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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

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4 September 1980
ENGLISH

ESTABLISHMENT OF A
COCONUT PROCESSING TECHNOLOGY CONSULTANCY SERVICE
UF/RAS/78/049

ASIAN AND PACIFIC COCONUT COMMUNITY

COCONUT PROCESSING TECHNOLOGY INFORMATION DOCUMENTS

PART 5 OF 7

"Domestic Coconut Food Processes"*

Based on the work of T. K. G. Ranasinghe
in co-operation with representatives of the coconut processing industry
of the Asian and Pacific Coconut Community and individual international experts

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Asian and Pacific Coconut Community

Jakarta — Indonesia

Our Nr :

P R E F A C E

A valid criticism against the poor performance of many agricultural extension services in coconut producing countries is that the services do not have or know what to "extend". A similar analogy can be applied to a consultancy service on coconut processing technology.

"Registering" coconut processes applied in the APCC countries, may be a simple achievement and considered unimportant, when one views the deluge of impressively formulated and identified objectives and programmes pouring out of international agencies and institutions. The fact is, that the disappointments from two UN Development Decades, could be traced to the failure to execute the basic "Home Work" essential for achieving the ultimate objectives.

UNIDO, which concieved and supervised the execution of this project, rightfully owns the entire credit for an important programme of meaningful benefits to APCC and APCC member countries. UNIDO has provided APCC with a firm basis from which APCC must now build and develop an essential service to those countries and individuals reliant on the coconut for their economic survival.

Godofredo P Reyes Jr
Director

13 June 1980.-

INTRODUCTION

The United Nations Industrial Development Organisation, Vienna, funded and executed this project "Establishment of Coconut Processing Technology Consultancy Service" for the Asian and Pacific Coconut Community based in Jakarta. The project was initiated in 1978 and completed within 18 months.

Coconut Processes, commercial and household, applied in the APCC member countries were documented in individual technology sheets by Consultants for specialised areas and by the Project Manager/Coconut Processing Technologist. Each technology sheet carries a product code, based on the Customs Cooperation Council Nomenclature (CCCN) which has replaced the Brussels Tariff Nomenclature (BTN). This facilitates easy reference to determine import or export duties, freight rates, etc, as well as coding for library systems. Where there are co-products or by-products in a process, only the main product has been taken into consideration for coding.

The immediate objective of the project is to make the technology sheets available to all concerned as a "Consultancy Service" in the framework of technical cooperation among developing countries and others interested in improving the coconut processing discipline.

The technology documented is not only on major commercial processes but also on the hitherto, somewhat neglected, rural and household processes. These processes offer a large scope for further development with appropriate and suitably scaled technology, in order to bring about the commercialisation of new or improved products.

The development of the Coconut Processing Sector through technical cooperation in existing commercial processes and the improvement of rural and household products, could mean higher incomes and better living conditions for several hundred million people living in the coconut areas of the world.

ACKNOWLEDGEMENT

The kind assistance and co-operation rendered by the counterparts, the national collaborating agencies and the excellent services given by the APCC Secretariat are gratefully acknowledged.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

This document is one of VII parts: -

PART I	COCONUT HARVESTING AND COPRA MANUFACTURE
PART II	COCONUT OIL EXTRACTION
PART III	COCONUT OIL REFINING AND MODIFICATION
PART IV	DESICCATED COCONUT MANUFACTURE
PART V	DOMESTIC COCONUT FOOD PROCESSES
PART VI	COCONUT COIR FIBRE AND PRODUCTS
PART VII	COCONUT SHELL PRODUCTS AND OTHER PROCESSES

These Technology sheets have been prepared by :-

P.C. Catanacan, UNIDO Consultant on oil extraction

H.B.W. Patterson, UNIDO Consultant on oil refining

P.M. Abaca, UNIDO Consultant on non traditional food

T.K.G. Ranasinghe, UNIDO Project Manager/Coconut Processing Technologist.

1979/1980

Consultancy Service on Coconut Processing Technology

UNIDO/APCC Project UF/RAS/78/049

PART V

DOMESTIC COCONUT FOOD PROCESSES

List of Technology sheets

Product code CCCN 20.07f
Technology sheet no. V / 1

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - EXTRACTION OF COCONUT MILK IN ASIAN HOUSEHOLDS

2. Uses of finished products : -

2.1 The main use of coconut milk is for cooking curries.

2.2 Coconut milk is used for preparing various traditional food such as deserts, sweetmeats and delicacies.

2.3 Residue used as animal feed.

3. Country of origin : -

SRI LANKA
INDIA (KERALA STATE)
INDONESIA
MALAYSIA
PHILIPPINES
THAILAND

4. Equipment : -

4.1 Description of equipment : -

4.1.1 Kitchen knife (heavy type) for splitting the nut into two along the 'equator'. See figure I.

4.1.2 Scraper or grater. See figures II, III and IV.

4.2 Materials : -

Not applicable.

4.3 Cost of equipment : -

4.3.1 Kitchen knife heavy type made of forged steel, about US$ 1 or 2.

4.3.2 Scraper - bench type US$ 1 or 2.
Scraper - rotary type hand operated - US$ 3 or 4. This rotary type is used in hotels etc in Sri Lanka.
Grater - serrated steel plate - about US$ 1.

4.4 Capacity : -

This does not arise as one or half a coconut is grated and milk extracted by family member for one household for each main meal.

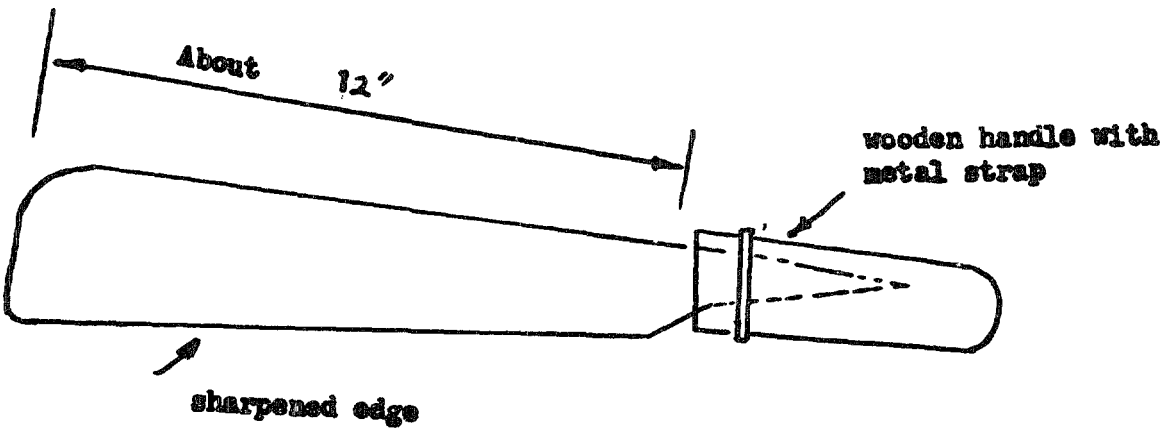
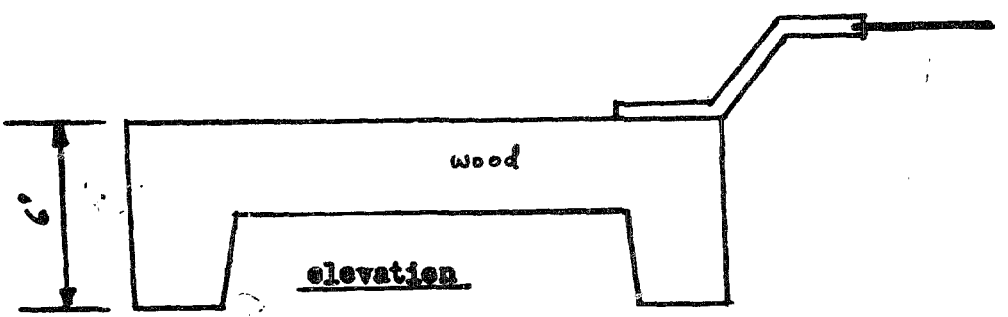


FIGURE I KITCHEN KNIFE (heavy type)



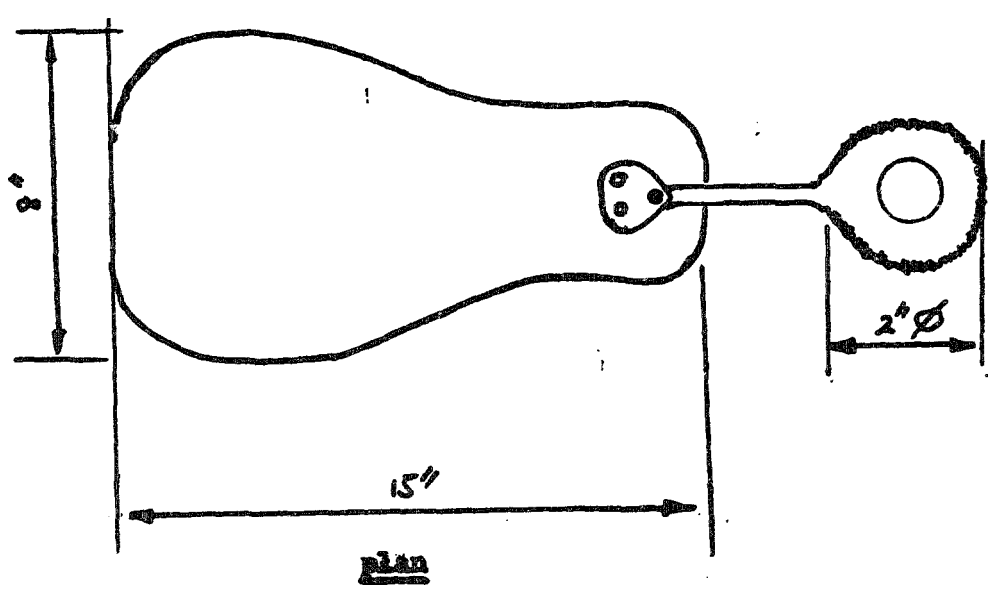


FIGURE II COCONUT SCRAPER (Bench type)

USED IN INDIA, SRI LANKA

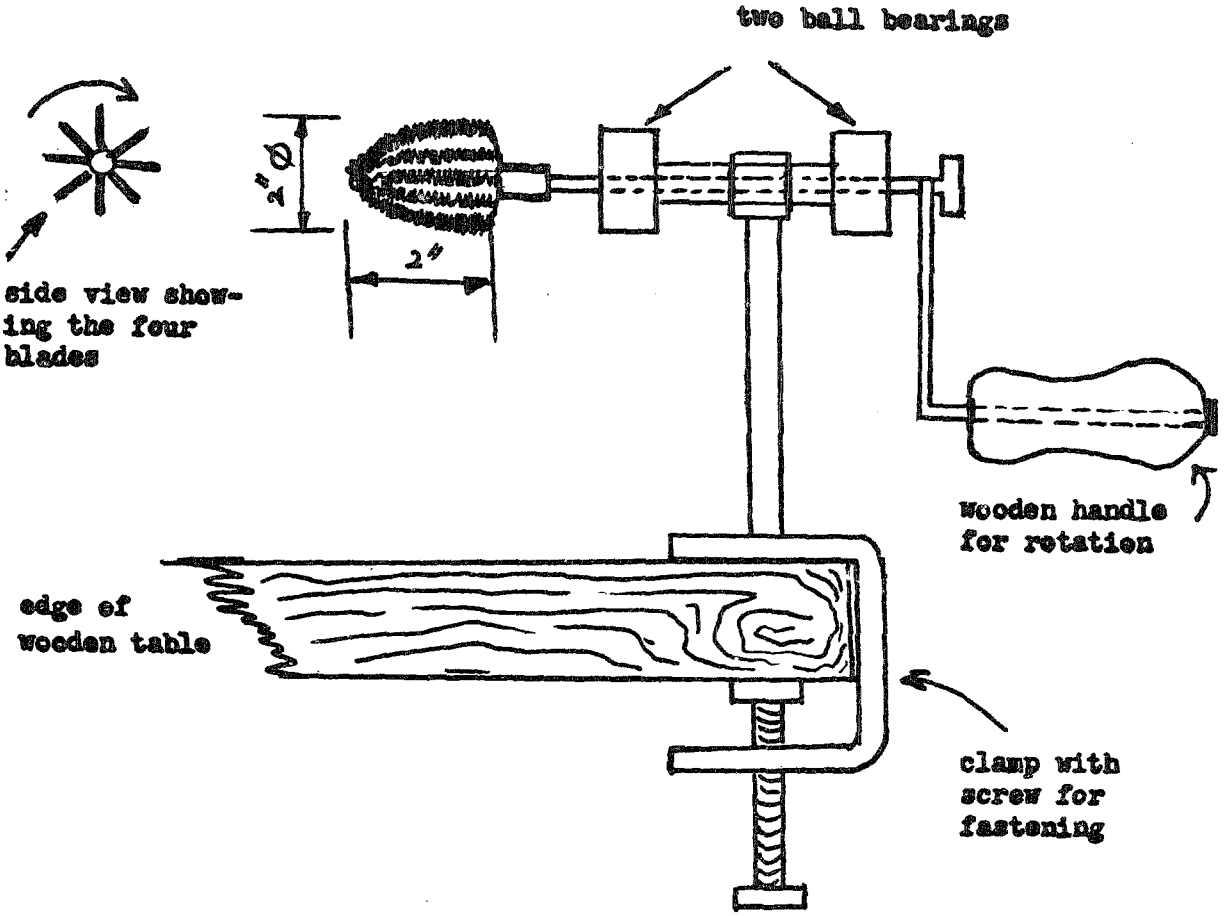


FIGURE III COCONUT SCRAPER - (Rotary type)
USED IN SRI LANKA

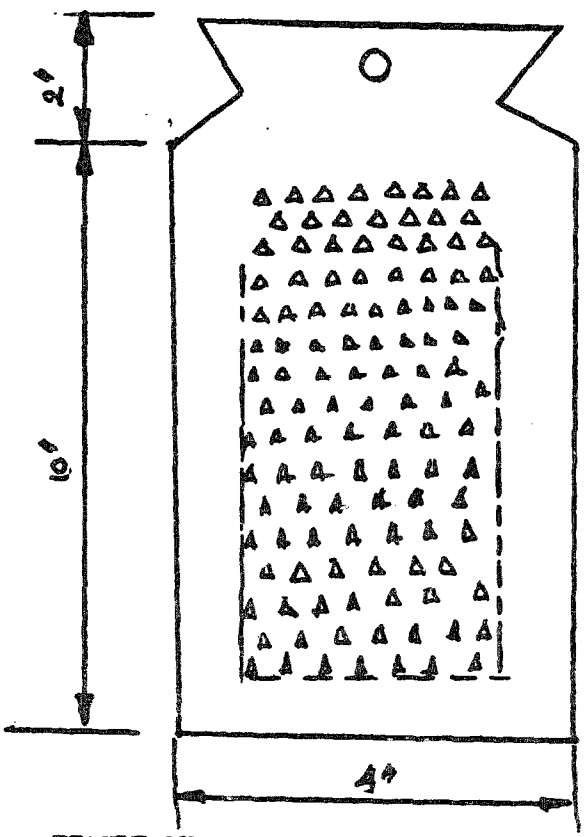
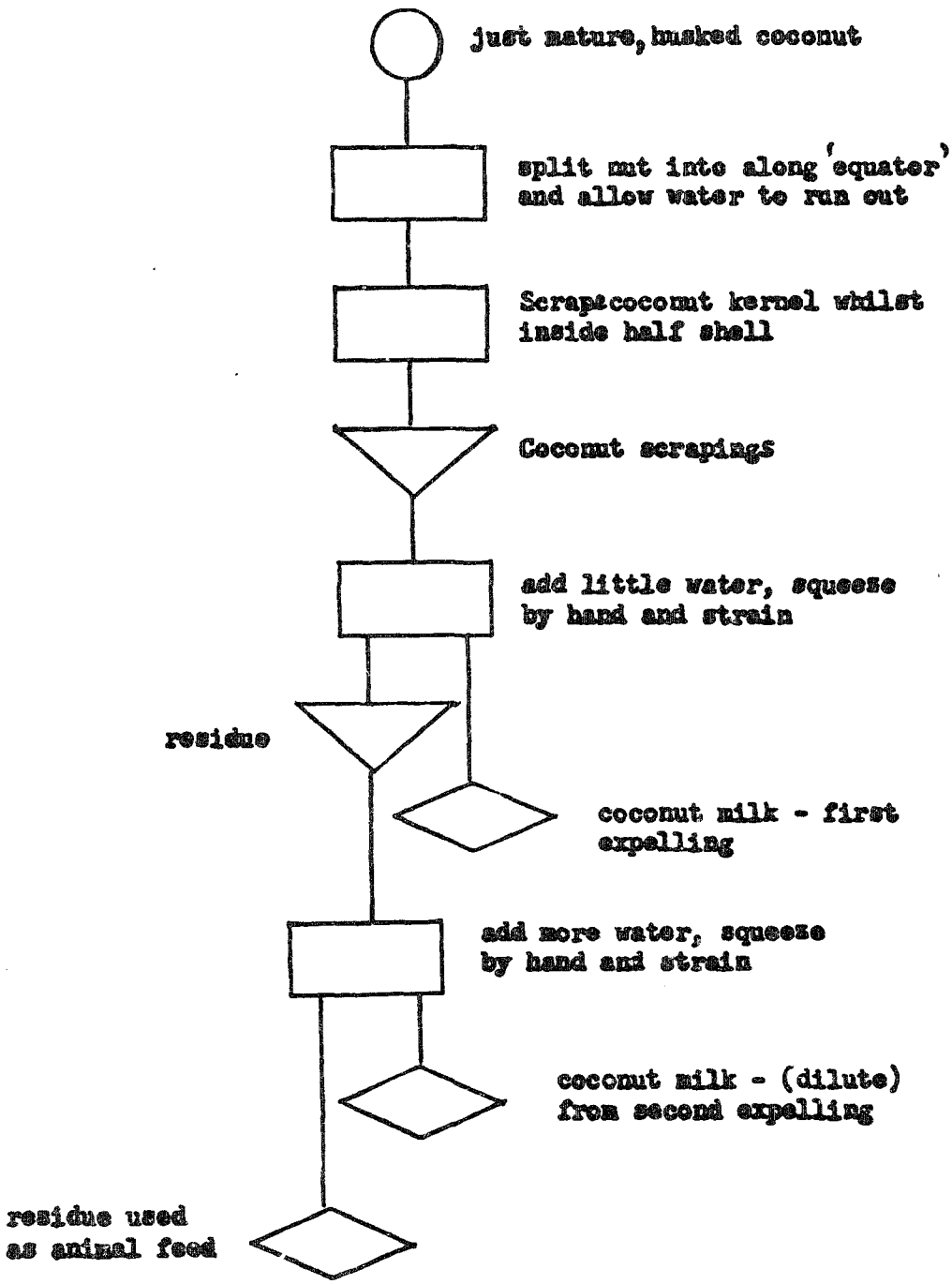


FIGURE IV COCONUT GRATER (Serrated metal plate)
USED IN SOUTH EAST ASIA

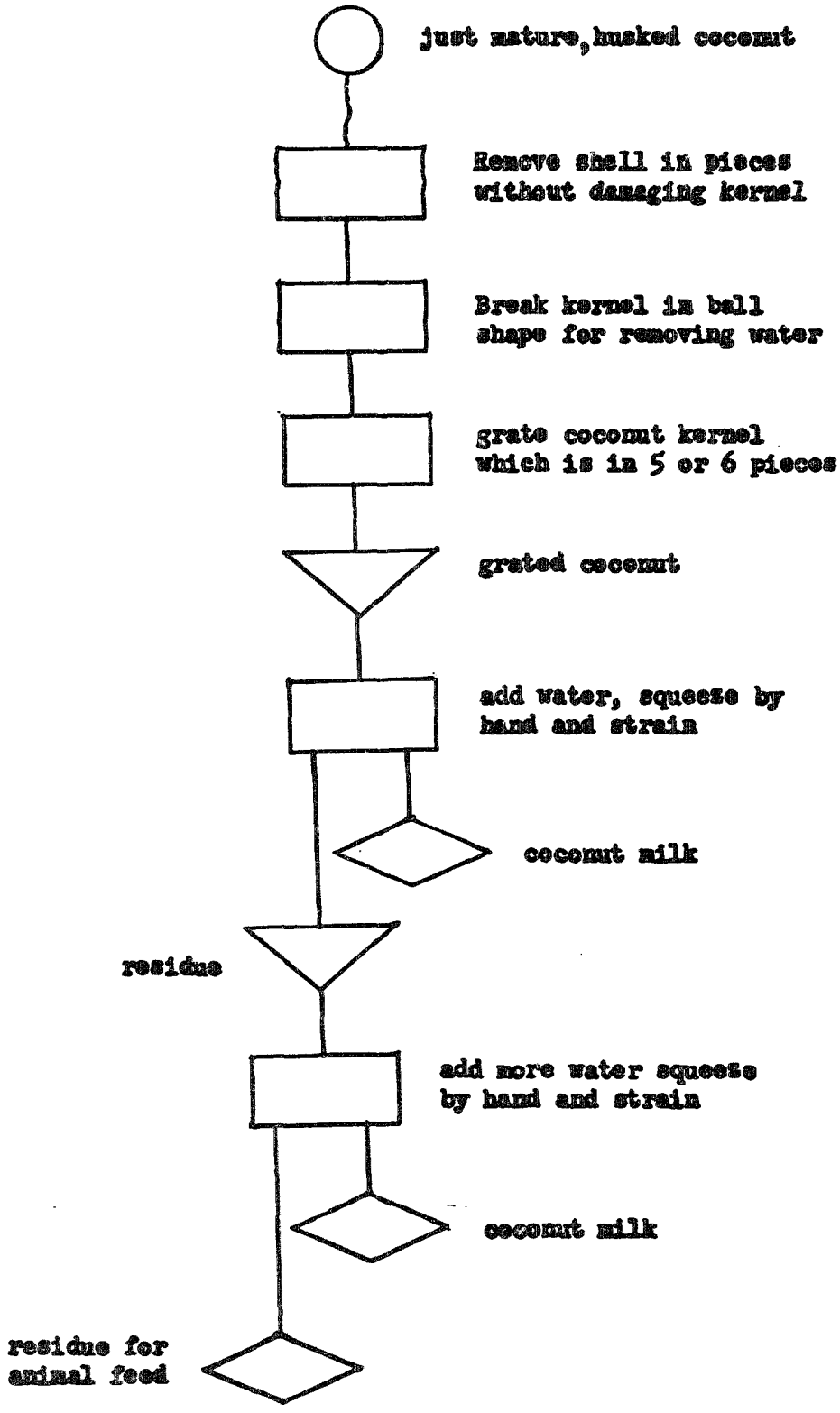
5. Process : -

5.1 Process flow diagram

System A - India and Sri Lanka



System B - In South East Asia



5.2 Description of process : -

Freshly husked just mature cocomuts are available in the market.

The husked nut is split open in two along the 'equator' and water allowed to run out in India and Sri Lanka. The half cocomut kernel with shell intact is scraped either using the bench type device or the rotary type. If the cocomut is not fresh or if beyond just mature, the kernel tends to get released from the shell resulting in difficulty in scraping. The coconut scrapings are squeezed after adding water for two separate expellings (occassionally three).

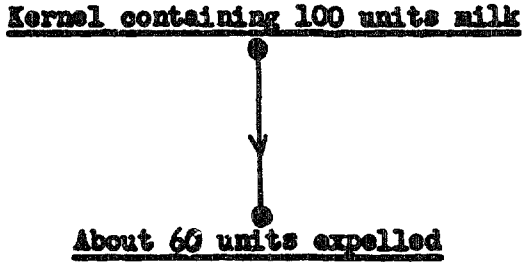
Owing to the very low efficiency of expelling milk by this household method, about 40% of the milk is lost in the residue. Where large amounts of coconuts are consumed as food nuts (50% of Sri Lanka's production) this wastage is considerable. The per capita consumption of food nuts in Sri Lanka varies between 90 and 120 nuts per person per year. This figure for Indonesia is 60 nuts. The need for an efficient system is obvious.

In Sri Lanka, where food is prepared for commercial purposes, a further amount of milk is expelled from the residue by suitable treatment. Either the residue is pounded or ground using the traditional domestic equipment and then squeezed by hand after adding warm water.

In South East Asia, the husked nut is first deshelled and the undamaged kernel is then broken to release the water. The kernel is broken up in several pieces. Each piece is held by hand and grated on the metal plate with serrations. Thereafter, expelling the

milk is carried out as usual.

5.3 Product flow diagram : -



6. Quality of finished product : -

Coconut milk is an oil/protein/water emulsion which provides important food intake for people living in the coconut areas.

The chemical composition (%) of coconut milk according to various sources is given below : -

Componant	Clements and Villacorte (1933)	Nathanael (1954)	Popper (1956)	Nathanael (1960)
Moisture	47.0 - 53.0	50.0	54.1	52.0
Fat	39.8	39.8	32.2	27.0
Protein	2.6 - 2.9	2.8	4.4	4.0
Sugars	2.8 - 3.2	3.0	-	-
Total solids	10.3 - 10.5	10.4	-	-
Ash	1.1 - 1.3	1.2	1.0	1.0
Carbohydrates	-	-	8.3	-
Starch	0.08 - 0.10	0.09	-	-

7. Source of information

Observations during field visits to member countries.

Product code: CCCN 20.071
Technology sheet no. V / 2

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - EXTRACTION OF COCONUT MILK IN PACIFIC HOUSEHOLDS.

2. Uses of finished products : -

The main use of coconut milk is for cooking and baking traditional food.

3. Country of origin : -

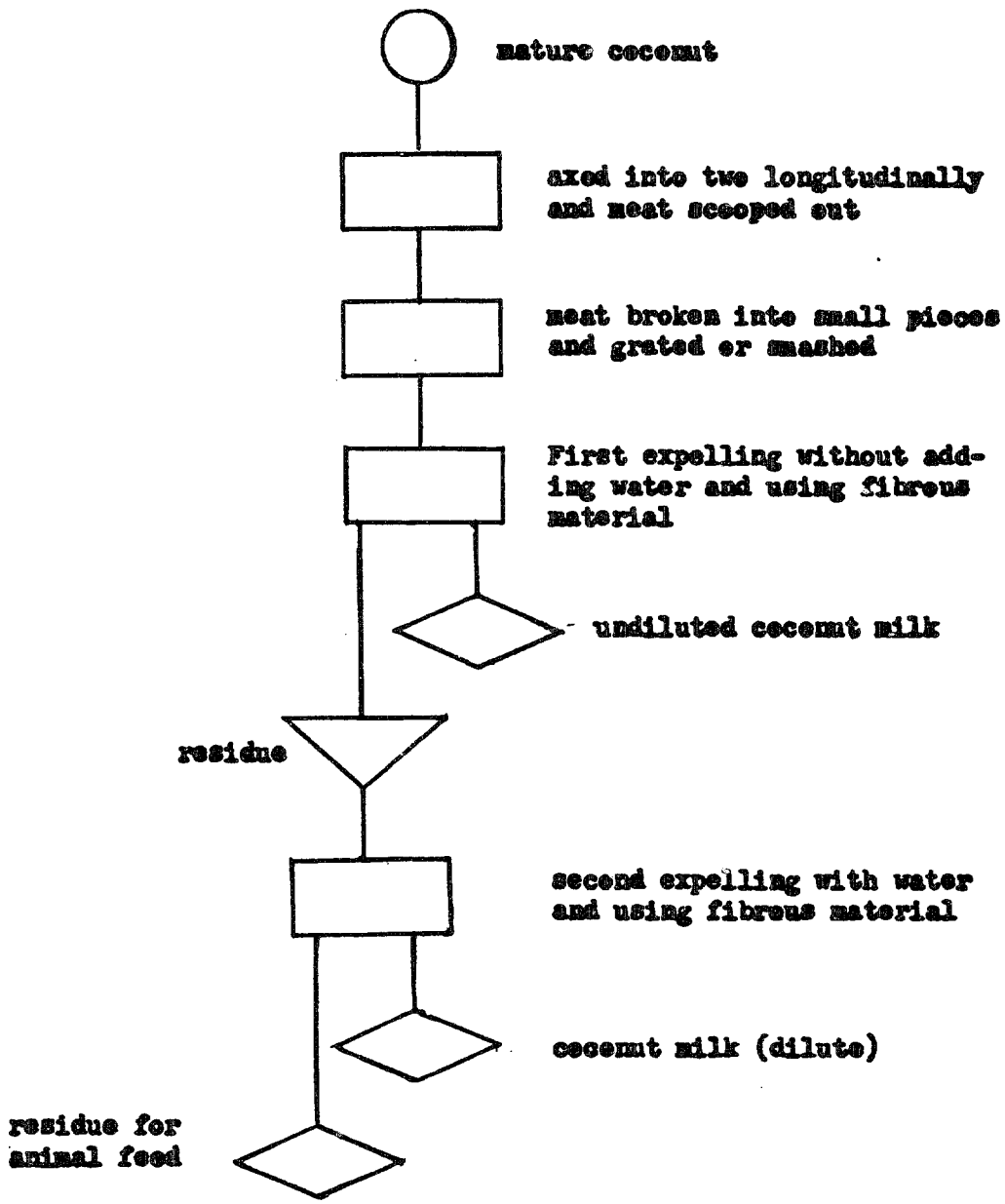
PAPUA NEW GUINEA
SOLOMON ISLANDS
WESTERN SAMOA

4. Equipment : -

Fibrous material from stem of a plant belonging to the banana family, known locally in Western Samoa as Tauaga and pronounced as Tauwanga.

5. Process : -

5.1 Process flow diagram : -



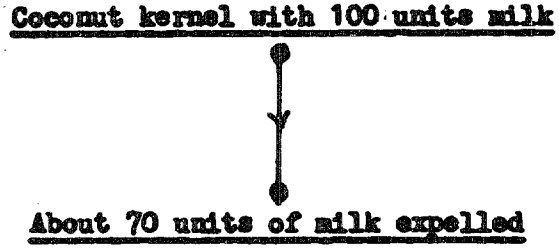
5.2 Description of process : -

The pieces of kernel are scraped or smashed into small ones. The mass of fibrous material is washed, cleaned and then placed inside the bowl with coconut. After some coconut gets entangled in the fibrous mass, it is twisted like wringing a washed towel to squeeze out the water. The milk expelled at the first attempt is undiluted. The second expelling is after adding water. The undiluted milk is used for traditional baked items in the earth ovens.

Use of the fibrous mass appears to perform a more efficient expelling than the use of hand only as in the Asian region. The level of oil remaining in the residue is quite acceptable for use as pig feed in this region where copra cake etc. is not available due to the absence of coconut oil mills.

It is to be noted that in the Pacific region the per capita consumption of coconut in all forms is between 300 to 500 nuts per person per year.

5.3 Product flow diagram : -



6. Quality of finished product : -

Coconut milk is an oil/protein/water emulsion which provides important food intake for the people.

7. Source of information : -

Observations during field visits to member countries in the Pacific region.

Product code CCCN 20.07f
Technology sheet no.V / 3

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

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"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - STABILIZED COCONUT MILK (Pilot Plant)

2. Uses of finished product : - Culinary purposes

3. Country of origin : - THAILAND

4. Equipment : -

4.1 List of equipment

Pinned roller grater	- hand feed, ½ hp motor
Coconut presser	- hand operated, vertical cage press with pressure applied by a mechanical screw advancing the pressure plate from above
Aluminium Kettle	- with steam injector
Autoclave	- standard equipment
Ointment mill	- Brevettato, 400 w, maximum r.p.m. 10,000
Soft drink bottles hand capping stand	- 230 ml capacity with crown caps
Materials	- 30 liters coconut milk Benzoic acid

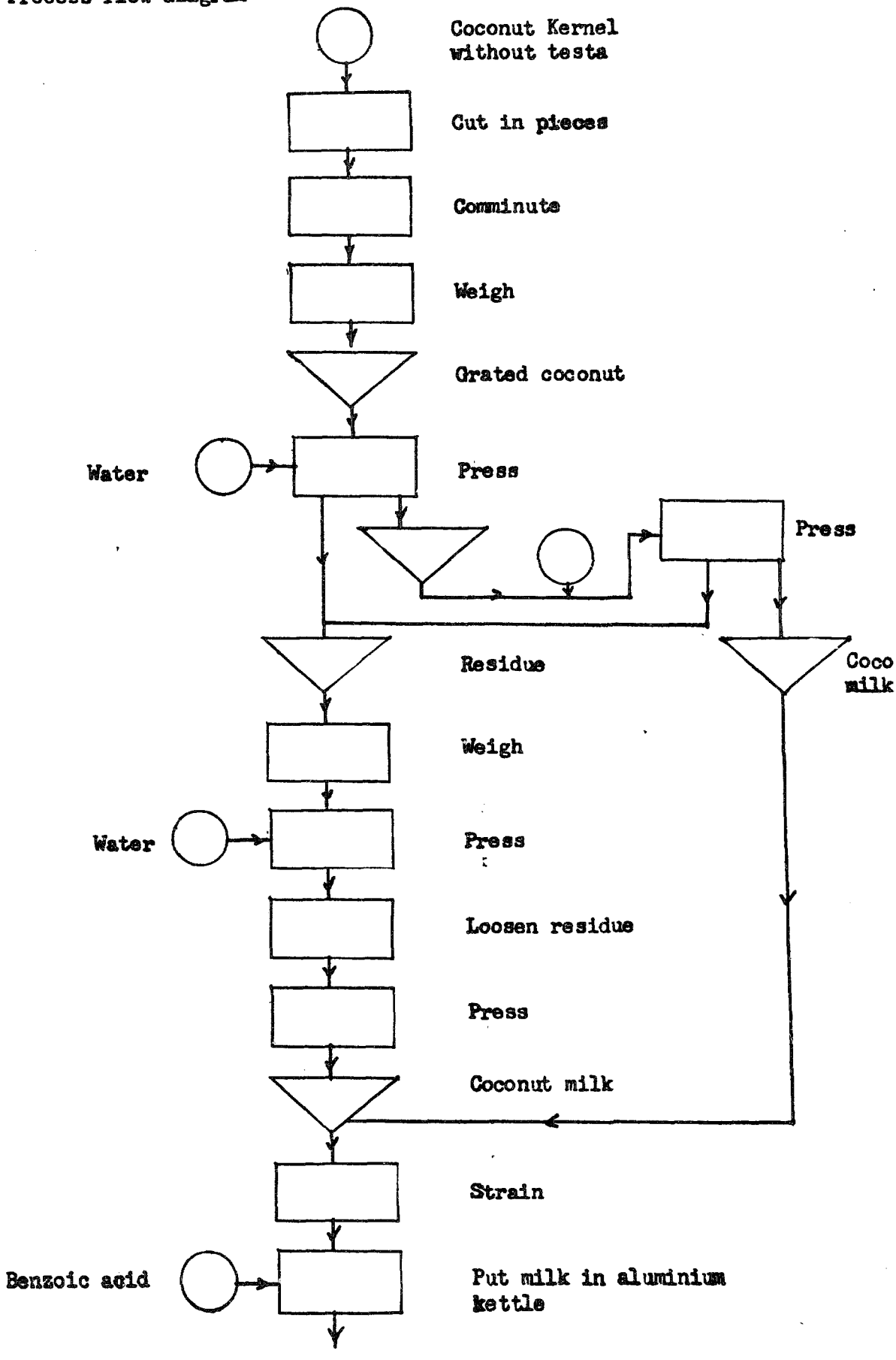
4. 4.2 Materials for construction: - Not applicable

4.3 Cost of equipment : - Approximately US$2,000

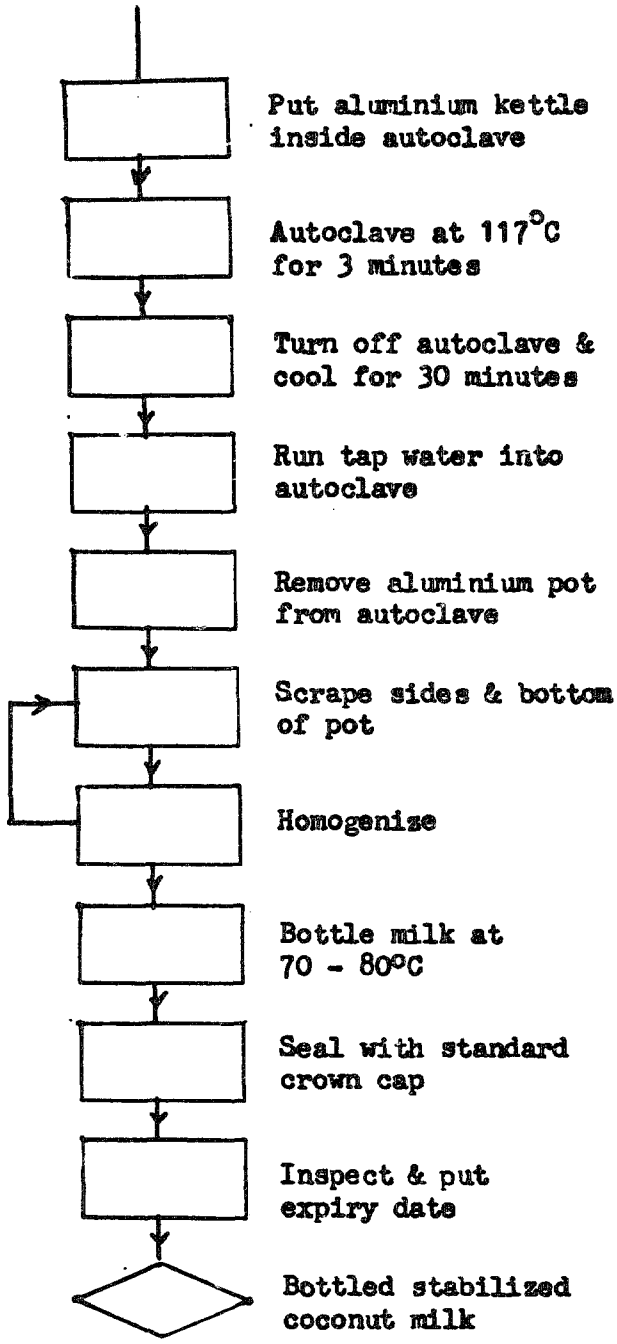
4.4 Capacity : - 30 liters per day.

5. Process

5.1 Process flow diagram



3.


Put aluminium kettle inside autoclave
Autoclave at 117°C for 3 minutes
Turn off autoclave & cool for 30 minutes
Run tap water into autoclave
Remove aluminium pot from autoclave
Scrape sides & bottom of pot
Homogenize
Bottle milk at 70 - 80°C
Seal with standard crown cap
Inspect & put expiry date
Bottled stabilized coconut milk

5.2 Process description

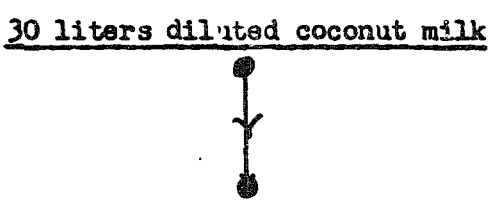
Ccconut kernel free from testa is cut into pieces & comminuted in a locally made coconut grater machine. Weigh comminuted coconut meat. Add ½ of its weigh of water. Extract the milk. Repeat procedure. Set aside milk (milk 1).

Weigh the residue. Add ½ its weight of water. Press until flow abates. Loosen the residue & press until flow abates (milk II). Pour milk I & II into one container.

Strain coconut milk in a cheesecloth. Put coconut milk in an aluminium pot fitted with a steam injector. Add 0.1% benzoic acid. (This will act as preservative). Put the aluminium kettle inside the autoclave, Autoclave at 117°C for 3 minutes with steam injection. Turn off autoclave & cool to atmospheric pressure. This takes about 30 minutes. At this point the temperature of the milk is about 100°C. Run tap water into the autoclave to cool the milk in the pot quickly to 80 - 85°C. Remove aluminium pot from autoclave.

Scrape sides & bottom of pot to dislodge any adhering curd. Homogenize for 5 minutes or until all the curd is thoroughly dispersed. Thereafter, turn on homogenizer intermitently to keep milk uniform during filling. Bottle milk at 70 - 80°C into 230 ml sterilized soft-drink glass bottles. Fill bottles ¼" in headspace or 200 ml. This is approximately the amount of milk obtained from half a coconut by hand squeezing. Seal bottles with standard crown cap immediately after filling shelf-life of the product in 7 days.

5.3 Product flow diagram



6. Quality of finished product: -

Stabilized coconut milk has the same appearance and quality as fresh coconut milk.

7. Source of information : -

Technological Research Institute
Applied Scientific Research Corporation
of Thailand
Phahonyothin Road
Bang Kehn, Bangkok
Thailand

Product code: CCCN 21.07

Technology sheet no.V / 4

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT CREAM - Pilot plant in Thailand

2. Uses of finished product : - Culinary purposes

3. Country of Origin : - THAILAND

4. Equipment : -

4.1 List of equipment

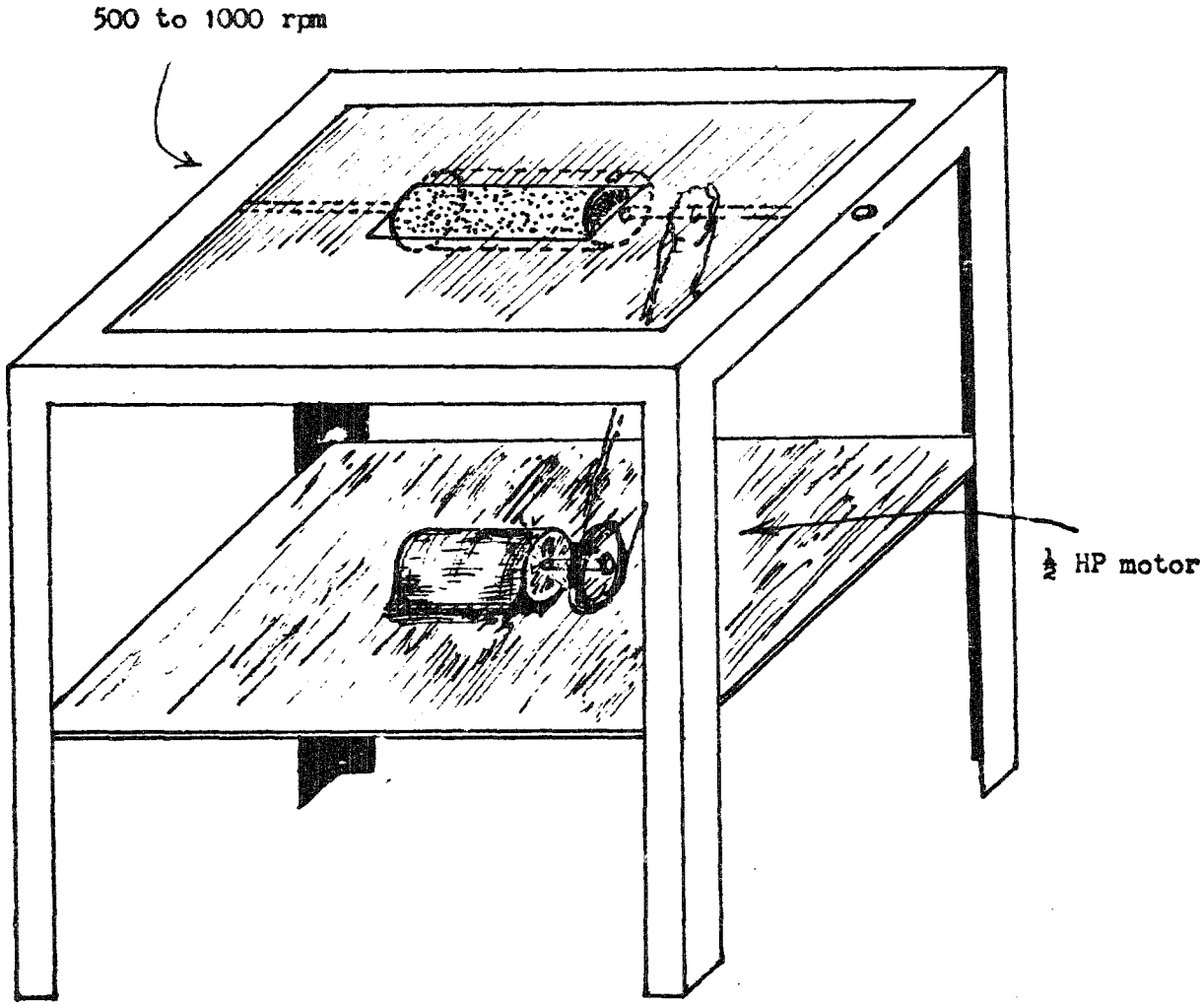
Knives - for removing husk
Deshellers
Knives - Sharp for scraping testa
Grating machine (please see illustration)
Expeller
Steam jacketed kettle w/ rotating blade.

4.2 Raw materials

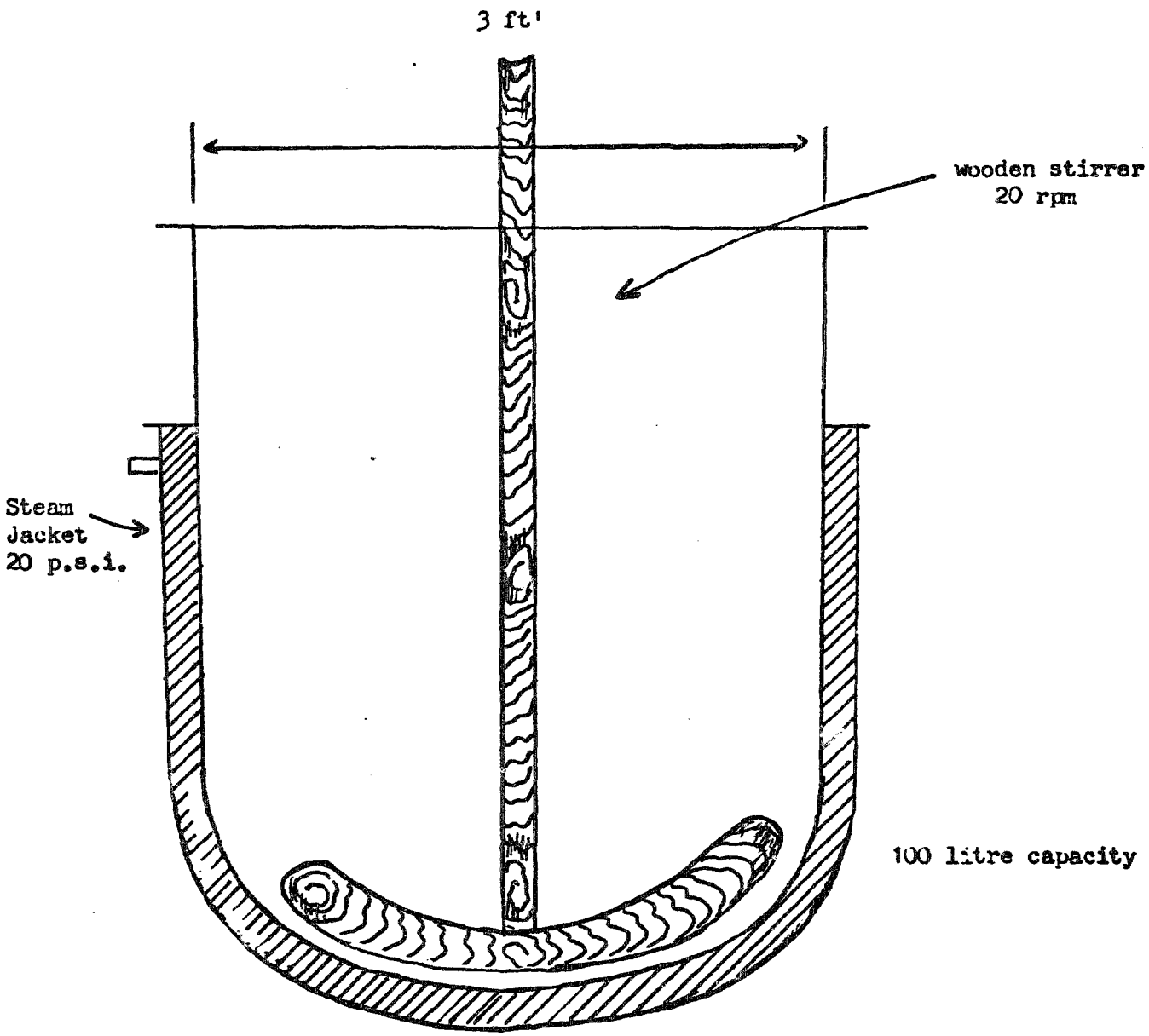
100 pcs mature coconuts	-	11-13 month old
Sodium metabilsulphite	-	150 gms (soaking medium)
Anthracine	-	4 ml
Pectin	-	240 gms
Sodium metabisulphite	-	600 ppm

4.3 Sketch of important equipment : -

Steam - jacketed kettle
Coconut Shredder



SKETCH OF COCONUT SHREDDER

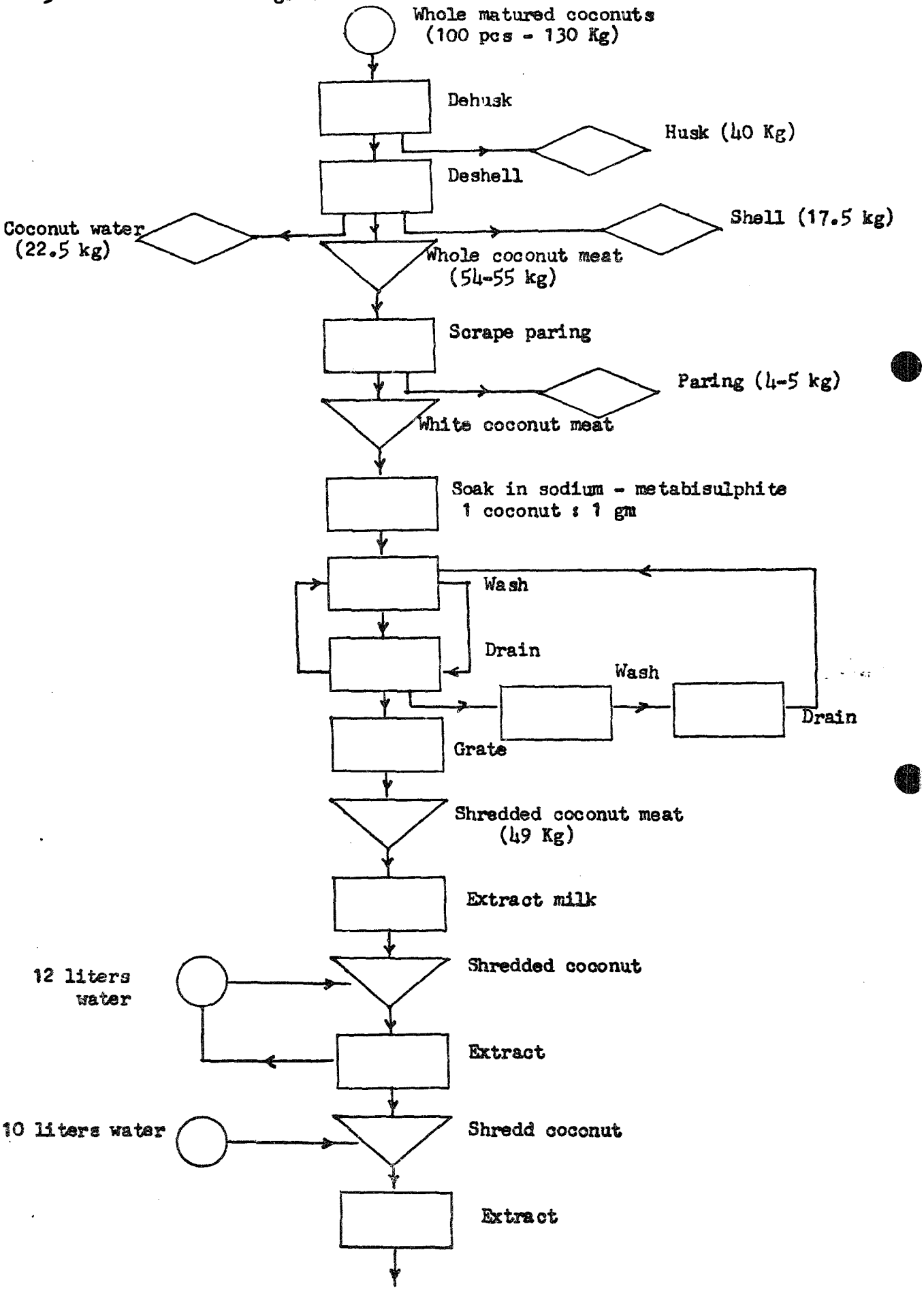


SKETCH OF STEAM JACKETED KETTLE

5. Process

4.

