CASSAVA PROCESSING IN GHANA

CASSAVA PRODUCTS & THEIR PROCESSING

TECHNOLOGY

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INTRODUCTION

About half the total root crop production in the tropics is provided by cassava (Manihot esculenta) which is the root crop most familiar to many indigenous populations in South and Central America, Africa and Asia and it plays a prominent role in their daily culture and subsistence (Ingram and Humphries, 1972). In Ghana cassava is very widely cultivated especially in the southern parts of the country and it accounts for more than half the total starch staples produced (Lartey et al, 1980).

The swollen roots or tubers are the economically useful part of the cassava plant. These develop radially around the base forming clusters of five to ten tubers per plant and are mainly utilised as a staple food essentially as a source of carbohydrate (Ingram and Humphries 1972).

Analytical results of the cassava tuber pulp by (Eyeson and Ankrah (1975) gave the following average figures per 100gm edible portion.

Moisture	5.6%	Carbohydrate	40.8g %
Protein	1.0g%	Fibre	0.8g%
Fat	0.4g%	Calcium	27mg%
Phosphorus	58mg%	Iron	9mg%

Apart from the low protein content (shown in the above data) which makes most nutritionists to consider it as an inferior food, cassava has an additional disadvantage in that it produces chronic toxic effects which are the results of the cyanogenetic glycosides present in some of the species. Added to these is the extremely perishable nature of the cassava tuber which makes it almost impossible to store for more than a few days without severe rotting.

Spoilage has been found to be the result of a combination of physiological and pathological factors and is commonly manifested as decay of the tissues often accompanied by a dark bluish discoloration and/or dark streaking of the infected areas. Among the microorganisms named to be responsible for the spoilage are Rhizopus spp., Bacillus spp. and Diplodia manihoti (Saccharomyces spp.)

A number of investigations have been conducted into methods of controlling spoilage and prolonging storage life. Some of the suggested methods (Ingram & Humphries, 1972) are:

(i) reburying the roots underground to preserve them until required.

(ii) heaping the tubers and watering them daily to keep them fresh

(iii) arranging layers of cassava tubers alternat[illegible] with about 7.5cm thick layers of the earth with the topmost layers covered with well beaten earth 15cm in depth and built up to a ridge to throw off water.

(iv) chemical treatment with formalin or ethylene dibromide and ethylene bromide mixtures

(v) coating with fungicidal waxes

(vi) storage at reduced temperatures (deep freezing)

(vii) storage in moist saw-dust in boxes or constructed palm fronds.

Of these the most effective methods are deep-freezing, storage between layers of earth, and storage in moist saw-dust.

The problems associated with the storage of fresh cassava tubers make it incumbent upon the food technologist to process the tubers as quickly as possible into suitable products with low moisture content which can be stored much more easily and which have a comparatively higher nutritional value and lesser toxic effects and can serve as convenient foods. Before the advent of cassava research many of these products have been processed traditionally in Ghana; notable among these are GARI, KOKONTE, STARCH, TAPIOCA AND AGBELIMA (cassava dough).

But research work at the Food Research Institute (FRI) in Accra has led to improvement upon the traditional processing technology of the various products and the development of new products.

The main purpose of this review is to render an up to date account of the traditional and improved processing technologies of cassava products as known in Ghana with the aim of appreciating their significance and identifying new areas of research as far as cassava processing is concerned. In addition an attempt is to be made to assess the quality parameters of some of the products. The products discussed here are AGBELIMA (cassava dough), GARI, KOKONTE, INSTANT FUFU POWDER, CASSAVA FLOUR, CASSAVA STARCH, TAPIOCA, and GLUCOSE SYRUP.

AGBELIMA (cassava dough)

The process of producing cassava dough from cassava tubers involves peeling, washing, grating, pressing and fermentation.

Traditional Processing Technology

Traditionally, cassava tubers are peeled by removing and slicing off the skin with a knife. The peeled tubers are washed thoroughly several times with water and grated. The grating which is basically a size-reduction process is done on perforated tin sheets by rubbing the peeled tubers over the rough side of the perforated tin sheets in a bowl. Following the initial grating the grated mash is packed into fibre bags or baskets and covered with a piece of sack. The liquid is squeezed out by placing heavy stones on the bags. This partial dewatering process takes about 2-3 days and during this period fermentation takes place. The fermented dough is packed into polythene bags in baskets and is ready for use as an intermediate product for many other cassava products like gari, akple, fufu and yakayake.

For certain other cassava food products like cassava balls (Agbelikaklo) and cassava biscuits (Agbelikponor) the cassava dough is required in the fresh unfermented form. In this case immediately after grating the cassava, the water and starch are squeezed out using a muslin cloth. The fresh unfermented dough is used immediately (Dovlo, 1972).

Improved Processing Technology

AGBELIMA production has been mechanised to an appreciable extent. The sequence of processing is the same as for the traditional method ie. peeling, washing, grating, pressing and fermentation. The peeling and the washing processes are the same as for the traditional method.

In the improved method, grating is done on an F.R.I. fabricated grater which consists of a trapezoidal hopper mounted on an angle iron stand. The grating rotor is made of wood 25cm in diameter and covered with a thick perforated, galvanized metal sheet (Lartey et al 1980). The peeled tubers are fed into the hopper and a lever is used to press the roots against the rotating rotor. An adjustable saw blade is incorporated which gives a clearance for controlling the particle size of the grated material. The grated mash is loaded into woven mesh sacks of polypropylene for subsequent pressing and fermentation.

Pressing is done in a hand operated screw-type mash press which consists of an angle-iron framework supporting galvanised metal sheets at the sides. Moving within this housing is a screw ram arrangement and a leverage system for pressing and unloading respectively. A perforated false bottom is provided which allows for a free passage of the cassava liquor on pressing through a chute into a container below.

