Original Research Article

Design and Development of Power Driven Gari Fryer

Abstract

Based on the tedious relative problem associated with gari frying. A continuous process power-driven gari fryer was developed in Federal Institute of Industrial Research, Oshodi. (FIIRO) to fry large quantity of cassava mash. The fryer has two sections: one to gelatinize the cassava mash and a second to dry it. The fryer was tested at time range of 20, 56, 64, 60, 68 mins and initial weight of dewatered cassava mash of 60, 100, 140kg. At constant speed of 8rpm, an initial weight of 140kg and a temperature reading of 120 of frying trough, an output of 83.2kg/hr was established with a yield of 59.4 (resident time 15mins) of dried gari without any peculiar odour. The capacity of the fryer is 500 kg per day against a manual method of frying of 5kg for 30 mins (100kg/day) in local cassava processing industry in Nigeria.
Keywords: Gari frying, Cassava mash, Capacity and Gari fryer

1.0 Introduction

Gari is a processed fermented product from cassava and is consumed in Nigeria as well as in most countries of the West African Coast and in Brazil. Its ability to store well and its acceptance as a convenience food are responsible for its increasing popularity in the urban areas of west and central Africa. The most critical unit operation that determines the quality of the final product in gari production is the frying operation otherwise known as garification. (Igbeka, 1995). Gari frying though, a dehydration process, is not a straight forward drying process. It is not possible to produce gari from cassava pulp by just passing heated air through it. The product from such an operation would be dried cassava pulp or granules and not gari. Hence, gari frying is an arduous and intricate operation that needs good understanding of the factors that affects the quality of the final product. Therefore, garification is a simultaneous process of cooking and dehydration operation.

Gari production consists of the following processing, peeling, washing, grating, fermentation, pressing, breaking of the cake, sifting, partial dehydration of the cassava mash and then final drying (IITA & SON, 2005). All these processing can be done manually at the village level while the use of equipment are employed at commercial level. Gari grains are classified into five categories. These are: Extra fine grains Gari, Fine Grain Gari, Coarse Grain Gari, Extra Coarse Grain Gari and ungraded Gari: (NIS 181: 2004). There are various methods of Frying Gari which are Traditional, Improved village method and mechanized method. (Igbeka, 1995). Traditionally Gari is fried in shallow earthen-ware of cast- iron pans over a wood fire. A piece of calabash sections or spatula-like paddles of wood is used to press the sieved mash against the hot surface of the frying pan but it must be scrapped quickly and stirred constantly to keep the material moving to prevent it from burning until frying is completed when it reaches a temperature of 80°C to 85°C. The process takes 30 – 35 minutes, with the moisture content of the final product reduced to about 18% (Bencini, 1991). The discomfort due to heat and the sitting position of the operator have been of concern to researchers. The preparation of gari from cassava has basically been done according to traditional processing technique and through this method: the best quality gari is obtained but it is time consuming, tedious and lends itself to health hazard for the operator. Hence, efforts should be made to mechanize the garification operation for large scale processing.

The basic technology of gari making involves partial gelatinization of cassava mash and finally drying the gelatinized mash to obtain the end product. In simple term this means cooking and drying of cassava mash in a continuous operation, i.e. two in one unit operation. Traditionally, this indigenous science has been defined when one observes a village woman doing the cooking (gelatinization) of cassava mash by supplying high heat and carrying out slow paddling. The drying is done at a lower heat and faster paddling intensity to facilitate the escape of moisture from the product. Since all these operations are manual the processor naturally inhales part of the hydrogen cyanide evolved and this is hazardous to human health. Levi and Cruche (1956) developed an improved village process including specially designed frying equipment among others. Collard and Levi (1959) investigated the fermentation of the cassava mash and found that there was a two—stage action. Further development of gari production equipment took place in Brazil and West Africa. The planetry dryer was a Brazillian technology. The rotary louvre fryer-dryer was a design of 12T Cote D'Ivoire. The open type paddled dryer was a design credited to PRODA and FABRICO in Nigeria.
All the surveys carried out have shown that the gari produced by various equipment has one deficiency or the other affecting its quality. The Brazilian planetary machine and 12T dryer produce gari that is not properly gelatinized as evidenced by a lot of floury powder present in the finished product. The gari product from PRODA and FABRICO machines has low shelf life as the moisture content is about 15%. The moisture content of standard gari is 10% and below for a shelf life of over one year. Thus, some innovations and improvements have been initiated and carried out in the equipment and the general set-up of the village method so as to alleviate the problem encountered in the operation. Improved village methods have some numbers of advantages over traditional method of frying. The nuisance of smoke was totally eliminated, the capacity and rate of frying were increased and fireplace is improved. The following equipment are improved village methods: (i) UNIBADAN (University of Ibadan) improved Gari Fryer is made of a rectangular fire place oven with a chimney and a frying pan. The fryer is operated by two people sitting on both ends of the fire place. (Egba, 1987). (ii) IITA (International Institute of Tropical Agriculture, Ibadan, Nigeria) model is a one-man operated Gari fryer with an elevated fire place oven. The frying pan is circular, made of cast iron and is smaller than the normal traditional pan in diameter but has more depth. The pan sits on the circular oven which has a chimney. (iii) RAIDS (Rural Agro- Industrial Development Scheme) developed by the Nigerian Federal Department of Agriculture and Rural Development is an improved fryer package for the Rural processor of Gari. It is similar to the UNIBADAN model and it is rectangular in shape.

