ASSESSMENT OF LOCAL TECHNOLOGY FOR GARI ROASTING

by

DODJI M. ATTIOGBE
ASST. RESEARCH OFFICER

FOOD RESEARCH INSTITUTE
P. O. BOX M.20
ACCRA.

JUNE, 1992

TABLE OF CONTENTS

SUMMARY

Many attempts have been made to solve the problems associated with Gari Production, with some results being achieved. Despite these, roasting remains one operation which needs to be critically researched into.

In this report the problems associated with the different unit operations have been briefly outlined. The report then goes on to discuss the traditional method of roasting gari and the various attempts made at mechanizing the roasting technology with an objective to determine how best to improve the technology in order to enhance efficiency.

One such attempt is the construction of Improved Stoves at the Cassava Processing Demonstration Unit, Pokuase under the African Regional Centre for Technology/Council for Scientific and Industrial Research (ARCT/CSIR) project. One of the achievements of the improved stove is that it takes the smoke away and as such eliminates inhaling of the smoke by the women. Due to the superiority in the design of the improved stoves over the traditional three leg mud stove, less fuelwood is used and hence energy is conserved.

The report also looks at an electrically operated mechanical roaster, which consists of a U-shaped stainless steel roasting pan and a horizontal driving shaft with four (4) pairs of arms welded to it.

Assessment of this roaster indicates among other things that:-

(i) the problem of having to sit beside the fire continuously and stir the gari is eliminated.

(ii) because the stirring rate was high the number of stirrers on the horizontal shaft was reduced from four (4) to three (3). This did not yield any better results when the roaster was tested again.

(iii) the samples of roasted gari came out dry, but not cooked.

Another attempt looked at, was the adaptation of a FATECO planetary roaster for roasting gari. Results from the adaptation test showed that, the gari obtained was fully gelatinized and the roaster had an average roasting capacity of 35kg/hr.

Assessment of the gari roasting technology showed that the mechanical roaster could be modified to successfully roast gari. It was also possible to design an efficient gari roaster based on the design of the planetary roaster.

1.0 INTRODUCTION

Gari is a cassava product consumed by a large percentage of the Ghanaian population and some nationals of countries in the West Africa sub-region. Its consumption extends to some countries in the South America continent, especially Brazil.

The objective of this report is to assess the local technology for roasting gari. The report discusses the traditional method of roasting as well as various attempts at mechanizing the process and explores the possibility of improving the technology in order to enhance efficiency.

2.0 PROBLEMS ASSOCIATED WITH THE TRADITIONAL METHOD OF PROCESSING CASSAVA INTO GARI

The main operations involved in the production of gari are; peeling, washing, grating, fermentation, dewatering, disintegrating, roasting, grading and packaging. (See appendix 1). These operations have problems which make the whole production process, difficult, tiresome and unhygenic.

Peeling: In this operation the peel of the cassava is removed using a knife. The cassava is held in one hand and the knife held in the other hand when peeling.

i) This is slow and time consuming resulting into a low peeling rate which varies between 35-50kg/h. (Amoa-Awua et al, 1991).

ii) The processor may cut her fingers with the peeling knife.

Washing: This operation involves the cleaning of peeled cassava in water using sponge at times.

i) processors may have to walk long distances to fetch water to enable them wash the peeled cassava

Grating: This is done manually using a hand held grater. The cassava is rubbed continuously on the grating surface and by this, cassava mash is produced.

i) The grating process is time consuming and has a low rate between 5-10kg/hr. (Amoa-Awua, et al, 1991).

ii) To be able to grate the cassava, a considerable amount of pressure is exterted by the women on the cassava to keep it in contact with the grating surface, thus making the process laborious. Also, because of the low rate, it requires a lot of labour in order to grate a sizeable quantity of cassava.

iii) The processor has to hold the cassava with her fingers and keep it in constant reciprocating action against the grating surface. There is the tendency for the processor to injure her fingers. As a result very small pieces of cassava cannot be grated for fear of injuring the fingers.

