around 125g or 4½ oz jar). The fastest commercial food filling lines were for baby foods - up to 800-1000 jars or cans/minute!

3. Conceptual aspects

Before coming to technical aspects of baby foods as defined above it it necessary also to draw attention to aspects of such foods which colour and condition the whole concept of producing and marketing them.

4. Food is emotive. Its selection and use is hedged around by taboos (traditional religious, legal etc), some of which are or were valid, some not, but which are disregarded at ones peril. This situation is even more acute in respect of baby food in a situation where the purchaser is not the consumer, the consumer is totally dependent on the purchaser for health, protection etc, and the consumer and purchaser normally have the closest personal and emotional links. In these circumstances, quality (appearance, flavour, etc), performance criteria (growth and health promotion, absence of harmful effects) and hygienic image (type of pack and presentation; factory image and reputation) all have major roles to play in effective sales promotion and achievement. The purchaser must be 'nursed' all the time - and the largest producers of baby foods in the world, Heinz and Gerber - do just this thing. Not only must the foods be sound and effective all the time but they must, from factory visiting and promotions deriving from the factory unit, be seen to be all the things claimed by the manufacturer and wished for by the purchaser. This introduces an entirely new, and over-riding parameter in the consideration of establishing a baby food manufacturing operation; it is normally quite unnecessary for adult foods which are judged on face value - flavour, texture, appearance etc.

It is in this overall context that the factory operation must be planned and executed.

5. Composition of baby food

So far as composition of these baby foods, major advances have taken place in nutritional requirement evaluation over the past two decades and WHO has provided very useful guidelines. At the same time they have made life more difficult for the manufacturer in two similar respects which cut across the traditional mothers evaluation of the flavour and attractiveness of a food for her child.

6. It has become known that two particular ingredients in food for infants and children are undesirable, certainly in the quantities heretofore provided. The items are salt, and sugar, (sucrose). Too much salt has recently been associated with cot deaths and is liable to predispose the infant to hypertension in later life; too much sugar is bad in several respects - dental caries, predisposition to obesity, high blood triglycerides with its subsequent implications for atheroma, replacement of other forms of carbohydrate such as cereals which provide additional nutrients to pure carbohydrate, etc etc.

7. Unfortunately mothers, used to quite high (1% or more) salt and also high sugar levels in food, are inclined to reject savoury foods for infants which are low in salt and also to reject 'dessert' foods which lack customarily sweetness. Babies do not demand the saltiness and sweetness demanded by adults; they are very happy to consume foods which are almost tasteless by adult standards. It is probably necessary to compromise on these factors initially, and to use a little added salt or sugar 'to make the food taste right!'. Later, the correct low levels can be introduced.

8. **Packaging**

A further indication of the extreme seriousness with which all aspects of infant foods is taken is the fact that where such products are usually canned - as in England - no longer is regular solder being used on the side-seams of the cans. At very considerable extra expense and difficulty, pure tin is used for soldering such cans, so avoiding any possible lead contamination of the food.

9. It is therefore very clear that a baby food operation must be approached with the greatest circumspection; it must be irreproachable in all aspects and fully up-to- date in the light of nutritional and paedriatic knowledge and practice.

4.2 General principles of baby food manufacture

1. General

Raw materials do not enter the baby-food plant until they are fully prepared - either canned (and in this instance pre-cooked), frozen (in this case fully washed and prepared but probably only blanched and therefore requiring cooking), or fresh but fully prepared, washed, peeled if necessary, cored or pitted if fruit requiring such treatment, trimmed and freed from bone, sinew and obvious fat if meat. All raw materials are thawed (if necessary) and are throughly rinsed in an air-jet washer with subsequent blower before further treatment. Top quality raw material is necessary throughout.

2. Cooking

Blanched and uncooked raw materials are sliced if necessary, to minimise cooking time, and then cooked either under pressure or more commonly in steam jacketed open pans which are conveniently fitted with wire baskets. The pans have hoods with extractors fitted. Cooking time is variable and appropriate to the raw material but always remembering that the materials have subsequently to be pureed. Continuous steam cooking of vegetables and fruits is appropriate if anticipated throughout justifies such cooking but at the projected production rate of 1 ton per hour would be unlikely to be appropriate but depending on the product mix and the components (number and quantity) in each mix. However, pan cooking provides greater flexibility and control and avoids clean-down time and gaps problems, and baby food production is, except in the largest plants, basically a batch rather than a continuous operation.

3. **Comminution**

- **Fruit and vegetables**

The first stage in comminution is by passing the cooked material through a pulper or 'passing' machine with a 0.045" screen. Then grinding or disintegration in a suitable mill is necessary and this is followed by passing the material through a fine screen finisher with 0.027 sq. inch to 0.033 sq. inch mesh.

- **Meat**

This is passed through a mincer with 1/8th" or 3/16th" holes. After add-back of about 5% of the cooking liquor, the slurry is emulsified or homogenised - usually in a suitable colloid mill - and is then, after addition of more cooking liquor if necessary, passed through the finisher as for fruit and vegetables.

4. **Mixing**

Mixing is a batch process. Ingredients, all of which have previously been through the fine screen finisher with the exception only of such items as concentrated orange juice and similar materials, are weighed into the elevating tipping hopper which discharges into a stainless steel lidded mixer. When mixing is almost completed, viscosity of the batch is standardised by the addition, as necessary, of precooked cereal flour, vegetable gums etc. Flavour, natural colours and condiments are added as and when necessary, as are any necessary vitamin and mineral supplements.

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5. **Preparation of Batch for filling**

The batch is pumped from the mixer to a sieve where the final check takes place on the absence of any non-comminuted materials. From the sieve the product goes to a scraped surface heat exchanger (Votator type) where it is heated to 190°-200°F.

6. **Filling and capping**

It is assumed here that filling is into conventional glass jars - some modifications will be necessary if and when filling into small aluminium foil laminate containers is envisaged (see later).

The glass jars are inverted and passed through a washer, finishing with a very hot rinsing spray. When almost dry but still very hot they are inverted and pass to the filler. A carousel piston filler is used with the product at not less than 180°F (preferably 190°F) and pre-steamed caps (with sealing compound appropriately softened) are affixed immediately with steam flow in a suitable capping machine.

7. **Processing**

This must commence withing 20-30 minutes of filling and capping. Process time and temperature vary with product - from atmospheric steam processing (fruit) to the usual water + superimposed air pressure retort processing (vegetables and meat-containing products).

Cooling follows to about 110°F.

Water used for processing and cooling must be filtered and chlorinated to a minimum residual chlorine content of 2-5 ppm. This being boosted to up to 20 ppm during clean-down periods.

8. Labelling and packing

Jars must be completely dry before handling and labelling. Both labelling and packing are standard operations.

4.3 Equipment schedule

1. A bowl chopper has not been included in the following schedule of equipment but would be necessary to provide particulate material (meat, vegetables, cereal products) in 'junior' foods. However, until product mix and formulae were established the size (and possibly number) of bowl choppers and associated sieves could not be estimated with any degree of realism.

2. The budget costs provided are those from a consortium of Mather & Platt Ltd., and Brierley Collier & Hartley. Costs have been requested from both Zacmi & Tito Manzini in Parma, Italy but nothing has yet been received.

3. It should be noted that to the f.o.b. prices must be added the following in costs:

- C.I.F. 5% ad Valorem
- Import Duties, Taxes, Dock Charges and transport 30%
- Installation Cost 12½%.

SCHEDULE OF EQUIPMENT REQUIRED FOR 1 TON/HR BABY FOOD PRODUCTION PLANT

It is assumed that all raw materials enter the plant ready prepared (except for slicing) - eg canned, frozen, and fresh. Only a thawing facility and rince will be necessary, plus slicing for rapid cooking of fresh and frozen materials. The assumption is made that a half of the raw materials are frozen.

Item No	Quantity	Description	Budget Cost FOB (each)
1	1	Thawing tank with conveyor with steam heater coil to thaw up to ½ ton of raw material per hour.	
2	2	Rinsing tanks (conveyor type) for washing all incoming raw materials before cooking. ½ ton/hr either in plastic boxes or crates or loose (eg potatoes).	
3	1	Slicer for slicing meat and root vegetables etc to allow of rapid cooking. Capacity 1 ton/hr.	
4	4	250-300 litre capacity s/s steam jacketed cooking pans or tanks.	
5	4	Hoods and exhaust systems for Item No 4.	
6	12	S/s wire baskets for Item No 4.	

Item No	Quantity		Description	Budget Cost FOB (each)
7	1		Overhead conveyor system to carry wire baskets after filling to the cookers and after cooking to empty into the hoppers of (a) or (b).	
8	2		(Pulping or passing machines, each with a capacity of 1ton/hr. ((0.045 sq" sieve)	
9	2	(a)	(Disintegrators/mills for further refining of vegetable and fruit (purees - capacity 1 ton/hr.	
10	2		(Fine screen finishers (0.027 sq" - 0.033 sq' mesh) for finishing (vegetable and fruit purees - 1 ton/hr.	
11	1		(Mincer, max capacity 250 kilos/hr, 3/8ths" - 3/16th" plate	
12	1	(b)	(Premier Colloid mill (or equivalent) for reduction of meat to (pass 0.027 - 0.033 sq" mesh.	
13	1		(Sieve (0.027 sq" - 0.033 sq" mesh) with tails recirculation to (colloid mill.	
14	1		Scraped surface heat exchanger to reduce 1 ton/hr of puree from 80^{o}-90^{o}C to 4^{o}C (for overnight chilled storage as necessary). Two stages, (a) cold water jacket, followed by (b) brine-cooled jacket.	
15	8		250 litre capacity s/s storage and conveying tanks on bogies.	

Item No	Quantity	Description	Budget Cost FOB (each)
16	8	100 litre capacity s/s storage and conveying tanks on bogies	
17	1	0-200 kg tank weighing station.	
18	2	600 litre horizontal mixers with elevating batching feed hoppers and lids.	
19	2	pumps from mixers.	
20	1	Scraped surface heat exchanger capacity 1 ton/hr from ambient to 200°F.	
21	1	Jar washer and steriliser to suit 'baby' and 'junior' jars with inverted wash and final very hot rinsing spray (product fill temperature approx 185°F).	
22	1	Piston filler maximum speed 150 jars/minute with change parts if necessary for "baby" (207 x 213) or "junior' (207 x 315) jars.	
23	1	Steam-flow jar capping machine maximum speed 150/minute; cap pre-sterilisation by steam.	
24	40	Standard Busse crates.	
25	12	Crate bogies.	

Item No	Quantity	Description	Budget Cost FOB (each)
26	1	Busse crate loader.	
27	200	Dividers for crates.	
28	5	3-crate vertical retorts with steam heated water reservoirs for retorting in water and with air over-pressure.	
29	5	Sets automatic control and recording equipment for retorts.	
30	1	Overhead monorail carte loading facility.	
31	1	Busse crate unloader.	
32	1	Jar dryer.	
33	1	Labeller.	
34	?	Case packers - capacity 120 jars/ minute.	
35	?	Case sealers.	
		P.C. sum to cover piping, pumps, conveyors, catwalk staging, etc etc.	

All plant to be of stainless steel where contact with food is involved and where white paint externally is not applicable because of temperature or for other reason. The plant must have 'aseptic' or 'hospital' appearance and ease of cleansing is of major importance.

4.4 Nutritional requirements in baby foods

1. Protein

The estimated protein nitrogen requirements for growth and maintenance in infants are:

Age	mg/N/Kg/day
0 - 3 months	233
3 - 6 months	188
6 - 9 months	158
9 - 12 months	116

From observation, satisfactory levels of mixed proteins are circa 25% above these values.

2. Translating the above into practical protein requirements for infants based on observed intake for normal growth:

protein g/kg body weight/day

Age	Human milk	Cows milk (humanised to protein equivalent to human milk)
0 - 3 months	2.6	2.2
3 - 6 months	1.9	1.8
6 - 9 months	1.5	1.5
9 - 12 months	-	1.25

Protein efficiencies of other proteins vary, and the efficiency of utilisation of course also depends on the saturation level of the child. About 35% of the protein intake must consist of essential amino acids in approximately optimal proportions.

The standard minimum for protein content in baby foods is 1.8g/100 Cals, this being of protein with a PER of not less than 70% of that of casein.

3. Energy

Energy needs of infants lie in the three categories:

(i) maintenance

(ii) growth and

(iii) activity, of which

(iii) is very variable and (i) and (ii) are related to body weight and climatic and other factors.

Observed requirements are:

K.Cals/kg/day

Age 0 - 3 months	3 - 6 months	6 - 9 months	9 - 12 months
120	115	110	105

The foregoing can be reduced for the present purpose into protein/Calorie ratios to provide a guideline in elaborating satisfactory formulae for auxiliary and weaning baby foods, and for 'junior' foods.

4. Minimum ratios recommended are:

Age	
0 - 3 months	circa 6.7% of total energy intake as protein
1 year	" 5.5% " " " " " "

Analytical values on products can indicate immediately if the above criteria are being met and formulae can be adjusted to meet these criteria if necessary.

5. Vitamins and minerals

The question of vitamin and mineral additions to baby foods needs consideration. So far as Vitamin C is concerned, it is almost universal for supplements to be given (eg rose-hip syrup), but not so for other vitamins.

Vitamin A	recommended intake is	1 - 7 months, 300 kg retinol (x 3 if β carotene)
		1 year 575 kg retinol (x 3 if β carotene)
Vitamin D	" " "	0 - 7 months, 10 kg cholecalciferol minimum
Vitamin B	" " "	0.33 mg/100 Cals in the food
Riboflavin	" " "	0.6 - 0.8 mg/kg of body weight
Nicotinic Acid	" " "	6 mg at 7 - 12 months 8 - 10 mg at 1 year upwards (Additional amount if nicotinamide used)

For other vitamins requirements are too vague to be considered.

6. <u>Minerals</u>

Only three minerals need to be considered in respect of baby food.

(i) Sodium chloride - common salt

This had already been mentioned. The US National Academy recommendation is that maximum salt additions to baby foods should be:

Age group	3 months	0.2% added salt
	5 months	0.4% " "
	8 months	0.6% " "

These should be reduced as and when public acceptance allows.

(ii) Iron

There is virtually no iron in milk, and babies subsist on pre-natal stores in the liver. Baby foods should therefore offer an iron supplement at the earliest moment. The current recommendation is 6.4mg Fe per 640 Cals.

This can be added iron pyrophosphate or sodium iron pyrophosphate which retain their absorbability quite well after processing.

5. The seal and the foil/plastic barrier provided by the packs under consideration are perfectly adequate for suitable pasteurisation and sterilisation procedures and subsequent long-term (up to a year or two) storage of products. Furthermore, atmospheric steam pasteurisation of product is no problem, nor is steam + superimposed air pressure sterilisation of those products requiring such treatment. The problems mainly arise from:

(i) the deformability of the packs

(ii) the shape of the packs including particularly the projecting seal area

(iii) the number or rate of production of the packs

(iv) seal formation and seal integrity

In respect of (iii) it has to be remembered that about 4½ of these packs would be produced in lieu of 1 normal 4½ oz (130g) glass container, and that 25,000 - 30,000 per hour might have to be dealt with if full production were packed this way. Other problems are defined in Appendix II.

6. There appear to be two potential ways of dealing with the problem of: rate of output.

First using a wide web with a cross section of six, eight or even ten cups, filling, and sealing with an equally wide 'backing' and cutting this web into appropriate lengths so that in each length there were, say, 60-100 sealed cups or finished packs requiring only cutting or 'trimming' into individual units. These lengths of filled and sealed 'web' could be very conveniently passed through the pasteuriser or, as necessary, through the retorting sequence, each layer in the latter case being divided by a suitable divider or preferably, to avoid deformation, placed in a rack of trays of appropriate size fo fit the available retort or steriliser.

(iii) Calcium

Calcium, usually as phosphate, is needed in 'Junior' baby foods to replace the calcium lost when basic milk feeding is terminated. A fortification level of about 30mg/oz.of finished product (or 1mg Ca/gramme) is appropriate.

7. Other Nutrients

As little sugar should be added to formulae as is possible for reasons previously mentioned. It is undesirable also from the obesity point of view for babies to develop a 'sweet tooth'.

8. The formulation of baby foods

Three major considerations affect the choice of ingredients and their proportions (when present as mixtures) in baby foods for a given market.

(i) The raw materials must be readily obtainable locally and purchasable economically.

(ii) The raw materials and their combinations must be reasonably well-known and familiar to prospective purchasers so as to form an easy transition to normal family meals.

(iii) No very strong or over-powering flavours should be present.

Recipes for appropriate mixes can be provided as and when required (and some typical mixes are detailed later) and these can be 'topped up' with a protein addition if and when necessary and following theoretical and actual analysis. All recipes require modification and adjustment to suit plant conditions and facilities:

9. Processing standards for baby food

These vary according to formula, pH, thermophilic load etc. Usually an F_o value of over 12 is used (frequently 15 or 16) to make quite sure of the safety of the product in use. Microbiological checks on all products on a scale very much greater than that used for adult foods is carried out. Mistakes and product recall are unthinkable in this context. Peas and spinach, widely used as ingredients in baby food, are particularly prone to carrying high loads of thermophiles, particularly in the case of peas due to deficiencies in pea blanching and in spinach due to inadequate washing. Corn, also frequently used in baby foods is another frequent source of high thermophil loads particularly if held at elevated temperatures between 100^oF and 180^oF. Pea blanching recommendations are as follows:

10. The recommendations made with respect to control of blancher contamination in the canning of peas apply also to other products that are blanched in a conventional pea blancher such as lima beans and green and wax beans.

11. **Blanchers**

Both rotary drum blanchers and tubular blancher systems may become contaminated with thermophilic spoilage bacteria. The contamination which occurs during shut-down period can be minimized by prompt cooling of blanchers after use, by thorough cleaning, elimination of steam leaks, and flushing of the blancher system before its next use. However, thermophilic contamination may also occur during operation of either type of blancher system.

12. In rotary drum blanchers the contaminating bacteria are able to grow on the inner surfaces, above the water line, where temperatures are reduced by cool air drawn into the blanchers under loose-fitting doors and other openings. Any surface in the blancher where the temperature ranges between 100°F and 180°F can be the site of bacterial growth from which heat-resistant spores will be washed by condensate into the blanch water, and there contaminate the peas.

13. Efforts to prevent contamination in rotary drum blanchers should be directed toward elevating inner surface temperatures above 180°F. Blancher doors should be closed and fastened at all times. Doors which are bent or other wise out of shape should be repaired in order to exclude as much cool air as possible. Vent stacks should be eliminated from the shell of the blancher. The coldest sections within a drum blancher are at the feed end. The use of a spray or steam jet, inserted at the upper edge of the feed end, which delivers steam or hot water (190°F or higher) over the inside surfaces has been found useful in preventing contamination. During operation the temperature of the blanch water should be as high as practicable (at least 180°F)

and the reels should be kept in motion continuously while the blanchers are being heated or being held at operating temperature. A continuous overflow from the blancher should be maintained during operation.

14. The blancher water should be dumped as often as practicable since the number of bacterial spores in the water increases with time and use. The drain and water supply pipes should be of sufficient size fo permit rapid draining and re-filling.

15. In tubular blanching systems a large percentage of the flat sour spore contamination occurs in the de-watering reel into which the peas are discharged from the blanchers. Thermophilic bacteria grow on the mesh of the screen and on the surface of the splash boards around the reel and the pan underneath. Spores produced by the bacteria are added to the peas as they pass through the reel or may be washed into the water and re-circulated in the blancher. This contamination can be reduced if sprays are installed to wash the surface of the reel with water which is preferably, but not necessarily, chlorinated. The use of cold water for this purpose is desirable to lower the temperature of the peas before they enter the quality grader. Sprays should also wash down the inner surfaces of the splash boards or canopy surrounding the reel. Tests have indicated that cold water is effective in reducing flat sour contamination when used in these sprays. The foam which accumulates on tanks supplying recovered water to tubular blanchers can be the growth site for thermophilic spoilage bacteria. A large, broad overflow should skim the surface of the tank. Top sprays delivering streams of water at a flat angle will help prevent the formation of foam and aid in skimming the tank.

16. It is important the peas be washed thoroughly after blanching. Adequate washing will remove large numbers of spoilage bacteria but cannot be depended upon to remove all of the bacteria added by a heavy contamination. Washing with cold water will reduce the temperature of the peas and thus help to minimize slime growth in subsequent equipment and prevent undesirable temperature increases in the quality grader brine if used.

17. <u>Spinach</u>

Spinach washing and blanching recommendations are as follows:

<u>Washers</u> Spinach washers include "immersion", "spray-rotary" and "spray-belt" types. They are used singly, in multiple, and in various combinations. Their primary function is to remove grit and adhering soil and concurrently the soil-borne bacteria which are present. In all types of equipment, the washing efficiency is determined, at least in part, by the amount of water used. Thorough washing is of primary importance and a large volume of water is required. Washers should not be overloaded because this reduces their efficiency. When both immersion and spray types are used in the same line, better results are achieved if the immersion washer is placed before the spray washer. The first washing should always be done with cold water. The use of warm water in the first wash may lead to increase of bacteria that come from the field with the spinach, thus contaminating the equipment. Water should not be recirculated where a single washer is used.

Blanchers. Blanching equipment may be a source of spoilage bacteria, particularly those of the thermophilic group. To minimize the hazards of spoilage from this source, the washing and cooling treatments previously discussed should be applied. Occasionally rotary drum pea blanchers have been used, but as this type of equipment is diffiucl to clean there is opportunity for the development of spoilage organisms, resulting in continious contamination of the spinach. Spoilage has been traced to such a blancher and its use is therefore not recommended. The blanch water should be renewed at a reasonably rapid rate.

18. Bacterial count

Blanching has been dealt with at length because it is a most common and fertile source of high bacterial counts arising in baby-food manufacture. Such counts are indesirable for a variety of reasons:

(i) the production of metabolites from the foodstuff on which they grow which are undesirable from flavour, nutritional and toxicity points of view. Some of these metabolites are not destroyed or removed in subsequent processing and can therefore provide health hazards as well as making the food less acceptable to the palate and overall less nutritious.

(ii) high counts mean a requirement for more intensive processing (higher F_o values) and more intensive processing tends in itself to lower nutritive values (particularly protein and vitamins) and organoleptic quality. Failing this degree of processing, spoilage can become very much more frequent and this just must not happen.

19. So at all stages in baby food manufacture, bacterial counts must be kept as low as possible and in practice this means that the time during which all materials are kept at temperatures between 100°F and 175°F must be kept to the minimum. It also means that plant must be chosen and installed in such a way that very thorough and very complete cleaning is easy and that it is obvious when it has been done so that no areas can be breeding grounds for the growth of organisms.

20. Plant cleansing schedules, usually involving three stages:

(i) a warm chlorinated water rinse to remove the bulk of residual material

(ii) a hot water detergent + germicide wash

(iii) a steam and water lance sterilising wash,

are used, but these are subject to variance according to whether in-place cleaning or demount cleaning is used.

4.5 'Aluseal' or similar packing of baby food

1. General

The concept of packing baby food in small (30ml appros) aluminium packages has been considered at length and discussed with several manufacturers of form/fill/seal equipment including the Bosch group 'Aluseal' (German), the Formseal (Plastimechanique - French), 'Capsulit' and Cavanna (Italy), Industries Roure (Spain), Erca 'Prime Pak' (French), 'Gasti' (German), and Metal Box (UK), eight in all.

In principle this concept is quite possible - though nobody has yet implemented it so far as can be ascertained, certainly not for baby-food.

2. The nomenclature of the operation is that a thermoformable 'web' or sheet of material - aluminium foil, a foil laminate, or a straight plastic or plastic laminate, - is 'thermoformed' using custom dies into flat bottomed cups, dishes or other containers with either parallel or tapered sides; normally circular, oval, rectangular or square in shape though all shapes are possible including hexagonal, pentagonal, octagonal etc etc. In point of fact, 'thermo' forming is not necessary for straight aluminium foil, but in this particular context where subsequent hermetic sealing is necessary, it is essential to use a laminate (eg foil/polypropylene) and 'therm' forming immediately becomes essentail because the plastic element in the laminate must be properly heat-softened (or plasticised) before the cup can be formed. The 'backing' which is the cover over the cup, is likewise of aluminium foil laminated to polypropylene (but usually much thinner than the 'web') and this polypropylene

(or other appropriate plastic in the laminate which has appropriate temperature/plasticity characteristics) constitutes the basis for seal integrity during both pasteurisation and, more important, sterilisation.

3. Machines can be obtained which are form/fill/seal in which reels of 'web' and 'backing' are fed in, the cups are formed, filled and sealed and then dealt with as necessary.

Alternatively fill/seal machines which accommodate pre-formed cups can be used and these have a reel of 'backing' to enable final lidding or covering and sealing of product to take place.

4. So far so good, but at this stage we have to consider the problems involved in pasteurisation or sterilisation of the completed sealed packs, and this is the area which so far has been neglected because these packs have up to now been principally used for packing materials which required no further treatment (eg jams).

The 'dairy' area is excluded from this consideration because so far this has been an aseptic operation which is inappropriate in the baby-food context at the present time. In the future, when baby foods can be sterilised by a 'holder' system similar to that used for milk pasteurisation some time ago, or by the modern HTST system used for the present-day sterilisation of milk, aseptic filling and sealing of baby foods may be possible.

5. The seal and the foil/plastic barrier provided by the packs under consideration are perfectly adequate for suitable pasteurisation and sterilisation procedures and subsequent long-term (up to a year or two) storage of products. Furthermore, atmospheric steam pasteurisation of product is no problem, nor is steam + superimposed air pressure sterilisation of those products requiring such treatment. The problems mainly arise from:

(i) the deformability of the packs

(ii) the shape of the packs including particularly the projecting seal area

(iii) the number or rate of production of the packs

(iv) seal formation and seal integrity

In respect of (iii) it has to be remembered that about 4½ of these packs would be produced in lieu of 1 normal 4½ oz (130g) glass container, and that 25,000 - 30,000 per hour might have to be dealt with if full production were packed this way. Other problems are defined in Appendix II.

6. There appear to be two potential ways of dealing with the problem of: rate of output.

First using a wide web with a cross section of six, eight or even ten cups, filling, and sealing with an equally wide 'backing' and cutting this web into appropriate lengths so that in each length there were, say, 60-100 sealed cups or finished packs requiring only cutting or 'trimming' into individual units. These lengths of filled and sealed 'web' could be very conveniently passed through the pasteuriser or, as necessary, through the retorting sequence, each layer in the latter case being divided by a suitable divider or preferably, to avoid deformation, placed in a rack of trays of appropriate size to fit the available retort or steriliser.

(The ideal solution of course would be continuously to pasteurise or sterilise the continuous web coming from the form/fill/seal machine but this is very definitely in the not too distant future.)

Following pasteurisation or sterilisation the sheets of 'web' would be dried and then cut or 'trimmed' to provide individual units which would then be collated and packed in cartons and/or cases. The same principle could be applied to groups of 4, 6 or 8 units and these could eventually be sold as multiples to be 'united' by the purchaser.

7. Second, starting either from a fill/seal or a form/fill/seal machine producing, finally, individual packs, it would be necessary to collate the packs and fit them or place them in an appropriate tray or other tailored receptacle for convenient processing. They would stay in this receptacle throughout either pasteurisation or sterilisation, being finally dried in it before any handling took place. Eventually it is probable that in this system it would be necessary for manual filling packs into cartons and cases.

8. With both methods it would be essential, as always in sealed packs, for the packs to be untouched by hand until they were finally quite dry and at ambient temperature.

The whole of this form/fill/seal/pasteurise/sterilise/pack sequence has furthermore to be considered in the light of other technical and financial necessities or desiderata.

9. Packaging capacity would need to be married most accurately to production rate. Failure to do this very accurately and maintain it accurately would lead to either wastage of product (it must be packed and being processed within 30 minutes of emerging from the scraped-surface heat exchanger) or under-utilisation of the expensive form/fill/seal machines(s), of the retort capacity and of labour.

10. To do this when a variety of formuale are being produced, each with somewhat different characteristics and demanding individual attention to preparation of various mix components would raise sever management, labour and overall control problems. Furthermore, clean-down of a complex line of this type when changing from one product to another would be very much more of a problem than with normal glass-jar packing.

11. It is, however, a perfectly possible operation but one which would require continuous highly skilled engineering and maintenance services as well as the other skills mentioned above. To initiate it would require some pioneering, as this particular operation is not one to which direct previous practical experience can be brought - all, or practically all, the component know-how is available, but this particular concatenation has not before been put together.

12. It is not possible at present to cost a 'hypothetical' 'Alupak'-style line for comparison with glass jar packaging. In such a comparison the known capital and running costs of jar filler and capper and of packages and of subsequent operations of retorting/pasteurising and packing have at present only the firmly known cost of the form-fill-seal machine(s) to set against the total picture on jars. Until shape of pack, materials of pack, processing detail etc are firmly defined it is not possible to hazard a guess at comparative costs overall.

However, one can compare:

(i) the form/fill/seal machine capital cost for 1 ton/hr with the equivalent glass jar packaging machines cost for 1 ton/hr.

(ii) very roughly the cost in packaging material to pack 1 ton of material in glass jars and caps, or in aluminium foil/polypropylene laminate.

13. Label cost must be added to the jars: the backing foil for the aluminium packs is of course already printed on the reel and is an integral part of the cost.

It is assumed, in the absence of anything definite to the contrary, that the same type of retorts would be used either for the glass jars or for the alupacks and that numbers of retorts would be the same. But, this is most unlikely to be the case because:

(i) glass jars <u>must</u> be retorted under water and with air overpressure. Coming up time is extended to avoid thermal shock and similarly cooling time is extended for the same reason. Therefore retort capacity needs to be considerable because of the extended cycle time to achieve the appropriate F_o value in packs of considerable diameter and depth (over 5 cm each way). In contrast 'Alupaks' could be heated fast under steam and air, and cooled equally fast, so reducing coming up and cooling times most significantly. Besides this, because of the small dimensions of each individual pack, process time would be a lot shorter for a given F_o value so that total cycle time could easily be no more than half that for glass jars.

15 A further consideration arises in connection with 'Alupak' style of packaging. For 'junior' food, a larger pack than 30 g would be necessary, and this would require change parts (dies, filler parts or adjustment, trimmers, collating mechanism and trays or other containers for processing etc) if it were to be produced on this line. This would increase down-time in the plant - or at best, overtime for engineering staff.

16. However, despite all these provisos and qualifications the two cost comparisons are:

(i) Packing in glass or 'Alupak' at 1 ton/hr - costs of machines for glass is the sum of items 21,22, and 23 on the baby food schedule; cost of form/fill/seal machines around £360,000.

(ii) Package cost (ignoring label on glass and the carton for the Alupak) approximates to:

Glass containers & caps - £120/ton of product
Alupaks or equivalent - £200/ton of product

17. In view of the uncertainties surrounding marketing of baby food in this new format and also in view of the high plant cost and on-going maintenance costs of the plant, it is suggested that the best way of getting into baby food production and sale would be concentrating first on producing the time-honoured glass jar as the major volume line but at the same time having one 'Aluseal' or similar machine on an experimental basis able to produce about 100 packs a minute which could be dealt with relatively simply and on which experience of all kinds could be gained - manufacturing, maintaining, costing, selling etc. Becuase glass jar equipment is relatively so very cheap, little would be lost if it were little used after a year or two.

If 100 packs per minute is thought to be too low a production rate, there are of course other form/fill/seal machines with greater individual capacities.

18. It should further be mentioned that, by analogy with the 'sterilisable pouch' technology and practice, it has been found necessary at the present stage of development, always to protect the deformable pouch by putting it in a carton to ensure that deformation is not such as to endanger the integrity of the seal. This might well be found to be necessary with baby food packs, in which case the 30g packs would need to be packed in multiples (probalby 4, 6 or 8, all of one kind or assorted) in cartons. This would be a fairly considerable on-cost.

19. The state of development of the art of possibly producing sterilised 'Alupak' or equivalent is exemplified by an extract from a letter from Metal Box Ltd. who after referring to their successes with heat sterilisable pouches (an entirely different concept in scale, materials and overall cost which is very high per unit) say in respect of Alupak-style containers:

> "So far as heat retortable containers are concerned, our developments are not sufficiently advanced for us to engage, at this time, in commercial discussions. We will, however, be happy to talk to you about this in some 6 to 12 months time".

20. This reinforces the previous remark made that nobody has done this yet and until all the necessary de-bugging and general development work has taken place it could not be recommended. Once established, the provision of ancillary equipment to make the whole operation more efficient and automatic follows fast and the recent Stork development on sterilisers for the relatively new heat sterilisable pouches refers to this and is described in Appendix II.

