# 10.3 Hazard analysis and critical control points (HACCP)

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## 10.3.1 Preprocessing steps - converting raw foods to ingredients

Fruit and vegetables as raw materials start as living cells and as such can vary in composition, colour, flavour structure and nutrient content. Thus a key part of describing a process is the preparation of detailed specifications for ingredients and packaging materials to ensure that final product performance and composition specifications can be met with the specified process and equipment. This is only possible if ingredients are preprocessed to the desired specifications.

Thus the processing of foods must be separated into two broad areas: preparation of raw fruit and vegetables for further processing to consumer products or ingredients; assembly of preprocessed ingredients to finished consumer products.

The assembly of preprocessed ingredients to finished consumer products will be discussed to illustrate principles used to describe a process for quality control. These principles

apply to the conversion of raw foods to processed products. The chief differences are the variations in raw product specifications and certain washing, peeling, size reduction and blanching or heat treatment steps needed to convert highly variable raw materials to standardized ingredients.

Typical operations using in converting raw fruits and vegetables to processed- ingredients for packaging and preservation or prior to a further heat treatment processing are as follows:

Harvesting or Gathering -- > Transport -- > Storage -- > Washing -- > Size Grading -- > Peeling (Removal of outer surface) -- > Size Reduction -- > Separation of waste -- > Sorting Inspection--> Storage

### 10.3.2 Process description for Quality Control

One of the most important specifications of a product is its safety in terms of microbial contamination, freedom from hazardous chemicals and absence of foreign materials such as metal pieces, non-edible parts such as pits or woody stem material and dirt, insect parts or other extraneous material.

The microbial safety of processed fruits and vegetables is of prime importance from a quality viewpoint. The following analysis is to provide a description of a process to help ensure that microbial safety can be achieved with a minimum opportunity for failure of the finished product to meet specifications.

### 10.3.3 Process operations

Food processing steps require a detailed description when microbial safety is a concern. The reason for this is that ingredients, packages, equipment, and the surroundings all potentially can contaminate the final product with pathogenic or spoilage microorganisms. Table 10.3.1 is a simple process description from a Hazard Analysis point of view.

Further, if the conditions of pH (acidity), temperature, moisture and nutrient level are suitable, rapid microbial growth is possible on processing equipment and in the food itself. Thus while microbiological specifications can be written for incoming ingredients, actual microbial counts can increase during each process step if the process is not designed properly.

One of the first requirements for the description of a process is to determine if an individual process step will increase (+), decrease (-) or result in nonchange (=) in the

microbial content of food undergoing the processing step. This can be determined from the chemical and physical conditions of the food and surroundings in each processing step.

The physical and chemical conditions of a food passing through a processing step can be recorded for each process step needed to prepare a finished product.

Fig. 10.3.1 is an example of a process for preparing a canned juice drink using a hot fill to prevent subsequent spoilage. A hot fill can be used since the product has pH below 4.5 and thus is considered an acid product. The product contains four ingredients: fruit concentrate, flavour mix, sugar and water. Two package components are shown: the can and the can cover.

Individual processing steps are identified in the preparation of the canned juice drink from warehouse inventory to just prior to can labelling. Processing steps needed to prepare the package for filling and sealing are listed on the right side of the chart.

For purpose of analyses the juice drink must have a pH of 3.8, a fill temperature of no lower than 190 F and must leave the cooling tunnel at a temperature below 90 F. These requirements are highlighted in their appropriate column to ensure that the proper process control and quality control procedures are in place.

Fig. 10.3.1 has a column titled: "Potential for microbial growth if out of control". This

column is included to allow each step to be challenged from a microbiological viewpoint. "What ifs" will show whether the specified Critical Control Points will protect the product from microbial failure.

Two sources of failure are evident. The can fill temperature must be 190 F or above and regular can and lid inspections are needed to ensure that double-seals are always within specifications. The pH of the system may be less critical since the fruit concentrate will bring the pH below 4.5 even without the dry mix.

The process steps shown above can be contrasted with the process used in the preparation of a vacuum packed, refrigerated, cooked meat soup (shown in Figure 10.3.2). This product depends on low temperatures for preservation as well as low vegetative microbial counts.

Equipment sanitation, prevention of air borne contamination during filling, seal integrity and rapid cooling are essential parts of the process.

Even with these requirements in control, the heat treatment given the products (heating to 200 F), with a variable 0-60 min hold) is not sufficient to inactivate Clostridium botulinum. Thus the product must be cooled to 35 F within 40 minutes to prevent any possible germination and outgrowth of Clostridium botulinum spores.

Further, the manufacturer of this product must provide a means to ensure that the product is

used within a specified time and is always kept at or below 35 F if it is to be released to the public.

| Operation | Equipment | (+,-,=)** | Reason | Temp. F |
|---|---|---|---|---|
| 1. Storage | Warehouse | | | |
| 2. Transport | Fork lift | | | |
| 3. Storage | Storage tank | | | |
| 4. Weigh dry ingred. | Scale | + | Poor sanitation | |
| 5. Weigh wet ingred. | Weigh Kettle | | | |
| 6. Blend*** | Kettle | | | |
| 7. Heat | Kettle | = | Low temp. | 195 |
| 8. Transport | Pump | = | Sanitation | 190 |
| 9. Delay | Surge tank | = | Low temp. | 190 |
| 10. Filler bowel level | Valve | = | Sanitation | 190 |
| control | | | | |
| 11. Separation | Pipe filter | = | Sanitation | 190 |
| | | | | |

| | | | | |
|---|---|---|---|---|
| 12. Can fill | Filler | = | Low temp. | 190 |
| 13. Lid coding | Coder | | | |
| 14. Seam | Double seamer | + | (Poor seams) | 190 |
| 15. Lid sterilisation | Can inverter | = | | 190 |
| 16. Hold delay | Conveyor | = | | 190 |
| 17. Can cooling | Cooling tunnel | = | | 90 |
| 18. Drying | Can dryer | + | Insufficient heat, leaks | |

**Source: D.F. Farkas (1991)**
**** "Potential for microbial growth if out of control"**
***** pH of the product is 3.8**

**Figure 10.3.1 Canned juice drink- Inventory of process steps for ingredients, packages and process conditions to provide a basis for Hazard Analysis (HACC)**

### 10.3.4 Food processes in general

**The above figures show typical product preparation sequences for a thermally**

**preserved and a refrigerated products. It is important to know the following information to determine the microbial safety of a product and to determine what quality control actions will be needed to achieve a safe product when used under the conditions for which it was designed.**

**First, all raw material, ingredients and packaging materials in contact with the food must be specified and if needed tested to meet specifications.**

**Second, it is important that an element of food be observed as it enters, passes through and leaves the process. This "ride" on a particle of the food should provide the following data at each process step from entry to discharge:**

- **Food temperature;**
- **Time at each temperature;**
- **pH;**
- **Oxygen concentration;**
- **Water activity.**

**Further if preservatives are required to prevent microbial growth, their addition point and concentration throughout the entire food mass should be shown. Finally for products which depend on a sealed package one should check the seal integrity of each**

**container produced.**

**As one rides along the food as it travels through each step it is necessary also to observe the number and types of microorganisms entering or leaving the food and if these numbers are increasing (+), decreasing (-) or remaining the same (=).**

**These data when reviewed for quality control procedures will help ensure a safe, reliable and cost effective process.**

**Figure 10.3.2 Vacuum packed refrigerated meat soup. Inventory of process steps for ingredients, packages and process conditions to provide a basis for Hazard Analysis**

### 10.3.5 Hazard analysis and critical control points (HACCP) in food industry - steps to be considered

a. **Acquire a good knowledge of the product flow-sheet, from raw and pack material suppliers to consumers.**
b. **Assess each step and establish associated potential risk for:**

- **Consumer safety (e.g. foreign bodies, microbiology, aflatoxins, pesticides, heavy metals, monomers, etc.);**

- **Edible quality of the product (e.g. taste, texture, colour, smell, appearance, etc.).**

c. **Plot a complete product flow-sheet and establish the Critical Control Points (CCP).**
d. **Associate with each CCP an action in order to eliminate risks and prepare an action plan.**
e. **Implement the agreed actions and keep records of results.**
f. **Evaluate the results of actions vs. risks and prepare an on-going working plan.**
g. **Decide on a permanent monitoring of CCP.**

TABLE 10.3.1 Simple process description for hazard analysis

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# Chapter 11 Fruit and vegetable processing units - general

# approach; preliminary study; how to invest, install and operate a processing centre; modular units: from farm/family to community/business level

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## 11.1 Preliminary study

**Each new fruit and vegetable processing centre needs a good, specific preliminary study including, among other considerations, the following aspects:**

a. **Raw material availability;**
b. **Raw material quality in adequate varieties for the types of finished products that will be manufactured;**
c. **Harvesting and transport practices and organisation from the field to the processing centre;**
d. **Processing capacity related to raw material availability: quantities, seasonability, etc.**
e. **Processing equipment size/capacity suitable for above points;**

f. **Availability of trained operators and resources to improve their knowledge;**
g. **Availability of workforce in the area and resources for training them in order to be able to assure adequate trained operators;**
h. **Availability of utilities: electricity, etc.**
i. **Position of the future processing centre as related to raw material fields and to closest transportation means; road access, railway access.**
j. **Last but not least, market availability for finished products and for optional semi-processed products.**

**The decision to invest in fruit and vegetable equipment MUST be taken case by case and only after an adequate, specific preliminary study has been carried out by specialists or a specialist organisation.**

## 11.2 How to prepare, start and operate a fruit and vegetable processing centre

**Additional recommendations and "hints" to prepare, start and operate a fruit and vegetable processing centre are as follows:**

a. **Assure a raw material temporary storage capacity/ surface for 2-5 processing**

**days. Invest in an adequate size cold room for sensible raw materials;**

b. **Plan the equipment to operate at the start-up for at least one working shift (about 7-9 hours) per day, for 5 working days per week; when needed, a second shift could be organized;**
c. **Plan to operate the processing centre for a maximum number of working days per year). In order to achieve this, invest in the buildings and equipment which will be able to:**