Dewatering and Fermentation: Dewatering of the cassava mash is achieved by packing the mash in sacks and putting heavy stones on them. The dewatering and fermentation processes take place simultaneously.

i) The women have to lift have objects like sandcrete blocks to place on the bagged cassava mash.

ii) These operations are carried out under insanitary conditions. The exudate from the bagged mash spreads around the area making the place soggy and attracting flies.

iii) The exudate,though high in starch is not collected. This starch when collected may be used for tapioca.

iv) Fermentation process not understood by processors. Sometimes the bagged mash are allowed to stay longer than necessary under the heavy objects. As a result the product becomes unduly acidic.

v) Fermentation period not standardized hence there is no quality assurance. Some ferment for two (2) days while others ferment for 3 or 4 days. In some cases it could even be five (5) days fermentation.

Roasting: Roasting is carried out in a shallow pan mounted over a three leg mud stove which employs fuelwood as its fuel.

i) This method of roasting is very tiresome. A processor has to sit behind fire for about two days to complete roasting of a batch.

ii) The heat and smoke pose a health hazard, eg. headaches, bodily pains, fever, heat rashes, diarrhorea, reddening of eyes, watering of eyes, other eye defects, profuse sweating and miscarriage in some women. (Amoa-Awua, et. al., 1991).

iii) The vapour contains some amount of cyanide and its continuous inhaling by the women can affect their health.

Packaging and Storage: The gari is packaged in jute fibre sacks. Some are also put into aluminium or enamel bowls.

i) Packaging is not air tight and as such there is a flow of moisture from the atmosphere which is at a high vapour pressure to the gari which is at a low vapour pressure.

ii) Because of the poor packaging method the gari tends to lose its crispness and prolonged storage may result in the product picking up enough moisture and grow mouldy.

3.0 ROASTING

Roasting of the sieved cassava mash consists of garification and dehydration. These two processes are not two different unit operations. They take place in the same roasting pan within the same time frame. Garification is heating the sieved cassava mash to genelatinize and dehydration causes the gari to harden gradually.

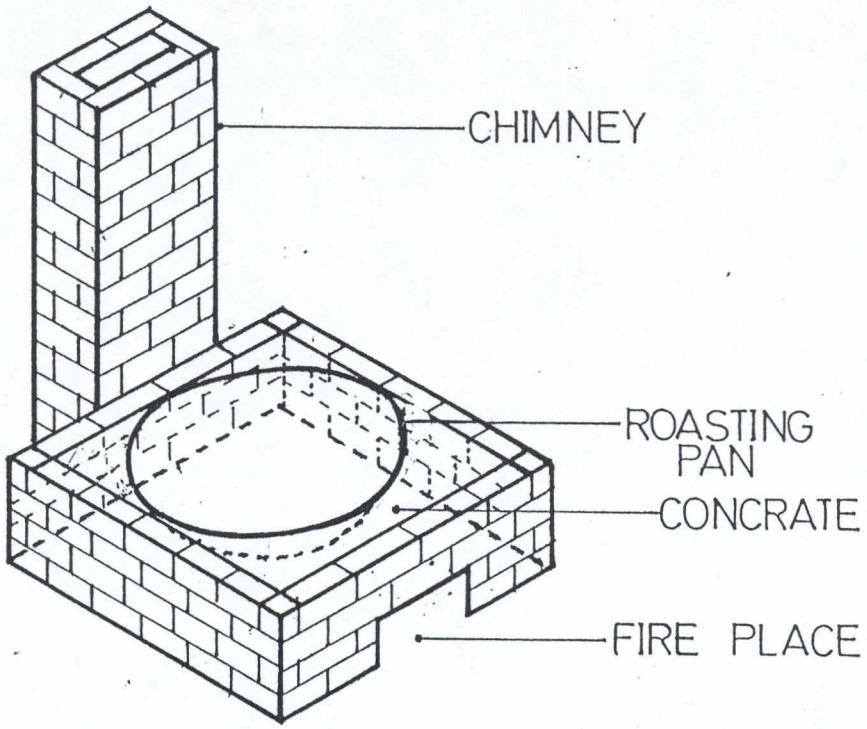
3.1 The Traditional Method of Roasting:

