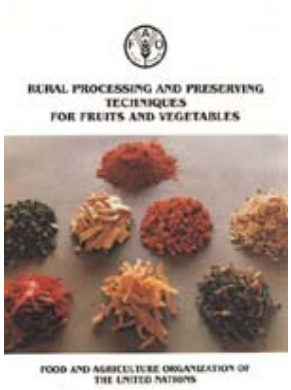

Rural processing and preserving techniques for fruits and vegetables

Food and Agriculture Organization of the United Nations

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Preface

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In recent years, developing countries have been asking for rural techniques for processing and preserving fruits, vegetables, roots and tubers, in order to increase the rural population's self sufficiency as well as their contribution to regional development.

One of the main obstacles to the development of these techniques is the lack of modern literature adapted to the socio-economic conditions of those countries.

The present manual has been prepared in response to this need and will constitute a practical instrument adapted to the requirements of extension-workers and trainers in the performance of their duties.

Any suggestion for the enrichment of this manual may be addressed to:

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Foreword

The present technical manual answers the problems of fruits and vegetables preservation in countries where the socio-economic conditions required for the development of food processing are not satisfactory.

In fact, the transfer of models of economic growth is not always possible: largescale industrial production requires considerable investment and markets that can ensure sufficient profits. The techniques described in this book are widely used in western countries, and here lend themselves to two types of application:

-processing by the producer of the fruits and vegetables required for family consumption;
-cottage-industry processing of products for the market by setting up modular units requiring an investment and limited expertise.

The size of the module unit allows to match the production and profitability requirements with the small demand due to the consumers' low purchasing power (See Appendix 2: Feasibility study on a tomato processing and preservation unit).

Moreover, the development of these activities will make it possible:

- to increase the value of local raw materials;
- to decrease post-harvest losses and to use processed products out of season;
- to increase farmers' income;
- to integrate family-type rural farming into the market economy;
- to support the local cottage-industry through the demand for the equipment required for processing and preservation activities.

Furthermore, by adopting these techniques, the producer becomes the originator of changes in his food habits and the promoter of the improvements in his nutritional standards.

The achievement of these objectives is bound up with the accomplishment of the following conditions:

- 1. appraisal of the market and the demand for the processed products;
- 2. study and organization of various stages of the marketing process, starting from selection of the packing material, which must be hygienic, recyclable and adaptable to the packing demands;
- 3. training of technicians and people responsible for the effective management of the equipments and resources available;
- 4. ensuring an integration among the various links of the chain of production in order to ensure a local production of improved varieties suitable for rural processing;
- 5. research on and development of the processed products as well as the processing and preserving technologies most suitable for the referred socio-economic environment;
- 6. provision of sufficient premises. in good condition and adequate for the activities;
- 7. development of a preferential credit system to ensure the funding of the activities.

In the long term, these conditions will permit a self-reliant and expanded development

of the module units and their contribution to the regional agro-feeding development.

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Rural processing and preserving techniques for fruits and vegetables

Introduction

The processing techniques considered in the present manual are the following:

- **sun-drying, with or without preservatives**
- **heat treatment, with or without preservatives**

Sun-driers are used for drying (see photos Nos. 1 & 2). They can be used in tropical countries when the average relative humidity is below 50% during the dry season. In the opposite case, cabinet driers run on electricity or diesel oil, or sun-driers fed with energy from food-waste recycling, will have to be used.

Simple equipment is required for processing, preserving and packing heattreated products (see photos Nos. 3, 4, 5, &6). A list of materials and equipment is shown in Appendix 1.

Sugar and potassium metabisulphite (K2S2O5) are used as preservatives. Salt helps the preservation.

Lemon juice and vinegar are added to the products to rectify the acidity.

Facilities with the following characteristics must be made available to the processing centre :

- **a fenced plot of land of approximately 500 m**
- **a 3 roomed building of approximately 80 m;**
- **a shed approximately 20 m in size**

Before starting the activities, the processing centre should come to an agreement with the fruit and vegetable farmers regarding:

- **the quality and quantity of raw materials to be delivered to the centre,**
- **the terms of delivery**
- **the frequency of delivery**
- **the purchase prices of the raw materials.**

1. Family-type sun drier

2. Sun-drier for use at centres

3. Hand-operated pulp extractor

4. Bottle capper

5. Improved gas-stove

6. Improved reinforced concrete

Hygiene measures

Hygiene measures are always very important, in particular for small enterprises. In the absence of such measures, the products will be liable to contamination by bacteria, yeasts and moulds. With regard to sundrying, the addition of salt and/or sugar and sulphur dioxide in the form of potassium or sodium metabisulphite, can provide protection for fruit and vegetables from the organisms mentioned above. However, preservatives cannot prevent the multiplication of germs if insanitary conditions prevail during the preparation of the products.