- **process as many species of fruits and vegetables as possible / as available;**
- **use as many preservation methods as possible, e.g. drying, dehydration, concentration, sugar preservation, etc.**

d. **Whenever possible, "rush" the utilisation of available raw materials during crop season by additional manufacturing of semi-processed products and transform these in consumer finished products during the off-season.**
e. **Excessive automatization of processing equipment DOES NOT directly imply a good quality of finished product;**
f. **Raw material quality is a major element with positive impact on finished product quality;**

g. **Initial and continuous personnel training and motivation is also an important factor in the success or failure of a processing centre and in assuring a constant finished product quality;**
h. **Keep finished product stocks at a minimum adequate level;**
i. **Remember that the three main "outputs" of the processing centre have to be prioritized in the following order:**

**Priority 1: Finished product quality conforms to specifications and standards: national and/or international, consumer special requests, etc.**

**Priority 2: Continuous and reliable supply of finished products to the domestic and export markets throughout the year (or at least throughout the "marketing season" of specific products);**

**Priority 3: Manufacturing and transport costs as low as possible, inside the stringent need to cover the first two priorities;**

**j) When deciding on the equipment output, take into consideration all elements specified and mainly raw material availability and market demand for a specific finished product;**

**k) Invest in simple, modular processing lines which can, with some simple on-site configuration modifications, process various types of finished products; this is mainly important for the first technological steps (preparation of raw materials, etc);**

**l) Plan to use as much as possible of the raw materials supplied / received to the processing centre.**

**This should be facilitated by the initial design and by a good day-to-day organisation and management; all these should enable, if necessary, to make a different use of each "quality" or grade of raw materials, e. g. using them for different finished products: one quality for drying/dehydration, an other quality for juices, etc.**

**m) Take into account the fact that the marketability of finished products will be differ in terms of types and quality for domestic and export markets.**

**Be sure that an export specialized staff/organisation will help with specific export advice. To export successfully is a different job to processing fruit and vegetables.**

**n) Avoid investing in one "big" processing line, very sophisticated in terms of automation, etc. with a high output capacity but having potential following drawbacks: being able to "generate" / produce only one finished product type from only one raw**

**material; having too high a degree of equipment fixation work for installation and therefore very high difficulties in using the processing equipment in a modular " interchangeable " way.**

**o) As an initial investment prefer small size processing lines, with modular equipment arrangement (i.e. able to be integrated in various technological configurations for processing of as many raw materials as possible and generating different finished products).**

**p) As compared with important processing units in developed countries, it is possible to formulate as a very general rule for developing countries, that for the usual size of equipment, for a comparable environment frame, the scale / size should be approximatively 1:10 from those actually in use in developed countries.**

## 11.3 Fruit and vegetable processing centre - module "level 5" family level

**a) Buildings**

**i. Covered area for temporary storage of raw materials and washing; surface = 10 sq. m.**

**ii. Room for wet processing (cutting, dipping, boiling, water blanching, pasteurization, etc.) = 25 sq. m.**

**iii. Room for dry processing = 25 sq. m. iv. Room for storage of processed products = 10 sq. m.**

**Area (i) is simply covered; area (ii) could be similar to a simple house kitchen; areas (iii) and (iv) could be similar to house rooms.**

**b) Outside drying yard**

**This area is needed in order to install: simple sun drying trays; tent sun dryer; cabinet sun dryer.**

**At best, this area have to be cemented to avoid excessive dust generation.**

**A minimum surface of 50 sq. m. is necessary.**

**c) Equipment and material**

**Working tables (2)**

**Improved stoves (3)**

**Stainless steel pots 51(2)**

**Stainless steel pots 101(2)**

**Stainless steel pots 151(1)**

**Stainless steel knives, 12-15 cm blade (10)**

**Stainless steel spoons, various shapes and sizes (5)**

**Stainless steel household sieves (3)**

**Wooden spoons (5)**

**Glass jars, various sizes and screw-on caps (200)**

**Aluminium pots: 251(1); 401(2);**

**Hand-operated pulp extractor**

**Bottle brushes (10)**

**Plastic lemon-squeezer**

**Stainless steel skimmer**

**Aluminium ladle**

**Sun dryer (tent type)**

**Sun dryer (cabinet type)**

**Standard wood sun drying trays (20)**

**Bottles (0.33 1)**

**Crown tops**

**Jars (0.300 1)**

**Screw-tops for jars**

**Wood (or other available fuel) heating plates**

**Hand-operated capping device (capper)**

**Work bench (3)**

**Stainless steel vegetable cutter (5)**

**d) Simple technological recommendations**

**i. Ingredients**

**- Sugar and potassium metabisulphite ($K_2S_2O_5$) are used as preservatives;**

**- Lemon or lime juice is added to the products to rectify the acidity (this improves storage stability and taste).**

**ii. Hygiene measures**

**- The workers should carefully wash their hands before any product processing operations;**

**- The utensils and equipment will have to be properly cleaned before and after use, in order to remove dust and any possible organic particle;**

**- The packaging materials, i. e. bottles and jars, have to be washed with a hand-operated appliance, hot clean water and sand. After washing, rinsing with clean water will be carried out;**

**- Damaged parts of the fresh raw materials, as well as waste, will have to be discharged and disposed outside of the working area;**

**- Before storage, the finished products will be washed and dried (this apply for jars and bottles) and properly labelled;**

**- The preparation and drying areas must NOT be located in the vicinity of a stock-farm.**

## 11.4 Fruit and vegetable processing unit - module "level 4" farm and/or community level

**a) Buildings**

**i. Covered platform for temporary storage of raw materials and washing; surface = 25 sq. m.**

**ii. Room for wet processing (cutting, dipping, boiling, water blanching, pasteurization, etc.) = 40 sq. m.**

**iii. Room for dry processing = 40 sq. m.**

**iv. Storage room for processed products = 20 sq. m.**

**All areas need to be on a cemented platform.**

**Area (i) is simply covered and surrounded by plastic sheeting to avoid dust contamination.**

**b) Outside drying yard**

**This area is needed in order to install various dryers: simple sun drying trays; tent sun dryer; cabinet sun dryer; cabinet solar dryer with heat collector, etc.**

**Ideally, this area should be cemented to avoid excessive dust generation.**

**A minimum surface of 70 sq. m. is necessary.**

**Access to the drying yard must be closed to non-production personnel.**

**It is useful to construct some surface for shade drying from the beginning; this surface could be also be used in order to protect, if needed, drying trays in case of rain.**

**c) Equipment and material**

**Working tables (3)**

**Scales: 0-50 kg, precision 1 kg**

**Hand refractometer 0-90 Brix (2)**

**Thermometers 10-100 C (5)**

**Improved stoves (3)**

**Stainless steel pots 51(2)**

**Stainless steel pots 101(2)**

**Stainless steel pots 151(3)**

**Stainless steel knives, 12-15 cm blade (10)**

**Stainless steel spoons, various shapes and sizes (5)**

**Stainless steel household sieves (3)**

**Wooden spoons (5)**

**Rigid plastic funnels, large bottom (10)**

**Glass jars, various sizes and screw-on caps (500)**

**Aluminium pots: 251(1); 401(2); 501(3)**

**Hand-operated pulp extractor**

**Electrical pulp extractor**

**Bottle brushes (10)**

**Plastic lemon-squeezer**

**Plastic colanders**

**Stainless steel skimmer**

**Aluminium ladle**

**Sun dryers (tent type)**

**Sun dryers (cabinet type)**

**Solar dryers (cabinet type) with heat collector**

**Standard wood sun/solar drying trays (30)**

**Bottles (0.5 1)**

**Bottles (0.33 1)**

**Crown tops**

**Jars (0.580 1)**

**Jars (0.300 1)**

**Screw-tops for jars**

**Electrical heating plates**

**Gas-fired heating plates and/or available fuel heating plates (wood, etc.)**

**Hand-operated capping device (capper)**

**Rigid plastic drums 501(5)**

**Work benches (3)**

**Stainless steel vegetable cutter (5)**

**d) Simple technological recommendations**

**i. Ingredients**

**- Sugar and potassium metabisulphite (K2S2O5) are used as preservatives;**

**- Lemon or lime juice are added to the products to rectify the acidity (this improves storage stability and taste).**

**ii. Hygiene measures**

**- The workers should carefully wash their hands before any product processing operations;**

**- The utensils and equipment will have to be properly cleaned before and after use, in order to remove dust and any possible organic particle;**

**- The packaging materials, i. e. bottles and jars, have to be washed with a hand-operated appliance, hot clean water and sand. After washing, a rinse with clean water will be carried out;**

**- Damaged parts of the fresh raw materials, as well as the waste, will have to be discharged and disposed of outside of the working area;**

**- Before storage, the finished products will be washed and dried (this apply to jars and**

**bottles) and properly labelled;**

**- The preparation and drying areas must NOT be located in the vicinity of a stock-farm.**

## 11.5 Fruit and vegetable processing unit - module "level 3" community and / or entrepreneurial level

**a) Buildings**

**i. Covered platform for temporary storage of raw materials and washing; surface = 50 sq. m.**

**ii. Workshop for wet processing (cutting, dipping, boiling, water blanching, pasteurization, etc.) = 70 sq. m.**

**iii. Workshop for dry processing = 70 sq. m.**

**iv. Storage room for finished products = 30 sq. m.**

**v. Room for simple Quality Control checks = 15 sq. m.**

**All areas need to be on a cemented platform.**

**Area (i) is simply covered and surrounded by plastic sheets in order to avoid dust contamination.**

**b) Outside drying yard**

**This area is needed in order to install various dryers: simple sun drying trays; tent sun dryer; cabinet sun dryer; cabinet solar dryer with heat collector, etc.**

**Ideally, this area should be cemented to avoid excessive dust generation.**

**An approximate surface of 100 sq. m. is necessary.**

**Access to the drying yard must be closed to non-production personnel.**

**It is useful to build some surface for shade drying from the beginning; this surface could be used also in order to protect drying trays with products in case of rain. Drums/receptacles with vegetables could be stored here during first step of lactic fermentation (preservation by natural acidification).**