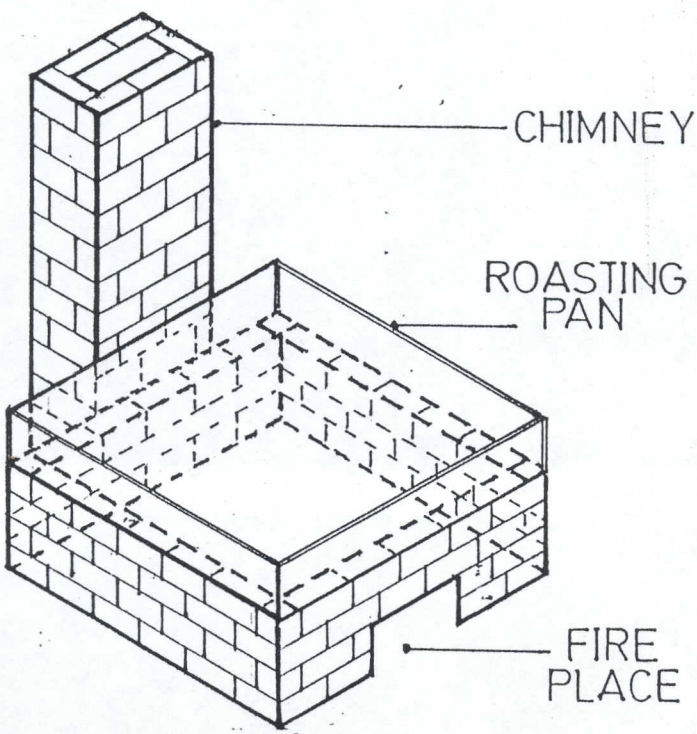
Traditionally, roasting is done in an aluminium pan mounted on a three leg mud stove and heated with fuel wood. The women sit by the fire and manually stir continuously using calabash or plywood cut to size as the stirrer. Intense heat is employed to gelatinize the sieved mash. After gelatinization the intensity of the heat is reduced to allow for dehydration. The women do this by removing some of the fuel wood from the mud stove. At the end of the roasting, the product becomes light or creamy yellow and cripsy.

3.2 Improvement On The Traditional Method:

3.2.1 The Improved Stove

Figs. 1 and 2 show the improved stoves installed at the premises of the Cassava Processing Demonstration Unit (CPDU) of the Council for Scientific and Industrial Research (CSIR) and is situated at Pokuase in the Greater Accra Region. The improved stoves use either the type of aluminium pan employed by the traditional method or a much larger rectangular pan. The design of the stoves in both cases is the same as can be seen in the diagrams. The rectangular roasting pan is larger than the aluminium pan and as such has a higher roasting capacity. The stoves are made of bricks and the roasting pan are built, into their top part. In case of the aluminium roasting pan, the top part of the stove is made of concrete. Each stove is provided with a chimney to take away the smoke and the means of heating is either by fuelwood or biogas. (Amoa-Awua and Dzokoto, 1990).


CHIMNEY
ROASTING PAN
CONCRATE
FIRE PLACE


CHIMNEY
ROASTING PAN
FIRE PLACE

3.2.2 Advantages of the Improved stove over the Traditional Method:

i) One of the major achievements of the improved stove is that it takes the smoke away and as such eliminates inhaling of the smoke by the women. Also reddening of the eyes due to the smoke is eliminated.

ii) The rectangular roasting pan, has a higher capacity compared to the traditional aluminium pan and hence reduces the time spent on roasting a batch.

iii) Due to the superiority in the design of the improved stoves over the traditional three leg mud stove, less fuel in terms of fuelwood is used and hence energy is conserved.

