AN EVALUATION OF IMPROVED GARI STOVES

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ABSTRACT

Traditional gari processing is a very labour-intensive activity and involves a number of unit operations which often result in accidents and health hazards to the operators. At the processing centres studied, a socio-economic survey revealed that the main problems encountered by the women were smoke in the eyes and heat from the traditional stove during the processing of gari. This paper discusses the preliminary evaluation of a stove which seeks to solve the problem by a double brick wall construction of the stove using thermal insulation bricks on the inside and a chimney to direct the smoke away from the women. Average temperatures measured 0.1m and 0.3m from the processing pan were 28°C and 25°C respectively for the improved stove. The corresponding values for traditional stoves were 45°C and 30°C, on a day when the average ambient temperature was 25°C. The smoke problem was also completely eliminated. The amount of firewood used to process a kilogram of cassava dough into gari was less on average by 16% in the improved stove than in the traditional stoves.

Key words: Evaluation, traditional processing, labour-intensive, improved gari stoves

1. INTRODUCTION

1.1 Background

Traditional gari is produced manually, usually by women and children, with most of the operations being carried out using simple and inexpensive tools and equipment. Although technology exists to automate all the operations, the traditional system remains economically viable where labour is available because little financial investment is needed. Apart from very small-scale production at the household level, the common arrangement is for gari producers to form a cooperative, allowing them to buy roots in bulk and then market the gari wholesale to traders or other large-scale buyers.

According to Hahn (1995), the traditional method of processing gari has a very high labour requirement and the labour productivity is low. The situation persists even now that it is rare to find the grating operation done manually and all cooperatives would own, or have access to, an engine-driven grater. Hahn (1995) also states that the drudgery associated with traditional processing is enormous and that better processing methods can improve life-styles by ensuring higher processing efficiency. Furthermore, these would also save labour, reduce drudgery and improve the quality of the products. This has been confirmed by the work that Igbeka (1993) has reported where simple ergonomics improvements to the frying task increased productivity, reduced fatigue and discomfort and contributed to improved quality.

1.2 Gari Processing Cooperatives

A socio-economic survey was carried out on three gari processing cooperatives at Asokwa, in Kumasi, Asilevikrom near New Edubiase, both in the Ashanti Region and Kesewokan near Daboase in the Western Region were studied. The gari processing cooperative is a collection of several groups of women who buy cassava roots in bulk and market the gari wholesale to traders and large scale buyers. The women processors do not own but have available to them the services of cassava graters, owned by private operators, which mills their cassava for a fee. Gari processing at the cooperative involves the following unit operations:

- peeling of tubers manually;
- washing of peeled tubers;
- grating the tubers into mash with a diesel engine or electrically operated cassava grater;
- fermentation of the mash in large baskets;
- dewatering of the mash by means of a hand operated screw press;
- pulverization of dewatered mash and sieving;
- frying of dewatered mash;
- cooling and final sieving of gari.

A survey conducted by Antwi (1998) identified the following as the main problems facing the women in decreasing order of priority:

1) smoke inhalation and heat from the gari processing stove;
2) cuts and bruises from knife wounds when peeling cassava tubers;
3) approach to the cassava grater - the point of loading too high with respect to the height of the women;
4) discomfort in scooping grated cassava into collecting pans;

disorderly movement of material from one point to the other.

2. GARIFYING PROCESS.

The garifying operation involves heat treatment of the raw dewatered cassava mash that has been pulverized into grains, to produce gelatinized (cooked) and dried grains known as gari. At the cooperatives, garifying is done by using an open circular aluminium pan set on an open fire. The operator sits sideways by the fire and continuously turns the mash in the pan with the right hand until the batch is ready. The pan is between 800 and 1000 mm wide. Meanwhile, the same operator pulverises and sieves dewatered mash with the left hand. The sieved material is spread thinly in the pan in 2-3 kg batches and stirred continuously.