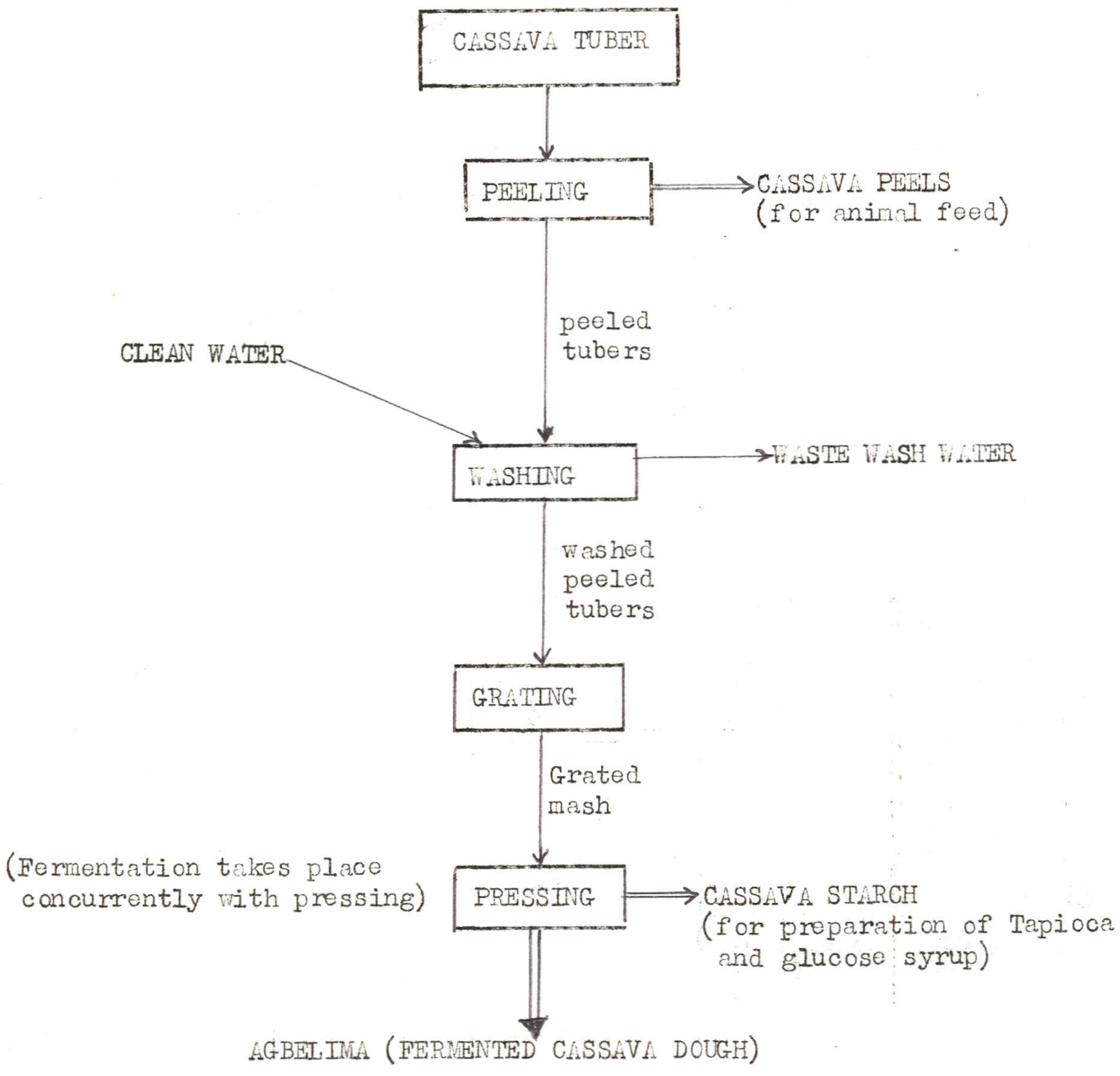
The loaded sack is placed in the press and pressure is applied from the top by means of the screw ram till about 30% of the weight of the cassava mash is pressed out as exudate. The partially dewatered mash is left in the press for about 60-72 hours for fermentation to take place (Laryea-Brown and Anderson, 1980). The product (agbelima) is then ready for use domestically or commercially.

Significance of the Improved Process

The significance of the improved process is that:-

(i) much time and labour is saved during the grating and pressing processes.

(ii) the fermentation process is controlled in such a way that the acidity of the mash is around 0.70% (lactic acid) and this makes the dough less acidic.



<u>SIMPLE FLOW DIAGRAM FOR AGBELIMA PRODUCTION</u>

GARI

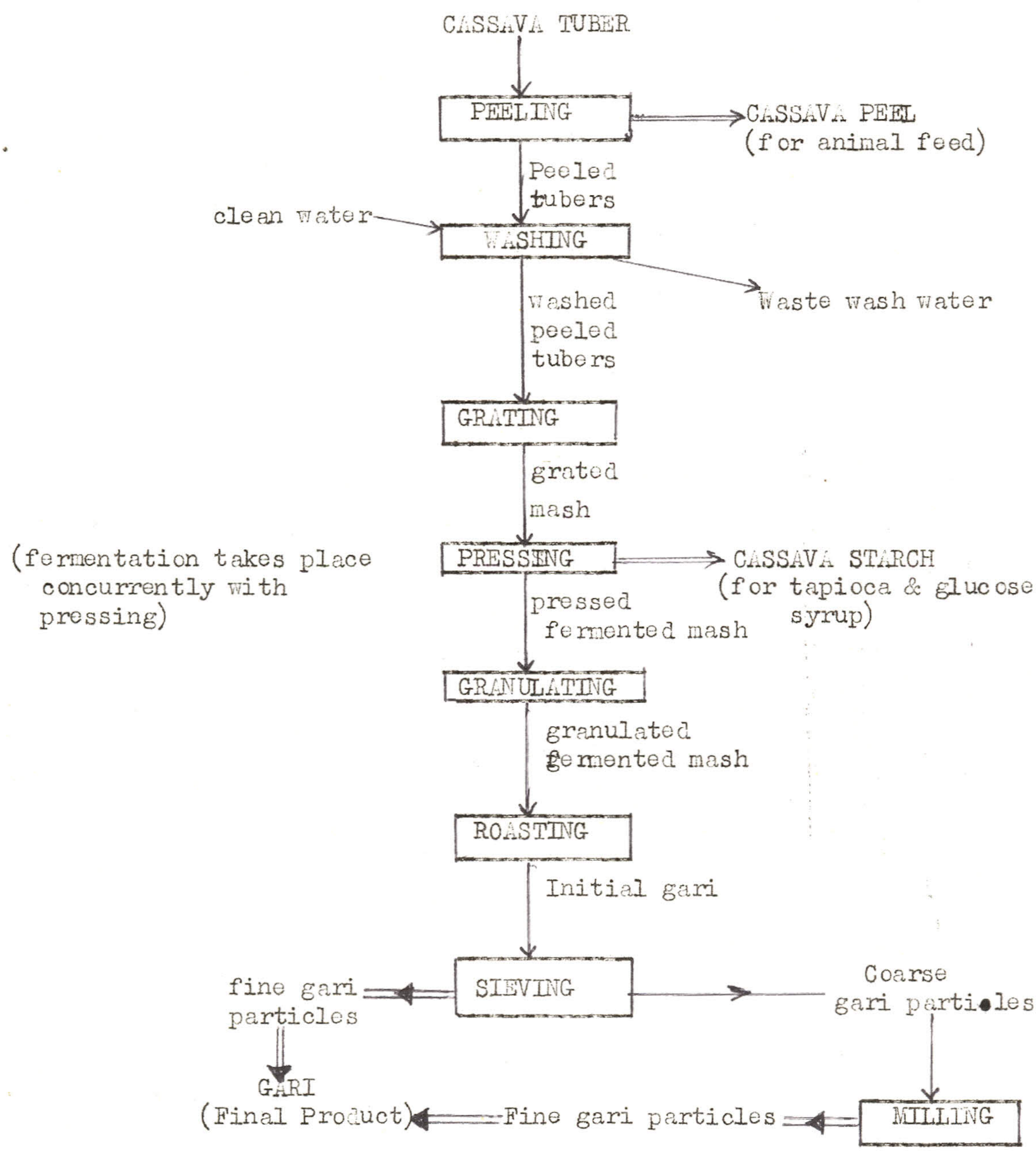
Gari is a granular product obtained by sieving cassava dough and then frying it.

Traditional Processing Technology

The cassava tubers are peeled, washed, grated and the grated mash pressed and fermented as in AGBELIMA preparation. For preparation of GARI the dough is allowed to ferment for an extended period of about 3-4 days in order to develop the highly desirable acidic taste in the product. The dough is then partly dried and granulated by disintegrating and forcing it through the traditional bamboo cane sieve on the application of moderate hand pressure. The granulated fermented dough is then roasted in a shallow earthenware pot, heated underneath by firewood. During the roasting process the granulated meal is spread in the earthenware pot and tossed constantly with a flat piece of calabash until it is formed into gelatinised grains. The product is sifted to obtain uniform grains of GARI after which it is further dried and packed into fibre bags for the market (Dovlo, 1972).