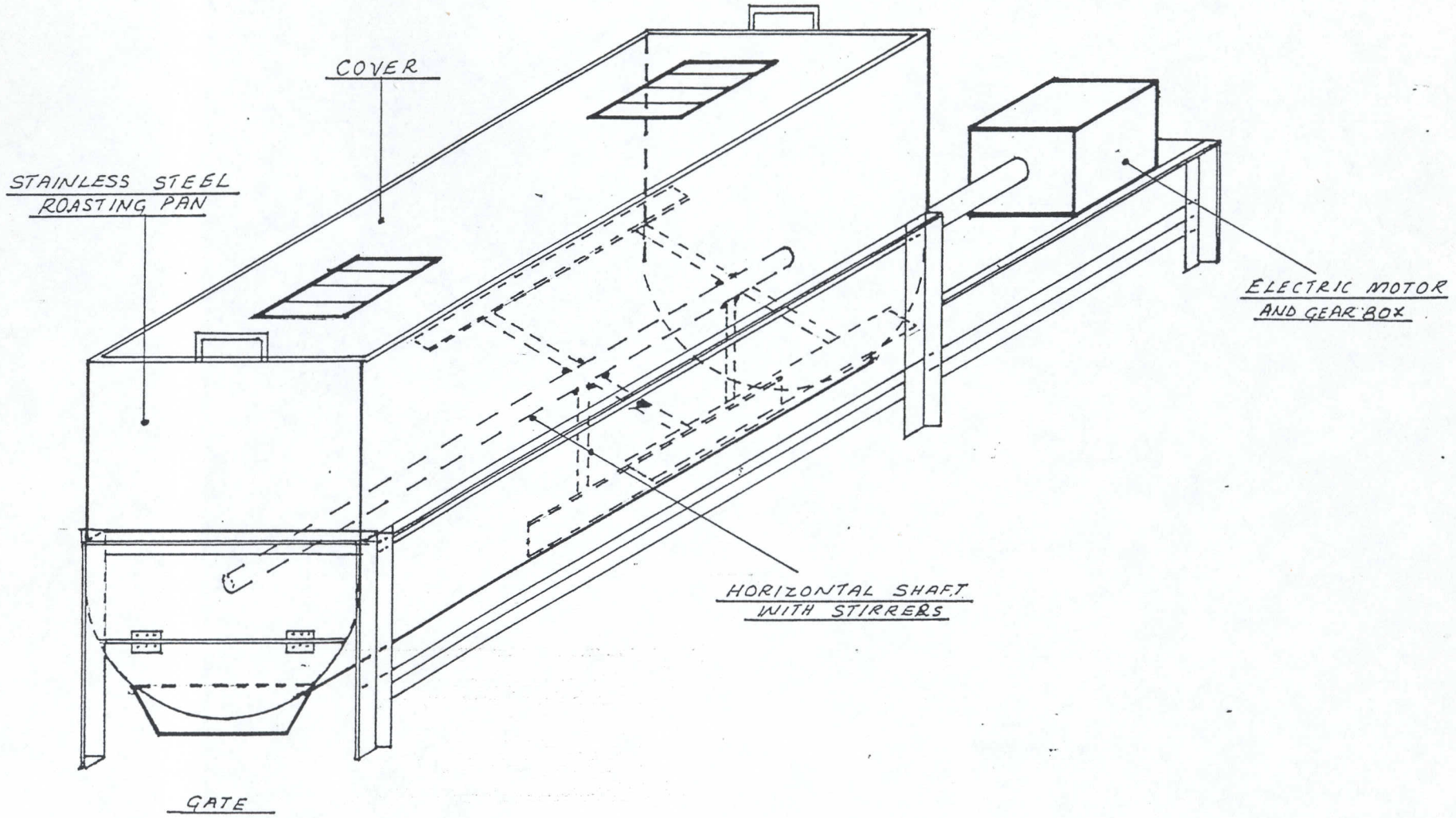
3.2.3 Problems Not Eliminated by The Improved Stoves:

i) The women have to sit by the roasting pans and stir continuously just like the traditional method.

ii) The heat in the vapour coming from the cassava mash being roasted causes the women to sweat profusely.

iii) The vapour contains some amount of cyanide and its continuous inhaling by the women may tend to affect their health.