**c) Equipment and material**

**Working tables (5)**

**Scales: 0-50 kg, precision 0.1 kg**

**Scales: 0-3 kg, precision 1 g**

**Hand refractometer 0-900 Brix (2)**

**Thermometers 10-100 C (10)**

**Screen pulper-finisher; capacity 50 kg/in sieves: 0.015 in; 0.030 in; 0.045 in.**

**Improved stoves (5)**

**Stainless steel pots 5 1(3)**

**Stainless steel pots 10 1(3)**

**Stainless steel pots 15 1(3)**

**Medium size SO2 generator**

**Electrical heated ventilated oven, cap. 30 1**

**Small cool / cold room: volume = 20 m; temperature = +4 C to + 15 C**

**Stainless steel knives, 12-15 cm blade (15)**

**Stainless steel spoons, various shapes and sizes (10)**

**Stainless steel household sieves (5)**

**Wooded spoons (5)**

**Rigid plastic funnels, large bottom (10)**

**Glass jars, various sizes and screw-on caps (500)**

**Aluminium pots: 251(3); 401(3); 501(5)**

**Hand-operated pulp extractor**

**Electrical pulp extractor**

**Bottle brushes (25)**

**Plastic lemon-squeezer**

**Plastic colanders**

**Stainless steel skimmer**

**Aluminium ladle**

**Sun dryers (tent type)**

**Sun dryers (cabinet type)**

**Solar dryers (cabinet type) with heat collector**

**Stainless steel drying trays (15) - for fruit leather**

**Standard wood sun/solar drying trays (45)**

**Bottles (0.5 1) Bottles (0.33 1)**

**Crown tops**

**Jars (0.580 1) Jars (0.300 1)**

**Screw-tops for jars**

**Electrical heating plates**

**Gas fired heating places**

**Hand-operated capping device (capper)**

**Rigid plastic drums 501(5)**

**Work benches (5)**

**Stainless steel vegetable cutter (5)**

**d) Simple technological recommendations**

**i. Ingredients**

**- Sugar and potassium metabisulphite ($K_2S_2O_5$) are used as preservatives;**

**- Lemon or lime juice are added to the products to rectify the acidity (this improves storage stability and taste).**

**ii. Hygiene measures**

**- The workers should carefully wash their hands before any product processing operations;**

**- The utensils and equipment will have to be properly cleaned before and after use, in order to remove dust and any possible organic particle;**

**- The packaging materials, i. e. bottles and jars, have to be washed with a hand-operated appliance, hot clean water and sand. After washing, a rinse with clean water will be carried out;**

**- Damaged parts of the fresh raw materials, as well as waste, will have to be discharged and disposed of outside of the working area;**

**- Before storage, the finished products will be washed and dried (this applies to jars and bottles) and properly labelled;**

**- The preparation and drying areas must NOT be located in the vicinity of a stock-farm.**

## 11.6 Fruit and vegetable processing unit - module "level 2" business level

**a) Buildings**

**i. Covered platform for temporary storage of raw materials and washing; surface = 100 sq. m.**

**ii. Workshop for wet processing (cutting, dipping, boiling, water blanching, pasteurization, etc.) = 100 sq. m.**

**iii. Workshop for dry processing = 100 sq. m.**

**iv. Storage room for finished products = 70 sq. m.**

**v. Quality Control Laboratory = 25 sq. m.**

**All areas need to be on a cemented platform; recommendations about processing workshops and all points related to buildings, equipment, etc. as presented in section 10.2 of this document (Good Manufacturing Practices - GMP - and Hygiene Requirements) must be integrated in the design and respected during construction, installation and operation.**

**Area (i) is covered and surrounded by plastic sheets to avoid dust contamination. Areas (ii), (iii), (iv) and (v) should conform to the quality standards described in section 10.2.**

**b) Outside drying yard**

**This area is needed in order to install:**

**i. various dryers: simple sun drying trays; tent sun dryer; cabinet sun dryer; cabinet solar dryer with heat collector;**

**ii. SO2 generator; sulphuring cells.**

**This area should be cemented to avoid excessive dust generation. A approximate surface of 150 to 200 sq. m. is necessary.**

**Access to the drying yard must be closed to non-production personnel.**

**It is useful to build some surface for shade drying from the beginning; this surface could be used also in order to protect drying trays with products in case of rain. Drums/receptacles with vegetables could be stored here during first step of lactic fermentation (preservation by natural acidification).**

**c) Equipment and material**

**i) Equipment for small size operations, trials, etc. similar to module "level 3".**

**ii) Equipment for raw material preparation before processing**

**Washing machine - dip washer A 106 with exit elevator out of tank.**

**Peeler with abrasive action A 302 B**

**Peeler for special products (with holes and knives) A 302 KS**

**Cutting machines - two models**

**iii) Equipment for preparation of pulp/juice extraction**

**Continuous simple crusher A 502 V**

**Horizontal pulper A 602**

**Turbo refiner A 605**

**Continuous extractor A 810**

**iv) Equipment for blanching/cooking/concentration/ evaporation**

**Cooking kettle - adapted to available heating source in the centre: gas direct or indirect heating (B 201); steam jacketed pans (B 202); electrical heating (oil jacketed) (B 2010). At least 3 cooking kettles (70-901; 100-1201 and 150-2001 capacity) are needed.**

**Continuous water blencher rotating drum model for vegetables B 204**

**Vacuum cooker B 2030**

**Large stainless steel tank for cooling after blanching**

**Steam generator**

**Double bottom tanks for scalding / blanching**

**v. Equipment for pasteurization, including preparation (deaeration, etc)**

**De-aerator for pulps, juices, etc.**

**Multitubular cooker - pasteurizer for pulps, juices, concentrates, etc.**

**Horizontal steriliser**

**Steam heated processing retort 120 l, model D 200 (or gas heated processing retort 120 l, model D100)**

**vi. Equipment for drying / dehydration**

**Cabinet dryers (5) - electrical / steam / fuel heated according to source of energy available in the processing centre**

**Medium size SO2 generator**

**Sulphuring cells (3)**

**Small size tunnel dryer vii. Filling machines**

**Pouch filler model E 104 for all liquid and paste products, dosing capacity: between 0.5 and 25 kg**

**Semi-automatic pneumatic closer model E 101 for all kinds of liquids, semi-liquids, pasty products and mixed products (with pieces)**

**viii. Seaming and capping machines**

**Seamer model V 10 C 502**

**Semi-automatic capping machine model C 604 for twist off, screw type, crown type**

**Relief marker for lids model C 701**

**ix. Miscellaneous equipments: mobile product wagons; storage tanks; mixing tanks; rotating mixer for mixed vegetables.**

**x. Medium size cool / cold room; volume = 30-40 m; temperature = + 2 to + 15 C.**

**xi. Laboratory equipment:**

**laboratory refractometer model ABBE F 1602;**

**thermobalance model F 1604;**

**laboratory retort model F 2500 (autoclave);**

**processing control oven (60 C) model F 1200;**

**pocket model pH meter F 1701;**

**laboratory model pH meter F 1703.**

**penetrometer;**

**microscope;**

**incubation oven;**

**analytical balance;**

**miscellaneous equipment & supplies: inoculation tubes, Petri dishes, Colony Counter, beakers, pipettes, etc.**

**xii. Control equipment:**

**can seaming checking display (on base and hand models);**

**reflexiometer model F 1603 for dense products;**

**jars vacuum detector with measure of cap deflexion;**

**various thermometers; various manometers: can vacuum indicator;**

**vacuum and pressure; standard);**

**hand model refractometers model F 1601 for juices, concentrates, jams, etc.**

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## 11.7 Fruit and vegetable processing centre - module "level 1" business and/or national level

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**The "level 1" module has two main characteristics: utilisation of complete processing lines; specific equipment for particular fruit or vegetable, for example: specific mango destoning machines, etc.**

**a) Buildings**

i. **Covered platform for temporary storage of raw materials and washing; surface = 100 sq. m.**
ii. **Workshop for wet processing (cutting, dipping, boiling, water blanching, pasteurization, etc.) = 150 sq. m.**
iii. **Workshop for dry processing = 200 sq. m.**
iv. **Storage room for processed products = 120 sq. m.**
v. **Quality Control Laboratory = 35 sq. m.**

**All areas need to be on a cemented platform; recommendations about processing workshops and all points related to buildings, equipments, etc. as presented in section 10.2 (Good Manufacturing Practices - GMP - and Hygiene Requirements) must be integrated in the design and respected during construction, installation and operation.**

**Area (i) is covered and surrounded by plastic sheets to avoid dust contamination.**

**Areas (ii), (iii), (iv) and (v) should conform to the quality standards described in section 10.2.**

**b) Outside yard**

**This area is needed in order to install:**

i. **various dryers: simple sun drying trays; tent sun dryer; cabinet sun dryer; cabinet solar dryer with heat collector;**
ii. **SO2 generator; sulphuring cells;**
iii. **storage of drums for natural acidified vegetables (preservation by lactic fermentation);**

**The area should be cemented to avoid excessive dust generation. An approximate**

**surface of 250 sq. m. is necessary.**

**Access to the outside yard must be closed for non- production personnel.**

**It is useful to build some surface for shade drying from the beginning; this surface could be used also in order to protect drying trays with products in case of rain. Drums/receptacles with vegetables could be stored here during first step of lactic fermentation (preservation by natural acidification).**

**c) Equipment and material**

**As a basic minimum, a "level 1" processing unit module needs the same equipment as a "level 2" module.**

**The following pages list recommendations for various specialised processing lines for tomato products and for tropical fruit products.**

### 11.7.1 Manufacturing processing lines for tomato products and tropical fruit products

**Flow-sheet of processing operations for tomato products**

**Figure 11.7.1 Manufacturing processing lines and equipment for canned tomato products and tropical fruit products**

**Factors affecting product quality**

**a) Causes of flat-sour spoilage of tomato juice:**

- **use of unsound, poor quality raw stock;**
- **rough handling of raw stock during transport and before and/or during washing operations;**
- **poor washing operations;**
- **high pH of raw juice;**
- **high level of contamination;**
- **insufficient heat treatment;**
- **contaminated equipment;**
- **poor sanitation.**

**b) Causes of spoilage of canned tomatoes:**

- **hydrogen swell - physico-chemical reaction between the metal of the can and the acids in the fruits;**

- **bacteria swell is usually caused by one or more members of the Lactobacillus group.**

**c) Causes of spoilage of tomato paste:**

- **leakage of container;**
- **inadequate cooling for product temperature;**
- **inadequate residual chlorine in the cooling water.**

**Most of these factors can affect also the quality of canned guava nectar, canned passion fruit nectar and of other tropical fruit products.**

**For the recommended heat processing times for tomato products see Table 11.7.1.**

**TABLE 11.7.1 Recommended process times for canned tomatoes by can size, minutes**

| | Still retort, 212F | | Agitating cooker, 212F | |
|---|---|---|---|---|
| Can Size | Water-cool | Air-cool | Water-cool | Air-cool |
| 303 x 406 | 45 | 35 | 14 | 9 |
| 307 x 409 | 45 | 35 | 14 | 9 |

| | | | | |
|---|---|---|---|---|
| 401 x 411 | 55 | 45 | 18 | 13 |
| 603 x 700 | 100 | 80 | 25 | 20 |