In the past years, a lot of Research has been carried out to fully mechanize gari frying operation but most of these designs did not produce the desired and acceptable product for the consumers. Perhaps, the designer of those equipment did not take into consideration the critical specifications of the existing local technology. In developing any mechanized Gari Fryer the following features have to be considered as basic requirements: i. A continuous process operation leading to mass production of moderate capacity. ii. A regulated Temperature mechanism which ensures simultaneous cooking and dehydration without roasting to desired moisture content after a specific period. iii. A mechanism that provides both stirring and lump breaking actions so that uniform cooking and dehydration in the entire mass is ensured and the desired texture produced. iv. An arrangement of paddles so as to produce a conveyor effect which will give the product a forward movement during the process (Igbeka, 1995). There are few mechanized gari processing plants in the Nigerian Markets which are found to be performing well as regard the quality of gari.

FIIRO started the research and development in the area of mechanization of gari frying operation in Nigeria. The need to reduce drudgery associated with cassava frying and drying leads to evolution of various gari frying equipment by FIIRO. A pilot plant of capacity of one ton per day was designed by FIIRO and the eqipment built on license to Messers Newell Dunford Engineering Ltd. of Surrey, England. The set of equipment contained, among others, a rotary kiln for gari cooking by gelatinization and a louvre dryer for final drying of gelatinized gari. A technical feasibility test—running of the plant was carried out to determine the economics of the process. Although good quality gari was produced, cost analysis showed that the production scale was uneconomic. Also, Brazillian model gari fryer, this fryer consists of a Semi- circular steel plate and operates in a batch drying process. Atop the plate is a large ring geared mashed to an inner annulus which is connected to a vertical shaft with large steel paddles. A specific batch of sieved cassava is dropped into the circular plate and the eccentric paddles shift the mass circularly to produce a dry product. Lastly is the power driven gari fryer which was otherwise tagged “UNIDO sponsored FIIRO gari fryer”. This model gari fryer has been on the accurate simulation of the traditional technique being that it consists of two units for gelatinization of cassava mash and final drying of the product to obtain quality gari.

2.0 Materials and Methods

2.1 Description of the Power Driven Gari Fryer

This fryer is a UNIDO (United Nation Industrial Development Organization) sponsored project designed and fabricated by Federal Institute of Industrial Research (FIIRO) Oshodi which is tagged with “Power Driven Gari Fryer”. It is a simple continuous process plant and consists of a semi-circular steel plate with rotating paddles fixed to a steel shaft slowly rotating on the axis of drum. The paddles are eccentrically located in such a manner that their motion compels the frying Gari granules to move from one end of the plate to the other. It consists of two trough chambers: gelatinization chamber and drying chamber. These two troughs are mounted on frame stand with insulation wall around the frame.

The paddles are powered by diesel engine via chain drive. The source of heat is through gas burner which produces a wall temperature of about 250^{o}C. The rotating paddles sweep the gelatinizing mash from the trough wall to prevent sticking and burning and at the same time move the material through the length of the garifier towards the discharge sprout. Frying and Drying occurs during this period, heat is supplied by Gas Burners. The fryer is as shown in figures 1 to 4.

Figure 1. Isometric view of the fryer from the right and left side

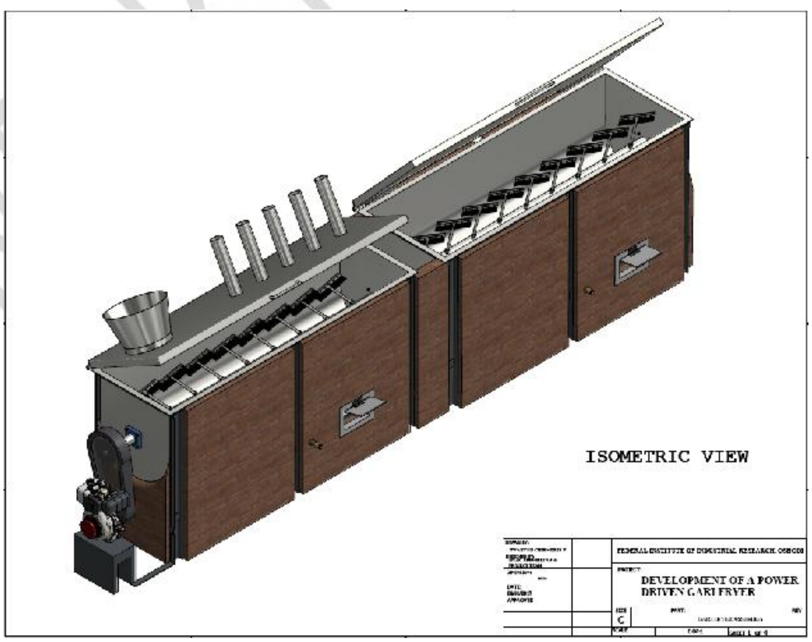


Figure 2. Isometric view of the fryer showing the paddles and inner part of the troughs.