MECHANICAL ROASTER



MECHANICAL ROASTER

The Mechanical roaster was designed by Messrs. Dzokoto and Opoku, all of the Industrial Research Institute (IRI). It was manufactured by IRI and tested at the CPDU, Pokuase.

The mechanical roaster is shown in Fig.3. The main components of the roaster are:

(i) a U-shaped stainless steel roasting pan.

(ii) a horizontal shaft with four pairs of arms welded to it.

(iii) four wooden blade stirrers each of which has been fixed to a pair of arms welded to the horizontal shaft. After a series of tests the wooden stirrers were reduced to three.

(iv) an electric motor coupled to the roaster via a gear reduction unit.

(v) a cover, mounted on top of the roasting pan.

The horizontal shaft which forms one unit with the stirrers, receives power from the motor via the gear reduction unit. The blades therefore stir the sieved dough at a low speed. The roaster is heated at the bottom by means of fuelwood or biogas. The lower portion of the roaster is covered with burnt bricks to prevent the loss of heat.

The roaster has a gate at one bottom end which remains closed when in operation, but is opened at the end of the roasting period for the gari to be scooped out. Before then, the motor is stopped and the heat drastically reduced. The gari is scooped manually out of the roaster through the gate.

4.1 Performance of the Mechanical Roaster

As stated above, the roaster was tested at the CPDU, Pokuase and the following observations made on its prformance:

(i) The problem of having to sit behind the fire continuously and stir the gari is eliminated .

(ii) Reddening and watering of the eyes, profuse sweating, heat rashes, headaches and othr eye defects resulting from the heat and smoke is eliminated.

(iii) The use of fuelwood still poses a hazard because of the smoke.

(iv) The cover provided at the top of the roaster saves the women from inhaling the vapour which contains cyanide.

(v) The stirring rate is quite high and as such does not allow enough time for the sieved dough to absorb heat to gelatinize.

(vi) Because the stirring rate was high the number of stirrers on the horizontal shaft was reduced from four (4) to three (3). This did not yield any better results when the roaster was tested again.

(vii) The samples of roasted gari came out dry, but not cooked.