**Source: Da Fonseca, J.L.F., Moy, J.H. (1975)**

**The relationship of direct refractometric readings for natural tomato solids are listed in Table 11.7.2.**

**TABLE 11.7.2 Refractometric readings for natural tomato solids**

| Tomato pulp- pure Concentration | Tomato paste % solids | % solids |
|---|---|---|
| Light | 8.0 - 10.1 | 24.0 - 28.0 |
| Medium | 10.1 - 11.3 | 28.0 - 32.0 |
| Heavy | 11.3 - 15.0 | 32.0 - 38.5 |
| Extra heavy | 15.0 - 24.0 | over 38.5 |
| Concentrated tomato juice | 20.0 - 24.0 | |

**Source. Da fonseca, J.L.F., Moy, J.H. (1975)**

**The processing time (spin process) for different packs of passion fruit juice are listed in Table 11.7.3.**

### 11.7.2 Manufacturing equipment for canned tomato products and tropical fruit products factory

**The products obtained in this factory would be mainly:**

- **guava nectar;**
- **passion fruit nectar;**
- **whole tomatoes;**
- **tomato juice;**
- **tomato paste; tomato pure.**

**The list of equipment by product is presented below; the first six items are common for all products:**

**(1) bin dumper;**

**(2) sizer;**

**(3) roller inspection table;**

**(4) soak tank washer;**

**(5) rotary washer;**

**(6) sorting, trimming table.**

**a) Production line for whole tomato products**

**(7) caustic peeler;**

**(8) inspection table;**

**(9) hand pack;**

**(10) salt dispenser;**

**(11) conveyor;**

**(12) juice filler; (juice is provided from pump 26)**;**

**(13) conveyor;**

**(14) steam flow steamer;**

**(15) conveyor;**

**(16) rotary pressure cooker;**

**(17) rotary cooler.**

**b) Production line for tomato juice**

**(18) distribution belt (common for all other lines);**

**(19) chopper;**

**(20) pump;**

**(21) hot break tank;**

**(22) pump;**

**(23) juice extractor;**

**(24) pump;**

**(25) heating tank;**

**(26) pump; ** (juice is fed into juice filler at (12) in whole tomato line from this point);**

**(27) strainer;**

**(28) filler;**

**(29) conveyor;**

**(30) seamer;**

**(31) conveyor;**

**(32) rotary pressure cooker;**

**(33) rotary cooler.**

**c) Production line for tomato pure, paste line**

**Tomatoes are fed into this production line from the hot break tank 21.**

**(34) pump;**

**(35) vibrating screen;**

**(36) pulper;**

**(37) pump;**

**(38) heating tank;**

**(39) pump;**

**(40) kettle;**

**(41) kettle;**

**(42) kettle;**

**(43) vacuum pan for paste;**

**(44) pump;**

**(45) finisher;**

**(46) pump;**

**(47) holding tank;**

**(48) pump;**

**(49) filler;**

**(50) conveyor;**

**(51) seamer;**

**(52) conveyor;**

**(53) cooler;**

**d) Production line for passion fruit and guava nectar**

**(54) elevator;**

**(55) passion fruit slicer;**

**(56) centrifugal peel separator;**

**(57) pump;**

**(58) distribution belt;**

**(59) disintegrator; (for guava nectar)**

**(60) pump;**

**(61) pulper; (for both passion fruit and guava)**

**(62) pump;**

**(63) finisher;**

**(64) pump;**

**(65) de-aerator;**

**(66) formulation tank; (preparation of syrup for both passion fruit and guava nectars)**

**(67) pump;**

**(68) flash pasteurizer;**

**(69) pump;**

**(70) filler;**

**(71) conveyor;**

**(72) seamer;**

**(73) conveyor;**

**(74) spin-cooker-cooler;**

**(75) cooling belt;**

**(76) conveyor.**

**All products use a labeller/caser (77) and a conveyor for finished products.**

**A passion fruit finished product can be processed as a good quality beverage base with sugar:juice ratio of 58:42, on dilution with 4 times its volume with water.**

**Passion fruit jelly is prepared containing 25% juice.**

**Tomato juice concentrated with a Bertuzzi vacuum evaporator and centritherm equipment can be obtained.**

**For tomato juice, two products have commercial application: canned natural tomato juice and spiced juice.**

**With small alterations of preparation equipment, mango products can also be obtained using the manufacturing plant described above for tomato and tropical fruits.**

**Temperate and tropical fruit jellies, marmalades, syrups, jams and various types of sugar preserves can also be manufactured in this plant as far as preparation and juice extraction equipment are available and that kettle can be used for cooking the preserves. The preparation equipment should be arranged in a "modular" way in order to enable multiple fruit processing steps.**

### 11.7.3 Equipment specifications

a. **Equipment should be designed to hold the product with minimum spills and overflow.**
b. **Surfaces in contact with food should be inert and non-toxic, smooth and non-porous.**
c. **No coatings or paints should be used that could possibly chip, flake or erode into the product stream.**
d. **Equipment should be designed and arranged to avoid having pipes, mechanisms, drives, etc., above the open product streams.**
e. **Bearings and seals must be located outside the product zone or sealed and self lubricating.**
f. **Proper design avoids sharp or inaccessible corners, pockets, ledges so that all parts can be reached and cleaned easily. Build so that units are easy to take apart**

**if necessary.**

g. **Loose items like locking pins, clips, handles, gates, keys, tools, fasteners, etc. that could fall into the product stream should be eliminated.**
**Figure 11.7.2 General layout for a fruit and vegetable processing unit/factory for tomato and tropical fruit products**

h. **Equipment should be laid out for easy access for cleaning and servicing. Three feet from walls and between lines is recommended.**

i. **Any and all containers, bins, cans, lug boxes, etc., used in the packaging or handling of food products should not be used for any purpose other than their primary use. Special containers should be provided which are readily identifiable and cannot get into the product stream.**

j. **All equipment parts that come in contact with foods must be constructed with rust-resistant metal such as stainless steel.**

### 11.7.4 Mango processing unit - mango juice in bags "hot fill" procedure

**a) Main production equipment**

i. **Scalder / washing machine model 1 106**
ii. **Destoner model 1602**

iii. **Thermobreak model CC05**
iv. **Refiner**
v. **Reception tank**
vi. **Transfer pump**
vii. **Mixing tank with shaking**
viii. **Transfer pump**
ix. **Tubular pasteurizer**
x. **Bag filling machine model E 104**
xi. **Cooling tunnel**

**b) Packaging materials**

**i. Special bags, capacity from 5 kg to 25 kg, with adequate valve system for filling and closing; adapted to bag filling machine model E 104.**

**Figure 11.7.3 Mango processing unit - Mango juice in bags "Hot Fill" process (Courtesy of H. Biaugeaud S.A.)**

## 11.8 Overall raw material consumption data / yield for fruit and vegetable processed products - approximate data

Table 11.8

Table 11.8 (continued)

Table 11.8 (continued)

Table 11.8 (continued)

## 11.9 Fruit and vegetable processing centre - quality control sheet daily recording sheet finished products defects

Table 11.9

Table 11.9 (continued)

**Recommended sampling plan on production/processing line**

- **Frequency: every two hours**
- **Quantity of finished product to be sampled from production line: two cardboard**

**cases (shipping packages)**

- **Analyze the two cases for defects according to specific control sheet (A)**
- **Analyze all receptacles or overwrapped units for specific defects (B)**
- **Open at least five receptacles or overwrapped units per shipping case and evaluate defects (C)**
- **Analyze at least two consumer packs for defects (D)**

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# Appendix I - Fruit and vegetable processing flow-sheets

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**GROUP 1.1 SIMPLE PROCESSING**

**PROCESSING OF MANGO BARS**

**Processing of mango bars**

**Ripe fruit is used; the mangos are washed, peeled and cut into pieces with a stainless steel knife. Pulp extraction is carried out with a hand-driven or electrical juice**

**extractor. Sugar, lemon juice (or citric acid) and potassium metabisulphite are then added to the pulp so that mixture contains 25% TSS (total soluble solids) as determined by a refractometer.**

**The composition of ingredients is as follows:**

- **sugar: 10 to 15% of the weight of the pulp;**
- **lemon juice: 2 spoons per Kg of pulp;**
- **potassium metabisulphite (K2S2Os): 2 g per Kg of pulp.**

**The pulp thus prepared is heated for two minutes at 70-80 C. It is then poured into aluminium trays coated with glycerine (this facilitates the removal of the dried pulp). The prepared pulp should be placed on trays at the rate of 15 Kg per square metre.**

**The trays are brought to a sun or solar dryer. The drying is completed when the product has the consistency of leather (about 15% moisture content). The yield ratio between raw material and finished product is about 12:1. Two or three layers of dried product are piled one on top of the other and cut into small squares (4 X 4 cm). Each square is wrapped in cellophane paper, packed in cellophane bags then labelled and stored in a dry place.**

## PROCESSING OF DRIED MANGO SLICES

**Processing of dried mango slices**

**Half-ripe fruits, without fibres, are used.**

**The mangos are washed, peeled and cut into 6-8 mm thick slices with a stainless steel knife. To obtain finished products with good quality and long storage life, the mango slices are soaked for 18 hours in a solution containing:**

*** - boiling water: 1 litre;**

- **sugar: up to 40 Brix (7-800 g);**
- **potassium metabisulphite: 3 g/litre of water;**
- **lemon juice: 2 spoons/litre of water.**

**The slices thus prepared are drained and placed on glycerine coated aluminium trays, which are placed in a sun or solar dryer.**

**The drying is completed when the product has a moisture content of 15%. The dried**

**slices (150 g) are packed in cellophane bags, labelled and stored in a dry place.**

**Mango bars and mango slices:**

**Storage life: about 9 months.**

**Remark: without preservative (potassium metabisulphite), the storage life of the products is relatively short.**

## PROCESSING OF MANGO JUICE

**Processing of mango juice**

**Fully ripe fruit is used. The mangos are washed, peeled and cut into slices with a stainless steel knife. Pulp extraction is carried out with a hand-driven or electrical juice extractor.**