Improved Processing Technology

After the initial processes of peeling, washing and grating of the tuber as described before, the grated mash is pressed in the screw press to a moisture content of 43 - 45% and allowed to ferment for not more than 72 hours (3 days) the dough is then disintegrated and and granulated by the traditional method of using moderate hand pressure to force it through a bamboo cane sieve. The granulated fermented meal is now roasted in large slightly concave metal pans gently heated underneath with firewood. The meal is spread thinly in the pan about 2-3kg at a time and stirred continously till the correct degree of crispness and a light yellow colour is attained. The roasted GARI is thoroughly cooled and sifted over the traditional bamboo woven-cane sieve (or an ASTM Mesh No.5 sieve). The coarse particles retained on the sieve are rolled-milled and added back to main batch to ensure a uniform product. The final product is now thoroughly cooled and packed in 1 or 2 kg batches in polythene bags or alternatively in 50kg jute bags lined with polythene sheets (Laryea-Brown and Anderson 1980).



SIMPLE FLOW DIAGRAM FOR GARI PRODUCTION

Significance of the Improved Process

(i) Much time and labour is saved during the grating and pressing processes.

(ii) The whole process facilitates increase in production rate by reducing the time used in grating and pressing. The fermentation time can also be reduced by inoculating the grated mash with exudate from a previous fermented mash prior to the dewatering process.

(iii) The efficient control of the fermentation ensures that the final product is neither too sweet nor too acidic.

(iv) A more uniform product is ensured by the milling of coarse particles and the addition of this to the original batch.

(v) Roasting in metalware pans (as opposed to earthenware pots) ensures a more efficient heat transfer and therefore efficient roasting (ie. short roasting time and a more crisp product.

(vi) the dryness and crispness of the product are maintained through the mode of packaging in polythene bags.

Quality Parameters of GARI

Good quality GARI should:

(i) be dry and crisp

(ii) be light or creamy yellow in colour

(iii) not be bland to taste but should have a slightly sour (acidic) and sharp taste but without any peculiar odours

(iv) preferably have a low fibre content

(v) swell to about three times its volume when soaked with water

(vi) have a comparatively lower cyanide content

(vii) the particles should be of nearly uniform size

(viii) the product should be clear and free from extraneous matter (ie. stones, dirt particles, insects or their parts) (Laryea-Brown and Anderson, 1980).

KOKONTE (FERMENTED CASSAVA FLOUR)

Traditional Processing Technology

Traditionally the bitter variety of cassava is normally used for KOKONTE production because of its low cost and abundance. The cassava tubers are peeled and washed several times with water. The washed tubers are cut into chips of approximately 1 x 1 x 2cm sizes or into 1-2cm cubes. The chips are washed, thoroughly drained and spread in thin layers on trays, concrete floors, roof tops etc. to dry. They are turned periodically to give uniform drying and are often collected or covered at nigh or when raining. The chips are dried to a moisture content below 14% which requires about three days in clear weather or between 4-6 days in bad weather. During the period of drying, fermentation takes place and the exposure of the chips to both dew and sunlight causes them to become mouldy and dark in colour. The dried chips are then pounded in a mortar to reduce their sizes after which they are milled into flour (KOKONTE) and packed in polythene bags for storage (Dovlo, 1972).

Improved Processing Technology

In the improved process cassava tubers are peeled, washed and grated on the FRI fabricated grater, as in AGBELIMA production. The grated mash is pressed using the screw press to squeeze out as much of the cassava liquor as possible. The partially dewatered cake is then loaded into aluminium trays at a rate of 12-15kg/sq meter allowed to stand for about 8-12 hours for a slight fermentation to take place and then dehydrated in a cabinet dryer or a solar tent dryer, to the desired moisture content of below 14%. The dried product is then milled into KOKONTE (fermented cassava flour) and packed in polythene bags for storage (Laryea-Brown and Anderson 1980).

Significance of the Improved Process

(i) Much time and labour is saved by grating as opposed to chipping in the traditional method.

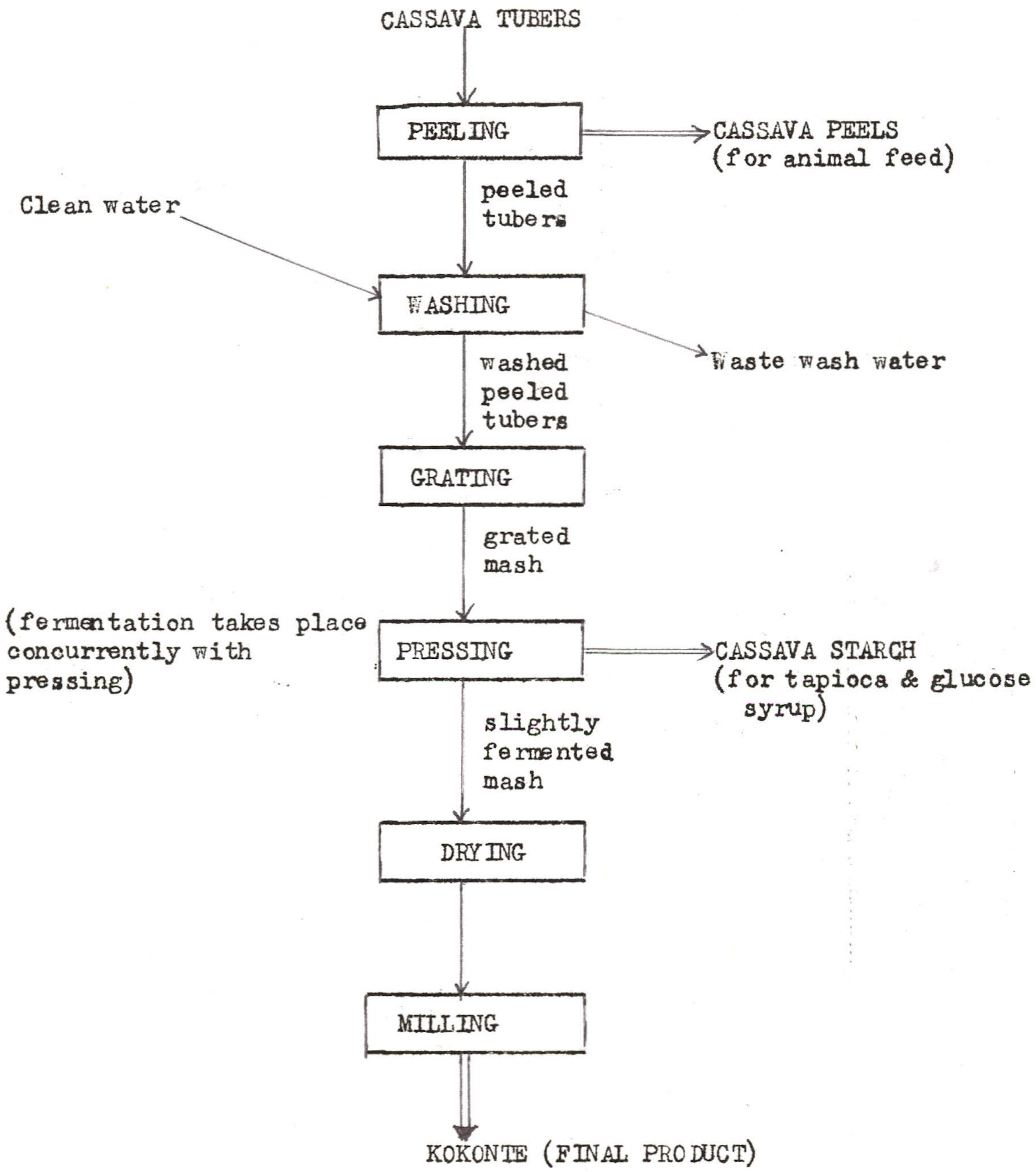
(ii) The final product is less starchy since some of the starch is pressed out before drying.