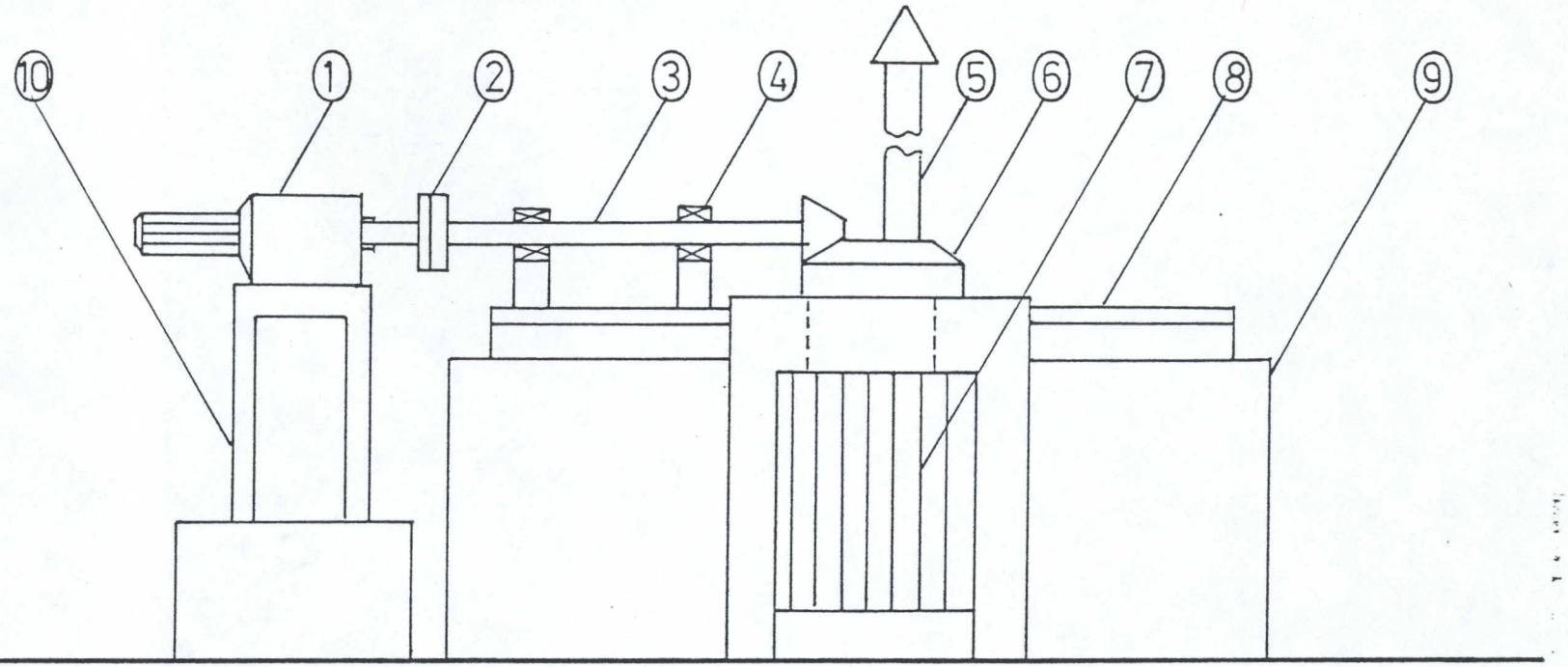


FIG. 4 FRONT ELEVATION OF PLANETARY ROASTER

N°	
1	ELECTRIC MOTOR & GEAR BOX
2	PULLEY
3	DRIVING SHAFT
4	BEARING
5	CHIMNEY
6	BEVEL GEAR ARRANGEMENT
7	FIRE PLACE
8	ROASTING PAN
9	STOVE
10	SUPPORT

5.0 PLANETARY ROASTER

As part of the study into the mechanization of gari roasting, a planetary roaster purchased from Farmers Technical Services and Training Centre (FATECO) by Food Research Institute (FRI) to roast groundnuts was used for roasting gari on trial bases. A line diagram of the planetary roaster is shown in fig.4, the roaster consists of:

(i) a roasting pan which is a 5mm thick cylindrically shaped mild steel plate.

(ii) a pair of stirrers, 180^{o} apart rotating in the horizontal plane.

(iii) a vertical driving shaft, onto which the stirrers have been bolted.

(iv) an assembly of bevel gear system which reduces the speed and changes the drive from horizontal to vertical.

(v) an electric motor and a gear box.

The roaster has three speed reduction units: The first is a gear box coupled to the prime mover (an electric motor). The second is by a V-belt drive and the third reduction is by the bevel gear assembly.

The roasting pan has a gate on the circumference of the sylindrical surface. This gate which is on the same level as the bottom of the roasting pan is opened after roasting to allow the stirrers to push out the product. The roaster is heated using woodshavings as fuel, but fuelwood could also be employed to heat it.

Performance of the Roaster

(i) The study shows that not all the products from the trials attained the standard colour of light or creamy yellow. This was due to the burning of the gari during the process of collecting the products, particularly when the quantity left is small. Another possible contribut-

ing factor is when the product begins to dry when it is not fully gelatinized.

(ii) By the acceptable standard, a good product of gari should swell about three times its volume when soaked in water. With the exception of three out of the eleven trials, all the products satisfied this requirement.

(iii) The particle size of gari obtained from the CPDU and that from the roaster were almost the same.

(iv) The average capacity of the roaster is 35kg/hr.

(v) The stirrers rotate at an average speed on 20.4 rpm.

(vi) The stirrers were not able to stir and scrap the sieved mash at the corners of the roasting pan. This is because a gap of 25mm and 30mm exist between the ends of the stirrers and the walls of the roasting pan respectively. This cannot be blamed on the roaster design because it was not designed for roasting gari.