5.1 Process flow diagram : -



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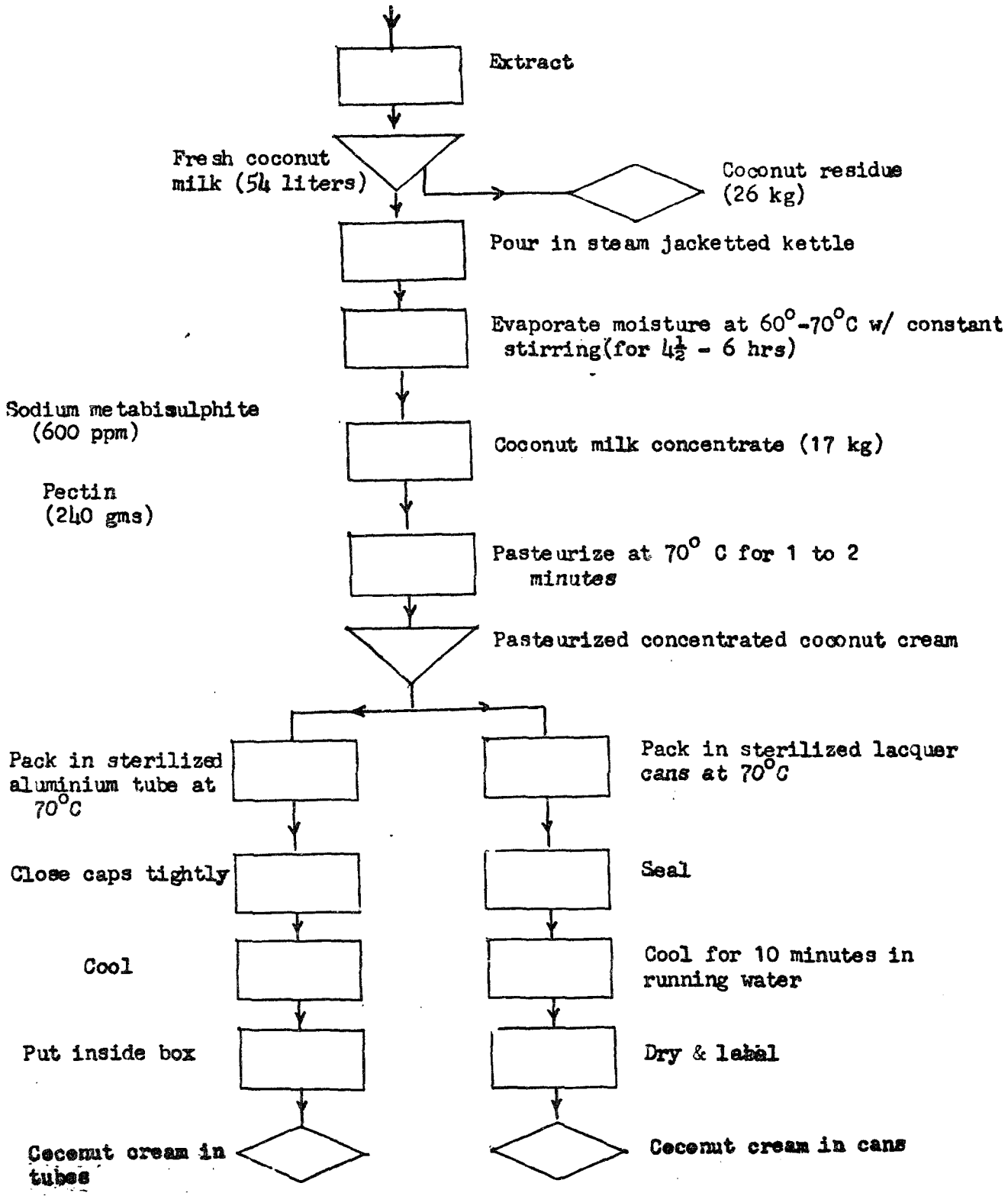

Extract
Fresh coconut milk (54 liters)
Coconut residue (26 kg)
Pour in steam jacketted kettle
Evaporate moisture at 60°-70°C w/ constant stirring(for 4½ - 6 hrs)
Sodium metabisulphite (600 ppm)
Pectin (240 gms)
Coconut milk concentrate (17 kg)
Pasteurize at 70° C for 1 to 2 minutes
Pasteurized concentrated coconut cream
Pack in sterilized aluminium tube at 70°C
Pack in sterilized lacquer cans at 70°C
Close caps tightly
Seal
Cool
Cool for 10 minutes in running water
Put inside box
Dry & label
Cocenut cream in tubes
Cocenut cream in cans

6.

5.2 Process description :

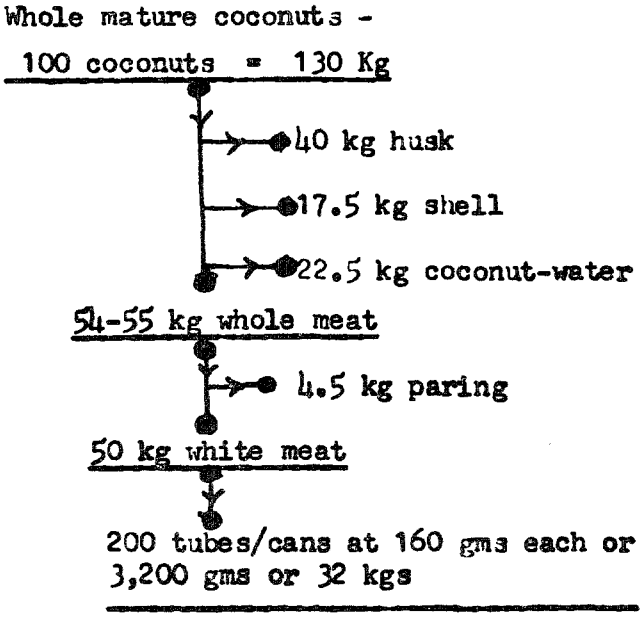
Dehusk 100 pieces of 11-13 month old coconuts, weighing 130 kg. Deshell. Waste materials from this process are coconut water & coconut shell. Scrape off the testa or paring using a sharp knife. Soak the white meat in a sodium - metabisulphite for 1 to 2 hours or overnight. Use 1 gm of sodium metabisulfite for every coconut. Dissolve in water. Wash & drain white meat for several times in order to remove any trace of sodium metabisulphite which was added to prevent spoilage & discoloration of the meat. Grate the coconut meat. Extract the milk using an expeller or screw juice extraction in this requence : Pour the coconut milk in a steam - jacketted kettle equipped with a blade, rotating at 20 rpm. Evaporate moisture at 60°-70°C with constant stirring for 4½ to 6 hours. Add 600 ppm sodium metabisulphite and 240 gms pectin to the coconut milk concentrate. Pasteurize at 70°C for 1 to 2 minutes.

To produce concentrated coconut milk in tubes, pack the sterilized aluminum tube at 70°C. Close the cap tightly. Let cool. Put inside box.

If concentrated coconut milk is desired, pack in sterilized lacquer cans at 70°C. Seal the can. Cool for 10 minutes in running water. Dry & label.

In both cases fill without head space. Net weight of both products are 160 - 170 gm.

5.3 Product flow diagram



6. Quality of the finished product :

It is a thick, cream colored emulsion, with very strong coconut flavor. Its proximate composition is 10-11 % moisture, 76-80% fat & 6-7 protein.

Add 3 times water if an undiluted coconut milk is needed in the food preparation; add 5 times water to produce diluted coconut milk.

7. Source of information : -

Institute of Food Research and
Product Development
Kasetsart University
Bangkok, Thailand.-

Product code: CCCM 21.07

Technology sheet no. V / 5

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT CREAM - Malaysia

2. Uses of finished product : - Culinary purposes.

3. Country of origin : - MALAYSIA

4. Equipment :

4.1 List of equipment

Deshelling tools	-	Standard equipment
Paring knives	-	Standard equipment
Cooking pan	-	To be used for sterilizing coconut meat
Disintegrating machine	-	To be used for comminuting coconut meat
Presser	-	To be used for extracting coconut milk
Steam jacketed kettle	-	Standard equipment
Laddle	-	To be used for stirring coconut milk
Containers	-	Cans or plastic pouches

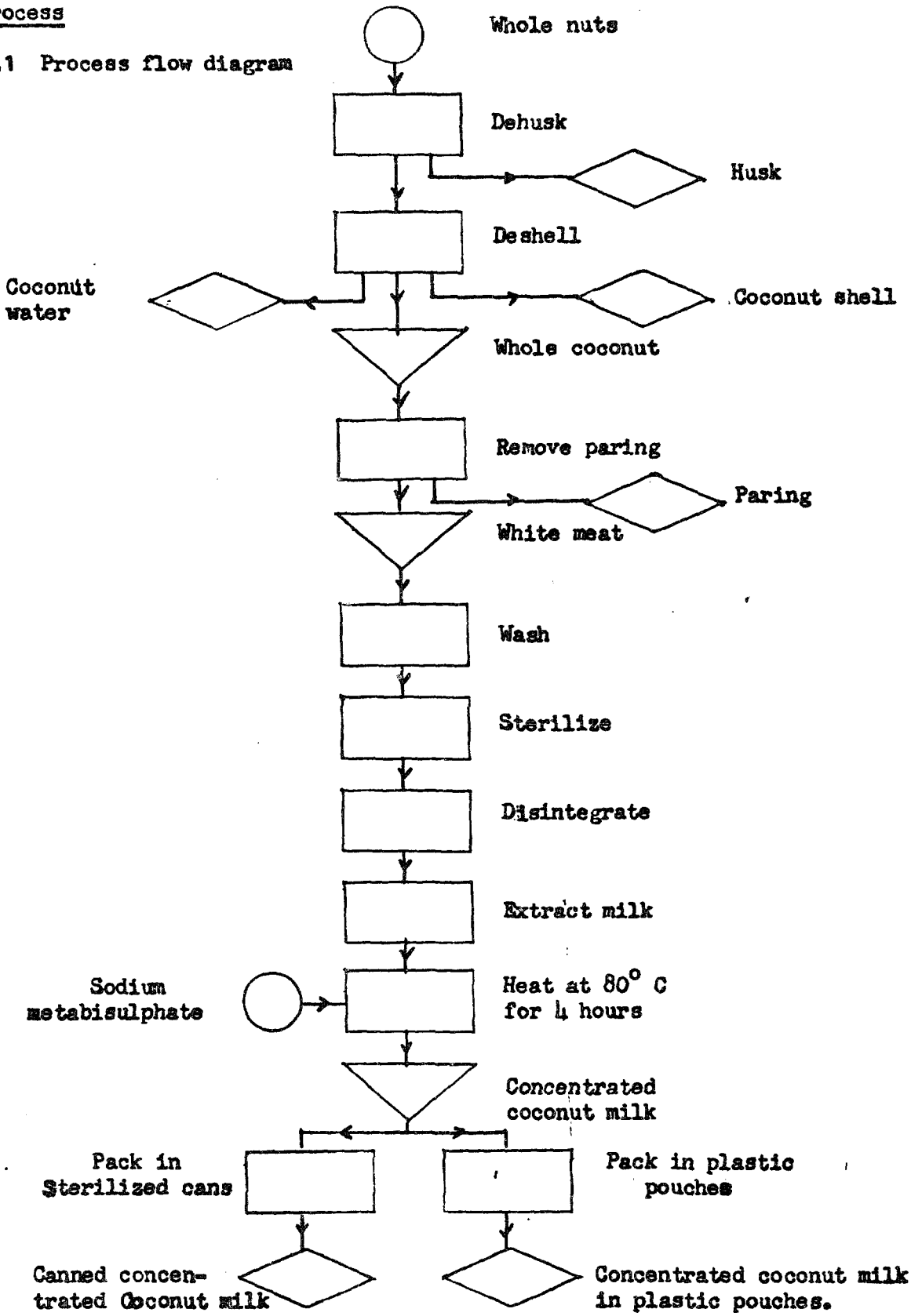
4.2 Materials for construction : - Not applicable.

4.3 Cost of equipment : - Approximately US$ 150.00

4.4 Capacity : - 30 liters coconut milk

5. Process

5.1 Process flow diagram



5.2 Process description :

Dehusk whole coconut. Remove the kernel. Coconut water is thrown away as waste. Deshell. Coconut shell is used as domestic fuel. Pare the whole coconut. Wash the white meat & then sterilize in boiling water for 1 to 1½ minutes. Comminute sterilized coconut meat. Extract the milk.

Concentrate the milk by heating in steam jacketted kettle at 80° C for about 4 hours with continuous stirring. For purposes of extending the shelf-life of the product add 600 p.p.m. of sodium metabisulfite.

Concentrated coconut milk can be canned and kept at room temperature or packed in plastic pouches & immediately frozen & kept at all times under freezing temperature.

The shelf-life of canned concentrated coconut milk is approximately six months while that of frozen coconut milk is appreciably longer.

5.3 Yield :

It has been calcul... that 3 oz of concentrated coconut milk is approximately equivalent to three times the weight of unconcentrated fresh coconut milk.

6. Quality of finished product :

Very thick coconut cream with 40 - 45% fat.

7. Source of information :

Agricultural Product Utilization Division.

Malaysian Agricultural Research &
Development Institute (MARDI)
P.O.Box. 202 UPM Post
Serdang, Selangor
Malaysia

Product code: CCCN 21.07
Technology sheet no. V / 6

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT CREAM - Pilot plant in Philippine

2. Uses of finished product : - Culinary purposes

3. Country of origin : - PHILIPPINES

4. Equipment

4.1 Description of equipment

Coconut meat grinder : Made of cold roll steel with a hopper, screw conveyor & two corrugated disc plates. Cut pieces of the coco meat are dropped into the hopper & by conveyor the coco meal are caught in between the teeth of the two disc plate where they are crushed into uniform sizes of around 16 mesh.
It is operated by a 15 horsepower electric motor.

Screw press (expeller) : Made of cold roll steel and could expel maximum amount of coconut milk from the coconut meat at optimum pressure & temperature, in order to protect the coconut milk from denaturation prior to processing.
It is operated by a 5 horsepower gear type electric motor

Centrifuge	:	Stainless steel De Laval type separator. It can separate coconut milk into 3 portions, namely coconut cream (fatty portion), skimmed milk (watery portion) and protein solids (solid portion)
Processing tank	:	Stainless steel, steam-jacketed tank standard equipment with a stirring rod and a discharge valve located at the bottom of the tank where the processed coconut milk can be transferred aseptically to the next processing equipment by means of stainless pipes.
Homogenizes	:	Stainless steel standard equipment with an operating pressure range of 0 to 500 kgm/cm^2.
Can sealer	:	A standard equipment adopted for sealing 10 oz cans.
Autoclave	:	A standard equipment made of steel, circular in shape operated between 10 to 11 psig from 30 minutes to one hour.

4.2 **Materials for construction** : Not available

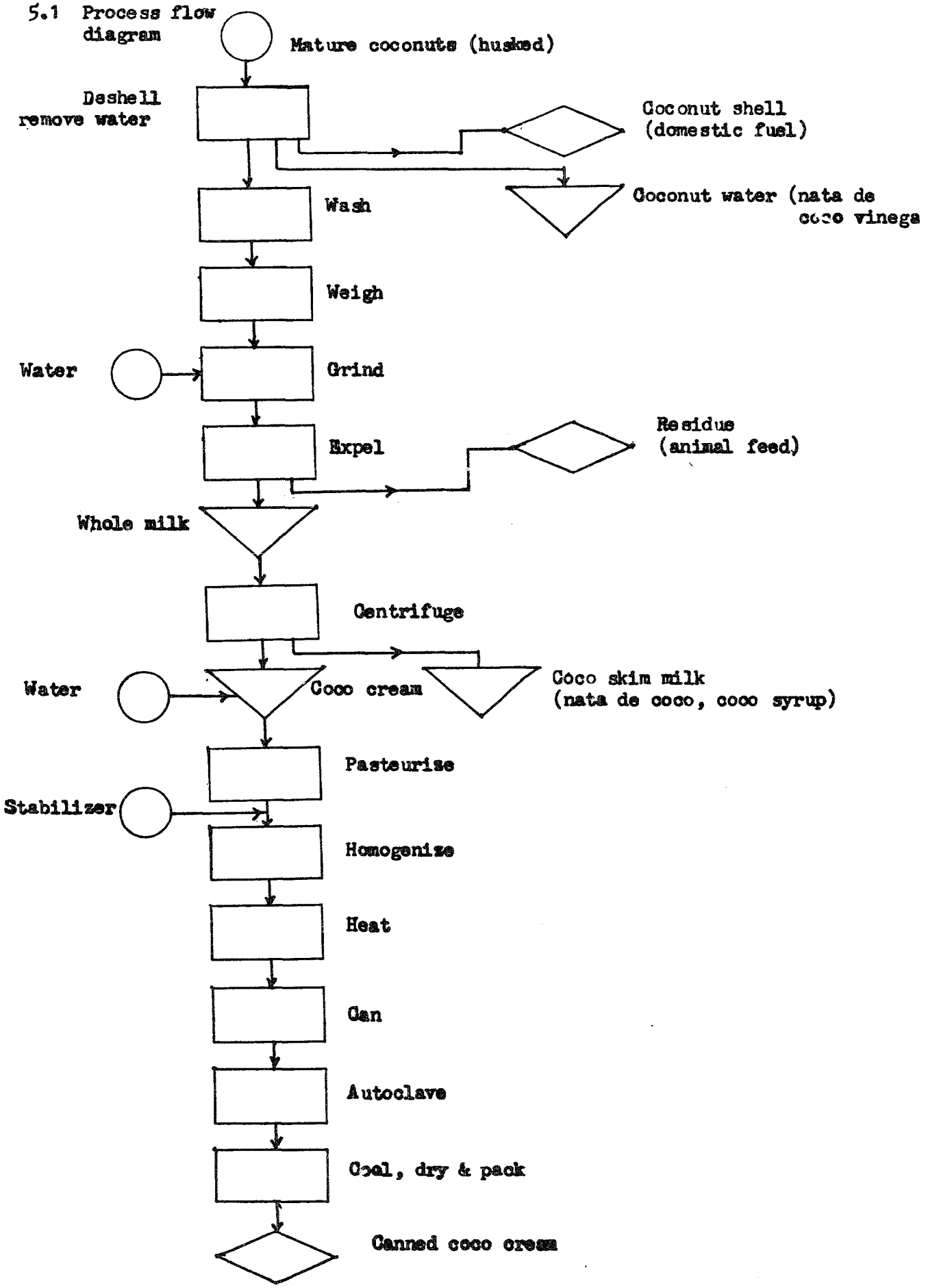
4.3 **Cost of equipment** :

Coconut meat grinder	₱ 29,000	$ 3,972.60
Screw press	20,000	2,139.72
Centrifuge	50,000	6,849.31
Processing tank	80,000	10,958.90
Homogenizer	100,000	13,698.63
Can sealer	10,000	1,369.86
Outoclave	10,000	1,369.86
	₱299,000	$40,958.88

4.4 Capacity	:	Coconut meat grinder - 1 ton/hour of fresh coconut meat
		Screw press - 1 ton/8 hours of fresh coconut meat
		Centrifuge - 200 litres/hour
		Processing tank - 500 litres of coconut milk
		Homogenizer - 200 gallons/hour
		Can sealer - 23 cans/minute

5. Process :

5.1 Process flow diagram



5.

5.2 Description of process:

Sound mature coconuts are selected & deshelled. Coconut water is collected & made into nata de coco or vinegar. The meat with paring is washed, weighed& ground. The ground meat is mixed with ½ to 2 times its weight of water & passed through a screw press or expeller to extract the coconut milk. The residue is used for animal feed. The whole coconut milk is transferred to the centrifuge to separate the cream from the watery (skim milk) portion. The skim milk is used for making nata de coco or coconut syrup. The cream is mixed with ½ to 2 times its weight of water and pasteurized for about 25 minutes. The pasteurized cream is mixed thoroughly with a stabilizer & passed through a homogenizer. The homogenized mixture is heated almost to boiling, filled hot in tin cans, sealed immediately & processed at 6 to 10 psig for 45 to 70 minutes in the autoclave. From the autoclave, the cocomilk in tin cans are cooled immediately by submerging in a cooling tank with running water, dried & packed in cartoon boxes of 24 cans per cartoon.

6. Quality of finished product :

Export quality coco cream.

7. Source of information :

Engineering Research Department

Industrial Research Center
NIST, P.O. Box. 774
Pedro Gil St. Ermita, Manila
Philippines.-

Product code: CCCN 21.07
Technology sheet no: V / 7

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT CREAM - Commercial plant in Indonesia.

2. Uses of finished product : -

For culinary purposes in Indonesia and for export.

3. Country of origin : -

INDONESIA. This process uses desiccated coconut for manufacturing coconut cream. The process was developed by the manufacturers whose main activity is manufacture of desiccated coconut. The plant is located in North Sulawesi.

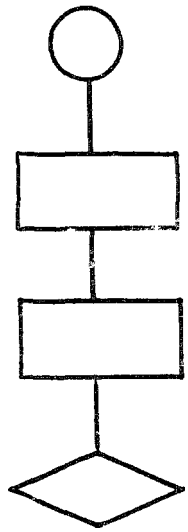
4. Equipment: -

Special grinding machine and packaging equipment for small plastic bags and tin cans.

Details of equipment, costs etc are not available.

5. Process: -

5.1 Process flow diagram: -



desiccated coconut

grinding

packing and sealing

coconut cream
(300 gm cans)

5.2 Description of process: -

Desiccated coconut is subjected to grinding by the use of special equipment. Details of the complete process are not known.

After grinding, the material is packed into plastic bags or "lift tab" cans of 300 gm nett.

5.3 Product flow diagram: -

Yields are not known

6. Quality of finished product: -

The cream upon dilution in hot water reconstitutes coconut milk similar to the original milk.

The local restaurants preparing typical food of West Sumatra (Padang) have found this product very acceptable.

7. Source of information: -

Observations during plant visit.

Product code: CCCN 21.07
Technology sheet no: V / 8

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT CREAM - Commercial plant in Western Samoa.

2. Uses of finished product : -

Exported for culinary purposes

3. Country of origin : -

WESTERN SAMOA. This plant uses an adaptation of the process invented by the Tropical Products Institute of England, and was set up with their assistance.

4. Equipment: -

Bush knives for deshelling
Paring knives for removal of testa
Tanks for washing kernels
Rotary grating machine with stationary and rotating discs
Screw type expeller
Stainless steel containers
Jacketed kettle of stainless steel for sterilization
Homogenizer
Canning equipment

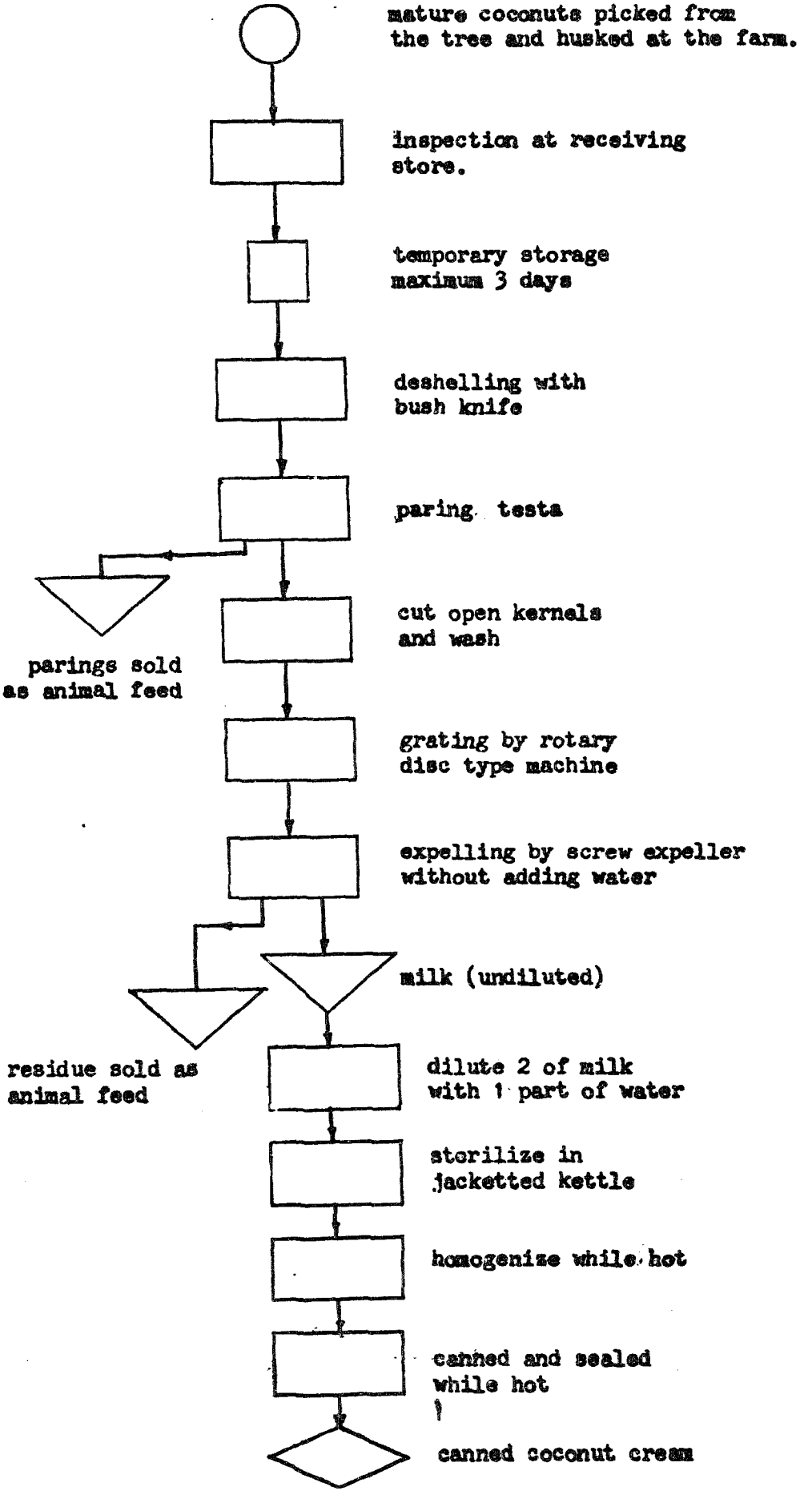
The details of equipment, costs, capacities etc are not available.

The capacity of the plant is 7000 nuts per 8 hr shift = 4200 cans of 15 ounces

∴ Capacity per year on the basis of 250 working days is about 1 million cans of 15 ounces each.

5. Process: -

5.1 Process flow diagram: -



5.2 Description of the process: -

Picked, mature coconuts are dehusked in the farms and brought into the plant within a few days. It is usual to allow nuts to fall naturally in Western Samoa but, such nuts are dry and hence not used for the process. At receiving, the nuts are inspected so as to reject any nuts under mature, over mature or those not freshly harvested and husked. The nuts are kept in the stores and stocks rotated to ensure that no nuts are held for more than 3 days.

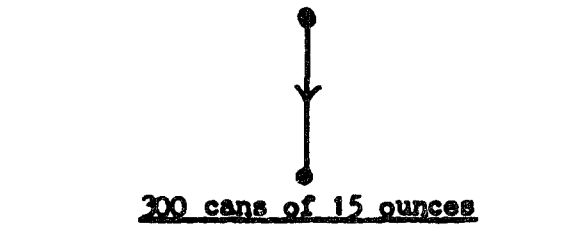
The nuts issued for the days production are deshelled by piece rate workers using bush knives. Thereafter the kernels are pared, cut open and washed thoroughly in fresh water.

The washed kernels are grated by a rotary device which has a stationary disc and a rotary disc. Thereafter the milk expelled by a screw expeller. Occassionally when the expeller is out of commission, the traditional expelling by the use of squeezing with banana type fibre is adopted (See technology sheet for "EXTRACTION OF COCONUT MILK IN PACIFIC HOUSEHOLDS")

The parings earlier removed, and the residue after expelling are sold as animal feed.

The coconut milk is diluted 2:1 and sterilized in a jacketted kettle for half hour, boiling of the contents taking place during the last 5 minutes. The cream is homogenized while hot. The canning and sealing operation is also carried out while hot. The cans contain 15 ounces (425 gm) each.

5.3 Product flow diagram: -



6. Quality of finished products: -

The coconut cream has excellent consumer acceptance by the Asian population in the many countries to which the product is exported.

7. Source of information: -

Observations during plant visit.

Product code: CCCN 20.05
Technology sheet no. V / 9

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND ASIAN & PACIFIC COCONUT COMMUNITY
"Consultancy Service on Coconut Processing Technology"
(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT JAM PROCESSING (Home Industry)

2. Uses of finished product : - Dessert

3. Country of origin : - Philippines

4. Equipment

4.1 Description of equipment & ingredients

Equipment:

Grater	metal sheet with serrations for grating
Basin	2 sets, round 12" diameter
Cheesecloth	½ yard
Cooking pan	Round 12" diameter
Casserole	Round 12" diameter w/ rack
Laddle	wooden
Bottles	Six pcs 8-oz capacity with caps
Tong	1 set, medium size
Weiging scale	: for kichen use

Ingredients	Proportion
Coconut milk	100%
Brown sugar	10.25% of weight of coconut
Glucose	5.5% of weight of coconut
Citric acid	0.25% of weight of coconut

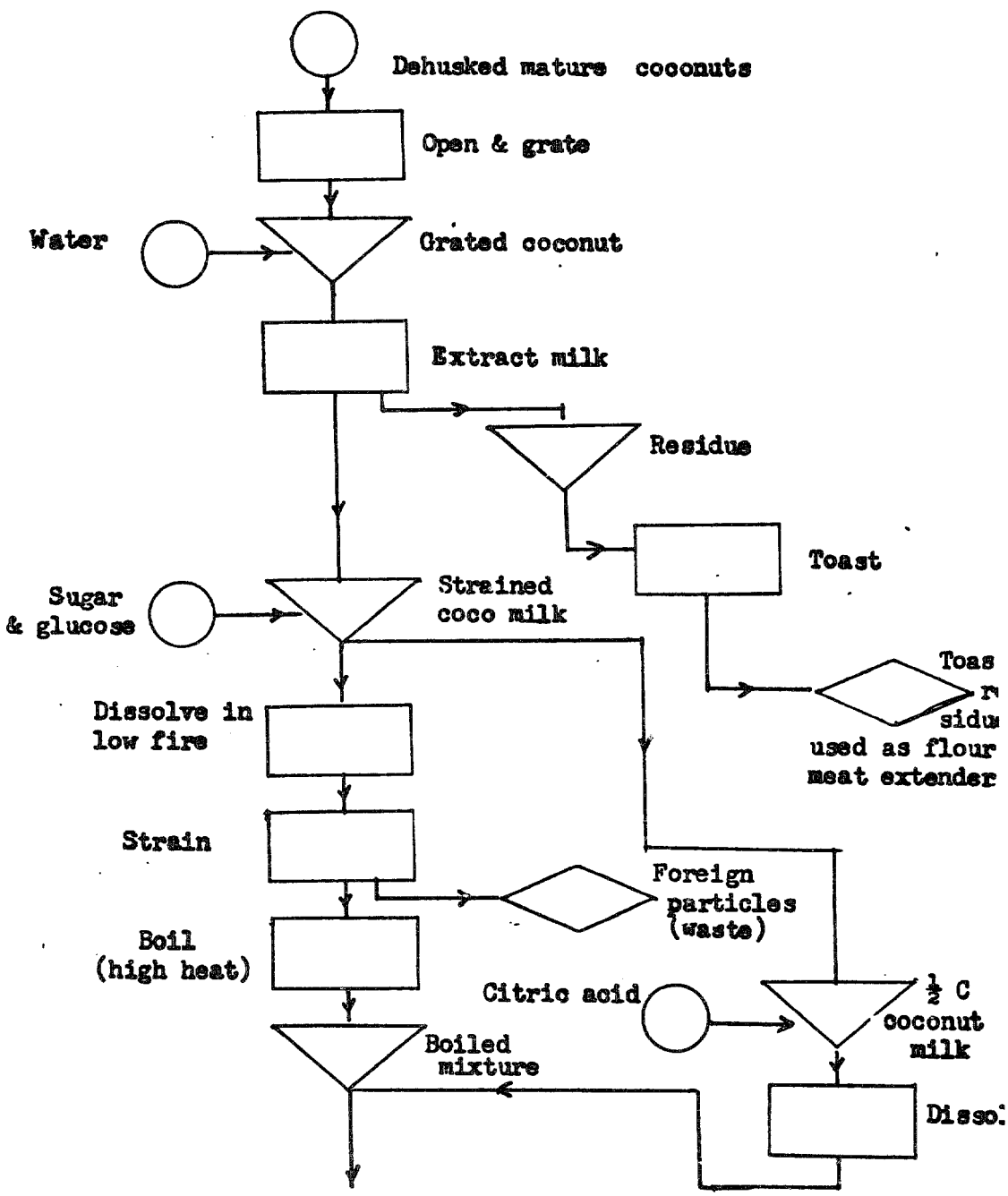
4.2 Materials for construction: not applicable

4.3 Cost of equipment : ₱ 100 $ 13.98

4.4 Capacity : Six 8-oz bottles

5. Process

5.1 Process flow diagram



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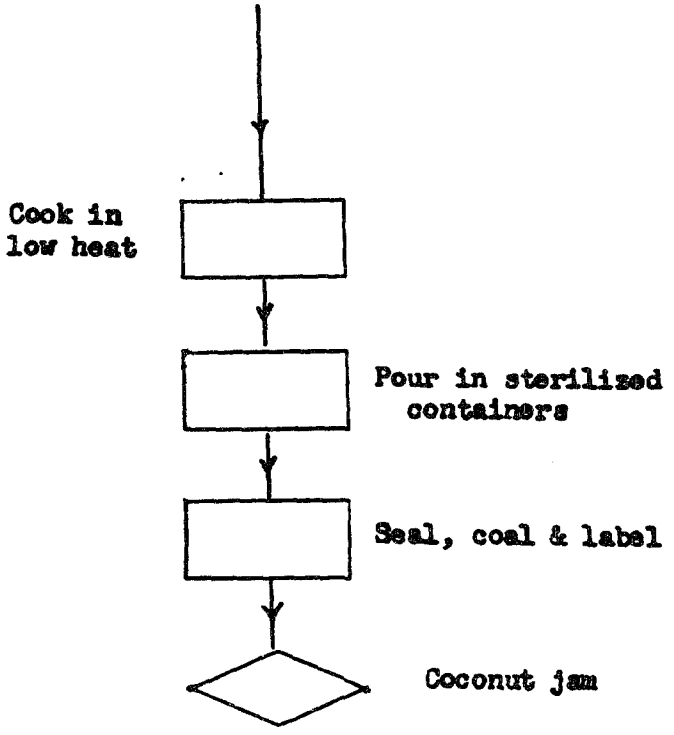


5.2 Description of process : -

Dehusked mature coconuts (12 pcs) are opened & grated. Lukewarm water is added to the freshly grated coconut in the proportion of 1 part grated coconut to 1 part water. Extract & strain the milk using a cheesecloth. Weight the coconut milk & the other ingredients to be used. Set aside ½ c. of coconut milk.

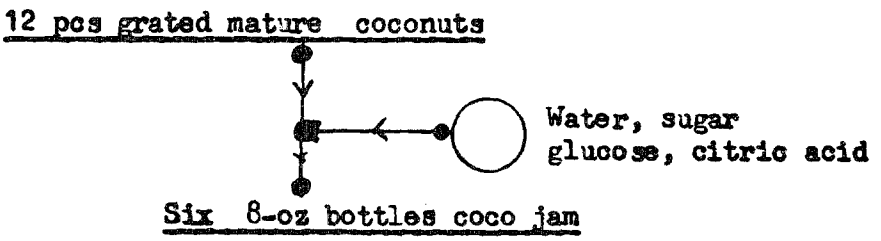
Pour the remaining coconut milk in a cooking pan. Add previously measured sugar & glucose in the cocomilk. Dissolve the mixture by stirring constantly while cooking over low fire (approximately 20 minutes). Strain mixture in a cheesecloth to remove foreign particles.

Boil the milk over high heat to evaporate water content. Stir constantly. Cook for approximately 40 minutes. When the mixture is almost thick add the coconut milk - citric acid mixture. Citric acid will prevent sucrose crystallization during storage. Cook in low heat (for approximately 25 minutes) until the mixture thickens.

Sterilize bottles by boiling them in a casserole completely submerged in water for 10 minutes. Remove bottles, using a tong & put them on the table up-side-down to dry.

Pour hot coconut jam in sterilized bottles while hot. Cover tightly cool & label.

5.3 Product flow diagram



6. Quality of finished product

It is a creamy, free - flowing, sweetened product, prepared from coconut milk & sugar with an average moisture content of 25%, 4% fat, 6% protein & 75% total solids.

7. Source of information : -

Food Research & Development Division

Philippine Coconut Authority
Diliman, Quezon City
Metro Manila
Philippines

Product code : CCCN 20.04

Technology sheet no: V / 10

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for: - NATA DE COCO CULTURE (Home industry) from coconut water or alternatively coconut milk.

2. Uses of finished product: - Dessert.

3. Country of origin: - PHILIPPINES

4. Equipment

4.1 List of equipment and ingredients

Basin	12 cups coconut water or milk
Laddle	1 cup sugar
Cup for measuring	2 cups mother liquor
3 culture jars	¼ cup glacial acetic acid
Casserole dish	sugar syrup (2 cups sugar and 1 cup water)
Sterilized bottles	

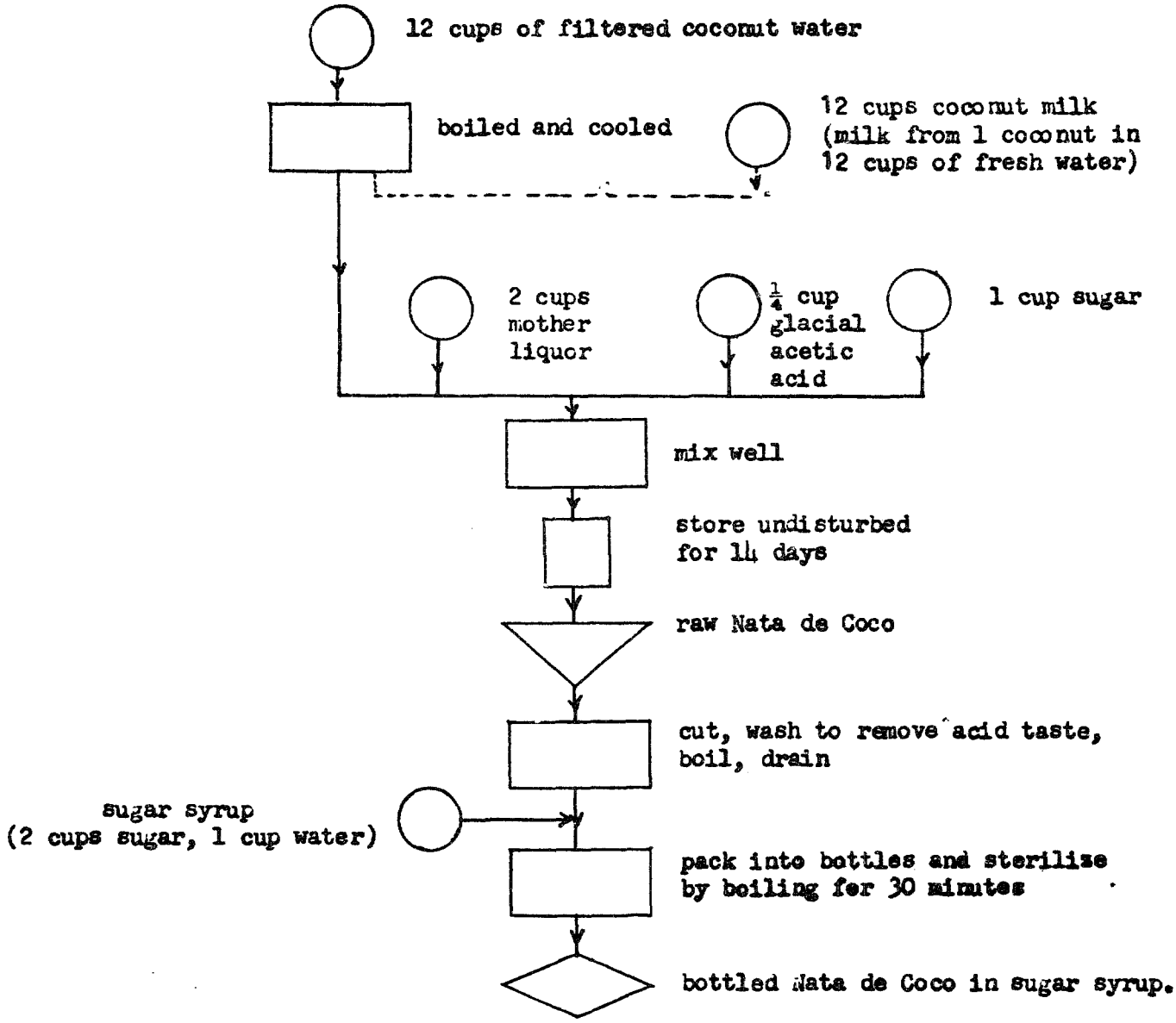
4.2 Materials for construction: - Not applicable

4.3 Cost of equipment: ≈ About ₱ 50 (US$ 6.73)

4.4 Capacity: - 1 Kg raw Nata de Coco every 15 days with above set of equipment.

5. Process

5.1 Process flow diagram: -

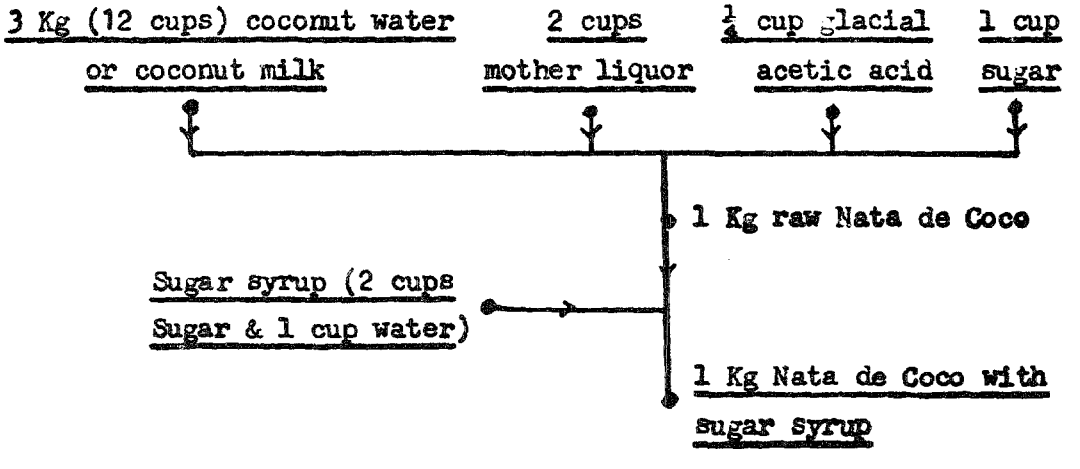


5.2 Description of process

The coconut water is boiled and cooled. Mix well the sugar, mother liquor and acetic acid in the coconut water. Alternatively an equivalent quantity of coconut milk made from milk of 1 grated coconut in 12 cups of fresh water can be used instead of coconut water. Pour into culture jars to a height of 60 mm (2½ inches), cover the jars with clean paper and incubate at 28°C (82° F), the temperature most favorable for the growth of the nata. The jars are left undisturbed or else the nata being formed at the surface will sink to the bottom. After 14 days when the nata is about 25 mm (or 1 inch) thick, pick the nata with a clean fork taking care not to contaminate the liquid below the nata formation. This liquid will be used again to culture nata and is called the "mother liquor".

Remove the cream formation at the bottom of the nata. Cut the nata into squares of about 25 mm (1" inch). Wash and boil for 1 minute in an open pan, drain, soak in water constantly changing the water. Repeat the procedure until all the acid taste is removed. Drain the nata for 2 hours. For every part of nata add 1 part of sugar. Colouring may be added if desired. Leave overnight. Cook until gummy texture is removed and nata is transparent. Add flavouring. Prepare syrup. Pack nata in jars ¾ full, add syrup to ¼ in headspace, seal cups tightly, process in boiling water for 30 minutes. Dry, cool and store.

5.3 Product flow diagram



6. Quality of finished product

The finished product has no harmful ingredients and is suitable for edible purposes.

7. Source of information:

Philippine Coconut Authority
Dilliman, Quezon City
Metro Manila
Philippines.-

P. M. A. 1979

Product code : CCCN 22.10
Technology sheet no: V / 11

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for: - VINEGAR BY FERMENTATION OF COCONUT WATER (Home Industry)

2. Uses of finished product: - Cooking purposes and making pickles.

3. Country of origin: - PHILIPPINES

4. Equipment:

4.1 Description of equipment and ingredients

Cheese cloth for filtering	16 cups coconut water
Kettle	$1\frac{3}{4}$ cups sugar
Laddle	1 teaspoon yeast
Jars (wide mouth) for fermenting	
Bottles for packing	

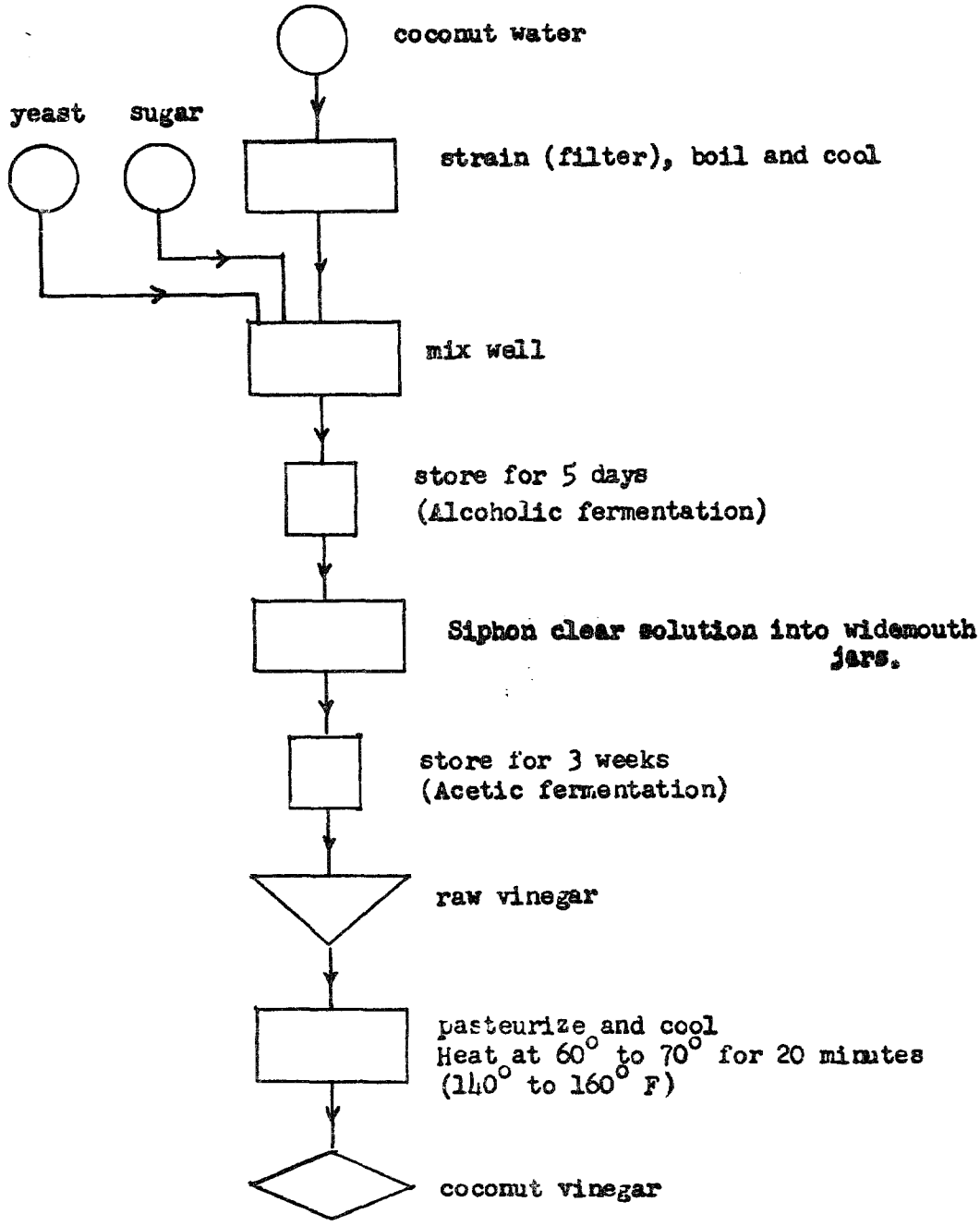
4.2 Material for construction: - Not applicable

4.3 Cost of equipment: - About ₱ 50 (US$6.70)

4.4 Capacity: - About 4.5 litres (1 gallon) Vinegar every 4 weeks with 1 set of equipment.

5. Process

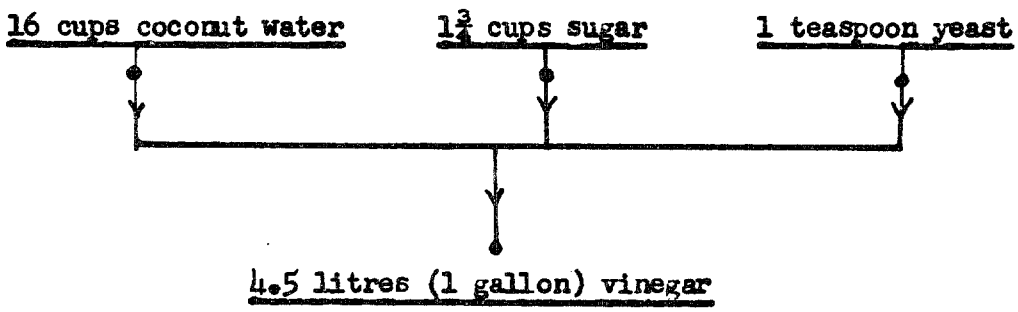
5.1 Process flow diagram:



5.2 Description of process

Strain (filter) coconut water through a cheese cloth. Boil for 10 minutes and cool. Add sugar and yeast and mix well. Pour into jars with wide mouth, cover with cheese cloth and store for 5 days for alcoholic fermentation. Siphon the clear solution and pour into jars with wide mouth, cover and again store for 3 weeks for acetic fermentation. Strain the contents and pack into bottles with narrow mouth. Seal tightly and pasteurize by heating at 60° to 70° C (140° to 160° F) for 20 minutes and cool.