(iii) The traditional method of drying exposes the cassava chips to mould growth but this is reduced in the improved method through the use of cabinet dryers to facilitate drying.

(iv) Aflatoxin contamination is reduced and the whiteness of the flour is enhanced because of the reduction in mould growth.

(v) As a result of the improved quality (whiteness) of the flour the thick porridge prepared from the flour has a lighter and more attractive colour compared to the dark appearance of porridge prepared from the traditionally processed kokonte flour.

(vi) Grating of the cassava tuber instead of chipping increases the surface area and therefore facilitates drying.



<u>SIMPLE FLOW DIAGRAM FOR KOKONTE PRODUCTION</u>

FUFU

Traditional Process

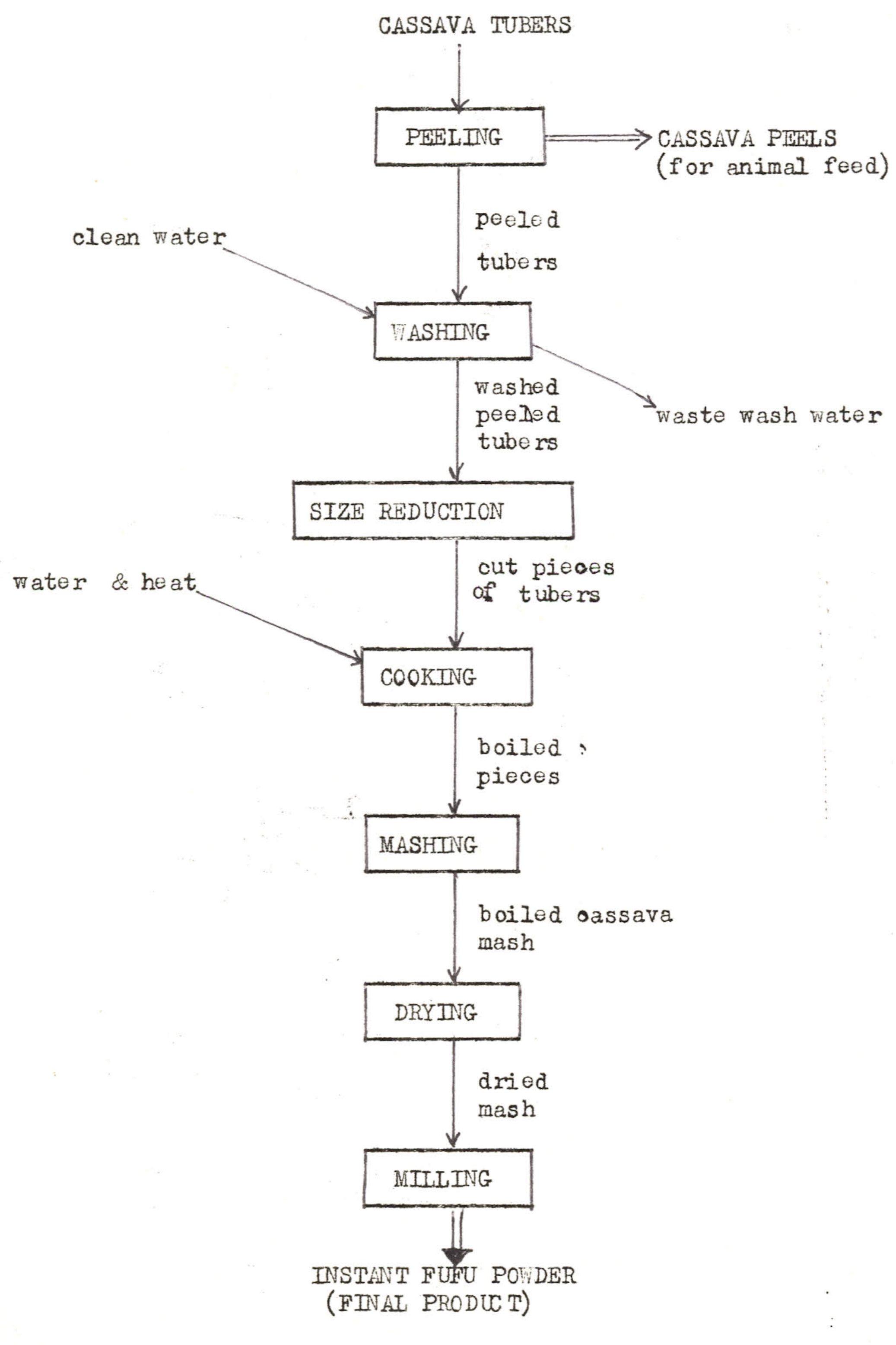
In the traditional method of preparing fufu the cassava tubers are peeled and washed. Peeling is done by outting through the peel along one side of the tuber and pulling off the peels by hand. The peeled and washed tubers are cut into smaller pieces and boiled for about 20-30 minutes, then pounded with a pestle in a mortar until a paste is formed.

Improved Processing Technology

In the improved method the cassava is prepared into an instant fufu powder which is reconstituted into the traditional fufu when required. In the preparation of the INSTANT FUFU POWDER the cassava tubers are peeled,washed and cut into smaller pieces and boiled for a period of about 20-30 minutes as in the traditional process. The boiled pieces are then mashed and dried in a cabinet dryer. The dried mash is milled into a fine powder to give the instant fufu powder. To reconstitute into the traditional fufu, the powder is mixed with a suitable amount of hot (not boiling) water and stirred rapidly until a paste is formed.

Significance of the Improved Process

The availability of the instant fufu powder saves the housewife from the labour, time and drudgery involved in making fufu the traditional way. Also, the production of the powder makes it possible for fufu to be made by one person without much inconvenience as opposed to the traditional method where two persons are needed to conveniently pound fufu.



SIMPLE FLOW DIAGRAM FOR PRODUCTION OF INSTANT FUFU POWDER

CASSAVA FLOUR (UNFERMENTED)

UNFERMENTED CASSAVA FLOUR is not produced traditionally in Ghana. The only kind of CASSAVA FLOUR produced traditionally is KOKONTE (fermented cassava flour) the processing of which has been described already. The Food Research Institute, Accra has developed a method of producing unfermented cassava flour for use in "Composite Flours" for baking purposes.