It is recommended that the following rules are adhered to:

- **i. the workers should carefully wash their hands before any product processing operation;**
- **ii. the utensils and equipment will have to be properly cleaned before and after**

use, in order to remove dust and any possible organic particle;

- iii. the packaging, i.c. bottles and jars, will have to be washed with a hand-operated appliance, hot water and sand (see photo No. 7);
- iv. damaged parts of the fresh products, as well as the wastes, will have to be discarded and disposed of outside the working area;
- v. before storage, the finished products will have to be washed, dried and properly labelled;
- vi. the preparation and drying area must not be located in the vicinity of a stock-farm.

7. Cleaning of bottles with hot water and sand

Fruits, vegetables and tubers for processing

The fruits, vegetables and tubers dealt with in this manual are:

Fruits

Mangoes, tomatoes and citrus fruits: lime (lemon), pomelo (grapefruit) and orange.

Vegetables and Tubers

Onions, green beans, okra, carrots, cabbages, yams and potatoes.

The processing of these fruits and vegetables has been requested by the Governments of Burkina Faso and Niger due to heavy postharvest losses suffered by them. For this reason, emphasis has been placed on certain products only. However, with the techniques explained in this manual, almost all tropical fruits and vegetables can be processed and preserved.

Quality and degree of maturity

It will not be possible to obtain products of high value from inferior-quality raw materials. It is necessary to ask the farmers for the best fruits and vegetables suitable for processing. For example, depending on the different end-products that we want to obtain, either fully ripe or underripe fruits, of a specific variety, are indispensible. The main characteristics of the raw materials are indicated in the description of the process.

Preliminary operations

Washing- Sorting- Peeling- Cutting

The raw materials have to be processed as soon as possible (within 48 hours after harvesting) in order to avoid deterioration.

The above operations are required for all fruits and vegetables, which will be washed before all the other steps except for onions and cabbages, which are washed after peeling.

The purpose of sorting is to separate the ripe fruits from the underripe fruits. At the same time, parts of damaged fruits will be removed. Some fruits are cut in two to check the inside.

Peeling facilitates the operation of cutting the raw material into pieces or into slices before processing. The slices must be of the same thickness: slices of the same thickness will require the same drying time. Details are given in the description of the process.

Blanching and sulphiting

These treatments improve the quality and keeping properties, and perserve the natural colour of dried products. Both treatments may be carried out at the same time. A solution is prepared with water and potassium or sodium metabisulphite (the strength of the solution is indicated under each product in the description of the process).The

raw material prepared is placed in a piece of cloth (or in a basket), which is plunged into the boiling solution. This operation lasts 3 minutes. When the cloth and its contents are removed. they are not drained back into the container. The amount of solution lost during these operations has to be replaced.

Sterilization

The purpose of sterilization is to destroy micro-organisms and to make the product preservable for some time. This operation is carried out in large pots, care being taken to place straw between the layers of containers and at the bottom of the pot in order to avoid breakages caused by convection due to boiling water (see photo No. 8). The last layer must be covered with straw and a lid of a smaller diameter than the pot then topped with a stone (see photo No. 9). The pot is filled with water up to at least 2 fingers above the bottles and jars. The water must come to a boil before calculating the time needed for the sterilization time. The time depends on the nature of the product and the size of the container: it is indicated under each product in the description of the process.

8. Straw must be placed in the pot to avoid rapping. Then the pot is filled up with water

9. Cover with straw the last layerof containers and cover with a lid of a diameter smaller

then that of the pot, then place a clean stone on top of the lid.

Packing

For dried products, cellophane is used to wrap and to bag the finished products. Jars may be used if available.