5.3 Product flow diagram



6. Quality of finished product:

Coconut vinegar is suitable for edible purposes. It contains not less than 4% (g/100 ml) acetic acid and usually about 6%. The vinegar is derived from alcoholic and acetic fermentation and contains no foreign matter except caramel.

7. Source of information:

- Philippine Coconut Authority
  Diliman, Quezon City
  Metro Manila
  Philippines.-

P. M. A. 1979

Product code : CCCN 22.10
Technology sheet no. V / 12

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND ASIA & PACIFIC COCONUT COMMUNITY
"Consultancy Service on Coconut Processing Technology"
(Project UF/RAS/78/049)

1. Technology sheet for : - **VINEGAR BY FERMENTATION OF COCONUT WATER USING BAMBOO GENERATOR**

2. Uses of finished product : - **Cooking purposes, pickle making.**

3. Country of origin : - **PHILIPPINES**

4. Equipment : -

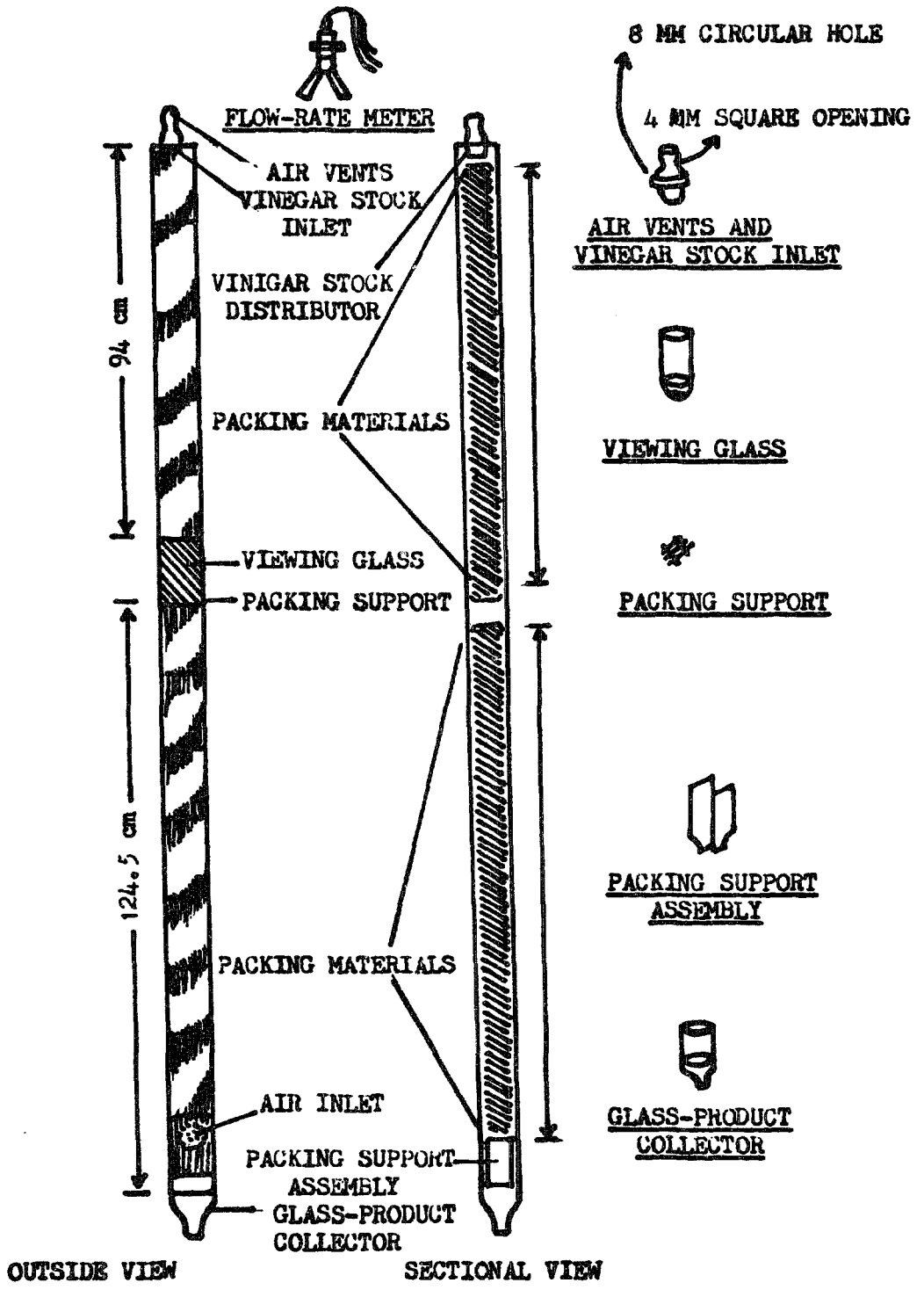
4.1 Description of equipment and ingredients

A single bamboo generator is composed of upper & lower compartments, each filled with packing materials one meter high. The lower compartment contains the packing support & assembly, thermometer & air inlet & glass product collector. The air vents, vinegar stock inlet, viewing glass & packing support make up the upper compartment.

Construction of Bamboo - Generator

(1) Use two dried straight bamboos of about 94 cm and 124.5 cm long with 9 cm outside diameter. Remove the nodes and smoothen inside wall with sandpaper.

(2) Upper compartment - The upper end of the upper compartment is first covered with a superimposed air vent. The air vent is a circular wood cover with a hole in the middle through which a bamboo 12 cm long and 4 cm in diameter is inserted. Before the bamboo is inserted, cover the hole with "sinamay" cloth. Two 4 cm square openings are cut on both sides of the bamboo protruding above the wooden cover. An 8 mm circular hole is bored in between but below the 4 cm square openings. The bamboo and the wooden cover are glued together and sealed with paraffin.



THE BAMBOO-GENERATOR WITH ITS ACCESSORIES

(3) An empty bottle of 9 cm outside diameter is cut at both ends and fitted at the lower end of the bamboo. This is called the viewing glass. The viewing glass connects the upper and the lower compartments.

(4) Lower compartment - Reduce the thickness of the lower end of the lower compartment to fit in the glass product collector. The glass product collector is a bottle of 9 cm diameter with the bottom cut and removed. Some 15 cm from the lower end of the bamboo tube a 5-cm hole is bored; this is the air inlet. A piece of bamboo tube of the same diameter is inserted to this hole. This bamboo tube must be inclined upward to prevent spilling of the solution. Another piece of bamboo is glued around the inlet and covered with "sinamay" cloth.

(5) Place one packing support in the upper compartment at the bottom part above the viewing glass. Another packing support and assembly is inserted from the bottom and placed just above the air inlet of the lower compartment.

(6) It is then filled with packing materials, coconut coir fibers washed with water and soaked in vinegar. These packing materials, with a wet weight of 850 gms, are equally distributed in the upper and lower compartments.

(7) The two compartments are joined in the viewing glass section with plastic tape. The joint is further sealed with paraffin to avoid contamination.

Equipment :

Bamboo generator	10 liters capacity
Casserole	big enough to contain 10 liters liquid of any shape
Vessel for feeding generator	4000 ml Erlenmeyer flash with removable plastic sidearm on side near the bottom in line with the section connection
Vessel for fermentation	any wooden or glass container big enough to contain 15 liters liquid, 1 vessel must be filled only ¾ full.
Vessel for collecting vinegar	Glass gallon jar

4.

Muslin cloth or coarse fabric
for filtering
Cooker or fire place

Ingredients:

10 liters (2.2 gn) coconut water
1.5 kg sugar (white or brown)
5 gm. Fleischmann's

Mother vinegar for innoculation to be used only once; the first time the bamboo generator is used.

4.2 Materials for construction: : -

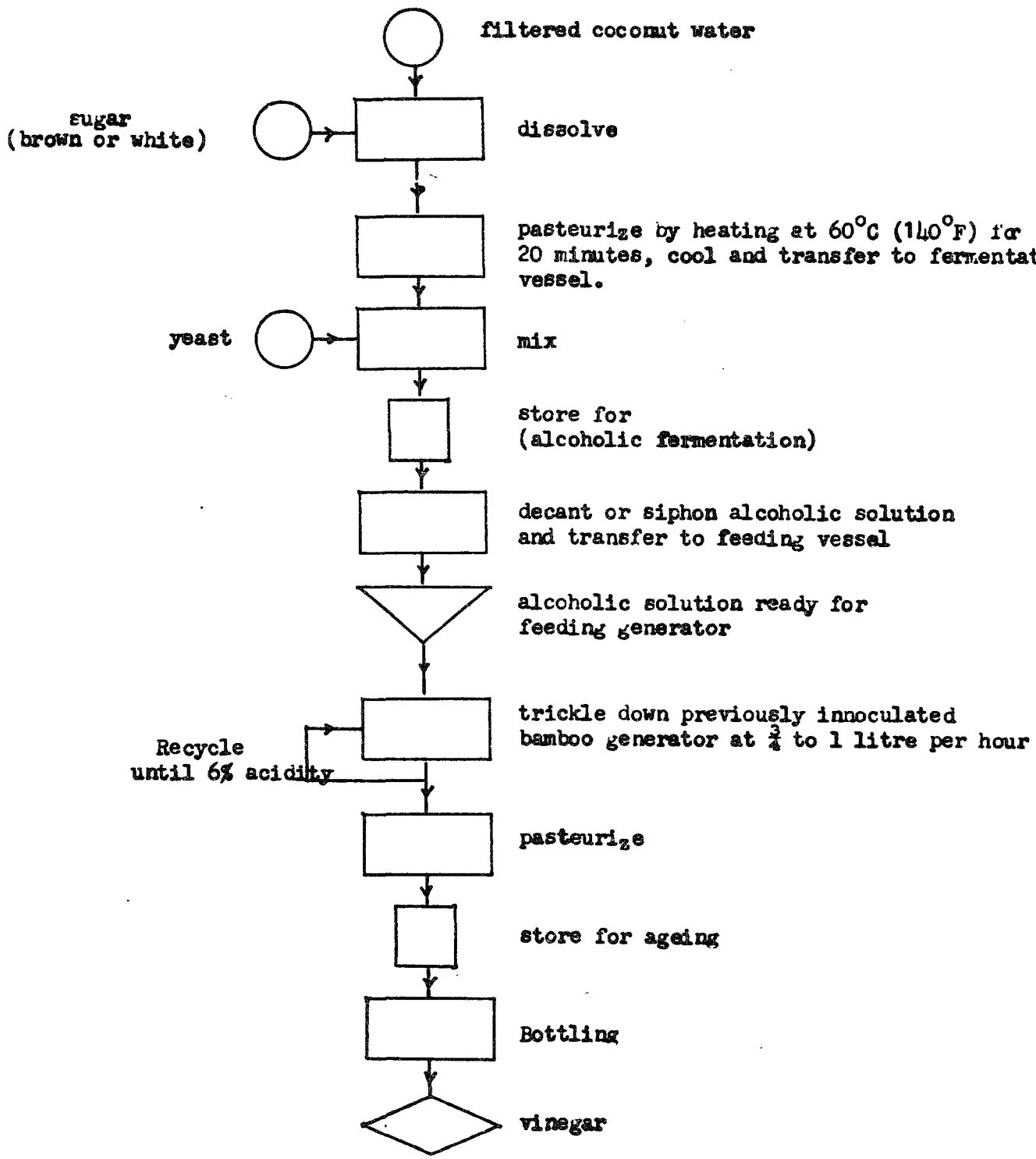
Dried straight bamboos of about 94 cm & 124.5 cm long with 9 cm diameter

4.3 Cost of constructien : - P800 ($110) for four column

4.4 Capacity : - 10 liters per column

5. Process:

5.1 Process flow diagram.



6.

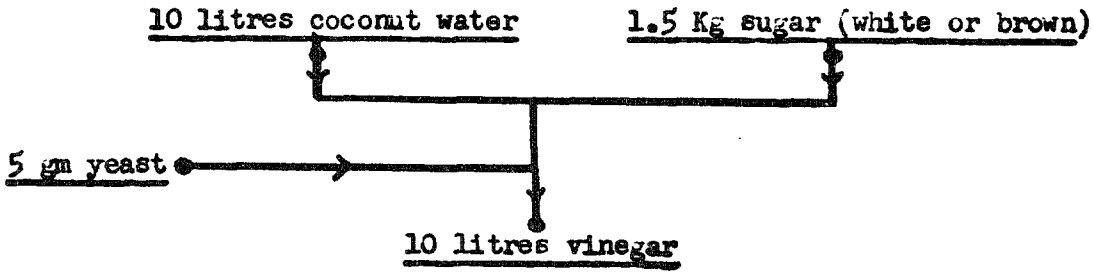
5.2 Description of process:

Filter 10 litres of fresh coconut water through muslin cloth or coarse fabric to remove dirt and suspended particles. Dissolve 1.5 Kg of white or brown sugar. Pasteurize by heating at 60°C (140°F) for 20 minutes and cool. Transfer to the fermentation vessel and add 5 gm of Fleischmann's yeast. Allow the solution to ferment until vigorous bubble fermentation stops. Decant or siphon the upper layer of the alcoholic solution without disturbing the sediment at the bottom. Transfer to feeding vessel above the bamboo generator. Now the alcoholic solution is ready for feeding into the generator which is previously innoculated.

Trickle down the alcoholic solution at the rate of $\frac{3}{4}$ to 1 litre per hour. Recycle the solution in the collecting vessel until an acidity of about 6% is obtained. The air vent of the bamboo generator must be kept fully opened during this operation. The vinegar finally collected is pasteurized, cooled and stored to age (mature). Thereafter the vinegar is bottled.

The innoculation of the bamboo generator is necessary for the first batch only. This is carried out as follows: - Close the air inlet of the bamboo generator and trickle down 4 litres of fermenting vinegar for 3 days. Fermenting vinegar is made by mixing 1 part of mother vinegar to 4 parts of alcoholic solution.

5.3 Product flow diagram:



6. Quality of Vinegar

Coconut vinegar is suitable for edible purposes. It contains not less than 4% (gm/100 ml) acetic acid and usually about 6%. The vinegar is derived from alcoholic and acetic fermentation and contains no foreign matter.

7. Source of information:

National Institute of Science & Technology
Pedro Gil Street
Manila
Philippines.-

Product code: CCCM 08.01
Technology sheet no. V / 13

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - CANNED YOUNG COCONUT IN SYRUP
(Research & Development)

2. Uses of finished product : - Dessert, baked products

3. Country of Origin : - PHILIPPINES

4. Equipment : -

4.1 List of equipment

Compact canning line - Ball

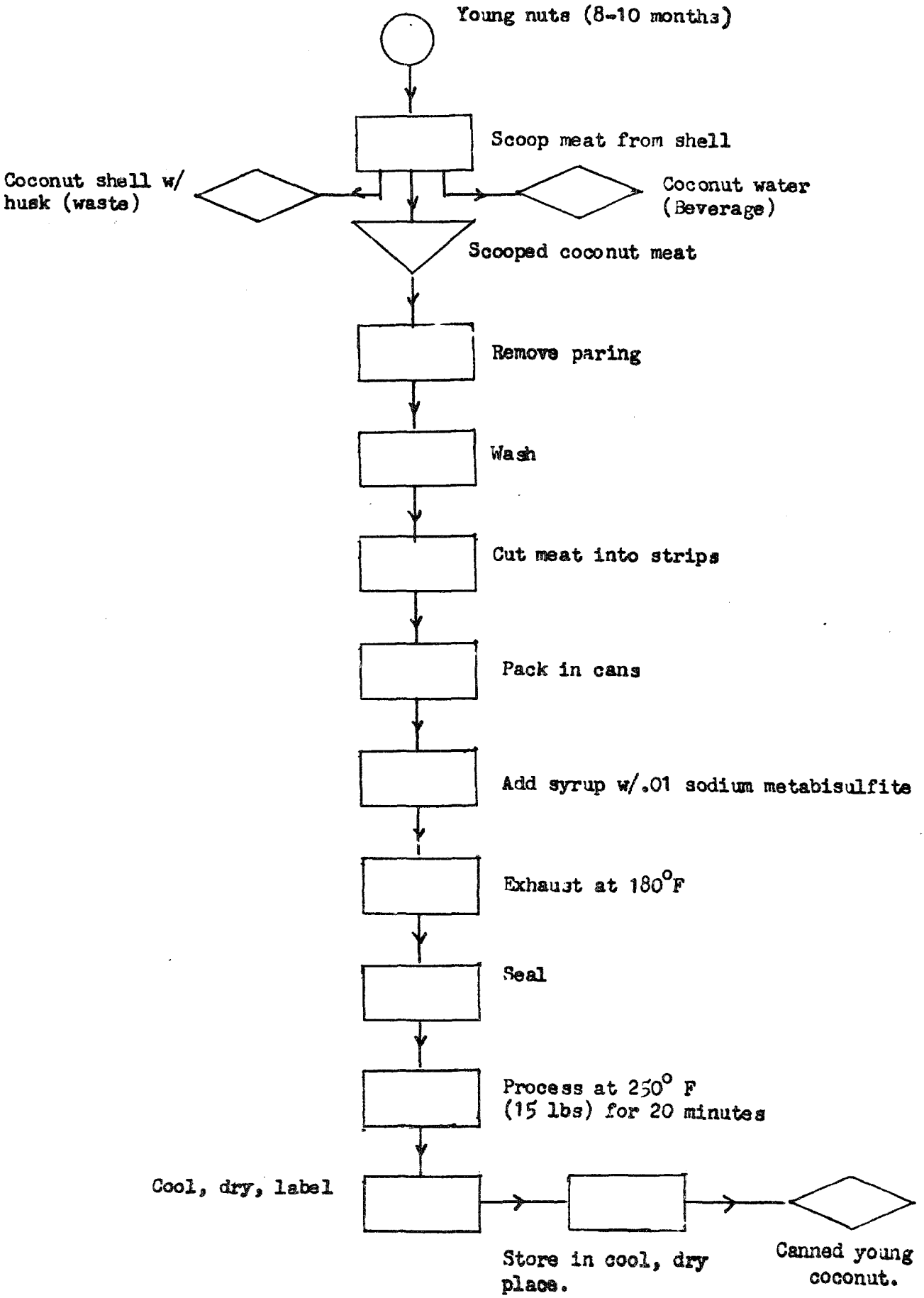
Can slicer - Automatic

4.2 Cost of Construction : - Not applicable

4.3 Cost of equipment : - ₱ 170,000 = US$23,287.67

5. Process

5.1 Process flow diagram



5.2 Process description : -

Scoop out meat of young coconut (8 to 10 months age). Remove paring using sharp knife. Wash the white coconut meat in tap water. Cut the meat into strips $\frac{1}{4}$" thick 3" long. Pack strips in 2T cans at 200 $\pm$ 5 grams/can. Add 50° Brix syrup with 0.01% sodium metabisulfite. Exhaust at 180°F (78°C). Seal. Process at 250°F (15 lbs) for 20 minutes. Cool, dry & label. Store in a cool dry place.

5.3 Process flow diagram : -

2500 gms white meat from 10 coconuts

↓

14 cans young coconut in syrup

6. Quality of finished product

Cream colored, sweetened young coconut strips.

7. Source of information : -

Food Research & Development Division

Philippine Coconut Authority
Diliman, Quezon City
Philippines

Product code : CCCN 08.01
Technology sheet no. V / 14

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - SWEETENED MACAPUNO (Coconut Sport)
(Home Industry)

A coconut tree that produces macapuno usually yields 1 to 2 macapuno nuts per bunch of ordinary coconut. The entire cavity of the macapuno is filled with soft & tender jelly - like endosperm, which is considered a delicacy in the Philippines.

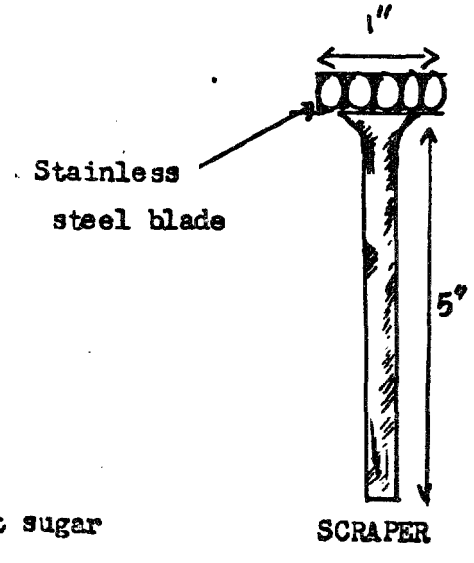
2. Uses of finished product : - Dessert

3. Country of Origin : - PHILIPPINES

4. Equipment : -

4.1 List of equipment

Cooking pan
Wooden laddle
measuring cup
Scraper (for young coconut)
Preserving bottles w/ caps.



SCRAPER

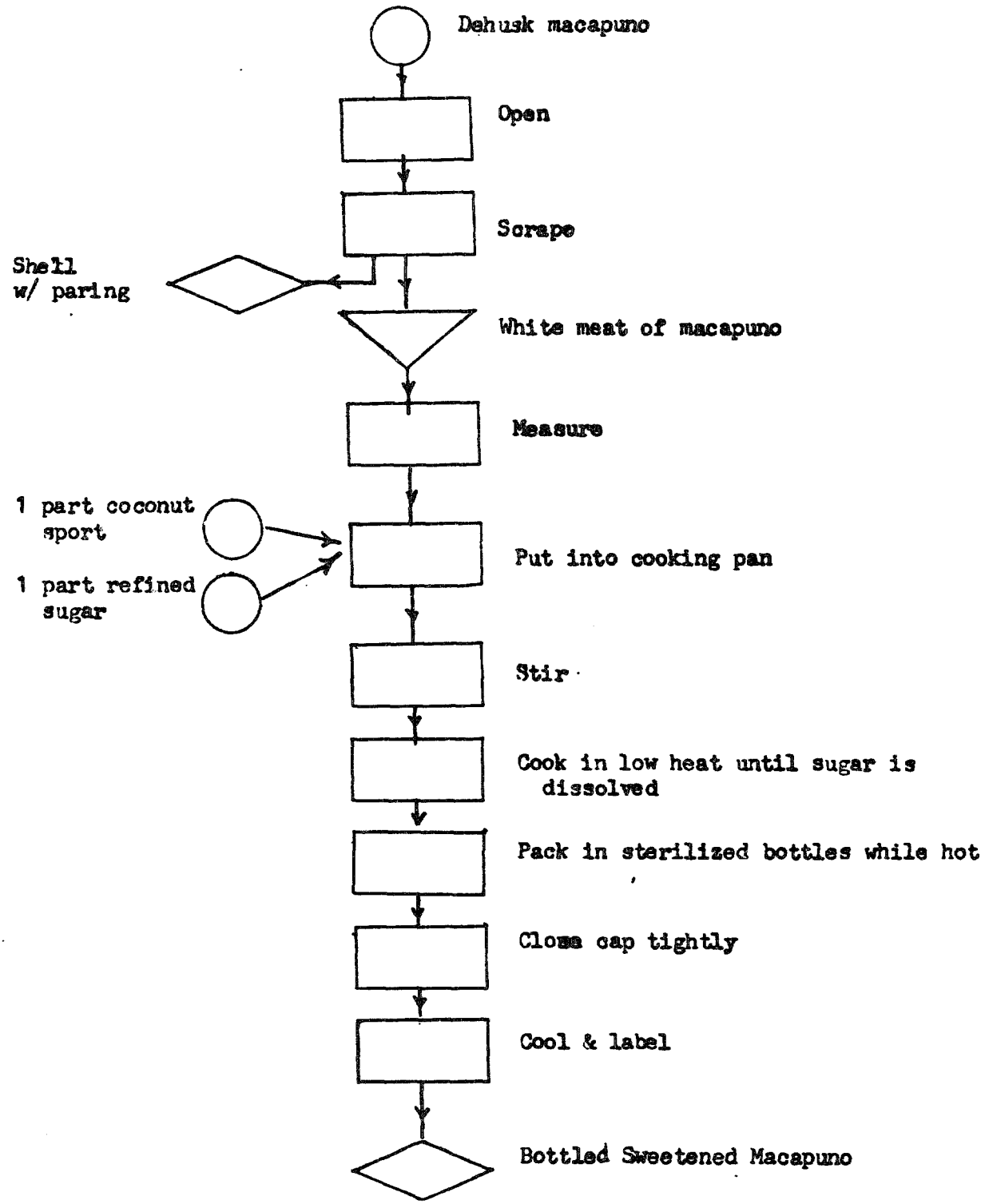
4.2 Ingredients : -

1 part coconut sport to 1 part sugar

4.3 Cost of equipment : - ₱ 100 = US$ 13.98

5. Process

5.1 Process flow diagram :



5.2 Process description

Dehusk macapuno. Open the nut. Scrape off white creamy meat using young coconut scraper. Measure the white meat. For every part of macapuno meat add a corresponding amount of refined sugar. Put the mixture is a cooking pan. Stir to partially dissolve sugar. Cook in low heat until sugar is totally dissolved (this takes approximately 30 minutes if only 1 nut is being cooked) Hot pack in sterilized bottle. Close cap tightly. Cool & label.

6. Quality of the finished product

It is a dessert product very similar to young coconut meat but has a very soft jelly - like endosperm .

7. Source of information : -

Food Research & Development

Philippine Coconut Authority
Diliman, Quezon City
Philippines.

Product code : CCCN 08/01
Technology sheet no. V /15

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT CHIPS
(Home industry)

2. Uses of finished product : - Snack item

3. Country of origin : - Philippines

4. Equipment

4.1 List of equipment :

Baking oven	1 unit
Potato peeler	1 dozen
Mixing bowl	1 large
Callander	1 large
Laddle	1 large
Tray	4 pcs. aluminum baking trays

4.2 Ingredients : -

6 mature coconuts (12 month old)
Soaking media ;

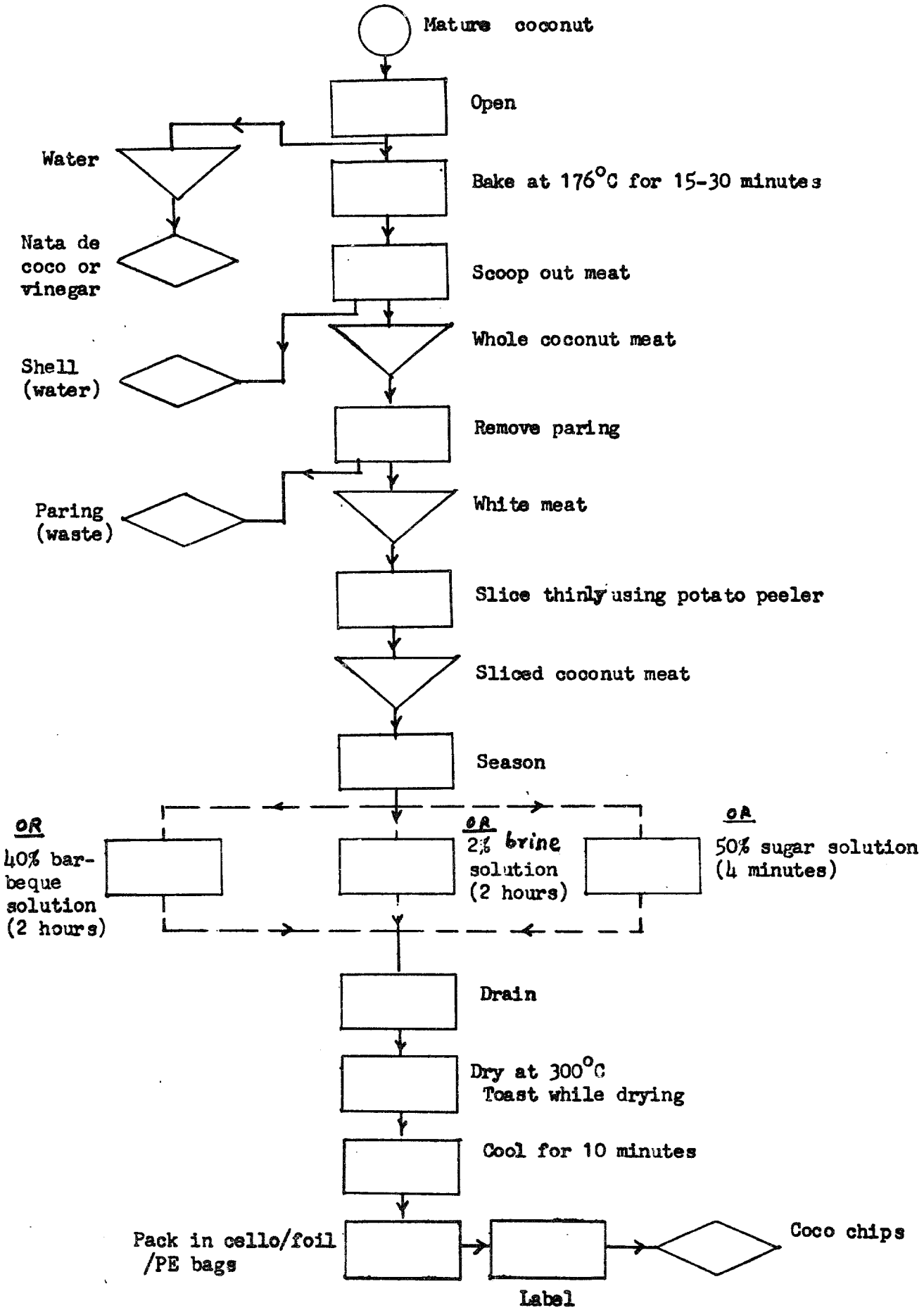
Sugar
Barbeque flavor
Salt

4.3 Capacity : - 6 Nuts every batch

4.4 Cost of equipment : - ₱2,190 = US$300.-

5. Process

5.1 Process flow diagram



5.2 Process description :-

Open 12 month old coconuts into two. Coconut water can be collected & be processed to produce coconut vinegar or nata de coco. Put the coconut inside the oven & bake at 176°C for 15 to 30 minutes or until the meat can easily be taken out of the shell. Scoop out the meat. Remove the paring using a sharp knive. Slice the white meat thinly with the use of a potato peeler, 2½" long. Season the sliced meat by soaking in the solution of desired flavoring :

Flavor	Concentration	Soaking time
Salt	2%	2 hours
Barbeque	4%	2 hours
Sugar	50%	4 minutes

The proportion of the soaking solution to the sliced coconut meat is 2 : 1. Drain in a collander for approximately 20 minutes. Spread thinly on a baking sheet & put in pre-heated oven (300°C). Toast while drying. Bake for 30 minutes or until desired brown color is obtained. Cool for 10 minutes. Pack in cello/foil/PE bags. Label.

5.3 Process flow diagram

1974 gms fresh sliced white meat from 6 coconuts

↓

987 gms coco chips

6. Quality of the finished product

It is a golden brown crunchy snack item with a criticial moisture content of 3 %.

7. Source of information :

Food Research & Development Division

Philippine Coconut Authority
Diliman, Quezon City
Philippines

8. Comment : -

This product is also being commercially produced by some desiccators in the Philippines. The meat is mechanically sliced & its moisture content is evaporated by passing through a conveyor type of dryer.

Product code : CCCN 20.05

Technology sheet no: V / 16

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
AND ASIAN AND PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for: - TUBO JAM FROM APPLE OF GERMINATED COCONUT (Home Industry)

2. Uses of finished product: - A nutritious dessert as well as a bread spread.

3. Country of origin: - PHILIPPINES

4. Equipment:

4.1 Description of equipment and ingredients:

Bowl for mixing	1 Kg of tubo
Pot	
Cooker	1 Kg of white sugar
Jars for packing	Vanilla flavouring

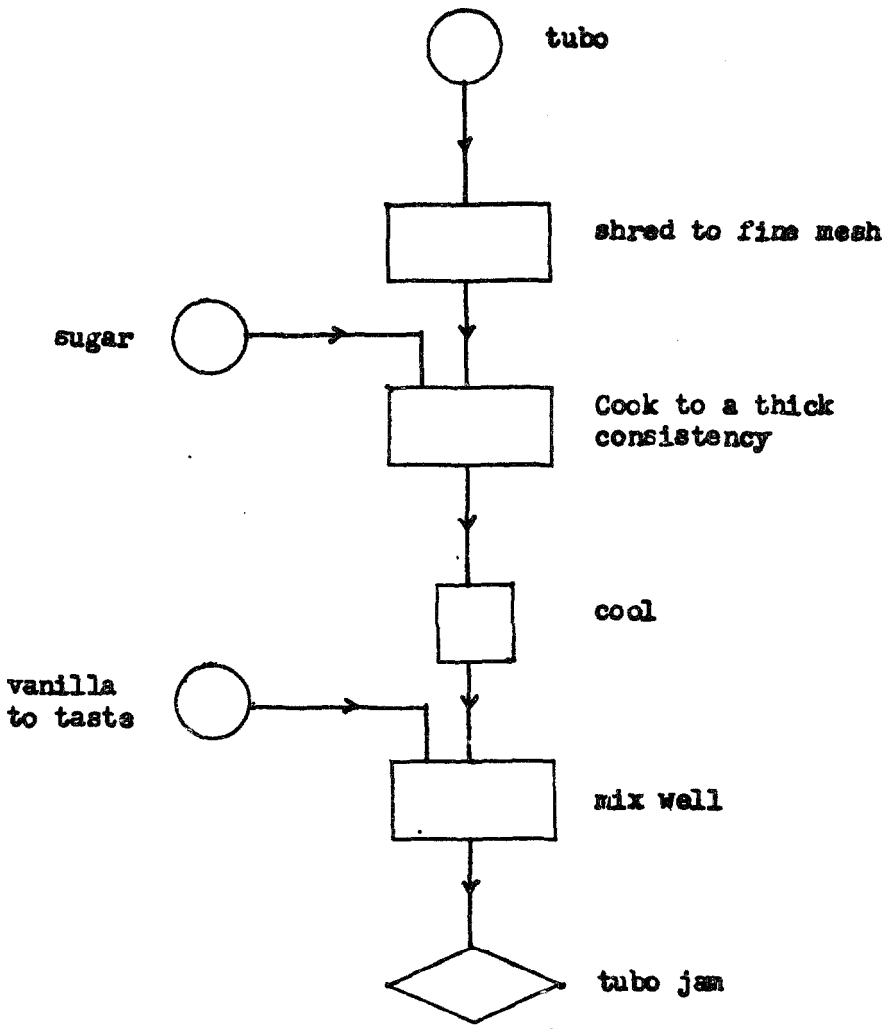
4.2 Materials for construction: - Not applicable

4.3 Cost of equipment: - About ₱ 100 (US$ 13.48)

4.4 Capacity: - About 1.25 Kg per batch.

5. Process

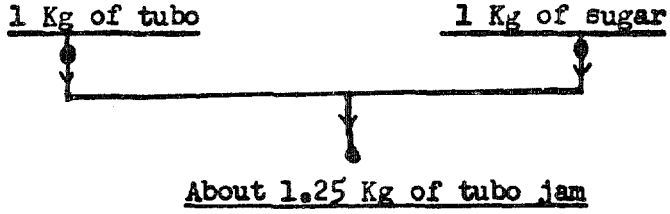
5.1 Process flow diagram



5.2 Description of process:

Take 1 Kg of clean tubo. Tubo is the apple (*hanstorium*) inside the coconut that has begun to germinate. Shred the tubo to a very fine mesh and add the sugar. Mix well while cooking to a sticky consistency. Allow to cool. Add vanilla to the desired taste and mix well. Pack into clean preserving jars, sterilize by boiling for 20 minutes and seal.

5.3 Product flow diagram



6. Quality of finished product:

The finished product does not contain any harmful ingredients and is suitable for edible purposes.

7. Source of information:

Philippine Coconut Authority
Diliman, Quezon City
Metro Manila
Philippines.-

P.M.A. 1979

Product code : CCCN 44
Technology sheet no. V / 17

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - DEHYDRATED COCONUT PITH & COCONUT PITH FLOUR (Terminal Bud or Cabbage) (Research & Development)

2. Uses of the product : - Culinary purposes

3. Country of origin : - PHILIPPINES

4. Equipment : -

4.1 List of equipment

Cabinet dryer	:	locally fabricated
Grinder	:	Almeda rice/corn grinder
Steamer	:	Standard equipment
Pail	:	1" high, plastic
Knives	:	3 Pieces
Collander	:	Plastic
Plastic sealer	:	Standard equipment

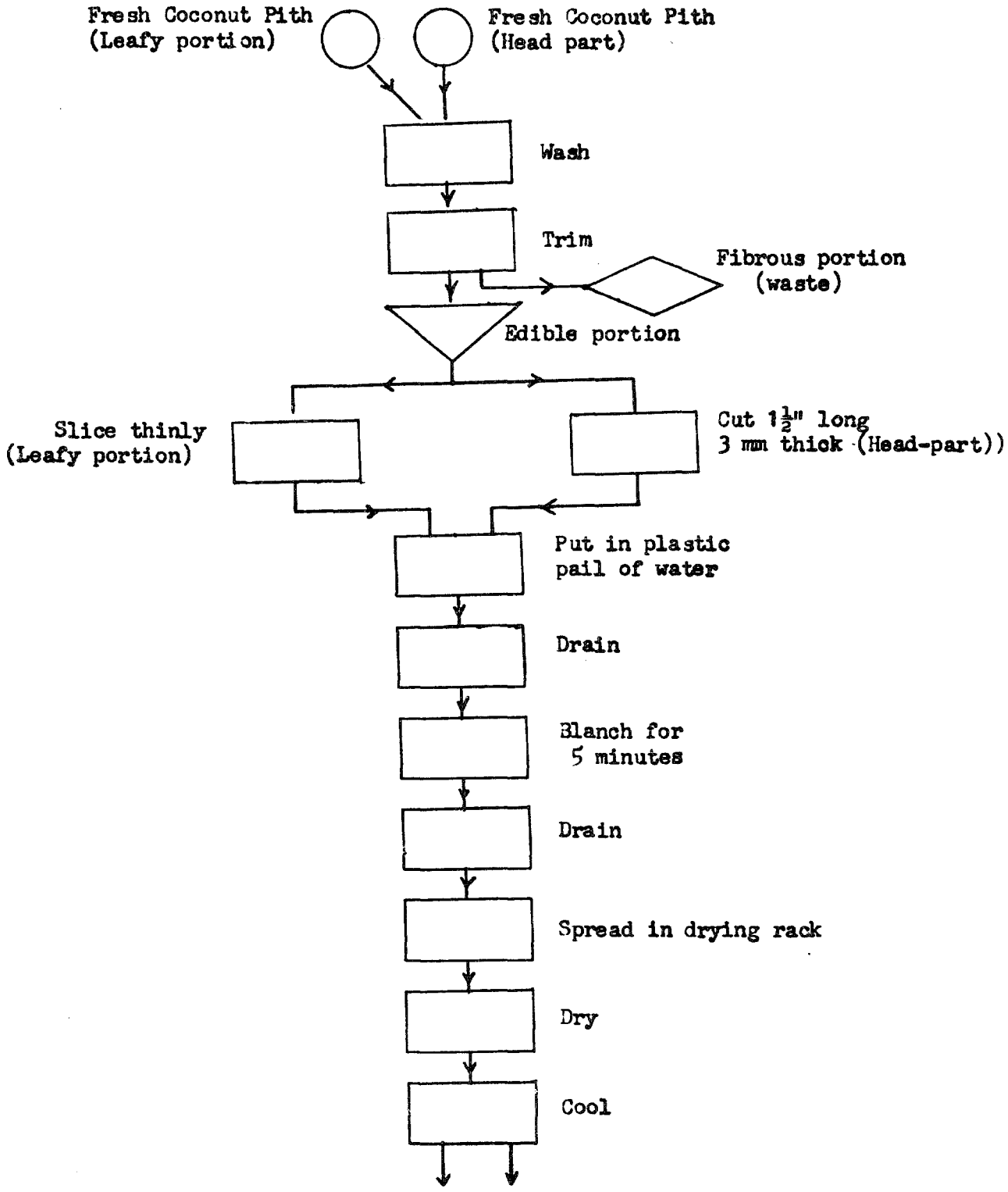
4.2 Materials for construction :

Cabinet dryer

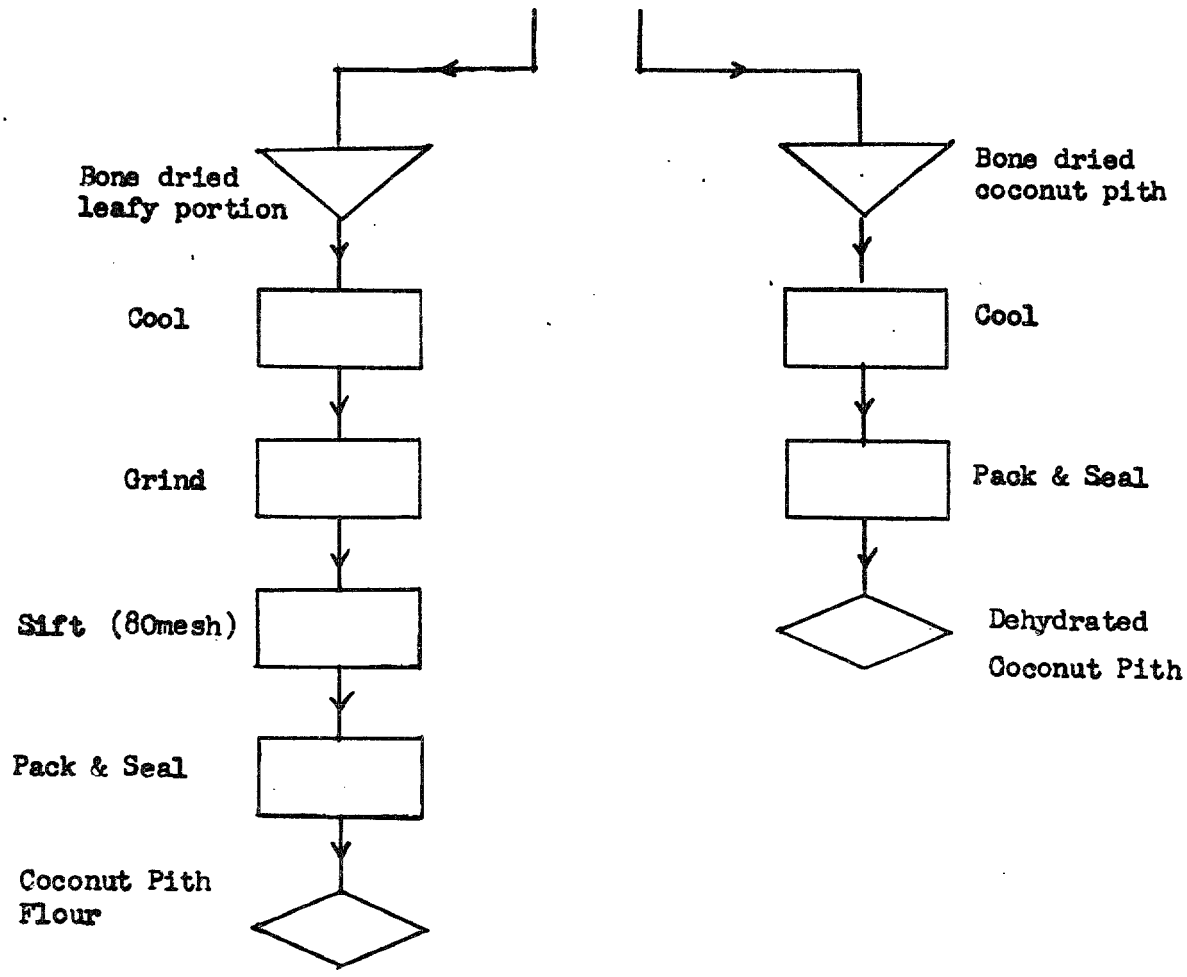
4.3 Cost of equipment : $200

4.4 Capacity : 5 Kg raw coconut pith/batch

5.1 Process flow diagram : -



3.


Bone dried leafy portion
Cool
Grind
Sift (80mesh)
Pack & Seal
Coconut Pith Flour
Bone dried coconut pith
Cool
Pack & Seal
Dehydrated Coconut Pith

5.2 Process description : -

Wash thoroughly head part or leafy portion of fresh coconut pith. Remove rough, highly fibrous portion.

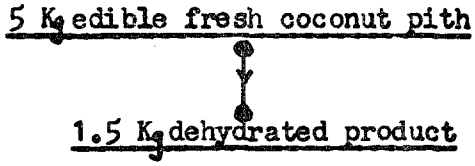
Cut the edible portion 1½" long & 3 mm thick (head part) or slice thinly (leafy part) & put them in a pail of water to prevent browning of the pith. Drain in a collander. Blanch in boiling water for 5 minutes. Drain.

Spread thinly the blanched coconut pith on the drying rack of the cabinet dryer. Dry at 100 - 120°F for approximately four hours or until the product becomes bone-dry.

Cool head part. Pack in polyethylene bags & seal.

Alternatively if the end-product is ubod flour, cool the bone dried leafy portion, grind, sift using 80 mesh sieve.
Pack & dry.

5.3 Product flow diagram : -



6. Quality of the finished products : -

Dehydrated coconut pith strips are bone dry & cream colored. Its rehydration capacity is 4.9. Rehydrate by boiling for 10 minutes.

Ubod flour is a high fiber, highly hygroscopic wheat flour extender.

7. Source of information : -

Food Research & Development Division

Philippine Coconut Authority
Diliman, Quezon City,
Philippines.-

8. Comment : -

There has been no research activity undertaken before to preserve coconut pith since one has to kill the tree in order to get the pith. However, a lot of coconut pith will be avialable in the Philippines starting the middle part of 1980 when the Philippine Coconut Authority starts its' 20-year nationwide re-planting programme.

Recommendation : -

If the product is to be commercially produced the use of mechanical cutter & commercially available forced-draft oven are highly recommended.

Product code : CCCN 15.07 1
Technology sheet no: F / 18

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/C49)

1. Technology sheet for: - COOKING OIL USING FRESH MATURE COCONUT (Traditional home industry)

2. Uses of finished product: - Home cooking oil is used by the rural population in remote coconut areas as edible oil. This is being rapidly replaced by industrially processed and refined oil.
By product - residue used as chicken feed.

3. Country of origin: - PHILIPPINES

4. Equipment:

4.1 Description of equipment:

Grater
Pots and pans
Strainer
Glass container
Cooker or fire place

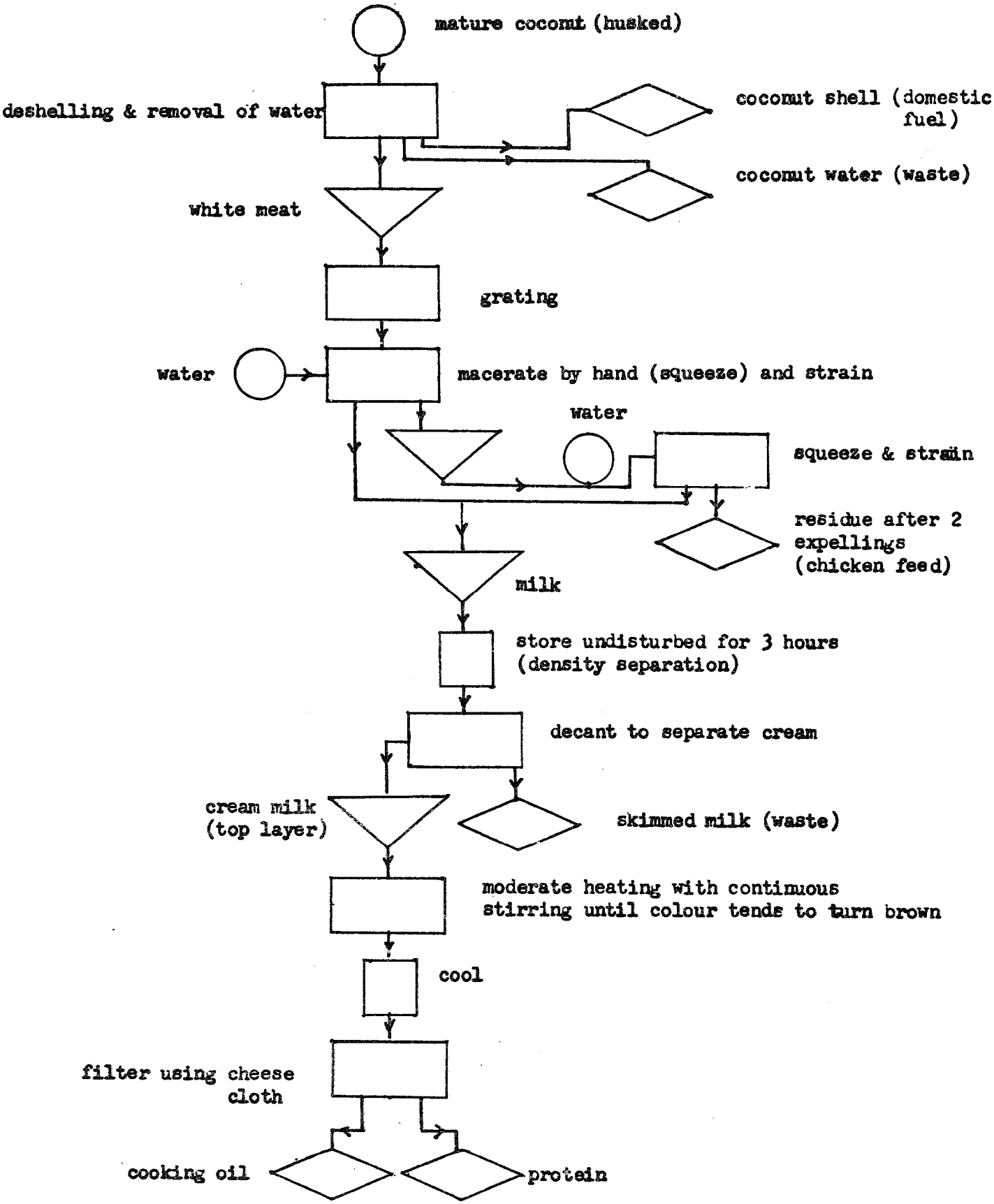
4.2 Materials for construction: - Not applicable

4.3 Cost of equipment: - About ₱ 100 (US$ 13.48)

4.4 Capacity: - Nominal capacity per family engaged for 10 hour working day is estimated at 20 Kg oil.

5. Process

5.1 Process flow diagram:

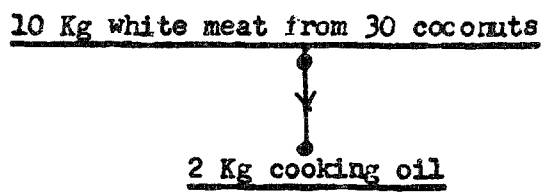


5.2 Description of process:

The husked nuts are deshelled and water allowed to run out to waste. The white meat is grated and fresh water added. After macerating by hand, the milk is squeezed. The first residue is treated similarly for a second expelling. The milk is collected into a large glass container and allowed to stand undisturbed for 3 hours. The cream milk settles at the top while the skim milk comes to the bottom. Separate the top layer by decanting or by gravity separation if there is an outlet and tap at the bottom of the container.