2.2 Design Analysis

2.2.1 Design Consideration

The design of the gari fryer-dryer which evolved by FIIRO/UNIDO is based on the principle of a two in one unit operation whereby the equipment has two compartments, one for the garifier and the other for the dryer. The type of gari fryer-dryer considered for the design is paddled type with continuous transfer mechanism. The garifier section has fewer paddles than the dryer side. Also the dryer side is open at the top while the garifier is partially closed. This would allow partial gelatinization at the garifier and drafting by escape of vapor at the dryer side.

The unit operations are therefore the feeder for input material, the garifier for the cooking of the material and the dryer for the roasting of the cooked product. It was considered to design for a capacity of 500kg per 8 hour day finished product. This was used as a base for the analysis of input raw material and by products. The size of any dryer has been shown to be estimated according to a length to diameter ratio L/D which, for commercial practice, is a value between 4 and 10. Also in conventional design, the dryer is sloped at an angle between 0^o and 10^o

2.2.2 Product Retention Time

The design equation of a dryer is empirically given as:

$$t = \frac{L/DR}{C_0(a - K_o V)} \qquad 1$$

Where t = product retention time; L the dryer length; Co. a constant between 0 and π; D the dryer diameter; R the r.p.m of shaft rotation; 'a' the slope of dryer; Ko a constant; V the linear velocity of the product being processed. The arrangement of paddles in the gari fryer-dryer and the radial arms have direct effect on the retention time of product.

2.2.2.1 Residence time during gelatinization

Using 1.2.4, residence time

$$t = Ln/2\pi N tan\,\theta = 15.6 \text{ minutes} \qquad 2$$

Where, L is length of fryer (235mm), r is width of paddling area (20mm), N is rpm of shaft (16 rpm), n is no of starts of paddles (2) and θ is angle of inclination of the paddle (8.5^0)

2.2.3 Design of the Paddle System

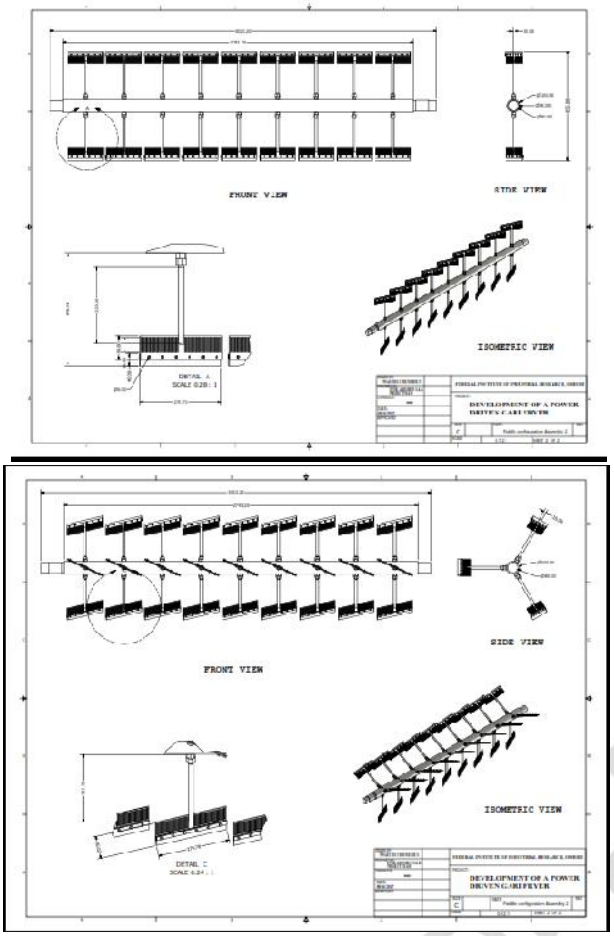


Figure 3. Shows the arrangement of two-start and three-start paddling system.

Considering a particular paddle inclined at angle θ as shown in fig. 3, the arrangement will be approximately similar to lead screw having a pitch as shown and helix angle θ.

Lead = Pitch for a single start arrangement so that

$$\frac{Lead\ (Pitch)}{2\pi r} = \tan\theta \qquad 3$$

Where r is the width of the functional part of the paddle.

For a multi-start, lead = Pitch x number of start i.e. Lead = Pitch x n

$$\frac{Pitch \times n}{2\pi r} = \tan\theta \quad \text{or} \quad \text{Pitch} = \frac{2\pi r \tan\theta}{n} \qquad 4$$

For every revolution of shaft, the material carried by a paddle moves through a length equal to the pitch, P.