Products processed by heat (juice, syrup, sterilized preserved products, jams), are packed in bottles and jars. Glass containers have the following advantages over metal boxes:

- **jars and bottles are reusable;**
- **closing is very easy: a lid is used for the jars and a cap for the bottles;**
- **a hand-driven tool (bottle capper) is used for capping and is very simple to operate, unlike the crimper for metal boxes.**

A label giving the following information must be placed the cellophane bags, bottles and jars:

- **the nature of product and ingredients**
- **the net weight**

- the origin
- the date of production and storage life

Avoid storing the finished products in humid places.

How to use the processed product

Dried products

Dried fruits are consumed as they are, but all dried vegetables in pieces are prepared by soaking and cooking, as follows:

- Add cold water to the dried product (10 times its weight). Bring to the boil and cook until product becomes sufficiently tender.
- Cover the dried product completely with cold water. Let it soak for 2 hours before cooking. This method gives a better taste to the product.

Crushed products may be added directly to sauces during cooking (see photo No. 10).

Bottled products

With the exception of tomato used for the preparation of sauces, other bottled

products are consumed as they are (see photos Nos. 11 & 12).

10. Using peeled tomatoes, good sauces can be prepared with other vegetables.

11. It is very easy to prepare sauces with peeled tomatoes

12. Having all year round processed by ourselves, we can improve the quality of our meals.

Description of the process

The description of the process is repeated for each different product in order that each fruit and vegetable has a basic and complete description.

Mango

a) Mango bars

Ripe fruits are used.

The mangoes are washed, peeled and cut into pieces with a stainless steel knife (see

photos Nos. 13 & 14). Pulp extraction is carried out with a hand-driven extractor (see photo No. 15). Sugar, lemon juice and potassium metabisulphite are then added to the pulp so that the mixture contains 25% 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 metahisulphite: 2 g per kg of pulp ($K_2S_2O_5$)**

The pulp thus prepared is heated for two minutes at 70-80C. It is then poured into aluminium trays coated with glycerine (see photo No. 16). Glycerine facilitates the removal of the dried pulps. The prepared pulp should be placed on trays at the rate of 15 kg per I m- of tray area. The trays are brought in to a sun drier (see photos Nos. 17&18). The drying is completed when the product has the consistency of leather (15% moisture content). Depending on weather conditions, the yield ratio between raw material and dried finished product is 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 (see photos Nos. 19,20 & 21).

Storage life : about 12 months

Remarks : Without preservative (potassium metabisulphite), the storage life of the product is relatively short.

13. After washing th emango is peeled...

14. ...aand wthen cut in pieces.

15. The pulp is separated from fibers with a hand-operated extractor

16. The preparated pulp is transferred to aluminium trays previously coated with glycerine.

17. The trays are placed in the sun drier

18. The drying is completed when the moisture content is about 15% i.e. when the drier mango has th econsistency of leather

19. The layers (2 or 3) put on top one another, are cut in squares

20. ...and wrapped in cellophane to protect them from humidity as well as from

excessive drying

21. Several squares are packed in the same cellophane bag.

PRODUCTION DIAGRAM Mango bars

b) Mango slices

Half-ripe fruits, without fibres, are used.

The mangoes 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 wate (see photos Nos. 22., 23, 24, & 25)**

The slices thus prepared are drained and placed on glycerine coated aluminium trays, which are placed in a sun-drier. 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 (see photos Nos. 26 & 27).

Storage life : About 12 months

Remarks : Without preservative (Potassium metabisulphite), the storage life of the product is relatively short.

22. After washing and peeling, mangoes are cut in slices and dipped in a solution containing, for 1 litre of water:

23. 3 g of potassium metabisulphite,

24. 2 spoons of lemon juice

25. ...and 700 g of sugar

26. The slices prepared are transferred to the drier

27. The dried slices are bagged.

PRODUCTION DIAGRAM Mango slices

Soaking : This consists in putting the mango slices in a solution for 18 - 20 hours. The

solution contains:

- **Water : 1 litre**
- **Sugar : 40 % degree Brix**
- **Lemon juice : 2 spoons per litre**
- **$K_2S_2O_5$: 3 g per litre**

C) Mango juice

Fully ripe fruits are used.

The mangoes are washed peeled and cut into slices with a stainless steel knife (see photo No. 28). Pulp extraction is carried out with a hand driven extractor. Boiling water, lemon juice and sugar are added to the pulp so that the mixture contains 12 % solids as determined by a refractometer and a 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**

Sterilization Time

Size of bottles in litre	Pre-heating	Sterilization time in minutes
0.33	X	20'
0.50	X	25'
0.75	X	30'

Allow the bottles to cool in the same container till the following morning then wash, label and store them (see photo No. 32).