The cream is transferred to a pan and heated gently with continuous stirring to avoid burning the protein content. Burning of the protein can be observed when it turns from white to brown colour. When the protein is just beginning to turn brown, stop heating and let the oil cool down. Filter the oil on a cheese cloth. The protein will be retained on the filter whilst the clean white cooking oil will collect into the container.

5.3 Product flow diagram:



6. Quality of finished product:

Analysis of coconut oil not available, the oil has been used by the rural population as edible oil for generations.

7. Source of information:

Philippine Coconut Authority
Diliman, Quezon City
Metro Manila
Philippines.

Product code : CCCN 15.07 1
Technology sheet no: V / 19

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COOKING OIL ("KLENTIK OIL") USING FRESH MATURE COCONUT - METHOD A (Traditional home industry)

2. Uses of finished product : - Cooking oil is used by the rural population in coconut areas. By-products:- The cake is rich is protein. It is mixed with sugar and eaten as sweet meat. The residue of white meat is used as chicken feed.

3. Country of origin : - INDONESIA.

4. Equipment

4.1 Description of equipment

Kitchen knife for splitting nut and deshelling.
Thick metal sheet with serrations for grating.
Pots, pans and strainer.
Traditional fireplace or Kerosene cooker (2 Units)
Funnel, deep spoons, empty bottles for oil.

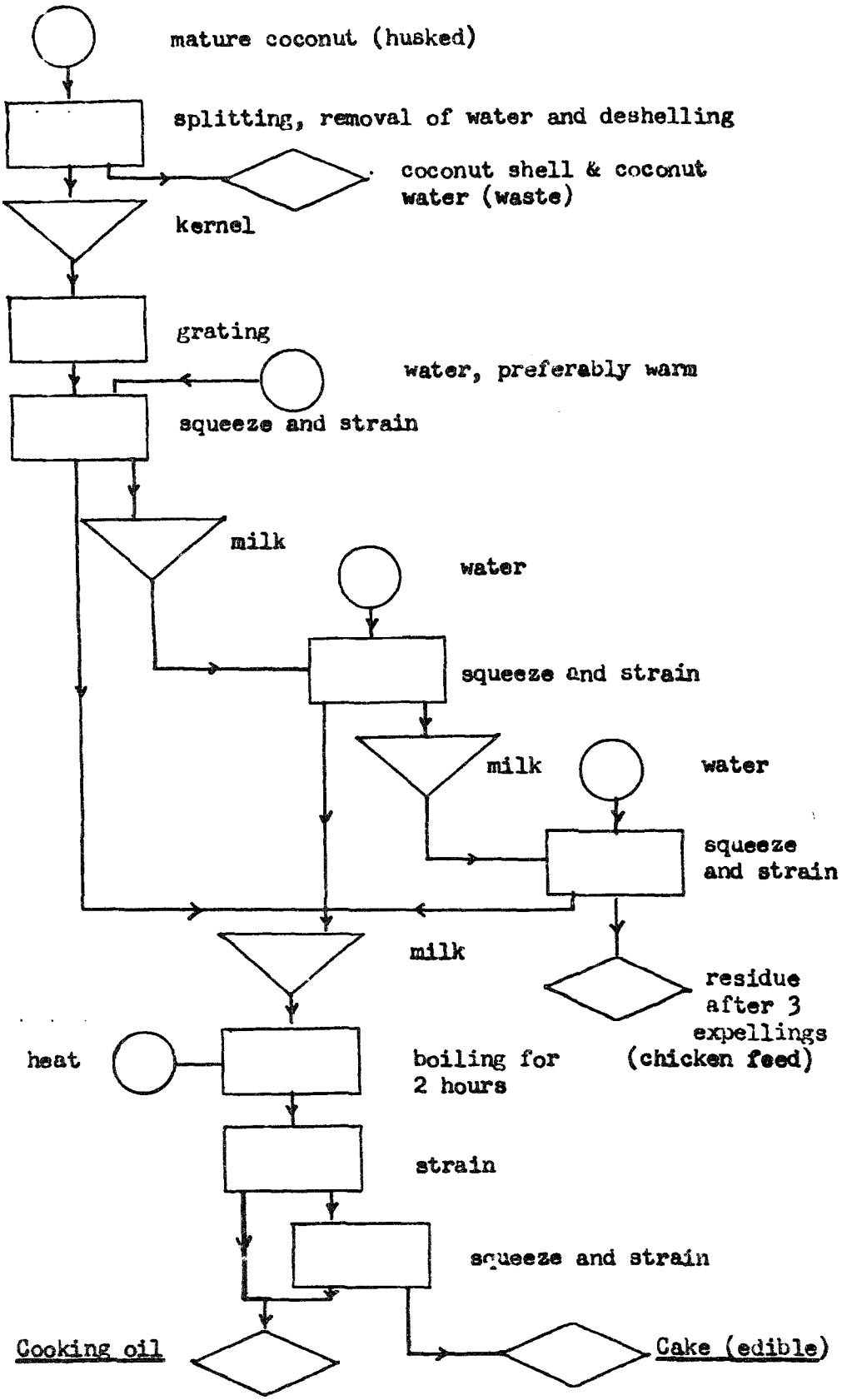
4.2 Materials for construction : - Not Applicable.

4.3 Cost of equipment : - About Rp 15,500 (US$ 25)

4.4 Capacity : - Nominal - say 100 coconuts giving about 15 litre of oil per working day for one family.

5. Process : -

5.1 Process flow diagram : -



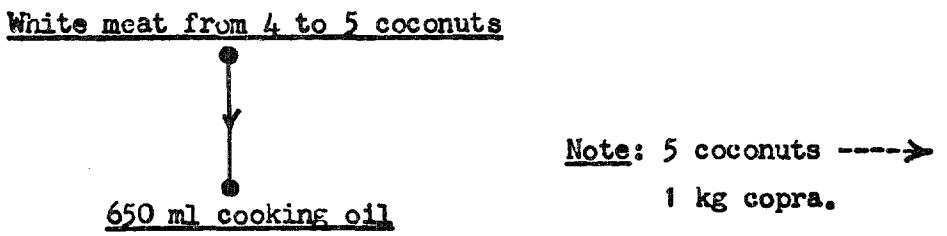
5.2 Description of process : -

The coconut is cracked using the kitchen knife and as the husked nut splits in two, the water runs out. The kernel is forced out of the shell. The white meat is then grated by moving the pieces against a serrated metal plate by hand.

Water (preferably warm) is added to the white meat and then squeezed by hand. The milk is strained using a kitchen strainer. The residue is similarly treated for two more expellings. The milk from all 3 expellings is collected together into a large pan and cooked (boiled) over the fire for two hours until all the water has escaped. The contents are strained to remove any residue which passed through the earlier strainers and the oil is collected. The brown coloured cake left in the strainer is squeezed by hand to extract more oil.

The cake after expelling oil is rich in protein. It is eaten as sweet meat after mixing with sugar. The residue is used as chicken feed.

5.3 Product flow diagram : -



6. Quality of finished product : -

Analysis of oil not available. However, this is one of the traditional methods for preparation of cooking oil and has been consumed by rural population for generations. The oil is coloured light yellow. The characteristic odour and flavour is desired by the people.

7. Source of information : -

Observations during field visit to East Java.

T.K.G.R. 1979.

Product code : CCCN 15.07 1
Technologh sheet no: V / 20

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COOKING OIL ("KLENTIK OIL") USING FRESH MATURE COCONUT-METHOD B (Small Scale industry).

2. Uses of finished product : - The cooking oil is used by the rural and urban population in coconut areas.
The cake is used as (a) cattle feed, (b) other animal feed after further processing or (c) exported for use as animal feed.

3. Country of origin : - INDONESIA

4. Equipment

4.1 Description of equipment : -

4.1.1 Cutter : - Two units of locally manufacutured rotary knife cutters to reduce the kernel into small particles.

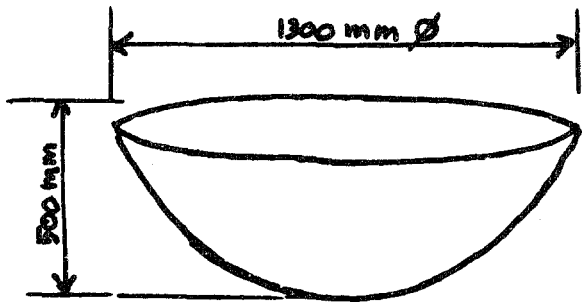
4.1.2 Cooking utensils : -
6 Units cooking pans.
6 Half barrels with strainers.
2 Stirrers.
2 Pouring devices
2 Sieve strainers.

These utensils are locally made. See page 2 for sketches and other details.

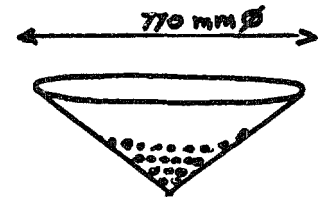
4.1.3 Fire place : - 6 units for heating the 6 cooking pans.

4.1.4 Expellers : - 4 units small expellers, Handar type. These are of Japanese design with capacity 120 kg/hr copra basis.

2.

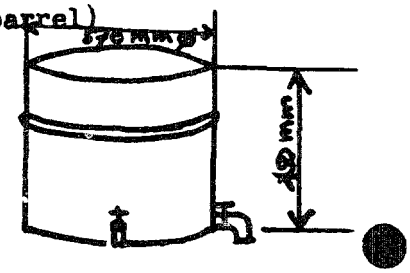


Steel cooking pan (300 litre)

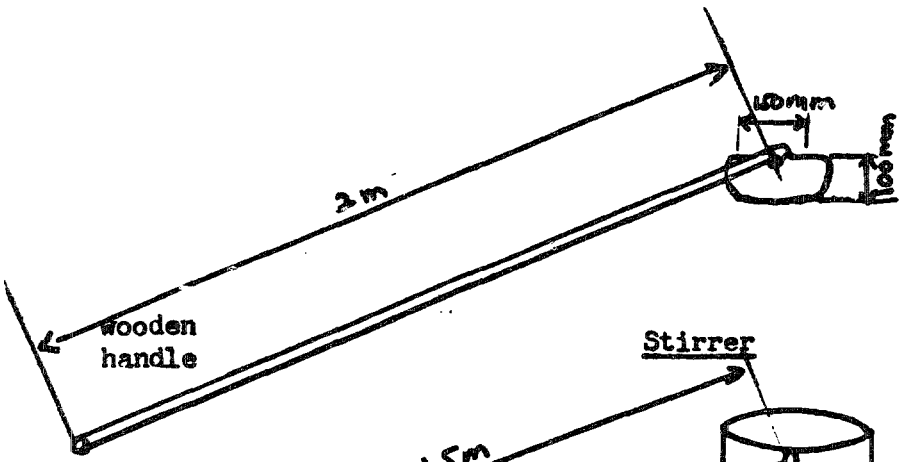


Strainer

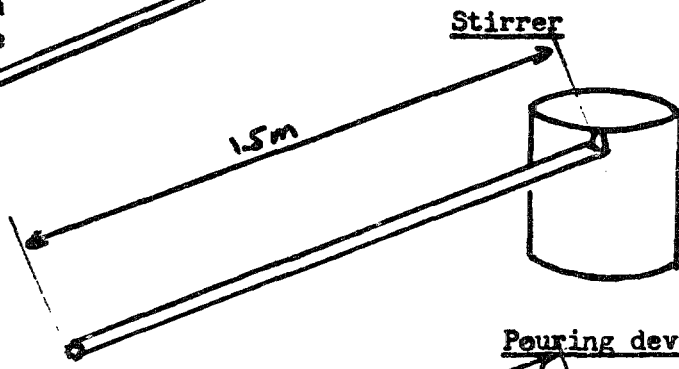
(To be placed on barrel)



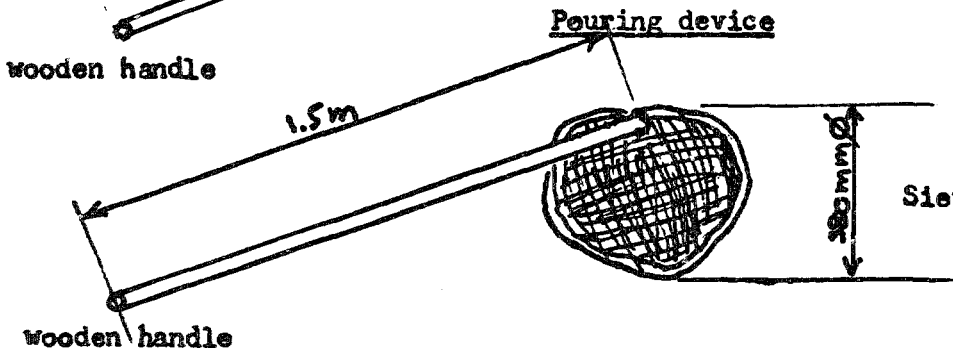
Half barrel (with two outlets)



Steel blade



2 litre capacity



Sieve of BSS 10

Sieve Strainer

4.1.5 Oil Sump : - Oil collection tank of 3000 litre capacity which can hold about 2.5 Tonne of oil.

4.1.6 Oil Pump : - for pumping oil from the sump to the overhead tank.

4.1.7 Overhead oil tank : - This has a capacity of 2.5 Tonne.

4.1.8 Other items : - such as weighing machines, piping etc.

4.2 Materials for construction : -

The building requirement is about 1000 square meter (About 10,000 square feet).

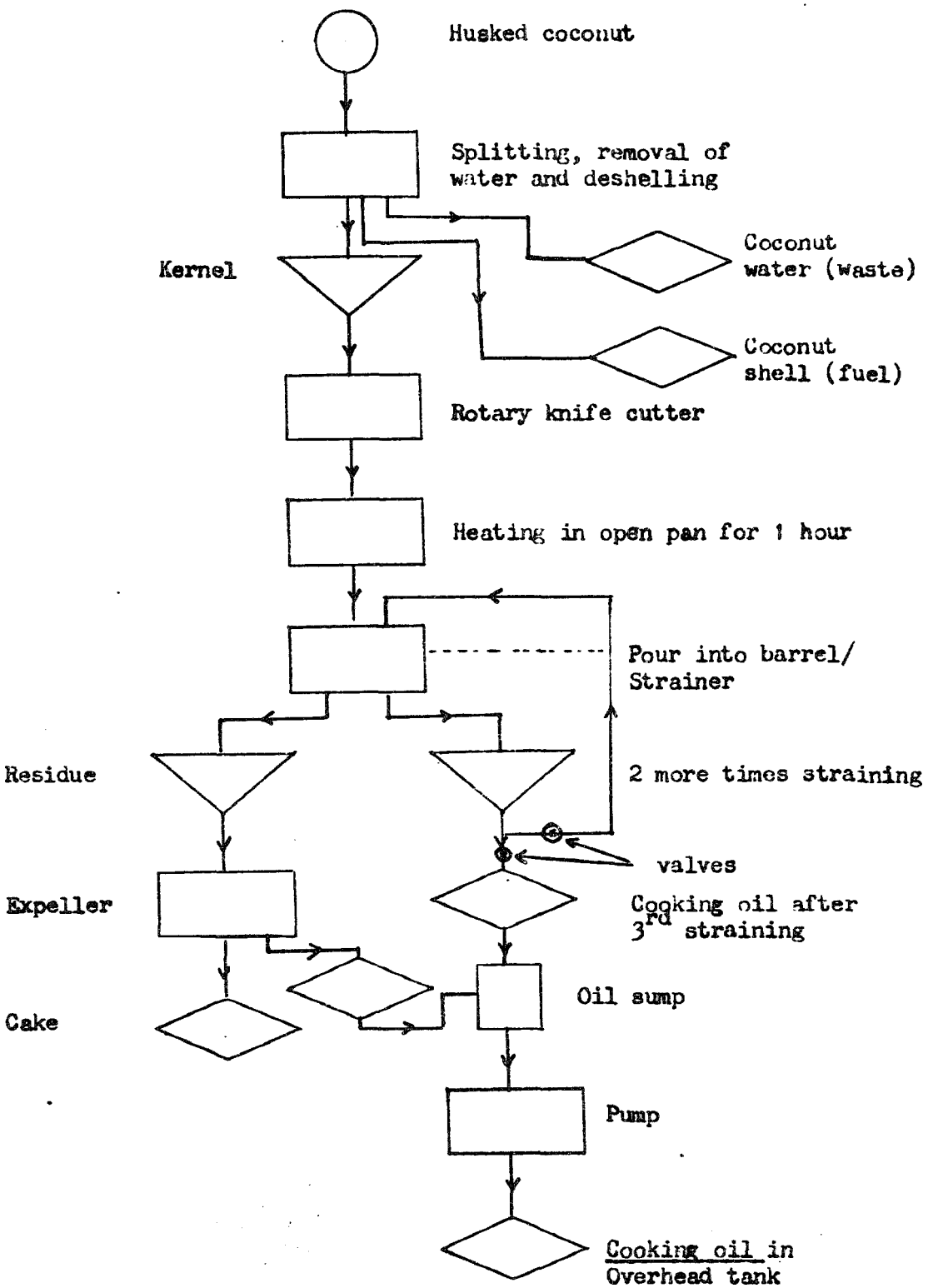
4.3 Cost of Equipment and construction : -

Cost of equipment	- Not available
Cost of Installation	- Not available
Cost of building (1000 m^2)	- Not available

4.4 Capacity : - Capacity of the plant for 8 hour working day is 25000 nuts giving 3 Tonne cooking oil.

5. Process : -

5.1 Process flow diagram : -



5.2 Description of process : -

Fresh mature husked coconuts are purchased on a quantity basis regularly.

The nuts are cracked, dewatered and kernel removed from the shell.

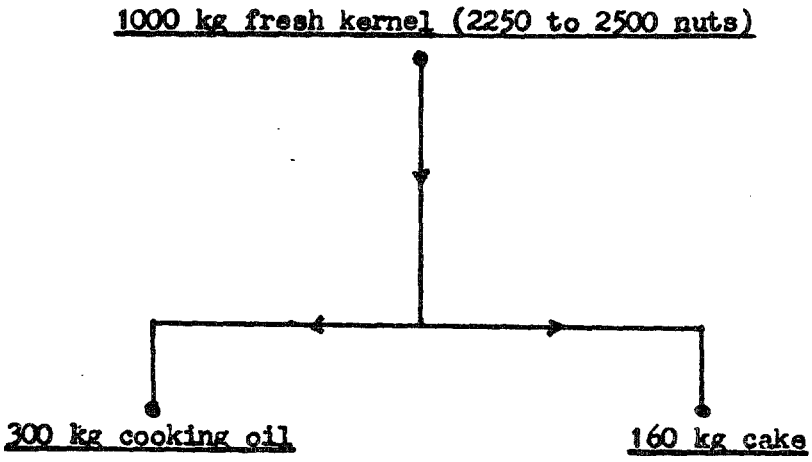
The kernels are manually elevated to a wooden loading platform above the two cutting machines and then fed into the machines at a regular rate. The coconut coming out of the cutter is similar to the manually grated coconut.

About 70 kg of cut kernel is loaded into each pan and heated for one hour until all the water has escaped. The fire is obtained from firewood logs. Sometimes the raw coconut shells are used for firing. In this case the fuel requirement just balances the shells separated. During the heating process the pans are stirred now and then. What is left in the pan is coconut oil and brown coloured cake. Each half barrel with strainer is placed adjascent to one cooking pan with one outlet returning the oil into the pan. Using the sieve strainer the cake soaked with oil is loaded onto the strainer of the barrel. The soaked oil strains and collects in the barrel while the cake remains on the strainer. The cake is then removed for expelling using the screw type small expellers. The oil (and some cake) in the barrel is returned to the pan and this straining procedure repeated two more times. The oil collected in the barrel after the 3rd straining is discharged into the oil sump through a piping arrangement by gravity flow.

The oil coming out of the expellers is also allowed to flow into the same oil sump by gravity through a piping arrangement. At the pipe outlet into the sump a sieve strainer is fixed to trap any cake in the oil.

The oil is pumped into the overhead tank the following day. This allows any cake particles still mixed with the oil in the sump to settle at the bottom. The cake left at the bottom of the oil sump is then collected for recycling in the expellers.

5.3 Product flow diagram : -



6. Quality of finished product : -

Analysis of oil not available. However, this is one of the traditional methods for preparation of cooking oil and has been cosumed by rural population for generations. The oil is coloured light yellow. The characteristic odour and flavour is desired by the people.

7. Source of information : -

Observations during field visits to West Sumatra and North Sumatra provinces of Indonesia.

T.K.G.R 1979.

Product code : CCCN 15.07 1
Technology sheet no: V / 21

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COOKING OIL ("BACING OIL") USING FRESH MATURE COCONUT - METHOD C (Traditional home industry).

2. Uses of finished product : - Cooking oil is used by the rural population in coconut areas as edible oil. Due to the dangers of the decaying action and rancidity, this method is being done away with. However, steaming the grated coconut is an interesting technique in promoting the release of oil from the white meat. By product - residue used as chicken feed.

3. Country of origin : - INDONESIA

4. Equipment

4.1 Description of equipment

Kitchen knife for cracking nut and deshelling
Thick metal sheet with serrations for grating
Pots, pans, and strainer
Steamer (kitchen type)
Traditional fireplace or Kerosene cooker
Funnel, deep spoons, and empty bottles for oil.

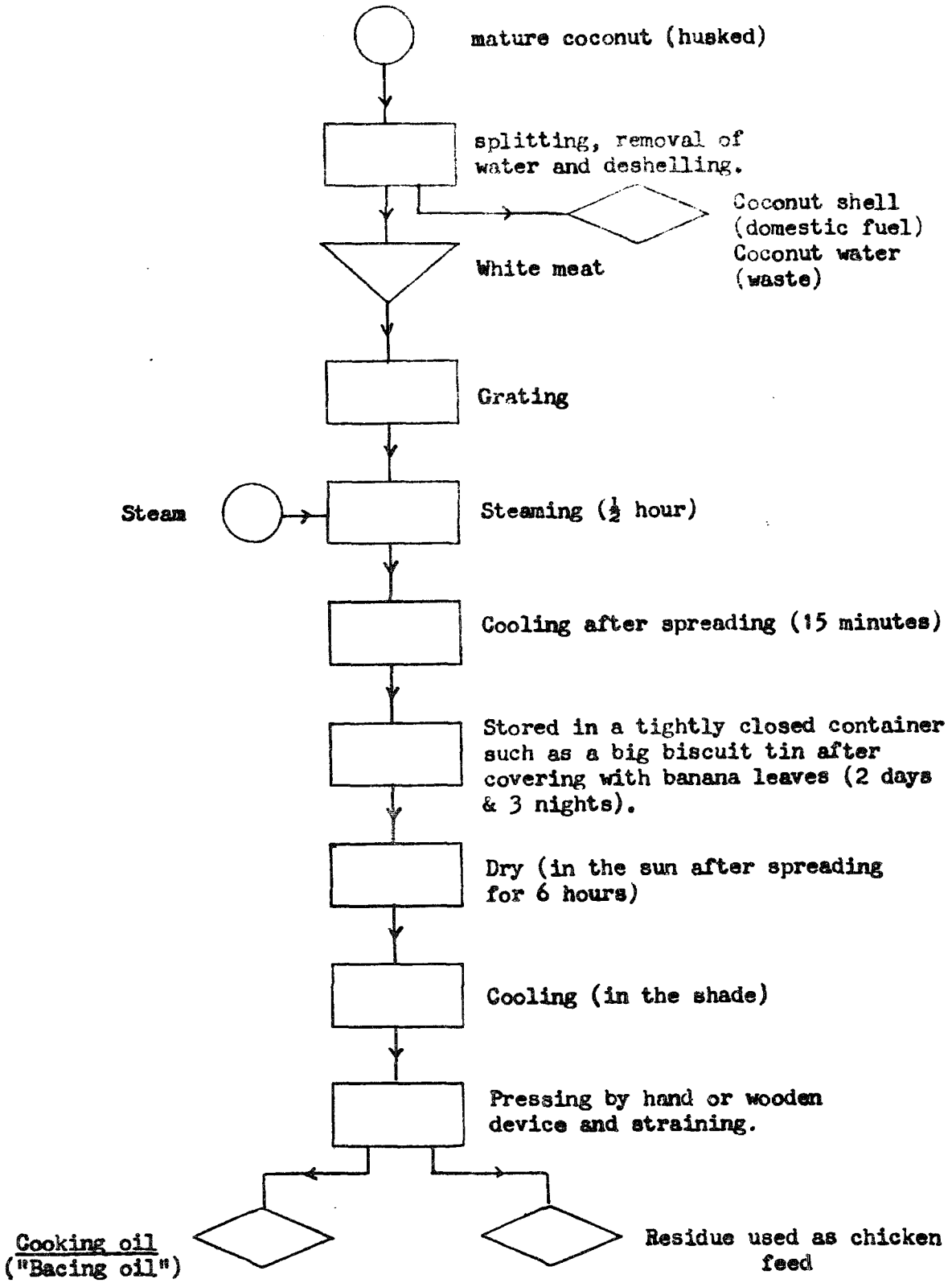
4.2 Materials for construction : - Not Applicable.

4.3 Cost of equipment : - About Rp. 18,500/- (US $ 30).

4.4 Capacity : - Nominal - say 100 coconuts giving about 15 litre of oil per working day for one family.

5. **Process** : -

5.1 Process flow diagram : -



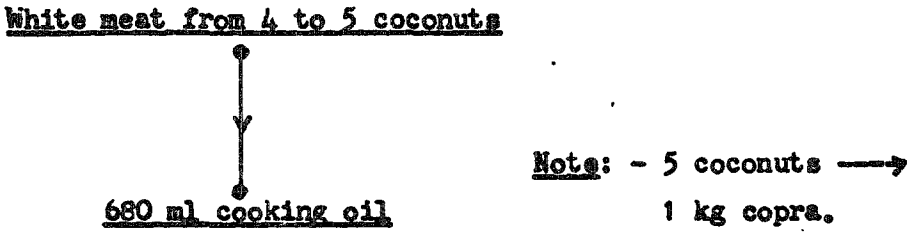
5.2 Description of process : -

The coconut is cracked using the kitchen knife and as the husked nut splits in two, the water runs out, and the kernel forced out of the shell. The white meat is then grated by moving the pieces against a serrated metal plate by hand.

The steamer is filled with grated coconut and heated for half hour. Thereafter, the steamed coconut is allowed to cool for 15 minutes by spreading evenly on banana leaves. After cooling, the coconut is packed into a metal tin such as large biscuit tin, using banana leaves as a lining. The tin is closed firmly and left for 3 nights and 2 days. During this period decaying takes place by bacterial action. Thereafter the contents are dried in the sun after spreading evenly for 6 hours on the 3rd day. After drying, the material is cooled under the shade.

It is then pressed by hand or by the use of a wooden device to expell the oil. The residue is used as chicken feed.

5.3 Product flow diagram : -



6. Quality of finished product: -

Analysis of oil not available. However this is one of the traditional methods for preparation of cooking oil and has been consumed by rural population for generations. The oil is coloured light yellow. The characteristic odour and flavour of the oil is desired by the people.

Due to the bacterial action causing the decay of the white meat, the product can cause stomach disorder. The high FFA content would also bring about similar adverse effects. This method therefore is

being done away with gradually. However, steaming the grated coconut is an interesting technique in promoting the release of the oil from the white meat.

7. Source of information : -

Investigations during field visit to East Java Province. This process is traditionally practiced in the Centra Java Province.

T.K.G.R. 1979.

Product code : COCN 15.071
Technology sheet no. V / 22

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT AQUEOUS PROCESSING - Hagermaier pilot plant of Philippines

2. Uses of finished product : - Beverage, baked products, meat extender

3. Country of origin : - PHILIPPINES

4. Equipment : -

4.1 Description of equipment :

Specifications for processing equipment are designed to produce sanitary protein end-product, with the versatility to prepare the main product either as a spray-dried powder or as an intermediate moisture syrup.

The indication "stainless steel" means that the material of construction should be stainless for those parts of the equipment which come into contact with the product. Other alloys may be used where stainless steel is not suitable, but these other alloys should never be copper or brass, because of their propensity to catalyze degradation of the oil.

The designation "sanitary design" means the equipment should be polished and so designed as to minimize dead spaces, where the product can hang on and stagnate. The equipment should be designed instead, so that any new product entering into the machine will displace the old product already inside.

Only one unit of each item is required unless otherwise stated.

Motor sizes are given in metric units, where 1 hp equals 0.75 kw.

Please note that only important equipment are included in the list.

Equipment for the receiving Section : -

Weighing scale for truck	:	Two units automatic weigh punch-out, drive on type. About 15,000 Kgs. capacity.
Conveyor	:	Three units, approximate dimensions: lift 4 meters, width 30 cm, length 20 meters, speed 20 m/min, 1 kw. motor, about 25 tons/hr capacity.
Yard Vehicle	:	1 unit, three ton capacity, with fork lift.

Meat Preparation Equipment :

Meat Preparation	:	1.5 meters wide, consisting of storage space for 100 nuts, a shelling & paring bench and space for accumulation & manual collection of shells. Stations are joined side-by-side to form two rows of 50 stations each.
Belt conveyor system	:	Through-put capacity about 6.5 tons/hr or 210 nuts/ min. Belt speed about 30 meters/min, width 15 m, length 85 meter with negligible incline, motor 0.5 kw. This is used for carrying whole kernels away from paring benches to the cutter.
Shelling tools	:	300 pieces standard equipment
Paring tools	:	300 pieces standard equipment
Cutter	:	Sanitary design. Stainless steel with 1 kw motor to reduce kernels approximately in quarters.
Conveyor	:	5 ton/hr. Through-out capacity, 12 cm longest dimension with semi-automatic weighing device, 40 cm conveyor width, length 30 meters. Rise 6 meters, motor 0.5 Kw. Sanitary design.

Extraction Equipment :

Wedge-and-die-plate mill	:	Through-put capacity 5 tons/hr; 33 mm oil-plate holes. Cutter blade speed 2,900 rpm, motor 45 Kw. Die-plate areas about 4,000 cm^2. Stainless
Disc attrition mill	:	Through-put capacity 5 tons/hr. The grinding disc should rotate about 1,800 rpm. Stainless steel. Sanitary design.

Mixer 1 : Continuous, cylindrical mixer with vertical axis. Seed material consists of 5 tons/hr. of comminuted meat and 3 tons/hr of diluted milk mixing chamber 1.2 m inside diameter & stand 4.4 m tall, 5 cubic meters capacity. Ribbon type agitator rotates at 15 rpm powered by 5 kw. rating. Stainless steel sanitary design.

Mixer 2 : Cylindrical mixer similar in design to mixer 1 except that it should be smaller & be equipped with a horizontal screw-conveyor to extract the mixed material from the bottom of the mixing chamber. The mixing chamber has 0.8 meter inside diameter & stand 4 meters tall, 2.0 cubic meters capacity & powered by 5 kw motor. Stainless steel. Sanitary design. Insulated to limit temperature drop to $5^{\circ}C$.

High-pressure screw press : 4.1 MT/hr input capacity, compression ration of about 12; 8 rpm screw speed & 10 kw motor, Stainless steel. Sanitary design.

Hammer-mill : 1 ton/hr through-put capacity.

Equipment for Liquid Processing :

Vibrating screen : 1.3 m^2 screen area, 150 mesh, 6 kw motor, Stainless steel. Sanitary design.

Holding tanks : 3 units, each equipped with a low-speed mixer, 0.5 kw motor.

Total capacity, 3,600 liters

Evaporator : Total evaporative capacity % 3.5 to 4.0 MT of water per hour, 4 to 5 MT/hr rate of evaporation.

Spray dryer for dehumidifier : Product feed rate of 0.8 MT/hr of concentrated coconut skim milk containing 55% moisture, air outlet $70^{\circ}C$. Stainless steel. Sanitary design.

Spray dryer for Cocotein : 130 kg/hr. feed rate. Production rate is 50 kg/hr. $70^{\circ}C$ outlet air temperature. Stainless steel, Sanitary design.

4.

Auxiliary Equipment :

Elictrical generator: 600 Kw output capacity; diesel-powered w/ diesel - fuel storage tank - 5 50,000 liters capacity.

Steam boiler : Shell-fired. 5,000 kg/hr of steam. 10 atmosphere operating pressure.

Air compresser: : 10 cubic feet per minute of air, with a pressure of 7 atmospheres.

Water softener : resin type, through - put capacity of 1,000 liters/hr

Water-cooling tower : 85 metric tons/hr, through-put capacity 50°C inlet temperature & 30°C cool water temperature.

4.2 Materials for construction :

Buildings	₱ 4,000,000	US$ 547,945.20
Materials for electrical installation	700,000	95,890.41
Piping, values and fittings	350,000	47,945.20
Concrete substructures & foundations	50,000	6,849,31
Miscellaneous installation & construction materials	200,000	27,397.20
	₱ 5,300,000	US$ 711,409.36

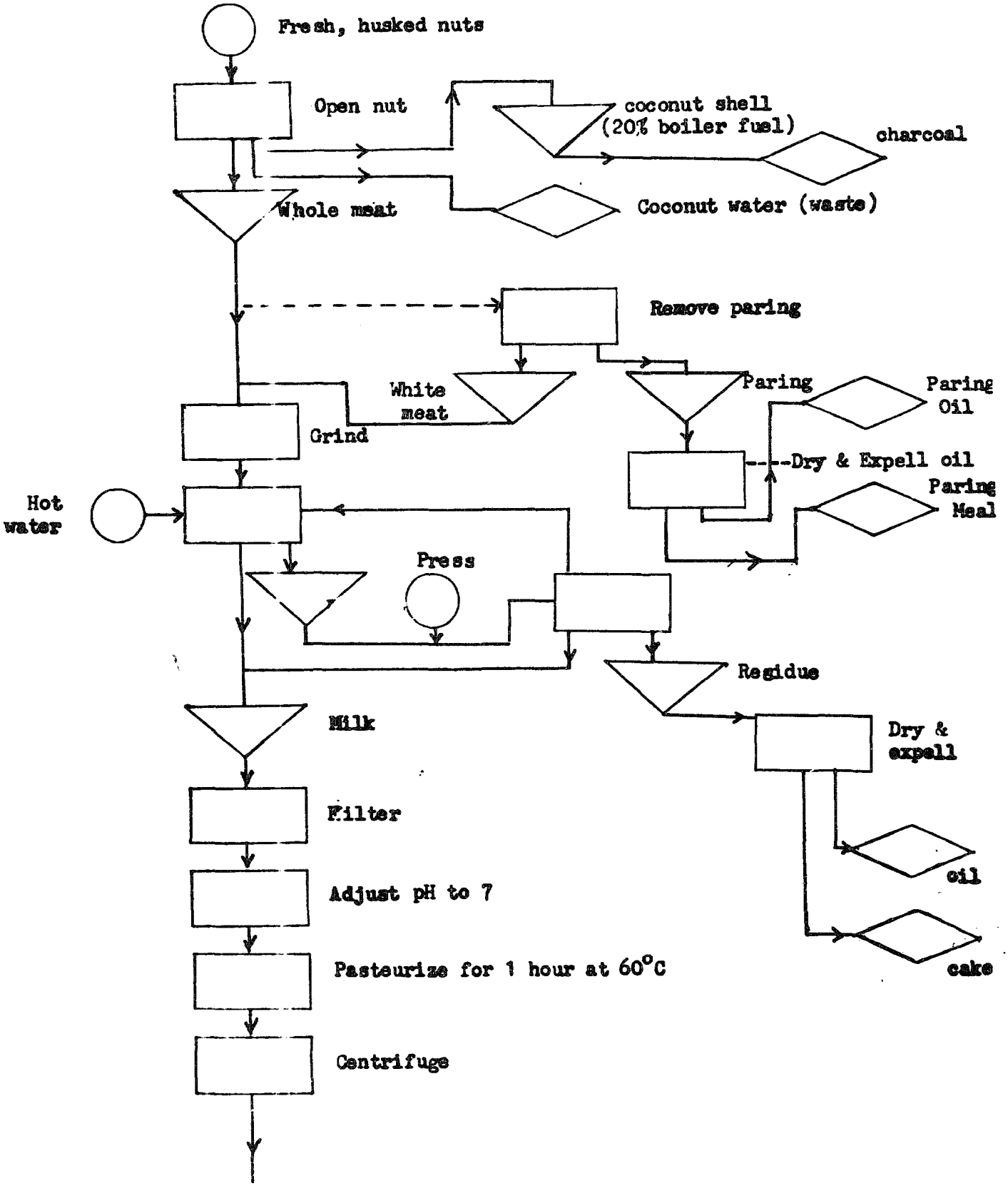
4.3 Cost of Equipment : : ₱ 17,000,000
US$ 2,281,879.19

Please note that prices given are supplies prices as of April 1977. Currency exchange rate used was US$1.00 to ₱ 7.45.

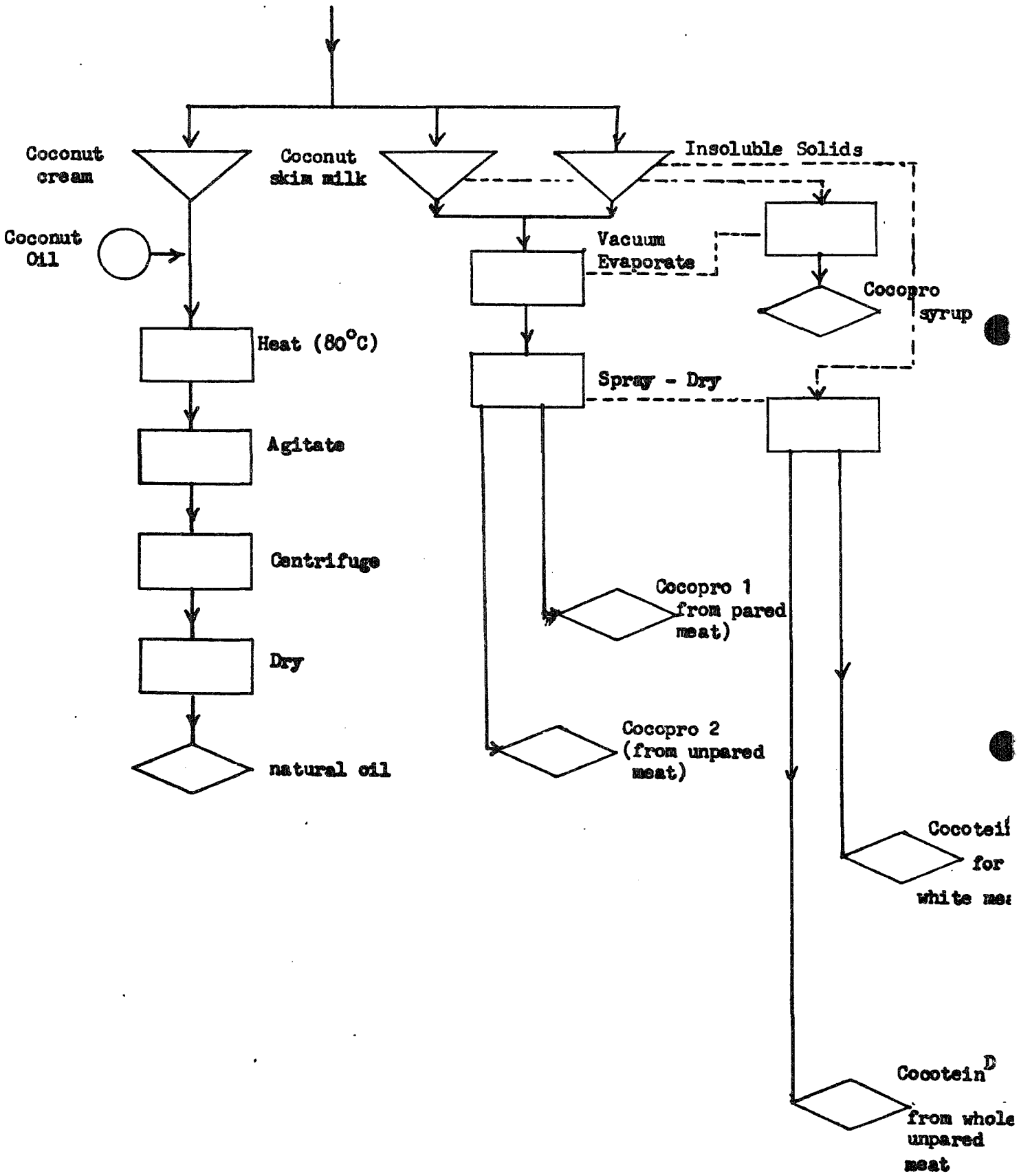
4.4 Capacity: 100T/day working at three shifts.

5. Process

5.1 Process flow diagram:



6.


Coconut cream
Coconut skim milk
Insoluble Solids
Coconut Oil
Vacuum Evaporate
Cocopro syrup
Heat (80°C)
Spray - Dry
Agitate
Centrifuge
Cocopro 1 from pared meat)
Dry
Cocopro 2 (from unpared meat)
natural oil
Cocotei for white me
Cocotein D from whole unpared meat

5.2 Description of process:

Fresh dehusked mature coconuts are used as raw material. They are opened & the meat is removed. The coconuts water is discarded. The coconut shells are made into charcoal except for about 20% which used as boiler fuel. Whole coconut meat may be used depending on the desired end product. If the paring is removed, this meal is dried & expelled to get paring oil & paring meal.

Fresh meat, (pared or unpared) is milled to reduce particle size, & extracted with water to separate the coconut milk from the residual solids. This procedure is repeated twice. The two materials resulting from the pressing operation are the liquid filtrate (coconut milk) and the solids (residue) the residue that comes from the press is dried in a rotary drier, pressed with an expeller to obtain expelled oil & residue presscake.

The coconut milk is filtered through a vibrating screen (120 mesh) to remove the last traces of residue. The pH of the filtered milk is raised from 6.3 to 7. The milk is pasteurized for one (1) hour at 60°C, then centrifuged in a cream separator to obtain: (1) the lightest phase, usually called coconut cream which contains approximately 65% of oil on a wet basis; (2) the aqueous phase, usually called coconut skim milk which is a solution of the soluble components of the coconut, with some suspended particles. With counter - current washing of the residue, the aqueous phase would contain approximately 9.5% solids as it comes from the separator; and a solid phase, consisting mostly of insoluble protein. The coconut cream is an oil in water emulsion. The emulsion is diluted with oil to reduce the moisture content, then heated to 80°C, agitated & centrifuged to recover its oil. This oil is in turn extracted with water & dried to produce a high quality oil product called natural oil.

The coconut skim milk & the insoluble solids are combined; their water is removed in two steps, namely, vacuum evaporation & spray - during to obtain a high-protein product. The spray-dried product is called cocopro 1 or cocopro 3 depending on whether the

Meat was pared or not before the coconut milk was extracted.

In an alternate method of processing, the coconut skim milk & insoluble solids are not mixed, instead they are processed separately. The coconut skim milk is concentrated by vacuum evaporation to produce cocopro syrup and the insoluble solids are spray-dried to obtain cocotein.

5.3 YIELD

From 1000 kg. of husked coconuts (wet weight basis)

Product	Mass of product	Protein in product	Oil in product
Residue	43.0 kg*	1.5 kg	10.0 kg
Insoluble protein	5.7	3.6	0.7
Skim Milk	44.0	11.8	0.6
O i l	142.0	0.0	142.0
Totals	234.0	16.9	153.0

* All results are on a dry weight basis

6. Quality of finished product

Composition of Oil Products

	Free Fatty Acids (% calculated as Lauric)	Iodine Value	Color Value	
			Red	Yellow
Natural Oil	0.05	6.4	0.2	0.9
Expelled Oil	0.05	-	1.6	1.6

Composition of Cocopro Syrup*

	Syrup 1	Syrup 3
Crude Protein (Nitrogen content 46.25)	27	
Ash	8.2	
Oil	7.	
Crude Fiber	0.0	
Carbohydrate by difference	58	

* a) Because of its high and variable moisture content, the composition of the syrup is shown on a dry basis, whereas other product compositions are reported on a wet basis, or "as is". The moisture content of the syrups averaged about 28% (wet basis), with a standard deviation of about 5 units.

b) Calculated here and elsewhere as 100 - (protein + ash + oil + moisture). Naturally, the moisture content is zero here, since the results in this particular table are on a dry weight basis.

Composition of Cocotein

	Cocotein W.	Cocotein D.
Moisture	6	6
Crude Protein	58	46
Ash	9	8.9
Oil	2.4	9
Crude Fiber	0.3	2.8
Carbohydrate by Difference	25	30

Composition of Spray - Dried Cocopro

	Cocopro 1	Cocopro 3
Moisture	4.3	4.0
Crude Protein	32	32
Ash	9.3	4
Oil	8	7
Crude fiber	0.2	2
Carbohydrate by difference	46	45

Packaging Materials

The following packaging materials have been found acceptable :

Spray-dried cocopro Cocotein	-	Laminated foil, metal or glass Polyethylene bags, laminated foil & glass or metal
Coconut Residue or Residue Presscake	-	Fiber sacks (lines with polyethylene bags, if food grade)
Natural Oil	-	Glass or metal

7. Source of Information

Hagenmaier, R. 1977. Coconut Aqueous Processing. San Carlos Publications, Cebu City, Philippines.

Product code CCCN 15.07 1
Technology sheet no: V / 23

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for :- WET PROCESS BY KRAUSS- MAFFEI / C.F.T.R.I. (pilot plant)

2. Uses of finished products :-

The uses on an experimental basis are :-

2.1 Clean coconut oil - edible use
2.2 Residual oil - crude oil
2.3 Protein coagulate - edible purposes
2.4 Coconut honey - food preparations

3. Country of origin :- INDIA

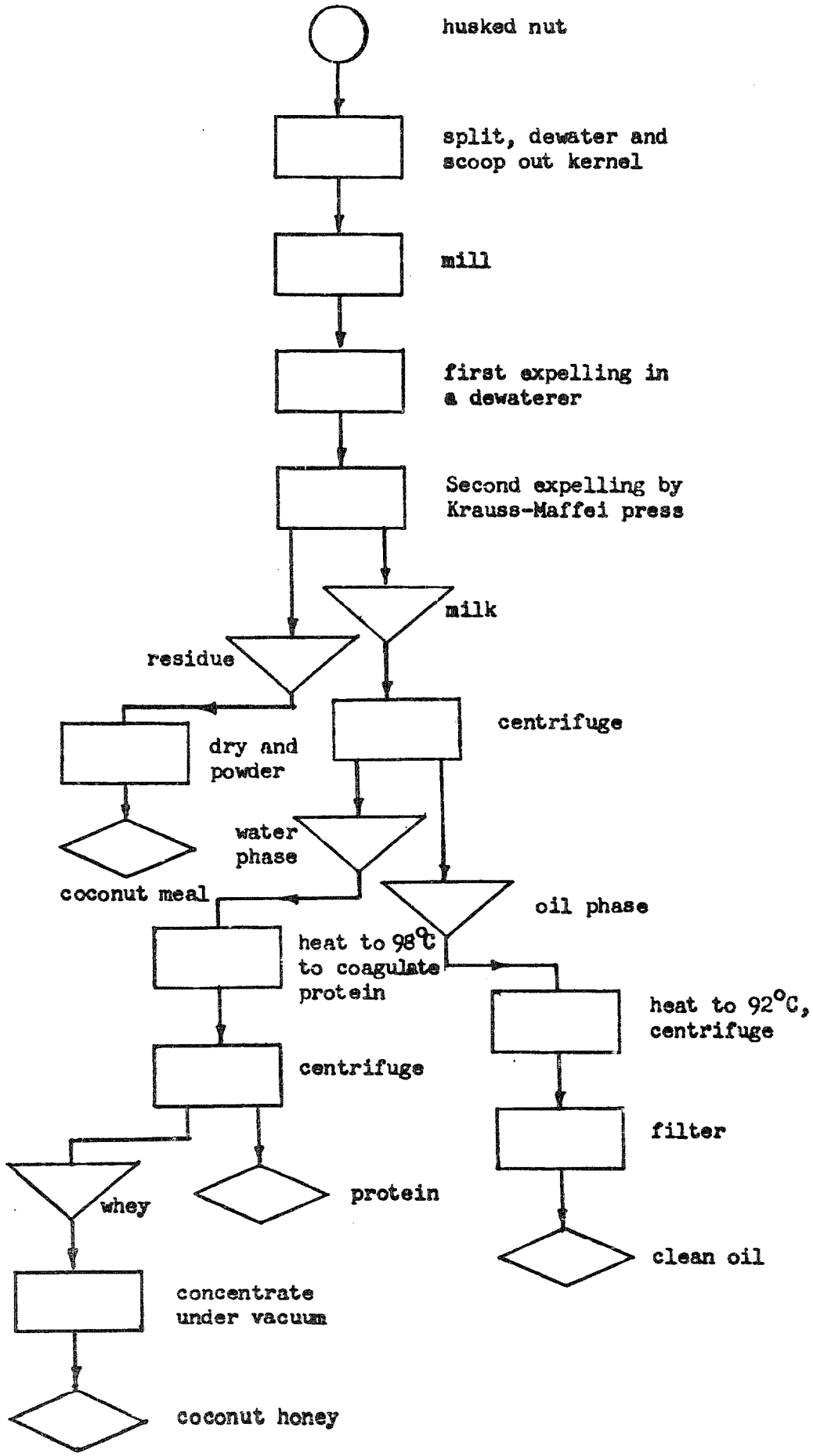
Original process by Krauss - Maffei, who gifted a plant to India. The plant was installed at the Central Food Technological Research Institute at Mysore. The original process was modified by CFTRI to maximise the oil yield.