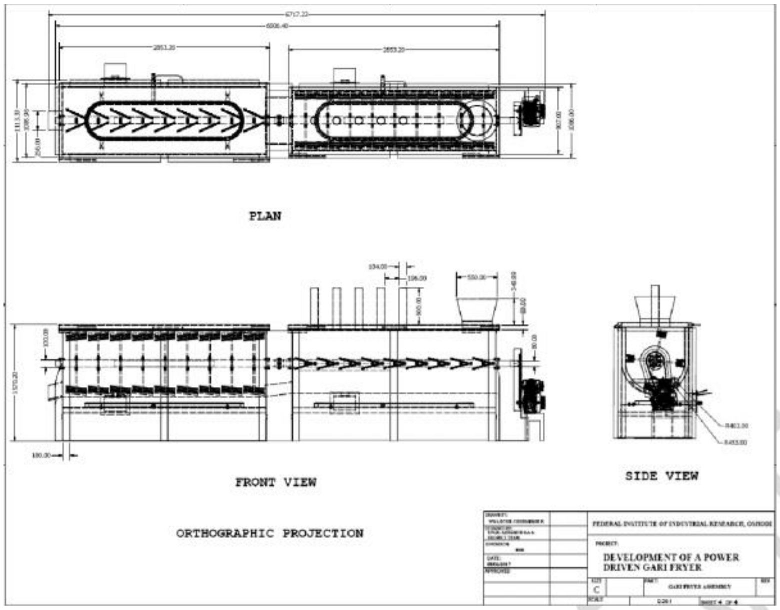


Figure 4 Orthographic view showing the garifier and dryer of the fryer

2.2.4 Design of Shaft

The main rotating shaft of the dryer carrying the paddles can be designed by applying the ASME code formula;

$$d = \left[\frac{16}{\pi Sm}\sqrt{(Cm\ M)^2 + (C_0 T)^2}\right]^{\frac{1}{3}} = 61.3mm \qquad 5$$

where d = shaft diameter; Sm the maximum shear stress of the shaft material; M the maximum bending moment; T the maximum torsional moment; Cm a constant called bending factor; Ct a constant called torsion factor.

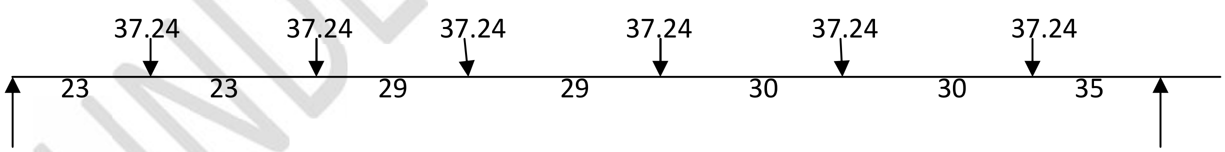


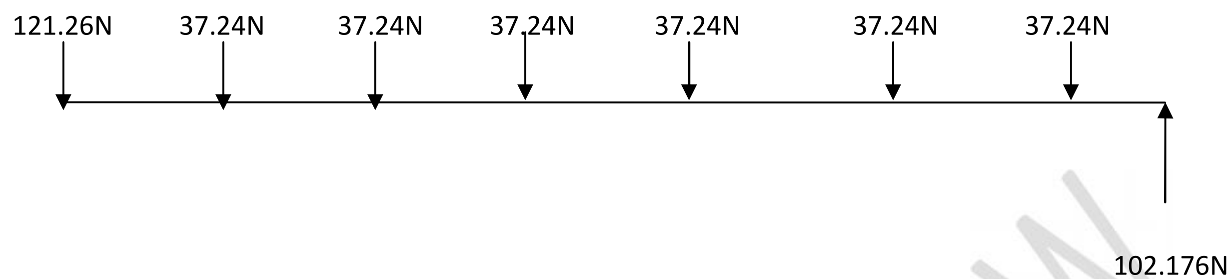
Figure 5 Fryer Shaft Loading

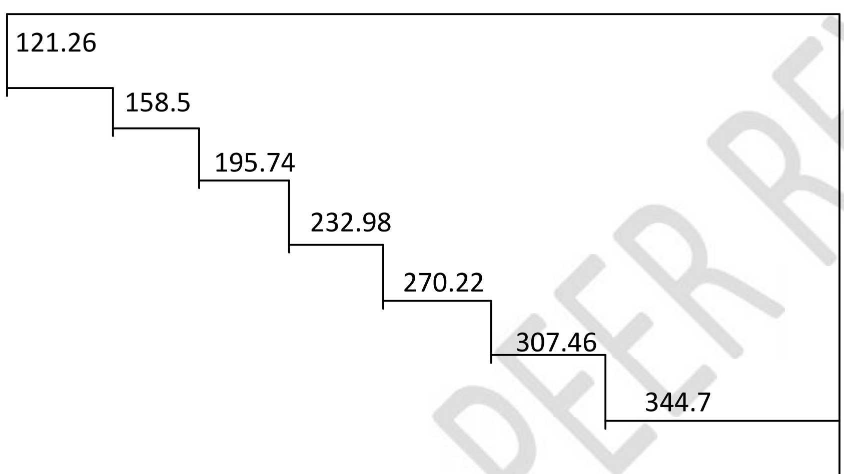
In fig. 6, the load at F can be assumed to be that due to shaft weight (50kg) and the uniform loading (0.015 x 2400 = 36kg) which add up to 61kg.