Storage life: About 12 months

28. After washing and peeling, mangoes are cut in pieces

29. The bottling of the already prepared and heated pulp must be done while it is hot

30. With a (bottle) capper, closing the bottles is very easy

31. Through sterilization, mango juice can be preserved for one year.

32. The bottle, washed and labelled, is ready for storage

PRODUCTION DIAGRAM Mango juice

d) Mango jam

Both ripe fruits and underripe fruits are used

The mangoes are washed peeled and cut in to small slices with a stainless steel knife (see photo No. 33). The amount of sugar required represents 60 % of the weight of the mango prepared. the cooking is done in two stages:

1st Stage

The 1st stage 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 55 Brix of solids by refractometer is reached.

2nd Stage

This stage consists in adding the remaining 30 % of the sugar, plus 2 spoons of lemon juice per kg of mango. Stir well during the entire cooking. until 67 Brix of solids by refractometer is reached.

The jars are filled while the mixture is hot (see photo No. 36). During the operation, the jam must be stirred with the handle of a wooden spoon in order to get rid of the air that has entered the jars. The jars are closed with screw-tops (see photo No. 37).

Cooling, washing and labelling are the last stages before storage (see photo No. 38).

33. After washing and peeling, the mango is cut in pieces

34. The refractometer allows one to know at every moment the degree of...

35. ...concentration of the jam

36. The jar is filled while the jam is hot

37. and closed with a screw-top

38. The jar, washed and labelled, is ready to be stored

PRODUCTION DIAGRAM Mango jam

Citrus fruits

a) Lemon and lime syrup

The fruits must he picked when fully ripe.

After washing, the fruits are peeled and cut into quarters (see photos Nos. 39 & 40). With a manual extractor, the juice is separated from the skin and the pips (see photo No. 41).

1/2 litre of water and 1.2 kg. of sugar poured into a pot. Boil for 5 minutes stirring all the time. Add the lime juice (1 litre) and, after boiling for one minute skim and turn off the heat. For better preservation, the preparation must be bottled and capped (see photo No. 42).

Cooling, cleaning and labelling are the last operations before storage (see photo No. 43)

Storage life: About 12 months.

39. After washing, the fruits are peeled and...

40. ...cut in pieces

41. With a hand-operated extractor, the juice is separated from the white skin and the

pips.

42. The bottling is done while th eproduct is hot...

43. ... and the quick sealing of the bottles allows a longer storage

PRODUCTION DIAGRAM Lime or lemon syrup

b) Pomelo/orange juice

The fruits are picked when fully ripe.

After washing (see photo No. 44), the pomelos are peeled and cut in quarters. With a manual extractor, the juice is separated from the skin and the pips (see photo No. 45). The juice is filtered through a fine mesh strainer and mixed with sugar at 5 % of its weight.

Heating to boiling point will allow the stabilization the micro-organisms liable to induce fermentation the phenomena of and a large quantity of essential oil to be removed by skimming.

Bottling and capping must be done while the juice is hot.(see photo No. 46). This,

together with a I minute sterilization, will result in longer preservation (see photo No. 47).6

Cooling, cleaning and labelling are the last operations before storage (see photo No. 48).

Storage life: About 12 months

44. Pomelos are tropical variety of grapefruits.

45. With a hand-operated extractor the juice is separated from the white skin and the pips

46. The bottling must be done while the product is hot

47. A 10-min. sterilization lengthens the storage life

48. The bottle, washed and labelled, is ready to be stored

PRODUCTION DIAGRAM Fruit drinks & cocktails Pomelo/Orange Juice

c) Fruits Drinks and Cocktails

After washing, the pomelos and/or lime are peeled and cut in to quarters. With a

manual extractor, the juice is separated from the skin and the pips. The juice is filtered through a fine-meshed strainer.

For lime-based drinks, 0.7 kg of sugar to 4 litre of water is added; for pomelo-based drinks, 0.5 kg of sugar to 3.5 litre of water is added and 0.6 kg of sugar to 3.5 litre of water for pomelo and lime cocktails. Bring them to the boil and add the filtered juice and again, to the boil. This process will allow the stabilization of micro-organisms liable to induce the fermentation of the juice and the removal of a large quantity of essential oil through skimming. The bottling and capping must be done while the preparation is hot. Sterilize for 10 minutes for longer preservation.