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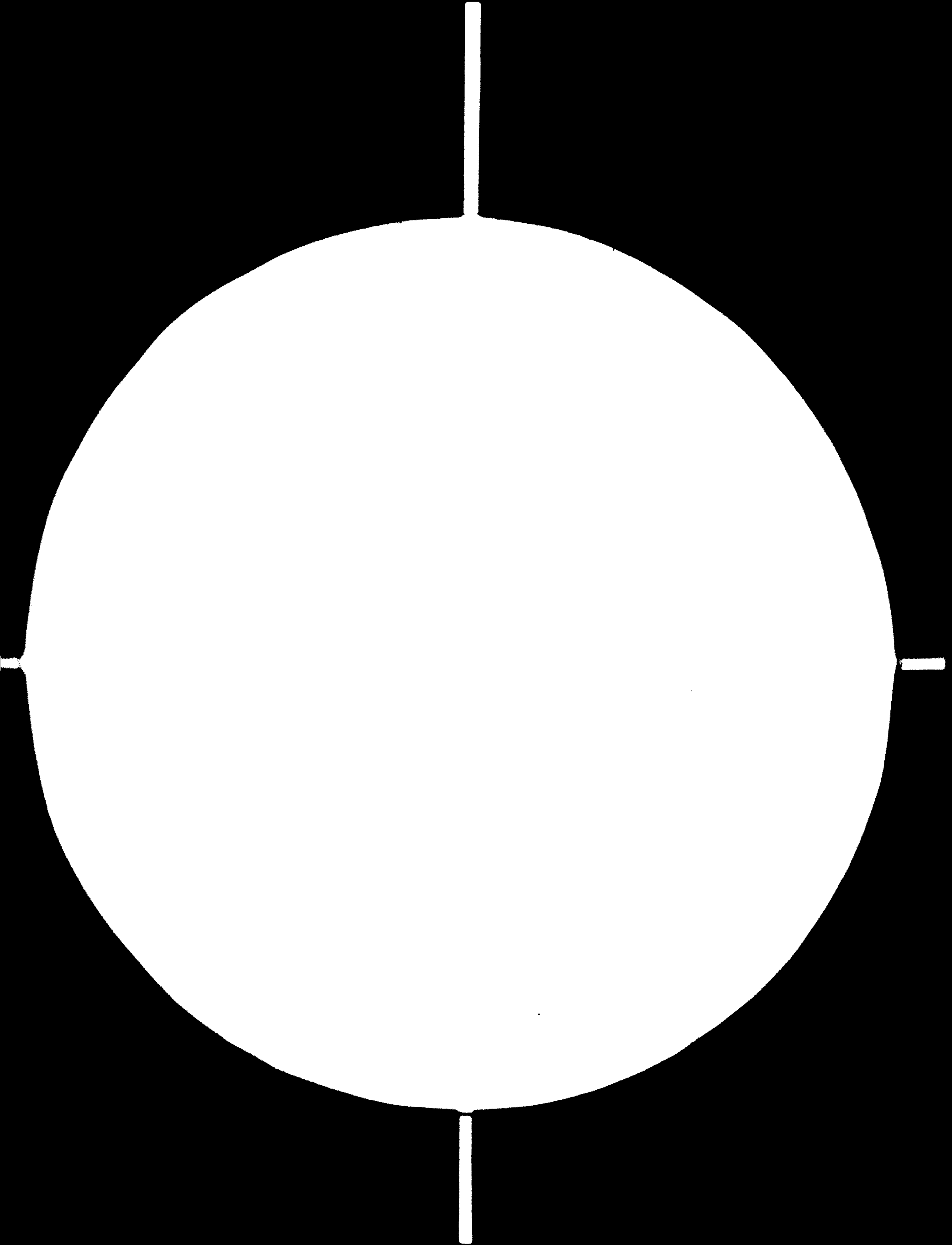

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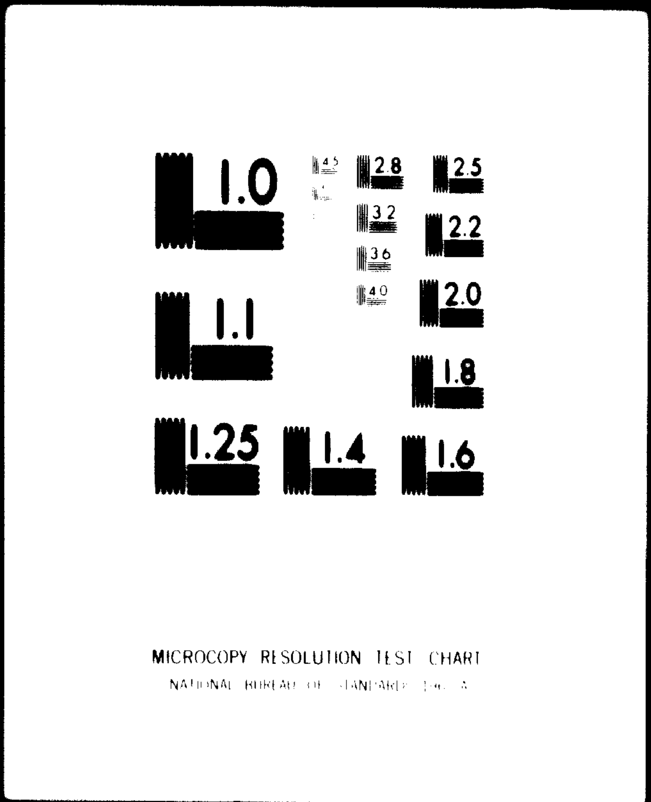

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4.6 Baby food formulae

1. Typical formulae of 2 or 3 years ago for baby foods are set out below, but some modification may be required in the light of most recent knowledge. (All raw materials except cereals and additives are cooked weights.)

Beef & vegetables

Beef	13 oz
Potatoes	12 oz
Carrots	12 oz
Peas (frozen)	4 oz
Onions	4 oz
Celery	2 oz
Pearl Barley	1 oz
Rice Flour	1 oz
Salt	½ oz
Monosodium Glutamate	8 grams

Beef stock (or water) to 4 pints

Yield 80 oz filling 18 to 19 standard jars

Mixed vegetables

Potatoes	1 lb 8 oz
Carrots	10 oz
Peas	6 oz
Celery	4 oz
Onions	3 oz
Pearl Barley	½ oz
Rice Flour	½ oz
Salt	½ oz
Sugar	½ oz
Monosodium Glutamate	15 grams

Water to 4 pints

Yield 80 oz

Apples

1 lb. of prepared (peeled & cored) apples yields 3½ - 4 jars of product.

Apples & Apricot

Approx. 50 : 50 purees give a satisfactory product.

Apple & Orange

Using a 4 x orange juice concentrate, the ratio of apple to orange is 4½ oz. apple puree + ½ oz. orange juice concentrate. Viscosity is adjusted with vegetable gum.

Ham & Carrot

Ham	20 - 30%	) According to strength
Carrot	70 - 80%	) of ham flavour

Veal Puree or Veal Dinner

Veal tends to be flavourless meat; therefore, it is not a good thing to mix it with mixed vegetables which "drown" its flavour. The basis for the veal formula, therefore, is veal + potato, suitably reinforced with a little onion and M.S.G.

Veal	45%
Potato	50%
Onion	5%

Liquid needs to be added to the mix (about 20 - 25%) to correct viscosity.

Chicken & Noodles

Cooked durum flour can replace the noodles here.

Chicken meat (puree)	40%
Cooked noodles (puree)	55%
Onion (puree)	5%

Liquid (about 20%) needs to be added - chicken stock or water.

2. **Processing variations**

It should be noted that though a specific time/ temperature in a retort for a given pack size of a product in which convection is not possible to any significant extent can be given to achieve a desired F_o value, such standardised conditions cannot be applied to all products and each one has to be considered separately. For example, whereas many products can be treated for a shorter time (eg 30 minutes) up to 121°C there are some (eg those containing egg and milk, possibly as custard) which deteriorate markedly if heated at above 105°C, and at this temperature commercial sterilisation in 4½ oz glass jars may take up to 1 hour.

3. **Storage of vegetables & fruits for baby food production**

We set out below the details of the requirements for many raw materials for processing.

Potatoes	-	about 7 months fresh, 5 months preferably canned (5 kg)
Carrots	-	about 5 months fresh, 7 months frozen
Peas	-	about 1 month fresh, 11 months frozen
Onions	-	about 6 months fresh, 6 months dried (powder, flake, etc)
Celery	-	about 4 months fresh, 8 months preferably canned (5 kg)
Apples	-	about 6-7 months fresh (according to varieties suitable) 5-6 months canned puree.
Orange	-	concentrate keeps well for up to a year
Apricot	-	about 1½ months fresh, 10½ months as canned puree

4.7 Proposed baby food plant layout

1. **General**

(i) The building chosen as most appropriate for the operation is that which is an extension of the factory Sanatorium and Office. It is approx 30m x 18m with a 10m x 6m extension into what is currently the laboratory/office end of the block.

(ii) It is proposed that this area should be divided into five parts;

(a) Packaging and other dry 'raw materials' area.
(b) 'Wet' raw materials preparation and cooking area.
(c) A pressurised filtered air area in which all processing and filling/sealing of foods would take place, and
(d) A final labelling, case packing and finished goods area.
(e) An air filtration and 'blowing' plant.

(iii) Areas (b) and (c) will require the provision of appropriately tiled floors with covered drain channels in the floors.

(iv) Area (c) will require to be clad, walls and ceiling, with either white tiles or stainless steel sheet -- a false ceiling will be necessary.

(v) Entry and exit of goods or personnel into area (c) will be via air-locks with automatic sliding doors operated either by photo-electric cell or by pressure pad, which are, of course, normally sealed. Windows into area (c) will be fitted.

(vi) Services necessary will be:

(a) mains water for raw material thawing, washing, cooking, jar washing and sterilisation etc
(b) chlorinated filtered river water for retorting and cooling and pasteurising
(c) steam at 100 p.s.i.
(d) electrical supplies in waterproof conduit and junctions etc
(e) compressed air.

2. Baby food production and packaging process

To be read in conjunction with Plant Layout diagram and Key to Equipment on Plant Layout at the end of this section.

All raw materials enter the plant washed, trimmed, peeled and/or stoned etc and ready for use. Raw materials, excepting cereals and supplements enter at (1) in appropriate S/S or plastic containers. Frozen materials too large for cooking directly are thawed as well as rinsed in (2). Rinsing and thawing tanks can have manual or automatic control of steam injection: raw materials should emerge at 20-25°C except such items as meat which have been pre-tempered to 25°F to facilitate slicing. Meat, at 25°F and above, is sliced (4) as are fresh root vegetables after rinsing. All raw materials other than canned are then placed in baskets (5) elevated on a monorail hoist and deposited in the appropriate cooker, (7) for meat, (8) for fruit or vegetables. Here the necessary amount of cooking takes place either in steam or boiling water normally at atmospheric pressure. Cereals entering at the alternate (1) are cooked in (9) which is provided with a permanent slow stirrer and a demountable high speed disintegrator/stirrer for suspending finely divided materials, and is tippable for contents to be poured into a basket or small tank.

3. The foregoing operations all take place in normal food factory conditions. The cooked ingredients plus rinsed and fully cooked canned ingredients are now hoisted (6) in their stainless steel baskets and pass on monorail through the automatic airlock doors operated by (11) into the area of the factory which is supplied with filtered air under a small positive pressure, is lined with tiles or stainless steel, and which is as aseptic as possible (outlined on the layout in heavy black).

4. Meat, plus some cooking liquor is tipped into the mincer hopper (13) fruit or vegetables go the pulpers (12). Minced meat is conveyed to (15), the colloid mill, and fruit and vegetables to mills (14). All milled products are 'finished' to the required fineness specification on (16).

Finished products, plus cooked cereals (weighed at (40)) and any necessary supplements (the latter pre-weighed into batch requirements) are weighed into a tank/hopper which is a part of but can be separated from (17) the weigher. The completed batch mix is elevated automatically and discharged into (18) the mixer. Following batch mixing and adjustment of consistency (water, gums etc) the mix is (19) pumped to a sieve and thence further pumped (21) to the (23) heat exchanger for rapid heating to filling temperature and passing to the (24) receiver tank. The filler (28) receives product from (24) and sterilised washed and hot glass jars from (25) and (26), via (27) an enclosed warmed conveyor, the jars are filled and pass to (29) the steam-flow capper which closes them.

5. All-fruit products are now conveyed to (34) the pasteuriser, then elevated (35) to the dryer (33) before passing out of the pressurised aseptic area to labeller (37) and case-packer (38) via the helical conveyor (36). All other products, needing retorting, pass from the capper (29) to the Busse crater (30) whence crates are elevated on a monorail overhead conveyor (6) before being lowered into (31) retorts. (NB Venting of retorts is to the open air but visible through a window.) After retorting and cooling in the retorts, crates are again hoisted on the monorail conveyor and deposited on (32) the Busse de-crater placed on the elevated platform on which the dryers (33) also stand. Jars pass from here through (33) the dryer and then, as for fruit products, to labeller (37) and to case packer (38). The area under the elevated platform and between pasteuriser and retorts gives appropriate storage and working space (39) for the crates and crate bogies.

If it is desired to hold prepared ingredients overnight, they must be immediately chilled, after finishing, to 4°C approx in (41) a brine cooled scraped surface heat exchanger, and then stored at just above 0°C in (42).

6. To avoid loss of filtered air, (43) nand 'interlocked door' airlocks are provided in cold store and for personnel entry.

Fire or emergency exists are indicated (44).

<u>Note</u> (1) No specific provision has been made in the line at present for 'Alupak' or similar packing by reason of the recommendations made on this subject.

(2) An optional small cold store for chilled overnight storage of finished raw materials has been outlined but it would additionally require a brine-cooled heat exchanger to cool hot finished ingredients before storage.

7. <u>Staffing of baby food plant</u>

Section I

<u>Raw materials reception, slicing, cooking and transfer to filtered air area</u>

Wet raw materials in 20 x 50 Kilo original containers to be handled each hour	1 man
Handling and supervising rinsing and thawing	1 man

Raw materials reception, slicing, cooking and transfer to filtered air area (contd.)

Slicing and cook-basket filling	1 man
Cooking and transfer of materials to filtered air area	1 man
Dry raw materials in, weighing etc	1 man

Section II

Filtered air area

Pulping, milling and finishing and transfer to weighing operative	2 men
Batch weighing and transfer to mixer	1 man
Mixing sieving and heat exchange - up to filler	1 man
Filling and capping (supervising)	1 woman
Pasteuriser and dryer - automatic - requires no personnel	
Crating, de-crating and retorting (3 crates each ½ hr or so)	1 man
Labelling and case-packing	2 persons
Goods out - general	1 man

Filtered air area (contd.)

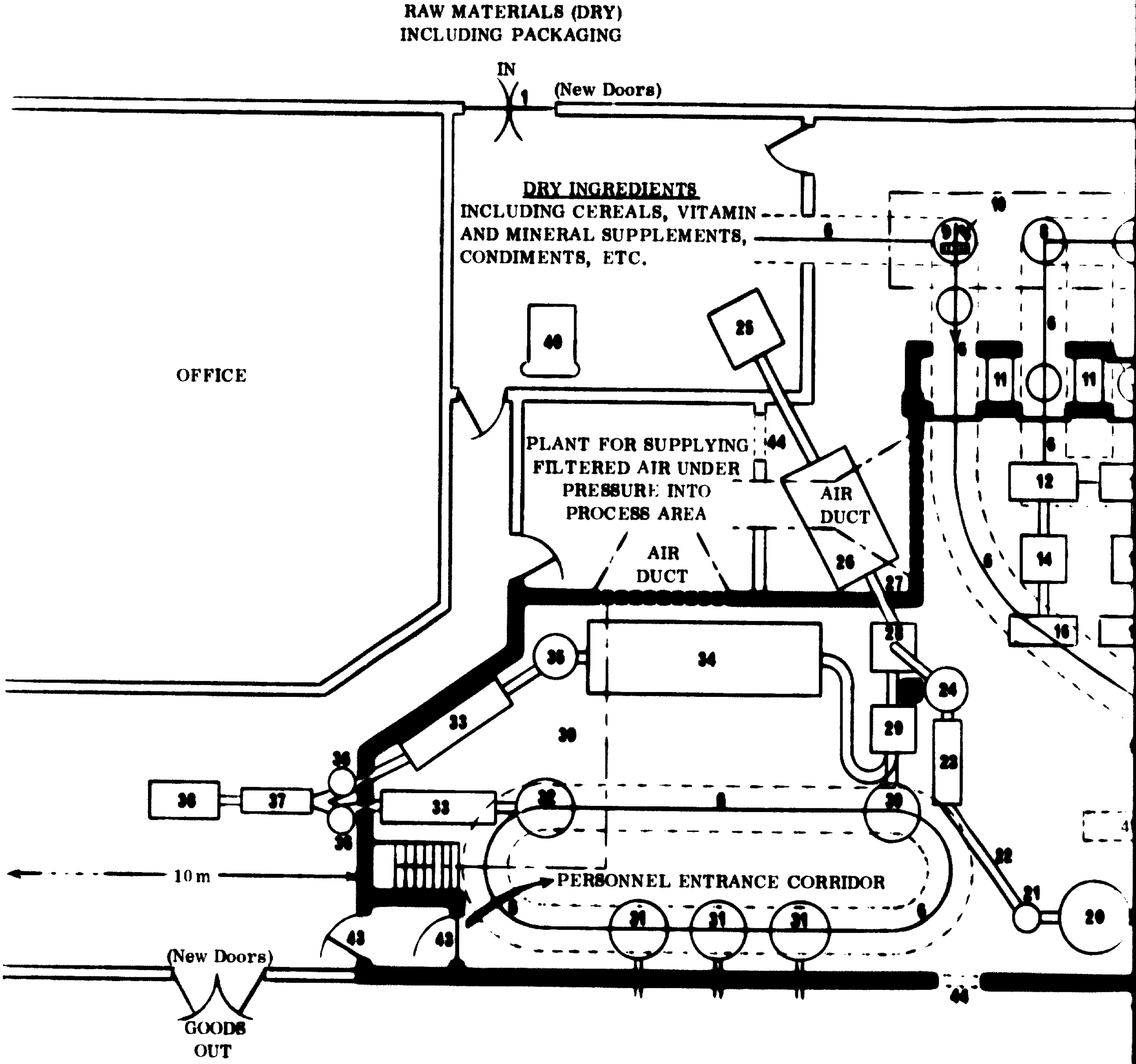
Plant Manager	1 person
Deputy Plant Manager	1 person
Maintenance and adjustment engineers	2 men
Quality control	1 man
	19 staff (including 2 or 3 women)

General cleaning services are extra.

All of those on specific duties have the responsibility of cleaning down plant in their charge.

Key to Numbered Equipment on Baby Food Plant Layout

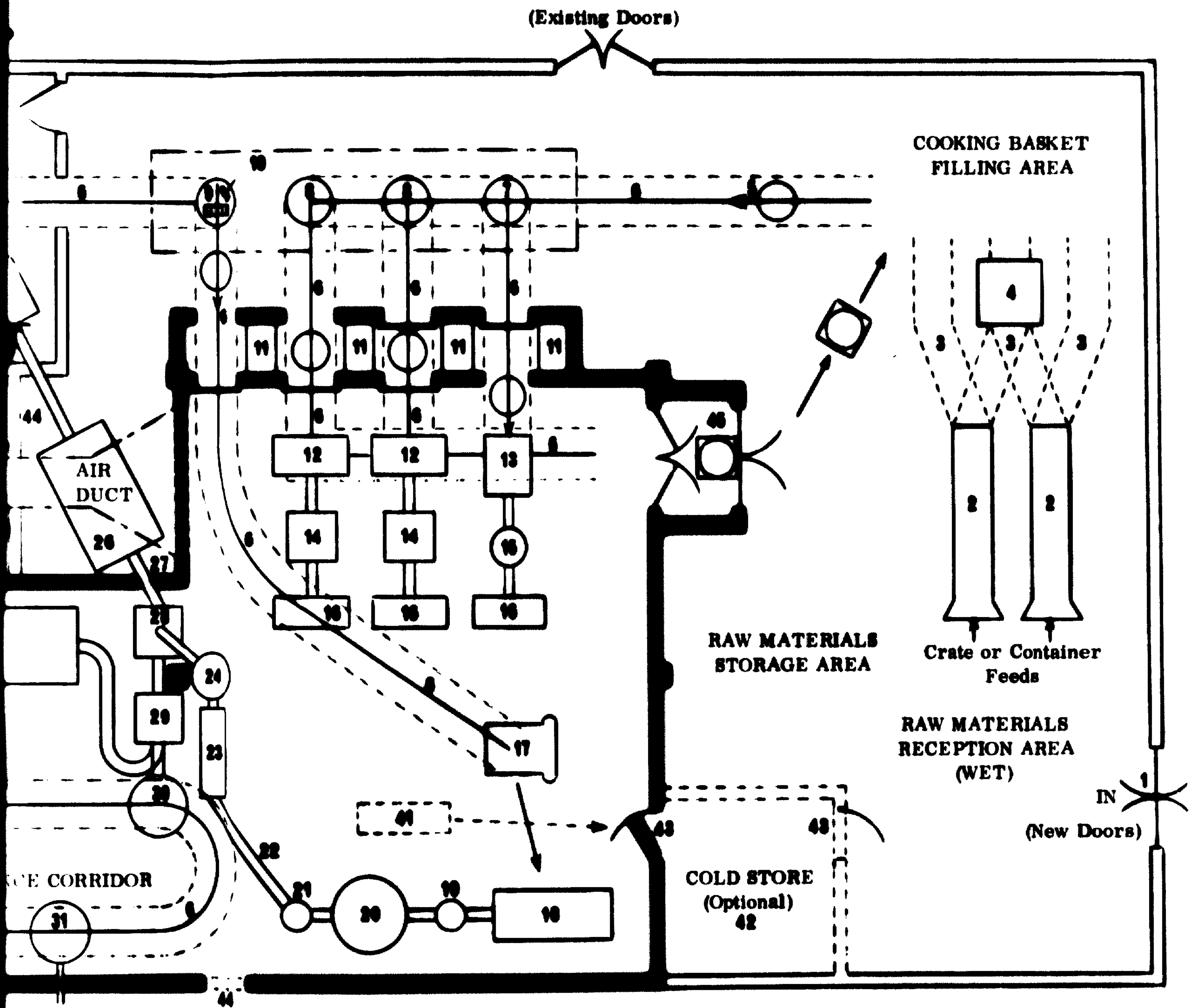
1. Self-closing heavy rubber doors
2. Rinse/thaw conveyor tanks
3. Conveyors
4. Slicer
5. S/S Cooking basket (filled)
6. Overhead conveyor (rail and hoist type)
7. Cooker for meat
8. Cookers for fruit and vegetables
9. Cooker for cereals etc with normal stirrer and optional high-speed stirrer
10. Extractor hood over cookers
11. Automatic door operating mechanisms for airlock doors (fail-safe)
12. Pulping machines
13. Mincer (for meat)
14. Mills (for fruit and vegetables
15. Colloid mill (for minced cooked meat)
16. Finishers
17. Weigher with 'elevating tank' weighing vessel
18. Mixer (ribbon or paddle)
19. Low pressure pump
20. Sieve (Russel or Apex type)
21. Pump (to supply pressure needed in S/S heat exchanger)
22. Under floor or overhead piping permitting personnel corridor
23. Scraped surface heat exchanger (steam heated)
24. Receiver tank
25. Glass jar de-palletiser
26. Jar washer and steriliser
27. Heated, enclosed conveyor
28. Filler with header tank
29. Capping machine (steam flow)
30. Busse crater
31. 3-crate vertical retorts with external venting, fitted for sterilisation under water and superimposed air pressure; venting visible through window
32. Busse de-crater
33. Jar dryers
34. Pasteuriser
35. Elevating conveyor
36. Helical conveyors (down)
37. Labeller
38. Case packer
39. Elevated staging providing storage/working space for Busse crates below
40. Weigher station for dry additions to batches or to cookers
41. Optional scraped surface heat exchanger (brine cooled)
42. Optional cold store (4°C) for overnight storage of prepared ingredients
43. Airlock doors with nand interlock ('nand' - computer term: both doors cannot be open simultaneously)
44. Fire exits (emergency)
45. Self-closing rubber doors - exit for empty cooking baskets



SECTION 1

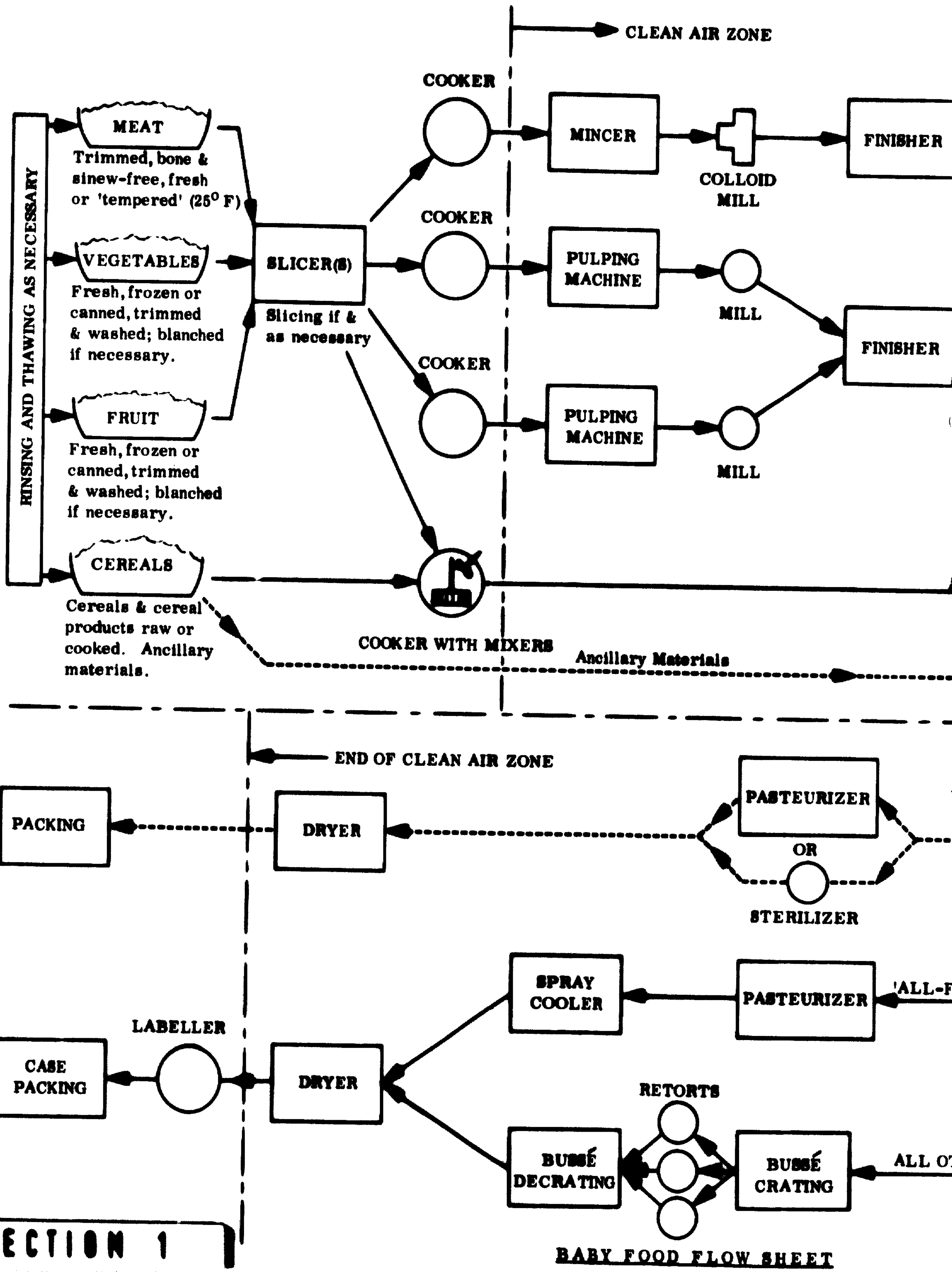
PROPOSED BABY FOOD PLANT

Scale 1:100

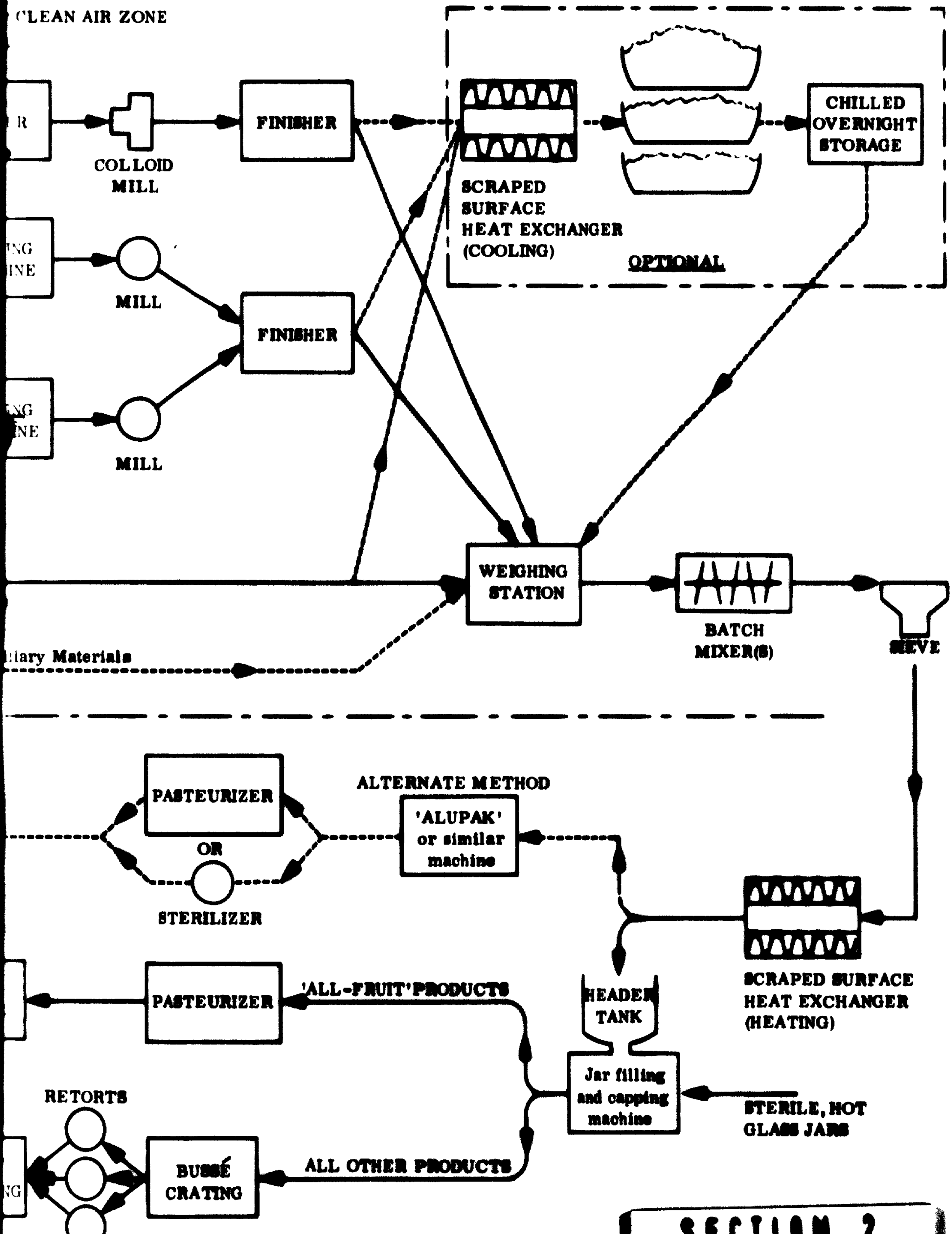


SECTION 2

PROPOSED BABY FOOD PLANT LAYOUT

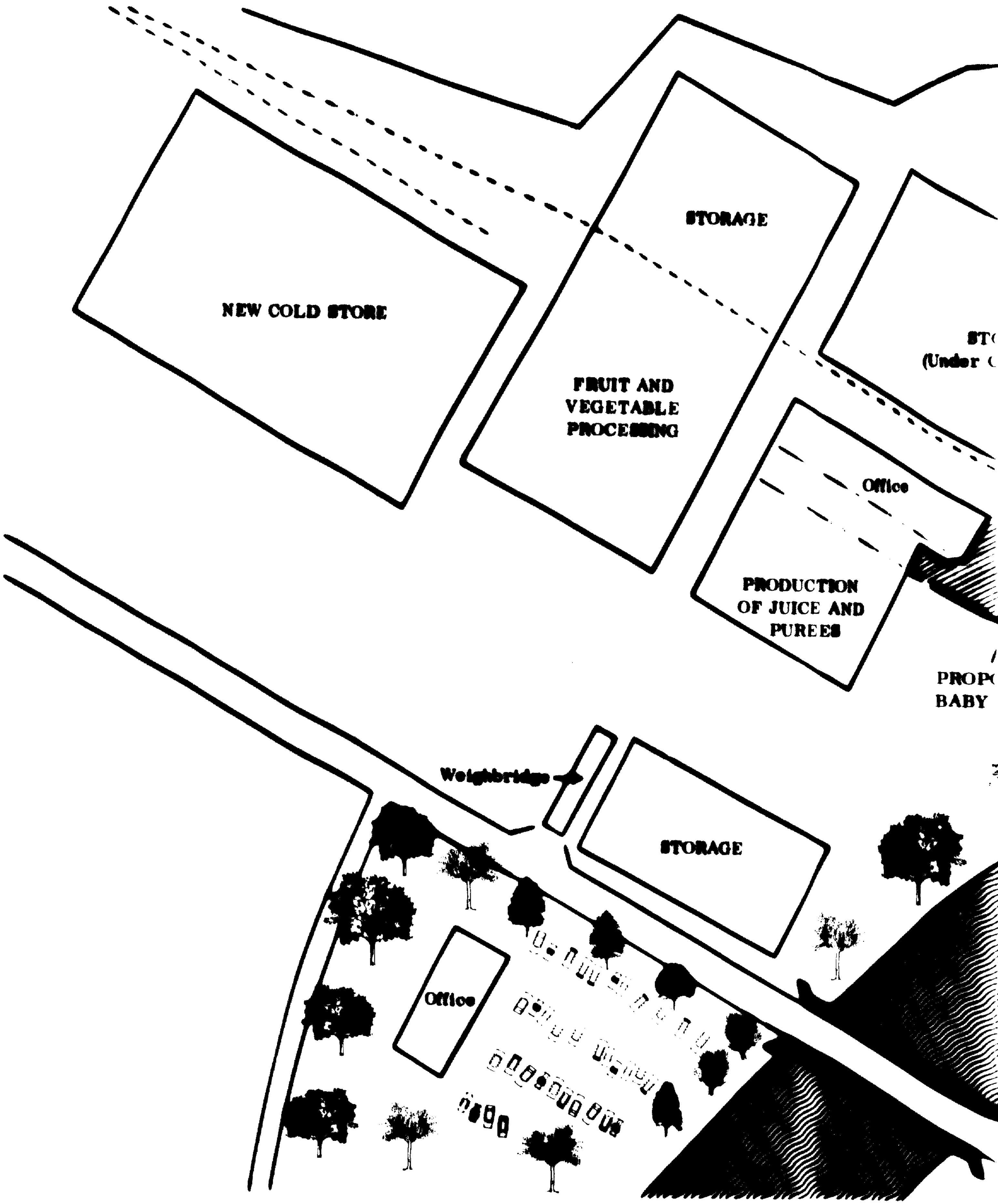

CLEAN AIR ZONE
COOKER
COOKER
COOKER
RINSING AND THAWING AS NECESSARY
MEAT
Trimmed, bone & sinew-free, fresh or 'tempered' (25° F)
VEGETABLES
Fresh, frozen or canned, trimmed & washed; blanched if necessary.
FRUIT
Fresh, frozen or canned, trimmed & washed; blanched if necessary.
CEREALS
Cereals & cereal products raw or cooked. Ancillary materials.
SLICER(S)
Slicing if & as necessary
MINCER
COLLOID MILL
FINISHER
PULPING MACHINE
MILL
FINISHER
PULPING MACHINE
MILL
COOKER WITH MIXERS
Ancillary Materials
END OF CLEAN AIR ZONE
PACKING
DRYER
PASTEURIZER
OR
STERILIZER
SPRAY COOLER
PASTEURIZER
'ALL-F
LABELLER
CASE PACKING
DRYER
RETORTS
BUSSÉ DECRATING
BUSSÉ CRATING
ALL O
BABY FOOD FLOW SHEET