Taking moment about G.

$24000R_3 + (200 \times 10) = (61 \times 1200)$, $R_3 =$ 29.7kg

Considering similar case for the dryer side, the loading is as shown in fig. 6.





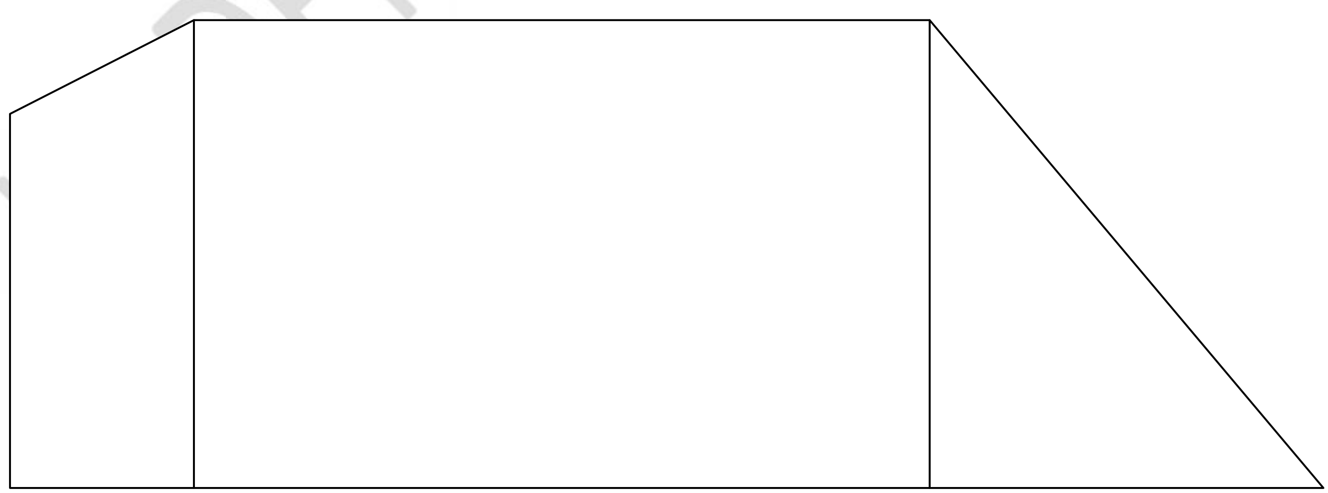


Figure 6 Dryer Shaft Loading

The loading at B is assumed to be 25kg shaft weight added to 0.03 x 2400 or 72kg due to the uniformly distributed load, totaling 97kg.

Taking moment about a.

97 x 1200 = 2400 R_2

or R_2 = 48.5kg

Suppose the two shafts are coupled as shown in fig. 5, then taking moment about A, (72 x 1200) + (60 x 2650) + (36 x 3900) + (10 x 5300)

= (2400 x 48.5) + (2700x 29.7) + 5100R_4

R_4 = 47.5kg

For vertical equilibrium

R_1 + 48.5 + 29.7 + 47.5 = 72 + 60 + 36 + 10

R_1 = 52.3kg

Considering the left side of the loading in fig. 5, at any distance x along AB, bending moment = $52.3 \times \frac{0.03x^2}{2}$

This equation can be used to build up a table as shown below: -

2.2.4.1 Shaft diameter required

Let the ultimate tensile stress for the shaft material be 400N/mm^2

Factor of safety = 12, Allowable stress, $\tau_{max} = \frac{400}{12} = 33.3N/mm^2$ = 3.4kg/mm^2

Shaft diameter is given by.

$$d_0^3 = \frac{16}{\pi \tau_{max}} \sqrt{(K_b M_b)^2 + (K_t M_t)^2}$$

where bending factor, K_b and torsional factor, K_t are 3.0 and 2.5 respectively.

$$d_0^3 = \frac{16}{\pi \times 3.4} \sqrt{(46859 \times 3)^2 + (2.5 \times 25200)^2}, \; d_0 = 61.3mm$$

A shaft of 65mm diameter is used for the design

2.5 Power required to drive the fryer – dryer

2.5.1 Rating of the screw conveyor feeder

Horse power required to drive a screw conveyor is given by

$$h.p = 1 + \frac{ALN + CWLF}{1{,}000{,}000} = 1 + \frac{(21 \times 2 \times 35) + (4.15 \times 58.53 \times 2 \times 1)}{1{,}000{,}000} \cong 1. \quad 6$$

where L is length of conveyor (ft), N is r.p.m of screw, C is ft^3 of material conveyed per hour, W is density of material transferred IB/ft^3