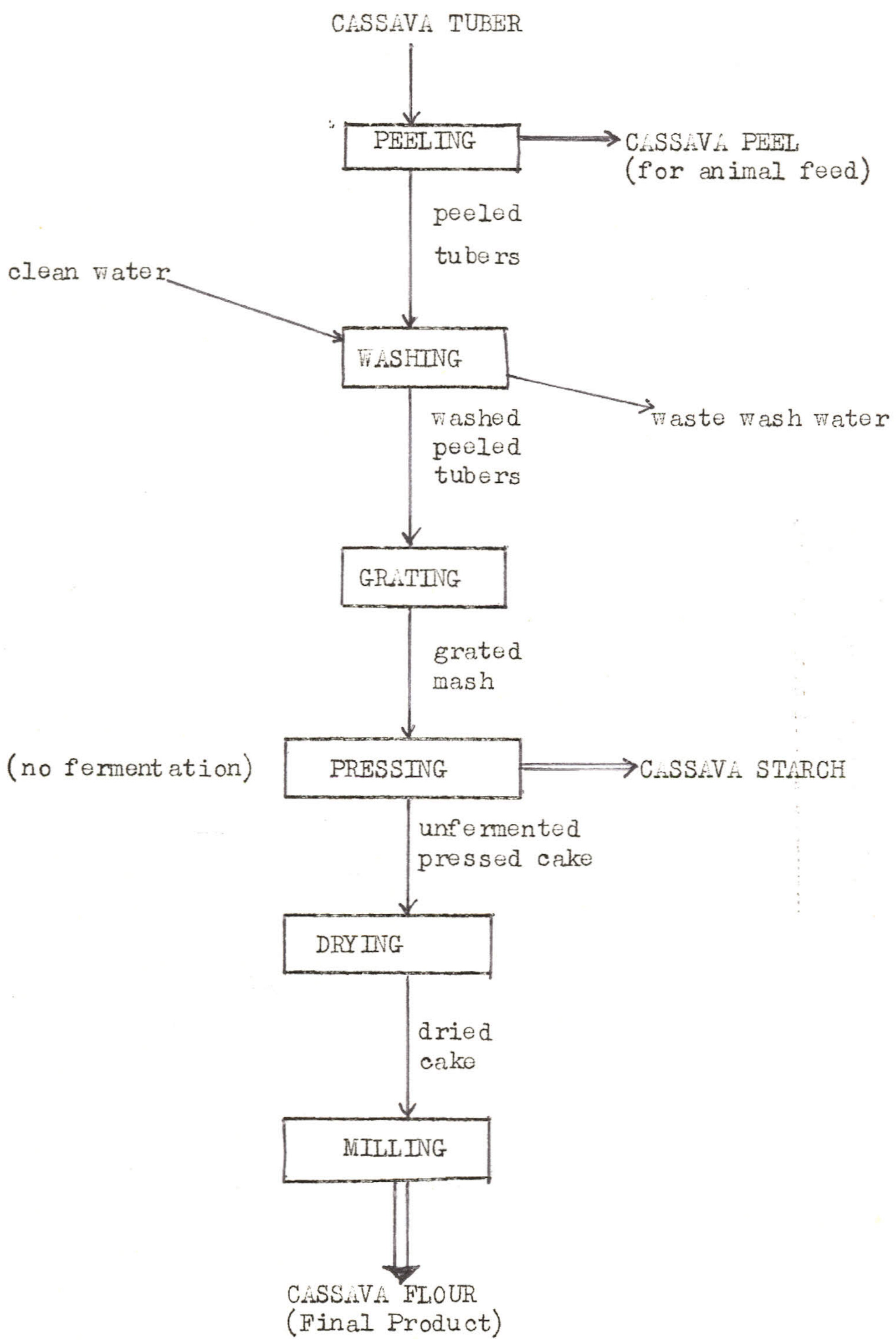
FRI Processing Technology

Cassava tubers are peeled and washed with several changes of water. The peeled, washed tubers are grated in the FRI fabricated grater and the grated mash is rapidly dewatered in a screw press without allowing time for fermentation to take place, the partially dewatered mash is loaded into trays at a rate of 12-15kg per square meter and immediately dehydrated in a cabinet dryer to the desired moisture content of below 14%. The dried product is then milled into a fine powder and packed in polythene bags (Laryea-Brown and Anderson, 1980).

Some Quality Parameters of CASSAVA FLOUR

Good quality CASSAVA FLOUR must:-

i. have a clean fresh odour free from any musty, earthy, rancid or other foreign characteristics.
ii. have a moisture content of 10-13.5%
iii. be very clean and free from pigment or dirt.
iv. have a pH of 4.7 - 5.3
v. be a fine powder .
vi. have an ash content of 0.2% or less (Brautlecht, 1953).



SIMPLE FLOW DIAGRAM FOR CASSAVA FLOUR PRODUCTION

CASSAVA STARCH

Traditional Processing Technology

Traditionally STARCH is obtained as a by-product of AGBELIMA or GARI production. The cassava liquor exuded during the initial pressing of the grated mash is allowed to stand undisturbed for about six hours during which time the starch settles to the bottom. The supernatant is decanted and the residual STARCH washed with clean water, allowed to settle again and the supernatant redecanted. The process is repeated until the desired whiteness of the STARCH is achieved. The resulting product is then dried.

Alternatively after the initial peeling and washing,the tuber is grated and ground with water into a starch slurry which is strained and allowed to settle. After settling the liquid is decanted and fresh water is added to produce another starch slurry and left to settle again. The process is repeated until the desired whiteness of the STARCH is achieved. The purified block of STARCH is then dried (Dovlo, 1972).