SECTION 1



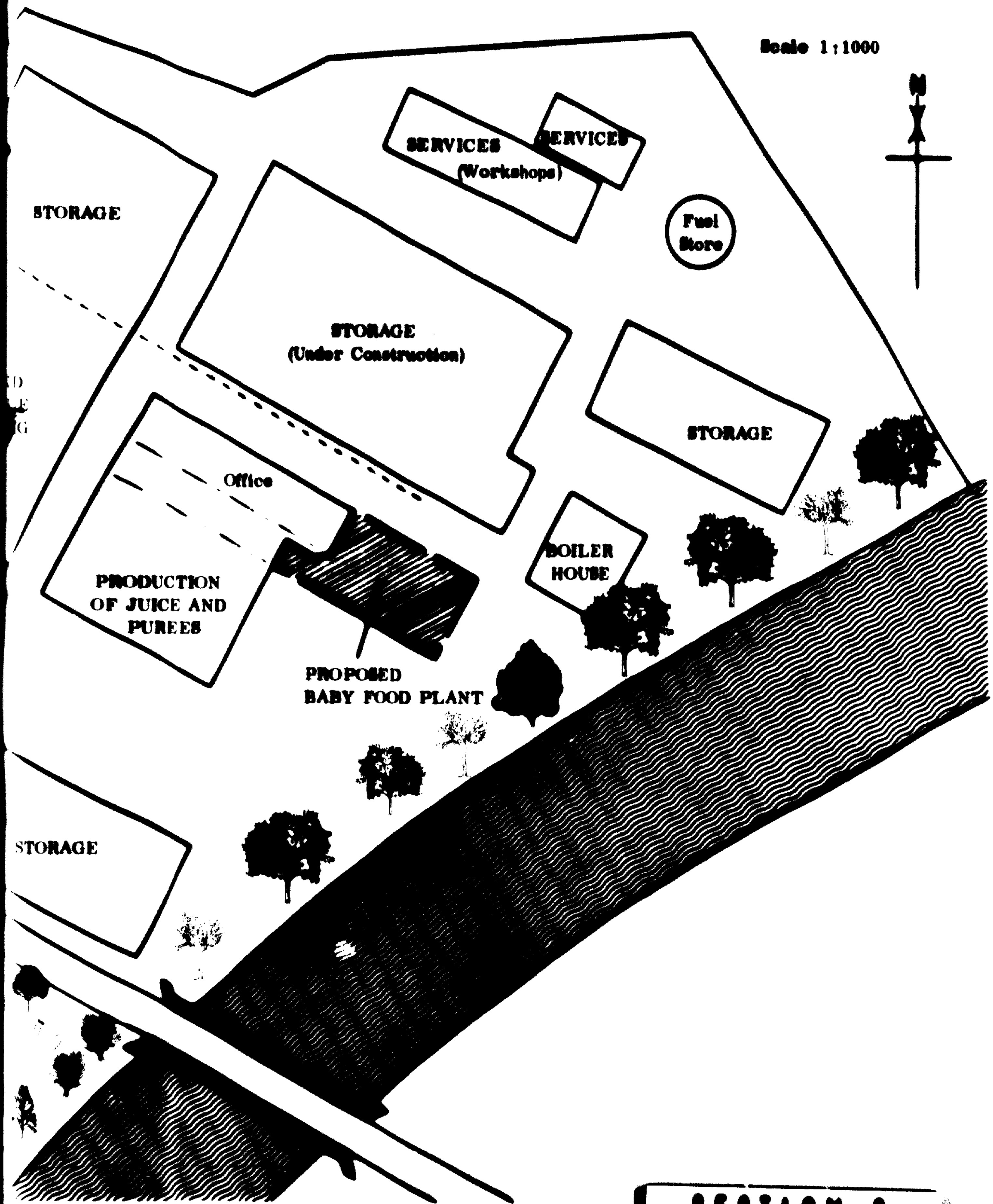
Y FOOD FLOW SHEET

SECTION 2



SECTION 1

VITAMINKA FACTORY SITE ...... BANJA



SECTION 2

FACTORY SITE ...... BANJA LUKA

4.8 Financial and economic analysis

1. Explanation

The full workings and explanations are set out in detail in Appendix IV at the end of this report.

The Baby Food Line is likely to involve an expenditure of not less than $455 thousand with a further $100 thousand in the sixth year.

2. While inflation is bound to continue during the period of the investment all workings are at current values. The assumption is that increased costs will be offset by increased prices.

3. Ex-factory prices

At this stage it is very difficult to deterimine the likely selling price of the baby foods and therefore the analysis has been worked on ex-factory prices. Retail price would have to include delivery, marketing expenses, wholesalers margin, and retail margin - in all adding up to not less than 100 per cent of ex-factory price.

Ex factory price is calculated to be $1400 per ton and would include production of small 120 gram and large 200 gram jars in the ratio 3:2. This would indicate individual ex-factory prices of:

Small jar	$0.168
Large jar	$0. 28

With our current level of knowledge we consider these prices to be in order.

4. Cash flow

In table 4.1 we set out the full cash flow for a ten year period. It will be seen that the flow becomes positive in the seventh year. The greatest deficit occurs in the second year. It should be noted that no provision has been made for any increase in working capital which in practice will be necessary.

5. The discounted cash flow analysis in table 4.2 gives an internal rate of return of 14.52% which at this stage indicates that the project should be considered acceptable and detailed workings planned.

6. Before the final analysis in undertaken a test marketing operation with imported baby foods would help - amongst other things to determine the likely retail price.

Table 4.1

Baby Food Line - Cash Flow 10 Years

$ '000

Expenditure and Income	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Expenditure -										
Fixed costs:-										
Management expenses	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0
Rent of factory	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Maintenace	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Variable costs:-										
Raw material	235.4	470.8	706.2	706.2	706.2	706.2	706.2	706.2	706.2	706.2
Productive labour	52.2	52.2	52.2	52.2	52.2	52.2	52.2	52.2	52.2	52.2
Power costs	2.3	4.7	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Packaging costs	275.0	550.0	825.0	825.0	825.0	825.0	825.0	825.0	825.0	825.0
Contingency	270.0	270.0	270.0	270.0	270.0	270.0	270.0	270.0	270.0	270.0
Capital expenditure	455.0					100.0				
Total Expenditure -	1,394.7	1,400.1	1,912,8	1,912,8	1,912.8	2,012.8	1,912.8	1,912.8	1,912.8	1,912.8
Ex factory income +	700.0	1,400.0	2,100.0	2,100.0	2,100.0	2,100.0	2,100.0	2,100.0	2,100.0	2,100.0
Net cash flow	(694.7)	(0.1)	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2
Cumulative cash balance	(694.7)	(694.8)	(557.6)	(320.4)	(133.2)	(46.0)	141.2	328.4	515.6	702.8
	-	-	-	-	-	-	+	+	+	+

Table 4.2

DISCOUNTED CASH FLOW ANALYSIS

Net cash flow		DF 14%	PW	DF 15%	PW
Year 1	(694.7)	.877	(609.25)	.870	(604.39)
2	0.1	.709	(0.08)	.756	(0.08)
3	187.2	.675	126.36	.658	123.18
4	187.2	.592	110.82	.572	107.08
5	187.2	.519	97.16	.497	93.04
6	87.2	.456	39.90	.432	37.67
7	187.2	.400	74.88	.376	70.39
8	187.2	.351	65.71	.327	61.21
9	187.2	.308	57.66	.284	53.16
10	187.2	.270	50.54	.247	46.24
			13.70		(12.50)

Internal economic return $= 14 + 1 \left(\frac{13.70}{26.20}\right)$

$= 14.52\%$

DF = Discount factor

PW = Present worth

V THE JAM MAKING OPERATION AT VITAMINKA

5.1 General

1. A distinction must be made between the two basic types of 'jam' produced in Yugoslavia, jam being loosely defined at this stage as a material containing approx 6% of fruit solids and approx 61% of sucrose or other added sugars. The two types are 'jam' produced principally from fresh or suitably preserved whole or nearly whole fruit, and 'marmelada' produced entirely from fruit puree whether fresh or preserved (frozen or SO_2) and/or pre-concentrated or not.

2. EEC Regulations

Under the new EEC regulations it is proposed to have within the EEC two basic grades of jam - the normal made with a minimum 30 - 35% fruit and the superior or 'Extra' with a minimum of 45 - 50% fruit. This definition will necessarily be modified in some instances where fruit is of particularly high solids and/or flavour concentration - eg it is very difficult to produce a satisfactory jam with more than 25% of blackcurrants.

3. These two classifications - Yugoslav and EEC - have little in common except that the final total solids content of the jams is around 67 - 68%, implying a minimum total sugar content (including fruit sugar) of around 64 - 65%. However, the wide variability of jam composition, jam set, fruit concentration etc etc throughout Europe at present means that Yugoslavia is fundamentally no more out of step with the proposed EEC regulations than many other countries, but in view of these forthcoming regulations would be well advised, for export purposes, to adhere to the proposals once they are finalised.

4. **Keeping quality**

There are proposals also for a 60% or less total solids jam which could well have a fresher fruit flavour, but would be of inferior keeping quality and liable in many circumstances to a high level of spoilage unless preservatives were included. A commonly used alternative here is to direct that jams be kept refrigerated after opening, but this is not always possible.

It is likely that in the higher grade EEC jam the use of fresh or frozen fruit only will be allowed, though canned fruit is an alternative used in some instances (eg apricot) and may qualify.

5.2 Raw material

1. Our original brief was to advise on the setting up of a jam-making facility at Vitaminka; in the event we must now review and comment on the relatively newly installed facility, its relationship to market needs, and on whether any extra facilities are thought to be necessary.

2. **Market requirements**

In the first place it must be said that in Europe the market for low grade jams is declining: the demand is for higher quality at a higher price. Higher 'quality' involves as high a fruit content as is necessary to achieve the desired flavour, colour and texture which best meets consumer preference, but above all it demands characteristics in the fruit and the way in which the fruit is used which over-ride and are more important than any detail in processing or in the other jam ingredients.

Because strawberry and cherry jam were observed being made, and because strawberry is by far the most difficult of the two in achieving top quality, it will be dealt with in detail as the example.

3. **Fruit quality**

For producing a top quality jam the choice of cultivar (or cultivars, as mixtures are frequently used) is all important. No added artificial colour will be permitted in EEC 'Extra' jams, and therefore the jam colour will basically be a reflection of the colour of the fruit used - likewise flavour will be characteristic of the variety or varieties used. But, epitomising the highest quality, the factor of ripeness and freshness is all-important. If over-ripe or bruised or otherwise damaged, fruit will not remain in large pieces (or even as intact berries) on jamming: if under-ripe it will lack colour and flavour. Furthermore, it should be graded for size to provide a uniform appearance and for ease in plant operation. The amount of handling, washing etc must be quite minimal and very gentle if fruits are to remain substantially intact. Blemished fruit must be rigorously excluded on the inspection tables.

4. It therefore comes down to the fact that the raw material for jamming is all-important because without detailed and accurate control of raw material to ensure its total suitability for the purpose intended, no plant or technique refinements will be able to compensate for any deficiencies in raw materials.

An additional necessity for the fruit to be used is that insofar as it is possible it should be satisfactory for freezing and capable on thawing of producing a jam substantially indistinguishable from that produced from fresh fruit - this effectively to extend the jamming period for the particular product. With some fruits (eg apricots) this is not currently possible except by canning them.

5. It follows from the foregoing that it is virtually impossible to produce really top-quality consistent jams from fresh fruit grown 400 Kms away; such production will not be possible until detailed control of much more local production is arranged. This principle applies throughout all fruit and vegetable preservation - all fresh raw materials should be produced if possible within a very few kilometres of the plant if highest quality standards are to be achievable. Only then can it be harvested and processed in part or wholly at the point at which all characteristics are optimum for the use to which it is to be put.

6. Quality of Vitaminka products

It is obviously an individual and local policy decision dependent on local market conditions and other factors as to whether and when this rule is broken but it can normally be done only in respect of product destined for the domestic or similar market. The fact that a very good strawberry jam, somewhere midway between normal and top-class, is being made at Vitaminka must not be allowed to cloak the fact that it cannot at present compete with several of the top-class specialist producers such as Elsenham and Tiptree whose products command premium prices everywhere.

7. **Fruit harvesting**

The escalation in costs of hand picking of fruit may force machine harvesting, with consequent loss of quality and limitation of cultivars suitable for such harvesting; insofar as hand picking can be retained in Yugoslavia it could be a significant advantage.

8. It should be noted that a prototype machine for harvesting strawberries has just been tested for the first time (June 1975) in the UK. It was promising but not applicable to all cultivars. Very much less promising was a de-stalking machine - a modified strigger - in dealing with strawberries.

5.3 Processing at Vitaminka

1. **Fruit handling**

No comment is necessary on the fruit reception, washing and inspection facilities except that it appeared that too little attention was being paid to the relatively delicate nature of the strawberries in general handling. Cherry stemming and pitting was satisfactory. The impression was gained that additional training for operatives would be necessary to initiate and maintain the very high standards necessary for top quality jam production.

2. **Vacuum pans**

The jam-making operation was standard except that 5 vacuum pans each of 1000 kg capacity and producing 700 kg batches of jam were in use instead of normal boiling pans and that this production was all pasteurised. Total batch production or cycle time (excluding pasteurisation), 1 hour. Assuming an actual production of 6 hours per 8 hour shift, then annual production based on 250 days, single shift, could be in excess of 5000 tons whilst multi-shift working would given a potential capacity of 15,000 tons or more.

3. The wisdom of the use of vacuum pans for jam production was queried in our original proposal and the additional expense involved in purchase and operation of this system is still, in retrospect regarded as probably unjustified. The original reasons for the use of vacuum euqipment in the jam making context were to:

- make jam of 60% solids so providing a yield increase of around 10%
- make jam of 'fresher' flavour than normal 67/68% solids jam
- preserve whole fruit structure more easily than in normally boiled jams.

The pre-requisite for making such jam was very clean fruit of excellent quality - in the presence of heavy bacterial and mould contamination 60% solids jams made at low temperature can have an unacceptably high spoilage rate. In any case, keeping quality of such jams once opened is very low. Pasteurisation of such jams introduces another process and makes exceedingly difficult the fruit suspension problem - the sooner the jam sets, the less opportunity there is for fruit to rise to the surface or sink to the bottom, and pasteurisation lengthens setting time inordinately.

4. In the event we find at Vitaminka that jams of normal solids concentration are being made in the vacuum pans so that there is no yield bonus; an additional process (pasteurisation) is found necessary because 'boiling' temperature in the vacuum pans is too low effectively 'commercially' to sterilise the product, and additionally there are or can be settling out or floating fruit problems. It is for the above reasons - among others - that vacuum pan jam manufacture in Western Europe has been almost entirely abandoned after the initial enthusiasm for it a few years ago - the extra costs are not commensurate with any gain of quality there may be.

5. Residual SO_2

One of the 'other' reasons for the abandonment of vacuum pan jam production in Western Europe is the major one of flexibility in use of raw material: fresh and frozen fruit is suitable for vacuum jam production but sulphited pulp is not unless a specific de-sulphiting operation is carried out first (boiling in water for a sufficient time under atmospheric pressure before the fruit goes to the vacuum pan for jamming). The vacuum jam process leaves an excessivly high SO_2 residue in jam unless this is done, and the statutory SO_2 limit (100 ppm in England but less elsewhere and in course of reduction everywhere) may well be exceeded.

6. **Skill in jam making**

A possible point in favour of vacuum pan jam making is the fact that a more consistent quality of product may be made by relatively unskilled labour when compared to atmospheric pan boiling, but first class operator skill is essential always to produce a first class product.

7. The world's topmost quality jams are still made, with loving care, in open boiling pans, because jam making like most of the commercial processes which have derived originally from the kitchen, is still just as much an art as a science. Eventually, jam quality is much more a function of the quality of the fruit used and the skill and care used in making the jam than the actual plant used in the manufacture. The argument could be used that where skills are lacking the more sophisticated process minimises the skills necessary to achieve a reasonably satisfactory product. But nothing can compensate for skills and know-how when it comes to making top-class product, and experience has shown as metioned above that in the long run the open boiling pan is still the best - and the cheapest - way of actually making the finest jams.

8. Other utilisation of vacuum pans

Before leaving the subject of vacuum pan making of jams, however, there are two ways of utilising such pans to get practically all the advantages of the vacuum pan without the subsequent necessity for pasteurisation and the many disadvantages which pasteurisation involves - financial (plant and process cost), product-wise with delayed set of jam etc. The first of these may also assist with the above-mentioned residual SO_2 problem.

9. If the boiling is started without vacuum so that initial boiling temperature is over 100°C, the necessary degrees of sterilisation is relatively quickly achieved. Then full vacuum can be employed until the end of the boiling at which time the vacuum is reduced to achieve a minimum temperature of 72°C at which temperature the jam is filled and then cooled. No pasteurisation is necessary or desirable. This particular method is indeed essential in making blackcurrant jam in vacuum pans to burst the currants and so prevent subsequent hardening and shrivelling of the currant skins.

10. Alternatively, the jam can be boiled as at present, but reducing vacuum for a short time at the end of the boil to raise the temperature to 78 - 82°C and fill at about this temperature. Again no pasteurising is either necessary or desirable.

In both cases viscosity can be controlled (assuming adequate pectin of correct grade and speed of set has been used) by pH adjustment.

11. Either of these methods could secure, eventually, a more acceptable jam - particularly in respect of fruit distribution - than the present method of operation, at the same time eliminating the need for pasteurisation and economising on production costs.

5.4 Proposed development

1. Objectives

Before making any further recommendations on the jam front it is necessary to consider the three current 'jam' objectives of Vitaminka:

- to produce 'diabetic' jams

- to produce jams of the very highest class in which the price constraints of normal jams do not apply, so overcoming the transport cost and high local sugar price barriers which otherwise would make them un-competitive.

- to produce low-calorie, low-sugar jams.

2. 'Diabetic' jams

Jams for the use of sufferes from diabetes are identical with ordinary jams except that in most cases sucrose is replaced by sorbitol. Total solids are normally still 67 - 68% and total 'sugars', by refractomater, are of the order of 64.5 - 65%. If such jams are felt to be not sweet enough (sorbitol has only about 60% of the sweetness of sucrose) then it is nowadays considered to be permissible to add a proportion of fructose which has around 140% or more of the sweetness of sucrose, w/w. Alternatively, 'low sugar' jams made with fructose and similar to other low-sugar, low-calorie jams are sometimes offered to diabetics.

3. No sucrose, glucose or invert sugar should be used in diabetic jams. Because normally in any one family there is only one diabetic, the unit pack size is frequently 125g - 130g and only relatively rarely more than 250g. This is for three good reasons:

(i) the cost of sorbitol makes the product much more expensive than ordinary jam

(ii) spoilage takes place after a time as with normal jams and is to be avoided both from cost and quality angles, and

(iii) the scale of production is so small that unit size needs to be small to achieve appropriate distribution.

We are also due to consider the use of 30g unit packs in the diabetic jam context.

4. Frequency of diabetes

The incidence of diagnosed diabetes is around ½ - 1% of the population and therefore the maximum potential market in Yugoslavia is provided by only approximately 200,000 persons. This market will demand a variety of kinds of jam. It is therefore regarded as inappropriate to manufacture diabetic jams in the large vacuum pans in batches of 700 kilos finished weight at 1 batch per hour; the small open pan method for the relatively much smaller requirement is very much more appropriate. In fact even if diabetic jams are consumed to the same extent in Yugoslavia as in England, the potential tonnage required in Yugoslavia will be only 180 - 190 tons p.a.

5. In any case, the diabetic jam line should be a separate entity from the current normal jam line, requiring as it does a completely separate and distinct filling and packing line. At the same time it would be convenient if it were adjacent to the existing line because it could draw fruit supplies from those which are being received, inspected, washed etc for the manufacture of normal jam. The line will therefore require a sorbitol syrup tank with metering pump, leading to the batching tank in which batches are prepared; a blow over tank feeding the jam boiling pan or pans; a jam reception tank (agitated), a swash plate tank fitted with a slow speed agitor, and appropriate feed from this tank to the header tanks on the glass-jar filler and capper and/or to the Aluseal (or similar) single portion filler and sealer. It will also be necessary to have a feed from the pectin make-up tank on the main jam line to the batching tank or to have a separate pectin tank.

(NB The proposal to use a blow-over tank at this stage in lieu of an open tank and pump is to avoid fruit damage particularly in view of the potential alternate use of this line for very high quality jams.)

6. Potential consumption

The nominated diabetic jam production is 1,000 tons p.a. (or 4 tons/diem on an 8 hr shift per 250 working days), equivalent to 5 kg of the jam being bought and consumed per annum by every diabetic person in Yugoslavia. This is nearly ½ kg per month or one 125 gram pot per week, which we would regard as a very optimistic potential rate of consumption.

7. Line utilization

However, this proposed 4 ton/day rate of production (250 working days) could easily be accomplished by the following arrangement on one-shift working. This plant when not in use for making diabetic jam would be ideal for the manufacture of the highest class jams, and in fact has been designed to be dual-purpose.

8. Plant required

The proposed additional line would comprise the following:

Sugar and sorbitol (and possibly fructose) make-up and storage tanks; pectin make-up tank.

Weighing station - a 0 - 100 kg platform scale with weighing tank, a circa 160 litre batching tank; a blow-over vessel c. 150 litres; 3 slow-boiling pans each of c. 180 litre brim capacity; canopy for boiling pans with exhaust system; single batch jam receiving tank with agitator; one 4/5 boilings swash plate tank; steel work staging to carry boiling pans and receiving tank to provide gravity flow, pans → receiving tank → swash plate tank; one large bore pump to convey jam to header tanks on fillers:

The calculations supporting this recommendation are:

Finished capacity of one boiling pan	= 100 kg +
Number of boilings required per day	= 50
Time required per boiling	= 20 minutes
Time required per daily production = $\frac{50 \times 20}{60}$	= 16.7 hours
Add additional 20% for down-time, charging etc	= 4.3 hours
Total boiling time required	= 21 hours

9. Three pans will therefore produce 5 tons of jam per day in 7 hours boiling time. This gives a margin over the basic requirement of 4 tons/day but with only two pans there would be significant under-capacity.

10. The reasons for special detail of this recommendation are:

(i) elevation of pans and jam reception tank to minimise pump damage to finished product whilst specially vulnerable; blow over tank to accomplish the same to fresh or preserved fruit component(s) of the boiling mix.

(ii) stirred jam receiving tank to permit (a) blending of 70% sorbitol, fructose, or sugar syrup for cooling the jam, and (b) the blending in of fresh or frozen fruit puree and other ingredients if required for extra flavour and quality, and (c) adjustment of pH and incidentally of setting characteristics.

(iii) swash plate tank holding 4 or 5 boilings with water (hot or cold) jacket to gently keep the jam mixed and to stop fruit separation prior to filling, to act as a buffer tank between boiling and filling, and to maintain and control accurately the temperature of the jam close to the ideal filling temperature even if there is a breakdown in the filling line.

11. **Jam filling**

5000 kg of jam = 40,000 units @ 125 g

Therefore filling speed required for 5.6 hours filling (ie 7 hours less 20% down-time) is 120 units of 125g/minute and this would demand, for example, a 4 or preferably 6 station Pfaudler carousel or rotary filler. The same filler could, with change parts, readily cope with, for example, a 250g or a 375g fill of very high quality jams. For 'Aluseal' packs, the maximum rate of fill per machine is 120/min of 30 - 33g units. Allowing for down-time etc it would be necessary to have at least 6 Aluseal machines to cope with the planned production rate, because these machines should not be run at maximum rate and there should always be a margin of over-capacity.

12. The desirable thing in Vitaminka's circumstances would appear to be to pack most of the jam on a normal line and have one or two Aluseal or similar machines in order to explore market potential for 1 oz (28 gm) unit packs of jams and to become accustomed to operational techniques etc.

13. **Jam closure - jars**

Steam flow closure followed by cooling, drying, labelling and coding would be necessary; no pasteurisation. The type of closing machine needed for this would be either omnia or white cap: for both expensive diabetic and extra high quality jams it is recommended that the extra cost of white cap or white cap style closures is justifiable. The cooler would be of the standard water spray type using potable water.

14 **Jam closure - 'Alupak' or similar**

H_2O_2 sterilisation of the packs before filling is not used and is not necessary; likewise no pasteurisation is necessary. Filling is carried out in as aseptic a manner as possible, and filled packs are inverted immediately after sealing to ensure sterility. Under these circumstances, whether a plastic or aluminium container is used with an aluminium lid and what shape it takes depends principally on cost and marketing factors, but where intact fruit are present in the jam, sufficient depth of container must be available. Cooling under these circumstances can be atmospheric.

15. Alupak or Aluseal packing is particularly appropriate for low sugar, low calorie jams, because of total unit use once opened; keeping quality until opened is satisfactory.

16. **Typical recipe**

A typical jam-boiling charge for a 180 litre boiling pan and for a medium grade jam follows. For top quality jam, except for blackcurrants, raspberries, orange and a few other berries where the fruit content must be lower, an additional 10 - 15 kg of fruit may be used in the charge with appropriate reductions (based on solids content) of sugar and possibly pectin. Also for top quality jams the glucose syrup is replace by sucrose - for diabetic jams the sucrose + glucose is replaced by sorbitol syrup with or without fructose:

Ingredient	Composition	Weight into boiling pan
Pitted Apricots fresh or frozen and/or Apricot pulp	All whole or halved pitted fruit or sulphited pulp including stones. Stones removed by bar sieving during jam manufacturing.	41 kg
Sugar syrup (70% soluble solids)	80^{o} Brix 43 DE glucose syrup 22%) Crystalline sucrose 52.5%) Water 25.5%)	73 kg
Pectin blend	Powdered pectin 6.25% Sucrose 31.25% Water 62.50%	10.4 kg
		Weight into jam receiving tank
Sugar syrup (70% soluble solids)	As above	10 kg

The blend of fruit/syrup/pectin is boiled to a soluble solids level of 64.5% (refractometer). The addition of the 10 kg syrup is to cool the jam to approx $85^{o}C$ and bring the soluble solids content to 65%. Fruit acids may be added (or sodium bicarbonate) to adjust the pH to the desired standard value between 3 and 3.5 on behalf of both flavour and viscosity.

17. **Sucrose. Syrup**

It should be noted that it is essential to have the sucrose in syrup form. If sucrose is used in crystalline form then batch time in the boiling pans may well be 30 instead of 20 minutes and the boiling pans will require power-driven stirrers. Syrup make-up and syrup storage tanks are therefore essential items in the jam-making plant and three storage tanks are needed:

(i) for the sucrose + glucose or invert syryp for cheaper jams and marmelada

(ii) for pure sucrose syrup for making top quality jams, and

(iii) for sorbitol or sorbitol + fructose syrup for diabetic jams.

The first of these three tanks may be omitted if the plant will never be used for making the relatively low quality jams.

5.5 Process control on the proposed new jam-making facility

1. Operation

It is estimated that the jam boiling operation, manually controlled, would require three operatives:

(i) Skilled jam boiler - to supervise the quality and sequence of the boiling by temperature and refractometer solids, and by adding pectin dispersions and fruit acid, and to add the cooling syrup to discharged batches. He would also actuate the blow-over operation for fresh batches.

(ii) Semi-skilled ingredients supervisor - to be responsible for ensuring the correct weights of each ingredient are ready in the batching tank for discharge into the blow-over tank. Also to supervise discharge into blow-over tank and jam feed from swash plate tank to header tank on filling machine. Also to prepare pectin dispersion and syrups. Also to carry out inspection of pulp.

(iii) Unskilled assistant to ingredients weigher - to bring ingredients, eg fruit, puree, sugar sacks, syrup etc, to weighing station. To provide jam boiler with minor ingredients. To assist with fruit and puree inspection, dumping of ingredients etc. To remove empty containers etc.

It would be feasible for the operation to be carried out by these threee operatives by completely manually operated valves.

2. **Automatic controls**

Alternatively, it would be possible to install on the plant the following control systems to minimise the risk of faults or mishaps and to help to achieve a consistent quality. It is not regarded as possible to reduce the number of operatives with a full control system, but if expansion of the plant was contemplated or increase of capacity, eg by using one or more extra or rapid boiling pans, was considered, some degree of automation would be required if the number of operatives was to stay the same.

3. **Automatic control schedule**

Plant	Level Controls	Action
Filler header tank	Extra low	Stop filler (with over-ride)
	Low	Call from swash plate tank
	High	Stop from swash plate tank
Swash plate tank water jacketed with temperature control to maintain jam at 85°C.	Extra low	Prevents flow to filler (with over-ride) Calls from jam receiving tank
	Low	Calls from jam receiving tank
	High	Prevents discharge from jam receiving tank
Jam receiving tank	Low	Closes outlet valve from jam receiving tank. Calls for jam batch. Prevents call from swash plate tank.
	Medium	Demands metered amount of syrup from syrup holding tank. Prevents call from swash plate tank.
	High	Allows call from swash plate tank,

Automatic control schedule (contd.)

Plant	Level controls	Action
3 slow boiling pans - bottom emptying	Low	Closes outlet valve. Calls batch from blow-over vessel. Opens pan inlet valve and closes inlet valves on other pans.
Temperature controls (possibly pressure compensated)	-	Cuts heat supply and signals to jam boiler who may (after checking temperature and refractometer solids) either satisfy call from jam receiving tank or renew heat supply to pan manually
Blow-over vessel	High	Closes inlet valve. Indicates "batch ready". Accepts call from boiling pan.
	Low	Closes outlet valve. Signals to ingredients supervisor and jam boiler that further batch is required.
Batching tank	High	Indicates "batch ready". Prevents discharge of incomplete batch to blow-over vessel. Supervisor (after ingredient check) discharges to blow-over vessel manually.

4. It is clear that the degree to which the plant should be automated (if at all) would need detailed examination with Vitaminka in the light of the following factors:

(i) The Additional cost of automatic process control

(ii) The availability of suitably skilled service engineers

(iii) The quality and skill of the operatives likely to be employed on the plant

(iv) Likely future expansion requirements

(v) The pattern of production - complete days on one jam variety only or mixed production.

3.6 Low calorie (low sugar - low total solids) jam

1. Such jams normally range from about 50 - 60% of total solids, with fruit contributing the normal amount - about 6%, but even lower total solids content jams have been produced and sold. Such jams are not of particularly high quality and it is suggested that they be made on the existing vacuum pan and pasteurisation plant. Such jams must be hermetically sealed and commercially sterile if they are to have an acceptable shelf-life after manufacture. Keeping quality after opening will be very poor indeed unless a preservative or a combination of preservatives (eg anti-yeast and anti-mould such as benzoic acid and sorbic acid or their Na or K salts is used), or they are effectively refrigerated. Whether legislation is likely to deter permit (1) such products to be called 'jams' and (2) the use of preservatives in them in the future is a very moot point.

2. Use of pasteuriser

One very significant criticism, however, arises here concerning the pasteuriser/exhauster at present being utilised in the plant. This is a single entry, single exit plant with a dwell time dependent on its length (fixed) and on the belt speed. It was observed being used to process canned fruit in syrup and, simultaneously, glass jars of jam.

3. It is not conceivable that in all the circumstances the ideal processing time for both of these packs was identical. Therefore, to achieve minimum satisfactory process in one it follows that over-processing was occurring in the other.

4. Under such conditions the use of a multi-entry spiral (or similar) atmospheric pasteuriser would have been indicated in which length of processing is governed by the entry point into the machine and in which simultaneous differential treatment of different sized packs is readily achieved.

Schedule of Equipment for jam-making Plant

Currently available fruit preparation equipment is adequate to supply the needs of the jam plant. We therefore start with fruit raw material ready for use - either fresh prepared, frozen or pulped and with SO_2.