Cooling, cleaning and labelling are the last operations before storage.

Storage life: About 12 months

Tomato

a) Peeled Tomatoes

For the preparation of peeled tomatoes, fully ripe but still hard, long and/or oval tomatoes are used (see photo No. 49).

After washing by hand in a basin, 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 30 seconds, then cooled in water at room-temperature. Scalding facilitates the bursting of the skin (see photo No. 50).

The jars, previously washed, are filled by hand (see photo No. 51). To eliminate the gaps created during filling, tap the bottom of the jar. Then add a small spoonful of lemon juice or vinegar (see photo No. 52). The filling is completed by adding the hot pulp. The jar is tightly closed with a screw-top (see photo No. 53).

Sterilization is carried out as follows:

Place straw or newspapers at the bottom of a pot in order to avoid direct contact between the jars and the source of heat (see photo No. 54). Straw must be placed between the layers of jars in order to avoid breakages caused by convection due to boiling water. The last layer must also be covered with straw, on which is placed a lid having a smaller diameter than the pot. The lid is topped with a stone to avoid other breakages.

Before counting the sterilization time, wait till the water comes to the boil (see table below):

Sterilization Time

Size of the jar in kg.	Sterilization Time
0.5	30 mn.
0.75	40 mn.
1 .0	50 mn.

Cooling takes place in the same pot. Leave the jars overnight and wash, label and store them the following morning.

Storage life: About 12 months.

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

50. The skin comes off easily once the fruits have been dipped in hot water and cooled in the water at room temperature

51. The bottling is done by hand

52. A small spoonful of lemon juice is added to each jar

53. The jar is closed with a screw-top

54. The bottom of the pot is lined with a straw. Straw is also placed between the jars to prevent rapping during sterilization

55. After sterilization and cooling, the jars are washed, and labelled and ready to be stored

PRODUCTION DIAGRAM Peeled tomatoes

b) Tomato pulp

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

After washing, the tomatoes are drained to get rid of the water on the surface. Sorting is done before the tomatoes are cut in to halves to facilitate the crushing and to detect any possible disease or decay inside (see photo No. 56).

A manual extractor is used to separate the pulp from the seeds and the skin (see photo No. 57). The pulp is transferred to a pot and heated until 7 - 7.5 Brix of solids by refractometer is obtained (see photo No. 58).

While still hot, the pulp is bottled with the help of a ladle and a funnel after correcting the acidity with a small spoonful of lemon juice or vinegar (see photo No, 59). The bottles are closed with a capper (see photo No. 60). The sterilization is done within the same duration as the jars of peeled tomatoes and under the same conditions (see photo No. 61). Cool overnight. Washing and labelling are the last stages before storage (see photo No. 62).

Storage life: About 12 months

56. The tomatoes previously selected are curt into halves, to facilitate qthe extraction and qto check whether the tomatoes are sound.

57. With an extractor, the pulp is separated from the skin and pips

58. The pulp is cooked in the pot till a concentration of 7.5% is reached

59. The bottles are filled after a spoonful of lemon juice is poured into each bottle

60. The bottles are closed with the help of a capper

61. and now, they can be sterilized.

62. The bottles, washed and labelled, are stored

PRODUCTION DIAGRAM Tomato pulp

c) Dried tomatoes

For the preparation of dried tomatoes, all kinds of tomatoes are used but always fully ripe ones.

Tomato pigments are stable because they are rich in carotene. Therefore, preprocessing, such as blanching and sulphiting is not necessary.

Washing and sorting are followed by cutting in halves lengthwise to eliminate the liquid and the seeds. These 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 then cut them lengthwise into slices of 6 to 8 mm thickness (see photo No. 63), and place them in sun-driers (see photo Nos. 64 & 65).

The fruit is dry when the raw material/dry product ratio is about 25:1.

On an average, 40 gr. of dried products are obtained from 1 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 (see photo No. 66).

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

63. After preliminary operations, the seedless tomato halves are cut in slices about 6 to 8 mm thick, slices of the same thickness will require the same drying time.

64. Tomato needs no blanching, so th eslices are directly arranged in the family sun-drier

65. ...or in a more sophisticated drier designer for the centres

66. The drier slices are kept in cellophane bags, firmly closed so as to protect them from humidity. The product must be kept in a dry and dark place.