**Boiling water, lemon juice and sugar are added to the pulp so that the mixture contains 12% TSS (total soluble solids) as determined by a refractometer and pH of 3.5 to 3.8. The composition of ingredients is as follows:**

- **boiling water: 1 litre/kg of pulp;**
- **sugar: 200 g/kg of pulp;**
- **lemon juice: 2 spoons/kg of pulp.**

**Bottles are filled and capped with a manual capper. Pasteurization times is related to the size of bottles.**

| Size of bottles in litre | Pre-heating | Pasteurization time in minutes |
|---|---|---|
| 0.33 | YES | 20 |
| 0.50 | YES | 25 |
| 0.75 | YES | 30 |

**Allow the bottles to cool in the same container till the following morning then wash, label and store them.**

**Storage time: about 12 months**

## Processing of mango jam

**Both ripe and underripe fruit is used.**

**The mangos are washed, peeled and cut into small slices with a stainless steel knife. The amount of sugar required represents 60% of the weight of the mangoes prepared.**

**The cooking is done in two stages:**

**1ST STEP consists in adding 70% of the amount of sugar calculated, plus 2 spoons of lemon juice per Kg of mango. Stir well during the entire cooking until 50 Brix of solids by refractometer is reached.**

**2ND STEP consists in adding the remaining 30% of the sugar plus 2 spoons of lemon juice per kg of mangos. Stir well during the entire cooking, until 67-68 Brix of solids by refractometer is reached.**

**The jars are filled while the mixture is hot ("hot-fill" process). During the operation the jam must be stirred with the handle of a wooden spoon in order to eliminate the air that has entered the jars. The jars are closed with screw-tops. Jars cooling, washing and labelling are the last stages before storage.**

## PROCESSING OF PEELED TOMATOES

## Processing of peeled tomatoes

**For the preparation of peeled tomatoes, fully ripe but still hard, long and/or oval tomatoes are used.**

**After washing, green tomatoes or those showing mouldy patches, black spots or presence of worms are picked out. The remaining tomatoes are dipped in boiling water for about one minute, then cooled in water at room temperature. Scalding facilitates the bursting of the skin.**

**The jars, previously washed, are filled by hand. To eliminate the gaps created during filling, tap the bottom of the jar. Then add a small spoonful of lemon juice or vinegar. The filling is completed by adding the hot pulp. The jar is tightly closed with a screw-top. Before counting the pasteurization time, wait till the water comes to the boil.**

**Pasteurization time is related to the size of the jars.**

## PROCESSING OF TOMATO PULP

## Processing of tomato pulp

**For the preparation of tomato pulp, fully ripe but not spoilt tomatoes are used.**

**After washing, the tomatoes are drained in order to eliminate the water on the surface. Sorting is done before the tomatoes are cut into halves to facilitate crushing and to detect any possible disease or decay inside.**

**A manual or electrical juice extractor is used to separate the pulp from the seeds and the skin. The pulp is transferred to a pot and heated until 8-90 Brix of solids by refractometer is obtained.**

**While still hot, the pulp is bottled with the help of a ladle and a funnel (previously "boiled" for few minutes in water). Acid correction is done with a small spoon of lemon juice.**

**The bottles are closed with a capper. The pasteurization is performed within the same duration as the jars of peeled tomatoes and under the same conditions. Cool overnight. Washing and labelling are the last stages before storage.**

**Storage life: about 12 months.**

## GROUP 1.2 - DRYING / DEHYDRATION

## PROCESSING OF DRIED CARROTS

**Processing of dried carrots**

**Roots with red cores and not woody are good for drying. Varieties such as "Chantenay Red Core" and "Imperator" are best for drying.**

**After removing the stalks and tips, wash the carrot, scrape, then cut into slices of about 56 mm thick using stainless steel knives. All green parts, if any, have to be removed.**

**For blanching, the slices are dipped for 3 minutes in boiling water containing 50 g salt per litre of water, followed by cooling in running water. In some processes, depending on the finished product specifications / customer standards, sulphiting is also carried out. This step is by dipping in a solution containing 3 g potassium metabisulphite per litre of water, during 3 min.**

**The product is then evenly spread on the trays of a dryer. The carrots are dried when the prepared MW material / dry products ratio is about 12: l (moisture content about 6%).**

**Cooling, packing, labelling and storage of dried products are performed according to same recommendations as for the other products.**

## PROCESSING FLOW-SHEET FOR APRICOT DRYING/DEHYDRATION

**Processing flow-sheet for apricot drying/dehydration**

**In order to obtain a high quality finished product, it is essential, among other points, that raw material characteristics fulfil the following requirements:**

- **fruit from varieties with kernel not adhering to pulp;**
- **clean fruit, e.g. not contaminated with dirt, soil, etc.;**
- **whole and healthy fruit;**
- **maturity/ripening according to needs for drying technology, e.g. having reached about 90% of the colour of fully ripe fruit;**

- **fruit with pulp which has a texture that enables it to keep its shape after cutting;**
- **fruit without physical damages or microbiological attack.**

**Fruit must be cut in halves with a knife; do not "separate" the two halves by hand.**

**Conventional sulphuring before drying is performed by exposing fruits on drying trays to fumes of burning sulphur in "sulphuring cells":**

**2 g of sulphur for each kg of prepared fruits; sulphuring time: 60 to 90 minutes.**

**In order to reduce SO2 content in finished product and to provide an alternative to sulphuring cells for small scale / farm operations, dipping apricot halves in various preservative solutions ("wet sulphuring") may be used.**

## PROCESSING FLOW-SHEET FOR DRIED/DEHYDRATED PLUMS (PRUNES)

**Processing flow-sheet for dried/dehydrated plums (prunes)**

**The lowest acceptable degree Brix for raw materials is 21 with an average at 24 Bx and a maximum at 30 Bx.**

**Mechanical drying installation (tunnel) can handle up to 8-11 t/day raw material.**

**Initial air temperature is 55 C and final air temperature is 72-75 C.**

**Plums are dried down to 23-24% moisture in the first step.**

**After storage, commercial practice is to re-process the prunes by immersion in warm water (80 C), containing 2% sodium sorbate, during 10 min and thus rehydrating products up to 26-28% or to 30-32% moisture; this treatment provides a ready-to-eat product which is very appreciated.**

## PROCESSING FLOW-SHEET FOR DRIED/DEHYDRATED APPLES

**Processing flow-sheet for dried/dehydrated apples**

- **After peeling and coring/slicing dip slices in salted water (2% NaCl) before further treatment in order to prevent browning due to contact of tissues with oxygen from air.**
- **Apples should be cut into in 8 slices (= cut each quarter in two slices). Peeling is**

**optional and depends upon customer specification or consumer preference.**

- **Sulphuring can be performed by two alternative methods:**

**a) Wet sulphuring: dipping slices for 10 minutes in a solution containing: 0.5% Potassium metabisulphite ($K_2S_2O_5$) + 0.2% Citric acid.**

**b) Dry sulphuring: keeping slices (on drying trays, in sulphuring cells) exposed to fumes of burning Sulphur**

**2 g Sulphur for each kg of apple; sulphuring time: 30-40 minutes.**

**- Resulphuring has to be performed by exposing dried apple in bulk to fumes of burning sulphur in order to avoid insect infestation.**

## PROCESSING FLOW-SHEETS FOR DRIED/DEHYDRATED LEEKS

**Processing flow-sheets for dried/dehydrated leeks**

*** It is necessary to separate the white parts of the vegetables from the green ones by cutting manually.**

**The following step - cutting operation - is then done separately for each colour.**

**Sorting and sieving steps require elimination of "fines" and a control of adequate separation by colour.**

## PROCESSING FLOW-SHEET FOR DRIED/DEHYDRATION POTATOES

**Processing flow-sheet for dried/dehydration potatoes**

- **Temporary storage in good conditions is done in darkness, at low temperatures (if possible at 10 C or down to 5 C). Potato peeling could be performed preferably by mechanical or chemical means. After each main peeling step, a manual rectification must be added in order to obtain good final results.**
- **After cutting, slices or pieces must be immediately dipped in 0.5% solution sodium metabisulphite for 1 minute and then kept in 2 % NaCl water solution until next processing step to avoid contact of tissues with oxygen from air.**
- **Slices optimal size could be evaluated at 5-6 mm.**

*** Optimal blanching time is 2-5 min according to variety.**

- **Treatment after blanching is dipping in water containing 8000 ppm S02 (12 g K2S2O5 to each litre of ater).**

**** Optimal dehydration temperature is 65 C.**

**An alternative treatment is with slices soaked in a 10-fold weight solution of 5% (w/w) sodium chloride (salt) + 1% K2S2Os for 16-18 h, at ambient temperature (around 20C) and then dried.**

## FLOW-SHEET FOR PROCESSING OF DRIED ONIONS

**Flow-sheet for processing of dried onions**

**Varieties with pungent flavour are the most appreciated; both coloured and white onions may be used.**

**After removing the tops, roots and outer integuments, onions are washed thoroughly and then cut into slices of 3 mm thick. It is preferable to cut at right angles to the core of the onions. After cutting onion slices are carefully washed. Blanching is not**

**practiced (it makes the onion lose its flavour).**

**The use of preservatives is not necessary; therefore, after washing and draining, the slices are spread evenly on the trays of a dryer. The onions are dried when the ration of prepared raw material to dry product is about 9:1 (moisture content about 5%).**

**Cooling, packing, labelling and storage follow the same operations as described in other flowsheets.**

**The dried product may be ground into powder (which tend to agglutinate without any anticaking agent).**

**The dryer used for onions must be reserved especially for onion (flavour / odour contamination possible to other products).**

**Storage life: about 12 months.**

## PROCESSING OF DRIED TOMATOES

**Processing of dried tomatoes**

**For the preparation of dried product, tomatoes should be ripe, of good red colour and should be firm.**

**Tomato pigments are stable because they are rich in carotene; therefore, pre-processing, such as blanching and sulphiting, is not necessary. Alternatively the slices may be dipped for 3 min in a solution containing 0.7% $K_2S_2O_5$ plus 10% salt.**

**Washing and sorting are followed by cutting in halves lengthwise to eliminate the liquid and the seeds. The seeds as well as the ones from tomato pulp processing can be used again as seeds if they have not gone through a heat treatment.**

**Empty the tomatoes and then cut them lengthwise into slices of 6 to 8 mm thickness and place them in dryers.**

**The tomatoes are dry when the raw material / dry product ratio is about 25:1. On an average, 40 g of dried products are obtained from I Kg of fresh tomatoes. The yield depends on the dry tomato residue and the degree of drying.**