Some Quality Parameters of CASSAVA STARCH

Good Quality CASSAVA STARCH must:-

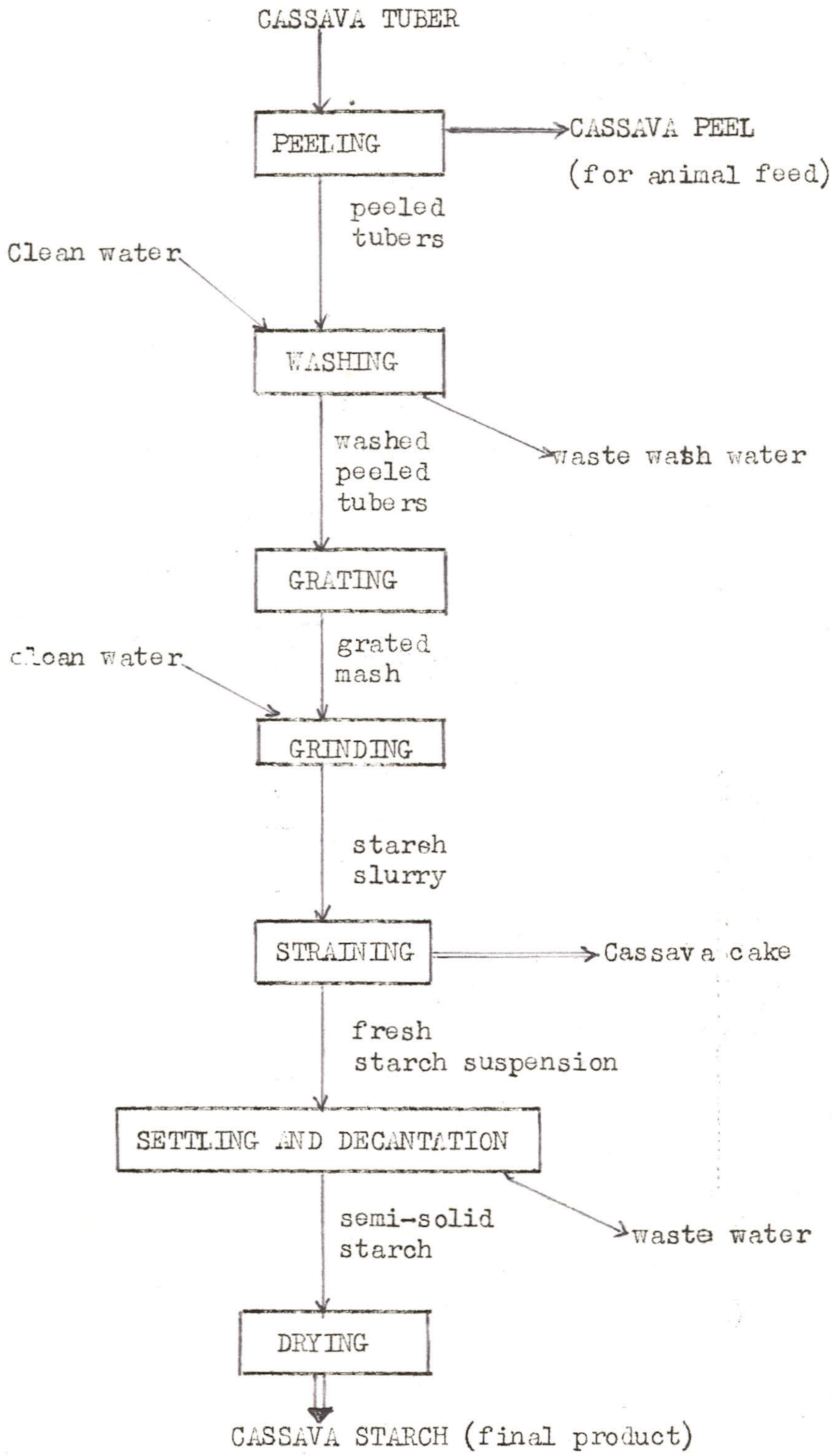
i. have a clean fresh odour free from any musty, earthy, rancid other odour of foreign characteristics.

ii. be free from foreign contaminants like pigment, dirt and protein.

iii. have a clean white appearance

iv. have a pH at 4.5 - 7.0

v. if sodium metabisulphite is used in its preservation it should show not more than a trace of SO_2 (Brautlecht, 1953).



<u>SIMPLE FLOW DIAGRAM FOR CASSAVA STARCH PRODUCTION</u>

TAPIOCA

Traditional Processing Technology

In TAPIOCA processing, fresh cassava starch is extracted from cassava tubers using the method described above. The fresh starch so extracted is partially dried and sifted over the traditional bamboo cane sieve.

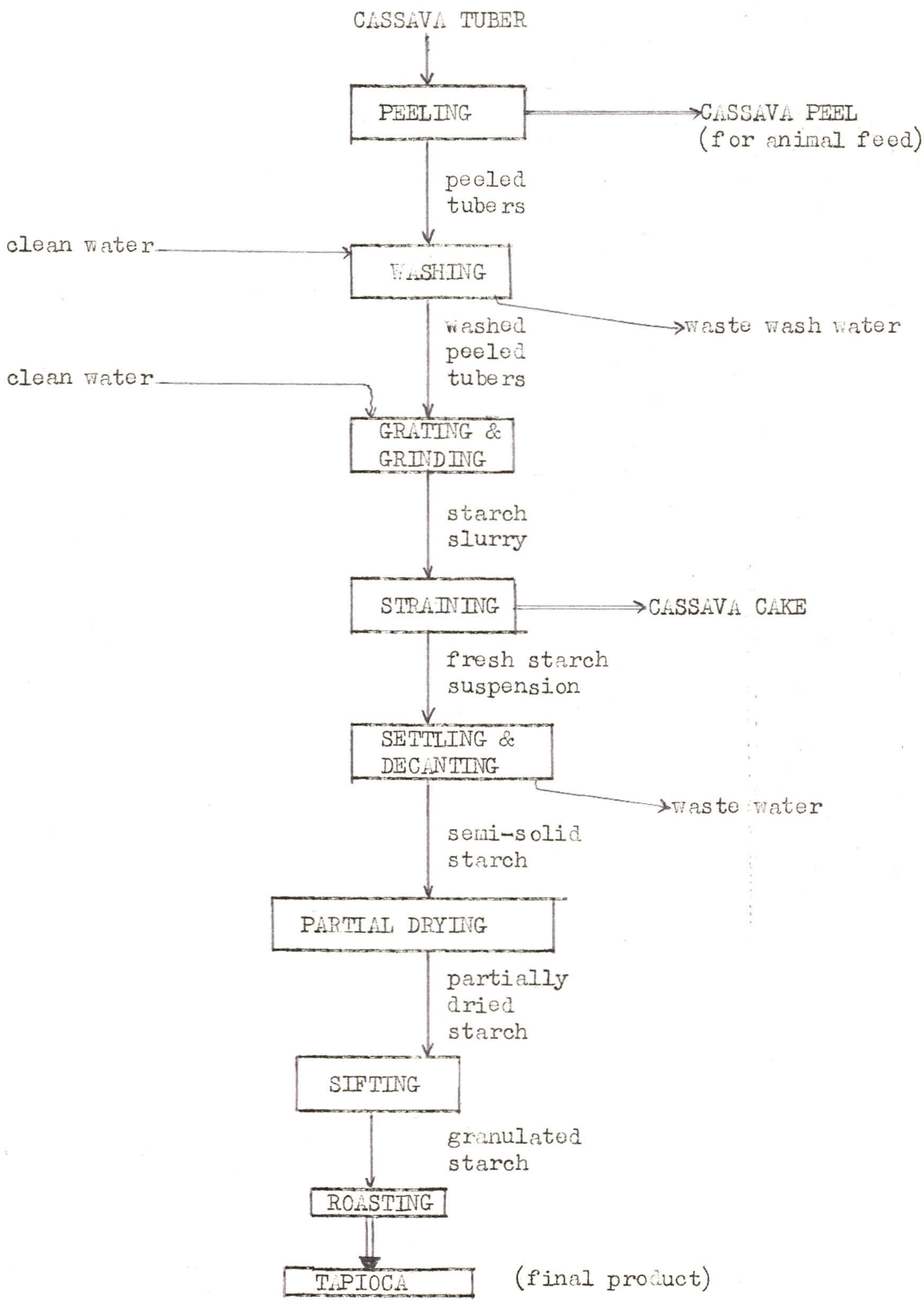
Finally the sifted starch is roasted in a hot, well greased earthenware pot until gelatinised granules are formed (Dovlo, 1972).