Item No	Item	Quantity	Details	Budget cost per item
1	Inspection tray	1	A translucent plastic tray illuminated from beneath, ideal for checking pulp quality.	£700
2	Inspected pulp receiver	1	A stainless steel pan mounted on fabricated steel bogey, 3 castors c. 90 litres capacity.	£325
3	Weighing station	1	0 - 100 kg platform scales with weighing tank.	£1000
4	Batching tank	1	Cylindrical open-tops/steel tank with bottom outlet valve, fitted with slow stirrer. C. 160 litres	
5	Blow-over vessel	1	Sealed s/steel vessel with top inlet and bottom outlet (with valve). c. 150 litres. Fitted for compressed air and mounted beneath 4.	£2300
6	Boiling pans	3	Static, open steam-jacketed s/stell boiling pans of approx 80 cms diameter and brim capacity of c. 180 litres. S/steel jacket. All mounted on steelwork staging	£1000 each
	Exhaust canopies Exhaust ducting system	3	Canopies and exhaust system for all three pans in s/steel sheet	£2700

Item No	Item	Quantity	Details	Budget cost per item
7	Jam receiving tank	1	Cylindrical open-top s/steel tank with bottom outlet valve, Fitted with agitator. Mounted on steelwork staging to allow gravity flow from boiling pans.	£2700
	Steelwork staging for 6 and 7.		Steelwork staging with ribbed aluminium flooring to carry boiling pans and jam tank (7). Also control panel, if provided. Open access to tank 7 is provided	£1550
8	Rod sieve	1	Pulping and sieving machine fitted with 8" cylindrical rod sieve. Produce is brushed through sieve by revolving brushes. c. 1 ton/hour. Removes stones etc.	£1600
9	Swash plate tank	1	Water jacketed trough with bottom sloping to outlet. S/steel inner vessel. Mild steel jacket. Fitted s/steel disc agitators driven by 1 h.p. motor. 500 - 600 litres.	£1950
10	Pump (wide bore)	1	S/steel fruit pulp pump with 2" (51mm) pipe connections. 3 h.p. 1,500 litres/hour.	£650
11	Filling machine	1	4 or 6-head rotary filler capable of filling glass jars of 125 ml, ¼ kilo and ½ kilo capacity at speeds 35/60/minute.	£1000
12	Syrup melting tank	1	Opens/steel cylindrical tank c.12000 litres. Fitted with agitator and steam heating coil. Suitable for allowing tipping in of sugar. Bottom outlet valve to 11. Gravity flow to 11)	£3900 (items 12 and 13)
13	Syrup holding tanks	2	Open s/steel cylindrical tanks c. 1200 litres with bottom outlet. Allows scooping out of syrups by hand.)	

Item No	Item	Quantity	Details	Budget cost per item
14	Metering pump	1	Pump which will, on demand, meter a pre-set quantity of syrup to 4.	£450
15	Pectin make-up tank	1	Small s/steel open cylindrical tank with fitted high shear Silverson mixer.	£1000
	Pipework and valves		S/steel pipework between items of equipment 3 - 11 and all necessary vavles (manual).	£1900

The budget costs provides are those from Brierley, Collier, Hartely & Co Ltd of Rotherham, Lancs, UK. Costs were also requested from Herbort of Braunschweig, W. Germany and from Zacmi of Parma, Italy. Herbort declined to sent budget prices for their equipment and no reply has yet has been elicited from Zacmi.

Process Control - Automation Requirement

Plant	Level Controls	Action
Filler header tank	Extra low	Stop filler (with over-ride)
	Low	Call from swash plate tank
	High	Stop from swash plate tank
Swash plate tank water jacketed with temperature control to maintain jam at 85°C.	Extra low	Prevents flow to filler (with over-ride). Calls from jam receiving tank
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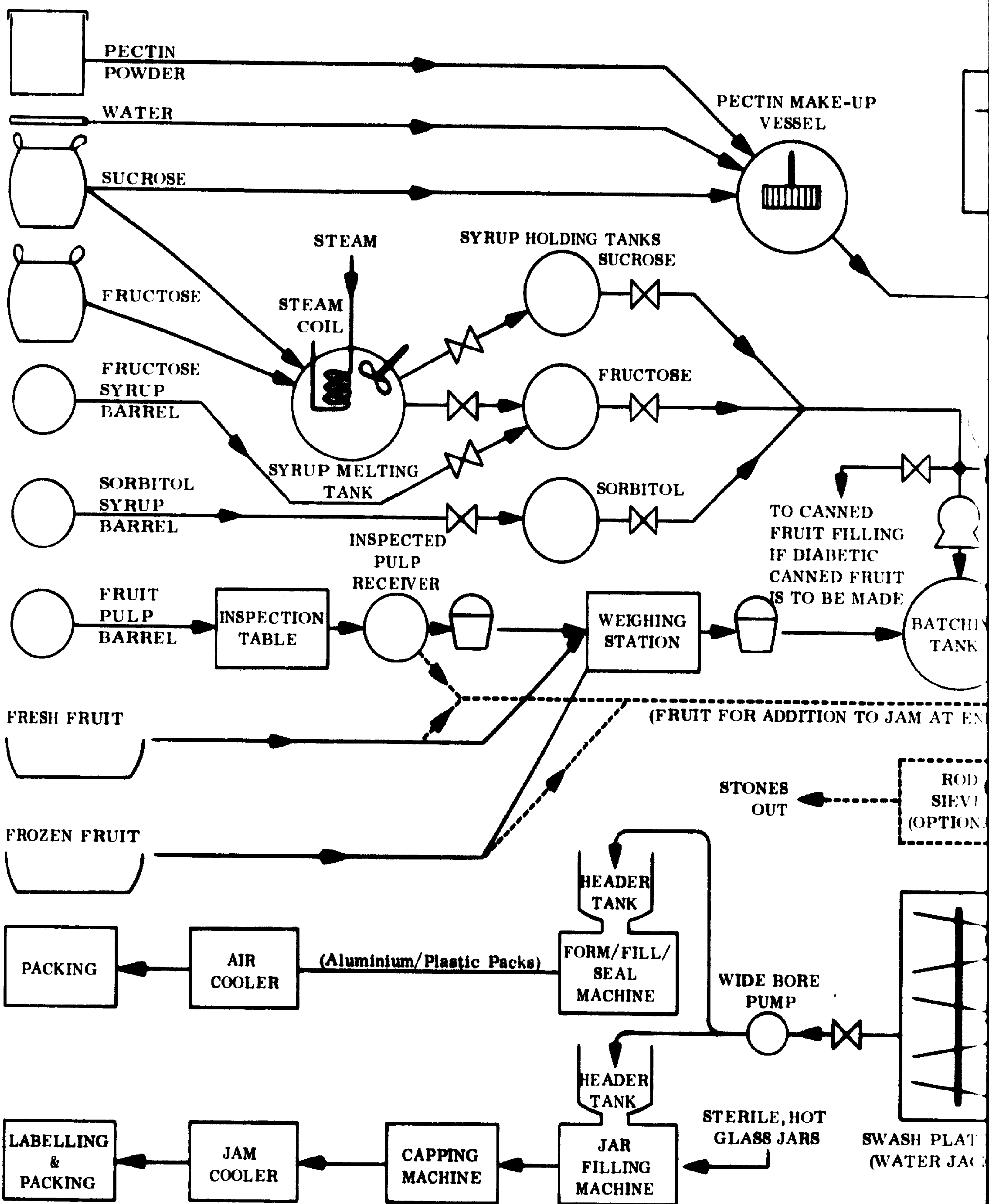
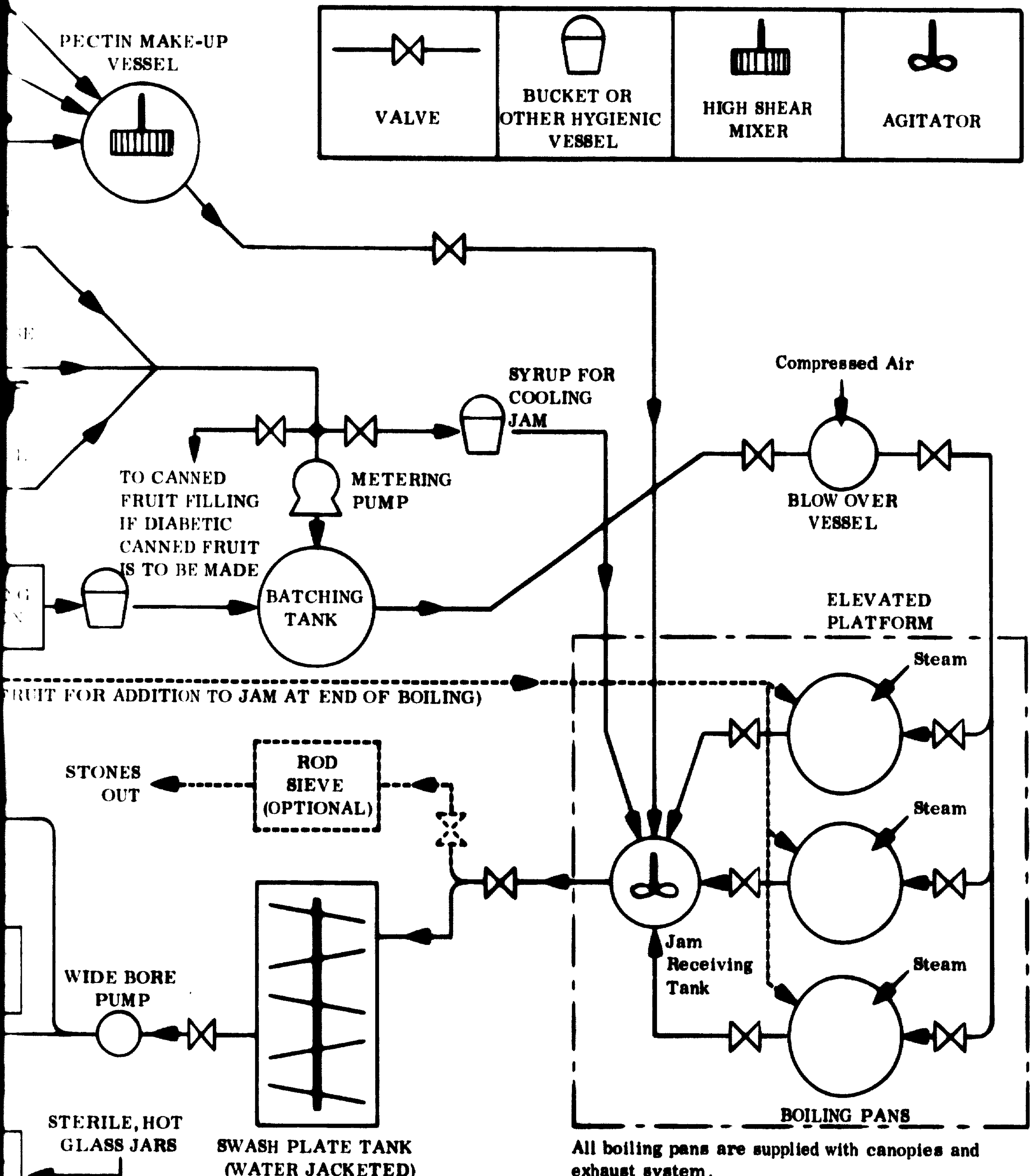
Temperature controls (possibly pressure compensated)	-	Cuts heat supply and signals to jam boiler who may (after checking temperature and refractometer solids) either satisfy call from jam receiving tank or renew heat supply to pan manually.
Blow-over vessel	High	Closes inlet valve. Indicates "batch ready". Accepts call from boiling pan.
	Low	Closes outlet valve. Signals to ingredients supervisor and jam boiler than further batch is required.
Batching tank	High	Indicates "batch ready". Prevents discharge of incomplete batch to blow-over vessel. Supervisor (after ingredient check) discharges to blow-over vessel manually.

Overall notional cost (ex B.C.H.) £7000



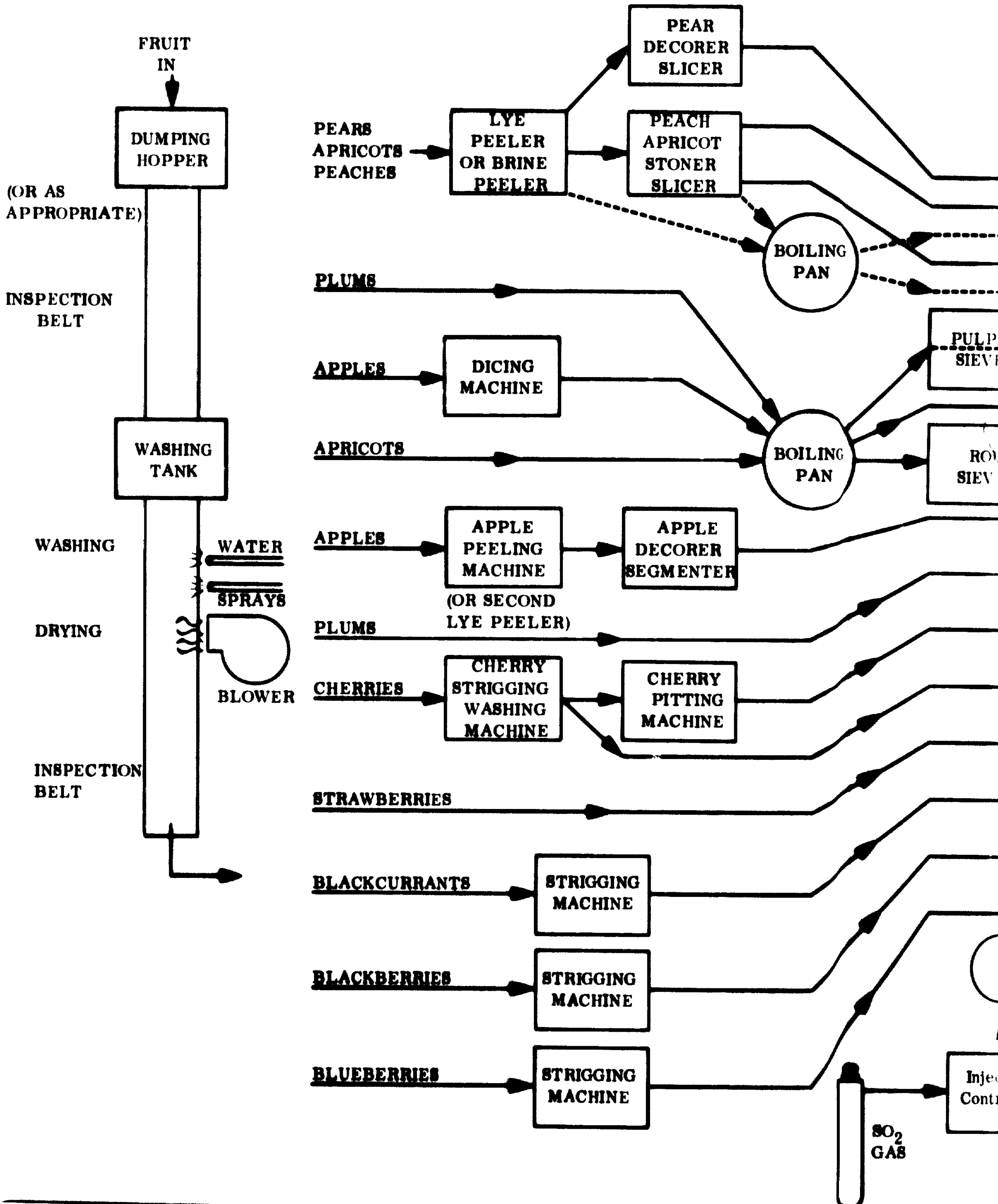
SECTION 1

FLOW SHEET FOR MANUFACTURE OF HIGH GRADE JAM A



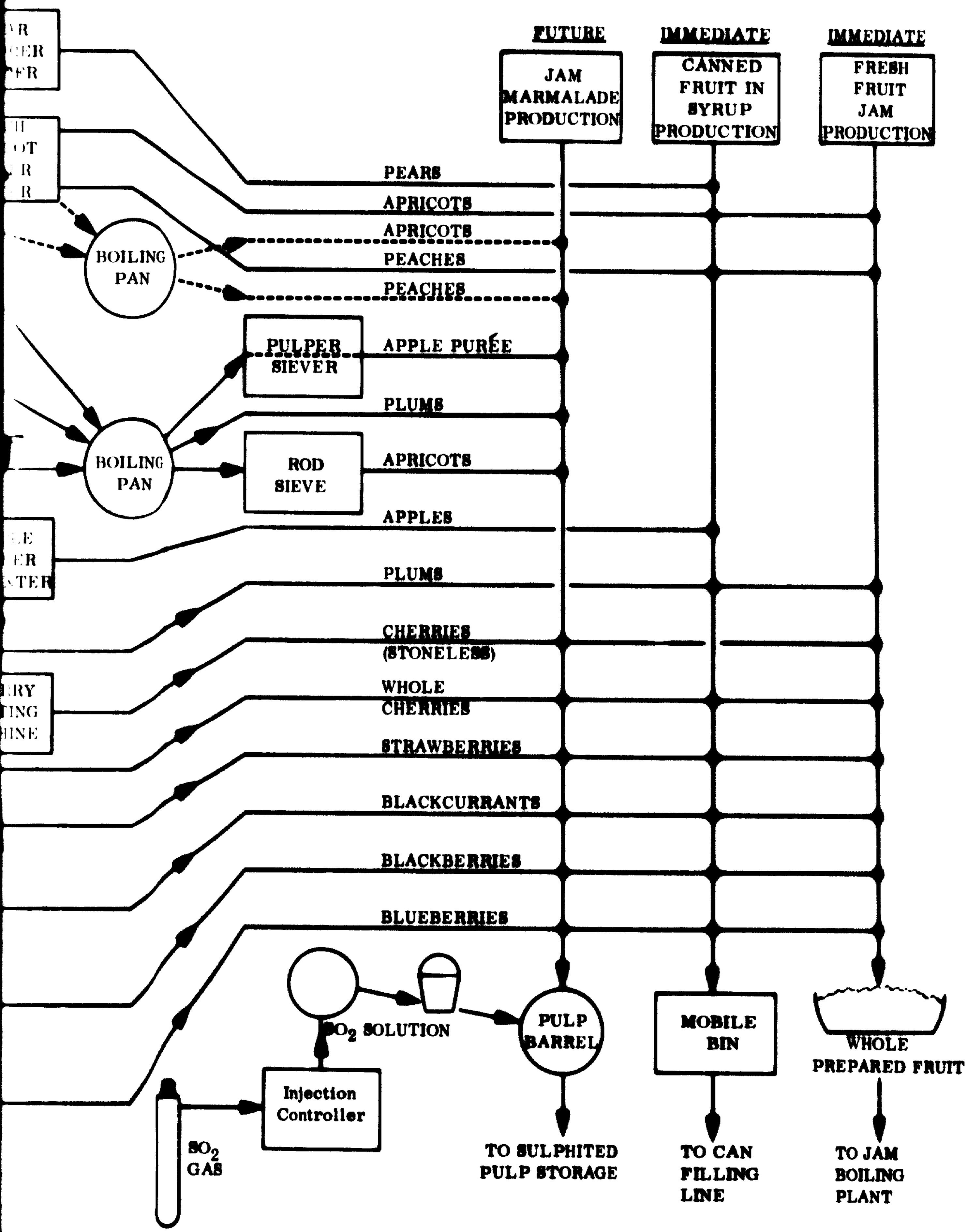
SECTION 2

RE OF HIGH GRADE JAM AND DIABETIC JAM



SECTION 1

FRUIT PREPARATION



…IT PREPARATION

SECTION 2

VI FRUIT JUICES

6.1 General

1. Fruit juices, like jams, canned fruit etc, are in quality ultimately dependent on the quality and characteristics of the raw materials from which they are produced. The cultivars used (in the areas of specific farmed crops) are important particularly when apple juice is being considered where great variety in acidity, sweetness, aroma etc occur. These factors also vary with the ripeness of the fruit and its length of storage. Off-flavours in juices can be caused by pest, fungal and other infections of the fruit and can arise from the enzymic changes which are the ultimate consequence either of infection or of physical damage.

2. Fruit quality

Initial quality of fruit has therefore a major influence on the potential quality of juice produced, and both purchasing and insepction techniques are of paramount importance in determining eventual quqlity.

3. Juice processing

Initial processing (following washing, inspection, trimming, etc) of the fruit for juice production takes two principal forms:

i milling, followed by high pressure removal of the juice (principally used for apples) or

ii 'breaking' the fruit (either hot or cold with pectinase largely destroyed in the first case and unaffected in the second) and removal of juice from the slurry so produced, or else using the slurry after refining and addition of sugar for nectar production

4. Vitaminka are very well equipped indeed for the production of single-strength apple juice - an appropriate apple mill in which damage to seeds is avoided, a Bucher-Guyer press (the ideal choice) which gives up to an 80% yield of juice, pasteurising equipment, a variety of screening and filtration equipment all allied with both pulp and juice depectinising tanks (pectinase treatment to reduce viscosity and improve filtration characteristics of first the pulp and then the juices) de-aeration equipment etc. There is only one problem therefore in the production of bright-filtered single-strength juice which can be bottled, pasteurised and sold in this form or alternatively concentrates as dealt with below. This problem consists in the fact that for final stability in the juice, whether or not reconstituted, tannins and other polyphenols present must be precipiatated by the addition of protein - usually gelatin - and the precipitation removed by ultra-filtration in a very high speed 'decanter' centrifuge. Such a machine is not currently available.

5. <u>Juice concentrations</u>

Additionally, when fruit juices must be concentrated for the ultimate production of very high quality concentrated fruit syrups or (and very much more important in terms of export potential) for the production of concentrates for low cost and ease of storage, low transport cost etc prior to reconstitution, there is one major limitation imposed by the evaporation plant in use - it has no facility for aroma stripping, and therefore the reconstituted product is markedly inferior to the starting material and is not up to the present standards of flavour demanded by the regular European consumer.

6. It should be mentioned here that the storage and transport handling of fruit juices has progressed during the past 25 years or so through the stages of pasteurised single strength juice in high pressure tanks, chilled and under CO_2; partial concentration of pasteurised juice in lower pressure (and hence cheaper) tanks, chilled and under low pressure CO_2; to high concentration of pasteurised juice which requires no CO_2 but is better for being kept chilled. This is an over-simplification, but will serve. This advance has been made possible by advances in evaporation technique by which change in flavour of juices has been progressively reduced until now with the most modern methods it is impossible for the average person to detect a difference between fresh juice and the same juice reconstituted from a concentrate.

7. This situation depende, however, for many juices not only on the concentration method used but on having initially 'stripped' or removed by fractional distillation at atmospheric pressure the very volatile top notes of the juice flavour and aroma (mainly esters) which would otherwise be lost during concentration, having kept this material separately in concentrated form, and having added it back when the juice is reconstituted from the 5 to 7 x concentrate. The Alfa-Laval method of stripping and concentration using 'Centri-Therm' equipment is an excellent example of the complete technique, an had been observed to score very nearly 100% in a 'fresh' versus 'reconstituted' test on a large panel of tasters.

8. It has to be remembered that, according to Fenaroli (Handbook of Flavour Ingredients pp 654 and 655) whilst over 60 different ingredients contribute to apple flavour, the very major ones are esters based on amyl alcohol, in particular the acetate, butyrate and valerate. Also ethyl acetate and geranyl acetate are prominent. All of these have a considerable measure of volatility (very low BP) and unless carefully preserved in a closed container, volatilise rapidly. It is no wonder then that a large proportion of apple flavour - like that of many other fruits including blackcurrants - tends to be evaporated and removed in the steam jet ejector or wet vacuum pumps used on fruit juice concentration evaporators.

9. There is currently no particular reason to doubt the efficiency of the vacuum evaporators at present used by Vitaminka or that the product they make is other than satisfactory as far as it goes - this is a matter which could not be assessed other than by inference from products tasted etc during the relatively short time available on this particular topic at the factory. But for Vitaminka concentrated juice products to get into the top league of fruit juices in Europe demands stripping and add-back of aroma, and until the necessary plant is secured prospects in this area are not promising. This applies particularly to apple juice - which is after all the principal bottled, pasteurised, straight fruit juice consumed in Europe - but is also important for other juices.

10. Aroma stripping is dealt with in detail in the article which constitutes Appendix I. The evaporative capacity of the present fruit juice concentrators is approximately 1500 kilos of water/hour. This means that roughly 1750 kilos of fruit juice can ve handles per hour based on a high degree of concentration and that the amount of concentrate produced per hour can be from about 220 to 350 kilos or more according to final concentration and initial total solids of the juice being concentrated. For fruit syrups, of course, very much more than 1750 kilos of juice can be handled.

6.2 Production of nectars

1. Production of nectars has not yet started at Vitaminka but such products are frequently not appropriate for concentration, and if any export were contemplated it might well have to be in a form ready for dilution by up to an equal volume of water. This would not, however, involve any concentration of the fruit juice, as nectars are customarily 50% or more of fruit juice with the top limit perhaps 75%, the rest being added water and sugar. Fruit pulp and the 'finishing' suspension thereof and the control of pectin content are all important factors in the production of first-class nectars, and are affected by evaporation, freezing, heating etc in various ways. This situation has been studied in depth in connection with tomato 'juice' which is really a tomato 'nectar', but to a very much less extent with other fruits, so that initially at any rate, most 'concentrated' nectars would be somewhat experimental. An exception might be for apricots and peaches normally produced in concentrated form on tomato paste plant with minor modifications, but not normally reconstituted into bottled nectars. The current limitations on distribution and sale of nectars however do not encourage the concept of export on any significant scale.

2. In the fruit juice area, therefore, it would appear that one basic necessity to produce an internationally saleable apple juice concentrate is an arome stripper to be added to the evaporation plant, and such an addition could prove very helpful indeed in respect of producing other fruit juice concentrates for whatever purpose they are ultimately intended.

3. Where normal or relatively low quality fruit syrups are being prepared it is current practice not to include 'stripped' aroma - ie if stripping has actually taken place - and this aroma concentrate is a valuable by-product very much needed and welcomed by flavour and essence manufacturers. This is a further reason for the acquisition of an appropriate stripping facility.

The other item of equipment which would assist in production most significantly would be an ultra-centrifuge (eg Sharples Super D-canter or equivalent) to be used for the purpose previously described and also for other difficult clarifying operations.

VII THE PROCUREMENT OF RAW SUPPLIES

7.1 The present situation - fruit

1. General

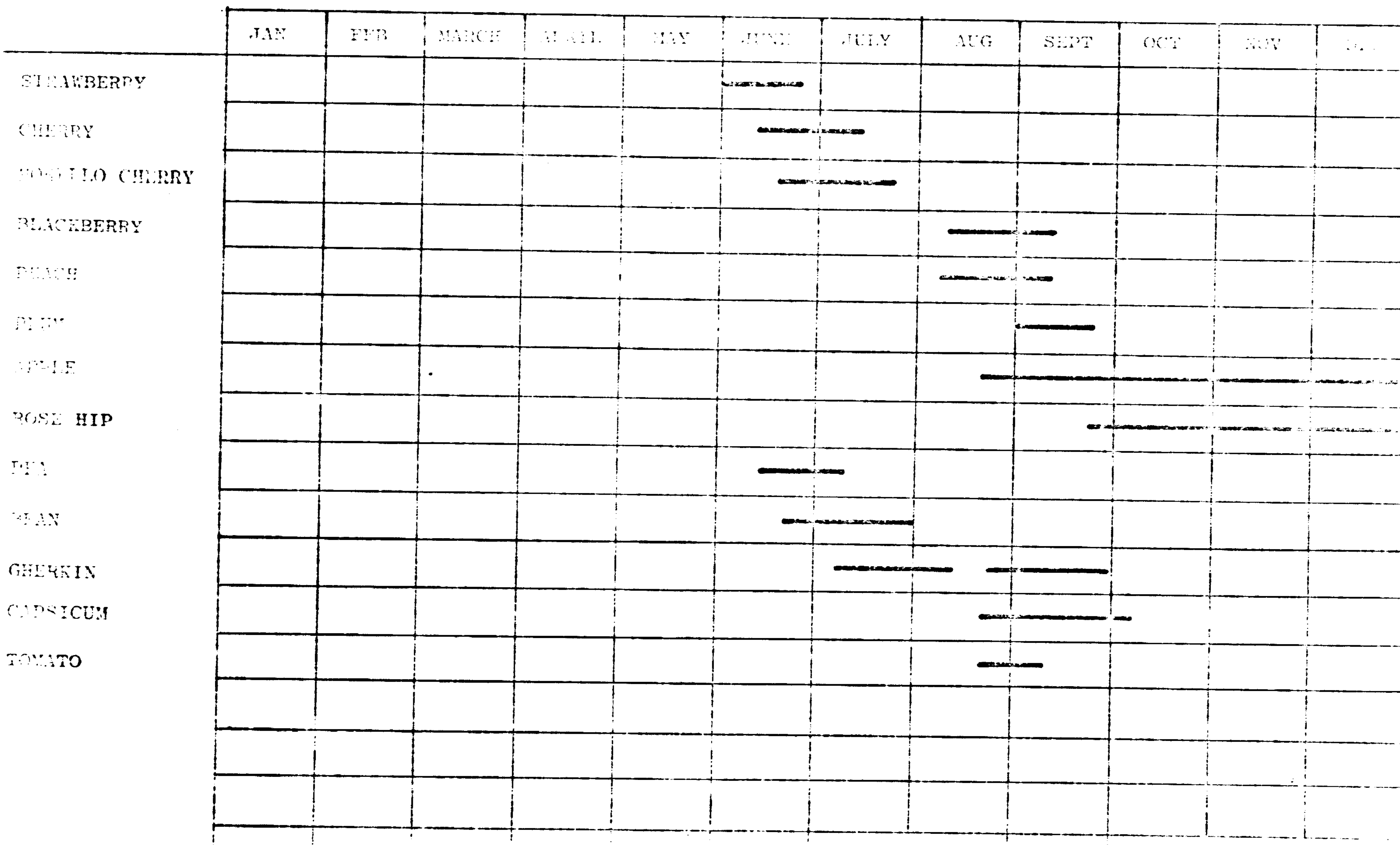
For the current year (1975) it is estimated that raw material intake will total more than 14,000 tons of produce, the vast majority of which is grown within a 50 km radius of the factory. Details of the individual requirement for each crop are set out in table 8.1 from which it will be seen that fruit accounts for about 56 per cent of the total intake.

2. The area surrounding Banja Luka is renowned for its production of high quality fruit; cherries both wild and cultivated together with blackberries are of particularly good quality. However, one major limitation exists and that is the availability of hand labour for picking.

3. In view of the fact that Vitaminka plans a 14-15 per cent annual expansion rate through to 1980 bringing output up to nearly 35,000 tons, it is essential that labour problems in harvesting should be resolved as soon as possible. The programme of expansion is also planned on the basis that fruits will expand 16 per cent per annum and vegetables by 13 per cent oer annum.

4. It must be emphasised that by 1980 nearly 25,000 tons of fresh or ready-to-process produce will have to be taken to the factory.

[illegible] HARVESTING [illegible] – [illegible]



JAN
FEB
MARCH
APRIL
MAY
JUNE
JULY
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SEPT
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NOV
STRAWBERRY
CHERRY
MORELLO CHERRY
BLACKBERRY
PEACH
PLUM
APPLE
ROSE HIP
PEA
BEAN
GHERKIN
CAPSICUM
TOMATO

5. **Fruit production**

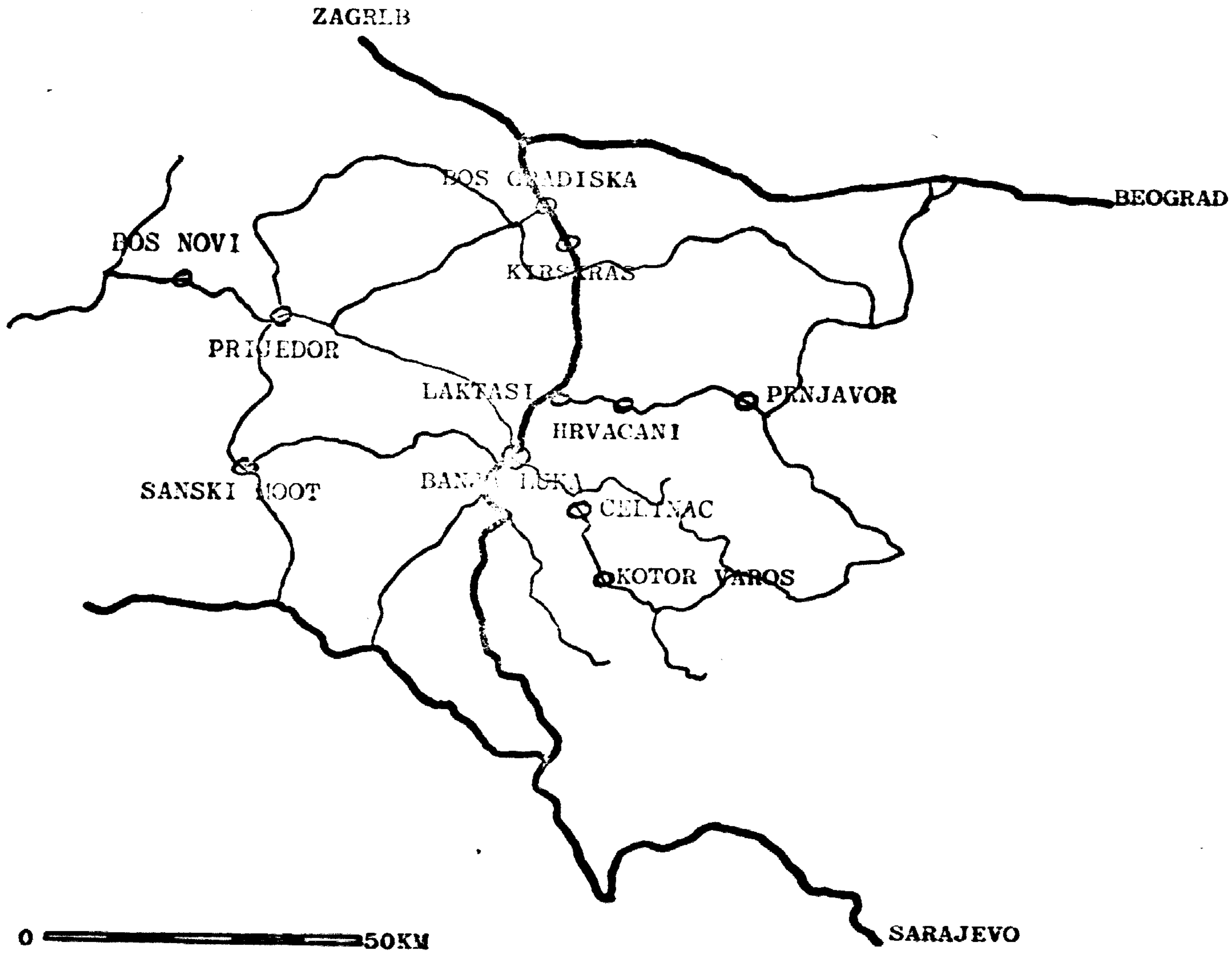
All apricots and bilberries are bought in and it is unlikely that production of these two crops will ever be seriously contemplated in this area. To date, however, most of the strawberries have been obtained from the other side of Belgrade but this year a local co-operative distributed one million plants amongst its members. There is no reason why the factory should not become entirely dependent upon supplies of locally grown strawberries. Indeed, it would seem to be highly desirably to reduce the travelling time between farm and factory.