**The last operations before storage are: cooling (half an hour at room temperature), bagging (in 100 g cellophane bags, closed to avoid humidity) and labelling.**

**The product must be kept in a dark place to reduce infestation by photophylic insects.**

**The dried slices may be reduced to flakes by rubbing through a sieve of about 10 mm mesh. This gives a better looking product which is easy to handle. The product may also be ground into powder but this will tend to cake and the colour is less appealing than the flakes.**

**NOTE:**

**Three processing recommendations made in this flow-sheet have to be followed, among others, for all dried/dehydrated products:**

1. **Let finished products cool down to room temperature for half an hour before packing/bagging;**
2. **Always store dried/dehydrated products in a dark place.**
3. **Place dried/dehydrated products in packing materials which have enough barrier effect against moisture transfer and close well.**

## GROUP 1.3 - JUICES, FRUITS IN SYRUP, SAUCES, JAMS, PULPS AND NECTARS. CANNED

## PRODUCTS

### Flow-sheet for orange juice processing

**Fruit to be used for juice production should be from a well run cultivation, freshly picked and well ripened.**

**The fruit is first sorted to remove rotten and other unfit items. It then passes through a soak tank of disinfectant and water and then to a brush-washer where rapidly revolving brushes and sprays wash the fruit very vigorously and thoroughly. The brush-washed fruit is again sorted and conveyed to the juice extractor, or halved and juiced.**

**The pulpy juice flows into the mesh screen finisher for the removal of seeds, heavy pulp and skin portions. The finished juice passes on to the blending, mixing and heating tanks where the requisite amount of sugar syrup is added, if sweetened juice is to be produced. Blended juice is pasteurized and filled into sterilised cans. Filled cans are sealed, cooled, labelled and packaged for marketing.**

# FLOW-SHEET FOR PROCESSING MANGO JUICE

Flow-sheet for processing mango juice

**Fruit to be used for juice production should be factory ripened. Fully mature, unripe mangos are harvested and shifted to the cannery where they are allowed to ripen in a closed atmosphere. Usually it takes about three to four days to ripen the fruit.**

**Fruit is then sorted and sound ripe mangos are passed to a soak tank of antiseptic and water, and then to a brush washer where rapidly revolving brushes and sprays wash the mangoes. The washed fruit is conveyed to the preparation tables where it is hand peeled. In some cases, the washed unpeeled fruit is steamed and pulped, but for a quality product it should be peeled.**

**The peeled mangos are steamed and pulped. The coarse pulp thus obtained is sieved with the help of a finisher and conveyed to the blending, mixing and heating tanks where the requisite quantity of sugar syrup is added. The juice is then pasteurized, filled into the steamsterilised cans and sealed. The sealed cans are water-cooled, labelled and packaged for sale.**

# FLOW-SHEET FOR PROCESSING OF PINEAPPLE JUICE

Flow-sheet for processing of pineapple juice

**Canned pineapple juice is now third to canned tomato juice and orange juice in terms of volume (world production). It is an excellent juice for canning, since it retains its fresh flavour and aroma remarkably well and is of an acidity and sugar content such that it is properly balanced in flavour.**

**Pineapple juice is a by-product obtained during the canning of pineapple slices or rings in syrup. The principal raw materials from which pineapple juice is prepared are the shredded meat obtained from the inner portion of the peels left after the peeling of the pineapple, the small pineapple that is too small for canning, the trimmed cores and the juice drippings from the crushed pineapple.**

**Small pineapples are peeled. The peeled, small pineapple cores and eradicated meat are shredded; the juice is extracted and then passed through a finisher. The juice thus obtained is blended with sugar syrup, pasteurized and filled into sterilized cans. The cans are sealed hot ("hot-seal" process), cooled, labelled and packaged.**

# SIMPLIFIED FLOW-SHEET FOR TOMATO JUICE PROCESSING

Simplified flow-sheet for tomato juice processing

**A hand-operated or an electrical juice extractor could be used. Refining is an optional step and will be performed if an additional centrifugal refiner is available as equipment.**

**Citric acid or lemon/lime juice will be added in bottles just before filling. Salt may be added to enhance taste.**

**Prior to use, empty bottles or jars (and crown-corks or caps) must be washed thoroughly, rinsed and then "sterilised" by keeping in boiling water for 30 min.**

*** Pasteurization is a very important step for the finished product shelf-life and must be carried out very carefully.**

**** DO NOT cool recipients after pasteurization in running water - there are risks of breakage; instead, leave recipients to cool down slowly overnight in the pasteurization pot.**

*** Pasteurization TIMES**

| Recipient countenance | Preheating | Pasteurization times |
|---|---|---|
| 0.331 | 60 C | 40 minutes |
| 0.501 | 60 C | 45 minutes |
| 0.661 | 60 C | 55 minutes |
| 0.751 | 60 C | 60 minutes |

## FLOW SHEET FOR PROCESSING OF MANGO SLICES IN SYRUP

Flow sheet for processing of mango slices in syrup

**Fully mature, unripe mangos are ripened in the cannery to optimum canning ripeness. Mangos high in flavour, with more flesh and low in fibre are always recommended for canning.**

**Sound ripe mangos are soaked in antiseptic and water, brush washed and then**

**conveyed to the preparation tables and hand peeled. "Cheeks" of the peeled mangos are sliced off and longitudinally cut into two or three slices. Side cuts are packed separately. Slices are then conveyed to the filling tables where they are graded for size, colour and maturity and filled into sterile cans. Filled cans are syruped, steam exhausted, sealed, processed in boiling water, cooled, labelled and packaged.**

**Stones with the left over flesh are steamed and pulped and the pulp thus obtained is packed as such or converted into mango juice or nectar.**

## FLOW-SHEET FOR PROCESSING OF PINEAPPLE RINGS IN SYRUP

**Flow-sheet for processing of pineapple rings in syrup**

**Pineapples are harvested when they have reached full maturity in order to obtain maximum flavour and quality. Usually the fruit is harvested when 20 to 25 per cent of bracts have turned orange in colour, and then transferred to the cannery in the shortest possible time. Fruit weighing 1.5-2.0 Kg are the best suited for canning as rings.**

**Fruit is size graded and the crown removed. It is then washed thoroughly and prepared, which includes peeling, coring, slicing and punching. Slices are then graded for size, colour and maturity. Slices should be free from peels and eyes. Each can is filled with slices of the same size and colour. The filled cans are syruped hot, exhausted, sealed, processed, cooled, labelled and packaged.**

## FLOW-SHEET FOR PROCESSING OF TOMATO KETCHUP OR SAUCE

Flow-sheet for processing of tomato ketchup or sauce

**Tomato sauce and tomato ketchup are popular condiments all over the world. Clean, wholesome tomatoes of intense red colour and of meaty, not watery texture are used for sauce making. High acidity and a rich tomato flavour are additional desirable qualities.**

**Sound tomatoes are washed very thoroughly, cored, sliced, heat crushed and pulped (through a pulper or juice extractor) to remove seeds and skins. Tomato pulp or paste is then cooked with the requisite quantities of spices, onions, garlic, sugar, salt and vinegar.**

**The whole mass is concentrated to a final TSS (Total Soluble Solids) of more than 25 per cent. The mass is finally passed through the finisher and filled into clean, dry bottles.**

**Bottles are cleaned, labelled and packaged for marketing. (Preservation is assured either by use of preservatives or by pasteurization).**

## SIMPLIFIED TECHNOLOGICAL FLOW-SHEET FOR FRUIT JAMS PROCESSING

**Simplified technological flow-sheet for fruit jams processing**

**Jams may be made from practically all varieties of fruit. Various combinations of different varieties of fruit can be often be made to advantage, pineapple being one of the best for blending purposes because of its pronounced flavour and acidity.**

**Sound fruit is sorted, washed in running water or, preferably, brush-washed and prepared. The mode of preparation varies with the nature of the fruit. For example, mangos are peeled, steamed and pulped; apples are peeled, cored, sliced, heated with**

**water and pulped; plums are scalded and pulped; peaches are peeled and pulped; apricots are halved, steamed and pulped; berries are heated with water and pulped or cooked as such.**

**Fruit pulp is cooked with the requisite quantities of sugar and pectin, and finished to 69% Total Soluble Solids (TSS). Permitted food colours and the requisite amounts of citric acid and flavouring are added at this stage. The product is packed in cans or glass jars, and cooled, followed by labelling and packaging.**

## PROCESSING FLOW-SHEETS FOR MANUFACTURING JAMS FROM BERRIES

Processing flow-sheets for manufacturing jams from berries

## FLOW-SHEET FOR MANGO AND GUAVA PROCESSING - PULPS AND NECTARS

Flow-sheet for mango and guava processing - pulps and nectars

## TECHNOLOGICAL FLOW-SHEET FOR PINEAPPLE CANNING

## Technological flow-sheet for pineapple canning

**Coring is a major limiting factor in the recovery of the fruit and in the whole processing operation. Trimming should be mainly to remove the deep "eyes".**

**Sugar syrup concentration is adapted to the type of finished products:**

**45-55 Brix for "Fancy" slices**

**30-35 Brix for "Choice" slices**

**20-25 Brix for standard slices**

**Removal of air is performed in continuous steam exhauster equipment for 7-9 min at 185212 F or discontinuously in boiling water.**

**Heat treatment is carried out in continuous rotary cookers at 212 F for 10-20 min.**

**Cooling is be done in rotary coolers in water for 10 min.**

## FLOW-SHEET FOR THE PROCESSING OF PASSIONFRUIT

Flow-sheet for the processing of passion fruit

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# Appendix II - Standards for grades of dried apricots

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### 1. Definition of the product

**These standards refer to apricots dried (naturally) or dehydrated, obtained from mature fruits, botanical name: Prunus Armeniaca L.**

### 2. General quality requirements

**In all categories, dried apricots must be:**

**2.1 Whole (with or without kernel) or halves;**

**2.2 Healthy and especially without mould, without visible evidence of attack by insects or by other parasites and without living insects in any stage of development;**

**2.3 Clean, without any visible foreign matter;**

**2.4 Without foreign smell (*) and / or flavour;**

**2.5 Fleshy, with an elastic and flexible pulp.**

**The moisture content must not be over 20%. However, at the request of customer, moisture content could be in the range of 20-25% or 25-30%, with the reserve of special processing treatment utilisation (for assuring shelf-life) and mentions in the section "Marks" .**