4. Equipment

Details of equipment etc not available.

5. Process: -

5.1 Process flow diagram: -



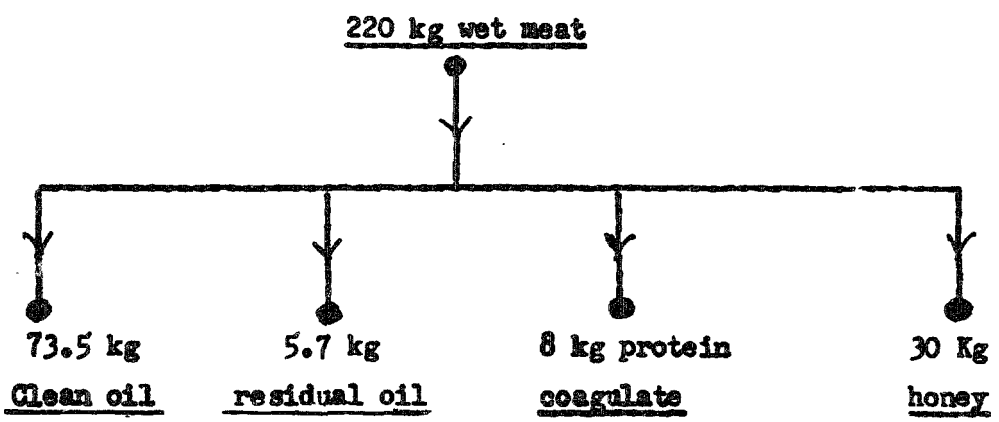
5.2 Description of process :-

Modifications were introduced by CFTRI in order to recover the maximum quantity of oil from the kernel.

Scoop out meat without subjecting the nuts to heat treatment. Mill. Squeeze milled meat in a dewaterer under a reduced pressure (2:1) & then feed into the K.M. press (12:1). With this two stage extraction method, roughly 93 per cent of the oil is extracted & the final protein recovery is 85%. Dry residue after milk extraction & feed into an expeller to extract the residual oil.

5.3 Product flow diagram :-

Results of a trial -



6. Quality of finished products

The coconut oil is of high quality edible oil.

The Consumption of other Products, percent :-

Product	Moisture	Protein (Nx6.25)	Fat	Minerals	Carbohydrates
Coconut honey (60^{0} Briy)	40.0	15.6	2.0	6.8	35.6
Acid coagulated proteins	6.0	74.3	3.1	6.1	10.5
Residual meal	8.4	66.1	3.4	8.2	13.9

7. Source of information:

The coconut palm and its products by PK Thampan, India 1975.

Product code CCCN 15.07 1
Technology sheet no: V / 24

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

" Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for :- WET PROCESS BY MODIFIED SOLVOL METHOD (pilot plant)

2. Uses of finished products:-

All the products are edible grade

2.1 Clean oil -

2.2 Protein sugar mixture -

2.3 Coconut flour -

3. Country of origin :-

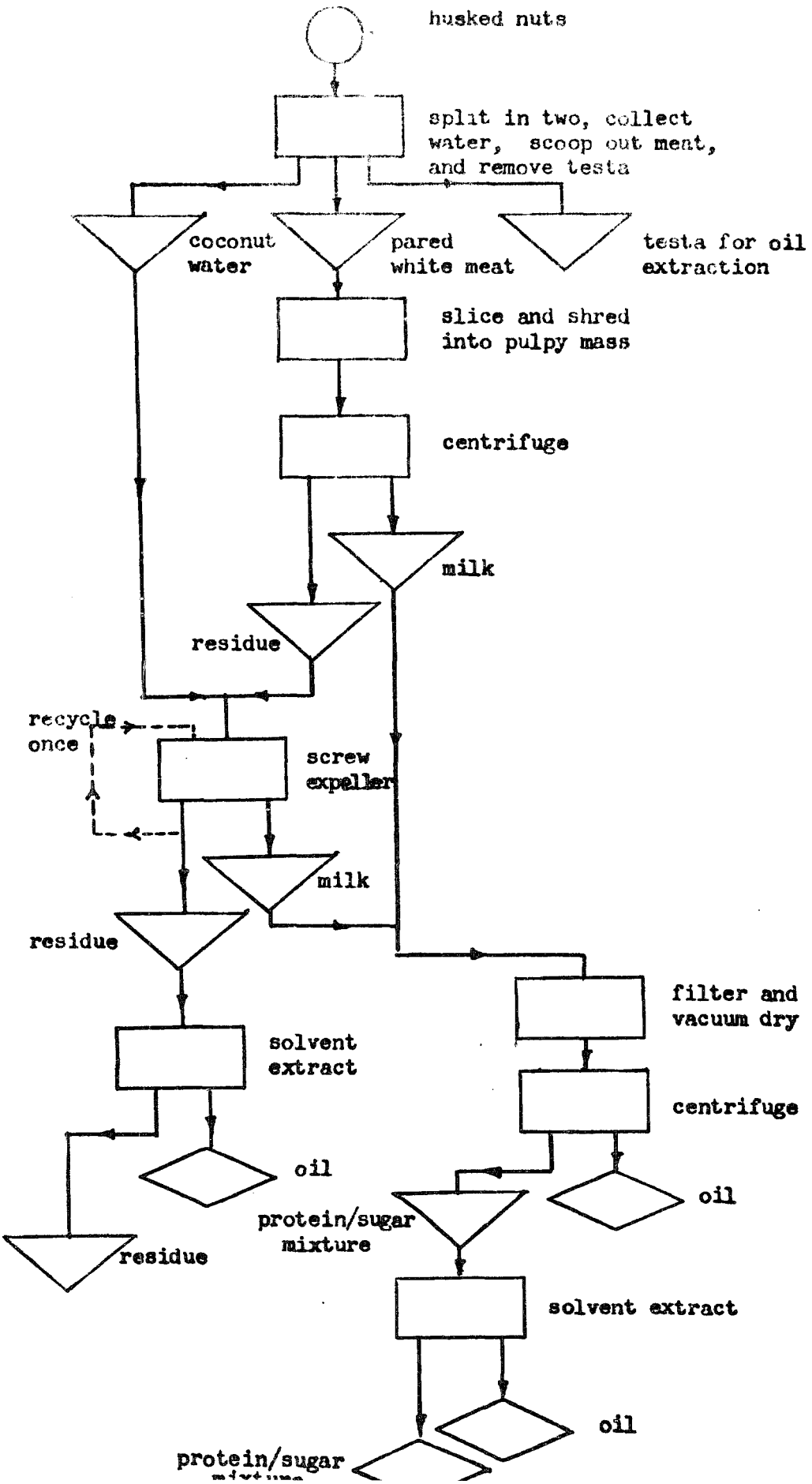
INDIA. In the early 1970 s, the Chemical Construction Company Private Ltd., developed this process and installed a plant at Faridabad, near New Delhi.

4. Equipment :-

Details of equipment etc are not available.

5. Process: -

5.1 Process flow diagram: -



5.2 Description of process :-

Cut husked nuts into halves. Collect water in a filter for use in subsequent operations. Scoop out meat. Remove testa. Keep testa in a separate container for separate oil extraction.

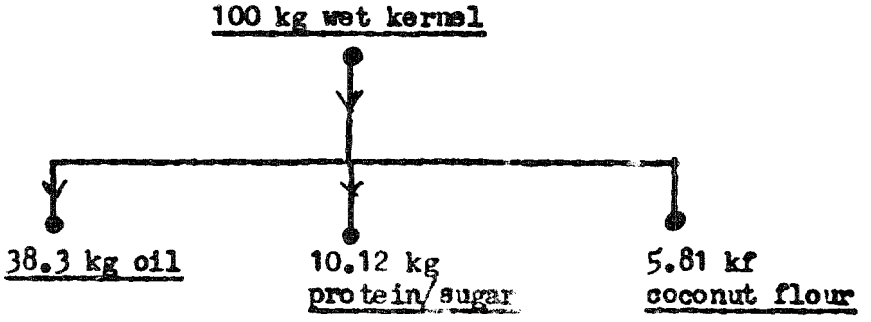
Slice pared meat & shred into a pulpy mass. Centrifuge to separate coconut milk from the meal. Add coconut water to the meal & press in a continuous screw to recover more milk. Repeat this procedure twice. Filter the milk & vacuum dry at low temperature to remove moisture. Centrifuge the resulting oil - protein - sugar mixture to separate the oil from the protein & sugar. Solvent extract protein sugar mixture to remove the oil adhering to the mixture.

In the same manner, solvent extract the meal & the parings after drying to remove & recover all the oil present. Desolventize thoroughly oil extracted from the meal & parings. Add to the oil recovered directly from the milk.

Pack resulting products - coconut oil, coconut protein sugar mixture & coconut flour for marketing.

5.3 Product flow diagram :-

Yields from the pilot plant are as follows



6. Quality of finished products

All products of edible quality.

Product code CCCN 15.07 1
Technology sheet no: V / 25

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Services on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for :- WET PROCESS BY TROPICAL PRODUCTS INSTITUTE (pilot plant)

2. Uses of finished products :-

2.1 Coconut oil - edible purposes

2.2 Protein isolate - has been successfully used for fortifying composite wheat flour breads.

2.3 Residue

3. Country of origin :-

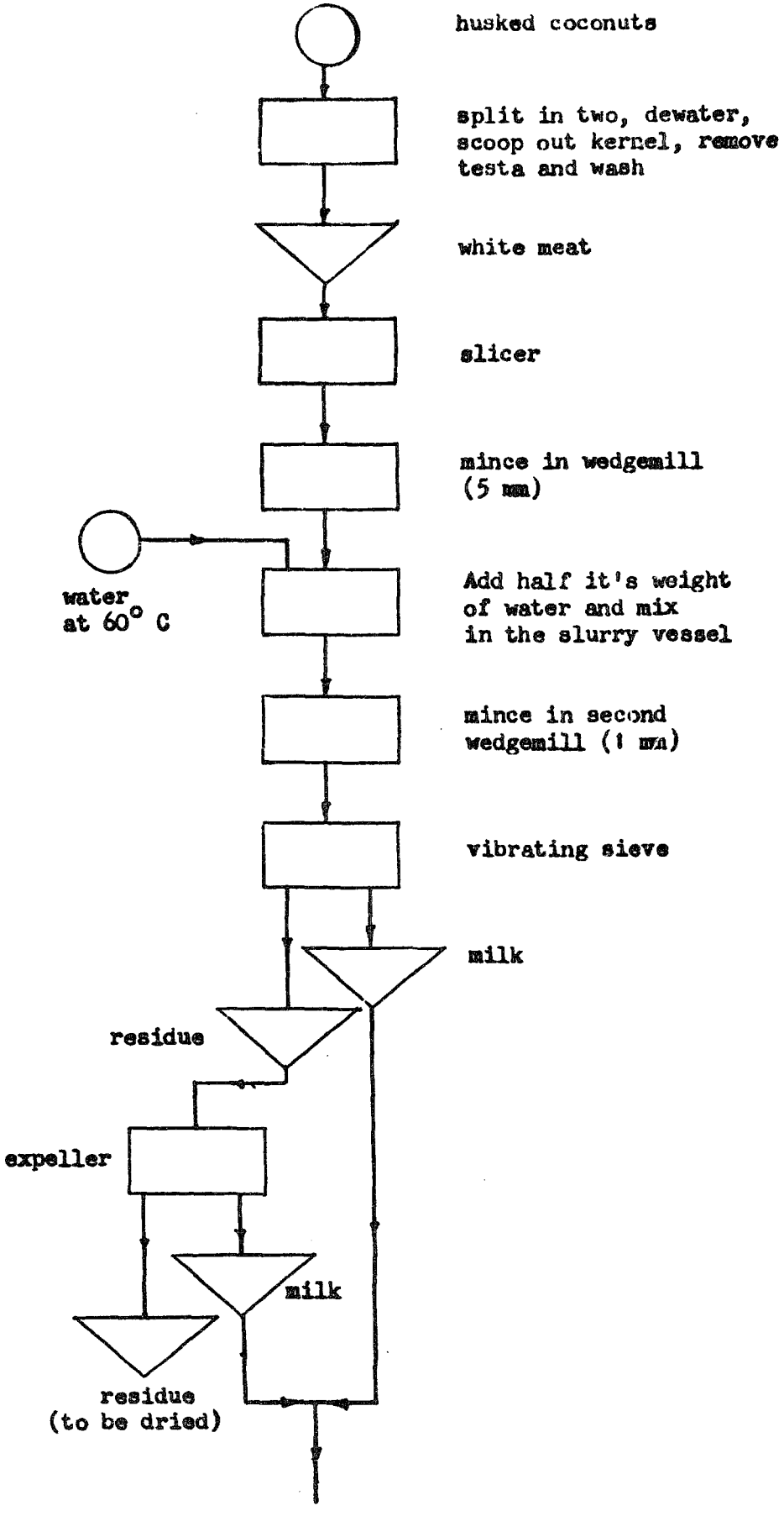
ENGLAND

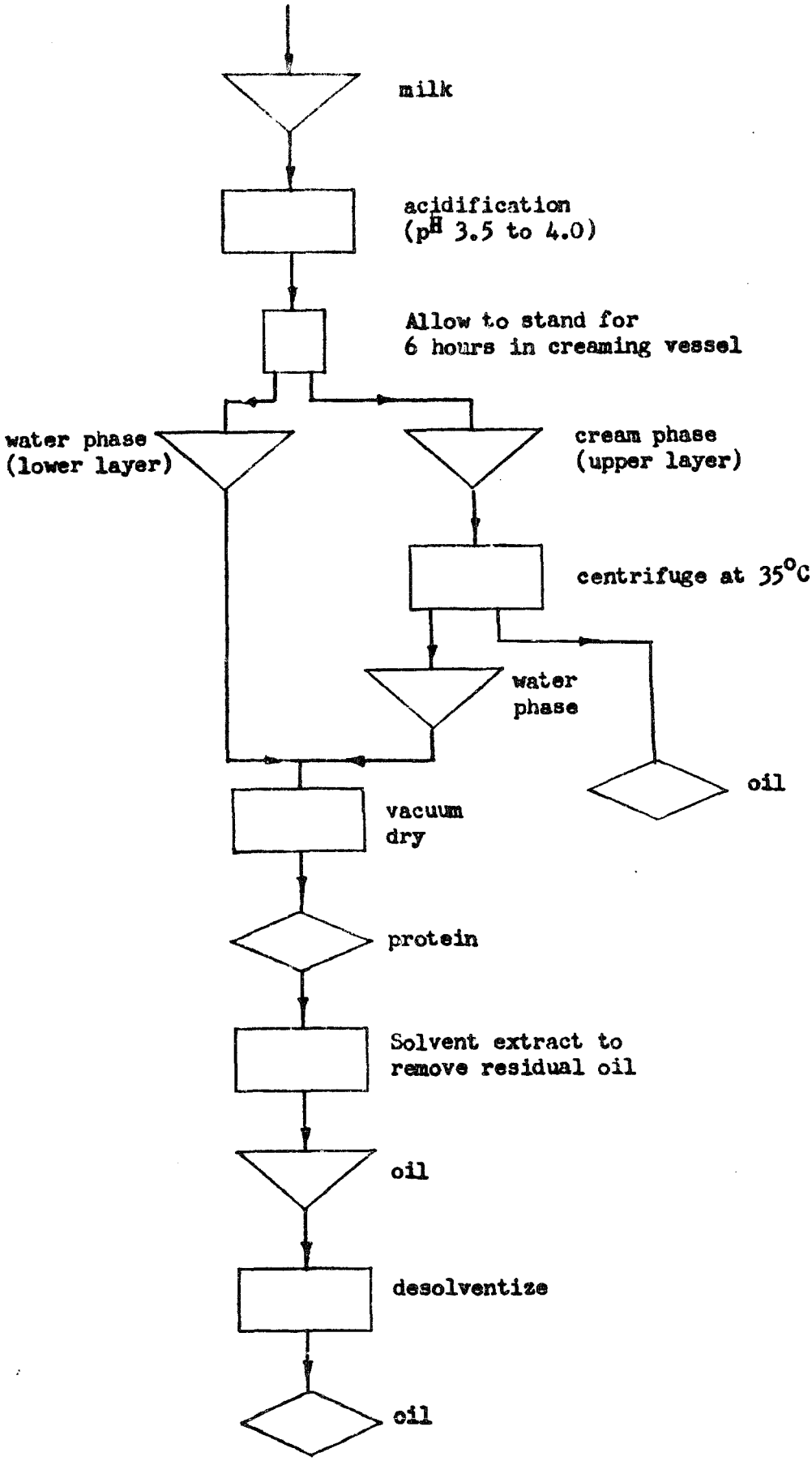
4. Equipment :-

Details of equipment etc not available.

5. Process: -

5.1 Process flow diagram: -




milk
acidification
(pH 3.5 to 4.0)
Allow to stand for
6 hours in creaming vessel
water phase
(lower layer)
cream phase
(upper layer)
centrifuge at 35°C
water
phase
oil
vacuum
dry
protein
Solvent extract to
remove residual oil
oil
desolventize
oil

5.2 Description of process :-

Slice fresh kernel & mince in a 5 mm wedgemill die plate. Mix the minced mass with half its weight of water & pass through a 1 mm plate assembly on a second wedgemill. Pass resulting slurry through the plate assembly of the second wedgemill. The resulting emulsion is passed through a vibrating sieve to remove the coconut residue under a high velocity overhead water spray. This facilitates the washing of the traces of oil & protein contained on the surface into the main emulsion. Press the residue again & add extracted milk to the main emulsion. Dry & bag the final residue to be used as ruminant feed or in an expeller mill to extract the residual oil.

Adjust emulsion pH of 3.5 to 4.0 & allow to stand for six hours. Remove lower water phase by gravity flow or by siphoning. Centrifuge cream phase at a temperature of 35°C to separate the oil & protein. Vacuum dry protein component at 55°C to 80°C. Extract residual oil with isopropanol. Desolventize defatted protein by vacuum drying for one hour at 60°C. Mill protein isolate to a powder. The oil yield is 80 to 85% and powder contains 80% protein.

6. Quality of the finished product

Main product - edible oil with 0.1 to 0.2 FFA

Other products - composition by percent :-

Product	Fat	Crude Protein	Moisture	Crude Fiber	Ash	Carbo-hydrate
Protein isolate	7.2	82.0	4.9	0.6	4.95	0.35
Residue or Meal	36.4	4.8	5.0	43.6	0.4	9.8

Product code CCCM 15.07 i
Technology sheet no: V / 26

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for :- WET PROCESS BY CHAYEN OR IMPULSE RENDERING METHOD (pilot plant)

2. Uses of finished products:-

2.1 Coconut oil - edible uses

2.2 Oil / protein complex.

3. Country of origin :-

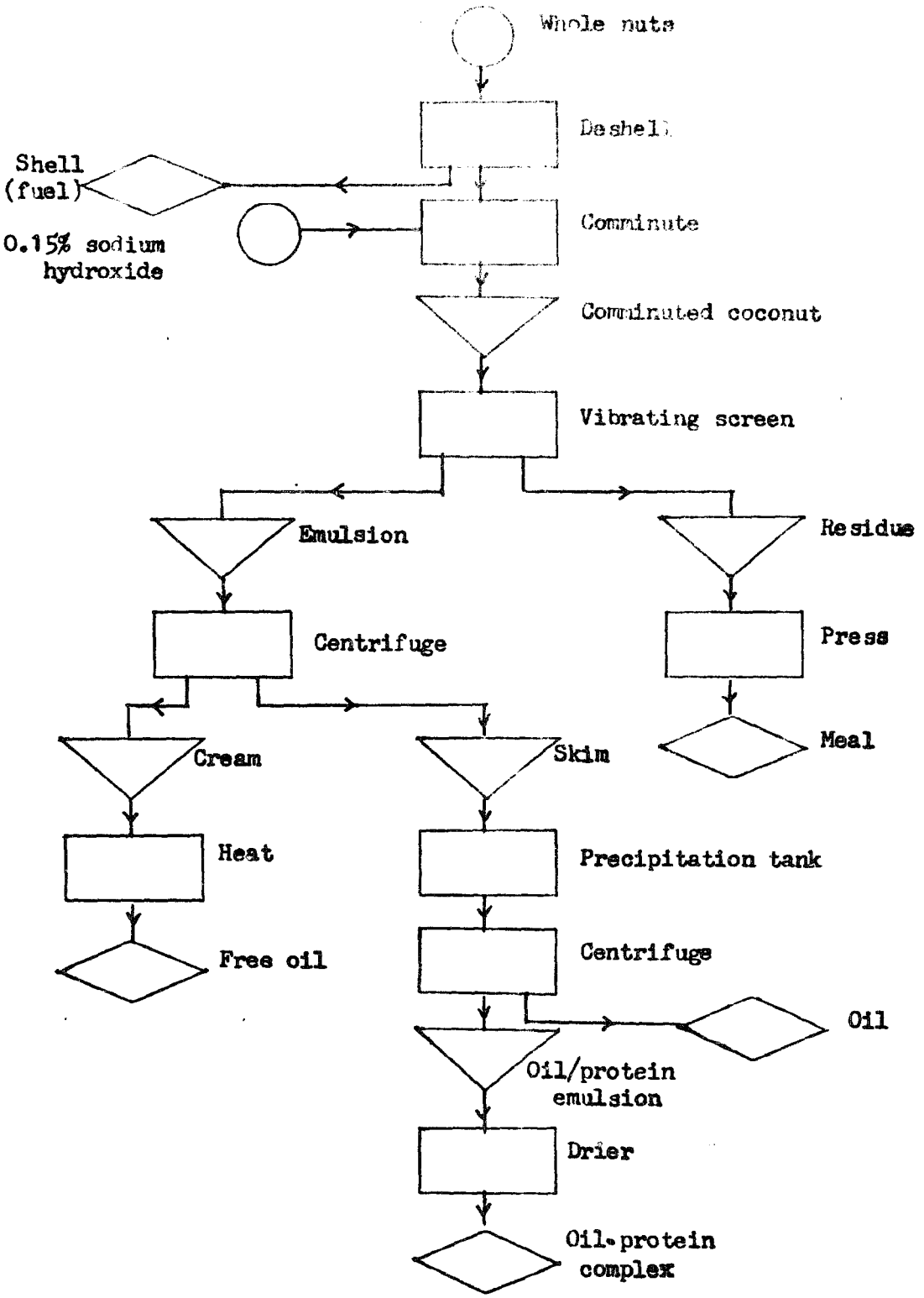
ENGLAND. The process was originally developed by British Glues and Chemicals Company Ltd. (now Croda International Ltd.)

4. Equipment :-

Details of equipment - not available.

5. Process :

5.1 Process flow diagram :



5.2 Description of process :-

Impulse rendering is described as "a mechanical rupture of the membrances of the fat containing cells by a series of high-speed impulses transmitted through the medium of a liquid, whereby the fat in the cells in liberated and is removed by the liquid in violent movement" - (Chayen and Ashworth 1953)

The fresh coconut kernels are fed into a hammer mill with ten times their weight of 0.15 percent sodium hydroxide solution. The fibre fraction is then removed on a vibrating screen, and the emulsion which passes through the screen is centrifuged to separate the free oil from the lipid - protein complex.

Typical recoveries are 80% of oil and 70% of protein.

6. Quality of finished products:-

The main product oil is high quality edible grade. The other products have the following composition on percent basis :-

Product	Oil	Protein	Carbohydrates	Ash	Biological Value	Net prptein utilization	Digestibility
Oil/protein complex	35	60	2.5	2.5	60	50	75
Meal	20	1.5	75	3.3	-	-	-

Product code : CCCN 15.07 1
Technology sheet no. V / 27

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - WET PROCESS BY HILLER
(patented process)

2. Uses of finished product : -

This patented process is reported to produce : -

2.1 Coconut oil for edible purposes

2.2 Coconut flour for edible purposes

3. Country of origin : -

UNITED STATES OF AMERICA : -
U.S. Patent 2583 022 (1952)

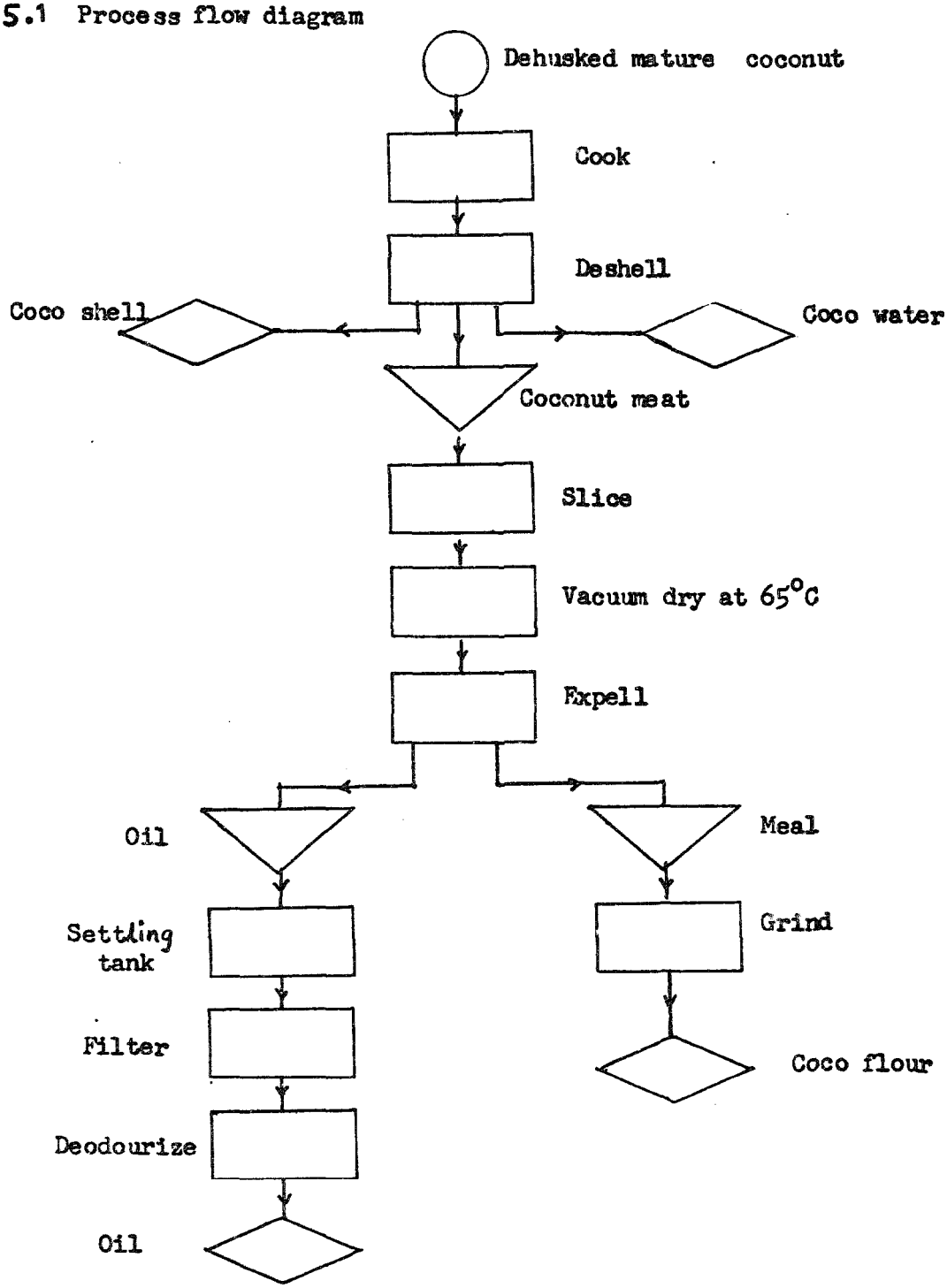
PHILIPPINES : -
Phil. Patent 186 (1954)

4. Equipment : -

Details of equipment etc not known.

5. Process

5.1 Process flow diagram



5.2 Description of process : -

Mature, dehusked nuts are placed in a cooker to facilitate removal of the kernel from the shell. Slice the kernel & vacuum, dry at 65°C & extract the oil using a conventional expeller. The cake is ground to produce coconut flour. The oil is allowed to settle in a settling tank, filtered & deodourized. The processing time is about three hours.

5.3 Product flow diagram : -

Details of yields are not available. However high yields of protein flour are reported.

6. Quality of finished products : -

The coconut oil is of high quality edible grade.

The composition of the coconut flour by percent : -

Oil content	12.2
Protein	18.2
Moisture	6.2
Crude fibre	20.0
Ash	4.9
Carbohydrates	20.4

Product code CCCN 15.07 1
Technology sheet no. V / 28

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for :- SOME PATENTED WET PROCESSES

2. Uses of finished products :-

2.1 Coconut oil for edible purposes

2.2 Protein for edible purposes

The advantages of the wet processes are :-

(a) By-passing copra stage and thus avoid deterioration and losses

(b) Avoids solvent extraction process.

The disadvantages are :-

(i) Uses high level technology

(ii) Oil recovery not as high as through copra process despite losses in the latter.

(iii) The protein product though edible grade has not yet found steady outlets for marketing.

(iv) The processes have yet to demonstrate economic viability.

3. Country of origin :-

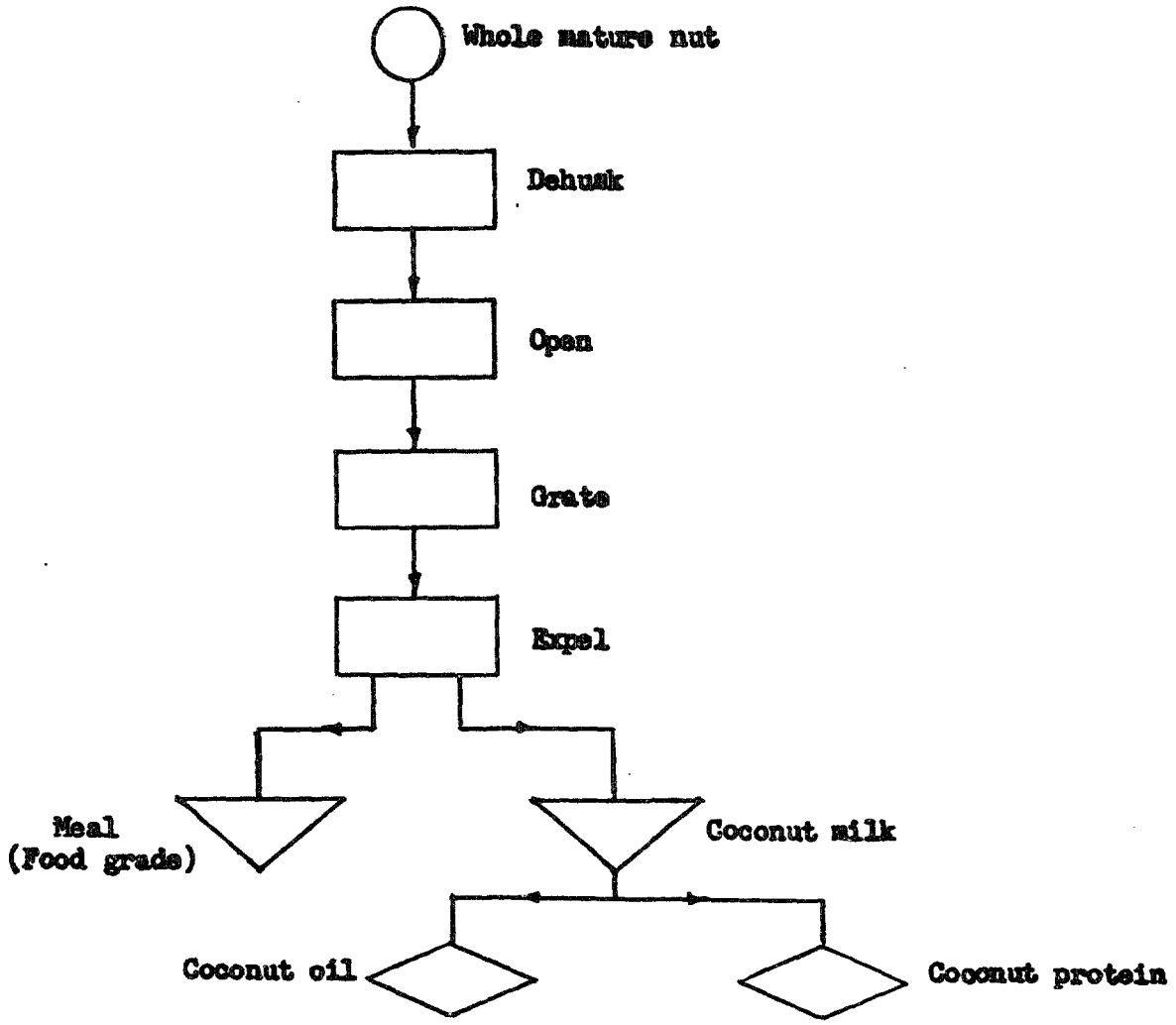
See Description of process.

4. Equipment :-

Details not known.

5. Process :-

5.1 Process flow diagram for the general wet process



5.2 Description of the process

5.2.1 Krauss - Maffei process (Pat no. 1,031,912 - 1958).

Steam husked nuts in an autoclave at a pressure of 3 kg/cm^2 for 10 minutes. Open the nut, scoop out meat, pass thru a cutter. Comminute further by passing through a roller mill. Screw press to extract the milk. Centrifuge to separate the oil phase from the water phase. Heat oil phase to 92°C, & filter to get good quality oil. Heat water phase to 98°C in a flow heater to coagulate the protein which is separated by centrifugation. Dry. Concentrate left - over whey under vacuum to a syrupy product called coconut honey. Coconut residue is dried in a drier & powdered to get edible quality coconut meal.

5.2.2 Robledana - Luzuriaza (Phil. Pat. 1 1948)

Grind fresh coconut meat & press to get solid residue & emulsion. Subject emulsion to controlled enzymatic action, freeze & thaw to separate the oil by centrifugation. Heat the water phase to get protein concentrate (60% protein). The residual meal is suitable for direct human consumption.

5.2.3 Gonzaga process (Phil. Pat 3 - 1948)

Grate coconut meat. Press. Put the coconut milk in a settling tank. Isolate protein by heat coagulation (100°C).

5.2.4 Diokno process (Phil. Pat. 7,674 - 1960);

Three fractions are obtained by centrifuging the comminuted meat namely coconut oil, protein rich solids and skim milk.

5.25 Lava process (Bri. Pat 505,211 - 1930; U.S. Pat 2,101,371-1937).

Extract oil from freshly grated coconut meat by water extraction & subsequent separation of oil from the protein. The by-products are the press cake with 8% protein, dried protein concentrate containing 75% protein in fairly pure state & an aqueous sugar - mineral solution.

Product code: CCCN 15.07 1
Technology sheet no: V / 29

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - DRY PROCESS BY YENKO (patented process)

2. Uses of finished product : -

2.1 Coconut oil for edible purposes

2.2 Coconut flour for edible purposes as protein

3. Country of origin: -

PHILIPPINES

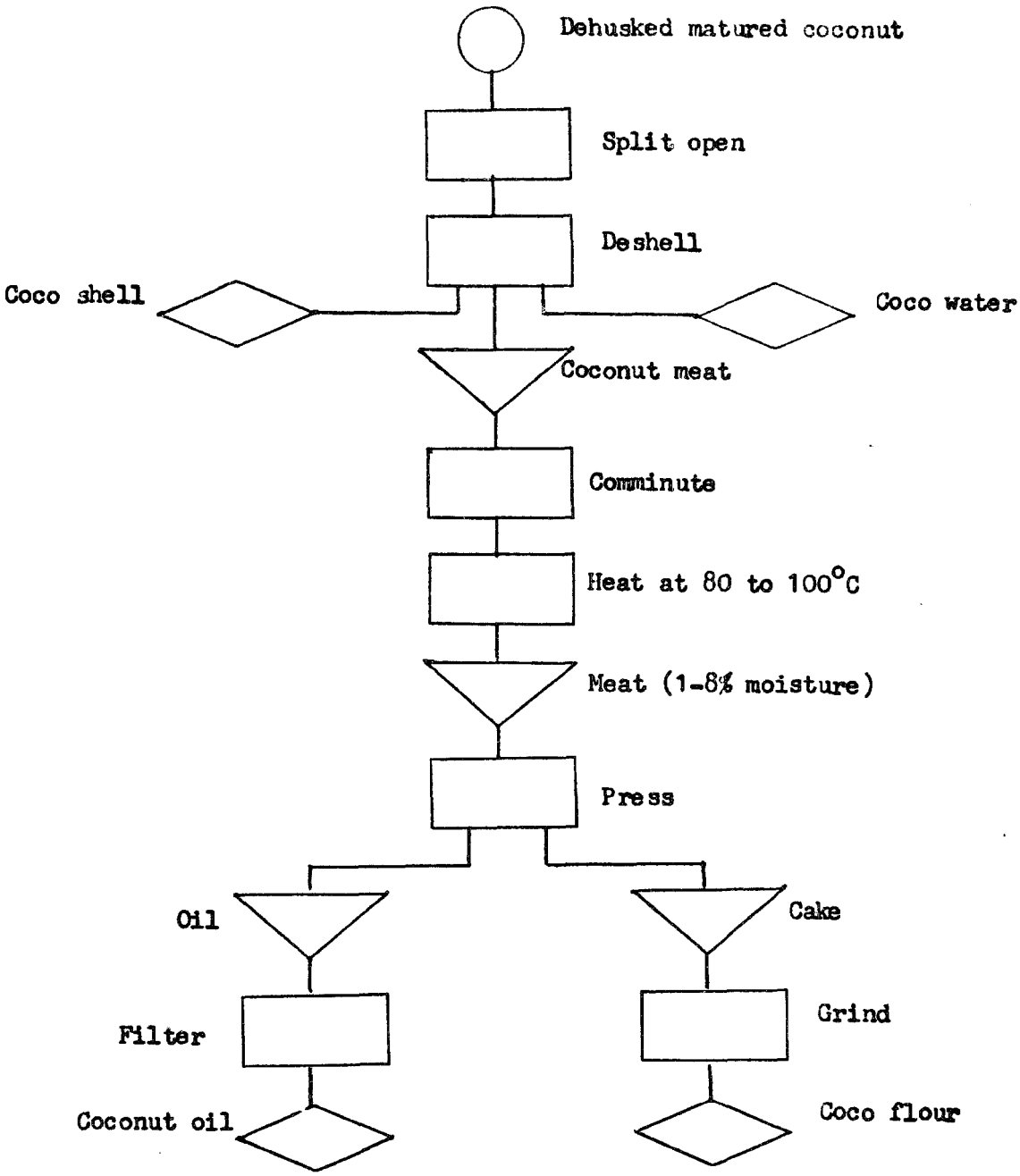
Phil pat 187 (1954).

4. Equipment: -

Details of equipment etc not known.

5. Process :

5.1 Process flow diagram



5.2 Description of process: -

Split open dehusked coconut. Scoop out meat. Comminute & heat in a chamber at 80 to 100°C until the moisture content of the meat is reduced to 4 - 8%. Press. Grind the cake into coconut flour. Filter oil for further processing.

5.3 Product flow diagram: -

Details of yields not available.

6. Quality of finished products

Coconut oil - high quality edible grade

Coconut flour - edible grade protein content

Product code CCCN 15.07 i
Technology sheet no.: V / 30

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for :- INTEGRATED DRY PROCESS BY N.I.S.T. (Philippines Patent)

2. Uses of finished products :-

2.1 Coconut oil - edible uses

2.2 Coconut flour - edible uses as protein

2.3 Coconut coir fibre

2.4 Coconut shell charcoal

3. Country of origin :-

PHILIPPINES - National Institute of Science and Technology

Phil patent 2041.

4. Equipment :-

See figure

See section 5.2 - description of process and equipment.

2.

Patented July 22, 1965 Patent No. UM-344

JESUS GUZMAN ALCANTARA ET AL
FLUIDIZED BED DRYER FOR COCONUT
PRODUCTS AND THE LIKE

Filled June 26, 1964 1 Sheet

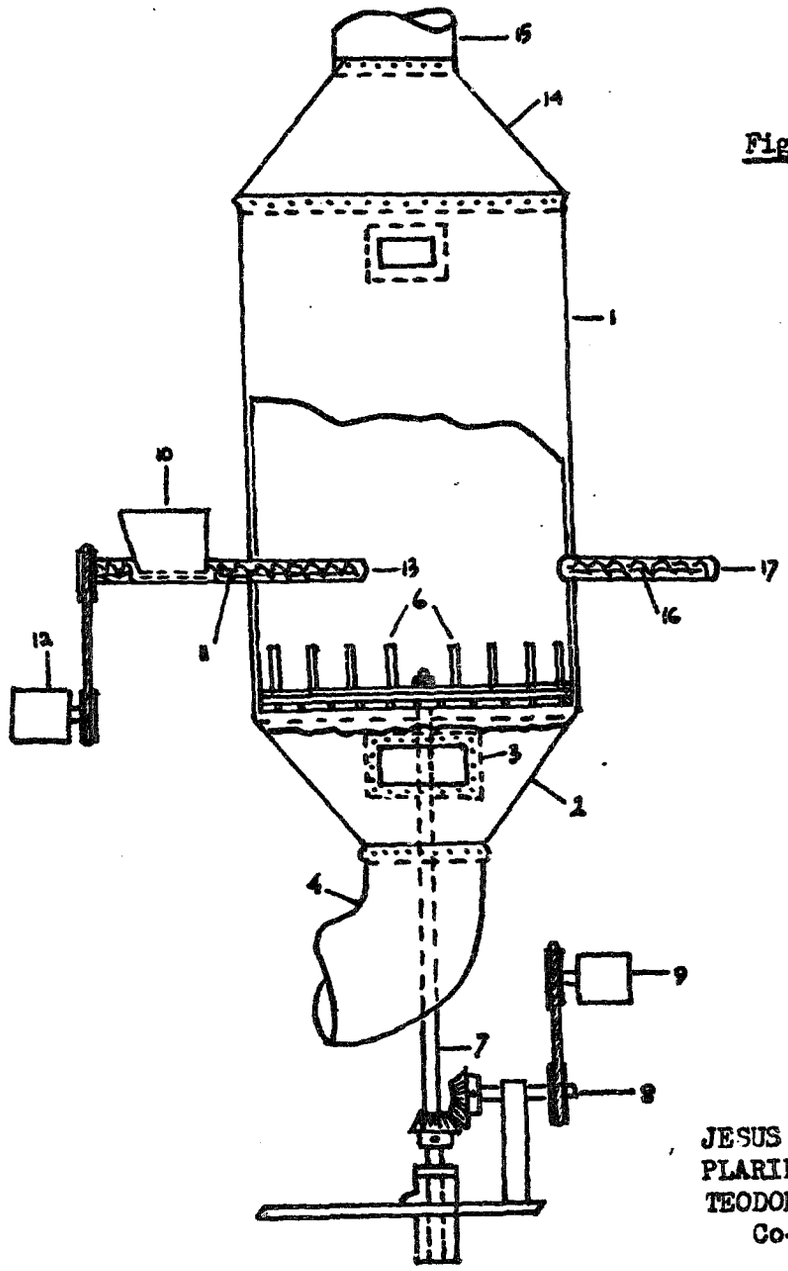


Figure 1

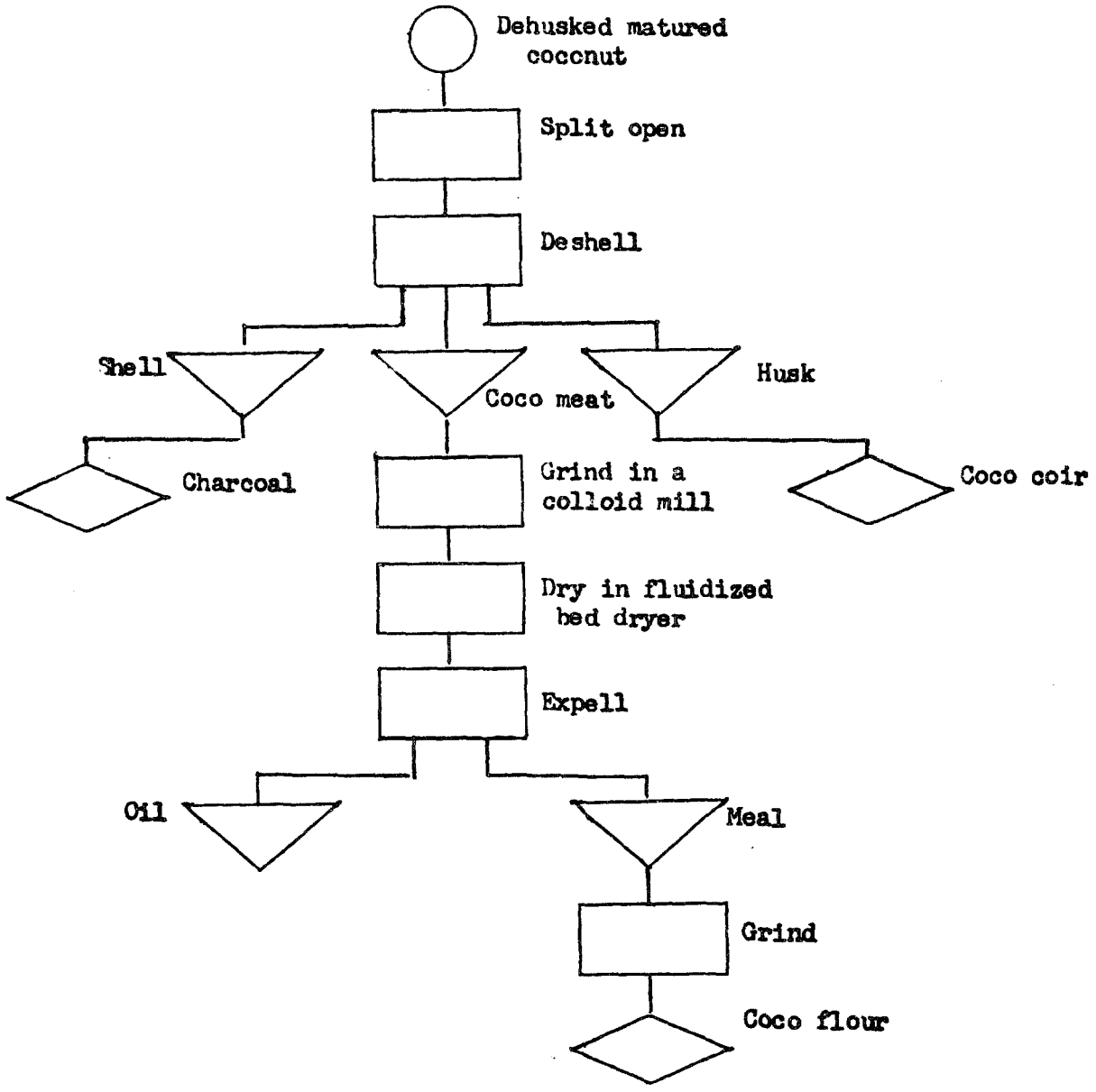
JESUS G. ALCANTARA
PLARIDEL H. RECATO
TEODORO T. GARCIA
Co-Makers

By: FELIPE LL. SANTILLAN
Patent Engineer Agent

3.

5. Process :

5.1 Process flow diagram



4. Equipment

4.1 Equipment for drying

4.

5.2 Description of process and equipment

The fluidized Bed Dryer is specially adapted for drying comminuted coconut meat and similar finely ground material with high moisture content.

Generally described, the dryer, as shown in Fig. 1, is made of stainless steel plate formed into an upright cylindrical chamber (1) having a perforated bottom plate (5), an inlet for the material to be dried with screw feeder (11), an inlet for hot air (4), an outlet for the discharge air and dried fine material (15), an outlet for the coarse dry material with screw type conveyor (16) and (17), and a rotating scraper rake (6) on the top face of the perforated plate. The conical bottom (2) has a glass window (3) and duct extension underneath (4) for the entrance of hot air admitted at controlled volume, pressure and temperature, and blown through a heat exchanger by an electric centrifugal blower.

The perforated bottom plate is made of stainless steel plate of sufficient thickness and fits snugly right where the bottom edge of the upright cylindrical drying chamber meets the top edge of the conical bottom. It is being continuously surface-scraped by the rotating scraper rake which is driven by an electric motor (9) through the vertical shaft (7) and worm gear assembly.

The drying operation of this fluidized-bed type dryer is simply described as follows: The finely ground wet material is fed from the hopper (10) and is conveyed into the drying chamber by the rotating screw feeder (11) which is driven by an electric motor (12).

It is discharge at the open end of the screw feeder (13) located at the center end of the screw feeder (13) it is spread over the spikes (6) of the rotating rake. The hot air current coming from the perforated steel, plate causes the fine material to be partly suspended and at the same time heat exchange between the material and hot air takes place. The water content of the material is evaporated and carried by the hot air current and out to the exhaust air duck.

5.

When the material loses enough water it becomes lighter than when originally introduced. The dry fine granulated particles are carried by the hot air through a collecting cyclone, where the air is separated from the dried fine material. This is finally collected into plastic bags and scaled for the market. The moisture content of the product varies from 1-3½% - the range acceptable to the market.

In the process of drying, the coarse particles are not carried by the outgoing air. These are discharged at the side of the drying chamber by the screw conveyor (17) and collected and bagged as another grade of the final product. If the moisture content is higher than 3-½% the material is passed through the secondary fluidized dryer for further drying until the desired moisture content is obtained.

The spikes of the rotating rake serve to break up any lump pieces of wet material. They also stir and agitate the material in the drying chamber. The quantity of dried fine material, carried by the hot air and collected by the cyclone collector, and the amount of coarse material discharged at the side are continuously replaced by wet material through the screw feeder so that there is a constant predetermined quantity of materials in the drying chamber. There is no accumulation of material inside the chamber. The operation is continuous.

Product code : CCCN 22.07
Technology sheet no: V / 31

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - TAPPING COCONUT SAP (LOCALLY CALLED TUBA). (Cottage Industry).