GLUCOSE SYRUP

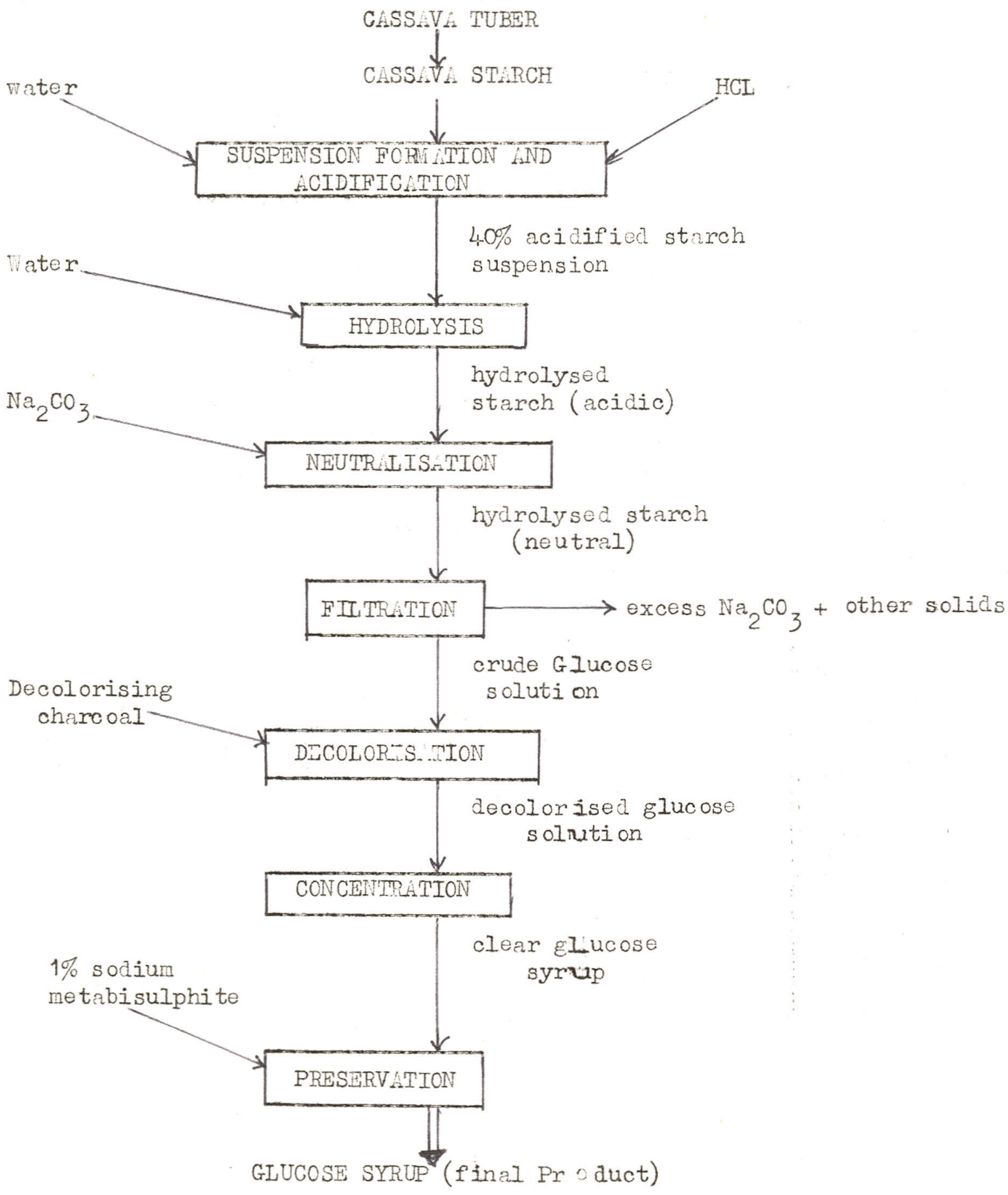
GLUCOSE SYRUP is the hydrolytic product of cassava starch. It is not produced traditionally in Ghana, however the Food Research Institute does produce GLUCOSE SYRUP from cassava starch.

Method Used by FRI

Cassava starch is extracted from cassava tubers in the usual manner, A 40% suspension of the cassava starch is made and acidified with HCL to a pH of about 2.0. The acidified suspension is placed in a pressure cooker and heated at 160°C until all the starch is hydrolysed. The suspension is then neutralised to a pH of 5.0 with soda ash (sodium carbonate) and filtered. The filtrate is decolorised using charcoal and evaporated in an open pan until a concentration of 80% solids is reached. The glucose syrup is preserved with 1% sodium metabisulphite solution (Ankrah E.K., 1976).



SIMPLE FLOW DIAGRAM FOR TAPIOCA PRODUCTION



SIMPLE FLOW DIAGRAM FOR GLUCOSE SYRUP PRODUCTION

CONCLUSION

It can be seen from the above that much has been achieved as far as the processing of cassava tuber is concerned. A lot more has been done in other research centres outside Ghana.

Some of these are:-

(1) Production of ethanol from cassava starch in one-step fermentation process - alcohol yields of between 82.3-99.6% are obtained (Abstracts on Cassava, 1981).

(2) Biochemical process for the synthesis of protein from cassava - the process yields a solid of 45-90% protein suitable for use as a food supplement (Abstracts on Cassava, 1981).

(3) The enrichment of cassava protein by fermenting starch without previous hydrolysis using the yeast Candida tropicalis. Cassava so enriched contains 21.3% protein, with essential amino acid content comparable to that of fish flour, is digestible and devoid of an acid taste. Since it is a common feed it's use is recommended in human nutrition (Abstracts on Cassava, 1981).

(4) The incorporation of fresh cassava into bread.

But in spite of these it cannot be considered that work done so far has been exhaustive. Even though the processing of cassava into various products leads to an increase in protein∠obtained is still low. Some research work can therefore be directed towards increasing the protein content of the various products whilst still making them useful in their traditional roles and uses and maintaining their quality characteristics. Some work has already been done in the F.R.I. on the fortification of GARI with textured protein.

∠content of some products, the level of protein

Some of the research works cited above show the possibility of enriching cassava meal or starch with single-cell protein. But there is the need to establish whether such protein enriched cassava meal can be used to produce the various products discussed in this paper (especially those that involve fermentation) and whether the products would have acceptable organoleptic properties.

It has also been reported by Favier (1977) that processing treatments such as soaking, peeling, milling, cooking even though eliminate toxic substances, make the products more acceptable for consumption, enable them to be stored more easily and improve their digestibilities, they result in considerable losses of nutrients like protein, fat, total carbohydrate, indigestible carbohydrate, ash, thiamin, riboflavin, nicotinic acid, calcium, total phosphorus, phosphorus, and iron. It is possible that other processing treatments employed in the production of the various cassava products could result in similar losses or other effects. It would therefore be in order if an investigation is made into the effect of each of the processing methods on the nutritional value of cassava products and how such losses can be minimized.