Where F range from 0.6 – 1.2 (F can be taken as I for convenience), N is 35 r.p.m, L is 3ft, C is $4.15ft^3/hr$

W = 58.53 Ib/ft^3

2.5.2 Rating of fryer – dryer drive

Maximum torque, M_t = 25200kg-mm = 2517.4N-mm = 2.571KN-mm

$$h.p = \frac{2\pi N\, M_t}{60} = \frac{2\pi \times 16 \times 2.571}{60} = 4 \quad 7$$

Where N = 16 r.p.m

2.6.6 Overall rating of main drive

Total power required: = power needed for feed screw + power for driving fryer-dryer

i.e Overall power needed = 1 + 4 = 5 h.p or 4KW

An electric motor, geared to speed 16 rp m, rated 5.h.p or 4KW., 3 phase, 50HZ, will be required for the design.

2.7 Material Balance Analysis

2.7.1 Mass Balance:

2.7.1.1 Mass of 100% Dry Gari

For an output of 500 kg gari per day of 8 hours having 8% moisture content; Taking X kg to be the mass of 100% dry gari. From % moisture content formula:

Then $\frac{500-X}{500} = 0.80, \quad X = 460kg$

2.7.1.2 Mass of Cassava to be processed:

Taking y kg to be total mass of cassava needed to produce 500 kg of gari of moisture content 8% and taking Z kg to be mass of water associated.

$y = (Z + 460)\ kg$

% mass of water associated is given by;

$\frac{Z}{Z+460} = 0.70$, $Z = 1075\ kg$ (Since moisture content of wet grated cassava = 70%)

Mass of cassava needed, y = 1075 + 460 = 1535 kg

2.7.2 Volume of cassava paste to be pressed

For a paste of bulk density 979.15 kg/m^3 and grated cassava of 1535kg.

Volume of paste $= \frac{Mass}{Density} = 1.55m^3 - - - - - - - - - - - - ()$

2.7.3 Mass of cassava mash after pressing

Moisture content can be reduced from 70% to 50% when grated cassava mash is pressed.

Taking the mass of water left in the pressed cake to be V kg. $\frac{V}{V+460} = 0.5$, $V = 460kg$

Mass of cassava mash after pressing= mass of 100% dry gari + mass of associated water left in the pressed cake = $460 + 460 = 920kg$

2.7.4 Amount of water pressed out

Amount of water pressed out = 1535 – 920 = 615kg

2.7.5 Mass of moisture in the gelatinized mash

Volume of cake $\frac{920}{979.15} = 0.94m^3 per\ 8\ hour\ day.$

Taking the moisture content after cooking to be 40% and w kg to be the mass of moisture in the cooked mash. $\frac{w}{460+w} = 0.40$, w = 307.2kg

2.7.6 Amount of vapor removable during cooking

Quantity of feed into the dryer = 460 + 307 = 767kg per 8 hr. day

Mass of vapor removed at gelatinization = 920 – 767 = 153kg

2.7.7 Amount of vapor to be ejected during drying

Taking M kg to be the vapor left after drying and the moisture content after drying to be 8%, Then $\frac{m}{m+460} = 0.08$, So $m = 40kg$. Hence, gari produced = 460 + 40 = 500kg

Amount of vapor removed during drying = 767 – 500 = 267kg

2.8 Design of Screw Conveyor Feeder

For 500kg of gari product per 8-hour day, the amount of material to be fed into the gari fryer from previous calculations is 920kg of pressed mash. So the required conveying capacity $= \frac{920}{8} kg$ per hour = 115kg/hr. Volume to be conveyed = $\frac{115}{979.15} = 0.1174m^3$ (i.e. v = 0.1174 x 10^6 cm^2)

Now Ift^3 = 28.3 x 10^3 cm^2, V = $\frac{0.1174\times10^6}{28.3\times10^3}$ ft^3, $= \frac{117.4}{28.3} = \frac{4.15ft^3}{hr}$. 8

From hand-book, material to be conveyed is in the class of wet malt, starch, etc. denoted as class 3 with factor 'X' between 0.66 and 0.75. Taking 'X' as 0.7 and speed limit of 35 rpm.

$V = \frac{4.15}{0.7} = 5.93ft^3/hr$; From capacity chart, screw diameter = 4'' = 100mm; pitch =2$''$ = $50mm$. The designed screw conveyor has the following details:

Diameter = screw conveyor which has the following details:

Screw diameter =100mm, Pitch =50mm, Speed =35 rpm, Length= 600mm

2.9 Equipment Heat Balance

Heat delivered by burner = losses + heat transferred through fryer shell to the product.

Assuming 20% of this heat is lost to the surrounding and heat transferred through the fryer shell is Qs. Taking heat supplied by burner to be Qg

$Q_g = 0.2Q_g + Q_s$ 9

Since heat Q_s is transferred by conduction,

$Q_s = -KA\frac{dt}{dx}$ 10

Where A is surface area of material of shell, K is the thermal conductivity of shell material, $\frac{dt}{dx}$ is the temperature gradient.