**The manufacturing and state of dried apricots should be such to enable them to support transport and handling and assure their arrival in good conditions to the delivery point.**

**3. Grading**

**The dried apricots are graded as follows:**

**3.1 "Extra category": Dried apricots shipped under this category must be of superior quality. If the product is whole, it must be without kernel. The colour has to be characteristic to the product and homogenous (colour "apricot") without any part which are black, discoloured or with texture defects. The halves must have a clean / net cutting (by knife).**

**3.2 "Category I": Dried apricots shipped under this category must be of good quality. If the product is whole, must be without kernel. The colour has to be characteristic to the apricots. Tolerance: slight appearance or colour defects (discoloured) and small cuttings of skin but with the condition that all these defects have no impact on product appearance, quality or shelf life.**

**3.3 Category II: This category covers dried apricots which cannot be classified in superior categories but are according to the minimum requirements defined in section 2. If the product is whole, it could be with kernel. Appearance and colour defects (spots, brown parts but without darkening of fruits) and slight damages of the skin are accepted with the condition that the finished product keeps its characteristics.**

**4. Size grading**

**The size grading is determined by the number of fruits per pound:**

| Category | Wholes | Halves |
|---|---|---|
| Very big | Less than 50 | Less than 100 |
| Big | 50-65 | 100-130 |
| Medium | 66-75 | 131-150 |
| Small | 76-90 | 151-180 |
| Very small | More than 90 | More than 180 |

**The size grading is mandatory for dried apricots in category "Extra" and "Category I" and has to be mentioned in section "Marks".**

**5. Tolerances**

**5.1 Category Extra: 5 % in weight of fruits not answering to the quality specifications for this category but in conformity with those of "Category I".**

**5.2 Category I: 10% in weight of fruits not answering to the quality requirements for this category but being in conformity with those of "Category II".**

**A maximum 0.5% in number of fruits having traces of mould or fermentation or containing dead insects or other parasites is also tolerated.**

**5.3 Category II: 15% in weight of fruits not answering to the quality specifications for this category but being in conformity with the minimum requirements defined in section 2. A maximum 1% number of fruits with moulds or fermentation or containing dead insects or other parasites is also tolerated.**

**The presence of any living insect or parasite is NOT tolerated, in any of their biological cycles.**

**In all categories, a tolerance is accepted for size grading - 10% in weight of fruits in each pack - in conformity with size from immediately superior and / or inferior size grade identified.**

**Tolerance in moisture level. - It is accepted a variation of 1% more or less as compared to the level indicated in section "Marks".**

**6. Homogeneity**

**The content of each shipping or consumer pack must be homogenous and must contain**

**only dried apricots of same origin, quality and size. The visible part of the pack must be representative of all the content.**

**7. Packing**

**The content of each shipping or consumer pack must be protected against any external or internal deterioration / damages. The packing and material must be new, clean, free from any foreign body, according to the specifications, in line with consumer requirements.**

**8. Marks**

**All packages of dried apricots must bear:**

**8.1 Indication as to contents and their origin: (country of origin name) Dried Apricots;**

**8.2 Indication as to the category: Extra, I or II;**

**8.3 Indication as to size grade: very big, big, medium, small or very small and type: wholes or halves;**

**8.4 The packer's mark as specified by local authorities;**

**These indications must be made clearly and legibly by means of indelible ink or branded outside the package in letters of 2 cm height;**

**8.5 Indication as to the moisture content, if above 20%, i.e. "Moisture content 20-25 % " or "Moisture content 25-30%";**

**8.6 Indication as to the net weight of the package.**

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# Appendix III - Recipe guidelines; dried fruit and vegetables

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**RECIPE GUIDELINES * - FRUIT PPESERVES WITHOUT SUCROSE**

**1. Strawberry jam with RSunett and Sorbitol**

**Ingredients:**

**Strawberries 500 g**

**Sunett 0.75 g**

**Sorbitol (powder) 250 g**

**Gelling agent**

**Method: Prepare the fruit as usual. Add the Sorbitol powder and the gelling agent and bring to the boil while stirring continuously. Dissolve the Sunett in some water and add it to the other ingredients. Add the additional ingredients which are usually added in producing jams. Let the ingredients boil for approximately 1 minute while stirring constantly. Fill into the prepared jars.**

**Calorific value: cat 480 kJ/100 g (ca. 115 kcal/100 g)**

**2. Berry jam with RSunett, cyclamate and sorbitol**

**Ingredients:**

**Red currant 100 g**

**Black currant 100 g**

**Blackberry 100 g**

**Sorbitol 150 g**

**Jelling agent to suit**

**Sunett 0.45 g**

**Cyclamate 0.45 g**

**Method: Prepare the jam in the usual way**

**Calonfic value: cat 480 kJ/100 g (ca. 115 kcal/100 g)**

**3. Red currant jam with RSunett and Sorbitol**

**Ingredients:**

**Red currants 450 g**

**Sunett 0.9 g**

**Sorbitol 450 g**

**Gelling agent**

**Method: Prepare the fruit as usual. Add the sorbitol and the gelling agent and bring to the boil while stirring continuously. Dissolve the Sunett in some water and add it to the other ingredients. Add the additional ingredients which are usually added in producing jams. Let the ingredients boil for between 2 and 4 minutes while stirring constantly. Fill into the prepared jars.**

**Calorific value: cat 897 kJ/100 g (ca. 215 kcal/100 g)**

## DRIED PLUM (PRUNE) PURE

**I. Ingredients Weight/measures**

**Soft pitted prunes 3 lbs.**

**Sugar 1/2 cup**

**Light corn syrup 1 cup**

**Boiling water 2 1/2 cups**

**II. Method**

**This pure may be made in any commercial-size processor with a 1-gallon capacity work bowl. Lacking a large processor, follow the instructions in the NOTE at the end of the recipe. Pure keeps well, refrigerated, for 6 to 8 weeks. Use directly from the refrigerator. Freeze for longer storage, thaw before using.**

**Place first three ingredients in work bowl fitted with the metal blade. Start motor and pour boiling water through feed tube. Process about 2 minute, until mixture is completely smooth. Stop motor occasionally to scrape side of work bowl. Cool completely; cover and refrigerate.**

**NOTE: To make pure without a processor, combine all ingredients in large saucepan.**

**Bring to boil, cover pan, and stew prunes slowly until fruit is very tender. Mash well with large wooden spatula, pressing prunes along side of saucepan. Alternatively, grinding this mixture through the finest blade of a meat grinder. You may multiply this recipe any number of times.**

**RECIPES**

**Apricot fruit preserves**

**1. 1 kg apricot halves (without stones) 0.6 kg sugar 5 g citric acid**

**Add 420 g sugar to prepared fruits and bring to boil; boil gently during 15 min**

**Add the remaining 180 g sugar and 5 g citric acid**

**Continue boiling gently up to required refractometric extract**

**2. 1 kg apricot halves prepared as above 1.5 kg sugar For all sugar to the fruit; mix gently with a spoon Leave the mix overnight**

**3. Dip apricot halves for 7 min in a solution containing:**

**2% sodium metabisulphite and 0.5% citric acid**

**Obtain fruit pulp by available means/equipment: a) through a sieve in traditional preparation; b) with a simple juice/pulp extractor in small scale operation; c) with a pulper in other cases).**

**Basic recipe is 1 kg fruit pulp + 0.6 kg sugar.**

**Methods for drying some vegetables and fruits**

**1. Garlic. - The cloves are separated and the outer skins removed by hand. The skins of individual cloves are not removed. The cloves are cut into pieces not more than 5 mm cube. No blanching nor other treatment are applied.**

**The product is spread evenly on drying trays. Dry until brittle. The final moisture content should be about 5%. The yield is about 5:1. After completing drying, separate dry skin by**

**winnowing.**

**The dry product may be ground into powder which should then be protected against**

**moisture pick-up as it is very hydroscopic.**

**2. Beetroot. - After washing, peeling and trimming the material is cut into slices about 2-3 mm thick. Only steam blanching could be used as water blanching will wash out the colour. The slices are immersed in a solution containing 8000 ppm SO2 for I minute.**

**The prepared material is placed on drying trays and dried to a moisture content of about 6%. Shade drying might also be tried. Overall shrinkage ratio is about 12:1.**

**3. Turnip. - The material is peeled after cutting off tops and roots then cut into slices 2 to 5 mm thick. The slices are submerged for 4 to 6 minutes in boiling water. Slices are dipped for I minute in a solution of metabisulphite containing 8000 ppm sulphur dioxide..**

**After treatments, material is spread thinly and evenly on standard trays and dried to a moisture content of 6%. Shrinkage ratio is 28:1.**

**Turnips are white fleshed, and Swede Turnip yellow or orange fleshed. The latter will produce a dried product of better quality.**

**4. Sweet pepper**

**The raw material is washed thoroughly and broken up. Cores and interlocular partitions are removed by hand. Defective parts are cut out with knives. The prepared flesh is held under water or a weak solution of sodium metabisulphite (2000 ppm SO2) before being hand cut into strips about 5 mm wide.**

**The cut pieces are dipped for 1 minute in a solution of 2000 ppm So2 (3 g sodium metabisulphite per litre).**

**The material is spread in a thin layer on trays and shade dried until crisp or to a moisture content of about 7%. Average shrinkage ratio is about 25:1; drying ratio is about 13:1.**

**For finishing, pick out any burnt or discoloured pieces; put the material on a sieve of suitable mesh to remove small pieces and "fines". Both green and red peppers may be used for drying.**

**5. Banana**

**Both fully ripe and unripe fruits can be dried, but since they are used for different purposes they must not be mixed together.**

**The fruit is washed, peeled and diced into transverse slices 10 mm thick or lengthwise.**

**Unripe fruits are blanched in boiling water for a few minutes and then peeled. The ripe fruits are not blanched.**

**The prepared material is dipped for 1 minute in a solution containing 2000 ppm sulphur dioxide.**

**The slices are dried on standard trays which have been coated with a very thin glycerin layer to avoid sticking. The final moisture content should be around 12%.**

**The dried slices prepared from unripe banana may be converted into flour which can be used alone or in combination with other flours.**

**Dried bananas produced from ripe fruit are usually consumed in the dry state, like dates.**

**Glossary**

**Shrinkage ratio: the ratio of unprepared raw material to dry finished product.**

**Drying ratio: the ratio of prepared raw material to dry product. ppm:parts per million**

**Carrot dehydration**

**As an alternative to described method, a double blanch processing was found to give significant increases in firmness.**