2. Uses of finished product : - Sweet sap: -
Before fermentation it is used as a beverage. This is also called tuba.

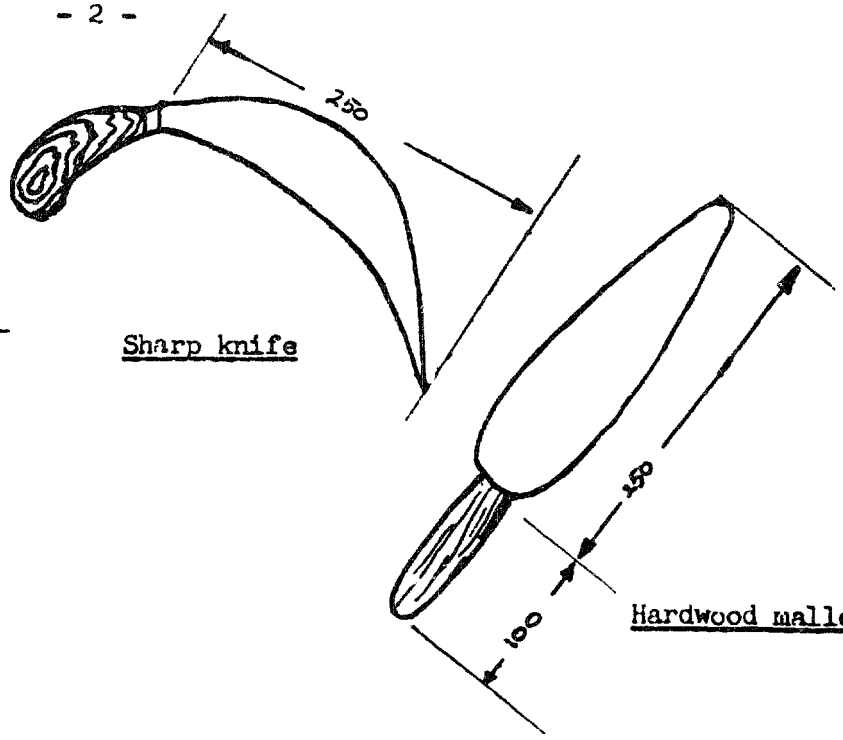
Fermented sap
After natural fermentation and addition of Ceriops tanbark for colouring an alcoholic beverage called Tuba is obtained.
When natural fermentation is allowed to take place for 5 days (without adding Ceriops tanbark), it is distilled and the distillate is known as Lambanog (also called Arrack, Uraca) which is used as a strong alcoholic drink.

3. Country of origin : - PHILIPPINES

4. Equipment: -

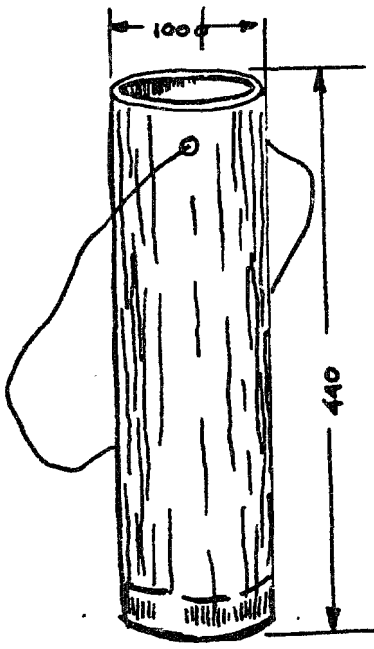
4.1 Description of equipment: -

The following simple equipment is used for the tapping process: -

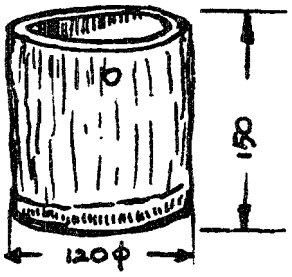


Sharp knife

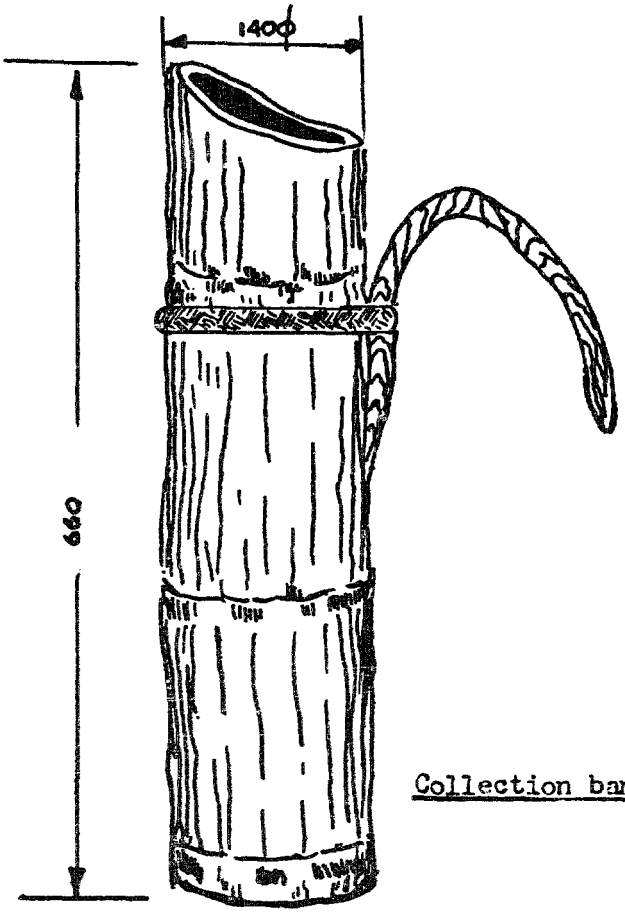
Hardwood mallet



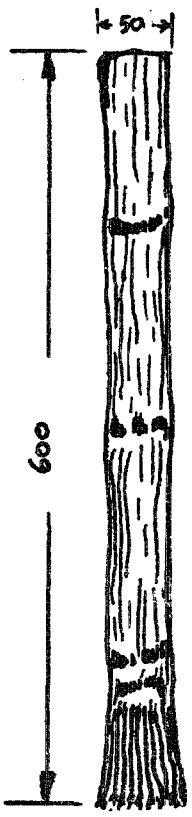
Bamboo receptacle



Bamboo vessel for tanbark



Collection bamboo



Bamboo brush

All dimensions in mm

EQUIPMENT FOR TAPPING COCONUT SAP

Sharp knife ('Sanggot')
Hardwood mallet for tapping
Bamboo receptacle ('Sahod')
Small bamboo vessel for carrying ground tanbark for tuba
Collection bamboo ('Kawit') with a wooden hook for the shoulder.
Bamboo brush ('Pitlagong')
5 gallon (27 litre) tin can or plastic jerry container
Fermentation vessels for Tuba.

4.2 Materials for construction: - Not applicable

4.3 Cost of equipment : -

Sharp knife		
5 gallon can		
Fermentation vessel		
Other items at no cost		
Total estimated cost	₱ 200	(US$ 30/-)

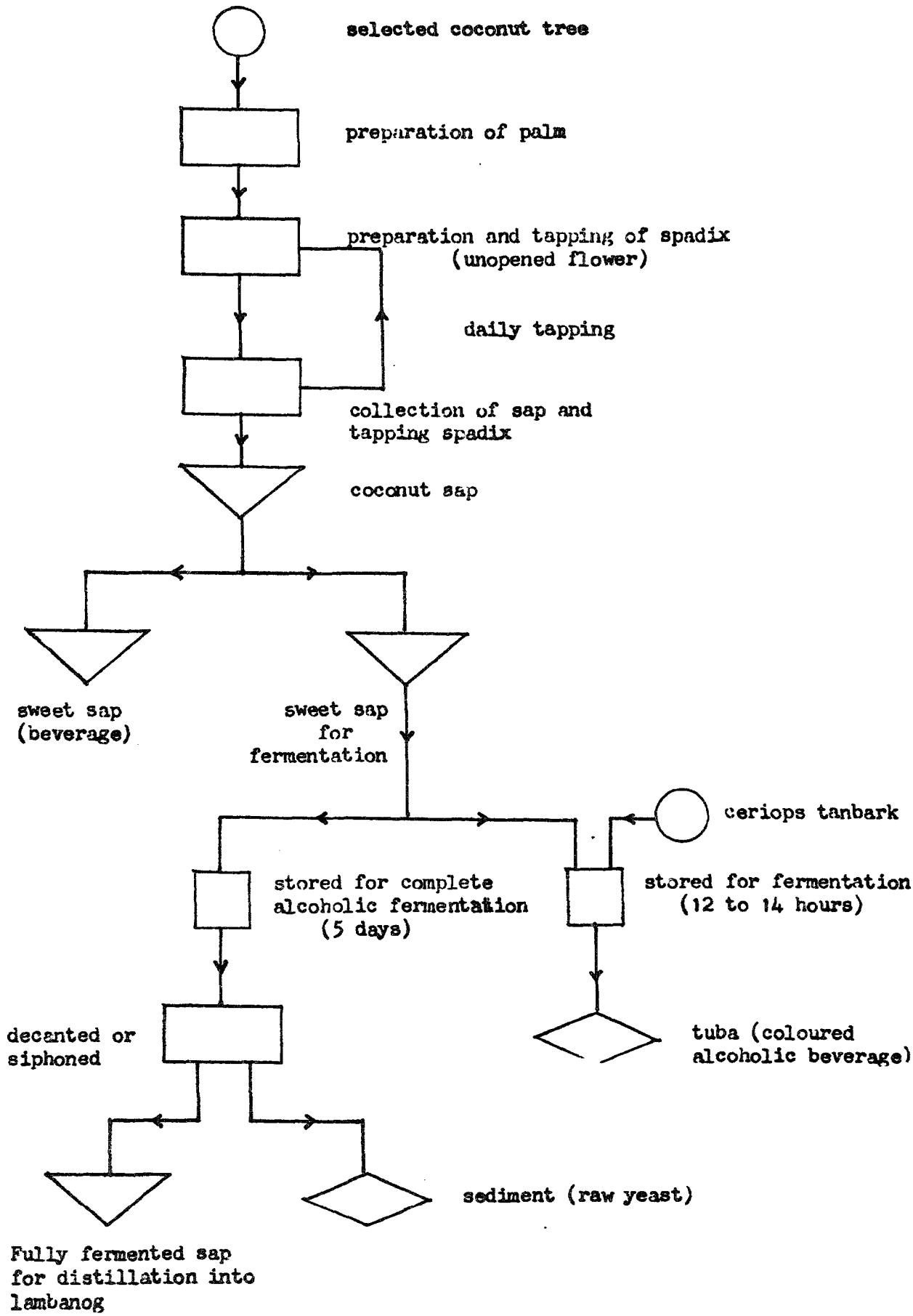
4.4 Capacity/Yield: - The average daily yield of sap per palm ranges from 360 to 1030 ml with an overall average of 650 ml. Thus the average per palm per year on the basis of 12 months continuous tapping will be 237 litres. Each spadix produces sap only for about two months.

It must be noted that the yield of sap has a considerable variation from spadix to spadix, palm to palm, day to day and season to season. Further, a greater flow of sap occurs during the night than during the day. The yield also varies on the variety of the palm, its age as well as the duration for which the palm has been continuously tapped.

The capacity of a tapper per 8 hour working day is 30 to 40 palms when gathering tuba. When gathering sap for making Lambanog, the capacity is 100 trees per working day.

5. Process: -

5.1 Process flow diagram: -



5.2 Description of process: -

The tall variety of coconut generally starts to bear fruit upon reaching 8 to 10 years and keeps bearing up to 60 years or more. Coconut trees which bear very well and are not too young or old are selected for tapping.

The tuba gatherer cuts V shaped notches onto the coconut trunk to serve as steps in climbing to the crown. The notches are large enough to accomodate a toe-hold. One side of the notch is parallel to the ground. At the crown, the dried leaves, weakly attached senile leaves, the stipules or "guinit" and the aborted spadices are removed.

The man gathering sap for making Lambanog does not climb each tree but moves from tree to tree by the use of bamboo poles connecting the palms. Two mature poles are securely tied to two adjascent palms just below the crown at a level that a man can stand conveniently when tapping and collecting sap. One pole serves as the foot bridge and the other as a hand rail. The palms are spanned by poles. The man climbs up the lead palm, walks across the bamboo bridges to the other palms and comes down the last palm.

A fully mature spadix will soon have its spathe burst open and when 'tapped' produces a reduced yield of sap. A spadix younger than this is selected for tapping and is indicated by a swelling at the base of the spadix due to the development of the female flowers. The spadix ceases to elongate shortly before the spathe splits open. This usually occurs from 75 to 90 days after the first appearance of its tip. The total length of the spadix is 700 to 900 mm. When suitable for tapping, the spadix will be about 600 mm long. A palm produces about 10 spadices per year. The number of spadices on any one tree at any time will be 2 or 3.

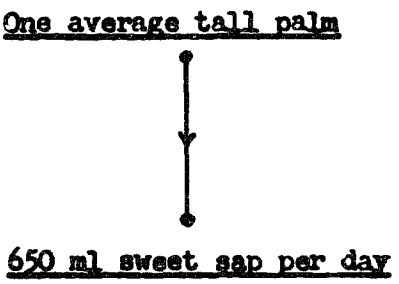
The selected unopened spadix is wrapped with abaca string or rattan strip along its length to prevent it splitting open. The spadix is gently tapped using a hardwood mallet so as to carefully bruise and rupture the tender tissues of the floral branch. The spadix is gradually bent downward without breaking the stem. The tip is tied down with abaca string to a nearby petiole (leaf branch). This bending procedure is repeated daily for one to two weeks until the spadix droops. When the bending down is more than half done the tip is cut open with a sharp knife ('Sanggot'). Three days later, the sap flows out. The daily slicing of the tip of the spadix allows the sap to flow continuously and the drooping position prevents the sap from entering the inflorescence and enables a bamboo receptacle ('Sahod') to collect the sap. The slicing is done once in the morning and once in the evening. The finer the slice, the longer is the life of the spadix. The bamboo receptacle is kept in position by fastening it to the spadix through two small holes at the top rim of the bamboo receptacle with the use of abaca string. The mouth of the bamboo receptable is covered with a piece of fibrous network of light brown stipules locally called 'guinit'. This keeps out rain water, insects, mice and lizards.

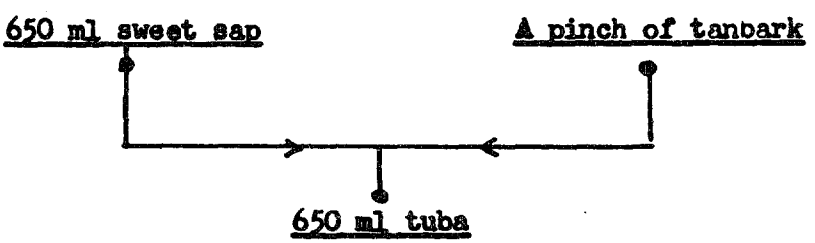
A tuba gatherer handles 30 to 40 palms daily. The palms are climbed twice a day to tap and slice the spadices, each palm taking about 5 minutes. For a morning tuba collection, the Ceriops tanbark is added in the afternoon and for an afternoon collection, it is added the following morning. The ground tanbark ('tungog') is carried up the palm in a bamboo about 120 mm diameter and 150 mm length. It is tied round the waist of the climber like a canteen. A pinch of tanbark which imparts an astringent taste to the sap is dropped into the bamboo receptacle for the purpose of colouring the tuba red. During collection, the tuba is transferred to the collection bamboo called 'Kawit'. With the wooden crook near the neck of the collection bamboo, it is hung on the back of the climber while moving up and down the palms. After transferring

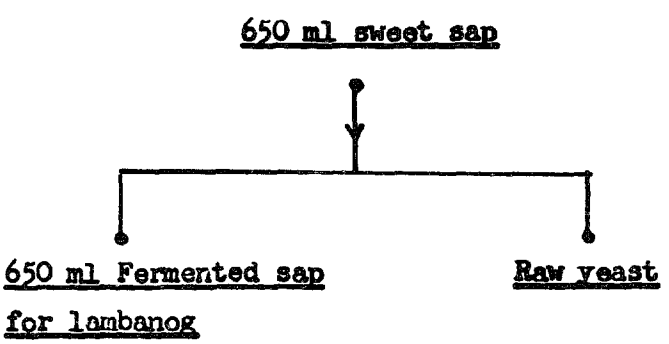
the tuba, the sediment in the receptacle is removed using a bamboo brush locally called 'pitlagong', while on top of the palm. The sediment adhering to this brush in turn is removed by beating it on the petiole. The collected tuba is filtered through a sieve of stipules or abaca fiber into a 5 gallon tin can or a plastic jerry container. The tuba is then ready for transportation to the market.

A man gathering sap for making Lambanog tends to 100 palms a day. The lead palm is climbed in 10 seconds. During collection, the receptacle is untied, contents stirred with a bamboo stick and the sap poured into the collection bamboo 'Kawit'. It takes about 9 full receptacles to fill up a collection bamboo. A 5 gallon tin can into which the sap in the collection bamboo is transferred is pulled up by means of a rope. It takes 1 to 2 minutes to complete collection from one palm. The movement from one palm to another takes 15 seconds. The spadices are sliced morning and afternoon. The sap for making Lambanog is brought to the distillery.

5.3 Product flow diagram: -







6. Quality of finished product: -

6.1 Sweet sap : - This is sweet, oyster white and transluscent. Highly susceptible to fermentation due to inositol content which is an essential growth factor for certain yeasts: -

Sugar content	-	12 to 18% (g/100 ml) as Sucrose
Specific gravity	-	1.07
P^H value	-	6.2 to 7.2 with 6.7 average.
Acidity	-	less than 0.1% (g/100 ml) as Acetic

6.2 Tuba : - This is red in colour due to the effect of the ceriops tanbark added: -

Sugar content	-	0.3% (g/100 ml)
Specific gravity	-	1.01
Acidity	-	0.5% (g/100 ml) as Acetic
Alcohol	-	5% (g/100 ml)

6.3 Fermented sap : - This is oyster white in colour and less transluscent than sweet sap: -

Sugar content	-	0.3% (g/100 ml)
Specific gravity	-	1.01
Acidity	-	0.5% (g/100 ml) as Acetic
Alcohol	-	7.5% (g/100 ml)

7. Source of Information : -

University of the Philippines
Los Banos, Central Experimental
Station, No. 76 - 149.
Los Baños, Laguna
Philippines.

T.K.G.R 1979.

Product code : CCCN 22.07
Technology sheet no: V / 32

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - TAPPING COCONUT SAP (TODDY) - (Cottage Industry).

2. Uses of finished product : - Sweet toddy: -

Sweet toddy (before fermentation) is used as a beverage, or used for processing into syrup (Treacle) and sugar (Jaggery).

Fermented toddy (Palm wine)

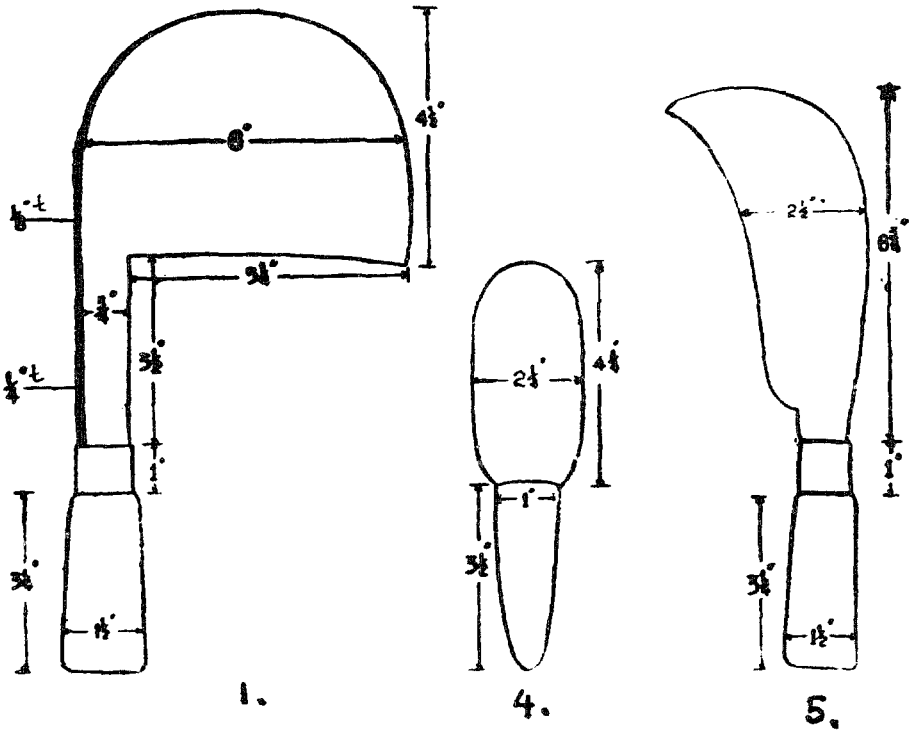
After natural fermentation it is used as an alcoholic drink. The sediment when separated from the liquid is raw yeast and this is occassionally used for baking traditional rice flour preparations. The fermented toddy is distilled to manufacture Arrack which is a strong alcoholic drink. The fermented toddy can also be further fermented into Vinegar.

3. Country of origin : - SRI LANKA,

Very similar techniques are engaged in INDIA, MALAYSIA and THAILAND for tapping sap.

4. Equipment : -

4.1 Description of equipment : - Details of the following implements are given in page 2.



TAPPING IMPLEMENTS

1. Tapping Knife
2. Box (Manna Pettiya)
3. Earthenware Pot (Unglazed)
4. Wooden Mallet
5. Cleaning Knife.

See Section 4.1

4.1.1 Tapping knife which is a broad blade razor.

4.1.2 Light weight box (locally called "Manna pettiya") for carrying the implements. This is tied round the waist

4.1.3 Earthenware pot (unglazed) with capacity $\frac{1}{2}$ to $\frac{3}{4}$ gallon (2 to 3 litre).

4.1.4 Hardwood mallet with a smooth egg shaped head and a tapered handle. The hardwood commonly used is tamarind.

4.1.5 Cleaning knife with a curved blade.

4.2 Materials for construction - Not applicable.

4.3 Cost of equipment : -

The cost of the equipment is estimated at Rs 100/= (or US$ 6.50 1 US$ = Rs 15.50.

4.4 Capacity/yield : -

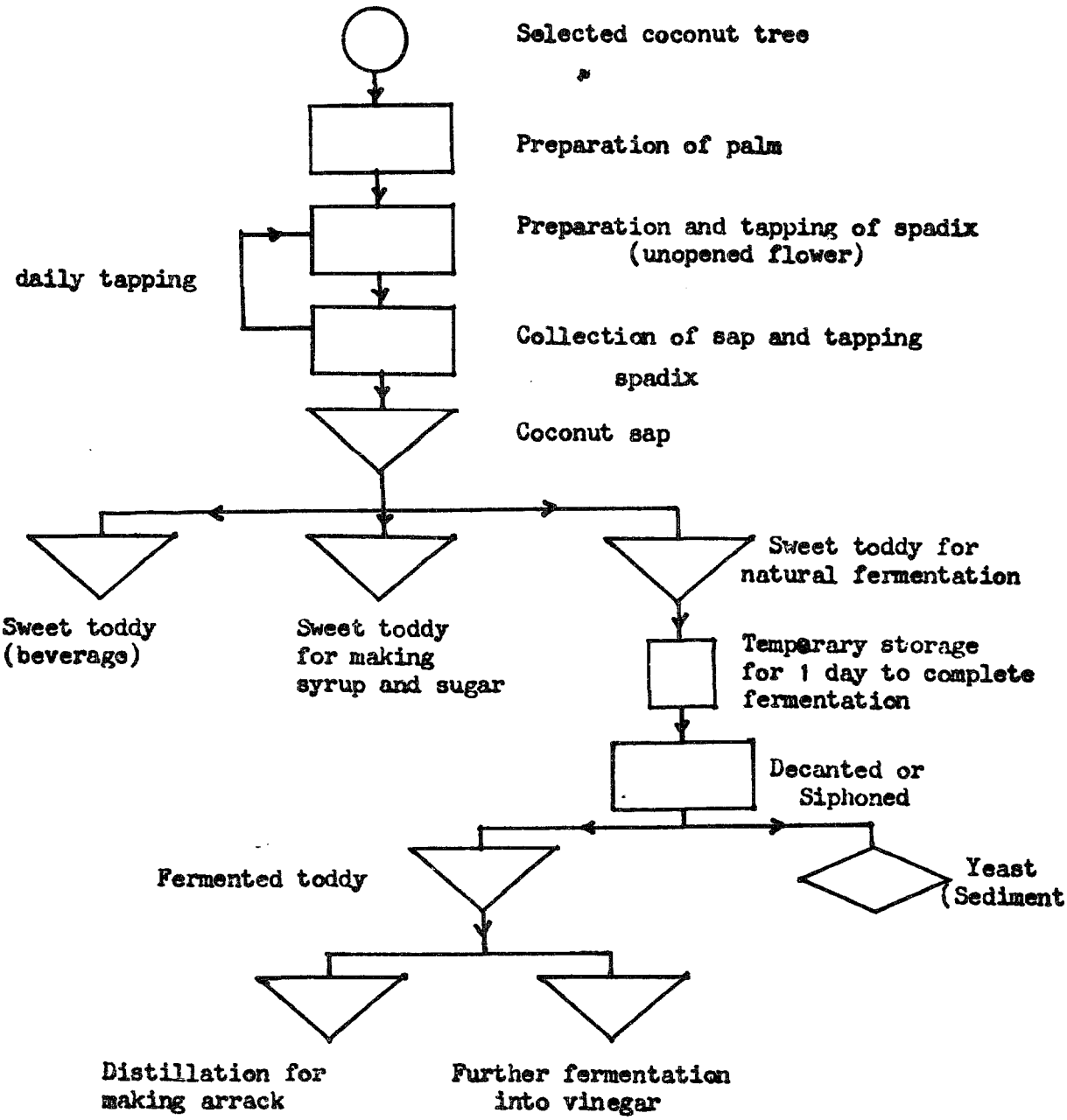
The average yield per palm per day with 8 months tapping per year can be taken as 2 bottles (1500 ml). Thus the average per palm per year (on the basis of 8 months tapping per year) will be 81 gallon or 370 litre. The average daily yield for typica x pumila F hybrid palm based on 12 trees over a one year period was found to be 3 bottles or 2250 ml per day (Ceylon Coconut Quarterly 1975 Vol XXVI Nos 1/2).

The yield of toddy depends upon the skill of the tapper. It must be further noted that the yield of sap has considerable variation from spadix to spadix, palm to palm, day to day and season to season. Further, a greater flow of sap occurs during the night than during the day. The yield also varies on the variety of the palm, its age, as well as the duration for which the palm has been continuously tapped.

The capacity of a tapper is 25 to 30 palms per working day when he has to climb the trees individually. In tapping groves however, where the palms are coupled with aerial ropeways, a man can manage 75 to 90 palms in a day, provided that he has an assistant on the ground to bulk the toddy that is collected and lowered down by ropes.

5. Process : -

5.1 Process flow diagram



5.2 Description of process : -

5.2.1 Meaning of tapping : -

The term "tapping" itself collectively denotes artificial extraction and the various processes of stimulating the different types of toddy yielding palms to exude juice (sap) from a selected part. Toddy is an exudate of plant sap, but in the different palm types employed for tapping, it is not necessarily drawn from the same region or portion of the palm.

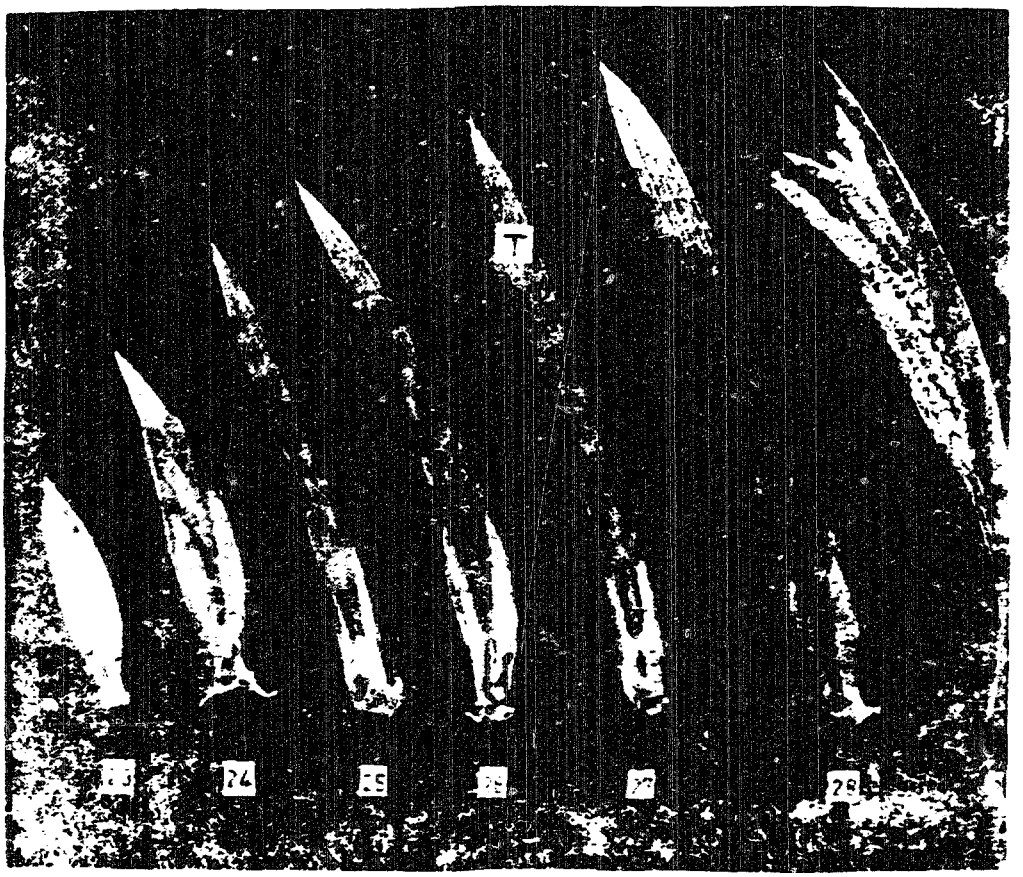
5.2.2 The spadix

In the coconut palm, it has been found that the tender spadix (floral branch or inflorescence) at a particular stage of development is best suited for tapping purposes. The spathe is the bract enveloping the spadix. In general, at any one time, if an average healthy coconut palm is stripped into its components, it should be possible to isolate about 44 developmental stages of the floral branch. These would range from the rudimentary initials to the cluster of ripe drupes as harvested. The figure in page 6 illustrates that the development stage 27 indicated with 'T' is the most suitable stage for tapping. The location of the spadix and it's details are also given in this page.

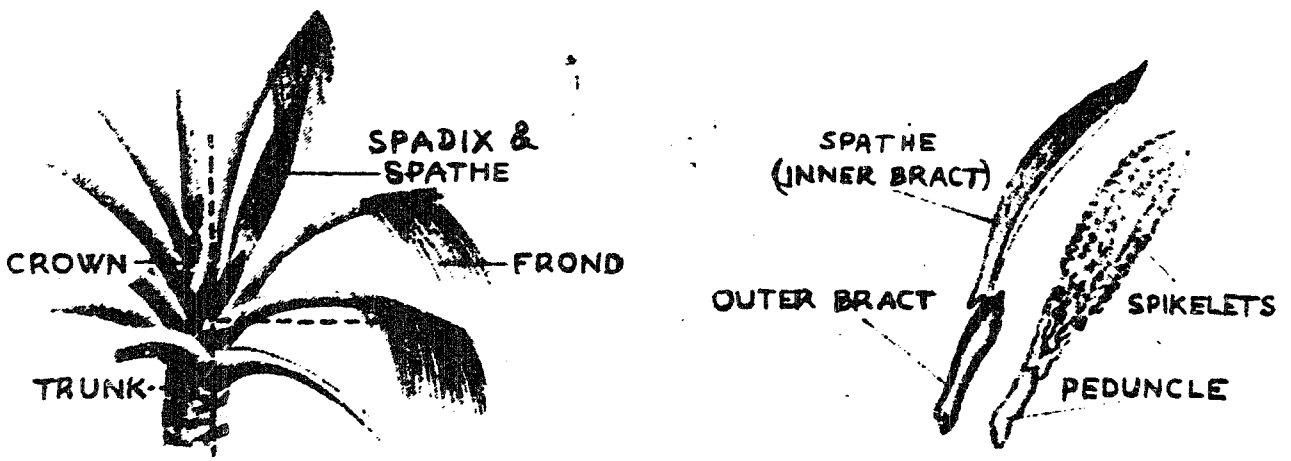
The spadix that is ready for tapping generally averages about 2.5 feet (760 mm) in length and about 3 to 5 inches (75 to 125 mm) diameter in the region of maximum girth.

5.2.3 Selection of palm

The selection of the palm for tapping is more a matter of instinct than communicable knowledge. The following characters however may serve as a guide in the pre-determination of suitable palms : -



THE STAGE 'T' AT WHICH THE DEVELOPING SPADIX
IS SUITED FOR TAPPING



LOCATION AND DETAILS OF SPADIX

See Section 5.2.2

(i) Palms with long inter-nodes

(ii) Palms bearing the full compliment of drupe developmental stages (usually 14).

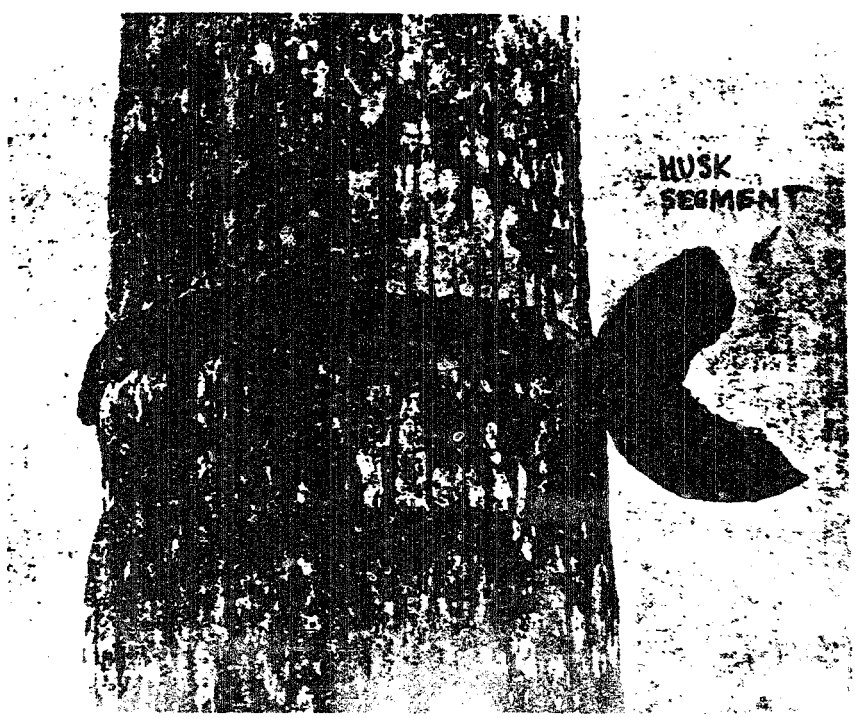
(iii) Relatively thin inner bract.

Judging from records in Sri Lanka it would appear that coconut palms could be tapped for an indefinite number of seasons as long as the rainfall is satisfactory and the palms are rested for 4 months in the year. In the dryer areas, the spadices after 3 to 5 consecutive seasons may propressively diminish in size and eventually abort. For best results it is always essential that the palms should be adequately manured. The practice of tapping alternate spadices though done in other countries has not be followed in Sri Lanka.

5.2.4 Preparation of palm : -

The preparation of the palm involves the following operations : -

(a) To climb the palm the toddy tapper generally makes use of segments of coconut husk fastened previously at convinient heights all the way up the trunk of the palm in the form of a ladder. This is illustrated in the figure.



When he has to climb palms that have not been prepared this way, he passes a girdle or loop (of soft rope, coir fibre or coconut leaflets) round his ankles to hold his feet close together and onto the trunk. With this simple contrivance he works his way up the palm like a looper caterpillar holding the trunk with his arms. When he reaches the crown of the palm, he settles himself on one of the larger fronds.

(b) While at the top of the palm, the tapper cleans and clears the crown with the cleaning knife.

(c) When groves of palm are to be tapped, the palms are inter-connected just below the crown with strong coir ropeways. Two ropeways are used for each pair of trees. The lower one to place the feet and the upper one to hold by hand. With this arrangement the tapper needs to climb up only one tree, attend to all the palms in the grove by moving from palm to palm using the ropways and finally climb down. This method which is much faster (See section 4.4 for capacity) however needs an unskilled assistant on the ground to bulk the collected toddy which is lowered in the pot by the use of a coir fibre rope.

5.2.5 <u>The tapping process</u>: -

The tapping process is essentially an art and the results therefore depend principally on the skill of the tapper. In essence the technique consists of carefully bruising and rupturing the tender tissues of the floral branch by gently hammering and pounding the spathe, without reducing the flower buds within to a pulp. These operations tend to direct the sap to the wounded parts through conducting elements within the stalk (peduncle) of the inflorescence.

Actually a variety of techniques are being used in Sri Lanka and elsewhere for achieving this but the method described in this document is the one that has been evolved

and adapted at the Coconut Research Board. This method has been found satisfactory in most respects, including yield coupled with rate and duration of flow of sap. It is recommended for the tall (typica) variety of coconut, which is grown extensively on plantation and commercial scale in many coconut growing countries.

The tapping technique described does not aim at "slaughter tapping" whereby the palm is forced to maximum yields but aims at a practical and logical technique for promoting even production over a long period of time.

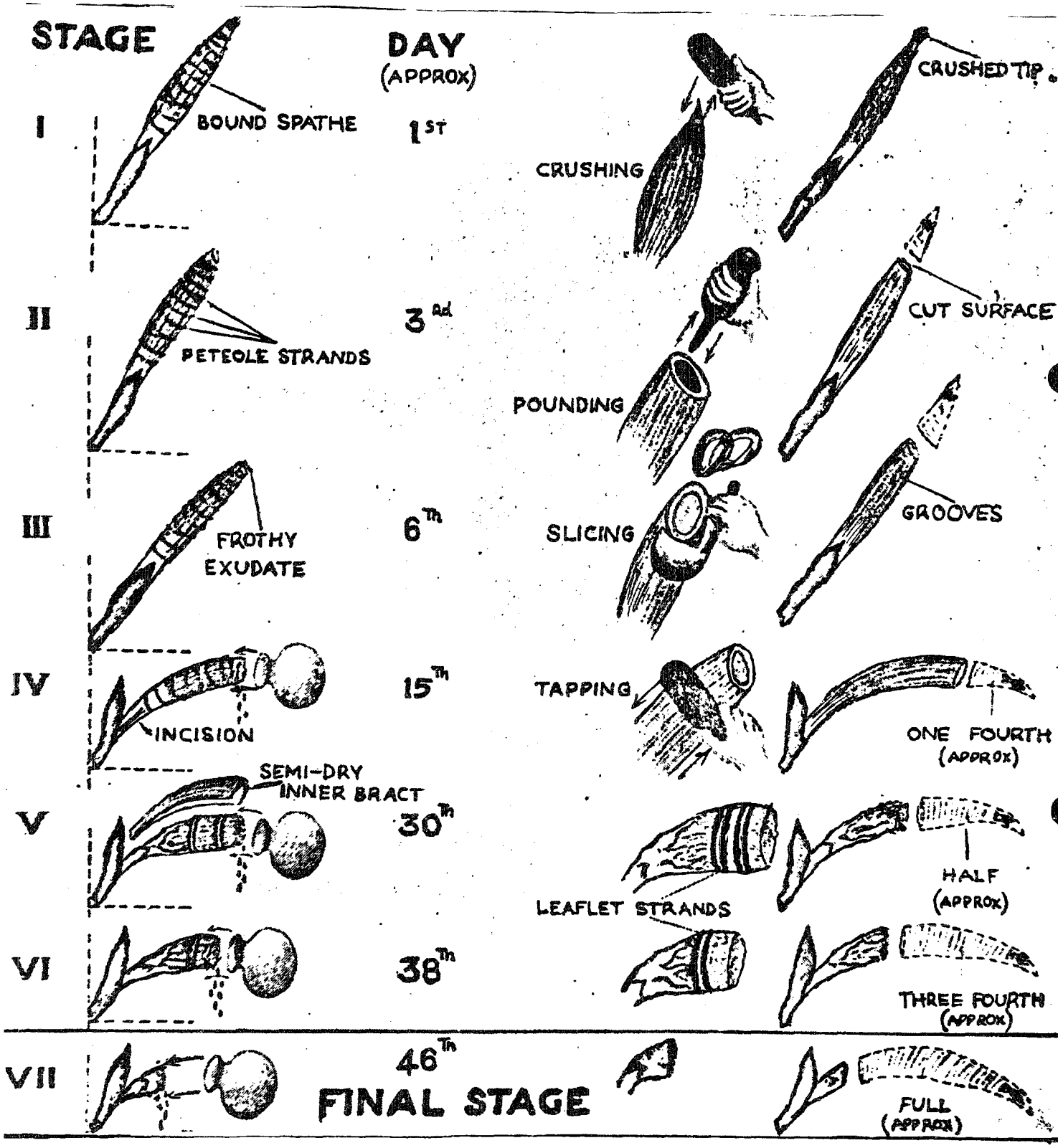
Apart from natural fluctuations in yield, contingent possibly on limiting and stable environmental factors, this method of tapping has been found to give economic and productive yields without causing any adverse symptoms on the palms.

5.2.6 The tapping technique

The various techniques described in this section on a day to day basis are illustrated in the figures given in page 10.

DAY 1 The operation on the first day (morning) in initiating the process of tapping, consist of binding the pre-selected spathe firmly all along it's length at intervals of ½ to 2 inches with fibrous strands. The strands are leaf stalks $\frac{1}{4}$ to ½ inch (6 to 12 mm) width stripped off from tender green fronds available at the crown of the palm. The binding prevents the splitting of the spathe (inner bract) due to expansion of the floral componants that are contained within. The outer surface of the spathe is then "tapped" or "beaten" all round with the hardwood (generally tamrind) mallet. In addition, the pointed apex of the spathe is also gently pounded using the tapered end of the mallet.

DAY 2 The tapping and pounding operations are repeated in exactly the same manner.



PROGRESSIVE STAGES IN TODDY TAPPING

See Section 5.2.6

DAY 3 The tapping and pounding operations are followed by cutting off transversely a length of about 2 inches (50 mm) of the composite apical tissues with the tapping knife. The cut end with the exposed flower buds is then carefully pounded with the handle of the mallet. This last operation is very essential and is restricted to the tip of the bound spathe only. The idea is to cause the crushed floral tissues to pack snugly at the apex thereby preventing the sap exuding from the terminals of the spikelets from running through the interstices and collecting within the body of the spathe. If this happens, the spadix may have to be discarded as spoilage would invariably set in consequent on heat and other fermentative changes.

DAY 4 & 5 Once each day, the operations of day 3 are repeated in the mornings preferably before 11.00 o'clock. The apical tissues however are not cut on day 4 & 5.

DAY 6 onwards to flow of sap From day 6 onwards till about day 12 or until the flow of sap commences, a slightly different technique is introduced. After the usual tapping and pounding operation, a very thin slice of about 2 mm from the apical tissues is pared off with the tapping knife. The slicing in done twice each day (before 11.00 am and about 4.00 pm) but the tapping and pounding operation is carried out only in the mornings until the flow of sap commences.

Though the tapper knows through experience the proper time when the toddy begins to ooze, yet the appearance of ants, bees, wasps and flies around the spathe and the characteristic smell of toddy are good indications of the time of exudation.

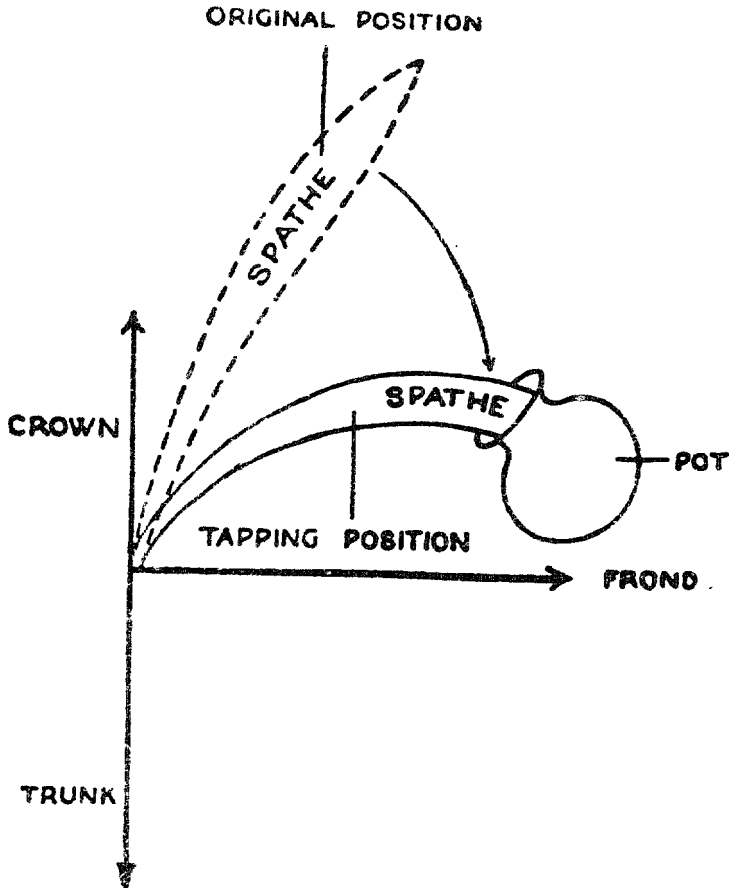
DAY 12 to 46 Once the sap begins to drip, (usually Day 12 to 15) the tapping and bruising operations are discontinued, but the exposed end of the inflorescence is shaved off afresh twice a day as usual.

At this stage, the earthenware pot is slipped over the free end of the spathe, supported in position by it's own weight or may be tied to a nearby frond. The figure in page 13 illustrates the original and tapping positions of the spathe. In the natural position, as the distal (far) end of the spathe is considerably higher than the proximal (near) end, there is every chance of the juice flowing from the cut end trickling down along the spadix into the leaf axil. This could cause spoilage at the base. In order to avoid this, the free end of the spadix is gradually bent down till it slopes at an angle of about 25° to the horizontal, and its tied down with coir rope to the frond directly beneath it. To facilitate this flexure, a longitudinal incision about 4 to 5 inches (100 to 125 mm) in length near the base of the spadix (above the point of it's union with the stem) splitting the outer and inner bracts alone may be made without injury to the stalk of the inflorescence itself.

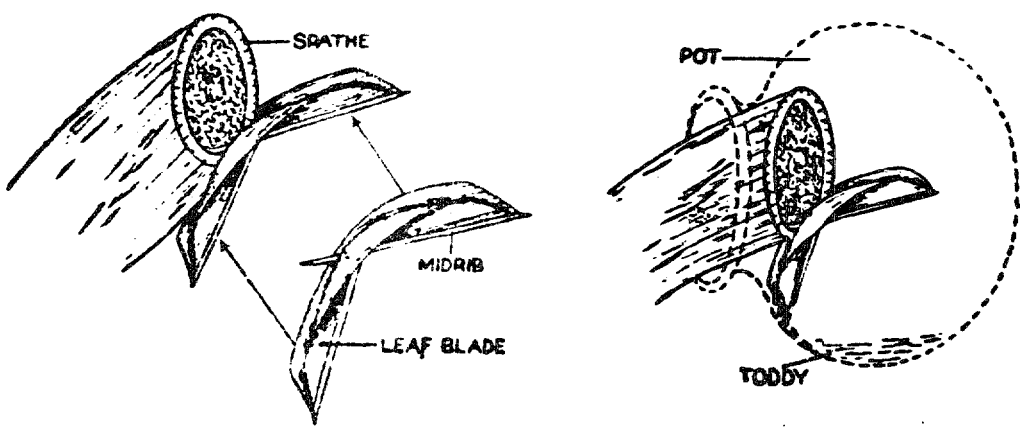
A device to direct the sap into the pot is to pin-on to the cut end of the spathe an improvised fluted spout. The spout is made from a 2 inch (50 mm) strip of the V-shaped green coconut leaflet with the ventral side upwards. The pinning-on is done using the midrib known as "eekil". The diagrams in page 13 gives details of this improvised spout.

Using the above technique, regularly paring the spadix and collecting the sap twice daily, it is usually possible to continue tapping a single spadix till it is reduced to a stump about 4 to 6 inches (100 to 150 mm) in length. Regarding the duration of tapping for a single spadix, an experiment has shown that from the onset of exudation the period is in the region of 31 days for the typica variety of the coconut palm.

To prevent any break in continuity, about three weeks prior to the anticipated time of cessation of tapping



BENDING SPADIX (AND SPATHE) FOR TODDY COLECTION



SIMPLE SPOUT FOR DRIPPING TODDY

See Page: 12.

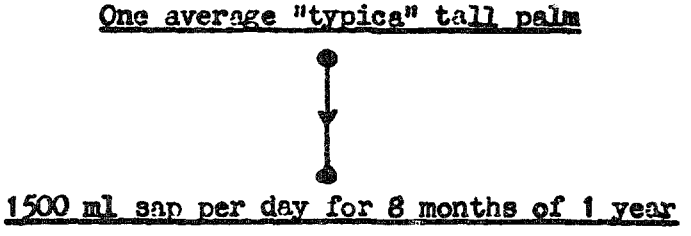
on a spadix; the next younger spadix in the crown is gradually prepared for tapping. It has been found possible to continue this sequence without a break for a period of one year in good palms.

The interval from the commencement of tapping to the dripping of the juice would depend on the skill of the tapper, the seasonal conditions prevailing and the nature of the palm. In the literature available on this subject, 10 to 35 days have been quoted by different writers. Employing the above method on selected palms, the time interval has been rarely found to exceed 12 to 15 days.

For the first few days, only a meagre flow of juice could be anticipated. Thereafter, as the flow increases, the sap is collected twice a day (morning and afternoon), the tapper pouring off the contents in the pot into a bigger one which he himself carries on his visits from palm to palm. When the tapper deals with groves of palms which are joined together with coir ropeways, the filled pots of toddy are lowered using a rope. An assistant bulks the toddy on the ground while the tapper draws the emptied pot up for further collection.

When the sole purpose of collecting toddy is for processing into syrup(treacle) or sugar (Jaggery), the earthenware pots used for collecting toddy are treated with lime to prevent alcoholic fermentation. The toddy collected in pots without such treatment undergoes fermentation due to the culture of yeast found in the environment.

5.3 Product flow diagram : -



6. Quality of finished product : -

Unfermented coconut sap is sweet, oyster white and transluscent. The average composition of Sri Lanka toddy (Nathaneal - 1956) is given hereunder : -

	Fresh toddy	Fermented toddy	Stale toddy
Total solids (gm/100 ml)	18.7	4.5	4.4
Sucrose(gm/100 ml)	16.5	-	-
Ash (gm/100 ml)	0.4	0.4	0.4
Acidity (gm Acetic/100 ml)	trace	0.6	1.6
Alcohol (v/v)	nil	7.5	6.5

7. Source of information : -

"Toddy Tapping" Leaflet No : - 48 (1967) issued by the Coconut Research Board, Lunuwila, Sri Lanka.

T.K.G.R. 1979.

Product code : CCCN 17.02
Technology sheet no: V / 33

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - PROCESSING COCONUT SUGAR FROM FRESH SAP (SWEET TODDY) - (Cottage Industry)

2. Uses of finished product : - Edible purposes and for preparation of traditional dessert.

3. Country of origin : - THAILAND

4. Equipment : -

4.1 Description of equipment : -

4.1.1 One horizontal fireplace with provision for two cooking vessels and chimney. See diagram in page 2 for details. This is inside a temporary shed for shelter.