PRODUCTION DIAGRAM Dried tomato

Onions

Dried onions

Varieties with pungent flavour are the most appreciated but troth coloured and white onions may be used. After removing the tops, roots and outer integuments, onions are washed carefully then cut in to slices of 3 mm thick. It is preferable to cut at right angles to the core of the onion.. Blanching is not practiced (it makes the onion lose its flavour).

The use of preservatives is not necessary; therefore, after cutting, the slices arc spread evenly on the trays of a drier. The onions are dried when the ratio of prepared raw material to dry product is about 9:1 (moisture content 5 %). The dried product may be ground into powder, which tends to agglutinate.

The drier used for onions must be reserved especially for onions. Storage life: About 12 months

PRODUCTION DIAGRAM Dried onions

Okras

Dried okras

The pods are cut into slices (around 5 mm. thick) after being washed thoroughly with cold water. For preservation purposes and in order to keep the green colour, blanching is carried out: wrapped in a clean piece of cloth' the product is dipped for 3 minutes in boiling water containing 50 g salt per litre of water and 3 g potassium metahisulphite per litre of water. The blanched okras can then he washed with cold water to remove the slimy material produced by boiling.

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

Storage life: About 12 months

PRODUCTION DIAGRAM Dried Okras

Cabbages

Dried cabbages

After removing the outer leaves. the vegetable is washed and cut into quarters. Cores are removed and the cabbages are cut into 5 mm strips. It is then washed to get rid of

dust' soil and insects. To keep the colour of the vegetable and for preservation purposes, blanching is carried out: wrapped in a clean piece of cloth, the product is dipped for 3 minutes in boiling water containing 50 g salt per litre of water and 3 g potassium metabisulphite per litre of water.

The product is then evenly spread on the trays of a drier. The cabbages are dry when the prepared raw material/dry product ratio is around 12 :1 (moisture content 5 %).

Storage life: About 12 months

PRODUCTION DIAGRAM Dried Onions

Yams

Dried yams

After washing and peeling, cut the tubers into slices and dip them in to cold water to avoid browning) The slices are cut in pieces of about 2 X I - I cm. For preservation purposes and to keep the colour of the tuber blanching is carried out wrapped in a clean piece of cloth, yams are dipped in boiling water containing. 50 g salt per litre of water and 3 g metabisulphite per litre of water Then drain the product anti arrange the

pieces on the trays of a drier l he yam is cried when the prepared raw material/dry product ratio is about 12 1 (moisture content 6 %)

Storage life : About 12 months

PRODUCTION DIAGRAM Dried yams

Potatoes

The process is the same for dried potatoes as for yams.

Carrots

Dried carrots

Roots with red cores are the best for drying. After removing the stalks and tips, wash the carrot, scrape, then cut in to slices of about 5 mm thick.

For preservation purposes and in order to keep the colour of the vegetable, blanching is necessary: wrapped in a clean piece of cloth, the slices are dipped for 3 minutes in

boiling water contain" 50 g salt per litre of water and 3 g metabisulphite per litre of water. The product is then evenly spread on the trays of a drier. The carrots are dried when the prepared raw material/dry product ratio is about 12:1 (moisture content 6 %).

Storage life: About 12 months

PRODUCTION DIAGRAM Dried carrots

Green beans

Dried green beans

After washing. cut the vegetables into 5 cm - long pieces. Fot preservation purposes and in order to keep the colour of the vegetable, blanching is carried out: wrapped in a clean piece of cloth, the product is dipped in boiling water containing 50 g salt per litre of water and 3 g metabisulphite ($K_2S_2O_5$) per litre of water.

Then drain and spread the beans on the trays of a drier. The beans are dried when the prepared raw material/dry product ratio is about I8:1 (moisture content 6 %)

Storage life: About 12 months

[PRODUCTION DIAGRAM Dried green beans]

Appendices

APPENDIX 1

List of equipment and materials

- Hand-operated pulp extractor
- Hand-operated capping device (capper)
- Manual refractometer (0 - 90B)
- Hand mill
- Bottle brushes
- Scales (100 kg)
- Scales (3 kg)
- Plastic lemon-squeezer
- Plastic colanders
- Stainless steel skimmer
- Wooden table (180 x 120 cm)