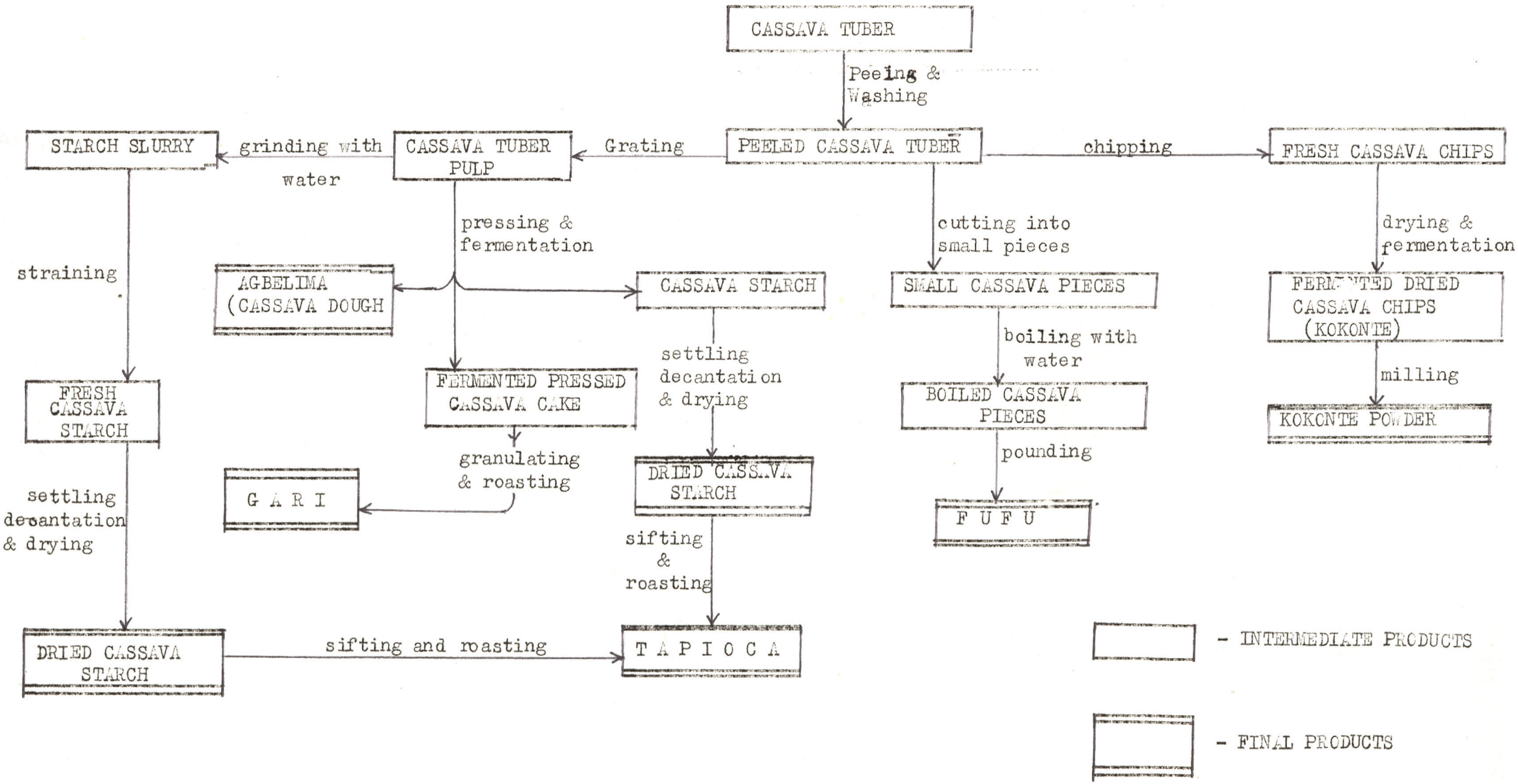
Other possible research problems that can be given attention are:

i. Improvement upon traditional method of tapioca production
ii. Development of an intermediate DEHYDRATED FERMENTED CASSAVA DOUGH that can be reconstituted for use in the preparation of gari, akple, yakayake and other agbelima based products.

iii. Protein enrichment of cassava starch with vegetable protein for the production of a more nutritious tapioca.

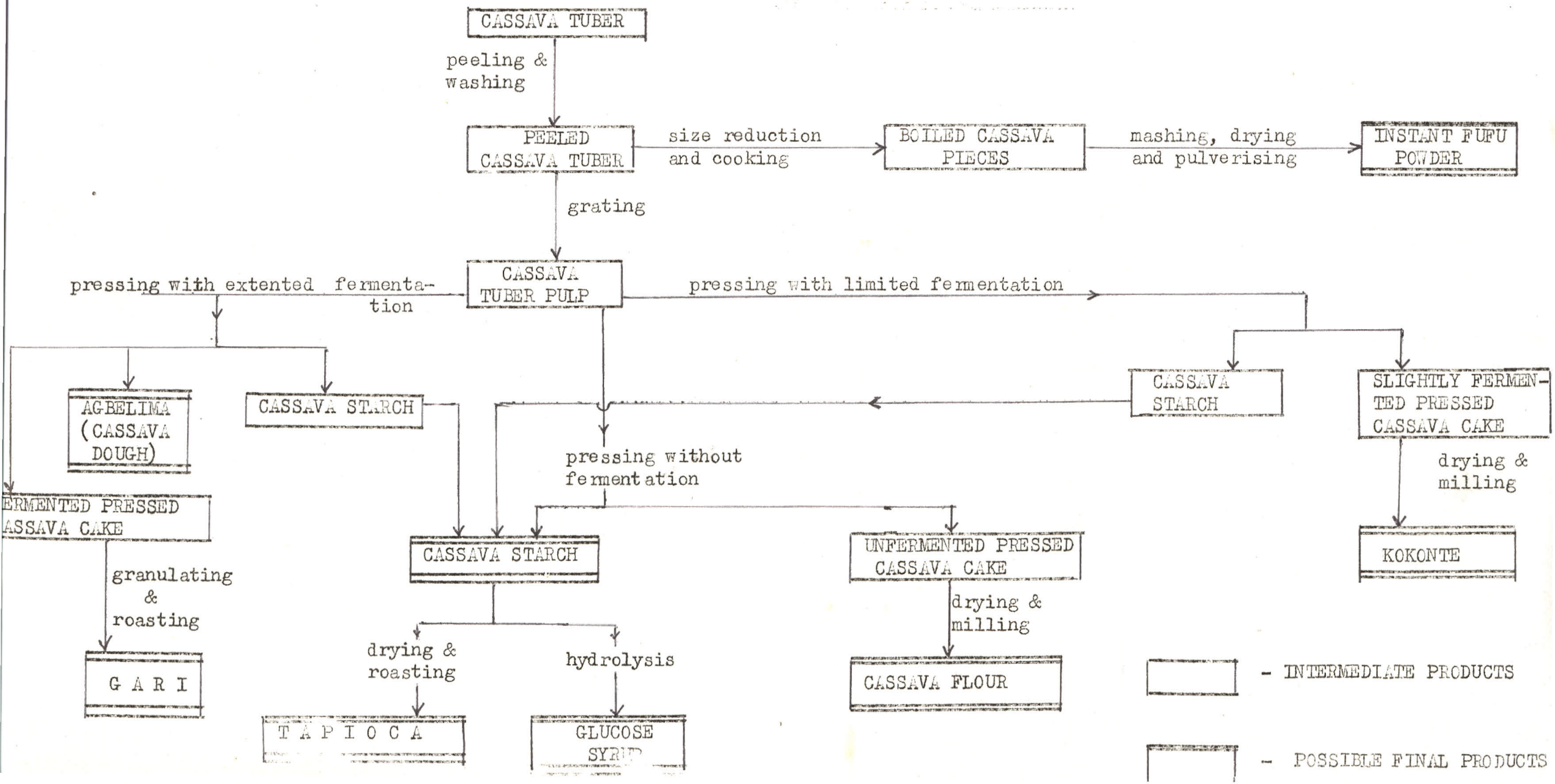
PROCESSING CASSAVA THE TRADITIONAL WAY

The flow chart below gives a summary of the major traditional cassava products and their processing methods.



PROCESSING CASSAVA THE IMPROVED WAY

The flow chart below gives a summary of the major cassava products obtained through F.R.I. (FOOD RESEARCH INSTITUTE, ACCRA) improved processing technologies. New products are included and where there are no improvements on the traditional product, it is maintained as such.



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