4.1.2 Two Cooking vessels of steel each 70 litre capacity. See details in page 2.

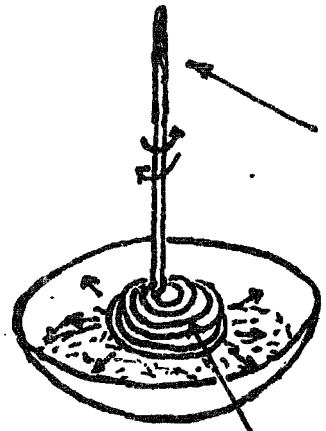
4.1.3 Two baskets of woven bamboo strips. See details in page 2.

4.1.4 Stirring device with spring coil. See details in page 2.

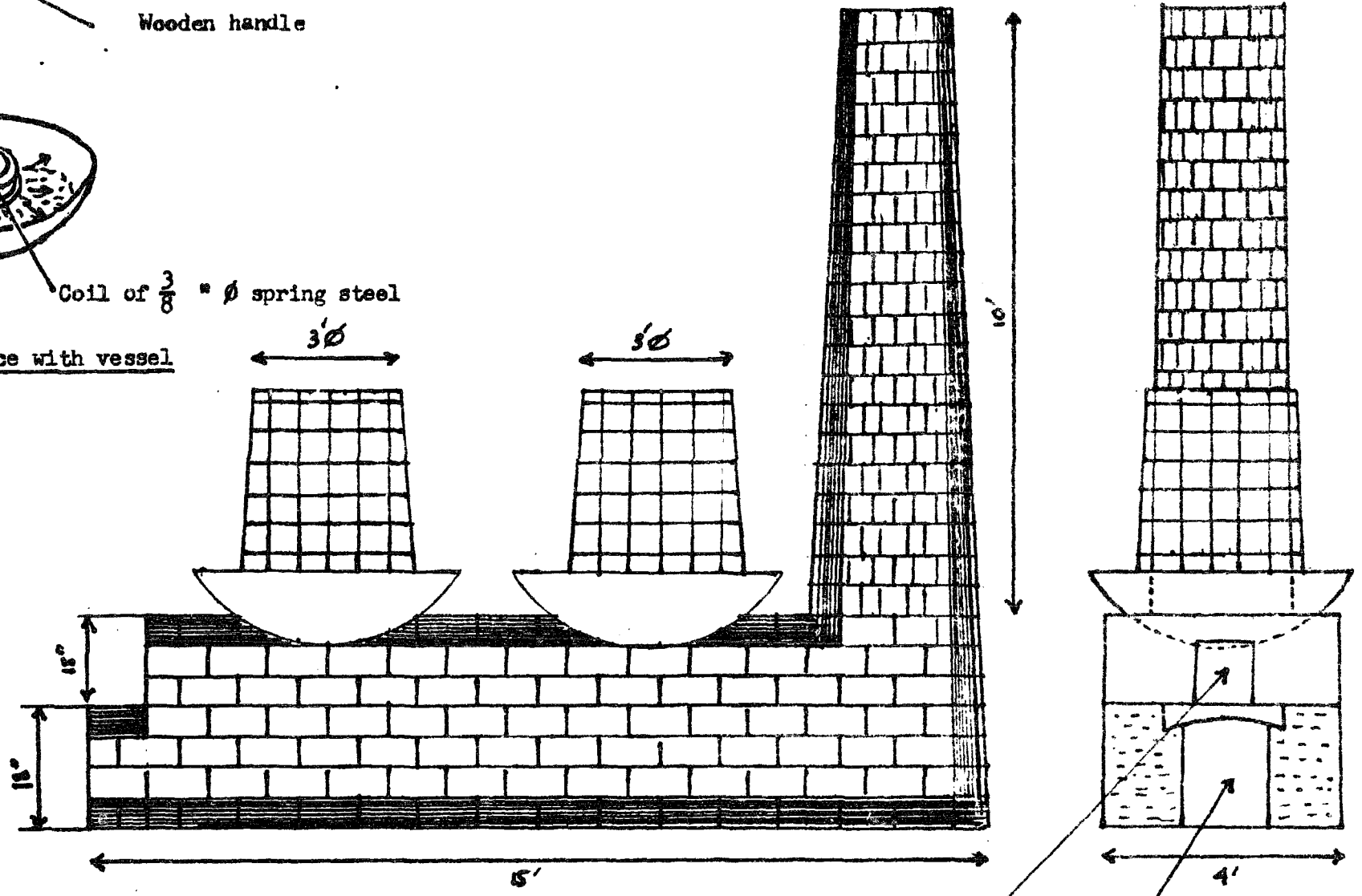
4.1.5 Bamboo vessels for sap collection

- 1.5 litre capacity for day collection.

- 2.0 litre capacity for night collection.



Stirring device with vessel



Sectional elevation

End elevation

4.2 Materials for construction : -

Ordinary bricks for foundation, side walls and chimney-quantity not known.

Fire bricks (large) of special shape for arch of horizontal portion of fire place. The weight of the cooking vessels is taken directly by the side walls.

The entire fire place, and chimney are housed inside a temporary shed of about 10' ft width x 16ft length. This provides for a little working space for crystallization of the sugar and packing the finished product. The shed is constructed entirely of local materials which would keep the cost very low. The chimney rises above the roof facilitating exhaust of smoke.

4.3 Cost of construction & equipment : -

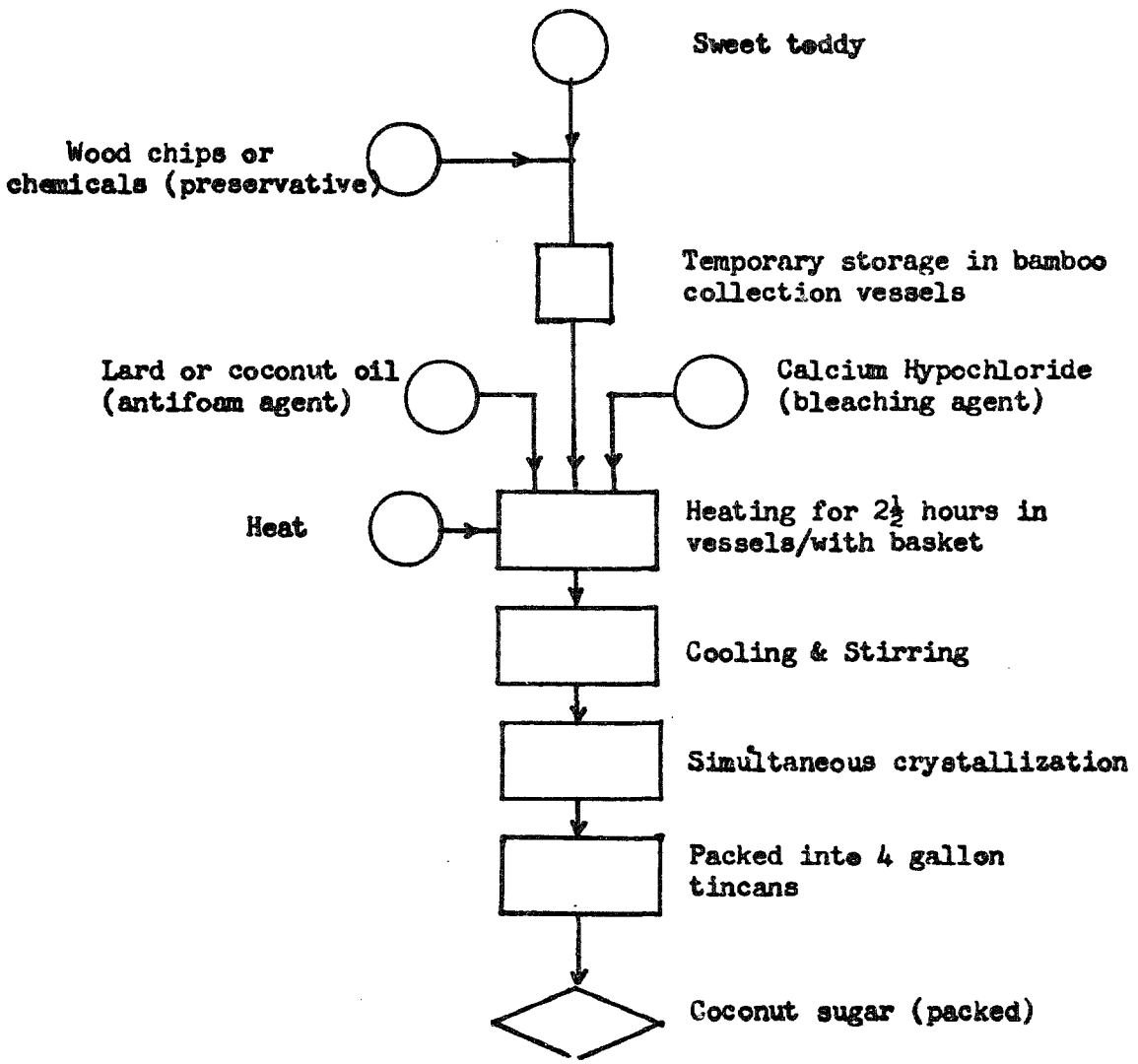
The cost details are not available.

4.4 Capacity: -

The output per vessel in 2½ hours cycle time is 7.5 kg sugar. The fireplace with two cooking vessels working for a 8 hour day with two members of the family can produce 45 kg coconut sugar per day.

5. Process : -

5.1 Process flow diagram : -



5.2 Description of process : -

Fresh sap (local name "Maprau") is collected on the tree into bamboo vessels. See technology sheets on tapping sap for details. The collection during the night is in 2 litre vessels while during the day, the collection is in 1.5 litre vessels, 3 to 5 gm of hardwood chips is added into the bamboo collection vessels while at the top of the tree to preserve the invert sugar content from fermenting into alcohol. There are two varieties of wood available for this purpose. The local names are "Kium" and "Payom". Care must be taken to ensure that not too much is added or else the toddy will become too bitter (astringent). The preservative is effective upto 6 hours at room temperature. Alternatively, chemicals can be added to perform this function. They are either 0.2% sodium Benzoate or 60 ppm of Sulfanilamide.

About 50 to 53 litre of toddy is poured into each 70 litre steel cooking vessel. Three or four drops of lard oil or alternatively coconut oil is added as an antifoam agent. One teaspoon of Calcium Hypochloride is added as a bleaching agent to improve the colour of the finished sugar. For each vessel, a basket made of bamboo strips is placed to contain rising foam during the heating process.

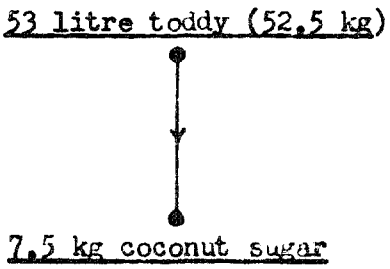
The fire is started and maintained for about 2½ hours until foaming ceases when the water content has evaporated. Coconut fronds, dried coconut leaves etc are used as firewood. Rapid boiling is avoided so as to minimize caramelization.

The vessel containing the thick liquid is now removed from the fire place and placed on the floor. As the cooling proceeds, the contents are stirred by the device. When the contents start to thicken further, the stirring device is dipped, lifted and rotated between the two palms of the worker. This throws out the material radially onto the walls of the vessel. This rapid cooling cum stirring action prevents any isolated crystallization. Towards the end of this operation, there is simultaneous crystallization

throughout the entire contents; giving rise to regular shaped small crystals. The colour of the sugar is light brown such as the colour of pine wood. From one vessel, about 7.5 kg of sugar is obtained per cycle.

The sugar is emptied from the vessel into 4 gallon tin cans and lidded.

5.3 **Product flow diagram : -**



Estimated yield is $\frac{1}{7}$ or 14.3% on weight to weight basis.

6. Quality of finished product : -

This edible sugar consists of regular shaped small crystals. The colour is light brown (pale brown) similar in colour to pine wood. As there is no removal of molasses, the sugar is neither a hard nor a granular substance but a very coarse semi-solid material.

The sugar is very sweet and has a characteristic flavour due to the raw material used.

7. Source of information : -

Observations during a field visit to a cottage industry on the outskirts of Bangkok.

T.K.G.R. 1979.

Product code : CCCN 17.02
Technology sheet no: V / 34

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT SYRUP (TREACLE) AND COCONUT SUGAR (JAGGARY) FROM FRESH COCONUT SAP (SWEET TODDY) - (Cottage Industry).

2. Uses of finished products : - Coconut syrup is used as a sweetening agent for many traditional food preparations including dessert.

Coconut sugar is used for edible purposes as well as a sweetening agent in many traditional food preparations.

3. Country of origin : - SRI LANKA. These products are also made in INDIA, MALAYSIA, INDONESIA and THAILAND. For Thailand, see separate technology sheet. As regards Indonesia, tapping coconut sap and manufacture of these products is confined to West and Central Jawa provinces. In other coconut provinces the Aren (Arenga) palm is preferred. Syrup and sugar are not produced in the Philippines and the coconut sap is used only as a beverage.

See separate technology sheet CCCN 17.02 for the commercial process in Sri Lanka for sugar manufacture.

4. Equipment : -

4.1 Description of equipment

An open steel cocking vessel of about 5 gallons (22 litre) capacity
Stirrer (wooden)
Traditional fire place
Bottles for packing syrup and or clean coconut shell halves for cooling and crystallizing the sugar.

4.2 Materials for construction : - Not applicable.

4.3 Cost of equipment : -

Estimated cost of cooking vessel is Rs.100/= or US$ 6.40 (Rs.15/60 per US$). Other costs donot arise for household process.

4.4 Capacity : -

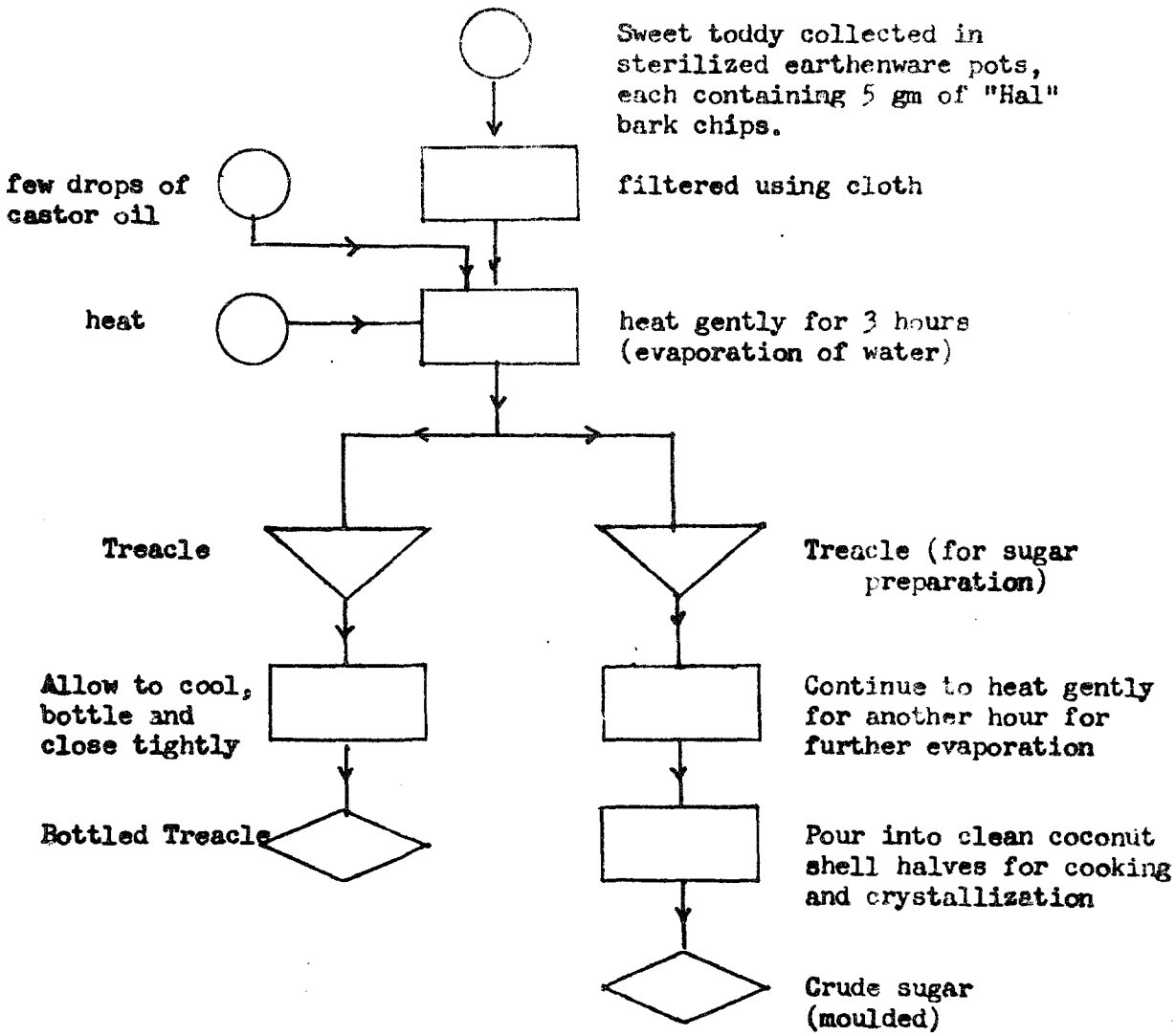
For the home process using a cooking vessel of about 5 gallon capacity and utilizing say 2½ gallon of it's capacity, the capacity per batch is as follows : -

For treacle (syrup) - 4 lb (1.9 kg) in about 3 hours

For sugar (Jaggary) - 3.5 lb (1.6 kg) in about 4 hours

5. Process : -

5.1 Process flow diagram : -



5.2 **Description of process : -**

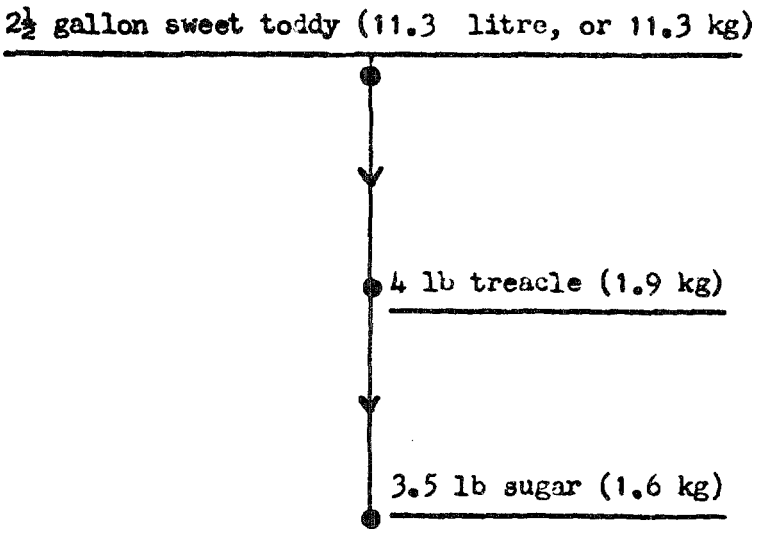
Sweet toddy is collected on top of the palm in sterilized earthenware pots. Sterilization is carried out by holding the pot to the naked flame. This destroys all the micro-organisms which cause fermentation. About one teaspoon (5 gm) of finely cut "Hal" bark (veteria acuminata) chips is added to each pot and this acts as an antiferment. For the treacle and sugar industry, the toddy must be collected twice a day (morning and afternoon) and then processed without delay to avoid losses due to fermentation action caused by the bacteria in the air.

The sweet toddy is filtered by cloth and poured into an open vessel for evaporation. The vessel is filled to only half capacity because, space is required for foaming which takes place during application of heat. A few drops of castor oil is added to reduce the foaming action.

Heating must be so controlled as to avoid excessive foaming and spill over. The contents must be stirred steadily. After about 3 hours heating, the loss of water content transforms the material into one of thick consistency. The syrup is now ready. It is allowed to cool and carefully poured into clean bottles and closed tightly after some time. The pouring should be gradual along the inner edge of the bottle to avoid aeration (bubble formation). The bottles have to be kept tightly closed to avoid mould attack.

When sugar is the desired end product, the material is heated with occasional stirring for a further one hour beyond the treacle stage for near complete evaporation of water. Heating should be done slowly so as to avoid caramalization of the sugars. When the material is very thick, it is poured into clean coconut shell halves for cooling and crystallization. The moulded sugar is removed from the shells and wrapped in special varieties of dried leaves.

5.3 Product flow diagram : -



6. Quality of finished product : -

Treacle : - This is a very sweet, thick syrup. It has a characteristic flavour due to the starting material being coconut sap. The sugar content is about 75%.

Sugar : - This is a crude, dark brown sugar in a moulded form. It is coarse and the crystals are in varying sizes. The characteristic flavour (due to the starting material) is enjoyed by the people in coconut areas. The sugar content is about 80%.

7. Source of information : -

Observations made in Sri Lanka by the writer.

T.K.G.R. 1979.

Product code : - CCCN 17.02
Technology sheet no: V / 35

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT SUGAR (JAGGERY) USING FRESH SAP (SWEET TODDY) - (Small Scale Industry)

2. Uses of finished product : - Coconut sugar is used for edible purposes as well as a sweetening agent in traditional food preparations.

Molasses This by-product is also used as a sweetening agent in traditional food preparations.

3. Country of origin : - SRI LANKA

See technology sheet for preparation of coconut sugar at the cottage industry level in Thailand.
See technology sheet for toddy tapping in Sri Lanka.

4. Equipment: -

4.1 Description of equipment and chemicals

4.1.1 A set of about 300 unglazed earthenware pots of 1 gallon (4.5 litre) capacity and specially treated as detailed in section 5.2 (Estimated Cost per pot Rp 3/-).

4.1.2 Muslin cloth for filtering toddy. Three square yards adequate for 6 months use. Cost per square yard Rs 25/- (estimated).

4.1.3 Three settling vessels of capacity 35 gallons (160 litres) Rs 1200/= each.

4.1.4 Three deliming vessels of rectangular shape and capacity 35 gallons. Rs 1100/= each.

4.1.5 Four concentration vessels of galvanised iron and 12 gallons (55 litre) capacity. Rs 300/= each.

4.1.6 Four stirrers and scraping devices (all wooden)

4.1.7 Two crystallizer vessels of capacity 30 gallon (135 litre) Rs 1400/= each.

4.1.8 One centrifuge, pedal operated (locally fabricated). Rs 7000/= each.

4.1.9 Two furnaces costing Rs 3000/= each.

4.1.10 Packing material for sugar and empty bottles for molasses.

4.1.11 Building of semipermanent construction and area 700 square feet. Estimated cost Rs 35,000/= at Rs 50/= per square foot.

Chemicals and laboratory equipment required

Lime (Calcium Carbonate)	-	2 Bushels for 5 days at Rs 16/= per bushel.
Trisodium Phosphate	-	500 lbs for 6 months at Rs 0/60 cts per lb.
P^H indicator paper	-	for 6 months use 3 units at Rs 50/= each

Thermometers (0-200°C range) - 2 Nos at Rs 100/= each.
Measuring cylinders (1 litre)- 2 Nos at Rs 48/= each.

4.2 Materials for construction : - Not applicable.

4.3 Cost of equipment and chemicals

Cost of building	Rs 35,000/=	
Cost of equipment	24,000/=	
Cost of chemicals etc for 6 months	1,900/=	
Total cost	Rs 61,000/=	US$ 3910

(1US$ = Rs 15/60)

4.4 Capacity/yield

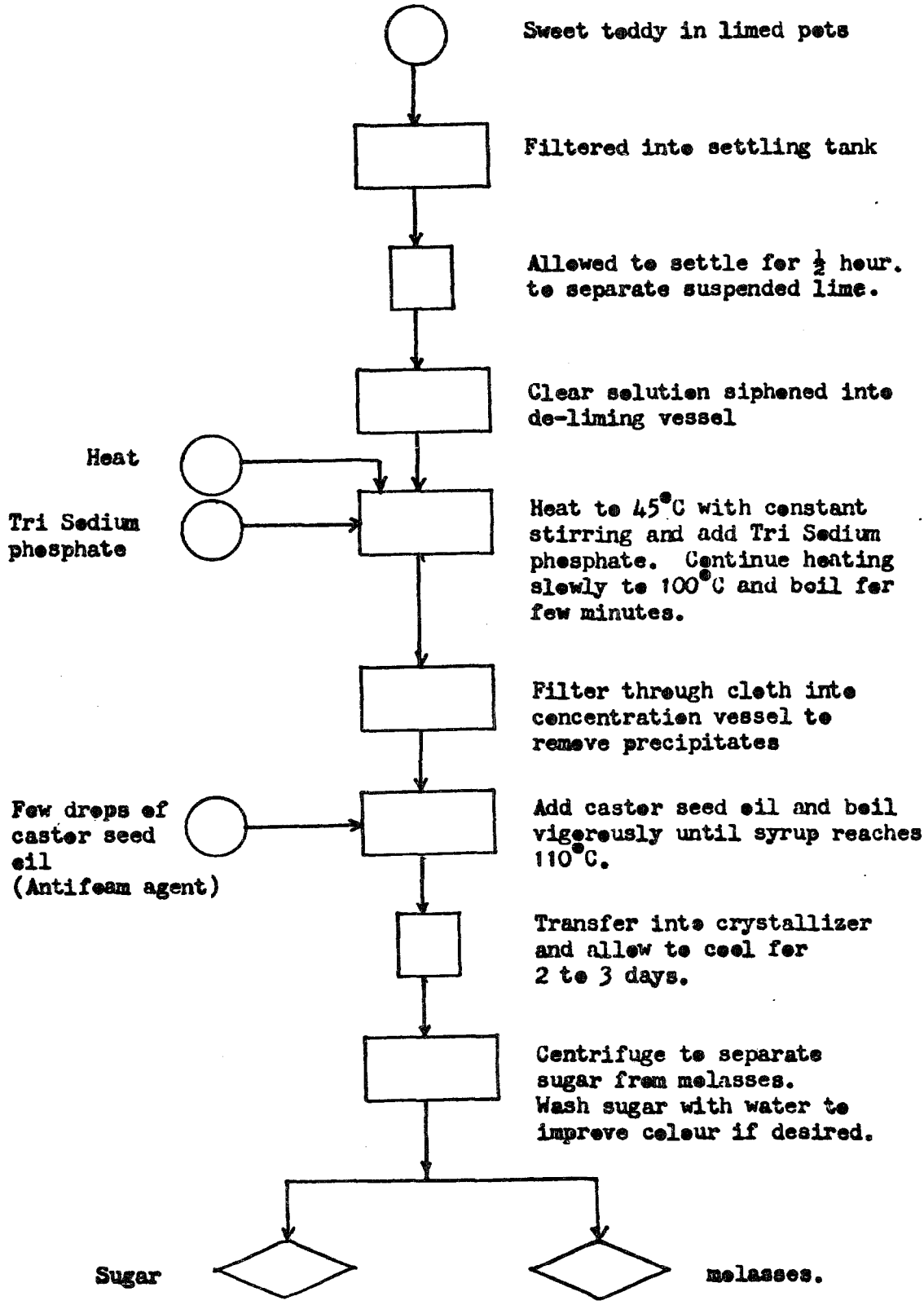
The average yield of todqy per palm per day is 2 bottles (1500 ml). The yield depends upon the skill of the tapper. It must be further noted that the yield of toddy has considerable variation from spadix to spadix, palm to palm, day to day and season to season.

The average yield of toddy from a grove of 80 palms is 26.6 gallons per day.

One gallon of toddy yields ½ lb sugar and 1 bottle of molasses. The capacity per day for the industry having a grove of 80 palms will be 13.3 lb (6 kg) and 26.6 bottles (20 litres) of molasses. If the sugar is not washed, the yield per gallon of toddy is $\frac{3}{4}$ lb sugar and $\frac{3}{4}$ bottle molasses but the sugar is dark brown.

5. Process

5.1 Process flow diagram



- 5 -

5.2 Description of process

5.2.1 Toddy tapping

The technology sheet for tapping toddy in Sri Lanka gives details of the process. The collection pot however has to be treated to prevent fermentation of the sugar into alcohol. The gove of palms is interconnected by ropeways to facilitate tapping and collection of toddy.

5.2.2 Treatment of collection pots

One gallon capacity unglazed earthenware pots are washed, dried and held to the naked flame to remove any live bacteria which causes fermentation of sugars into alcohol. This procedure is carried for all pots every two days. Freshly burnt lime (Calcium Carbonate) in the form of a paste is applied to the interior of the pot. The dosage per pot is 9 to 13 gm ($\frac{1}{3}$ to $\frac{1}{2}$ ounce) which is 0.2 to 0.3% by weight of sweet toddy held in the pot. Due to the liming of the pots, the sweet toddy collected is maintained alkaline (P^H above 7) so that the inversion of sucrose does not take place due to the culture of bacteria found in the air.

5.2.3 Collection of sweet toddy

Every morning the tappers climb the palms and lower the pot containing the toddy using a coir rope. A fresh pot is immediately hoisted up the palm and placed in position for collection during the next 24 hours. Whilst on the palm during the morning, the spadix is pared (sliced thin) to promote flow of sap. The paring is carried out again in the evening but collection of toddy is done only in the mornings.

Any fermented toddy is detected by it's smell, as well as by the bubbling of gases. This is confirmed by the

P^H indicator paper. Fermented toddy is not used for manufacture of sugar.

The average yield of toddy per palm per day is 2 bottles (1500 ml).

5.2.4 Filtration of sweet toddy

The sweet toddy is filtered (through muslin cloth to remove resins, insects, ants etc) into a settling tank of 35 gallon capacity. This is allowed to stand for half hour to settle any excess lime suspended in the toddy. The clear solution is siphoned out for the de-liming process.

5.2.5 De-liming process

The de-liming vessel is of rectangular shape and of capacity 35 gallons. The vessel is gradually heated with constant stirring using a wooden ladle until toddy reaches a temperature of 45°C. At this point 10% tri-sodium phosphate solution is added slowly to precipitate the calcium salt as insoluble calcium phosphate. Usually 1 to 1½ lbs of 10% solution required per gallon of sweet toddy. The addition of phosphate solution is stopped when the P^H value drops to 6.8 to 7 as tested with P^H indicator paper. Thereafter the temperature is slowly raised to 100°C with occassional stirring. After a few minutes of boiling, the solution is carefully transferred to a 35 gallon settling tank to remove the precipitates by straining through a filter cloth. The clear filtrate free from lime is now ready for concentration and crystallization.

5.2.6 Concentration and crystallization

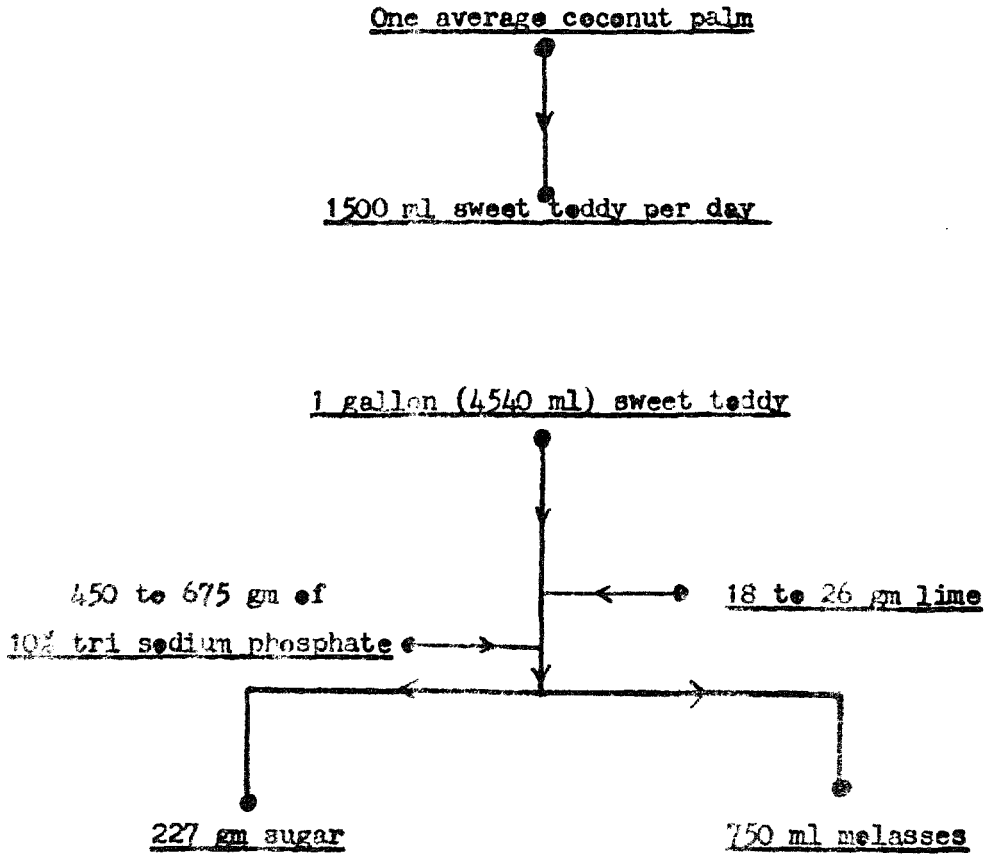
The clear solution is boiled vigorously after sprinkling a few drops of caster seed oil as an antifoam agent. The syrup is continuously stirred while boiling to prevent caramelization. Gradually the syrup thickens into a semi-solid state.

When the temperature of the syrup reach 110°C, it is lowered into a 30 gallon crystallizer and allowed to cool slowly at room temperature with intermittent stirring for 2 to 3 days. Thereafter, the crystallized syrup is centrifuged in a pedal operated locally fabricated centrifuge.

A spray of water is given to obtain a whiter colour sugar which is desirable.

The yield of sugar is normally $\frac{1}{2}$ lb (227 gm) with 1 bottle (750 ml) of molasses from 1 gallon of sweet teddy. If however, the water wash is not carried out, the yield per gallon of teddy will be $\frac{3}{4}$ lb (340 gm) sugar and $\frac{3}{4}$ bottle (560 ml) of molasses. This however gives a sugar which is not quite suitable.

5.3 Product flow diagram : -



6. Quality of finished product: -

The cocenut sugar is coarse and brown in colour. It is very sweet and has a characteristic flavour due to the source being from cocenut sap.

7. Source of information: -

Study carried out by UNIDO Industrial Ecenomist attached to APCC - Reference Report of Cocotech meeting 13 - 18 October 1975 in Jakarta. Document No. ACC/COCOTECH - 75/III-B/2.

T.K.G.R 1979.

Product code: CCCN 22.10
Technology sheet no: V / 36

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - VINEGAR FROM COCONUT SAP (TODDY) USING GENERATOR PROCESS (Small scale industry)

2. Uses of finished product : - Household and commercial uses in preservation of fruits, vegetables, preparation of pickles, sauces, chutneys and other manufactured products.

3. Country of origin : - SRI LANKA

4. Equipment : -

4.1 Description of equipment: -

The principal components of a generator assembly comprise of a feed (or supply) vat, an acetifier and a receiving trough. For a diagram of the assembly see Figure 1, page 2.

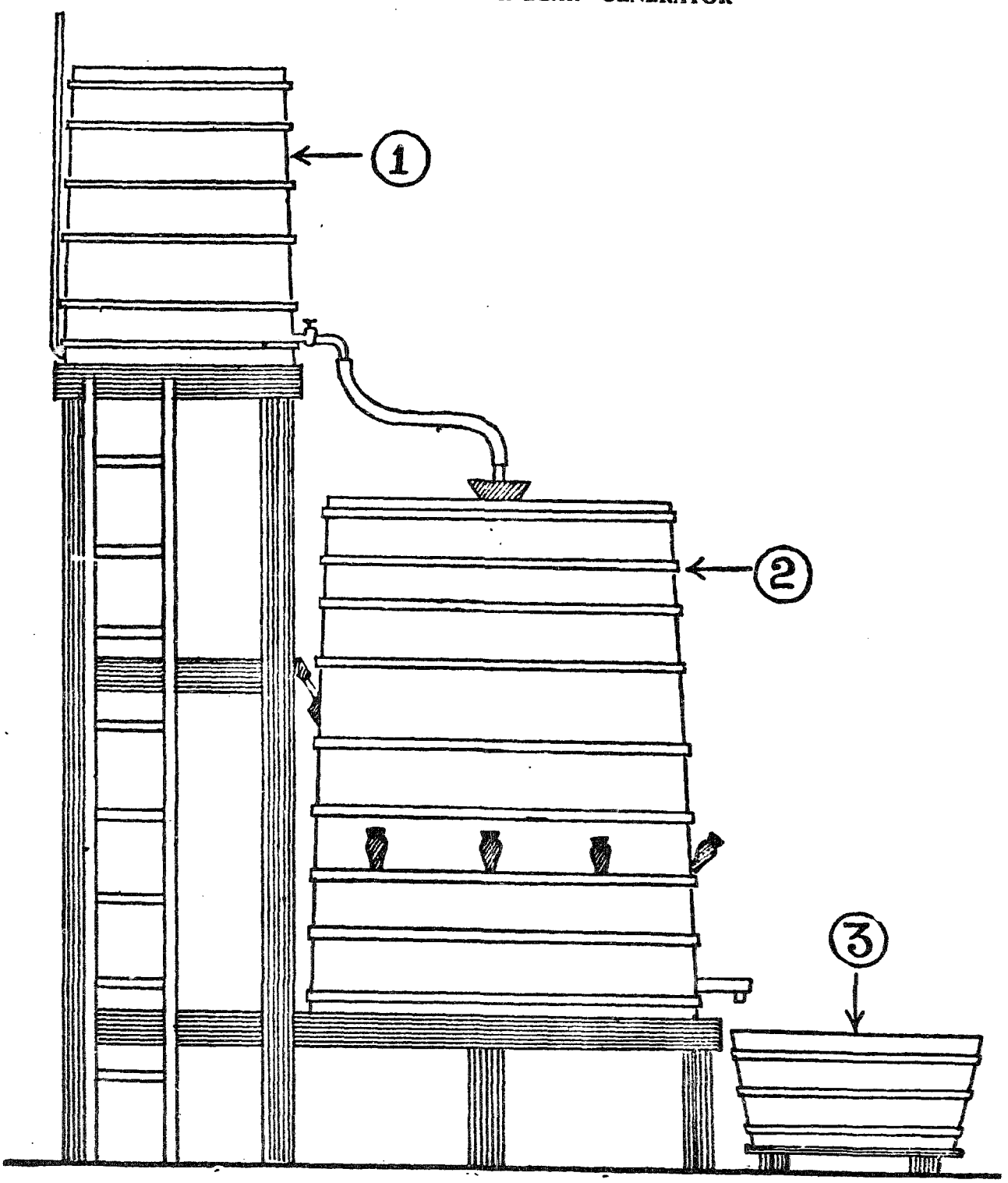
4.1.1 Feed vat: - This is a simple conical wooden vat with a capacity slightly exceeding 150 gallons. To minimise evaporation losses, it is preferable to make this a closed covered vessel with a 16 inch square opening on top (like a man-hole) with a suitable lid.

The vat should be provided with a gauge (to indicate liquid level) and a glass tap (connected by rubber tubing to the acetifier) to regulate the feed rate. For details see Figure II, page 3.

4.1.2 Acetifier: - This is the vital part of the assembly. It is a tall conical wooden vat (about seven feet high) with three superimposed compartments, separated by perforated shelves.

FIGURE 1

COMMERCIAL SCALE VINEGAR GENERATOR

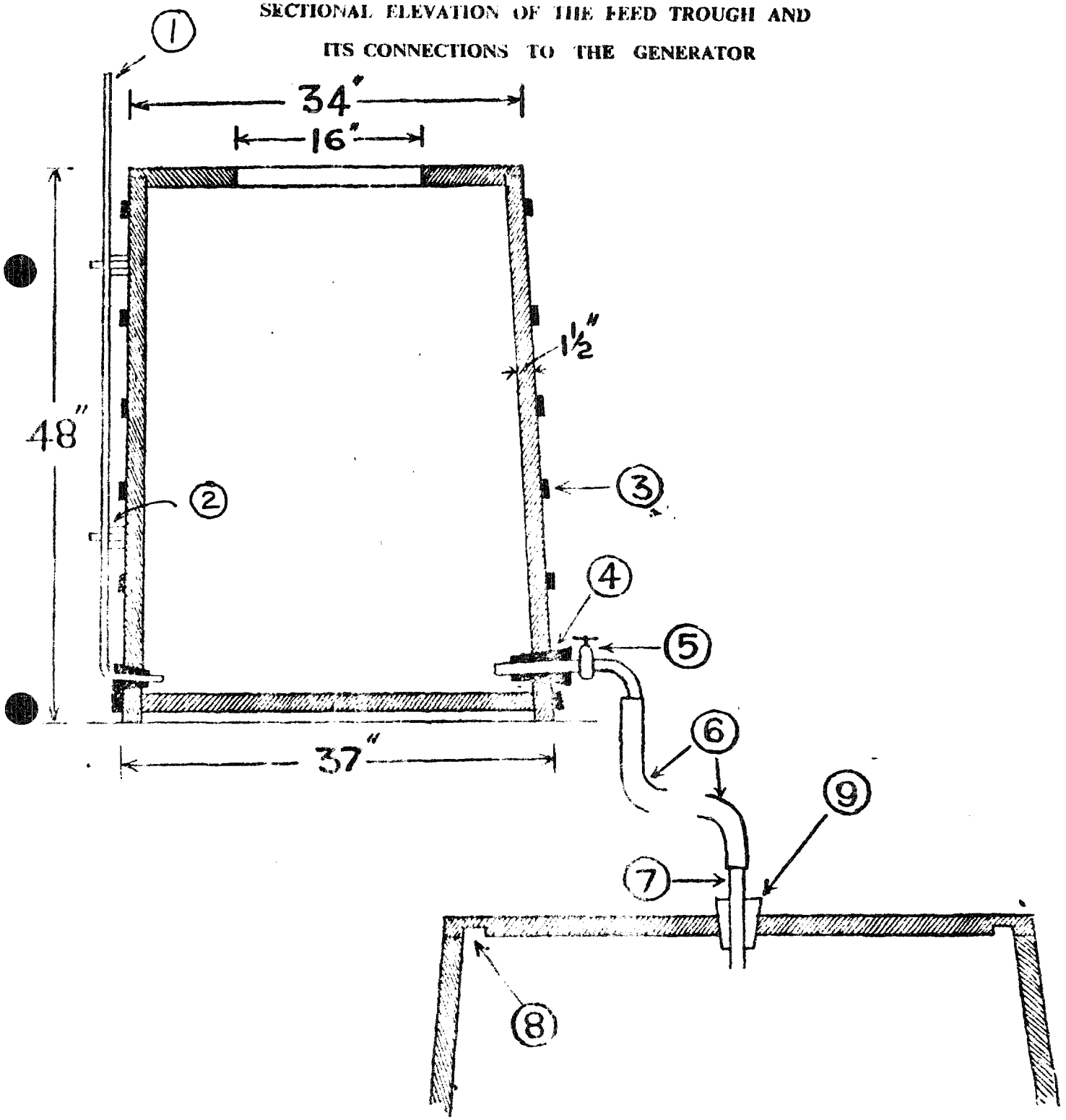


(scale half inch to a foot).

1. Feed Trough 2. Acetifier 3. Receiving trough.

FIGURE II

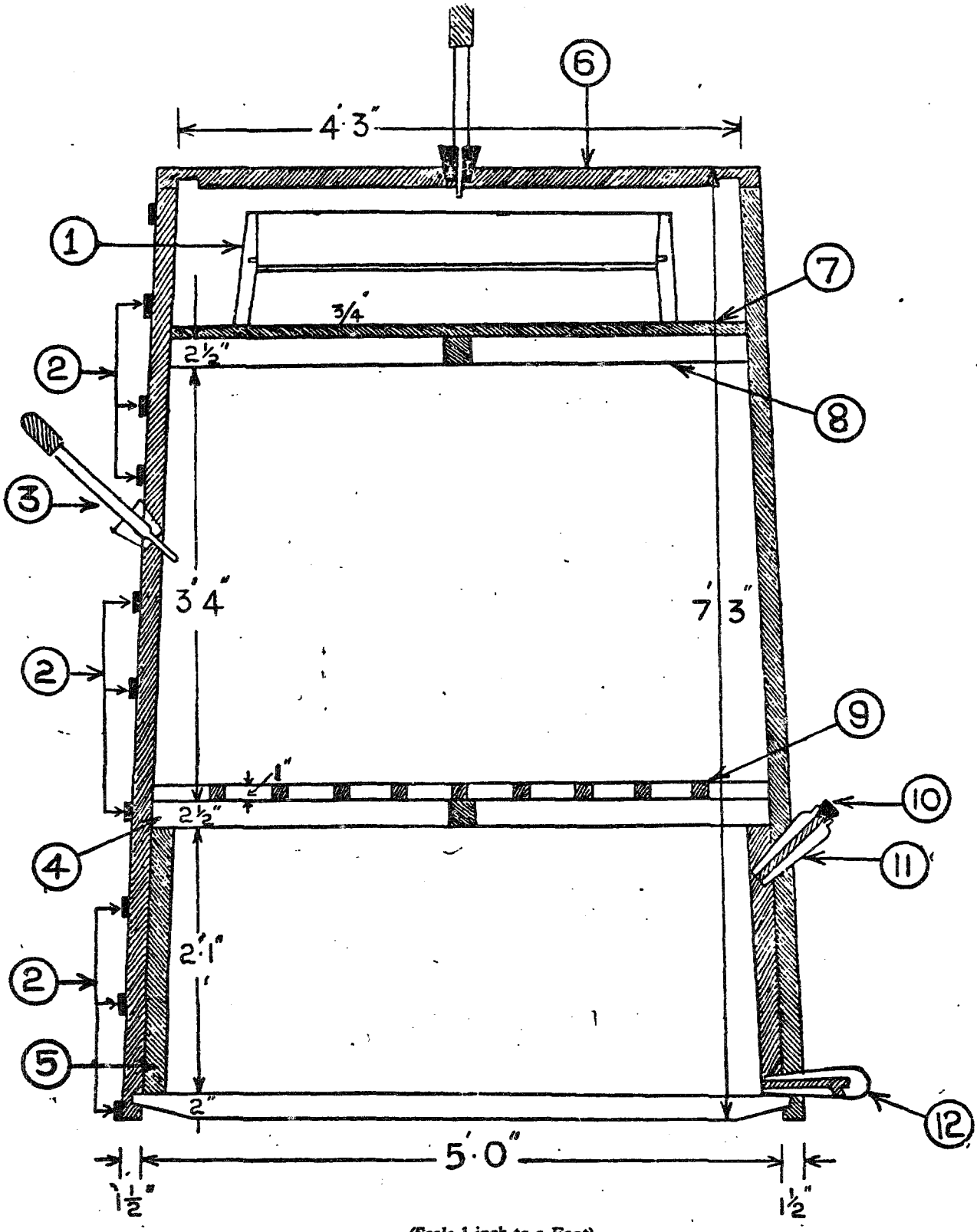
SECTIONAL ELEVATION OF THE FEED TROUGH AND ITS CONNECTIONS TO THE GENERATOR



(scale 1 inch to a Foot)

1. Gauge
2. Fastener
3. Hoop (Iron)
4. Rubber Bung
5. Glass Tap
6. Rubber Tube
7. Glass Tube
8. Groove to Fit in top lid to Generator
9. Rubber Bung.

SECTIONAL ELEVATION OF ACETIFIER SHOWING IN DETAIL EACH COMPONENT PART

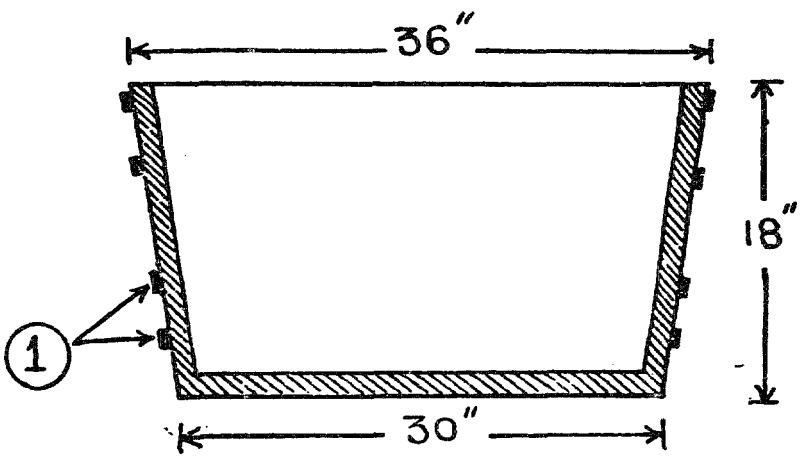


(Scale 1 inch to a Foot)

1. See detail No. 6. (Tipping Trough and Stand)
2. Iron Hoops. 1½" x ¼"
3. See detail No. 8. (100° C. Thermometer and its fixture.)
4. See detail No. 1. (No. 1. Frame for Support of Perforated Wooden Partition).
5. 2½" x 1½" Truss.
6. See detail No. 7. (2" Thick wooden Top Lid and Inlet).
7. See detail No. 5. (2nd. Perforated 3/4" Thick wooden partiti
8. See detail No. 4. (2nd. Frame for support of 2nd Wooc Partition.)
9. See detail No. 3. (Perforated 1" thick Wooden Partition.)
10. Rubber Bung.
11. See detail No. 2 (Air Vent 8 in all). 12. 3/4" diameter Exit T

FIGURE IV

SECTIONAL ELEVATION OF RECEIVING TROUGH

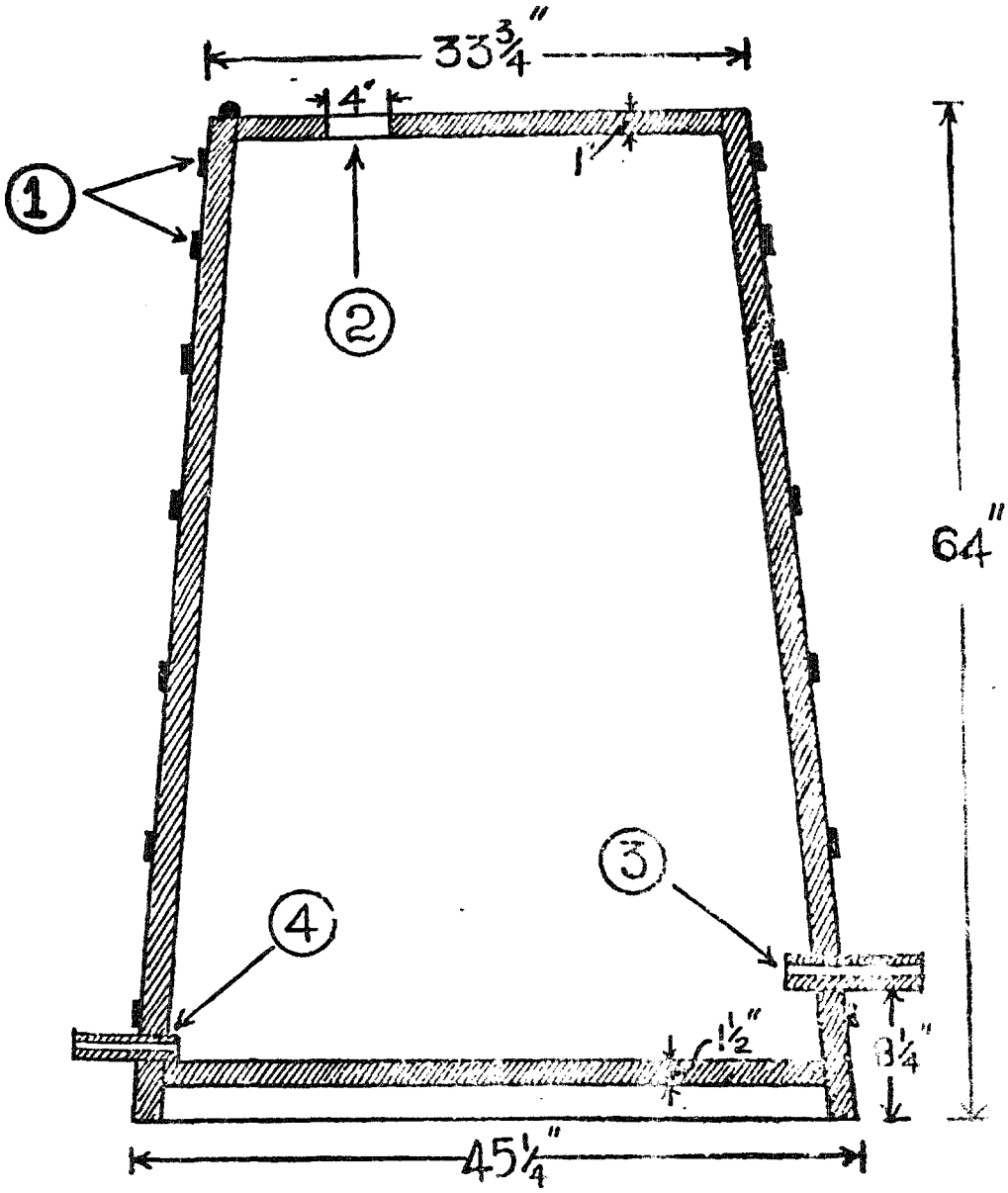


(Scale one inch to a Foot.)