Circular-shaped pieces of calabash sections are used to press the sifted mash against the hot surface of the frying pan, to scrape it quickly to prevent burning and to stir the mash vigorously until gelatinized grains are formed. The process generally takes 30-35 minutes and is stopped when the material makes a rustling noise. Judging the point at which frying is complete is a subjective matter, depending largely on the experience and skill of the operator.

Traditional frying causes a great deal of discomfort to the operators because of their being in contact with heat, smoke from thefire and steam from the heated cassava mash. Moreover, energyconsumption per unit of output is relatively high. Attempts to mechanize or automate the garification operation are still going on and researchers have reported some results (Igbeka & Akinbolade 1986, Odigboh and Ahmed, 1982).

2.1 Improved garifying stoves.

Simpler upgraded equipment for roasting consist of an array of smokeless stoves, built of burnt clay bricks and heated from a common fireplace. The fire is fuelled with firewood or biogas obtained from biomass residues of cassava processing.

More sophisticated equipment normally takes the form of a mild steel trough with rotary rakes and paddles positioned on a central shaft to dislodge the gelatinized bed of pulp from the fryer wall to prevent sticking and burning and to transfer the material through the length of the garifier. Gelatinization is complete in about 15 minutes and the rest of the time spent inside the garifier is used to reduce the moisture content to the desired 8-11% suitable for long term storage.

Another development worth noting is a box-type stove developed by the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria. The stove is insulated with mud plaster with the burning chamber consisting of a half-size oil drum extended on two sides and provided on one end with a chimney for more efficient combustion. A wooden box to hold sifted cassava mash comes with the unit. It is positioned directly on top of each pan to prevent spillage and provide easy access for loading. The arrangement minimizes spillage and product contamination (Hahn, 1995).

2.2 Proposed improved stove.

The proposed stove is based on the operations at the Asokwa, Asilevikrom and Kesewokan cooperatives and is meant to be an improvement on their current stove with very few changes to their current mode of operation. Antwi (1998) showed that the women are in several small groups. He also found out that each group usually had three fireplaces which they operated simultaneously anytime they had cassava to process. A survey conducted by Antwi (1998) showed that the women were all agreed that the smoke in their eyes and heat from the stoves were their greatest worry.

2.3 Design and construction of improved gari processing stoves.

Based on discussions with the women and other observations made, it was decided that a three-stove-one-chimney arrangement be considered for construction at the three cooperatives. The three stoves are set at 120o with respect to each other with a chimney in the middle. The following anthropometric measurements were also considered in the design of the stove:

Woman stature: 1563 mm
Sitting height: 853 mm
Knee height: 501 mm
Shoulder to fingertip: 708 mm

The material selected for the construction was burnt bricks, which is readily available in the areas where they were constructed. The fireplace was built with two layers, one of thermal insulation bricks and the other of ordinary bricks. Thermal insulation bricks were used for the inside of the firing chamber with clay as the binding material, while ordinary bricks were used for the outside with cement as the binding material for strength and durability.

The arrangement is such that all the three or any of the three stoves can be used at any time. Figure 1 below shows the improved gari stoves.

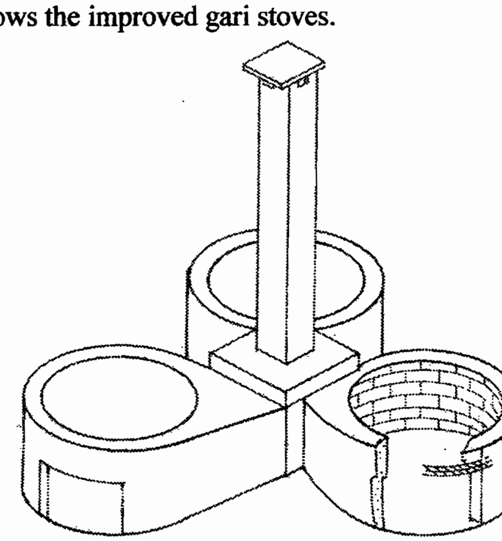

Figure 1: Schematic diagram of the improved gari stoves.