6. Peaches, apples and plums are available in virtually unlimited quantities and it is understood that there are no problems in organising deliveries of any quantities required. Vitaminka is the sole buyer of rose hips in Yugoslavia and takes in supplies from all over the country. Availability is limited by pickers at harvest time.

7. Three types of cherries are purchased; the black wild cherry which gives a deep near-black colour when added to jam made from cultivated fruit and the sour or Morello cherry. All other things being equal the processing quality of this fruit is excellent. So too is the quality of blackberries which grow wild. As far as is known no attempt has yet been made to grow cultivated blackberries.

8. Finally a large number of wild trees produce Cornell berries which can be made into a jam of excellent flavour. Also, there could be some potential for juice. Around Banja Luka there are many alpine/wild strawberries again of excellent quality but its high labour requirement precludes anything more than 10 tons being harvested each year.

LOCATION OF KEY CO-OPERATIVES SUPPLYING VITAMINKA



9. **Co-operative marketing**

All the local fruit is picked within a radius of 20-50 kms by local farmers who deal with Vitaminka through their own farming co-operative. There are ten independent co-operatives in the area. The most important one is at Prnjavor which supplies some 30 per cent of the factory's requirements; Laktasi supplies 15 per cent, Prijedor 7 per cent and the remainder supply 5 per cent or less.

10. Although each farmer is permitted to farm up to 10 hectares he and his family are also encouraged to pick wild fruit in the woods. Other than family labour, no other organised fruit picking takes place.

11. The role of the co-operative is one of co-ordination. In principle it negotiates a contract on behalf of its farmers with Vitaminka. Primarily the contract mainly concerns quantities ie that over the season a given quantity of fruit will be made available to the factory. The co-operative is also in a position to stimulate farmers' interests in growing new or better crops. Thus the co-operative acts as a trader, as an adviser and also as a banker in making short term credit available. Although the co-operatives have also been integrated with the AIPK organisation, the current contractual negotiations will continue.

12. **Collecting centres**

Each co-operative has a number of collecting centres ranging from 10 (Prnjavor) down to 2(Prijedor) in number, into which farmers deliver their fruit in 3-6 kg returnable plastic trays. The co-operative checks the produce for weight and quality and then arranges for the factory to collect. In the larger centres there is a representative of the factory.

13. <u>Transportation</u>

The Vitaminka lorries visit each collecting centre once a day and more frequently if the fruit is available. The driver of the lorry making the collection is responsible for the quality inspection of the fruit and has powers to reject any tray where he considers the quality is too low. The fruit is loaded onto canvas covered six ton fixed bed lorries which are also able to tow a four-wheeled covered trailer. All this work is done by hand; pallets are not used until arrival at the factory.

14. Although the lorries and trailers are sheeted, air bleeds are left through which cooling air can enter during the haul. In the more remote areas there is considerable dust on the road and as a result most of the fruit appeared to be contaminated on arrival.

15. <u>Identification</u>

By the time the fruit arrives at the factory it has lost its identity as regards both the farmer who delivered it and possibly the collecting centre from where it was taken. The factory has therefore been unable to assemble data which would indicate those areas/farmers from/which the best fruit is picked.

16. <u>Unloading and storage</u>

At Vitaminka the fruit is unloaded by hand onto 120 x 80 cm four-way entry pallets and either left out under an open shed ready for immediate processing or put into a cool store. Thereafter prepared fruit may be sulphited or frozen in trays in a freezing room. All movements within the factory premises are carried out by fork lift trucks.

17. **Trays**

Although it was understood that the retunable plastic fruit trays were usually subjected to a thorough cleaning regime by dipping in an solution containing 15 - 20 ppm of free chlorine, all were very dirty and this could well have contributed to the visible fungal deterioration which was taking place. It is understood that a new powered-washer will be installed next year. We consider this item to be of the utmost importance in maintaining quality.

7.2 Evaluation and recommended improvement - fruit

1. General

It is significant that the greater part of Vitaminka's future expansion is based on the assumption that there are sufficient supplies of raw materials to keep the factory fully supplied. During the on-site examination we were unable to obtain any statistical data on the agricultural structure of the area nor any indication of its potential. We were, however, informed that some information was available at AIPK and that FAO had also prepared a report on the area.

2. However, from what we have seen and heard there is little doubt that while the true potential productive capacity of the area is as yet largely untapped, the real problem facing Vitaminka is whether sufficient quantities of the right quality of produce can be delivered to their factory at the right time in the right condition so that the proposed production programme can be maintained.

3. We consider that the real key to the problem is the availability and willingness of local farmers to meet this challenge. In turn, Vitaminka must itself see that those farmers co-operating with the company should be well rewarded for their efforts.

4. We feel that this examination is best split into two parts. The first part is to see what long-term action should be taken by Vitaminka and the second part, what action could be put into effect almost immediately. We feel it should be emphasised that unless Vitaminka takes a lead in this matter all impetus will be lost as no other organisation or body has the knowledge of the problems or indeed incentive. At the same time, however, we urge Vitaminka to always take the broader view of farming rather than solely an interest in those crops it wishes to procure.

5. We see Vitaminka playing a vital role as the means of helping the individual farmer in the area to maintain acceptable living standards. The link between the two - the co-operatives - is already established; what is now requires is a development of this bridgehead.

6. Long-term development

Here the essential need is to maintain if not to increase the rural population to ensure that sufficient hands are available to pick the crops. This is essentially a matter of economics as has been suggested above. Not only is it necessary to increase the actual quantity of fruit picked per person but to reduce the costs of the operation.

7. Mechanical harvesting of fruit

In the immediate future - the next five years - we do not see mechanisation playing any part in achieving either of these two objectives. Machinery for the picking of raspberries and blackcurrants shows very considerable promise but as far as we are aware these two crops have not been grown on a large enough scale in the area to attempt mechanical harvesting. We think replicated agricultural trials should be established to determine the most suitable varieties to grow for this purpose. We feel the only other crop which lends itself to mechancial harvesting are cherries, using a tree-shaking technique, but extensive field trials and experiments have yet to be undertaken.

8. When mechanisation comes it will have to be undertaken on a sufficiently large scale to make it economic. One question to be resolved is whether an individual farmer with his 10 hectares will be able to put aside a sufficiently large area of land in one block. One solution might be to persuade 3 or 4 neighbouring farmers to join together in a syndicate of their own and share costs and proceeds.

9. Another possibility is that Vitaminka should take an active role in planting new cherry orchards, even by making available the finance to meet the initial capital expenditure of plants. We understand that some interest has been shown in such a development. While one would prefer to see larger commercial plants such an investment scheme might prove to be highly attractive to individuals or groups of farmers, preferably the latter. The method of financing could be on an equal share basis:

one-third Vitaminka

one-third co-operative

one-third individual or group of farmers

While labour for harvesting remains such an important factor, the participation of individual farmers seems critical. In order to encourage new plantings perhaps consideration could be given to any group of farmers showing an interest by making available land over and above that which they already farm in order to increase theor individual farm areas. If experience of other countries is to be drawn upon, the problem of the small size farms in Yugoslavia will have to be faced sooner or later and the above suggestion seems highly practicable under the circumstances.

10. In the meantime we also consider that every encouragement should be given to farmers to establish berry fruit plantations - particularly blackberries, as ultimately the cost of picking wild fruit will become prohibitive. We even think experiments should be carried out in the hills to improve the access of the pickers to wild blackberries. In the densely populated parts of southern England there is quite a large area of common land upon which wild blackberries thrive. Over the years thousands of pickers have trodden down tracks through the thickets to increase the accessible surface. We think that "artificial tracks" could be made by mechanical slashers. It is not impossible that by paying further attention to controlling surface water run-off and perhaps some small-scale fertilisation as well, increased yeilds of better quality fruit could also be achieved.

11. Increased yields plus faster picking rates (the pickers would not have to walk so far per kg of fruit picked) would help to attract a wider spectrum of potential harvesters.

12. <u>Wild tree fruits</u>

The outlook for wild cherries and Cornel berries must be assessed pessimistically. However, to some extent Vitaminka may have already moved towards an expedient solution. We understand that the school holidays start at the peak of the wild cherry season, but as yet no tradition of children organised into large picking teams has yet been established. We are told that 100 children can pick up to 5 tons per day. We feel that this approach is the only one which is likely to yield positive results and should not be too difficult to maintain once the tradition has been accepted. One advantage of the large-scale approach is that over the years a wide knowledge of the better yielding areas can be recorded subsequently saving valuable child time looking for likely places. Ultimately, access to these areas could be improved reducing the costs of extracting the picked fruit.

13. <u>Experimentation</u>

We have already referred to the need for field trials and experimentation. It is essential to determine which varieties give the highest yields of processing quality fruit and what cultural practices should be adopted. It is essential that trials are replicated on a number of sites to determine regional variations. We think these sites should be jointly operated by the local co-operative and Vitaminka working in unison.

14. <u>Extension</u>

At the later stages we see no reason why development trials should not be carried out on the farms of the better growers in an area. Example is possibly the best teacher of all and we feel that the staff of both the co-operative and of Vitaminka should be involved. It is essential for the farmers to have confidence in the Vitaminka field staff.

15. Farmers often feel that processors are too remote from the real problems of farming. We feel that much good could come from a direct farming involvement by Vitaminka. We suggest that two 10 hectare farms should be secured. The first should be a "model farm" which should set out to show what can be achieved if finance, expertise, availability of market and general managerial ability are not restrained.

The second farm should be what the "average fellow" has to put up both by way of land and buildings. Finance should be limited to the maximum available through normal channels. However, the essential factor would be the above-average ability of the individual running the farm.

16. Vitaminka would be in a position to show farmers exactly what can be achieved. This would mean that all accounts would have to be made available. They could in fact be used as the basis of a farming newsletter which could be circulated through the co-operatives.

17. Farmer advisory groups

We feel it is essential that Vitaminka should build up a closer understanding of farmers' attitudes and thinking. We also feel that farmers should be given the opportunity of discussing with Vitaminka their day-to-day problems and long-term aspirations. We appreciate that formal liaison exists between Vitaminka and the co-operatives, but we would like to see also a means of 'grass-root' contact.

We recommend that Vitaminka should form a "Farmers Advisory or Consultative Group". The Group would consist of no more than 8-10 farmers, preferably drawn from different parts of the area surrounding the factory. We suggest that Vitamnika should first identify those farmers who are generally considered to be the most advanced and go-ahead and then select the group from this list.

We think the Group would give Vitaminka a two-way means of communication - first, a sounding-board for future Vitaminka policy and secondly as a means of getting information on agricultural develpoments back to the farmers. The Group would therefore be technically orientated, whereas contact with the co-operatives is bound to be more commercial.

18. Short-term improvements

We consider the two main short-term improvements rotate around the quality of the incoming fruit and the efficiency by which it is handled. The first essential is to identify the actual farmers who pick quality fruit and then secondly ensure that they are rewarded. This indicates that Vitaminka must be more closely associated with the individual co-operatives.

19. Quality premium

There are any number of payment schemes but they must be seen by the farmer to be fair. However, before they can be introduced it is necessary that quality standards are prepared. One system would be to make the contract price the middle point - ie the crop in accordance with the defined standard. Should certain faults exceed a pre-determined tolerance then the price would be reduced by say 10 per cent. On the other hand, if fruit of exceptional size or quality was brought in 10 per cent would be added to the price.

20. In order to promote a sense of competition, a quality league could be established amongst the co-operatives and possibly amongst the individual farmers as well.

21. **Handling**

We appreciate that during our visit to Vitaminka the weather conditions could not have been worse, but even subject to this qualification we consider some of the fruit arriving at the factory had lost considerable quality since picking.

22. We understand that some farmers may pick fruit and leave it standing around the farm until a sufficient quantity is available to make it worth their while taking it to the collecting centre. Two problems arise, in that some fruit may 3-4 days old before it reaches the collecting centre, and it also becomes very difficult for both Vitaminka and the Co-operative to know how much fruit may arrive in any one day. The whole problem is compounded by the fact that in any one consignment there is a very wide range of quality.

23. Without statistical data on the number of farmers, the intensity of production and the rate of picking of each individual crop, it is difficult to arrive at any precise answer. We feel that two broad solutions may exist, and it is even possible that they could work alongside one another in parallel. The basic objective

24. **Collection by farmers**

This would be a viable proposition if a number of farmers would come together and agree a rota as to who should collect from the other farms and take to the Collective centre. Distance and problems of identification would limit the size of the operation, particularly as horse-drawn transport is the only means available. At the same time, crop contamination by dust on rural roads would still remain a problem.

25. Collection by vehicles

There would appear to be a valid case for suggesting that closed insulated vans of 1½ - 2 tons nominal capacity should visit a point near each farm at a fixed time each day. The driver would be responsible for quality inspection and for check-weighing - being assisted by a representative of the Co-operative. A number of vans would then serve a larger vehicle which would take the produce back to the factory. If necessary these lorries could leave trailers at certain points down the road.

26. Cooling

As such, we feel that the present collecting centres could be dispensed with - in any case those currently being used do not have any proper cooling facilities. We suggest that the present road vehicles used for this job should be fitted with insulated container bodies. These could be pre-cooled each time the vehicle returned to the factory. If during transport the internal temperature rose above the external ambience, filtered air would be circulated by means of small fans.

27. Numbers of vehicles involved

There is no reason why the teams should not be kept on the road 24 hours a day. At the peak of the season, assuming full operation, the system would have to cope with 8 - 10 tons per hour. With a cycle time of 4 hours for each load, between 5 and 6 sets of vehicles and trailers would be required. Each of these units would be served by two of the smaller vans with a capacity of 1½ - 2 tons.

7.3 The present situation - Vegetables

1. General

The total requirement of vegetables is estimated to be in the region of 6250 tons in 1975. Details of the individual tonnages are set out in Table 8.1.

2. There are very obvious differences in the approach to vegetable production as opposed to fruit production. The reason for this is that pea, bean and potentially tomato production is essentially a large-scale operation - completely beyond the capacity of a farmer with only 10 hectares. The production of these crops is therefore left to the Kombinats, who can provide land of not only high productive capacity but also of sufficient area. Availability of finance for the heavy investment in mechanisation would in any case preclude the participation of the small farmers even co-operatively organised.

3. However, as can be seen from the production programme, there are a number of labour-intensive crops which are well within the capabilities of farmers on the better soil types, namely: Cucumbers/Gherkins, Capsicums, Aubergines. As a result the production of these crops is currently being co-ordinated by the local Co-operatives.

4. Vegetable production

The production of vegetables is concentrated within a 40-Km radius of the factory (really a half-circle). At the present time Vitaminka works with two Kombinats and three Co-operatives in the area.

5. Peas

Two Kombinats have contracted to grow peas, namely Romanovci which is about 30 Km away and grows 500 ha, and Srbac, which is further (about 40 Km) and which grew 150 ha this year. At Romanovci there is a stationary viner, otherwise the majority of the crop is harvested by mobile equipment, there being two machines on one Kombinat and five on the other.

6. The tenderometer reading for peas in the field is acceptable between 100 and 160, the lower level being aimed for. In most years yields of 4 tons per hectare and over are expected. In the current year harvesting was delayed by rain, which was followed by very hot spells, and the crop appeared to be maturing very fast. It is understood that at the end of June hail damage subsequently caused severe losses.

7. The harvesting operation was being delayed by very heavy weed infestations indicating that not only are improvements in cultural practice required, but spray chemicals may also be in short supply. We also consider that the practice of cutting the vines so far ahead of the viner is detrimental to the quality and in future much tighter control should be kept of this operation.

8. Green beans are grown on the same Kombinats as the peas. At the time inspected the crop appeared healthy, although the initial germination might have been a little uncertain. All harvesting is undertaken mechanically.

9. Carrots were also grown on one Kombinat, the area not being very large. The drills were about 40 cm apart and germination had not been good. It was felt that the plant population per square meter of land would not give the intensity to ensure an even size of carrots. One possibility would be to grow five rows planted 30 cm apart or closer on a raised 'bed' of soil; we think such a layout would greatly increase the proportion of carrots suitable for processing.

13. The price formula for peas provides for a 10-year guaranteed price indexed to the July 21st exchange price for wheat in Novosad, plus a premium of 30 per cent. This formula appeared to be working quite well, taking into account the maturity and yield expected from the crop. However, there were indications that 'freezers' were prepared to pay a higher price, and as a result the impression was created that the Kombinat concerned was giving priorities of supplies to the freezer, although in all only a fraction of the total was involved.

14. No chilling plant had been installed at the Kombinat supplying the 'freezer' in question, in spite of the distance involved. The general impression created was that neither the field nor yard organisation was able to withstand the continued high pressure of a full-scale freezing programme, where every second counts.

15. Transportation

The harvested peas were transported in open tipping lorries containing 2 - 3 tons. These vehicles were open to the air and therefore considerable dust contamination could be expected. The total cycle time for each vehicle was in the order of 3 - 4 hours.

7.4 Evaluation and Recommended Improvements - Vegetables

1. General

We think that the problems which Vitaminka will face in the future with increased demands for vegetables for processing will be much less than its problems of fruit supplies. The Kombinats have already shown that large quantities of peas and beans of good quality can be produced economically. There is now also every sign that individual farmers, given the right encouragement, will increase their production of labour-intensive crops.

2. In view of the fact that in the near future Vitaminka intends to flow-freeze peas, we feel attention must be drawn to a number of aspects which unless attended to could cause low quality of the final product. We must first emphasise that in particular pea-freezing is critical as regards the maturity of the crop. Two factors are involved: first the need to establish a programme of plantings which will ensure as far as possible that a sequence of crops are available for processing, and second the need to harvest, transport and process the crop as soon as its optimum processing maturity is reached.

3. Agronomic problems

We feel that the present small-scale field trials could be very considerably expanded to provide a sufficient level of statistical replication. We feel special attention should be paid to variety testing - particularly the testing of the seed of one variety procured from different sources. For example, in the United Kingdom, seed from America is sometimes found to be 5 - 6 days earlier than home-grown seed of the same variety. Such time-saving could be of critical importance in a difficult harvesting season.

4. As regards the present high level of weed contamination in the crops, we feel that rotation cultivation and the judicious use of spray chemicals would soon reduce the level of infestation to acceptable levels. Certainly this year's harvest was being made very difficult for this reason. Perhaps specific attention should be drawn to the fact that many of the "weeds" were in fact germinated grain left by poor combine settings during the previous harvest.

5. Organisational problems

We have already referred to the indeterminate level of field organisation and control - which in fact appeared to differ greatly between the two centres where peas were being harvested. With the exception of two machines, all the viners appeared to be well maintained and threshing performance was very good, with virtually nil losses. We suspect that with the limited period of time available for harvesting there was insufficient viner capacity - nevertheless the viners seen at work were not fully stretched.

6. The only communication between field and processing plant was by telephone - and this some distance away from the centre of operations. We consider that it is essential that a radio-telephone network be established. Better communications will do much to shorten the gap between harvesting and processing. The programme co-ordinator, by knowing the actual harvesting rota - the position of every transport vehicle - can then give directions to obtain optimum performance.

7. **Further training**

We fully appreciate that Vitaminka is trying to build up its own traditions and experience in this very difficult subject. We consider that some further training of the Kombinat managers and senior procurement staff of Vitaminka is called for, and accordingly recommend that a 2 - 3 week study tour to examine commercial freezing operations in other countries should be undertaken next year. We suggest that visits to Holland the UK would provide a very comprehensive background to current organisation and technical development. The Yugoslav harvest is earlier than those in both the UK and Holland, and therefore the potential clash of interests should be overcome satisfactorily.

8. The study tour should include the following aspects:

- Current agronomic practice
- Agronomic research and development
- Co-operative organisation of production and harvesting
- Commercial organisation of procurement and harvesting.

9. **Relationship with Kombinats**

In future we feel that it is essential that any one Kombinat should only make contract with one processor for any given crop - unless prior agreement is obtained from all concerned.

10. **Transportation**

At the present time we think that the transport requirement is being satisfied. At present we do not think washing and cooling plant should be installed at each Kombinat, but if for any reason the time between harvesting and processing cannot be reduced through better organisation, such an investment may have to be made.

11. **New products**

Production of a number of new crops for processing were discussed during our visit.

Green Runner Beans - this is a highly labour-intensive crop and therefore suitable for small farmers. The beans have to be grown on wirework to give sufficient height and no mechanisation is possible. It is a very popular vegetable in the UK, fresh or frozen - but because of labour costs is slowly pricing itself out of the market.

Calabrese - especially in the frozen form is very popular in most frozen food markets of significance. Calabrese of very good quality is grown in Italy, and we see little reason why production should not take place in Yugoslavia.

Maize - The market for the canned product seems to be expanding, but because of brand dominance in western markets (Green Giant) direct competition should be avoided. Vitaminka could perhaps offer and contract to pack on behalf of a major company. Currently the Dutch seem to dominate the frozen market.

Mushrooms - We understand that there is no large-scale production of this crop in Yugoslavia. All other things being equal, we can see the obvious advantage of having available a crop which could be processed in the winter. The processed market for this product has in recent years been very well developed, and we therefore consider that the investment study should include study of the market situation, particularly if an export programme is to be undertaken.

7.5 Reception, Handling and Storage of Intake Produce

1. General

All produce arriving in trays is off-loaded by hand onto pallets which thereafter are moved by forklift trucks. Although Box pallets are available, we understand that these are only used for produce after deep-freezing or for apples in the environmental store.

2. We think attention should be given to sending the road vehicle out with pallets, so that the pallets are loaded with the trays of produce while in the lorry. This would enable a fork-lift to be used for off-loading at the factory, thus increasing the rate of vehicle turn-round and lessening labour requirements.

3. In the case of closed vehicles, as recommended for handling fruit, a roller-conveyor floor can be fitted.

4. Movement of produce

We think that it is essential to keep incoming produce out of the sun, even at the expense of slightly increasing the cost of handling.

5. Storage facilities - intake

Space in the reception area for incoming produce is at a premium. Dry goods now stored in the open will be taken into a new building under construction which will help to increase the parking area. It is our view that if the incoming produce is 'graded' into pallet loads in the production area, the speed of unloading the vehicle and the allocation of produce for immediate usage and storage will enable much faster turnarounds. At the present stage, therefore, we do not see any need to increase the existing area of shedding.

6. **Cold Storage**

Vitaminka has plans to increase the capacity of cold storage by 1,000 tons, making 2,000 tons in all. We understand that the existing capacity is under great pressure at present. When the Baby-food line is in full production up to 500 tons of prepared raw material well be required to be stored; this will effectively utilise half of the capacity now being contemplated. Our view is that all 'finished' products, e.g. frozen berry fruit for export, should be stored for only a short time on the Vitaminka site.

7. In view of the high cost of new cold stores, it would be desirable to hire capacity in, say, Zagreb, for finished products, rather than create new facilities. In five years' time the current plans should have been brought to fruition, and it will be easier to determine any shortfall in capacity. Our view is that the cold storage facilities at Vitaminka should be utilised for new intake, and that finished products should be stored, and if necessary repacked, near the main centres of distribution or export.

8. The proposals which we put forward for the re-organisation of the jam production permit the continued use of temporarily preserved pulp with SO_2. This in itself will help to reduce the need to keep large stocks of frozen fruit for re-processing into jam in the stores. This again emphasises the advantage of the open-pan method of producing jam, as opposed to the vacuum process. In view of these factors, we confirm that it would be unwise to commit a very substantial financial allocation to construct new frozen capacity until a much more definite need can be shown.

Table 7.1 **Raw material intake of major fruits and vegetables 1975 (estimated) and prices at collection centre**

	1975 intake	Source	Prices Normal	Prices High quality
Fruit	tons		DN/kg	DN/kg
Cherries **Black (wild)**	800	local	(4.30)	5.30
Dark	300	"	4.50	5.00
Morello	200/250	"	6.30	7.00
Peaches	250/300	"	4.30	5.00
Apricots	(750)	Novisad	5.20	5.50
Plums	2000	local	2.00	2.40
Strawberries	200/300	Slavojnia	6.00	-
Apples	2000	local	1.20	-
Blackberries	700	"	5.00	6.00
Bilberries	16	Bugolni	-	-
Rose Hips	300/400	total Yugoslavia	5.30	-
Wild strawberries	10	local	6.30	-
Total fruit	7800			
Vegetables				
Peas	1500	local	3.80	-
Beans (green)	1000	"	3.00	-
Cucumbers	1000	"	1.50	4.00
Capsicum (Red)	1000+	"	2.55	3.00
Capsicum (white)	500	"	3.20	-
Tomatoes	1000	"	1.50	-
Carrots	150	"	1.40	1.60
Onions	-	"	3.00	-
Pepperoni	50/100	"	4.70	-
Aubergine	-	"	2.30	-
Red Beetroot	-	"	1.40	-
Total vegetables	6250			
Total fruit & vegetables	14000			

VIII General Organisation and Administration

8.1 General

1. We were invited to report on and make recommendations on the organisation of Vitaminka. We have interpreted this in its widest meaning as we feel that the management of Vitaminka would not only wish to have a free expression of view but would also wish to have some means of interpreting and evaluating our opinions.

2. First, we must emphasise that with the time available in the project area it would be impossible to give a full financial and management appreciation. We also suggest that the criteria upon which our comments are based may not take into account the fact that those Vitaminka would have chosen in the same circumstances may be very different.

3. Our approach has been to undertake a management audit which examines each function performed by the company and to award points depending on the degree of success or otherwise achieved. Each main business function is separately evaluated and is given a weighting on its relative importance. The audit selected has been based on a method of evaluation developed by the American Institute of Management as a comparative guide.

4. Management Audit Rating Table

	Optimum Rating	Minimum rating for excellence
Economic function	400	300
Corporate structure	500	375
Health of earnings	600	450
Service to stockowners	700	525
Research and development	700	525
Directorate analysis	900	675
Fiscal policies	1100	825
Production efficiency	1300	975
Sales vigor	1400	1050
Executive evaluation	2400	1800
Total	10,000	7,500

It will be seen that each function is given a relativity to the next. However, all points are scored on an entirely subjective basis. Each of the above items are given a main heading as follows:

8.2 Economic function

"What is the evidence that Vitaminka renders an essential service well and has dealt fairly well with all its public over the last ten years or more?"

1. The company was founded after the last war, to process locally produced fruit and vegetables for both home and export markets. Following the earthquake in 1969 the company suffered an immediate set-back. However, with emergency finance the premises were reconstructed and production continued and expanded.

2. Throughout its history, with the above exception, the company has shown a steady growth by developing its range of products to meet apparant home and export demand.

3. The company would appear to have been soundly managed since its inception and any changes that may have taken place have been as a result of natural expansion and the need to redefine job responsibilities.

4. Vitaminka is by far the largest food processing company in Yugoslavia with strong market domination in Bosnia and the north of the country. The company's products would appear to be competitively priced and sell well provided that a place on the shop shelf can be secured.

5. In 1972 total sales reached $8 million; these fell to $5.5 million in 1973 but recovered to $7.5 million in 1974. As an employer Vitaminka is one of the largest in the area. However, much of the employment is seasonal and as yet out-of-season employment has been slow to develop. The management is very conscious of this need and are doing their best to make the necessary adjustment.

Vitaminka therefore plays a significant part in keeping the nation fed, but recently foreign exchange earnings have been very small indeed and are unlikely to show any great growth over the next five years.

8.3 Corporate structure

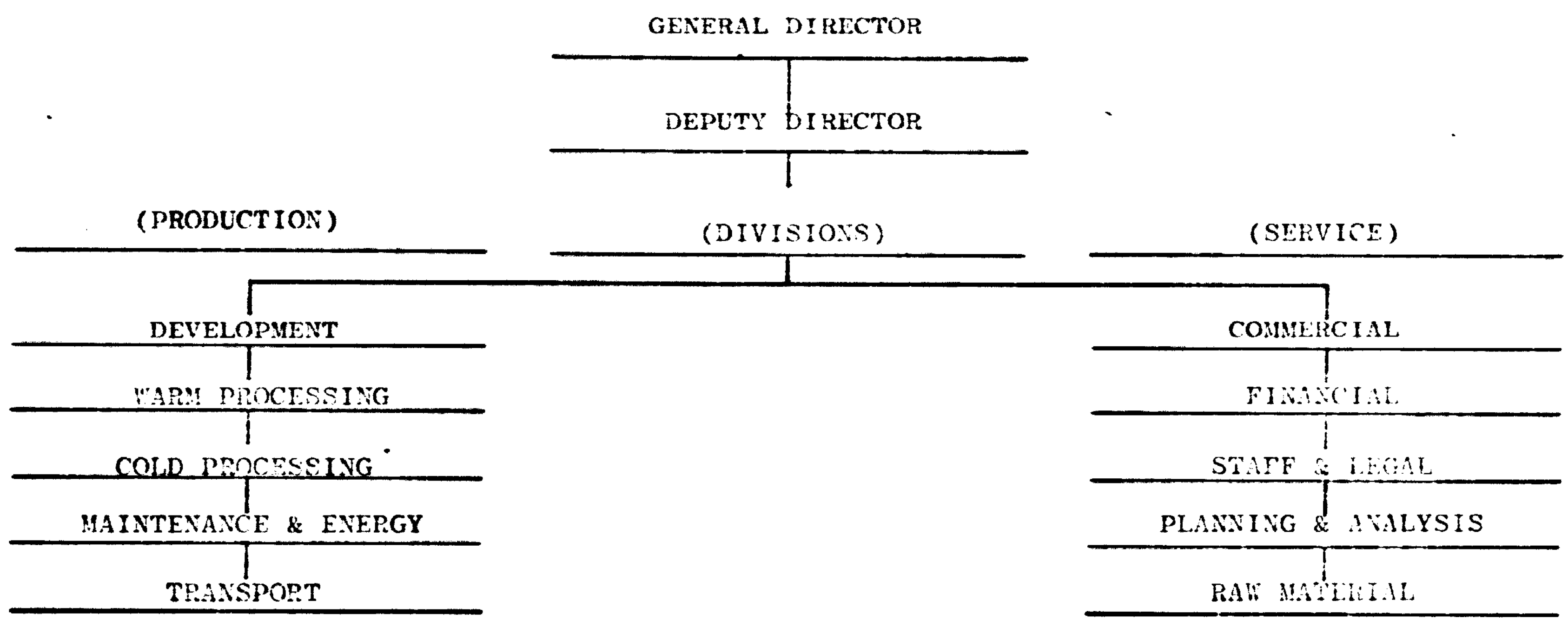
"What is the evidence that the company has good lines of communication and that every executive clearly knows his responsibilities and authority?"

1. Vitaminka is currently undergoing a period of reorganisation at management level. Our comments are therefore directed towards the new situation rather than the past.

2. The new organisation chart is set out in overleaf from which it will be seen that the company is divided into "production" and "service". However, all division report directly to the General Director, and each is headed by a divisional director. The only variation is that the Production Director is responsible for both warm and cold processing but delegates responsibility for cold processing to his deputy. Elsewhere we have recommended that the Baby Food processing unit should be completely self contained, and therefore a new division should be created.

3. Details of the functions undertaken within each division are set out in table 8.1. We have noted that in the new organisation provision has been made for a Development Division. Had such a move not been made we would have recommended it in this report. We consider that the formation of this division is essential to the future health of the company. We would, however, like to see one additional function included in the division - namely Operations Research. It would appear tp us that the highly trained staff in this department should offer a "consultant" service to the other division. We do not understand why this division should be classified as production when its function is purely service. This, however, is an internal matter.

NEW ORGANISATION CHART - VITAMINKA



A PRODUCTION DIVISION

Department	Main functions
1. Development	- Market development and research - Product research and development - Agricultural research and development - Economic and financial programming
2. Warm Processing	- Technical service - Production - Quality control - Operations planning and records
3. Cold Processing	- Production and storage - Machine service and maintenance - Technology and calculation
4. Maintenance and Energy	- Maintenance and servicing - Energy service, steam and power - Operations planning and records
5. Transport	- Internal transport - External transport - Operations planning and records

B ADMINISTRATION DIVISION

1. Commercial Section	- (a) Sales: field sales services; storage and despatch; book-keeping and sales analysis - (b) Purchasing: supply offices; storage service
2. Financial	- Financial operation and control - Book-keeping
3. Staff and Legal	- Legal and general services - Personnel - Restaurant/canteen
4. Planning and Analysis	- Statistics and information - Plan and analysis - Wages and calculation of income
5. Raw Material	- Purchasing - Storage service - Book-keeping and calculation

4. The direction of the company cannot be directly compared with that found in say a capitalist company in the USA; the difference being that the workers in Vitaminka substitute by right of law the shareholders of the company, although they have no shares as such. They can vote on all matters of major policy and indeed upon the appointment of directors. All decision of the board are taken under sufferance of the workers.