**Lots (6 kg) of whole carrots are blanched by immersion in a large excess of water at 60 C in a steam jacketed kettle for 45 mini then blanched again for 6 min at 100 C in boiling water. The high temperature blanch was designed to inactivate enzymes that have the potential to generate off-flavours during storage in the dry conditions.**

**The carrots are then immediately peeled by immersion in 10% sodium hydroxide at 90 C for 1 min. passed through a rubber stud roller peeler to remove loose skin, sprayed with cold water and trimmed by hand. They are diced into 9.5 mm cubes in an Urschel dicer and passed over a vibrating screen to remove small pieces.**

**The product may be spread on wire mash aluminium trays and conventionally air died in a cabinet dryer with cross-flow air for 1.5 hr at 82 C and then at 66 C for 3.5 hr to obtain a final moisture content of about 6-7%.**

## TECHNOLOGICAL FLOW-SHEET FOR DRIED/DEHYDRATED MULBERRIES

**Technological flow-sheet for dried/dehydrated mulberries**

**- Treatment before drying is as follows:**

**** Dipping fruits for 5 minutes in a solution containing**

**0.5% Potassium metabisulphite and**

**0.2% Citric acid**

**- Technological steps and treatment are the same for white and for black mulberries.**

## PROCESSING OF DRIED GREEN BEANS

**Processing of dried green beans**

**Only stringless varieties should be dried. Suitable varieties are "Contender", "Tendergreen", "Tenderlong". Harvest the pods whilst the seeds are still small.**

**After washing, snip off the ends of the pods. The material is then cut into pieces 3 cm in length using a diagonal cut.**

**For preservation purposes and in order to keep the colour of the vegetable, blanching and sulphiting are carried out.**

**For blanching, the product is dipped in boiling water containing 50 g salt per litre of water, during 3-4 min.**

**After cooling, sulphiting is carried out by dipping in solution containing 3 g potassium metabisulphite per litre of water, during 3 min.**

**Then drain and spread the product on the trays of a dryer. The beans are dried when raw material/dry product ratio is about 18:1 (moisture content about 6%).**

**Storage life: about 12 months.**

## PROCESSING OF DRIED OKRA

**Processing of dried okra**

**Young tender pods are preferred.**

*** The pods may be dried whole, in the form of slices (about 6 mm thick) or in halves cut lengthwise.**

**The pods are washed thoroughly to remove dirt. Both end are trimmed and any discoloured or damaged tissue is removed.**

**For preservation purposes and in order to keep the green colour, blanching is carried out: the product is dipped for 3 minutes in boiling water containing 50 g salt per litre of water. The blanched okras can then be washed with cold water to remove the slimy material produced by boiling.**

**The product is then sulphited by dipping for 3 minutes in a solution containing 3 g potassium metabisulphite per litre of water.**

**The product is then drained and finally placed on the trays of a dryer. The okras are dry when the prepared raw material/dry product ratio is about 12:1 (moisture content 4-5%).**

**Cooling, packaging, labelling and storage are carried out as recommended for the**

**other finished products.**

**Storage life: 12 months**

## PROCESSING OF DRIED CABBAGES

**Processing of dried cabbages**

**After removing the outer leaves, the vegetable is washed and cut into quarters. Cores are removed and cabbages are cut into 5 mm strips. It is then washed to eliminate dust, soil and insects.**

**To keep the colour of the vegetable and for preservation purposes, blanching and sulphiting are carried out.**

**Blanching is performed by dipping for 3 minutes in boiling water containing 50 g salt per litre of water. After cooling, sulphiting is carried out by dipping in a solution containing 3 g potassium metabisulphite per litre of water, during 3 minutes.**

**The product is drained and then evenly spread on the trays of a dryer. The cabbages**

**are dry when the prepared raw material / dry product ratio is around 12:1 (moisture content 5%).**

**Cooling, packing, labelling and storage are carried a out as recommended for other products.**

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# Appendix IV - Complete units and various equipment and material for fruit and vegetable processing

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4. **FLOW DIAGRAM OF TRIPLE EFFECT POLYVALENT FRACTIONAL**

**EVAPORATOR FOR TOMATO PASTE UP TO 320 BRIX AND CONCENTRATED CLARIFIED FRUIT JUICE TILL TO 720 BRIX - ING. A. ROSSI**

5. **SMALL SCALE STERILIZERS - STERIFLOW(r) - BARRIQUAND**
6. **TECHNOLOGICAL PROCESSING LINE FOR OBTAINING TOMATO JUICE BEFORE CONCENTRATION TO TOMATO PASTE**
7. **TECHNOLOGICAL LINE FOR TOMATO JUICE CONCENTRATION AND TOMATO PASTE PASTEURIZATION**
8. **POTATO PROCESSING UNIT - TECHNOLOGICAL LINE FOR POTATO FLAKES DEHYDRATION ON DRUM DRYERS**
9. **VARIOUS SIZES AND TYPES OF GLASS JARS**
10. **EQUIPMENT FOR "DRY SULPHURING" OF FRUIT BEFORE DEHYDRATION / DRYING**

**1. Vegetable Processors**

**2. Automatic Sieves - Pulper**

**4. Flow Diagram of Triple Effect Polyvalent Practional Evaporator- Ing. A. Rossi**

## 5. Small-scale Sterilizers - Steriflow(r)- Barriquand

## 6. Technological Processing Line for obtaining Tomato Juice before concentration to tomato paste

### (1) to (6) - WASHING - SORTING EQUIPMENT GROUP

1. INITIAL WASHING
2. DRUM
3. FINAL WASHING
4. AIR COMPRESSOR
5. SORTING BELT
6. RETURN BELT

### (7) CRUSHER

### (8) ROTATIVE SEPARATOR

### (9) PULP CRUSHER

### (10) SEED SEPARATOR

**(11) PREHEATER**

**(12) COLLECTING TANK**

**(13) PUMP**

**(14) PULPER**

**(15) REFINER**

**(16) SUPER-REFINER**

**(17) JUICE STORAGE TANK BEFORE CONCENTRATION**

## 7. Technological line for tomato juice concentration and tomato paste pasteurization

1. **FIRST EFFECT EVAPORATOR**
2. **SECOND EFFECT EVAPORATOR**
3. **THIRD EFFECT EVAPORATOR**
4. **PUMP**
5. **PUMP**

6. **PUMP**
7. **PUMP**
8. **STORAGE TANK**
9. **STORAGE TANK**
10. **CONDENSER**
11. **VACUUM PUMP**
12. **PUMP**
13. **PASTEURIZATOR**
14. **DOSING AND FILLING MACHINE**
15. **CLOSING MACHINE**

## 8. Potato Processing Unit - Technological line for potato flakes - dehydration on drum driers

## POTATO PROCESSING UNIT - TECHNOLOGICAL LINE FOR POTATO FLAKES DEHYDRATION ON DRUM DRYERS

### (1) Vertical transporter

**(2) Separator for soil, stones, etc.**

**(3) Size grader: whenever possible, potatoes with a diameter of 20 to 80 mm are preferred for processing into flakes. The fresh potatoes with a diameter exceeding 80 mm could be oriented to temporary storage and / or to direct delivery on the fresh fruit and vegetable market.**

**(4) Storage tank**

**(5) Washing machine, rotary type**

**(6) Vertical transporter**

**(7) Storage tank**

**(8) Vertical transporter**

**(9) Weighing device**

**(10) Vertical transporter**

**(11) Peeling machine, steam type; for other installations lye peeling equipment could**

**be used.**

**(12) Rotary washing machine**

**(13) Transport and control belt**

**(14) Weighing and distribution system**

**(15) Vertical elevator**

**(16) Cutting machine**

**(17) Equipment for starch removal / washing**

**(18) Continuous blanching machine: 80-83 C, for 7 min.**

**(19) Cooler: in a water stream at 14-15 C.**

**(20) Machine for potato boiling: in water vapour, at 100 C, for 20 min.**

**(21) Vertical transporter**

**(22) Press or granulator: change boiled potatoes to a paste; for a good operation at drying stage it is recommended that the paste contain at least 20% dried substances (no more than 80% moisture).**

**(23) Feeding device for drum dryer; at this processing step, there are various additives that are added to the hot paste (in order to maintain taste, flavour, stability and structure of the finished products - potato flakes).**

**For 1000 kg paste 120 g of sodium sulphite and 40 g sodium bisulphite are added; in order to facilitate addition and an homogenous distribution, weak sulphite solutions are preferable. Depending on the sanitary regulations in various countries it is also possible to add other antioxidants.**

**Monoglycerides could be added for flakes texture improvement.**

**(24) Drying drums: potato pure is dried as a continuous sheet / film having 6% moisture. Rotating speed of the drum should be adjusted according to paste dried substances content; this speed could be between 1.8 and 2.3 rotation per min (RPM). Steam used for heating will have a pressure between 5 and 6 kgf / cm.**

**It is possible to estimate that a potato paste with 80% moisture could be dried to a 4.5-**

**5% moisture content in about 20 see using the following operating parameters: steam pressure = 6 kgf / cm; 2 rotations per min (RPM).**

**(25) Equipment for removal and cutting of potato dried sheets (26) Vertical transporter**

**(27) Machine for cutting sheets into flakes size / shape**

**(28) Transport and control belt**

**(29) Vertical transporter**

**(30) Vibrating / calibrating machine**

**(31) Transport belt**

**(32) Conditioning**

**(33) Packing: packaging material should be airtight in order to avoid moisture pick-up and enough strong / rigid to protect flakes from breaking. Opaque packaging materials are recommended.**

**Finished product quality characteristics:**

- **Colour: white / yellowish;**
- **Taste and flavour similar to those of pure prepared from fresh potatoes;**
- **Moisture content: 6%;**
- **Additives: sulphites = 300 ppm; antioxidant = 0.35%.; emulgator = 0.4%;**
- **Microbiological quality: total plate count = 50000 germs/g;**
- **Reducing sugar = 3% maximum;**
- **Summerson calorimetric scale coefficient = less than 150.**

**9. Various sizes and types of glass jars**

**9. Various sizes and types of glass jars (continued)**

**SO2 GENERATOR**

**SULPHURING INSTALLATION**

**CONVERSION TABLES - FAHRENHEIT SCALE AND CELSIUS SCALE**

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