- **Wooden bench**
- **Wooden spoon**
- **Stainless steel knives with 12-15 cm blade**
- **Plastic funnel**
- **Aluminium ladle**
- **Metal pails**
- **Aluminium pot 25**
- **Aluminium pot 40**
- **Aluminium pot 50**
- **Aluminium basin**
- **Aluminium rod**
- **Aluminium dish**
- **Potassium metabisulphite**
- **Cellophane in sheets**
- **Cellophane bags**
- **Fastening rings**
- **Improved stoves**
- **Sun-drier (tent type)**
- **Sun-drier ("banco") type.**
- **Aluminium trays**
- **Stainless steel fine-meshed sieve**

- Glycerine (purity 35-88 %)
- Bottles (0.5 litres)
- Bottles (0.33 litres)
- Crown-corks (caps)
- Jars (0.580 litres)
- Jars (0.300 litres)
- Screw-tops for jars
- Labels
- Glue for labels

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Feasibility study

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FOR ONE UNIT IN US$

A. Production

Bottles of 500 g of tomato pulp
Jars of 500 g of peeled tomato

Raw material	Working day	Capacity per day	Yield %	Output/ day	No. of pieces season
18 000	60	300	50	300	18 000

B. Investment Cost	US $
1. Fixed investment	
- Building & land (renovation)	1 000
- Equipment & Materials	2 118
- Insurance etc...	-
- TOTAL B 1	3 118

C. Working Capital Cost	
- Wages (8 women x 60 d x 500 CFAFr)	860
- Stocking of material	13 757
- TOTAL B 2	14 617
Total B = US$ 17 735	
D. Annual Management Cost	
1. Raw Material and Materials	12 857
2. Wood	900
3 Wages (7 women)	860
4. Maintenance of equipment	100
5. Depreciation (5 years on 2 118 - building)	1 000
TOTAL C	16 142
E. Profit Margin	

1. Receipts	
18 000 b x US $ 1 06*	19 080
2. Expenditures	16 142
PROFIT MARGIN	**2 938**
D/B = 2 938/14 617 = 20 %	

***See: Processing cost of tomato pulp**

Cost of equipment, materials, and raw materials

(TOMATO PULP)

Description	**Quantity**	**US$**
Hand-operated pulp extractor	3	864
Hand-operated capping device (capper)	2	130
Manual refractometer (0-90 B)	1	425
Scale (100 kg.)	1	175

Scale (3 kg.)	1	28
Plastic lemon-squeezer	2	2
Plastic colanders	1	9
Wooden table (180 +120 cm)	1	58
Wooden bench	3	32
Wooden spoon	3	5
Stainless steel knives	10	18
Plastic funnel	3	16
Aluminium ladle	3	21
Metal pails	3	28
Pot 25 (aluminium)	2	64
Pot 40 (aluminium)	1	100
Pot 50 (aluminum)	2	270
Basin (aluminum)	3	70
Rod (aluminum)	3	41
Dish (aluminum)	3	4

~~Potassium metabisulphite (1/2 kg)~~	~~12 bts~~	~~71~~
Cellophane bags	500	37
Stove	1	250
		2.118
Cardboard boxes	750	750
Bottles l/2 kg.	16.000	5.715
Crown-corks (caps)	16.000	172
Jars 0.580 kg.	8.000	1.070
Screw-tops	2.000	250
Labels	18.000	193
Tomatoes (kg)	18.000	4.176
Lemon-vinegar		486
Wood		900
Straw		15
Salt		30
		13.757

Processing cost of tomato pulp

1. Raw Material	**CFA Fr.**
Tomato (65 CFAFr/kg x 100 kg)	: 6 500
Lemon or vinegar	: 360
Salt	: 200
Wood	: 1 400
Straw	50
	8 510 CFA Fr.
2. Packing	
Bottles 100	: 10 000
Caps 100	300
Labels 100	: 300
Cardboard boxes 4	: 1 120
	11 720 CFA Fr.
3. Wages	

7W x 500CFA Fr. 4. Miscellaneous, Maintenance	:3 500 CFA Fr
Depreciation 15 % (1 + 2 + 3) 23 730:	3 560 CFA Fr.
Total	27 290 CFA Fr.
27 290: 100 pieces :	272.90 CFA Fr.
Profit margins 10 % :	**37.90 CFA Fr.**
6. Cost price	**: 300CFA Fr.: US $ 1.06**

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Processing cost of tomato pulp

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