5. In essence the board of directors agree a plan annually which defines their work parameters. The General Director acts as chairman of the board at meetings and is the official representative of the company at outside meetings.

6. Production is divided into warm and cold processing but otherwise it is considered that the profitability or not of each product line is not immediately apparent to those responsible for its supervision or to the company's directors. The reason for this is that the individual product costings do not charge specific process costs to each product but spread all overhead and operating costs over the total production.

The above comment may create the impression that Vitaminka is lax in planning and financial control. This is not the case. The planning and overall control functions are excellently executed and at all times all executives are aware not only of the performance of their own division but of the company as a whole. Nevertheless we feel that we must draw attention to this significant area of individual product profitability.

8.4 Health of earnings

"What is the evidence that the company has shown real health of earnings in the last ten years in terms of its potential within the industry?"

1. Capital share

In 1974 the company was valued at about 100 million dinars ($5.9 million). Investment was split almost equally between fixed plant and equipment and buildings. As at 1975 Vitaminka had been financed as follows:

Long-term bank loan	70%
Own capital	30%

After the 1969 earthquake when the factory was destroyed the whole operation was totally refinanced. Therefore the above position is after five years of loan repayments.

2. Working capital was raised to 30 million dinars ($1.8 million) in 1974. This was due to inflation and also to the fact that major customers were extending the period normally taken for settling accounts - a situation which has not been resolved - and a further application has been made for a loan to increase working capital to 40 million dinars ($2.35 million).

3. Long-term financing is usually through the Federal Authority for Reserve together with the participation of a local bank usually in the ratio 60:40. However, after the earthquake Vitaminka was able to draw upom a special reserve fund for the reconstruction of Banja Luka.

4. **Interest rates**

Because of the problems after the earthquake Vitaminka was given a longer period to repay long-term loan and was allowed 12 years instead of 8-10 years. Interest rates vary from 3% to 8%, the short-term loans being charged at a higher rate. The interest rates charges against each amount of capital are as follows:

Capital value	Interest rate
60%	3%
20%	5.5%
20%	8%

It is anticipated that new project borrowings will be charged at 5 per cent in the future.

5. **Future investment**

Over the next five years 100 million dinars ($5.88 million) is to be set aside for new investment in processing. Of this total some 60 per cent will be spent on machinery and equipment.

6. **Return on investment**

Total income over the next five years will rise to 360 million dinars ($21.2 million) and an 8-10 per cent net profit is anticipated. In 1974 when turnover was 180 million dinars ($10.6 million) profit was 5.6 per cent on turnover - ie 10.1 million dinars ($600,000). This was lower than planned but 1974 proved to be a difficult year. Also, following the earthquake, profitability has taken time to build up, mainly due to the high level of loan repayments. Net profit on total capital employed is therefore 7.8 per cent.

Note: Vitaminka released copies of the accounts which are forwarded under separate cover. An undertaking that all financial documents would be treated as confidential was given.

7. It is not possible for us to compare the performance of Vitamika with other food processors in Yugoslavia. Every month Vitaminka sends to the Institute of Economic Expertise in Beograd a report of its financial results. In return the Institute prepares a quarterly bulletin comparing the performance of each company - this data is coded so that theoretically individual companies cannot be compared.

8. The final assessment must be that Vitaminka has achieved the financial objectives it has set itself. The company would appear to have no problem in increasing its borrowings.

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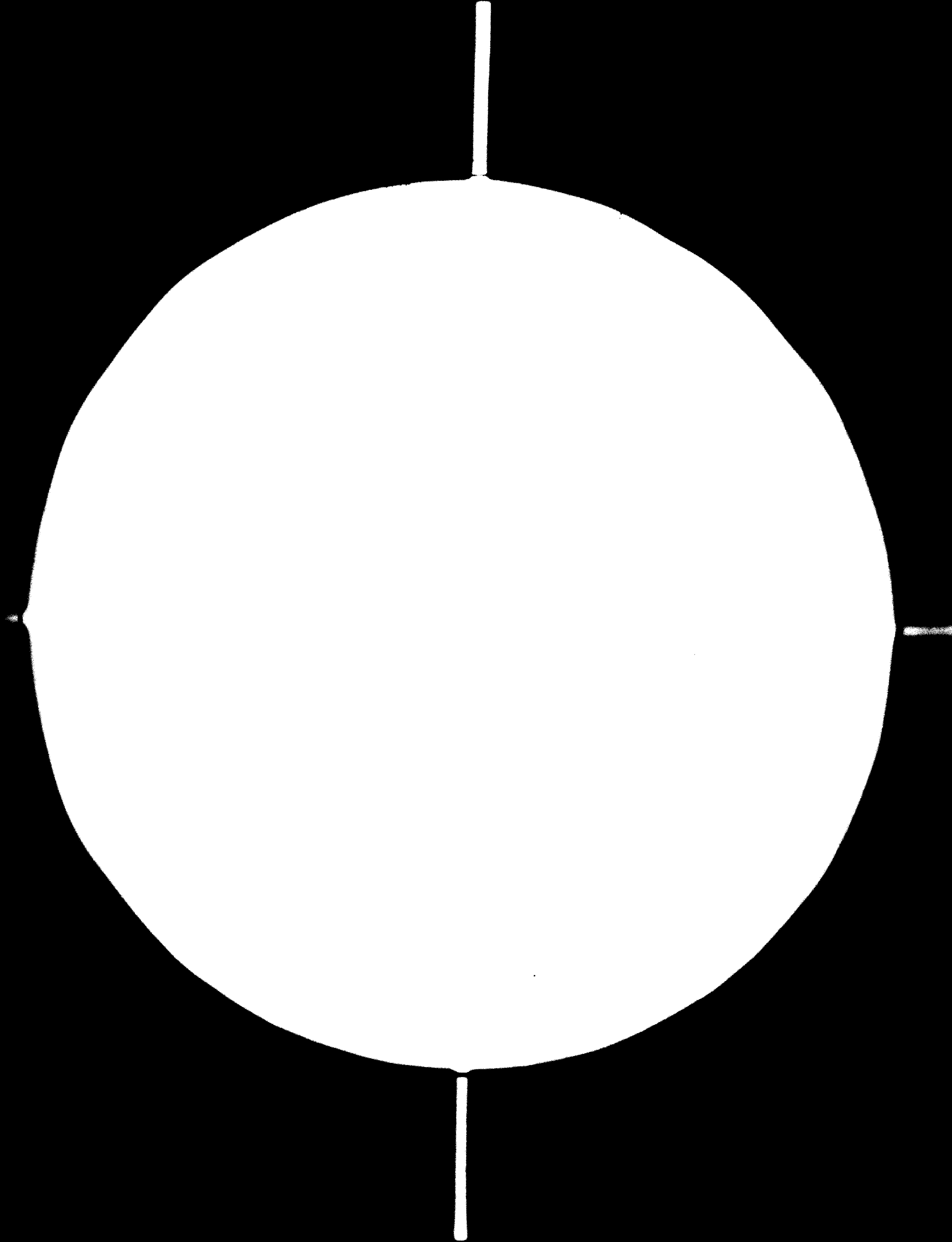

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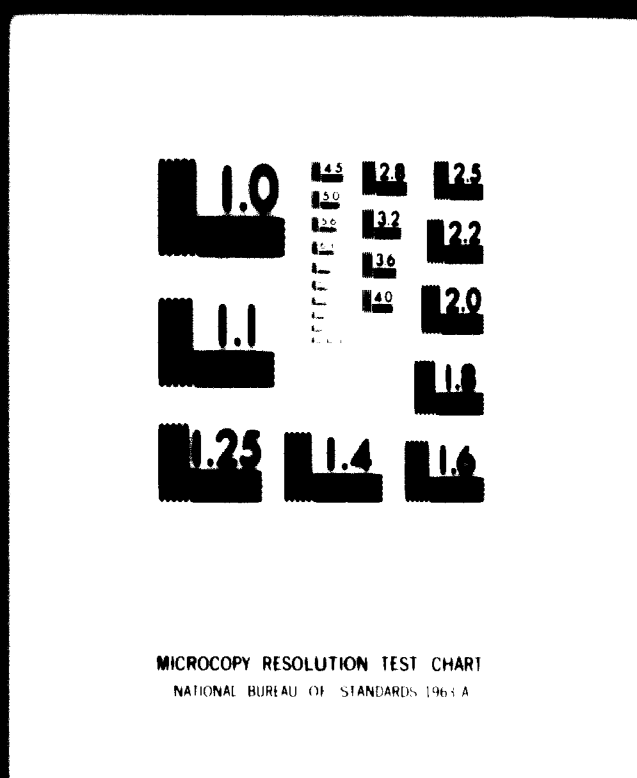

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8.5 Service to stock owners

"What is the evidence that the company has gained its stockowners co-operation and support by keeping then well rewarded and well informed?"

1. In view of the structure of the company this part of the audit was almost impossible to complete in this form. As was said earlier, the established shareholders of the company are in effect those who actually are employed.

2. In Yugoslavia each company agrees how profits should be distributed, having first paid off loans, interest payments, local and federal taxes and above all a provision for future investment. Having agreed a level of base salary, should the company make a loss the base salary is reduced by up to 20 per cent. On the other hand, there is a wide range of incentive and bonus payments. A bonus is paid to permanent and casual staff if the target has been exceeded either by using less staff or through increased output.

At the end of the year bonus payments and share of profits should amount to 25 per cent of the total remuneration. Therefore, unless a profit is made salaries are likely to be reduced by up to 40 per cent of the usual take home pay.

3. The permanent labour force is as follows:

Workers in direct production	218
Administration	53
Others	86
Total	357

Large numbers of casual workers are also employed particularly during June, July and August when the factory is at its peak production. At these times more than 300 casuals may be employed making a total labour force in excess of 600.

4. Vitaminka has been able to pay all workers the previously agreed level of profit share, and at no time has the company experienced any difficulty in recruiting either production or service labour.

8.6 Research and development

"What is the evidence that the company has done everything possible towards research in management, production methods, marketing and diversification?"

1. The only true research activities have been in the field of new product development, basically recipe formulation. The new Development Division currently being forms would in most respects seem to anticipate the major criticisms we would make in this specific area. We consider the separation of product formulation from routine quality control highly desirable as the two functions are very different. Problems arising from production quality control would otherwise be pushing the longer-term development of new products into second place.

2. By management research we mean the study of work and the necessary evaluations to promote greater efficiency. Elsewhere, we have referred to this function as operations research. In our opinion the greatest outstanding need at Vitaminka at the present time is an on-site detached evaluation of each activity, to determine whether it is necessary in the first place; if the present approach can be improved either by changes in the process or the addition of further investment; and finally a measurement of the optimum performance that should be achieved.

We emphasise that this activity should be taken into every division of the company. Consideration should be given to seeking outside technical assistance as regards the training of the Operations Research Officer. In the short term we recommend that U.N.I.D.O. should be consulted as regards the temporary appointment of a Production Adviser with wide experience of the food inudstry to help in the reorganisation recommended in this report.

3. Again no market or economic research has been undertaken and we consider the company's performance has suffered as a result. We emphasise that market research is essentially a dynamic subject and in consumer markets must be supported by sufficient funds so that the necessary field work can be undertaken. We also move that there is little information in Yugoslavia on consummers shopping habits. Continuous audit information provided by such companies as Nielsen in the West enables a close monitor to be maintained on own and competitors sales, stock, position etc. We suggest Vitaminka takes the necessary action to promote this activity.

8.7 Directorate analysis

> "What is the evidence that the company has selected a proper sized board of capable men of integrity - with outsiders on the board passing on such matters as salaries, bonuses and pensions?"

1. Again we appreciate that this definition may be more appropriate to a capitalist organisation. Nevertheless we feel some useful comparisons can be made.

2. As was stated earlier the board of the company comprises the directors of the production and service divisions. There is no external director associated with the company. On the other hand we assume that with the formation of AIPK where the General Director will be representing the company thus creating a valuable two-way exchange of information.

3. During our discussions in the project area we had the opportunity of meeting most of the key directors. Without exception we were impressed by their keenness, knowledge of their specific discipline and above all a determined loyalty to ensure that Vitaminka succeeds.

4. We identified one area where we feel there are some shortcomings. Vitaminka has a broad or lateral management structure and therefore much has to be left to the individual initiative of each director. We felt that where short-comings were apparent in one director's division, the other directors were unwilling to recognise and comment on. We think it is a matter of importance that directors should develop a more critical approach to their everyday work and contact with their colleagues as a deficiency in any one division affects all the others.

5. There would appear to be a reasonable spread in ages across the board and therefore it would seem that continuity for the future is assured.

[illegible] Fiscal policies

"What is the evidence that the company handles its capital well in all areas under all circumstances?"

1. We have insufficient information to produce historical background but even if available recent performance was greatly upset by the 1969 earthquake.

2. We consider the level of business planning and budgeting control to be of a very high order. Details of the performance of each shift are analysed not only as a means of financial control but to calculate the bonuses due to the workers.

3. Before the start of every week a detailed production programme is circulated setting out the work programmes and requirements of in-puts - ie raw materials, cans, jars, etc.

Every day a production summary of the previous day's work is prepared and circulated. This document records the levels of efficiency obtained at each shift and for each product.

Finally, a monthly summary of actual performance against the levels of efficiency obtained at each shift and for each product.

If during the analysis of the month's statistics it is found that there have been increases in planned costs an immediate enquiry is held to determine the reason.

4. Many of the individual directors hold informal meetings with their staff each morning to discuss general day-to-day matters. Every month there is a formal meeting to discuss the overall management and performance of the company. However, there is usually an unofficial meeting of directors every week.

5. Within the overall concept of the company's financial structure adequate provision is being made to create sufficient reserves to cover the increased replacement costs of plant facilities over and above the depreciation charge against earnings. Inflation accounting as such is not undertaken but those responsible are aware of the problem.

6. It is anticipated that future expansion will be financed by own reserves and from the Federal Authority for Reserves, together with supporting loans from local banks. We draw attention to one small problem area. A large proportion of the Vitaminka equipment is purchased from abroad with hard currency. Also no tin plate is manufactured in Yugoslavia and again this requires an annual allocation of hard currency. To offset this demand, it will be necessary for Vitaminka to increase foreign exchange earnings. Unless this can be done the company could find itself having to wait for its currency allocation.

8.9 Production efficiency

1. We have no comparative data for the productivity growth per worker, but compared to plants operating in Western Europe there would appear to be very high levels of manning. These are, however, offset by the fact that labour is much cheaper. For example, the cost to the factory of labour per hour is as follows:

foreman	35 dinar/hr	($2.06)
group leader	21 dinar/hr	($1.24)
skilled worker	19-20 dinar/hr	($1.12-1.18)
unskilled "	13 dinar/hr	($0.76)

2. In the future the company plans a 10 per cent increase in overall employment. This will be 4 per cent less than the increase in production for the same period. We understand that this future projection is based on past trends.

3. The factory has established quality control procedures both for the fresh and processed products During our visit it was apparent that intake quality control examinations had to take into account the overall low quality of the produce because of the poor weather conditions. Consignments were being accepted which in our opinion would otherwise have been rejected in a normal year.

As regards the finished products, all tests were being undertaken in the factory except for micro-biological examination. No consignment could leave the factory until the results of this test were known.

4. The company has not been subjected to labour disputes of any magnitude and in view of the participation in the company by all workers why should there have been?

5. A fairly flexible approach to production schedules has to be kept because of the high degree of seasonality of the produce. However, on the long-term basis we feel that the presence of a market research executive soon to be appointed will enable a tighter liaison between sales forecasts and production schedules to be maintained.

6. We have already drawn attention to the fact that the individual profitability of each product is not readily apparent because of the method of analysis chosen. This is a serious short-coming particularly as we feel some rationalisation of products and/or pack types and size must take place if the factory is to become more efficient.

7. We feel that the existing procedures for job evaluation and merit rating are not sufficiently definitive and must be improved upon. During own investigation we were unable to obtain details of job specifications and as a result we are of the opinion that much greater attention must be given to the service side of the enterprise in the future.

8. We consider that the productive efficiency was being affected by poor quality maintenance. There appeared to be no formal planned maintenance routine and on occasions machines in line service were obviously out of tune for lack of vital attention.

9. We have also been highly critical of the poor hygenic standard throughout the factory. Although routine washing down procedures were theoretically in existence they were not being adhered to. We regard this as the most serious area of criticism we have had to make. The fact must be stated that as long as the current standards of hygiene are in existence products from the factory will be totally unacceptable to a number of leading retailers in Western Europe.

8.10 Sales vigor

"What is the evidence that the company handles its sales problems aggresively, ethically and effectively?"

1. Because of the system of distribution in Yugoslavia whereby the wholesalers buy and distribute only to their own shops the company only has to deal with a relatively few customers. All export sales have to be negotiated through a central export agency.

2. Overall, some 64 per cent of Vitaminka sales are in Bosnia but good markets also exist in Croatia and Slovenia. Because of the increasing costs of transport, markets further afield become too unprofitable.

3. The company does not regularly rely on market research field work as a means of estimating demand for its products. However, a number of macro/economic commodity reports have been prepared in the past.

4. Market price is first theoretically calculated and then a price is fixed in relacion to other products. In jams for instance Vitaminka aims for the premium end of the market. However, the wholesalers are in a very strong position and would often appear to take the initiative. This is a position which is of much concern in the company.

5. To date advertising has been limited to trade journals only, but it could be that a consumer advertising programme might help to break through the "wholesale barrier". Vitaminka have opened warehouses in Zagreb and Rijaka where retailers can themselves collect their deliveries on a cash and carry basis, which is helping to greatly expand turnover in each area.

6. In order to achieve a higher level of sales Vitaminka will have to become more competitive and agressive in those markets it can best serve. In this adynamic programme of market research will be the essential precursor.

8.11 Executive evaluation

(a) "What is the evidence that the company now has a good executive staff at first, second and third levels?"

(b) "What is the evidence that the company locates men of integrity, ability, and industry and then utilizes every sound means of recruiting, training, developing and advancing these men as well as separating those who do not measure up to their jobs."

(c) "What is the evidence that the company has built a strong unity of command that will undoubtedly continue beyond the term of the incumbent president?"

1. All executive appointments are filled by means of open competition. First the appointment is advertised and a short list of suitable candidates prepared. These candidates may be asked to prepare in writing a detailed programme as to how they would approach the job. Finally each senior candidate is interviewed by the Board, and an appointment is offered. The successful candidate will then be confirmed in his appointment by the Collegium of all workers.

2. We noted that there were no executive training programmes in existence, a shortcoming which we feel might be rectified in the near future. Likewise at top management level no arrangements had been made for this activity to be pursued. However, in this case we feel that the more immediate requirement is to increase individual experience through study tours, preferably out of Yugoslavia.

3. Because of the level of management structure of Vitaminka and the defined methods of control which are in existence, the problem of executive succession is possibly not so important as with a more pyramidal structure. We have gained the impression that senior appointments would in most cases be made from outside.

8.12 Conclusion

1. We set out below our numerical evaluation.

Economic Function	300
Corporate Structure	350
Health of Earnings	400
Service to Stockowners	500
Research and Development	350
Directorate Analysis	600
Fiscal Policies	700
Production Efficiency	600
Sales Vigor	800
Executive Evaluation	1500
Total	6100

2. In undertaking this exercise we have tried to give a genuine appreciation of our views and have awarded high scores for what we consider to be good, just as we have had to deduct points for those aspects we feel should be improved.

3. In several years time we would expect Vitaminka to score at least the minimum rating for excellence, which we think should be the basic criterion of any ambitious and go-ahead organisation.

8.12 [illegible]lusion

1. We [illegible]ut below our numerical [illegible]ation.

Econom[illegible]unction	300
Corpora[illegible]ructure	350
Health of [illegible]ings	400
Service to [illegible]kowners	500
Research and [illegible]elopm[illegible]	350
Directorate An[illegible]is	600
Fiscal Policies	700
Production Effic[illegible]	600
Sales Vigor	800
Executive Eva[illegible]n	1500
Total	6100

2. In und[illegible]g this exercise [illegible]ave tried to give a genuine appre[illegible] of our views and h[illegible]warded high scores for what we [illegible]er to be good, just as [illegible]ave had to deduct points for [illegible]aspects we feel should be [illegible]oved.

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APPENDIX I

Aroma Recovery and Retention in Liquid Foods During Concentration and Drying Part 1 Processes

Chaim H. Mannheim PhD **and Nehama Passy** MSc

The aromatic quality of a food is determined by the bouquet and strength of a complex mixture of volatile odorous compounds. During processing many valuable compounds are lost with water vapours. This paper reviews the process of preserving or maintaining the typical aromatic bouquet.

IN the process of concentrating or drying of foods, such as fruit and vegetable juices, milk and coffee, many volatile components are removed with the water vapours (Fig. 1). These volatiles, which are present at very low concentration (ie ppm or ppb range), constitute the specific aroma of the food which is the characteristic quality that distinguishes one food from another and often determines its quality and consumer acceptability. The aroma compounds consist of esters, aldehydes, ketones, alcohols, mercaptans, amines etc and they vary in their solubilities, boiling points and molecular structure.

During concentration and drying, beside aroma losses, changes may occur which affect the "aroma" quality of the product. The appearance of a "cooked" flavour or an oxidised flavour are examples for detrimental changes. On the other hand the development of dimethyl sulfide during tomato juice concentration is considered to be a desirable change[1].

The principal processes existing today in the food industry for preserving or maintaining the typical aroma bouquet are:

1. Recovery of the aroma by removing it from the food before or during the evaporation process and concentrating it into an essence. The essence has to be reincorporated into the final product in the right proportion, so that the product will be acceptable and in such a fashion that losses during storage will be minimized. Examples of such processes, which will be mentioned here are: evaporation, gas stripping extraction and adsorption.
2. Retaining the aroma in the product, or a portion of it, during the water removal process. Freeze concentration, reverse osmosis and centrifugal separation are examples for such processes.
3. Fortification of the final product with natural or synthetic essences in stabilized form.

(¹)Dr Mannheim is Professor of Food Technology in the Department of Food Engineering and Biotechnology, at the Technion - Israel Institute of Technology in Haifa, Israel.

(²)Mrs Passy is working as research engineer in the Food Industries Research and Development Station at the Technion Research and Development Foundation, Haifa, Israel.

Aroma recovery processes during concentration

In the conventional systems for recovering volatile flavours, the feed material, which is an aqueous solution containing volatiles, is subjected to heat to vaporize part of it. The resulting vapour fraction, containing water vapour, volatile flavour components and non-condensable gases, is separated from the residue (the stripped juice) and condensed (Fig. 2). The vapour fraction is then passed to a system for concentration of the volatile

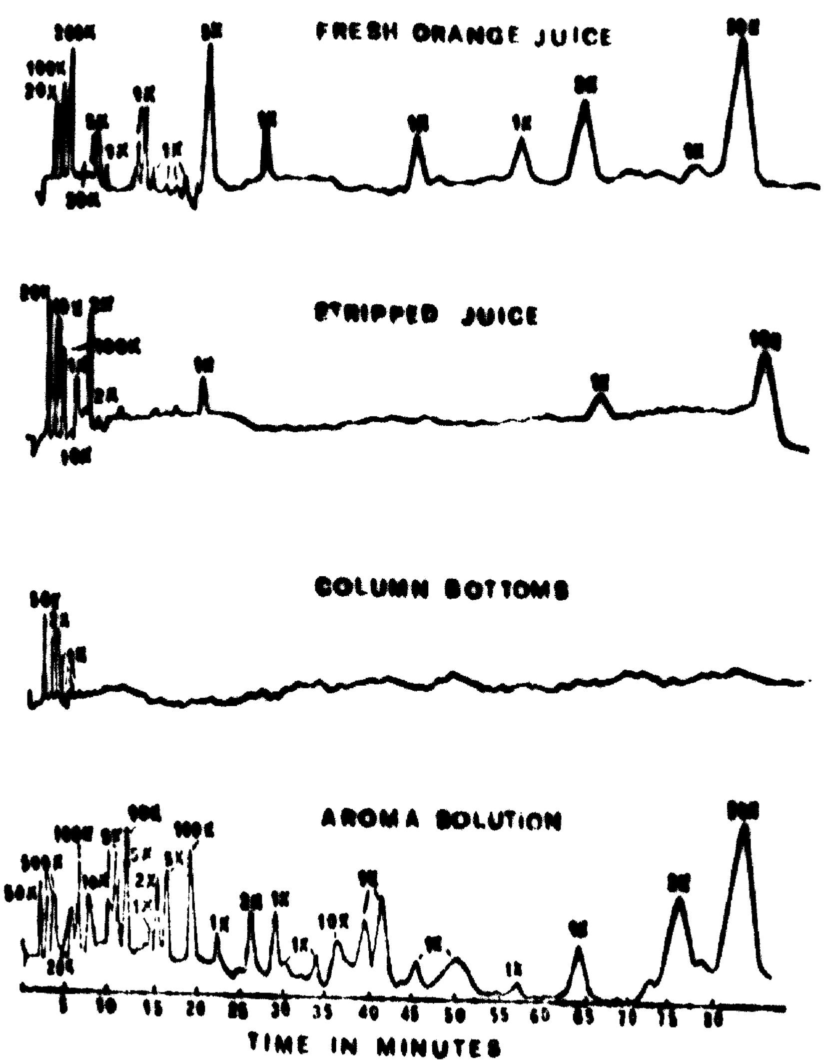

Fig. 1. Headspace gas liquid chromatogram of orange juice streams during concentration.

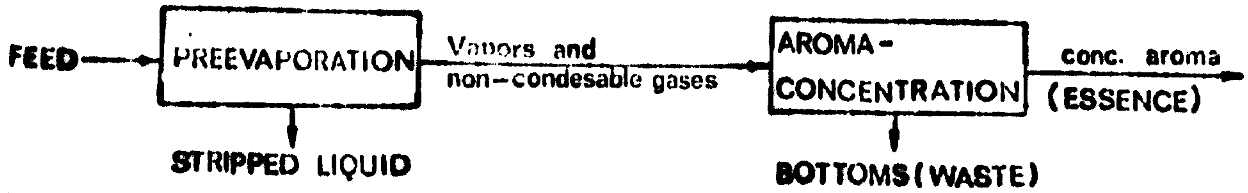

Fig. 2. Schematic diagram of aroma recovery process.

flavours to an essence, so that it may be added to the final product.

Fractional distillation, stripping or extraction are forms of aroma concentration. Usually, the aroma is concentrated 100-150 fold, i.e. in a volume corresponding to 1/100-1/150 of its initial volume.

The choice of the evaporation process depends on the nature of the food and the aroma. If the aroma is generated by heat (as in cooking of poultry, meats, vegetables, soups, etc.), and the products are not heat sensitive, atmospheric evaporators or vacuum pans may be used. If the product and the aroma are heat sensitive, such as in citrus and tomato juices, coffee, milk, etc., evaporators with short residence time and low temperature - are used. Viscous products which tend to foul the heat transfer area need specially designed evaporators, such as wiped film, agitated film or scraped surface evaporators. The subject of choosing an appropriate evaporator for various foods is reviewed by Thijssen[1] and by Mannheim and Passy.[2]

Theoretical background

In any aroma recovery process the aroma is transferred from the liquid food to another phase. This second phase may be a gas (evaporation, gas stripping), a liquid (liquid extraction) or a solid (adsorption). The dilute aroma must be concentrated so it can be incorporated back into the food.

The separation of an aroma component can be achieved only if its distribution in the two phases (the food phase and the aroma containing phase) is different. This difference is expressed thermodynamically by the selectivity factor - β_{ij}.

$$\beta_{ij} = \frac{y_i/x_i}{y_j/x_j}$$

where y_i and x_i are the vapour-phase mole fraction and liquid mole fraction of component i respectively, and y_j and x_j for component j. When this value is large, almost complete separation of the component is possible in a single stage, otherwise many stages are necessary to separate the different components.

For *vapour-liquid* systems the selectivity is designated by its relative volatility. This parameter for an aroma compound which is infinitely dilute (as compared to water), at a given temperature, is proportional to the product of its activity coefficient and vapour pressure of the compound.

Multicomponent solutions of aroma are very complex to describe thermodynamically. However, due to the fact that aroma occurs in food in very low concentration, the calculation of the relative volatility is simple and possible provided that activity coefficients of the components and their vapour pressure are known, and their total concentration do not exceed 10^{-3} mole fraction.[1]

It was found that in dilute aqueous systems, high-boiling compounds are more volatile than low-boiling compounds. This arises from the fact that within a homologous series the relative volatility increases with the lengthening of the hydrocarbon chain. The decrease in vapour pressure is more than compensated by an increase in activity coefficient. The activity coefficient depends on the nature of molecular interaction in the liquid phase, i.e. it is a function of the pressure, temperature, and composition of the mixture. For small pressure changes, the variation in activity coefficient is negligible. Temperature has a significant effect, but for small temperature changes simple correlations may be applied. In cases where aroma solutions are very dilute, changes due to concentration are neglected. However, due to the existence of solutes the equilibrium is altered because of the changes in the activity coefficients.

The relative volatility of an aroma compound in water can be estimated from available correlations and models in the literature. When these methods fail, the relative volatility must be determined experimentally.[3,4]

The situation gets more complex when dealing with systems that have an essential oil and lipid (triglyceride) phase (citrus juices), since these phases alter the vapour-liquid equilibrium, and thus the relative volatilities. The calculation and use of the relative volatilities of aroma solutions is a factor of prime importance in the design of the aroma recovery process, as it gives the distribution of the volatile aroma compounds in the various stages of the rectification process.

In *liquid-liquid* equilibrium (liquid extraction) the aroma compounds distribute between two liquid phases, namely an aqueous phase, called the raffinate, and a solvent phase, called the extract. The selectivity is than:

$$\beta_{iw} = \frac{y_i/x_i}{y_w/x_w} = \frac{p_i^{(s)}\ j_w^{(w/s)}}{j_i^{(w/s)}}$$

where y_i and x_i denote concentrations of component i in the solvent phase and in the aqueous phase respectively, y_w and x_w are the water concentration in the solvent and aqueous phases and j_i the proper activity coefficients. The activity coefficients for the solvent can be calculated from solubility data, and those of the aqueous phase from calculations and measurements, as mentioned before.

Evaporation

Milleville and Eskew[7] demonstrated methods for the recovery of concentrated essences from apple and other non-heat sensitive fruit juices making it possible to manufacture continuously juice concentrates which contain most of the original aroma.

The basic stages of this process for apples are: superheating the juice; flash-vaporization of 10% to 20% of the juice at atmospheric pressure; separating vapours from the unvaporized juice, (the vapours are now concentrated about ten fold) and are then fractionated at atmospheric pressure to obtain a concentrated essence.

This process was successfully adapted to other fruits, and may be used with most non-heat sensitive fruits, such as apples, grapes, cherries, and berries.[8,9]

The potential heat damage to the stripped juice during or immediately following the stripping is of vital importance. Consequently, essence recovery must be designed to remain within the heat tolerance limits of the particular product being stripped.[10] Juices which are too heat-sensitive to be concentrated at atmospheric pressure and high temperatures, such as citrus juices, coffee, milk, etc., must be handled at sub-atmospheric pressures. In this case, the liquid food is concentrated under vacuum, and the volatile flavours in the vapour phase are recovered by condensation at low temperatures.

The aroma removal from liquid foods is further complicated by the presence of dissolved solids, insoluble substances, emulsions, or high concentration of alcohol. Pectin or suspended pulp may absorb aroma components and influence aroma partition between a fruit juice and its vapour.[4] Aroma molecules distribute between the aqueous phase and the oil phase, altering significantly the vapour-liquid equilibrium.[11] In orange juice, for example, d-limonene which accounts for 90-95% of orange oil, is part of the water insoluble fraction of the aroma. Massaldi and King[12] found that this substance actually dissolves in three liquid phases: the aqueous phase, the lipid (triglyceride) and the essential oil phase.

Another difficulty is the removal of air and non-condensable gases in the aroma recovery system, since most fruit juices contain air which is released with the vapours. Special precautions have to be taken to prevent losses of valuable volatiles with the vent gases. These gases are passed through a scrubber wherein they are brought into contact with an absorbing liquid such as water, for absorbance of the flavouring components. While these scrubbing systems work well in cases in which volatiles are water-soluble they were found to be ineffective in cases of nonpolar volatiles. In addition to the problem of high losses of volatiles with the vent gases in the vacuum system, there is the problem of modification of the apparatus as regards its size. The system (fractionation column and some other vapour handling parts), must be enlarged to accommodate the much larger volume of vapour existing under vacuum conditions. Also, the loss of volatiles in the vent gas is roughly in inverse proportion to the absolute pressure at which the system is operated.

The major advantage of reduced pressure distillation is the diminished danger of an artifact flavour formation. Consequently, essences recovered from vacuum systems are much richer in materials of low volatility, and poorer in materials of high volatility, and thus may not closely resemble the flavour of the original food.