Other construction details include the following:

(a) The height of the stove above ground level is 400mm. This height allows both the women and children to stir easily without raising and stretching their hands too much.

(b) The height of the chimney is 3250 mm, about 600 mm above the roof level. This height ensured that smoke from the stove does not in any way interfere with the operations of the women.

3. EVALUATION OF IMPROVED STOVES

Evaluation of the improved stoves involved a measurement of the temperature of the outside of the stoves and the chimney, as these gave an indication of the heat radiated to the working environment of the women. The time taken to process a known quantity of sieved cassava dough and the amount of fuel wood used in the processing were also noted. The results are summarised in the tables and figures below.

The surface temperatures of the improved and traditional stoves, Figure 2 show that the surface temperatures of the Traditional Stove are consistently higher than those of the Improved Stove. These high temperatures are radiated to the surroundings of the traditional stoves.

Figure 2 shows the quantity of dough processed over a period of 120 minutes (two hours).

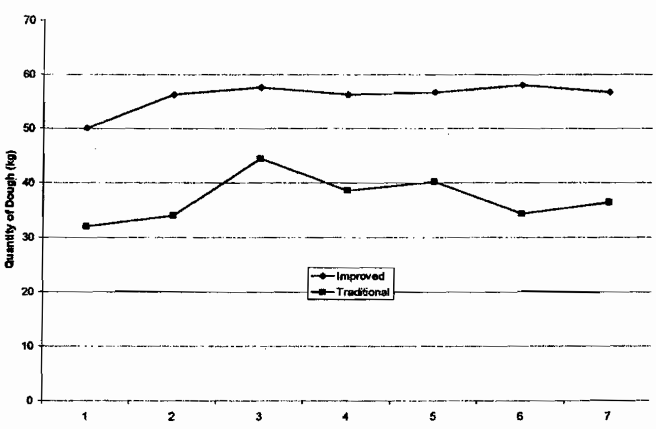

Figure 2: Quantity of dough processed in two hours (120 minutes).

Two hours is the average period during which the women swap roles in order that they could take a break. These tests were conducted over a period of one week. Eight different operators were used to operate the improved as well as the traditional stoves and the quantities of material processed were weighed. The tests were all conducted around the same time of day throughout the week. Different quantities of fuel wood were used in the various tests. The calorific value of all the wood used is assumed to be the same for all the tests conducted, as the fuel wood used was bought from the same source. The graph shows that for all the quantities of dough processed over the period, the improved stove was used to process more dough than the traditional stove. The quantities of fuel wood used were, however, different for each of the tests. The only parameters of interest for all the tests were the time taken and the amount of dough processed during the period.

Figure 3 shows the relationship between quantity of fuel wood used to process a quantity of dough. The diagram shows that for nearly all the measurements taken, the quantity of dough processed using the improved stove was higher. This trend might suggest that the improved stove is more fuel efficient due to the construction and heat retention capabilities.

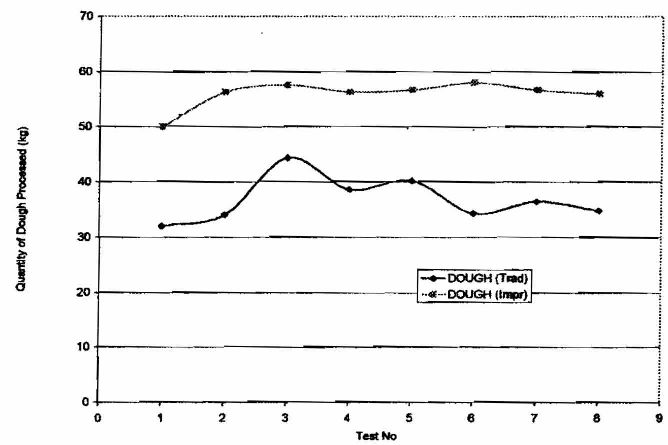

Figure 3: Quantity of dough processed per kilogram fuel wood used.