$Q_s \int_{x_1}^{x_2} dx = -KA \int_{T_1}^{T_2} dT$. Where boundary dimensions are x_1, x_2 for thickness of material and T_1, T_2 for surface temperatures. $Q_s(X_2 - X_1) = -KA(T_2 - T_1)$, i.e. $Q_s(X_2 - X_1) = KA(T_1 - T_2), (T_1 > T_2)$ or $Q_s = \frac{KA(T_1-T_2)}{(X_2-X_1)}$

In this case, $T_1 - T_f = 300^0C$ from experiment.

$T_2 = T_m = 248^0C$

$X_2 - X_1$ = material thickness = 3mm

Assuming that 25% of the shell surface is covered by the gas oven;

Area, $A = \frac{\pi \times r_g \times L_g}{4} = \frac{\pi \times 0.23 \times 2.345}{4} = 0.423m^2$ 11

$Q_s = \frac{KAT}{X}$ = 48.5 x 0.423 x 17.3 x 10^3 = 354918.15 KJ/8 hour day = 12.32KJ/s

Using 2.3.1, $Q_g = 0.2Q_g + 12.32$ or $Q_g = 12.32/0.8 = 15.4KJ/s$

Heat value, λ_g of butane = 126400KJ/m^3 k

Gas consumed = $\frac{15.4}{126400} = 1.218 \times 1.218 \times 10^{-4} m^3/s$ = 3.5m^3/8 hour day.

Density, g of butane gas = 2.58kg/m^3. Gas consumed = 2.58 x 3.5 = 9.05kg/day

So a 50kg butane gas bottle will be used up in 5 days, working 8 hours per day, i.e. one working week.

3.0 Performance Evaluation

3.1 Materials and Processing

Cassava roots were brought from a local farm around FIIRO. The roots were processed in the food processing pilot plant of FIIRO in this order: Weighing: peeling, washing, grating, fermenting, pressing, granulating, frying and bagging. Gas was refill into the cylinder which was used as source of heat. The cassava used was hand peeled, washed, grated using electric motor power driven grater it was allowed to ferment before dewatering with a hydraulic press to form cake mash (granulation) which is introduced to the fryer (figure 1) to be processed into gari. The equipment was used to fry the processed dewatered cassava mash into Gari. Three different tests were carried out using the equipment. The dewatered cassava mashes were fried in batches, with each of the samples weighed before and after frying using weighing scale.

The initial and final temperature of each of the samples was also determined using thermometer.

The moisture content and the analytical characteristics of the Gari samples produced were determined at the food and analytical section of FIIRO. The results are as presented in Tables 1, 2 and 3. The Yield of Gari was determined using

$$\text{Yield of Gari} = \frac{\text{Weight of fried Gari}}{\text{Weight of the cassava roots}} \times 100\% \qquad 12$$

4.0 Result and Discussion

Table 1 revealed that the time of frying ranges between 14 minutes to 17 minutes. While the final weight of dried Gari ranges between 11.2kg to 20.8kg. Thus the average output of dried Gari for the fryer is about 80kg/hour. This is a great improvement over manual method of frying which is time consuming (about 30 minutes for just 5kg Gari) uncomfortable and lend itself to health hazard for the operator.

Table 2 and 3 presents the analytical characteristics and microbiological analysis of the samples of Gari produced by the fryer. Comparing the values obtained from the samples produced with the standard values on table 4 and 5. It will be observed that these values fall within the range of the standard values except for some samples with a slight deviation from the standard value for instance, Sample A which is a bit higher in ash content than the standard value.

Microbiological analysis indicates that the samples produced from the fryer are safe for human consumption. Since the values of Total plate count and yeast and mould count obtained for the samples fall within the acceptable values, while coli form count were Nil and E.coli were not detected.

Table 1: Time and yield of gari of the gari fryer

S/N	Initial Wt. kg	Final Wt. kg	Initial Temp ^oC	Final Temp. of Samples	Outside Temp. of Frying Trough	Time of Frying	% Yield of Gari
1.	15	11.2	27	90^oC	80^oC	5mins	74.7
2.	15	10.4	27	87^oC	77^oC	14mins	69.3
3.	25	16.1	27	85^oC	92^0C	16mins.	64.4
4.	25	16.4	27	85^oC	85^oC	15mins.	65.6
5.	35	18.4	27	87^oC	85^oC	17mins.	52.8
6.	35	20.8	27	87^oC	90^oC	15mins.	59.4

Table 2: Proximate Analysis of the gari samples

Test Performed		Results		
Proximate Analysis		A	B	C
Moisture	%(w/w)	7.38	5.89	2.78
Ash	‘’	2.51	1.37	1.11
Crude Fiber	‘’	2.69	2.89	2.54
Crude Protein	‘’	1.45	1.38	1.97
Fat (ether extract)	‘’	0.62	0.01	0.34

NFE (Carbohydrate)	‘’	85.35	88.46	91.26
Total Acidity as Lactic Acid	‘’	0.40	0.40	0.40