A patent by Mojonnier Bros[11] combined the aroma recovery of grape juice with concentration performed under atmospheric pressure in the essence recovery stage, followed by vacuum evaporation to the desired concentration. In this process 90% of the aroma of grape juice is removed by evaporating 30% of the water atmospherically followed by concentrating the aroma 150 fold in a fractional distillation column. This process is not suitable for citrus, since in the concentration stage the juice is subjected to atmospheric pressure. Bombon *et al.*[14] described a new method based on a low temperature evaporation, using a liquid-sealed vacuum pump which at the same time served as a compressor and absorber of the volatiles from the noncondensible gas stream. This process was named *WURVAC*. The same basic idea was patented by Brent *et al.*[15]. Another method of aroma recovery under vacuum was developed by Wolford *et al.*[16]. This method is particularly applicable to the low-temperature evaporators, and the essence is recovered before the juice is fed to the evaporators. About 15% of the juice is evaporated and the volatiles are concentrated in a series of condensers until the volume is about 1/100 of the original juice

Gas stripping

The transport of vapours can be also achieved by sweeping the boiling mass of a liquid food in the evaporator with an inert gas such as nitrogen. Smith and Conwell[17] used a system in which the volatile flavour materials were removed in a nitrogen stripping column. In this process, the heated feed material was directly brought into contact with the inert gas in a stripping column while at atmospheric pressure, and this gas containing the volatiles was returned into the cooled concentrate. The *WURVAC* process was modified by Bombon *et al.*[18] by the introduction of a stream of nitrogen at the bottom of the stripping column, and collecting all the aroma in the vacuum pump sealant. In this way, the aroma can be collected in any food grade solvent used in the pump. It is best achieved by applying low temperatures in the condenser, and low gas velocities. The low gas velocity reduces entrainment and losses with the vent gases which might occur. Another modification of the *WURVAC* was described by Bomben *et al.*[19] making aroma concentrates suitable for dehydrated products. In this modification a nitrogen stream was introduced at the reboiler, passed through the distillation column carrying over all the aroma from the condenser to a diaphragm vacuum pump (Decora), and to traps cooled with dry ice and acetone at atmospheric pressure where the volatiles were condensed. The authors claimed that they obtained 1,000-2,500 fold essences from orange, apple and tomato juices.

Another method of aroma stripping is by steam distillation. Many of the essential oils presently used are obtained by steam distillation of flowers, leaves, kernels, bark, etc. Even today the practice of steam distillation in the cosmetic and food industry remains more an art than a science because the essential oils are usually mixtures of complex organic compounds. A recent review on steam distillation basics is given by Ellerbe.[20] Steam distillation is also used in the coffee industry to remove aroma from roasted and ground coffee prior to extraction.[21] The coffee particles are first wetted by means of the condensing steam, and then steam stripped at varying temperatures and pressures. Steam stripping can also be used to concentrate watery aroma solutions in a stripping column.

Liquid extraction

In a liquid extraction process, a solvent is mixed with a food material or aroma solution, allowing sufficient contact time for the aroma to achieve equilibrium distribution between the two phases, separating the two phases and recovering the solvent. The proper solvent should have a high selectivity β, so that its amount will be minimal and also so that the distribution of aroma favours the solvent. Other requirements are that the solvent should be non-flammable, non-toxic, chemically non-reactive, have a different density than the aqueous phase, recoverable and be relatively inexpensive. Such a process, using liquid carbon dioxide under pressure for the recovery of aromatic compounds from fruit juices, was suggested by Schulz and Randall.[22] Liquid carbon dioxide is a selective solvent for the aroma constituents of fruits, such as esters, aldehydes ketones and alcohols. Sugar, acids, salts, amino-acids, oils and water are insoluble in it. Highly concentrated aroma concentrates, in the order of 100,000 fold were achieved.

Carbon dioxide as a liquid can exist at a temperature range of −56 to +31°C, at corresponding saturation pressures of 5.1 and 73 atmospheres. Solubility favours operation at the higher temperature and pressure range.

Adsorption

In adsorption, some solid surfaces have the property of binding selectively various compounds from a mixture. The adsorption may be physical where the bonding between the adsorbing solid and the adsorbed compounds is reversible, i.e. by raising the temperature, reducing gas pressure or extracting with a solvent, the adsorbed compounds may be removed from the adsorbent in an unchanged form, or it may be chemical and irreversible adsorption.

The selective ability of charcoal to adsorb aromatic substances was used by Gross and Rahal[23] and by Rahal.[24] Charcoal has the great advantage of having low affinity for water. It provides a large surface area for adsorption and a great capacity for the adsorption of organic compounds. Even traces of such compounds are picked up from aqueous vapours and liquids. The efficiency of adsorption is not diminished by dilution, but it is likely that artifacts are formed, mainly depending on charcoal quality. The aromatic compounds are back-extracted by a suitable solvent, with no tendency to form azeotropes, and with low surface tension. However, separation of aroma from solvent, without losses, poses a problem. This process is not used commercially for aroma recovery.

Aroma retention during concentration

In concentration processes where the aroma is retained in the product, water is selectively removed from the liquid food by one of several ways. Freezing and crystallization of ice crystals and their separation from the concentrated liquid, i.e. freeze concentration, is one way. Permeation of water through a selective membrane by applying a driving force for water transport, i.e. reverse osmosis or ultrafiltration, is another way. Still another way is the centrifugal separation of pulp from serum (in juices), concentrating the serum and combining with the pulp which contains all the aromatic substances.

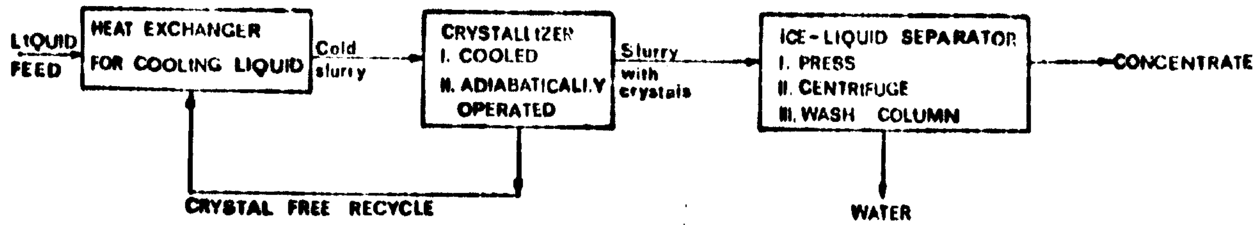

Fig. 3. Schematic diagram of freeze concentration process.

Aroma retention processes during concentration

Freeze concentration

In freeze concentration water is removed from a solution by freezing and separation of pure ice crystals. While freezing juices, water forms an eutectic mixture (of ice and hydrate) with other components present in the juice. The ice crystals formed are of rather high degree of purity, and the remaining material is left in a more concentrated form (Fig. 3).

Concentration by this method offers a product with exceptionally good qualities as compared to evaporation. The volatiles are not lost at these low temperatures, thermal degradation is prevented and modification of flavour due to chemical reactions and changes of colour are minimized.

The extent of concentration is influenced by the product characteristics and the rate of freezing. The selectivity of the dewatering is completely controlled by the efficiency of the separation of ice from the concentrated liquid.[4] This efficiency is determined by the specific area of the ice crystals; the smaller the area the lower is the amount of mother liquor occluded within or between the ice crystals, which is the main source of losses in this method of concentration. Crystallizers therefore must be designed toward the formation of large ice crystals. Equipment for such freezing systems employs crystallizers with direct or indirect heat removal. In direct heat removal the solution is circulated in a vacuum chamber, part of the water evaporates removing heat from the solution, and these vapours are compressed and condensed. In indirect heat removal the coolant is separated from the liquid by a metal wall.

The ice-liquid separation may be performed in a centrifuge, a press, a washcolumn or a combination of these devices. If a centrifuge is used care must be taken to avoid flavour losses due to gas stripping in the centrifuge.

Undoubtedly freeze concentration is a superior method from the quality aspect, however it has found only very limited application in industry. Initial investment costs are five to ten times those needed for evaporation and operating costs are also considerably higher despite the fact that only 81 kcal/kg are required for freezing as compared to 540 kcal/kg needed for evaporation at atmospheric pressure. Furthermore, other methods of flavour recovery or retainment achieve good results at much lower costs and by using simpler systems.

Reverse osmosis and ultrafiltration

The use of selective, semipermeable membranes for removing water from liquid foods, is attractive due to the fact that membranes can be operated at ambient temperatures without heat damage to the product and without change of phase.

Membranes are now available in a wide range of porosities from "open" ones for ultrafiltration, to "tight" ones suitable for reverse osmosis. A major difficulty in membrane transport techniques is the "concentration polarization" phenomenon. This increases the osmotic pressure near the membrane thus reducing the flux through it significantly. Additional difficulties are the masking of the membranes with oils from the food and formation of gels, enforcing a frequent change of membranes, making the process uneconomical.

Merson and Morgan have used a modified cellulose acetate membrane for the concentration of apple and orange juices. Tight membranes were required to retain the water-soluble aroma compounds found in apple juice. However, oil soluble aroma substances of orange juice were completely retained even with "open" membranes. This indicated that, in order to retain all the water-soluble aroma constituents, permeation rates had to be reduced to about 35 l/m² per day. Another disadvantage of this method is the concentration limit of 35 to 45° Bx and difficulties caused by the presence of pulp. So far, the advantages in power savings have not been compensated by above disadvantages and membrane techniques are not used commercially in the fruit juice industry.

Centrifugal separation

A different approach to assure a "fresh" juice taste in the final product is that involving removal of a portion of the juice prior to concentration or the use of some fresh juice and its combination with the concentrate. The part to be removed should contain most of the typical aromatic components of the specific juice. In the case of citrus, the fresh bouquet of the juice is mainly attributable to the essential oils, but it has been shown that the water soluble components also play an important role (Fig 4).

Methods applying the retention principle include the addition of fresh juice to concentrates with or without added peel-oil called "cutback", using an oil-juice emulsion obtained by the centrifugation of fresh juice, followed by concentration, or centrifugal separation of pulp prior to concentration. Meinzer described a method of concentrating citrus juices by separating pulp and serum from the juice by centrifugation, freeze-concentrating the serum, and recombining the concentrated liquid with the pulpy material containing all the aromatic substances. Lund separated the pulp from the juice of select oranges, heated the wet pulp to deactivate enzymes, and recombined it with the serum. This portion was used to fortify concentrate made from low quality fruit.

Several patents involving the centrifugal separation of juices in the production of citrus concentrates have been issued. The difficulty in this process concerns the heat treatment necessary for cloud stabilisation, which may alter the flavour of the product.

Peleg and Mannheim investigated such a process, and found it practicable to obtain a high quality and stable frozen orange concentrate by separating juice into serum and pulp, concentrating the serum alone, and recombining it with chilled pulp (Fig 5). As compared with other similar processes, the pulp was not subjected to any heat treatment, and therefore all the aromatic compounds in it were retained undamaged. The concentrate was stable, despite the presence of active enzymes, since the final product was at about 55°Bx, at which concentration enzymatic activity at low temperatures is negligible. Great care must be taken to keep the separated pulp chilled or frozen until reincorporation into the concentrate, and the final product must also be preserved in the frozen state.

Another advantage of concentrating the low viscosity serum separately is the achievement of better heat transfer coefficients, facilitating concentration, enabling the attainment of higher concentrations, and reducing browning-damage to a minimum. Bolin and Salunke compared flavour losses occurring in juices during concentration processes, and found that freeze-concentration resulted in the least losses, with slightly higher losses in the diffusion membrane concentration method. Concentration by reverse osmosis of apple, peach and cherry

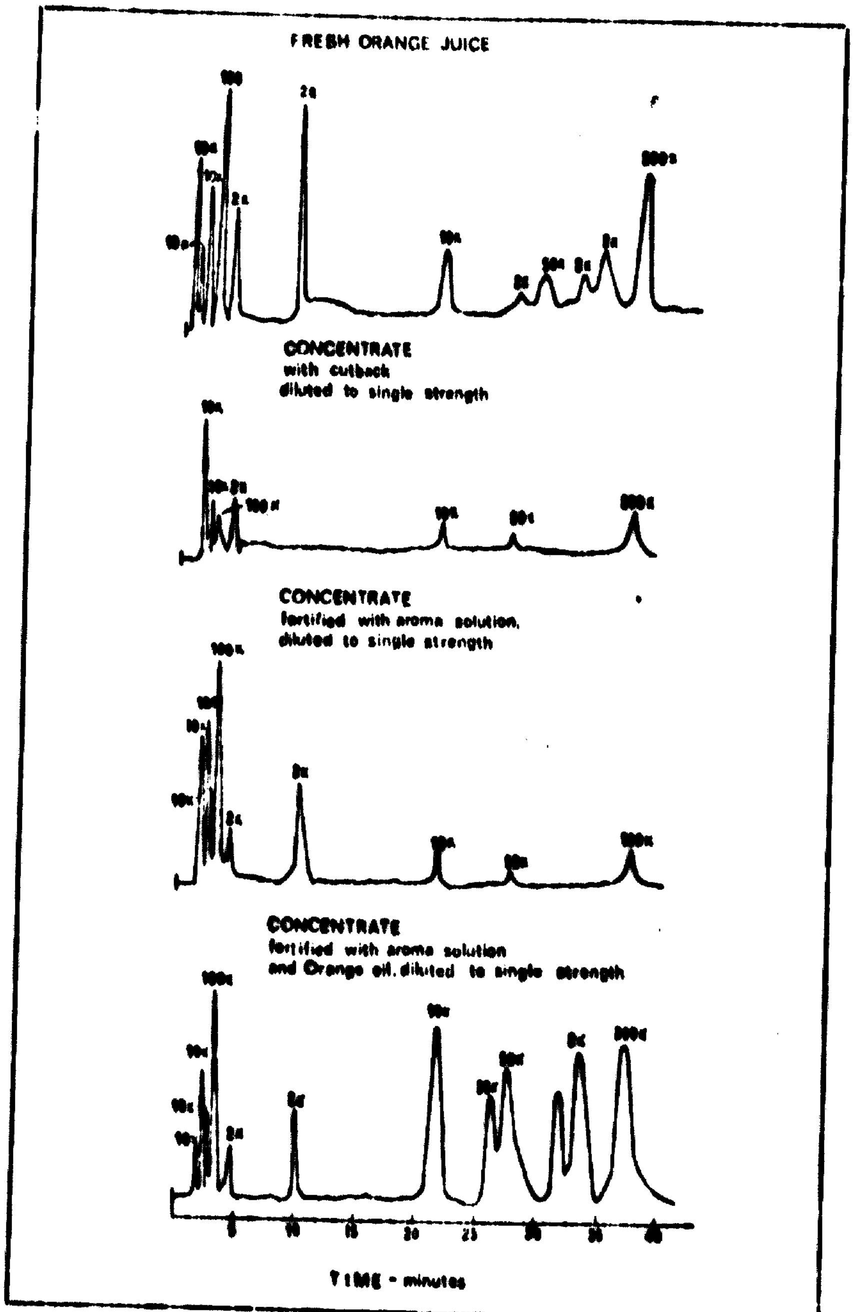

Fig. 4. Headspace GLC analyses of orange concentrates diluted to single strength fortified with aroma and orange oil as compared with fresh orange juice.

Table 1. Average volatile retention of fruit juices concentrated by various methods.

Juice	*Freeze conc.* (%)	*Diffusion membrane* (%)	*Reverse osmosis* (%)	*Foam-mat dried* (%)
Apple	63	8	16	6
Cherry	69	56	26	37
Peach	—	56	27	20

juices resulted in noticeable flavour losses (Table 1).

Aroma retention during drying processes

Owing to their higher relative volatility, most aroma components tend to escape more rapidly than water during drying operations. The loss of aroma during drying is controlled by convective and molecular transport in the specimen.

There will be a significant aroma retention during drying only if the aroma molecules in their way to the evaporating surface are less mobile than the water molecules.[7] This can be done by lowering the water concentration at the evaporating surface very quickly, forming a thin layer which is permeable to water only and which is retaining the aroma compounds present in the sample (Fig. 6). Such a rapid decrease of the surface water concentration can be obtained in spray drying and in freeze drying.

Foods are divided into two groups in regard to heat and mass transport; structured foods which become porous during drying (potatoes, carrots, etc.), and liquid foods (coffee, milk, fruit juices, etc.). Thijssen[17] summarised optimum process conditions for obtaining maximum retention of aroma during dehydration as follows:

(a) High initial dissolved solids concentration;
(b) in air-drying—high liquid temperatures; in freeze-drying—low drying temperatures;
(c) High molecular weight of dissolved solids;
(d) High molecular weight of aromas;
(e) High mass transfer coefficient in the phase surrounding the drying sample and low moisture content of that phase;
(f) Absence of circulation currents in drying liquids;
(g) Large dimensions of drying samples.

These favourable conditions can be obtained during spray-drying, freeze-drying and slab-drying. This subject was extensively reviewed by King[11], Bomben *et al.*[4] and Punting *et al.*[3]

Spray drying

Spray drying is one of the most widely used techniques for drying liquid foods, such as milk, eggs, coffee and tea extracts. Spray drying consists of dispersing the liquid food into a stream of hot air in tiny droplets, drying the droplets almost instantaneously and separating the dried product from the air stream.

When the liquid is sprayed from the atomiser disc or the nozzle in the form of droplets, the heat of evaporation is transferred by convection and conduction from the hot air to the droplet surface, and vapour is transferred by diffusion and convection back to the gas stream. Due to the high mass transfer coefficient in the gas phase, the droplets form a "dry skin" on their surface permeable to water only, thus inhibiting aroma losses from the surface and retaining the aroma still present in the droplet. When the vapour leaves the droplet, from its wet center, a balloon-like expansion of the droplet occurs, and the droplet now loses volatiles from the inside of the balloon wall Rulkens and Thijssen.[42] The usual form of the dried particles is a hollow, thin-shelled sphere.

Process conditions resulting in reduction in aroma losses were found to be a combination of high feed concentration and a feed temperature just high enough to enable good atomisation. In spray drying of coffee extract, Sivetz and Foote[7] report retention of volatiles up to 100% when the dissolved solids concentration was increased. A similar effect was reported by Thijssen and Rulkens[3] for the retention of model aroma components

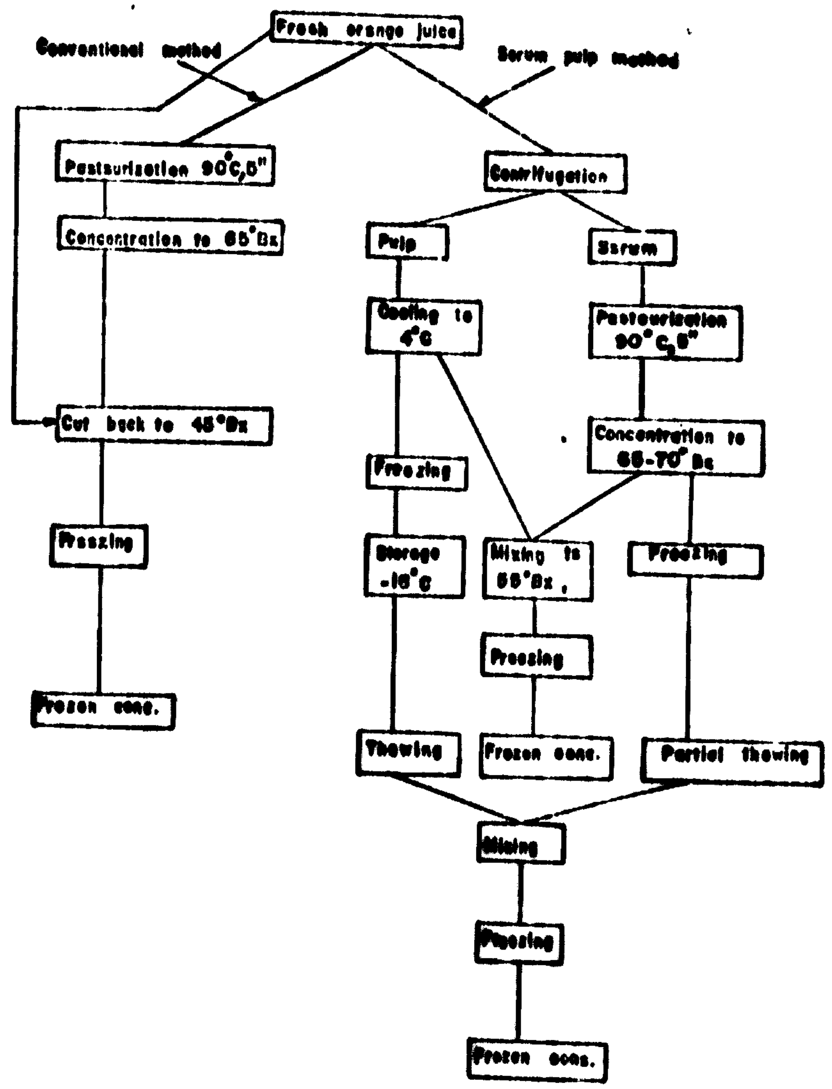

Fig. 5. Schematic diagram of conventional and serum—pulp method for preparing citrus concentrates.

in coffee extract. A novel development, so called "duel-drying" seems very promising. In this method the droplets are first partially dried in a spray-drier and then transforred to a bod-drier where they are completoly dried. This combination of two different drying techniques has the advantage of a rapid dry-skin formation to ensure high volatiles retention followed by an additional drying at low temperature, which prevents balloon-like expansion and thermal degradation thus retaining more of the aroma as compared to normal spray-drying.[38]

Freeze-drying

In freeze-drying there is a simultaneous removal of ice by sublimation from a frozen product, and removal of water by evaporation from the concentrated liquid between the ice crystals. The water leaves the frozen material by sublimation, and thoreforo the solids are held in thoir original position and can neither mix nor react with each other. The structure of the freeze dried particles is thus a lacy network of solid strands, among which are spaces left by vaporisation of water.[4] The low evaporation temporaturo prevents thermal degradation, gives the product o structural rigidity, and aroma lossos are relatively small. The subject was reviewed extensively by King.[40]

If the liquid food is frozen slowly, the ice crystals are almost pure, and the volatile aroma components are concentrated in the liquid phase which has a porous honeycomb-like structure. Due to the low temperaturo of the concentrated liquid near the sublimation front, generally below $-20°C$, and the corresponding low water concentration, generally below 35 wt%, the diffusion coefficient of the volatile molecules in the liquid is much smaller than that of water. Therefore, the aroma escapes from the liquid slower than the water. The aroma molecules may escapo from the liquid layer at and above the ice front into the gas pores; the ice crystals themselves are impermeable. Due to the water vapour pressure gradient in the porous layer and the low temperature, the water concentration at the gas-liquid interface decreases rapidly until it reaches a critical value, and the interface becomes completely impermeable to aroma and the remaining volatiles are completely retained in the liquid.[39]

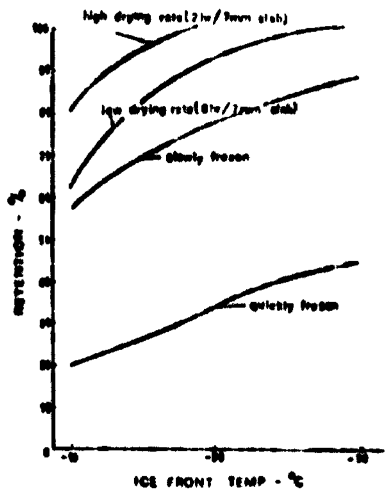

Fig. 6. Effect of drying rate, freezing alcohol retention in a freeze dried slab of malto dextrin. Initial malto dextrin rate and ice front temperature on concentration 19%. (Thijssen, 1972).[39]

The final retention of volatile aroma components in the product is dependent on many process variables such as dissolved solid concentration, frezing and drying rates, temperature of ice front, absolute pressure in the drying chamber, as well as other variables depending on the liquid food properties such as: size of aroma molecules, the presence of oil emulsion and colloidal matter and the size of the oil droplets.[4]

At present, the relatively small advantage of the higher quality of the product, as well as limitations arising from heat and mass transfer problems, and the necessity for expensive packaging necessary to prevent changes during storage make freeze drying of fruit and vegetable juices not a very practical solution.

Drum drying

In this widely used method for drying relatively non-heat sensitive foods, heat is supplied by a heated surface such as a drum. This process is easily controlled, drying time is relatively short and the use of heat is economic, however, aroma retention is very low. Thijssen and Rulkens[42] reported no aroma retention for coffee extract dried on an internally heated drum. Higher retention might be obtained by using drying aids to increase the viscosity. Good results can be obtained for dried tomato paste and similar products.[47]

Slush-evaporation

A new promising concentration process as regards aroma retention was reported by Lowe and King[12] namely, "slush-evaporation" or "slush drying". Its main features are that the feed juice is in a partly solid, partly liquid state, and that the drying mechanism is a combination of vaporisation and sublimation. It has a beneficial effect on aroma retention due to the low temperature. As compared to freeze-drying the drying rates are higher, i.e. mass transfer driving forces are larger because of the much higher vapour pressure of water. This combined with lower refrigeration cost, make the process more oconomical than freeze drying. Lowe and King report that after concentrating apple juice to 70% dissolved solids the retention of aroma components was better than 40%.

Circle 4 on enquiry card

There are several other drying mothods proposed to remove water from fruit juices and other liquid foods which include puff-drying, foam-mat drying, dispersion drying, solvent drying and turbulent film drying. During most of these processes aroma losses are rather high and if used they require aroma reincorporation into the final product.

Flavour fortification

There are several ways to restore the original flavour lost during water removal. One way used for citrus and other juices is the addition of fresh "cut back" juice to a concentrate and adjust the final concentration to 45 Brix. In order to assure optimum flavour, cold pressed peel oil must also be added to bring the recoverable oil value to about 0.025% on a reconstituted basis. Another way is to "add back" high density concentrate having a good colour and flavour to a low colour and high acidity juice before or after evaporation of the latter. Another way of restoring the characteristic aroma of the processed food is to enhance it with essences. This has been a common practice in the apple, grape and pear juice industry for many years. The addition of essences to citrus concentrates has also been introduced several years ago. It replaces, to some extent, the need for addition of "cut back" juice. Bomben *et al.* showed that aroma solutions could be used, instead of "cut back" juice, to make a single-strength chilled orange juice stable for one month at 0 C. Comparing the enhanced juice with the conventional cut back chilled juice showed no difference. Recovered essence should be used together with cold pressed peel oil to obtain a full fresh flavour bouquet in frozen concentrates.

There is an optimum level of essence that can be added to juice and other products to obtain a good flavour. Increased levels may result in a lowered quality. Also, the flavour content of essences differs considerably from one source to the other.

Many spray or freeze dried powders are almost completely devoid of their ...al aroma compounds. Instant coffee is a good example for such products. In order to restore the aroma to the final product it must be enhanced with essences prior to final concentration or after it. Aroma bearing stabilised coffee oil, or steam distillate or combinations of them may be added to highly concentrated extracts prior to spray or freeze drying or applied during agglomeration. In some cases finely ground "colloidal" coffee particles are used to enhance or stabilise coffee aroma.

"Locked-in" flavours

Cold pressed citrus oil or recovered volatile materials or essences of 100-150 fold concentration are suitable for adding to juice concentrates and products made from them, such as beverages, juices or jellies. However, these products cannot be added directly to dehydrated juice powders since this would increase the moisture content above the value required for storage stability. Also, the flavour compounds in the concentrated aqueous solution are susceptible to oxidation, hydrolysis and other undesirable reactions. In such cases the oils or essences are dispersed into a solid carrier such as: natural gums, gelatin, glycerol, sorbitol, sugars or corn syrup solids. The carrier system is a "locked-in" dispersion of fine droplets of oil in the mixture of sugars and stabilisers. The process consists of incorporating flavouring materials into a carrier under such conditions that prevent excessive loss of volatiles. A solid carrier for flavouring oils must be edible, rapidly water-soluble and oil-soluble, flavourless and odourless and impervious to air. If it meets these conditions, the flavouring oil will be protected against oxidation and volatilisation during storage, but will dissolve rapidly in water when reconstituted.

Spice oils and oleoresins have been spray-dried after blending with dextrose and salt and dispersing in a colloidal solution of vegetable gum. However, the loss of oil during spray drying is considerably higher, and oxidative reversion more likely, for this type of product then for oils locked in amorphous cabohydrate mixtures.

Synthetic flavours

Over the years many attempts have been made to analyse the flavour containing notes in natural flavouring materials and substitute them with synthetic preparations made from pure organic compounds. Sometimes natural flavours are merely reinforced with synthetic organic substances to obtain a more concentrated flavouring material. These flavouring materials exist as water or oil soluble liquids or powders and often contain stabilisers or cloudyfying agents depending on the end use. Such preparations are widely used in the beverage trade but are prohibited for use in pure natural products such as juice and coffee.

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Aroma Recovery and Retention in Liquid Foods During Concentration and Drying Part 2 Aroma Evaluation and Product Stability

Chaim H. Mannheim PhD **and Nehama Passy** MSc

The aromatic quality of a food is determined by the bouquet and strength of a complex mixture of volatile odorous compounds. During processing many valuable compounds are lost with water vapours. This paper reviews the process of preserving or maintaining the typical aromatic bouquet.

ONE of the greatest difficulties in aroma research is the evaluation of quality and concentration.

The aromatic quality of a food is determined by the bouquet and strength of a complex mixture of volatile odorous compounds. In the correct proportions, these volatiles constitute the characteristic aroma of the food. The aroma of coffee is a mixture of about 600 different components present at extremely dilute concentrations (ppm and ppb range). The aroma of fruits contains hundreds of volatile compounds.

Detecting and identifying these low concentration compounds was almost impossible until the availability of gas-liquid chromatography. Since then hundreds of aroma compounds have been identified in foods, but only in a few cases has it been possible to determine which compounds actually constitute the specific aroma of the product.

The flavour industry has produced many imitation food aromas, but only in very few foods the natural aroma could be precisely copied. Usually, it is too complex to be artificially reproduced by merely combining the identified compounds.[1]

The human nose can detect odoriferous compounds at very low concentration. However, it should be emphasized that the human sensory receptors evaluate the effect of the entire range of compounds present, as compared with analytical methods which evaluate single constituents, functional groups or groups of components only. Several researchers have therefore combined gas-liquid chromatography and olfactory analysis by means of the nose to evaluate the separated compounds leaving the GLC column by splitting the stream before the detector. The accepted methods of defining essence concentration is by the term fold. This is the volumetric ratio between liquid feed and essence obtained. This definition is rather arbitrary, and does not give any true indication of the aromatic quality of the essence. Basically, essence is composed of 92 to 95% water, 5 to 8% alcohols (methyl and ethyl alcohol), and some tenths of a percentage unit of the typical aroma contributing constituents such as aldehydes, ketones, esters etc. Therefore, in choosing a method of aroma evaluation, care must be taken to decide upon one that analyses the typical aromatic constituent of the product concerned.

Methods of analysis

Gas chromatography

A commonly used technique for vapour or head space analysis is by gas-liquid chromatography. It is possible to sample vapours directly from fresh or processed fruits and obtain chromatograms emanating from the products which may identify and determine relative concentrations of the volatile components.

The basic feature of this technique is to bring to equilibrium, inside a thermostated sealed container, the vapour and liquid phases containing the volatile aroma components. Then a vapour sample is injected into a gas-liquid chromatograph equipped with a flame-ionization detector. The chromatogram obtained, called aromagram, enables a fast and easy fingerprint type evaluation of the aromatic compounds, and with proper calibration also their concentration.

The advantages of the method include: analysis of volatiles from fresh living fruit; no artifacts are introduced with solvents; changes with storage or processing may be easily monitored; and the technique is fast and simple for identification purposes. However, there were many difficulties due to the presence of water vapour and large volume injected, as well as problems arising from the nature of the product such as limited solubility in aqueous phase. To overcome these difficulties many modifications were developed.

Chemical methods

Essential oil analysis

In orange juice d-limonene, which accounts for 90-95% of orange oil, is known to be part of the water-insoluble fraction of the aroma. A chemical method to estimate recoverable oil in orange juice, reported as d-limonene was developed by Scott & Veldhuis. The method is based on extraction and distillation of the oil, followed by bromate titration. If all the oil is extracted from the juice, a direct estimation of the total oil content, characterized as d-limonene, is obtained.

Based on vapour headspace analysis, Massaldi & King developed an alternative technique for the determination of d-limonene in synthetic emulsions and in orange juice. It involves dilution with water to a point well below the solubility limit of the volatiles followed by vapour headspace analysis using a flame-ionization chromatograph. The advantage of this method lies in its generality, ie enabling determination of any volatile component's distribution between phases.

COD method

The chemical oxygen demand (COD) is a measure of the water-soluble volatile constituents present in aroma essences. The analysis consists of oxidizing a sample distillate by means of a dichromatic solution in a strong acid medium, and colorimetric evaluation of the complex formed. The main compounds present in any essence responding to this method are methanol and ethanol, so that the value of the results is limited except that it gives an overall estimation of how well the volatiles are being collected.

Other methods

Another approach has been the estimation of oxygenated terpenes as C H O; saturated aliphatic aldehydes as octanol; α, β -unsaturated aldehydes

(1) Dr Mannheim is Professor of Food Technology, in the Department of Food Engineering and Biotechnology, at the Technion - Israel Institute of Technology, Haifa, Israel.

(2) Mrs Passy is working as research engineer in the Food Industries Research and Development Station at the Technion Research and Development Foundation, Haifa, Israel.

as citral and for esters as ethyl butyrate.[1,1]

The major characteristic constituent of Concord grape flavour is methyl anthranilate. This compound is estimated by coupling it with a potassium or sodium salt of alpha-naphthol-2-sulphonic acid, which gives a coloured complex.

All above methods are helpful in judging the effectiveness of a given recovery method, but do not provide a good measure of quality. Therefore, all chemical, or other tests concerning aroma must be accompanied by organoleptic evaluations.