(vii) The limiting capacity of the roaster is due to the power rating (1.5kw) of the prime mover and not the capacity of of roasting pan. (Attiogbe, D.M. 1991).

.0 CONCLUSION AND RECOMMENDATIONS

The improved stove though not mechanized is an improved system over the known traditional method and must be appreciated. The design of a burner using biogas is a step in the right direction. The use of Liquified Petroleum Gas (LPG) is also recommended. This is cheap and its usage would also help in a small way to preserve our forest.

The design objective of the mechanical roaster is good, as such, the design must be modified to achieve the target of roasting gari to the acceptable standard quality. The following modifications are being recommended to enable the roaster work efficiently:

(i) The stiring rate should be reduced. This means reducing the speed of the horizontal driving shaft. A speed of 8 rpm is recommended. The reason for this is that, the base area of the roaster being heated is small and the sieved mash needs to spend some time in contact with the base so as to absorb enough heat. This is very necessary particularly during the period of gelatinization.

(ii) The number of stirrers must be reduced from three (3) to two (2). This will reduce the stirring rate.

(iii) For effective control of the roaster temperature, the use of LPG stove is recommended. Therefore, a burner to match the heating portion of the roaster must be designed. This design should include a heat insulating element that will prevent heat loss.

(iv) The roaster should be sloped, with the side having the gate being at the lower end. This will facilitate the means of collecting the product. A permanent slope however, will affect the roasting process, in that, most of the sieved mash being roasted will be packed at the lower end of the roaster and

eventually affect the quality of the gari. This calls for a design that will permit the roaster to be horizontally seated when roasting and tilted when the product is ready for collection.

(v) The diameter of the horizontal driving shaft carrying the stirrers must be increased. It will help in stirring the gari and at the same time provide enough strength to withstand the stresses induced which will otherwise cause failure in the shaft.

The planetary roaster can be modified to obtain an efficient gari roaster. The following are modifications which can be adopted to achieve this:

(i) The size of the roasting pan can be increased to take in more of the sieved mash. This has to be accompanied with a corresponding power rating of the prime mover. This will increase the kg/hr. output of the roaster.

(ii) The design of the roaster should avoid sharp corners along the base of the roaster. The stirrers should also be designed to have radius of curvature corresponding to that of the roasting pan.

(iii) The speed of the vertical shaft carrying the stirrers should be reduced in order to reduce the stirring rate. This is necessary to reduce the time for gelatinization.

(vi) The system for heating the roaster must be designed to allow for effective control of the roaster temperature, particularly during the period of drying the gari. This will provide the opportunity to avoid burning of the product and to achieve the standard colour of gari.

(v) The design should include a mechanism that will allow for easy collection of the product after roasting.

The mechanical roaster has been moved from the IRI to the FRI mechanical workshop and the recommendations made above will be applied in modifying it.

.0 Acknowledgements

The author wishes to express his deepest gratitude to Mr. B.L. Lartey, Chief Research Officer and Head of the Engineering Division, for reading through the report and making valuable suggestions.

Many thanks also go to Mr. W.K. Amoa-Awua and Mr. S.K. Noamesi both of the Food Research Institute for the encouragement they gave and also for reading through the report and making suggestions.

Finally, the author extends his sincerest gratitude to the typists of the Food Research Institute who typed both the draft and the final report.

8.0 Reference

1. Amoa-Awua, W.K. and Dzokoto F. (1990)
Manual on Cassava Processing at the Cassava Processing Demonstration Unit.

2. Amoa-Awua, W.K., Alhassan, R., Dziedzoave N.T, Adjei, R.K., and Yeboah C.T. (1991).
A Rapid Appraisal of the Importance of Cassava Processing and Utilization in the Agriculture of Marfokrom.

3. Attiogbe D.M. (1991).
Adaptation of Fateco Planetary Roaster for Roasting Gari.

9.0 APPENDIX

FLOW CHART OF THE MAIN PROCESSING INVOLVED IN PRODUCTING GARI