1. Iron Hoops.

FIGURE—V

SECTIONAL ELEVATION OF FERMENTATION VAT

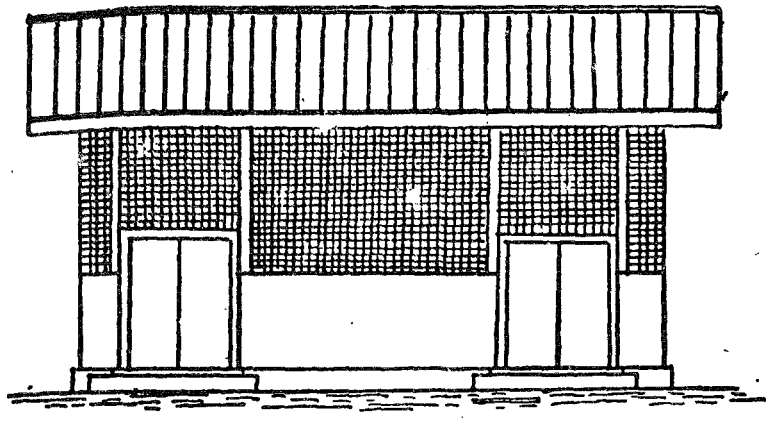


(Scale 1 inch to a foot)

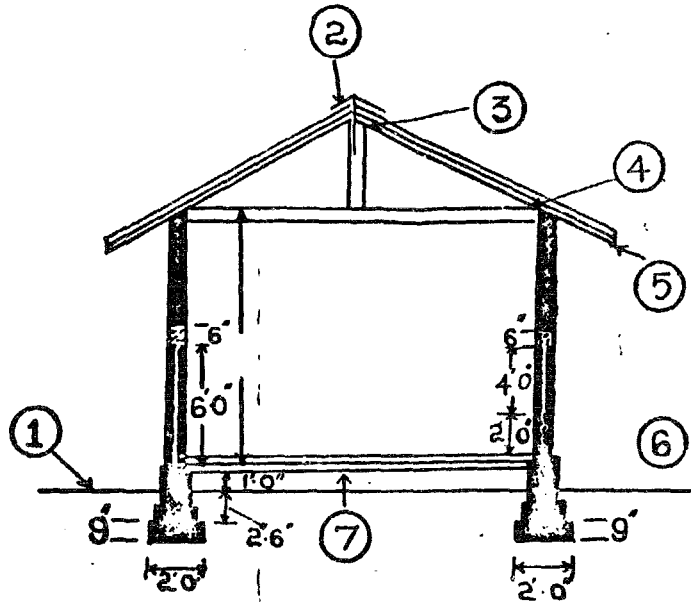
1. Iron Hoops
2. 4" diameter Feed Vent 6" from edge with wooden Plug.
3. Exit Tap or Faucet.
4. Exit Tap or Faucet for Dregs

FIGURE VI

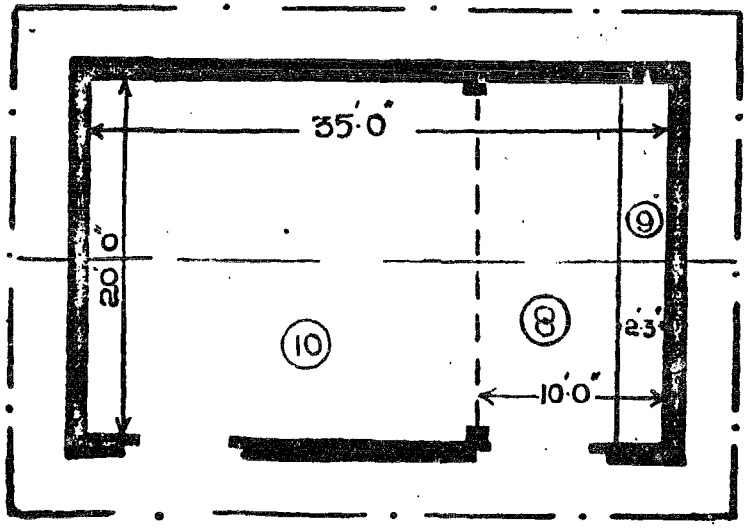
FACTORY HOUSING



FRONT ELEVATION

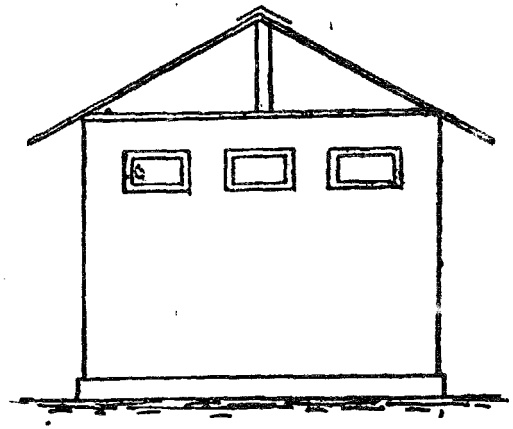


SECTION A. B.



PLAN

(Scale 1 inch to 8 feet)

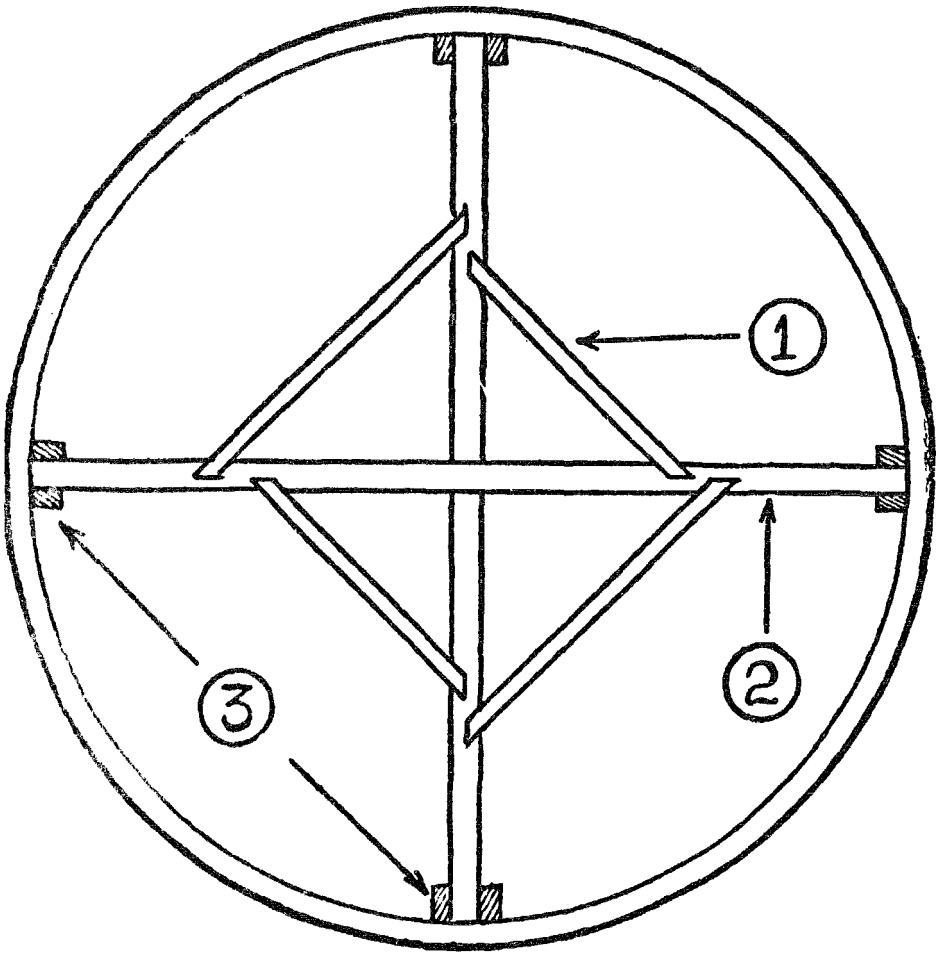


SIDE ELEVATION

1. Ground Level
2. Ridge Tile
3. 6" x 2" Ridge Plate
4. 4" x 2" Wall Plate
5. 8" x 3/4" Valanced Boar
6. D.P.C.
7. Filling
8. Cement Floor
9. Work Bench
10. Consolidated Rammed Floor

DETAIL NO. 1

1" FRAME FOR SUPPORT OF PERFORATED WOODEN PARTITION

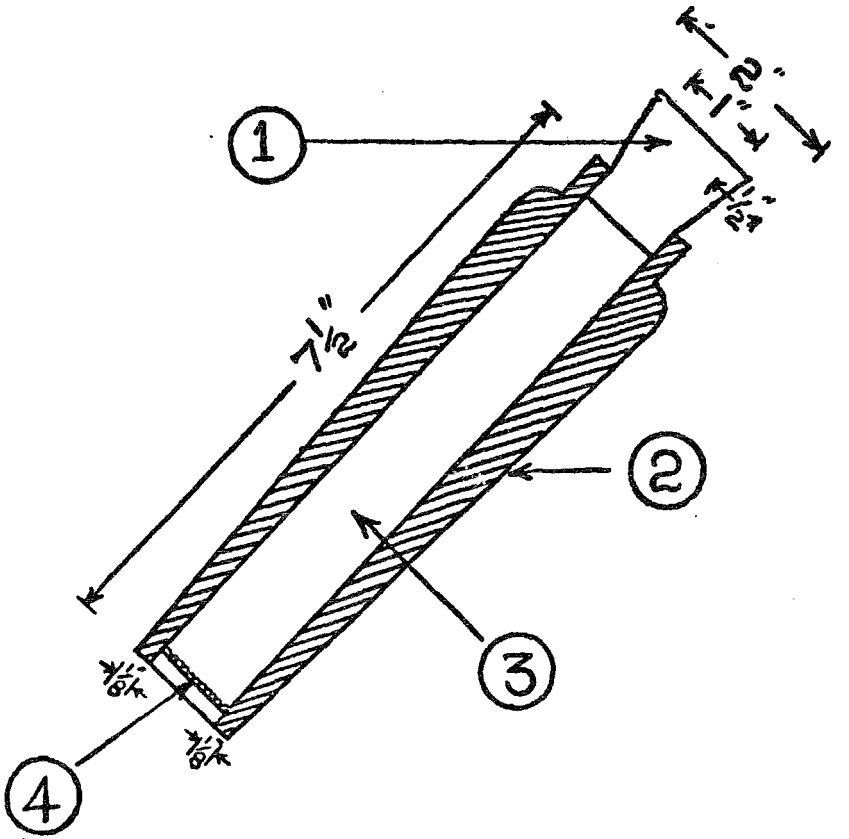


(Scale 1" to a foot)

1. Supporting Frames 1" x 1½"
2. Cross Beams 1½" x 2½"
3. Trusses 25" Long 2½" x 1½"

DETAIL NO. 2

CROSS SECTION OF AIR VENT SHOWING AIR PASSAGE

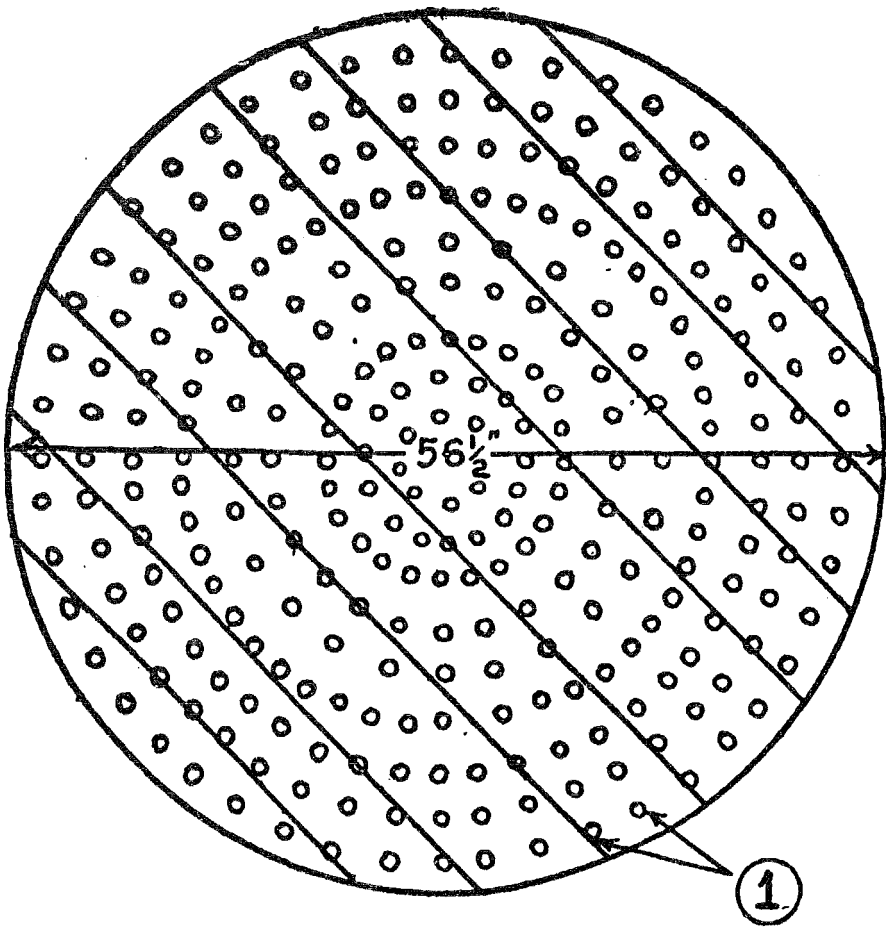


(Scale ½ full size)

1. Rubber Bung
2. Moulded Teak Air Vent.
3. 1" diameter Air Passage.
4. Stainless Steel Mesh.

DETAIL NO. 3

PERFORATED 1" THICK WOODEN PARTITION



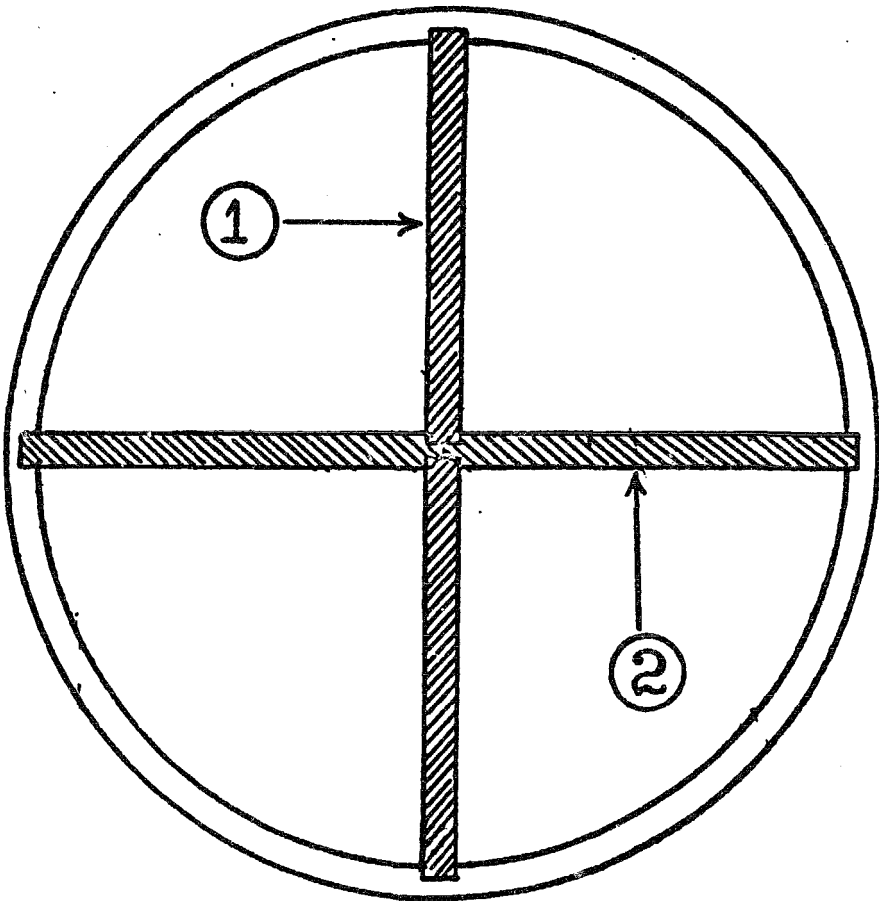
Note :—This partition will be fitted in 9 Nos. and trimmed to size as required.

(Scale 1 inch to a foot.)

1. 1" Diameter Perforations at 3" centres in 9 concentric rings.

DETAIL NO. 4

2nd FRAME FOR SUPPORT OF 2nd PERFORATED WOODEN PARTITION



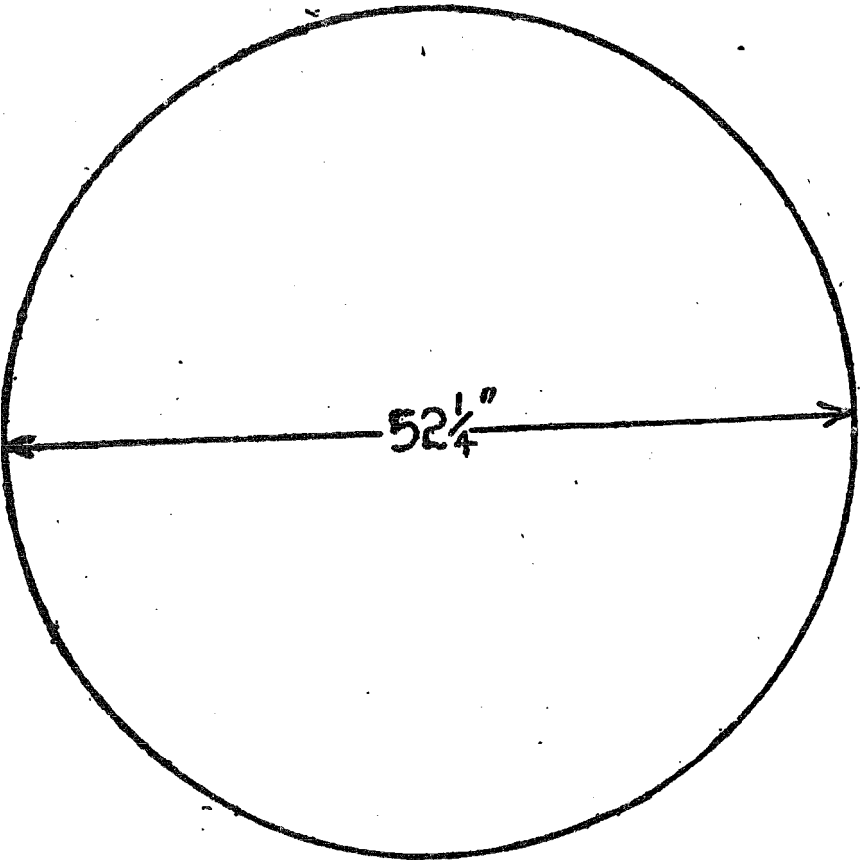
Note :—Sizes of members are same as in frame No. 1.

(Scale one inch to a foot)

1. Fitted in two pieces
2. Fitted in one piece.

DETAIL NO. 5

2nd PERFORATED 3/4" WOODEN PARTITION



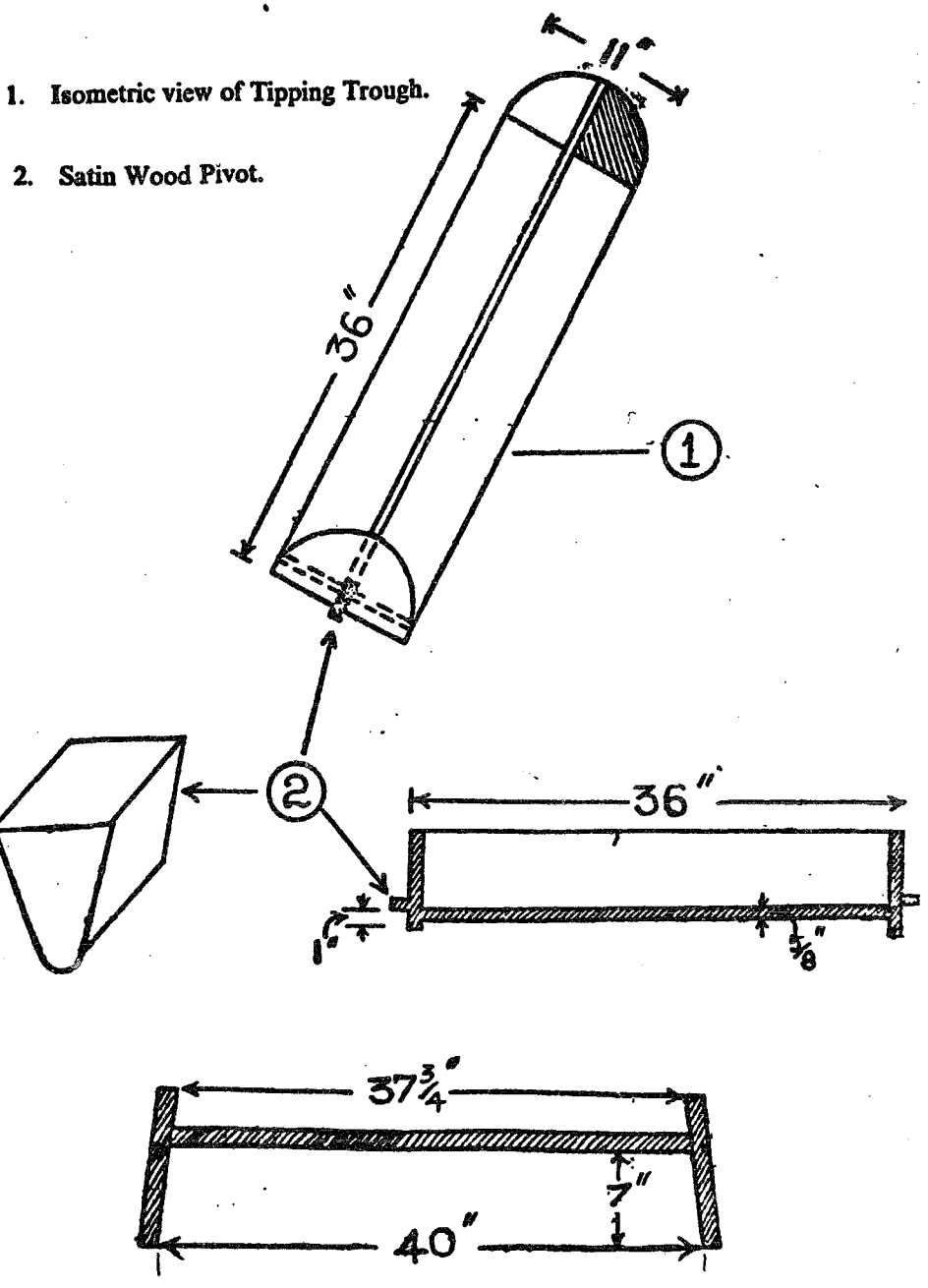
Note :—The perforations are at 3" centres but unlike in Partition No. 1. the diameter of each perforation is only ½"

(Scale 1 inch to a foot)

DETAIL NO. 6

TIPPING TROUGH AND STAND

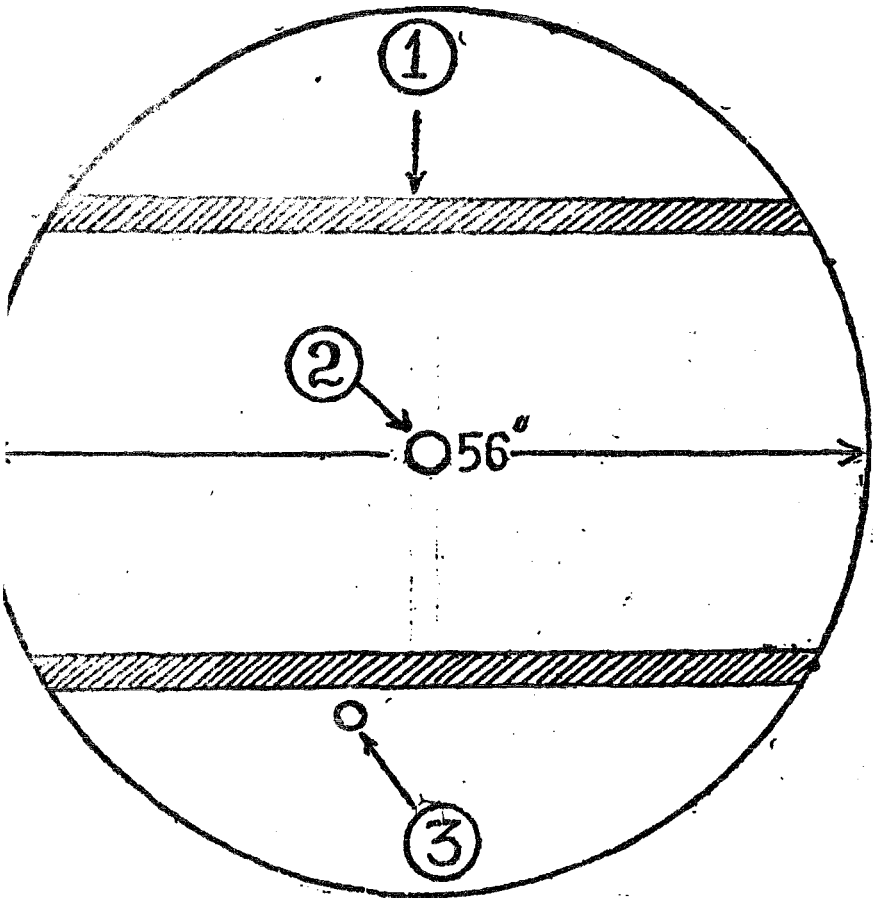
1. Isometric view of Tipping Trough.
2. Satin Wood Pivot.



(Scale 1 inch to a foot)

DETAIL NO. 7

2" THICK TOP LID AND INLET

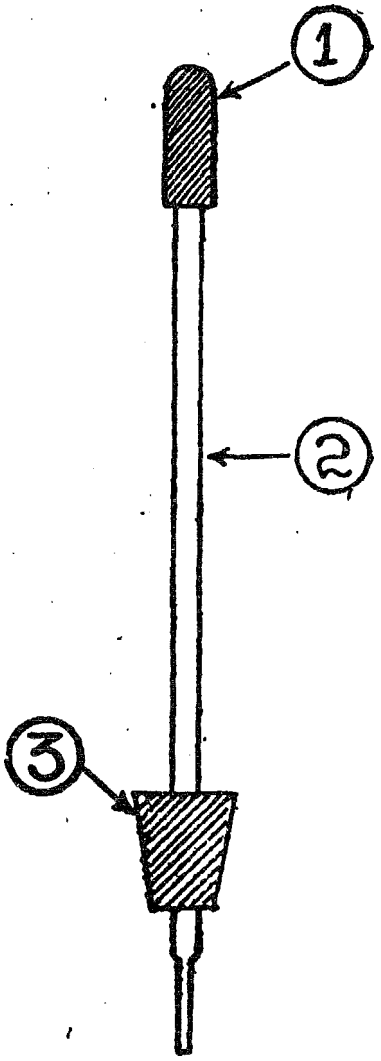


(Scale 1 inch to a foot)

1. Clamp.
2. 2" diameter Hole to take in inlet tube mounted on rubber bung
3. 1" diameter Hole covered with stainless steel mesh for passage of Air.

DETAIL NO. 8

100°C THERMOMETER AND ITS FIXTURE



1. Rubber pressure tubing
2. 100°C Thermometer
3. Rubber Bung

The upper compartment (or Dispersion Chamber) contains the distribution apparatus which insures even application of the vinegar stock over the generator packing material. The central compartment (or packing chamber) contains the supporting medium which offers the necessary surface area for the active growth of vinegar bacteria and their contact with air. The lower compartment (or collection chamber) serves as a sump for the collection of the vinegar. It also contains 8 ports for the admission of air, and a exit cock or faucet for drawing off the vinegar. The acetifier is shown in figure III, page 4. See also details No. 1 to 8, pages 8 to 11.

4.1.3 Receiving Trough: - This is an open wooden vessel for collecting the vinegar that is run off from the acetifier. This receptacle is only for temporary storage, and is particularly useful during the recirculation operations of the vinegar stock. For details see Figure IV, page 5.

4.1.4 Fermentation vats: - A series of conical shaped wooden vats are required for fermentation of toddy into alcohol without any acetification taking place. The toddy is properly filtered before charging the vats. The design should be such that air supply is limited. The vats should be kept full to minimise air inside and the covering should be loose so as to permit exit of carbon dioxide formed during fermentation. See figure V, page 6 for details.

4.1.5 Accessory Equipment: - In operation, the vinegar stock has to be distributed uniformly and intermittently over the generator medium in small but constant amounts. An automatic feeding device therefore becomes essential. Though a stainless steel revolving sprinkler (or sparger) is ideal, an automatic wooden tilting trough located in the dispersion chamber and resting on the top perforated shelf is good enough. The constructional details of a suitable tipping trough are given in Detail No. 6, page 10.

A thermometer graduated to 100°C and fitted by means of a rubber bung into the packing chamber, is useful, especially when the generator is being seeded and started off. See Detail No. 8, page 11. Thermometers fitted into the dispersion and collection chambers are also useful but not essential. Though a stainless steel centrifugal pump for recycling the vinegar stock is the best arrangement, this operation could also be done manually. For this purpose stainless steel (or aluminium) receptacles alone should be used. Six pot shaped vessels with a capacity of about a gallon each would be required for working a single generator.

For checking the quality of the raw material and the efficiency of acetification some form of analytic control is essential. For this purpose simple titration apparatus comprised of a 25 (or 50) ml. burette with stand, a 5 or 10 ml. pipette, about 6 x 250 ml. titration flasks, and a wash-bottle would be required.

An alcoholmeter (or ebulliometer) with a stainless steel boiler and inner condenser tube, covering a range of 0-12 per cent alcohol by volume, is also an essential prerequisite. A suitable type of instrument could be procured from Messrs. Joseph Long Ltd., 184, Station Road, Harrow, Middlesex, England. There are also many other suppliers of such equipment.

4.1.6 Aging casks or barrels: - These are wooden casks or barrels for aging the vinegar for periods of 3 to 6 months.

4.2 Materials of construction

4.2.1 Details of the equipment have been given under section 4.1

4.2.2 Building/factory requirements: -

To house a single generator assembly and equipment (including a work bench for analytical operation) a building 35' long X 20' broad, with side walls 15' high would be convenient. Dwarf side walls 5' 6" high along the length of

the building with a mounted wooden trellis reaching to roof level would be ideal. See Figure VI, page 7. The roof of the building should have ceiling to keep the atmosphere cool and also to prevent contamination from dust and falling debris.

In conformity with present excise regulations the floor of the factory would have to be a permeable stratum. Clean white river sand is generally used which would readily soak up any splashed liquids.

Provision should be made for entry of diffused daylight, and ample natural ventilation to facilitate removal of stagnant air and fermentation gases. Trellis work on two sides of the building (as suggested above) should be suitable.

When a factory is being built, every source of infection, such as manure heaps, decomposing materials and rubbish heaps of debris, should be avoided, as they can act as source of wild organisms which can infect the raw materials and vinegar in the factory.

Cleanliness is of prime importance; for, the generators provide an excellent, breeding place for flies and other vermin which is unhygienic and can reduce yields and capacities to a very marked degree.

A supply of fresh potable water should be always available near the factory site.

4.3 Cost of equipment & construction: -

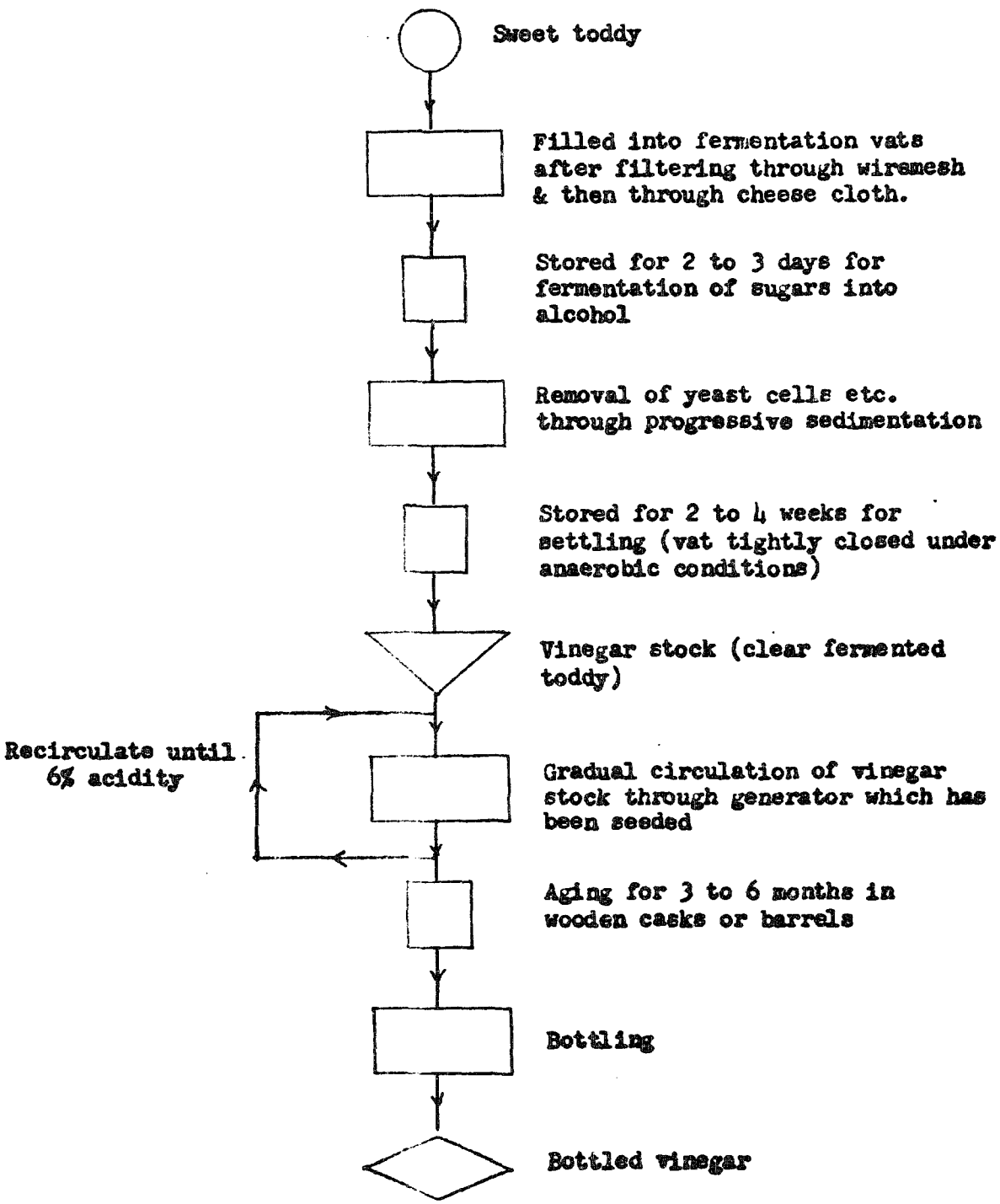
These details are not available

4.4 Capacity: -

150 gallon (680 litre) per batch with one generator assembly.

5. Process

5.1 Process flow diagram



5.2 Description of process

5.2.1 What is vinegar?

In general terms vinegar may be defined as a condiment made from watery solutions of sugar or starchy materials by two separate microbial processes. The first is an alcoholic fermentation of naturally occuring (or converted) fermentable sugars by certain species of yeasts called Saccharomyces. The second is the so called oxidative fermentation of alcohol so produced, by species of bacteria called Acetobacter.

Owing to the fact that a wide variety of sugary or starchy substances can be used for the production of vinegar, its exact composition will depend on the raw material that has undergone these fermentations apart from the actual conditions of manufacture, aging and storage. Essentially however, the finished product is a dilute solution of Acetic acid containing salts and extracted matter from the source material and certain aromatic minor constitutents produced during the fermentations.

The term vinegar itself is of French derivation signifying 'sour wine'.

5.2.2 Coconut toddy as raw material: -

Coconut toddy by itself is an excellent raw material for the manufacture of high grade vinegar. It needs no fortification with adventitious sugar or salts and possesses the overriding advantage of being a well balanced medium containing sufficient nutriment for the growth and activity of yeasts and bacteria.

5.2.3 The "Generator Process"

The vinegar generator is designed to provide the maximum surface exposure for a volume of vinegar stock (vide infra) in order to supply enough air for the acetic

acid bacteria to efficiently and quickly oxidise the alcohol to acetic acid.

A survey of the existing industry has shown that 'Generators' with a collection chamber capacity of 150 gallons would be an appropriate and convenient size for most vinegar makers to instal. Whilst in certain factories a single generator of this size would be adequate, others would need to operate batteries of two or more of this size, depending on the quantities of toddy handled.

In essence the generator is a countercurrent gas absorber wherein the acetic bacteria cause the oxidation of alcohol to acetic acid. Air for the alcohol oxidation is admitted to the generator below the false bottom through the eight air vents and it circulates naturally owing to the heat of oxidation in the packing.

The vinegar stock from the feed vat is uniformly sprayed over the surface of the inert porous medium or packing material (maize cobs in this case) at the surface of which the oxidation takes place. The stock which drains off from the packing by gravity into the base of the generator is run out and pumped (or poured) back into the feed vat, from which it is recycled till acetification is complete.

The ordered sequence of processes in the manufacture of vinegar from coconut toddy are relatively simple and can be operated at low cost.

The re-circulating generator has several economic advantages. It may be operated at low cost, and is relatively simple and easy to control. There is a distinct saving of factory storage space, and equipment. A generator assembly described above could replace about 9 x 1000 gallon vats. The process is continuous and provides a means of steady and efficient production of vinegar with low working losses. The process combines speed of action

with high fermentation efficiencies resulting in higher acid strengths of the finished vinegar. The packing material used is inexpensive and easily procured. It would not require renewal for at least a year.

5.2.4 Vinegar Stock: - The preparation and (if necessary) blending of a suitable alcoholic liquor (fermented toddy in this case) constitutes the first stage, in the process. The term 'vinegar stock' is popularly assigned to this alcoholic wash.

As the quality and composition of the toddy used are as important as the details involved in the manufacturing process, it is important that care should be exercised in its collection and handling. A system of graduated straining is useful to remove suspended impurities. Wicker baskets may be used at the tapping 'topes' for removing the grosser foreign matter (including bees, wasps and other insects) from the toddy, before it is bulked in casks. On reaching the factory the finer suspended matter may be removed, by passing through 'staybrite' steel wire meshes of different gauge, and ultimately through cloth, into the fermentation vats. Toddy filtered this way will be found to be agreeable in taste and smell and will also be quicker and smoother in fermentation than the unstrained material.

To ensure an economic conversion of sugar to alcohol and to obtain a better quality vinegar stock, control of the alcoholic fermentation is desirable. If acetic acid is produced in any quantity, the fermentation may cease before all the sugar has been converted. A concentration of 0.5 per cent acetic acid markedly dimishes the activity of the yeast and higher concentrations will completely inhibit the alcoholic fermentation.

The use of conical vats of graduated sizes (depending on the volume of toddy to be fermented) of the type shown in Figure V has been found to be the best way of limiting the air supply, thereby discouraging the development of acidity and obtaining a satisfactory fermentation. The vats should be kept

nearly full and only loosely covered in order to facilitate the exit of the carbon dioxide gas produced.

The yeasts naturally present in the toddy can produce a rapid clean and fairly satisfactory alcoholic fermentation without the raw material having to be seeded with any selected yeast starter.

It will be found that fermentation will be complete within 48 to 72 hours, after which the yeast cells and other debris should be removed by progressive sedimentation. After a storage period of 2 to 4 weeks is allowed for settling, the supernatant stock may be drawn off (racked) and is ready for acetification.

If the vinegar stock is to be stored it is important to place it in casks under anaerobic conditions. If stored in the open, the stock is subject to serious loss of alcohol by evaporation as well as by metabolism by oxidative yeasts. The unprotected stock will also attract flies and vermin and is objectionable from the stand-point of sanitation.

5.2.5 Seeding the Generator: - When a sufficient quantity of vinegar stock has been accumulated the acetifier may be seeded with vinegar bacteria. To do this, maize cobs (after removal of seeds) which have been previously cleaned, washed and dried are soaked in good unsterilized vinegar for about 6 hours and packed fairly loosely in the packing chamber of the acetifier between the two perforated shelves. It is a good plan to pack the bigger cobs at the bottom and the smaller ones near the top. This arrangement would facilitate the free circulation of air even after the growth of bacterial film over the cobs. Nearly eight thousand selected cobs will be required in all for one acetifier.

About 150 gallons of fresh, sound, unsterilized, unclarified incompletely oxidised vinegar in active acetification, drawn from a high production efficiency vat (not maturation cask) is placed in the feed vat. The best suited samples for use as a starter

will be found to analyse above 3.5 per cent of acid and above 2.5 per cent V/V of unoxidized alcohol. This fresh vinegar is slowly re-circulated through the generator for 72 to 120 hours or more with all the air vents closed. When the temperature of the interior of the generator starts to increase the generator may be regarded to be seeded and ready for operation.

5.2.6 Operation after Seeding: - Once the generator is seeded, its operation consists in recirculation at a regulated rate of flow; each batch of vinegar stock through the packing, and controlling the air supply by opening one or more air vents, until, the alcohol is oxidised. If too much air is allowed to enter, there can be over-oxidation of the alcohol resulting in wasteful loss of acid.

For maximum efficiency, certain optimum conditions of flow and air supply could be worked out through experience. In general the rate of flow from the feed vat may be so adjusted that it would take about six hours for the 150 gallons to run out into the collection chamber.

It is important to remember that just after seeding, it would be injudicious to pass raw vinegar stock through the generator. The first batch should preferably be a blend of 25 per cent vinegar stock and 75 per cent of the starter that has gone through the generator for seeding. The subsequent batch could be a mixture of 50 percent vinegar stock and 50 per cent of the first batch after acetification. In the third and subsequent charges the percentage of vinegar stock could be gradually increased but mixed with reduced quantities of acetified vinegar from the immediately preceding batches, till the generator settles down to smooth operation. Once this happens the vinegar stock could be used without blending with acetified vinegar.

In newly constructed generators, the raw unseasoned timber in contact with toddy attracts the development of worms and maggots. For a period of about a month, at intervals of 3 days

it is absolutely important to remove the lid of the generator and clean the dispersion chamber with a clean damp cloth. The tilting trough cradle and top perforated shelf should be taken out, flushed with clean water and put back. Once the generator shell is seasoned and soaked with acid there should be no further trouble and the washing and cleaning operations could be discontinued.

5.2.7 Aging: - When the vinegar has reached its maximum strength it must be aged before it is bottled, and is at its best quality for table use. The aging is done in wooden maturation casks or barrels that are kept full and closed, so that destruction of acid by oxidation by the vinegar bacteria does not occur.

During the period of aging which could range between 3 to 6 months, a certain amount of sedimentation takes place which improves the appearance and clarity of the vinegar.

5.3 Product flow diagram

Yields etc. are not available.

6. Quality of finished product: -

The strength of the vinegar is about 6% (gms Acetic acid per 100 ml. of solution).

The quality of the vinegar produced is good and uniform and the process is hygienic as it takes place in a closed acetifier whereby insect and putrefactive organism are excluded.

The analytical characteristics of coconut toddy vinegar manufactured by this process compare favourably with reputed imported brands of vinegar.

7. Source of information

Leaflet no. 22 (1971) issued by: -
Coconut Research Board,
Lunuwila,
Sri Lanka.-

Product Code: - CCCN 22.09 c
Technology Sheet Nb: V /37

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

AND ASIAN & PACIFIC COCONUT COMMUNITY

"Consultancy Service on Coconut Processing Technology"

(Project UF/RAS/78/049)

1. Technology sheet for : - COCONUT ARRACK

2. Uses of finished product : - Alcoholic drink

3. Country of origin : - SRI LANKA AND PHILIPPINES

4. Equipment

4.1 List of equipment

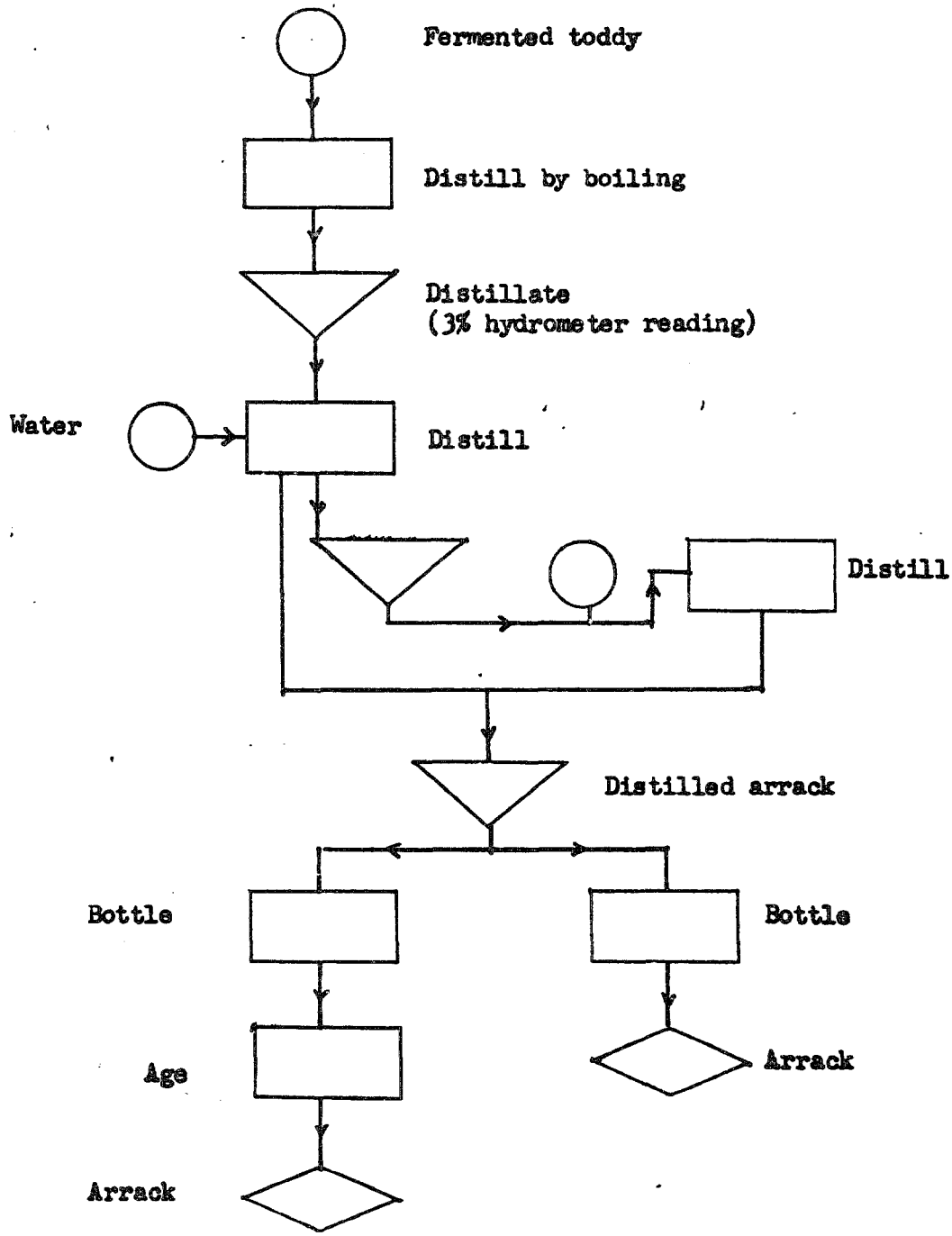
Glass container - 1 gallon capacity
Kitchen Thermometer - Fahrenheit reading
Cooking vessel
Hydrometer

4.2 Cost of construction : - Not applicable

4.3 Cost of equipment : - US$ 20.

5. Process

5.1 Process flow diagram



5.2 Process description

Distill fermented toddy by boiling. Fermented toddy begins to boil between 200°F & 205°F. The distillation is stopped when the hydrometer reading of the distillate records three per cent Boiling point at this stage is 211°F. Reduce strength of the distillate by adding water. Distill again. Repeat process. Distilled arrack may be bottled & sold, or bottled & matured or aged, to improve the taste.. Length of ageing process varies. After ageing, bottled arrack is ready to be sold or for consumption.

5.3 Yield

The range of recovery is from 11.5 to 25 per cent of the original toddy.

6. Quality of the finished product

The reported analytical valued of the arrack (parts/100,00 absolute alcohol) are: -

Esters	-	164 to 258
Total acids	-	116 to 158
Fixed acids	-	6 to 13
Volatile acids	-	105 to 152
Furfural	-	0.45 to 1.32