Organoleptic tests

The most important and common methods are: the threshold test which determines the smallest amount of a material that is detectable when it is diluted with a standard inert material and it gives the threshold value. The test can be applied for flavour as well as odour evaluations. This method may be used to test the strength of essences, and to follow changes in threshold levels during storage. Another test used to compare one essence with another, or evaluate the effect of incorporating an essence into a product is the triangle test.

Flavour changes and stability of juices

Canned juices

The retention of flavour during the storage of fruit juices is of prime importance if they are to find consumer acceptance. Juice deterioration is mainly attributed to undesirable changes in flavour and colour[9]. For instance, pineapple and tomato juices change very slowly during storage, but orange and apple juices undergo rapid changes in flavour. Canned and bottled citrus juices develop off-flavour during storage at room temperature, and in few months the bottled products become unpalatable. Grapefruit juice is probably the most stable of the citrus juices, though changes in its flavour are probably masked, to some extent, by the acidity and bitterness of this fruit. Orange juice is generally more stable than tangerine juice; this may be partly due to the difficulties and attention in preparing tangerine juice without incorporating excess peel oil. At lower temperature (4 or 5 C) the flavour changes are much slower.

Peel oil, even in small quantities, is responsible for the characteristic flavour of citrus juices and juices devoid of peel oil are rather insipid. It has been found , that off-flavours which develop during heating and storage may be attributed to changes in the peel oil and lipid fractions. By a catalytic reaction in the acid solution, followed by hydration and dehydration reactions, a series of compounds such as 1,8-terpone, 1,4-cineole and alphaterpinene are formed. Some of these are more soluble in water than limonene, and have pungent flours responsible for off-flavour in canned orange juice.

In canned grapefruit during storage, traces of acetic acid, furfural and two unsaturated acids with the general formula $C_?H_?O_2$ appeared. Also, a hundred-fold increase in methanol content, as well as an increase in linalool monoxide and alpha-terpinol, were determined. The above are probably the substances that induce the undesirable tastes[1].

Single strength, pasteurized, canned limeade develop off-flavours known as 'terpeney' caused by the peel oil present in the juice. In respect to the development of general off-flavours the pulp is considered to be a major factor.

In stored orange juice, a significant loss in total volatile oil was found, and the conversion of hydrocarbons to alcohols (alpha-terpinol, carveol), along with the loss of esters, aldehydes and linalool was established. Changes in the lipid fraction were also believed to be responsible for at least a part of the off-flavour developed in aged canned juice.

In grape juice, anthranilic acid esters and other esters which characterize the specific flavour disappear almost completely.

Frozen concentrated juices

Undesirable changes occurred during the storage of frozen concentrated juices are different from those in canned juices stored at temperatures above freezing. Browning, colour changes and the loss of vitamins are inhibited. At temperatures below —18°C frozen citrus concentrates are stable for a few years[1,2]. These investigators found no significant flavour changes in frozen concentrate, containing unpasteurized fresh juice (added as cut back), when stored at —18 C or below for one year. At higher temperatures, flavour changes occur more rapidly. Storage at —15 C and —12°C for extended periods, or at higher temperatures for brief periods of time, will result in flavour damage, loss of cloud and possibly gelation.

The off-odour and off-flavour termed 'cardboard off-flavour' — (COF), develops sometimes in stored frozen citrus concentrates between two days to several weeks of storage, and may disappear after prolonged storage. It may be related to physiological immaturity in the fruit. It is believed that COF is of biochemical origin, rather than attributable to oxidation of fats, and represents intermediate stages in the biosynthesis of lipids, and is probably enzymatically catalyzed.

It should be mentioned that the higher the concentration of the juices the better their stability. At 58 or 65°Bx the tendency of the concentrate to clarify and form gels is less and flavour stability is better than at 42°-45°Bx.

Essence stability

Aroma solutions, obtained in aroma recovery systems are not very stable during storage. Stability is affected by the presence of an oil phase, oxygen, and the storage temperature. Jualagne *et al* have investigated the stability of apple and found, by means of GLC threshold values, that only at —34°C did the essence retain its intensity and quality for two years. At —4°C, losses in essence quality exceeded these at —1°C. A similar study with orange essence indicated that essences rapidly lost their fresh orange character at 1 and 21°C. Aroma strength, as measured by threshold determinations, remained fairly constant at —18 to —7°C for periods of up to one year. Significant changes in aroma character were observed within 6 months at —7°C. The most significant change in strength, as indicated by aromagram, was attributable to the loss of d-limonene. Light and oxygen, as well as storage temperature, affected the alteration in aroma character.

Products enhanced with essences

It is well known that products enriched with essences loose their aroma intensity during storages. Bomben *et al* showed that aroma solutions could be used, instead of cutback juices, to make a single-strength chilled orange juices stable for one month at 0°C. Comparing above juice with conventional cut-back chilled juice showed no difference. A similar comparison with frozen concentrated orange juice showed that initially the product fortified with essence was stronger, but that this initial advantage disappeared during storage at —18 to —7 C. After about one month, no difference was discernible between products with cut-back juice and with essence.

Dougherty et al.[1] studied the effect of essence enhancement on flavour of frozen concentrated orange juice. They could not find, even after 30 months storage at —22°C, any significant loss of flavour. However, the orange essences produced by different recovery systems differed considerably in their strength and chemical composition, and thus their addition to the concentrated frozen juice produced different flavourings.

From the above discussion it may be concluded that, in order to improve juice flavour by the addition of essential oil at relatively high temperature, a terpeneless oil is preferable. Alternatively, storing juice or concentrate without oil or essence, and adding the latter only near the time of consumption, is beneficial.

Powders

The principal reactions responsible for the deterioration of the quality of dehydrated juices during storage are:

1. Browning reactions which involve compounds containing carbonyl groups, organic acids and nitrogenous compounds and result mainly in discolouration of the product.

2. Lipid and essential oil reactions,

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Aroma recovery and retention in liquid foods during concentration and drying

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including mainly oxidation, isomerization and hydrolysis reactions result in flavour changes of the product, and development of undesirable off-flavours. Also, such flavour changes are accelerated in dried products by the presence of trace metals (iron, copper etc) acids, moisture, heat and exposure to light and air. The conditions which favour increased stability of powders while in storage are low moisture content, inert atmosphere, low temperature and stabilizing additives.

For most dried juice products, a satisfactory moisture content for a storage period of 6 months at 32°C or 1-2 years at 21°C, without damage to quality, is about 1% or below.

This low moisture content prevents the reaction between substances present in high concentration and close proximity, which cause off-flavour and off-colour. It also prevents caking in these products. However, by increasing storage temperature, the relative humidity increases, and the critical point when 'stickiness' starts, may be reached.

On the other hand, in products where rancidity and other oxidation reactions occur, the moisture content for maximum stability corresponds to the monomolecular value, and if reduced below this value, oxidation will be accelerated. This value is different for various materials. It is about 6.5% for starchy foods like potato, 3.5% for protein foods like meat, and near zero for fruits and other high sugar products. Stability problems encountered in the commercial distribution of fruit juice powders arise mainly from reactions among the water-soluble constituents. Reactions such as oxidation of carotenoids are usually not significant, therefore by reducing the final moisture content to a very low value, the browning reactions will be inhibited.

Two ways have been used to reduce moisture content of dried juice powders from the 2-4% level to 0.5-1%. One method is "in package desiccation", which enables a low storage temperature, ie, 21°C after packaging. This allows for reduction of moisture to a suitably low level before any high temperatures, are encountered. If a desiccant is used, water vapour pressure in the container ensures a low, at a moisture content that, without desiccant, would produce a damaging effect to the product. The other way to reduce moisture is using dehumidified air and a low-temperature drying stage which requires several hours in special equipment.

High oxygen content in the atmosphere surrounding the dried product is damaging to colour and flavour. Therefore, vacuum, nitrogen and CO_2 are used extensively for packaging of powders. The storage at low temperatures greatly prolongs the time of retention of good flavour and colour in dried juice products. Mylne & Seamans[33] found that puff-dried orange powder packed in air and stored at 21°C had lower organoleptic score than the same powder, vacuum packed and stored at the same temperature. Wong et al., (1956)[34] found that storage stability of puff-dried tomato powder at 21°C and 32°C was considerably better in vacuum or inert gas packs than in air packs. The effect of oxygen presence combined with high storage temperature is very detrimental to the product.

Sulphur dioxide is widely used as an additive due to its chemical preservative effect during storage of dried fruit and vegetables juices. Its use is based on prevention of carbonyl group reactions with amino groups, by forming addition compounds with the carbonyls. A secondary effect is its action as an antioxidant. However, in fruit and vegetable juice powders, the high concentration of the naturally present ascorbic acid is an equal or better antioxidant for lipid oxidation reactions.

Addition of 500 ppm sulphur dioxide was found to protect tomato concentrate's flavour during puff-drying, so that the temperature could be increased to 88°C without off-flavour production, while without it off-flavour could be detected at 70°C. This use of sulphur dioxide enables a shorter drying time or a lower moisture content.

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APPENDIX II

Automatic sterilizer now available for flexible pouches

K RUIG*

Increasing outputs of pouches call for automation of the processing lines. In this article the author describes an automatic continuous pouch sterilizer. The first machine, designed to handle 27 000 pouches/hour, is now being installed in Japan at the plant of Housefoods in Osaka

For many years pouches made of plastics or of plastics and aluminium foil have been used in the food industry. Originally they were only used for the packaging of easy-to-keep products like dried soups, milk powder and snacks; later on they also appeared to be suitable for preserves like meat products, soups and vegetables. Today specially designed pouches are being applied in the pharmaceutical industry.

In Norway, concentrated soups and ready-to-eat meals in plastics pouches have been popular for a long time. In Denmark meat products in pouches are selling well. However, in order to cope with the sterilization temperatures and pressures, and the prevention of re-infection, these types of pouch must be made to exacting requirements.

Originally it was difficult to obtain an hermetic seal. Quite a lot of problems had to be overcome; due to product remnants the seals were not really dependable. Even without products being trapped the seals remained the weak spots of the pouch. Another problem was the occurrence of delamination during the sterilization process. Folds and wrinkles in the pouch were also a problem; caused not only by mechanical handling but also by the difference in the coefficients of expansion of the various material layers of the pouch. These folds and wrinkles easily lead to material breakage and thus involve the risk of spoilage.

In spite of many improvements these problems have not yet been fully solved. The number of rejects in the production of products packed in pouches is many times higher than that in cans, bottles or jars. This is the main reason why the use of pouches in the food industry has not grown as rapidly as expected. The turnover in the leading countries like Norway and Denmark, and later on Italy, has grown slowly in the last 5 years. Japan seems to be the exception; here the production of preserved food in pouches has expanded enormously in the last few years and Japan is now far ahead of all other countries. Some thirty different kinds of flexible pouches are used there and daily sales amount to 2 million units.

Increasing outputs call for automation of the processing lines – something which has been accepted for the handling of preserves in cans, bottles and jars for many years.

Originally the pouches were first formed, then separately filled and finally sealed by a heat-sealing machine. The increasing demand for automation has induced more and more factories to opt for multi-function machines. These machines mostly of the rotary type, comprise: a pouch forming section, which pulls the laminate from the roll, folds it and seals the bottom and the side seams; a dosing valve to fill solid particles (frequently a pump-filler); a vacuum valve to dose liquids; a sealing section, which stretches the open top of the pouch and seals it (often applied in conjunction with an evacuation unit to prevent air inclusion in the pouch) and a discharge chute for the filled and sealed pouches. Here the automation stops and the pouches are sterilized in conventional discontinuous autoclaves.

In view of the trend towards increasing line speeds it has been questioned whether the pouch forming-, filling- and sealing machine combination actually presented the right solution. The single filling station soon appeared to be the bottle-neck when operating at high speeds.

Consequently, there is a tendency towards separate machines for each function, with loose automatic fillers to fill a number of pouches simultaneously. Of course these machines operate continuously and fully automatically.

As regards sterilizing equipment, things are quite different. The filled pouches are placed manually in a horizontal position on trays; a series of trays is positioned into a frame (often provided with wheels) and subsequently the frame is transferred to the autoclave for sterilization. This is, of course, a labour-intensive job, creating a bottle-neck among the other machines on an automated production line.

However, there are more drawbacks attached to the retort system: uneven heat penetration in pouches with air inclusion; risk of unsterilized pouches getting into the flow of sterilized pouches; abrupt pressure transitions; abrupt temperature transitions; stained spots on aluminium pouch material, due to contact with stainless steel trays; a

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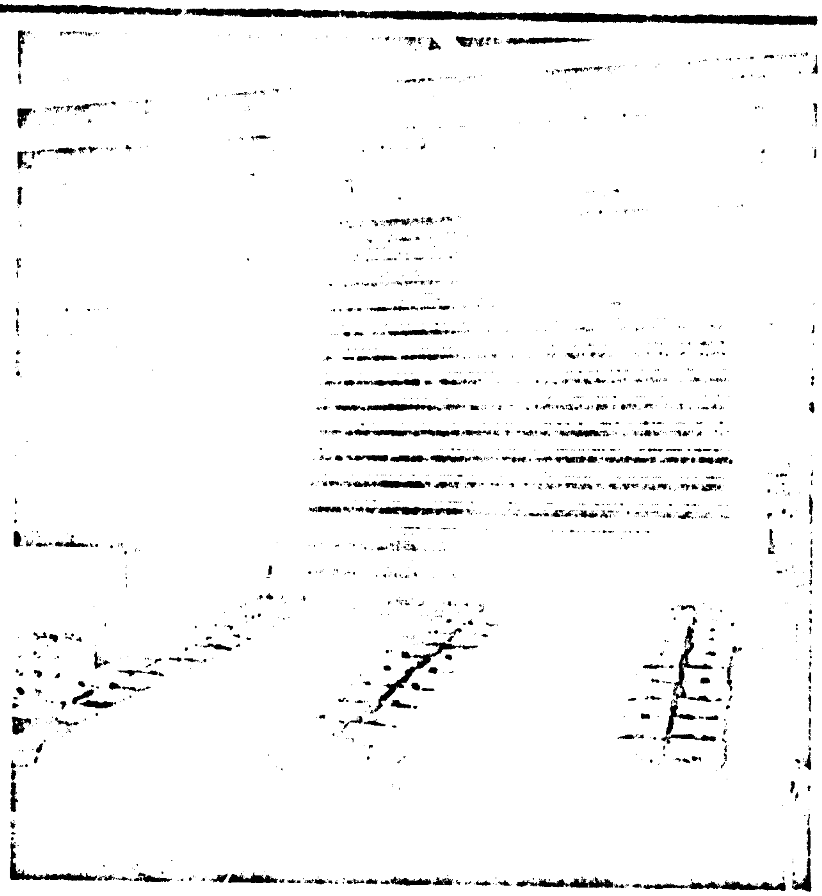
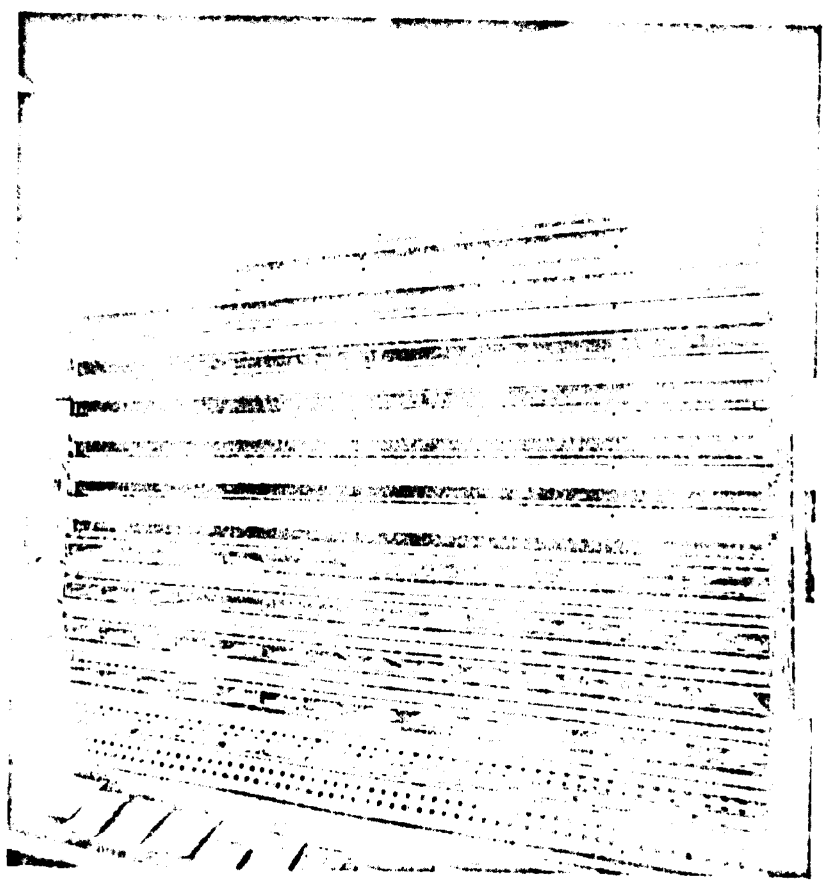
*Stork Amsterdam

Pouch sterilizer

Right: The in-feed of the sterilizer.
Below: The automatic out-feed of the Hydromatic sterilizer.





"banana" effect (pouches become warped), which is caused by the phenomenon of the heat transfer from the tray to the lower side of the pouch exceeding that from the flow to the free sides of the pouch. This also explains why the free surfaces of many pouches —contrary to the surfaces which were in contact with the trays— do not become wrinkled.

It goes without saying that the extent of this risk of pouch damage largely depends on the type and quality of the pouch material. These materials have to meet very exacting demands. Re-infection owing to pouch damage, as well as reduction of taste and colour quality due to uneven or excessive sterilization, are quite unacceptable. Of course, the possibilities offered by continuous sterilization were considered: the uniform product treatment, the careful mechanical handling, the savings in labour and the low water and steam consumption. In short, all the advantages of continuous hydrostatic sterilization, which have gradually become well known in the food industry, are needed for industrial pouch processing.

However, the existing continuous sterilizers do not appear suitable for the handling of pouches without special provisions. Although many articles on fully automatic pouch processing lines have been published, many designs never left the drawing board or resulted in patent applications which were not applied on an industrial scale. Some developments did result in pilot plants, but (as far as known) never in industrial units for commercial production. However, a continuous sterilizer for pouches has been developed, which has proved to be feasible. One machine, designed to handle 27,000 pouches/hour, is now being installed in Japan.

After many years of research and experiments, a continuous sterilizer for pouches, the Hydromatic, has been introduced by Stork-Amsterdam BV of Amstelveen-Holland. The development of the Hydromatic was based on the following demands: no seam and other pouch damage in infeed, sterilization and discharge sections; prevention of pouch deformation (wrinkling, folding, warping and delamination); optimal product quality (uniform sterilization); high outputs and great operational dependability.

The Hydromatic for pouches is

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rostatic principle. ...eheating and cooling ...ast for the safe handling ...rable packs. Experience ... abrupt changes in the ...a pressure gave rise to folds ...ikles in many pouches; only ...a pressure increase during heating ...gradual pressure decreases during ...oling can prevent pouch damage. ...he pressure of the saturated steam in the sterilizing section is in equilibrium with two water columns. The temperature in the sterilization section depends on the height adjustment of the water columns. Equipped with two endless chains, between which the holders for the packed product are fitted, the machine also has an automatic infeed mechanism which transfers the containers into the holders. In these holders the packed product passes through the various sections: preheating, sterilization (pasteurization under 100 degrees C is also possible) and cooling. After completion of the process cycle the containers are removed from the holders by means of an automatic discharge system.

Steam not appropriate

Steam sterilization is not the appropriate process for pouches because saturated steam pressure is insufficient to prevent damage to the welding seams and allow the pouch wall to be uniformly in contact with the product, thus ensuring rapid and uniform heat transfer. This is why overpressure sterilization is applied for this purpose. In the overpressure process for flexible packs and glass jars with vulnerable caps, the pressure prevailing in the sterilization section exceeds that of the saturated steam at the sterilization temperature.

The process times and temperatures are steplessly adjustable between wide limits and temperature and pressure transitions during the process are very gradual. Consequently, in this system, the sterilization pressure and the sterilization temperature are independent of one another. Heat transfer is chiefly accomplished by condensate at the desired sterilization temperature; air provides the desired overpressure. The amount of overpressure depends on various factors including: sterilization temperature, head space in the pouch, filling temperature, product and pouch material.

Since these factors are different in each individual factory, the process conditions and type of sterilizer cannot be determined until extensive simulation tests have been carried out. The correct overpressure is of vital importance; if the pressure is too high the pouch will suffer damage; the same happens if the pressure is too low. Of course a constant pressure throughout the sterilization process is a must. The necessity for gradual pressure build-up and release has already been discussed.

It will be clear that it is quite impossible to design a standard sterilizer for pouches. Each pouch sterilizer must be adapted to the specific requirements of the individual project. This is possible by the use of standard components allowing the assembly of a practically, "tailor-made" Hydromatic.

The advantages (as well as the drawbacks) of pouches have been clearly discussed in many publications. However, one fact deserves some further elucidation because it is not often given much attention while being of vital importance to the sterilization: rapid heat penetration. Characteristics of a pouch, as compared with cans, jars or bottles, are a large contact-surface of product, flatness (the short distance to the centre of the product) and the thin wall of the pack.

These characteristics result in a rapid heat transfer, which often allows sterilization times to be reduced considerably without affecting the lethality (extent of micro-organism killing). Consequently, improved organoleptic properties may be expected. However, the effect of over-sterilization will increase accordingly, with all its adverse consequences for many products. A uniform treatment of all pouches is therefore of utmost importance.

Holder shape

For a rapid, even heat penetration and careful pouch handling it is essential that the right type of transport holder is applied. The development of this holder was aimed to provide no welding-seam damage, even pouch support, uniform distribution of product throughout the pouch and no damage to pouch surfaces.

Though the basic shape is identical for all pouches, the holders still have to be specially adapted to the pouch dimensions of each individual operation. Each pouch rests in a horizontal position in its own pocket; excessive load on the welding seams is thus avoided, which is of importance — particularly during the sterilization process. Additionally, as all the pouches lie clear of each other, each side of the pouch will come into contact with the sterilizing medium. Once the pouches have been automatically loaded into the holders, the holders are automatically closed by visors. Each pouch is then locked up in its own pocket. By its shape the visor also performs a function in effective preheating, sterilizing and cooling.

The infeed takes place automatically. The continuous sterilizer may be connected to 10-16 pouch lines. This means that the production of some 10-16 filling and sealing lines is handled simultaneously in a single machine, in one process, and under the supervision of one operator.

The pouches are admitted in rows. Each row, which may consist of 10-16 pouches (depending on pouch dimensions), is synchronized with the main conveyor chains of the Hydromatic sterilizer: in other words: the rows are phased with the travelling speed of the holders. A safety system precludes improper loading.

The machine is equipped with an automatic discharge system. The infeed mechanism is located at the front of the sterilizer, the discharge system at the rear. This precludes the risk of unsterilized pouches getting mixed up with sterilized ones. The discharge system unloads the holders one by one and the pouches are transferred to a discharge conveyor via a slide plate. Both infeed and discharge systems have been designed to warrant careful pouch handling and thus prevent welding seam damage and scratches on the laminate material.

A double insulation with aluminium cladding minimizes radiation heat losses, which results in significant savings in steam consumption (less than half used with a retort system) and enhances the working climate in the factory hall. The machine is equipped with a corrosion inhibitor dosing system to limit rusting of the tower walls to a minimum, which extends the service life of the installation considerably.

In view of the essential importance of a high product quality, in which respect the right type of sterilizer plays a significant role, the Hydromatics in operation are regularly inspected by the manufacturers' technical service organization and water treatment laboratory.

The sterilizer is also suitable for the sterilization of other easily damaged packs such as deep-drawn aluminium foil cups. Hydromatics are built for outputs ranging from 50 up to 500 containers per minute.

APPENDIX III — Product List for Canned fruit and Vegetables

Peas	can	250gr
Peas	can	1/2
Peas	can	1/1
Peas	can	1/5
Peas with carrots	can	1/2
Peas with carrots	can	1/1
Green beans	can	1/2
Green beans	can	1/1
Green beans	can	5/1
Carrots in salted water	can	1/2
Carrots in salted water	can	1/1
Carrots in salted water	can	5/1
Ayvar	Glass jar	1/2
Ayvar	Glass jar	1/1
Peppers in oil	Glass jar	1/1
Peppers in oil	Glass jar	2 1/2
Peppers in oil	can	5/1
Hot peppers	Glass jar	1/2
Hot peppers	Glass jar	1/1
Cucumbers	Glass jar	1/1
Cucumbers	Glass jar	2 1/2
Cucumbers	can	5/1
Cucumbers delicacy	Glass jar	1/1
Tomatoes green	Glass jar	1/1
Stewed vegetables	can	1/2
Stewed vegetables	can	1/1
Red beet	Glass jar	1/2
Red beet	Glass jar	1/1
Red beet	can	5/1
Peppers with cabbage	Glass jar	2 1/2
Mixed marmalade	can	5/1
Apricot marmalade	can	5/1
Rosehip marmalade	Glass jar	1/2
Rosehip marmalade	Glass jar	1/1
Plum jam	Glass jar	1/2
Plum jam	Glass jar	1/1
Peach jam	Glass jar	1/2
Peach jam	Glass jar	1/1

continued over/........

Apricot jam	Glass jar	1/2
Apricot jam	Glass jar	1/1
Sour cherry jam	Glass jar	1/2
Cherry jam	Glass jar	1/2
Cherry jam	Glass jar	1/1
Sour cherry jam	Glass jar	1/1
Strawberry jam	Glass jar	1/2
Strawberry jam	Glass jar	1/1
Stewed plums	can	1/1
Stewed plums	can	5/1
Stewed peaches	Glass jar	1/1
Stewed cherries	Glass jar	1/1
Stewed cherries	can	5/1
Stewed strawberries	can	1/2
Raspberry syrup	bottle	1/2
Raspberry syrug	bottle	1/1
Orange syrup	bottle	1/2
Orange syrup	bottle	1/1
Bilberry juice	doypack	200 gr.
Sinalco orange	doypack	200 gr.
Sinalco citro	doypack	200 gr.
Bilberry juice	bottle	1/1

APPENDIX IV

NOTES ON FINANCIAL ANALYSIS OF BABY FOOD LINE

1. **General**

These notes provide the workings and explanation of the economic analysis of the baby food line set out in section IV of the report. At the outset it must be appreciated that many estimations have had to be made in view of the fact that there are no detailed figures available in Yugoslavia. However, where possible the estimates have been based on figures obtained from Western European sources.

2. The order of these notes follows that set out in tables 4.1 and 4.2.

3. **Fixed costs**

Management expenses

	$
Director Baby Foods	4000
Asst. Production Manager	2800
Quality Control Asst	2600
Maintenance Engineer	2600
Foreman	2400
2 Clerks	4000
	18400
plus 8% Social Security	1500
plus 33.3% for overheads	6000
say,	26,000

Overheads are intended to cover office and administrative expenses charged by Vitaminka.

4. **Rent of factory**

In view of the fact the baby food line is likely to be installed in an existing part of the factory, a rent has been charged instead of a capital sum. The rent is based on current building costs including services at $240 per square metre and is charged at 10 per cent of the total capital value.

$$\text{rent} = \frac{600 \text{ sq.m.} \times \$240 \times 10}{100}$$

$$= \$14,400$$

5. **Maintenance**

Maintenance has been charged at 2.5 per cent of the total capital sum on an annual basis.

Variable costs

6. **Raw materials**

The cost of raw materials has been estimated by first determining the likely percentage between the main items on production and then calculating the cost of raw materials on the basis of the items contained in each recipe. The precentage of each product to be manufactured is set out below:

Product group	% total		Items	% in group
breakfast	10	(5)	Egg and bacon	50
		(5)	Egg and ham	50
				100%
Meat and vegetables etc	55	(14)	Beef & vegetables	26
		(13)	Chicken & noodles	24
		(11)	Ham & carrot	20
		(11)	Veal puree	20
		(6)	Mixed vegetables	10
				100%
Desserts	35	(17)	Apple puree	50
		(7)	Apples & apricots	20
		(7)	Apples & prunes	20
		(4)	Apples & orange	10
				100%

In table I of this annex the actual quantites of each product to be manufactured have been calculated. It has been assumed that production will start at 500 tons in the first year, 1000 in the second and 1500 in the third and thereafter.

The individual requirements for each basic foodstuff are given in table II. All workings are in prepared tons and farm prices have been adjusted to take this into account. Process ratios are not easy to calculate but if anything, the requirements of raw materials has been over estimated. See table III.

Where raw materials have to be processed for storage the cost of canning or freezing and storage have been included at the standard costs used at Vitaminka.

It should be noted that even at 1500 tons per year output only 500 tons of frozen produce will be required.

7. **Productive labour**

Productive labour has been calculated at Vitaminka inclusive of rates:

3 @ (35Dn/hr) $2.06/hr = $12,900 per annum
16 @ (20Dn/hr) $1.18/hr = $39,300 per annum
Total = $52,200 per annum

The above figures are inclusive of all holidays, etc.

8. **Power and process costs**

The following costs have been derived from Vitaminka's own calculations to which has been added a 20 per cent increase:

	$/ton processed
water	1.76
steam	1.47
electricity	0.59
losses	0.06
	3.88
+ 20%	0.78
Total	$4.66

At 500 tons = $2330
1000 tons = $4660
1500 tons = $6990

9. <u>Container and packaging costs</u>

A.

	small 120 gm	large 200 gm
Glass jars & tops	$45 per 1000	$50 per 1000
Labels	$5 per 1000	$5 per 1000
Total	$50 per 1000	$55 per 1000
Number of ton	8333	5000
Ratio in use	6 : 4	
Actual cost	5000 $250	2000 $275
Average container cost per ton	$525	

B. Packaging cost 100 x 10kg cases per ton @ $0.25 per case:

0.25 x 100 = $25 per ton

C. Summary of costs:

Container costs = $525

Packaging costs = $25

<u>Total cost per ton = $550</u>

500 tons = $275,000
1000 tons = $550,000
1500 tons = $825,000

10. <u>Contingency</u>

A contingency sum amounting to $270,000 has been included to cover any eventualities. This amounts to 14 per cent in a full year.

11. <u>Capital expenditure</u>

Included in the provision of capital expenditure is a sum to cover internal fitting out of the building.

Adjustments have been made to the cost of the process machinery to take into account shipping charges, import duties, etc, and installation.

<u>It should be noted that due to inflation the original estimated cost should be revalued upwards by not less than 20 per cent per annum.</u>

The provision for consultancy and market research have been capitalised - reoccuring expenses would be covered by marketing expenses and charged annually.

The whole capital cost is charged in the first year on the basis that the amortalisation will be over 10 years. However, a replacement charge of $100,000 is provided for in the sixth year to cover excessive wear and tear.

Capital expenditure

1.	**Plant and equipment**	
	A. Estimated total cost of line f.o.b.	235,000
	B. Shipping charges @ 3 per cent	7,000
	C. Import duty, dock charges, internal transport, etc @ 30 per cent	70,500
	D. Installation charges @ 10 per cent	235,000
	Sub total	$336,000
2.	**Miscellaneous equipment**	
	Conveyors, doors, air conditioning	$94,000
3.	Consultancy, market research and development	$25,000
	Total	$455,000

Annex Table II **Baby food line** **Cost of raw materils including process and storage cost for 1000 tons**

(tons)

	Tons Required	Farm Price	% Extraction	Fresh Prepared +420	(A) Tons	Fresh In-Take Unit Price	Fresh In-Take Total	(B) Tons	Frozen Price	Frozen Total	A + B	300T	1500T
Beef	36	1,600			36	1,600	57,600				57,600		
Veal	40	2,500			40	2,500	100,000				100,000		
Ham	33	1,200			33	1,200	39,600				39,600		
Bacon	5	1,400			5	1,400	7,000				7,000		
Chicken	52	1,100			52	1,100	57,200				57,200		
Eggs	70	920						70	920	64,400	64,400		
Carrots	128	82	80	123	75	128	9,630	53*	195	10,321	19,951		
Celery	11	150	75	220	4	222	880	7	393	2,750	3,360		
Onions	27	176	75	255	14	255	3,570	13	336	4,362	7,932		
Peas	19	224	-	224	-	-	-	19	392	7,459	7,459		
Apples	279	70	80	108	140	116	16,240	139*	190	26,470	42,710		
Apricots	35	324	75	451	3	451	1,353	32*	541	17,312	18,665		
Oranges	6	-	-	-	-	-	-	6	600	3,600	3,600		
Prunes	30	141	50	301	-	-	-	30	483	14,475	14,475		
Pearl Barley	4.5	140			4.5	140	630				630		
Rice Flour	3.5	175			3.5	175	613				613		
Noodles	45	250			45	250	11,250				11,250		
Canned					525		311,166	419 (324 frozen)	159,649	(944)	470,815	235,407	706,222

Annex Table II

Estimated Raw Uncooked Weight of Raw Materials - (ready-prepared)   Base: 1000 tons

	Egg bacon	Egg ham	Beef veg	Chicken noodles	Ham carrot	Veal puree	Mixed veg	Apple puree	Apple apricots	Apples prune	Apples orange	To
1000 ton programme	50	50	140	130	110	110	60	170	70	70	40	
Beef			35									3
Veal						40						4
Ham		5			20							3
Bacon	5											
Chicken				52								5
Egg	35	35										7
Carrots			35		90		12					12
Celery			6				5					1
Onions			11	6		6	4					2
Peas			11				8					1
Potatoes			35			55	30					12
Apples								170	35	40	34	27
Apricots									35			3
Oranges											6	
Prunes										30		3
Pearl barley-dry			4				0.5					4.
Rice flour-dry			3				0.5					3.
Noodles-wet				72								7
												(45
Stock liquor	10	10				9						2
												100

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