Figure 4 shows the variation in quantity of dough processed by two operators under different conditions (in the morning, afternoon and evening) alternatively using the traditional as well as the improved stoves.

Further evaluation of the improved stoves involved a measurement of the outside temperature of the stoves and

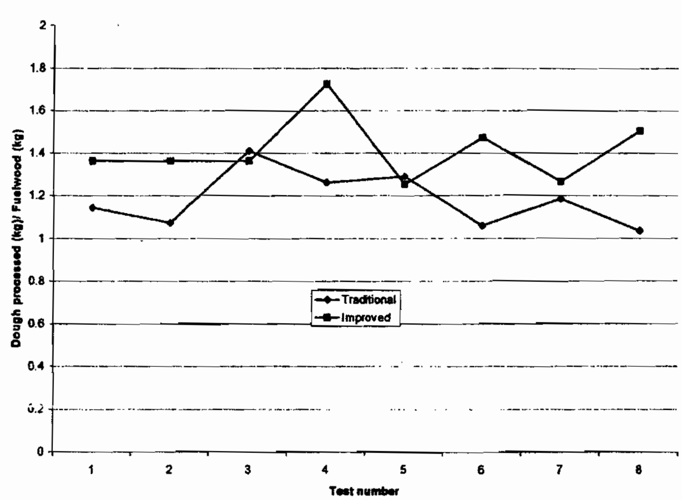

Figure 4: Quantity of dough processed under different

the chimney, as these gave an indication of the heat radiated to the working environment of the women. Thermisters were used to measure the temperatures at various points on the improved and traditional stoves, which were recorded using a Grant Squirrel Meter/Logger. The surface temperatures of the improved and traditional stoves, Figure 5 show that the surface temperatures of the traditional stove were consistently higher than those of the improved stove. The average surface temperature of the traditional stoves was 93.9°C and the corresponding value for the improved stove was 58.2°C. The heat from the surface of the stoves is radiated to the working environment of the gari processors, resulting in thermal discomfort.

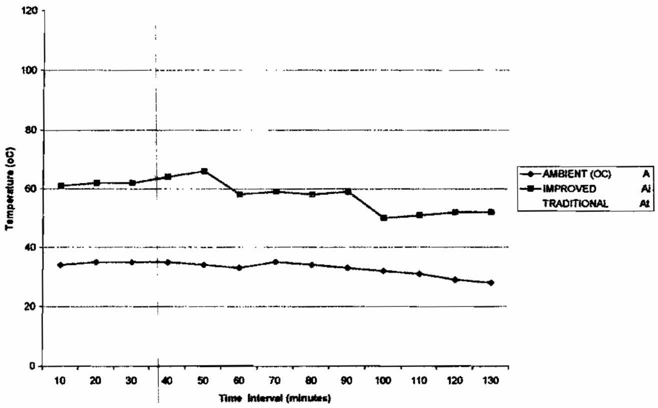

Figure 5: Temperature variation over time

4. CONCLUSION

The improved stove as designed and constructed performs better than the traditional gari stove. The higher cost of construction could be justified by a longer service life and better working conditions for the women, which could result in fewer days spent off the job because of ill health. The possibility also exists for the use of materials such as clay, which can greatly reduce the cost of the stoves considerably.

Acknowledgements:

The authors acknowledge with thanks the financial assistance received from the Silsoe Research Institute of the United Kingdom, for the design, construction and testing of the improved stove at the Asokwa Cooperative in Kumasi, and Opportunities Industrialization Centre International (OICI) of USA for the construction of the improved stoves at Asilevikrom and Kesewokan. The contributions of Mr. Michael Antwi and Peter Dakudzi, former students of the Department of Agricultural Engineering is also gratefully acknowledged.

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