Table 3: Microbiological Analysis

Samples		A	B	C
Total Plate Count	Cfu/g	9.2 x104	5.0 104	9.3 x 104
Yeast & Mould Count	‘’	1.5 x 102	5.0 x 104	3.8 x 104
Coli form Count	‘’	Nil	Nil	Nil
E. coli	‘’	ND	ND	ND

ND = Not Detected

Table 4. Analytical Standard of gari in Nigeria

Analytical Characteristics		**Range of values**
The total acidity of Gari	→	< or = 1% m/m measured as lactic acid
Total Cyanide content of Gari	→	< or = 20.0mg/kg.
The moisture content of Gari	→	< or = 7.0%m/m.
The crude fiber content of Gari	→	< or = 2% m/m.
The Ash Content of Gari	→	< or = 1.5% m/m

(NIS 181: 2004 – Standard for Gari) IITA and SON

Table 5: Nutritional composition of Gari sievates collected from source locations in southern Nigeria.

Composition		Range of values
Ash	→	0.99 _____ 1.59
Crude Fiber	→	1.66 _____ 2.91
Crude Protein	→	0.61 _____ 1.38
Fat	→	0.26 _____ 0.61
MFE (Carbohydrate)	→	85.0 _____ 87.7
Totality Acidity		

Nwokoro, S. O et al (2005)

5.0 Conclusion

On the basis of the physical characteristics of cassava mash, power- driven Gari fryer was designed, constructed and tested. At constant speed of 8rpm, an initial weight of 140kg and a temperature reading of 120 ⁰C of frying trough, an output of 83.2kg/hr was established with a yield of 59.4 (resident time 15mins) . The capacity of the fryer is 500 kg per day against a manual method of frying of 5kg for 30 mins (100kg/day) in local cassava processing industry in Nigeria.

References

1) Akinrele I. A; Cook A. S, Holgate R.A (1962): the manufacture of Gari from cassava in Nigeria.

Proceedings of first international congress on food technology. Pp 633 – 634, London.

2) Bencini, M.C. (1991): Post Harvest and processing technologies of African staple foods: a technical compendium. Agricultural Services bulletin no. 89; FAO, Rome.

3) Egba A.J. (1987): Design and Construction of Gari fryers for local use. (B.Sc.) project report,

Agricultural Engineering Department, University of Ibadan, Ibadan, Nigeria (unpublished).

4) Gevandan, A., Chuzel, G., Didier, S. and Andrieu. J. (1989): physical properties of cassava mash. International journal of food science and technology 24 : 637 - 645

5) Igbeka J.C. (1995); Recent Development in Gari Frying process and equipment.

6) Njie , D. N., Rumsey T. R. and Singh R.P.(1998): Journal of Food engineering, vol. 37, issue 1, 63-76

7) Nwokoro, S.O (2005). Nutritional composition of Gari sievates collected from some location in southern Nigeria. Pakistan Journal of Nutrition. 4(4): 257 – 261.

8) Odigboh and Ahmed, (1982): Design and Development of commercial Gari fryer. M.Sc project.

Department of Agricultural Engineering University of Nigeria Nsukka, (UNN) Nsukka.

9) Igbeka J.C and Akinbolade A, (1986); Design and Development of Mechanized Gari fryer. M.Sc. Project Department of Agricultural Engineering University of Ibadan, Ibadan.

10) Sanni, L. O, Maziya – Dixon, B., Akanya, J.N., Okoro, C.I, Alaya, Egwuonwu, C.V, Okechuku, R. U., Ezedinma, C.,Akoroda, M., Lemchi, J., Ogbe, F, Okoro E., Tarawali. G., M Kumbira, J., Patino, M., Ssemakula, G. and Dixon A., (2005), standards for Cassava products (Gari) and guidelines for export. IITA, Ibadan, Nigeria. Pp. 39-42.

Appendices

Summary of Analysis

Unit operation	Input (kg)	Output (kg)	Water Removed (kg)
Press	1535	920	615
Gari fryer	920	767	153
Dryer	767	500	267

Summary of Design Information

			Fryer	Dryer
(a)	Fryer/dryer: Shell diameter	=	460mm	700mm
	Length	=	2.345mm	2440mm

	No. of paddles =	12	18
	Paddle arrangement	= 2-start	3-start
	Paddle inclination	= 8.5^0	15^0
(b) Energy:	Resident time for gelatinization	= 16minutes	
	Resident time for drying	= 14 minutes	

Butane gas consumption per 8 hours day = 16kg

(c) **Drives**

Drive shaft = 5.3m long x 65mm diameter coupled in the centre with rigid coupling.

R.P.M of shaft = 16

Supports = brass bushings.

R.P.M. of feeder = 35; Feeder length & dia = 600mm x100mm

Drive motor = Geared, 5 h.p. 50Hz.

(d) Equipment output = 500kg of gari per 8 hours per day.

(d) **Maximum Torsional Moment on Shaft**

On the dryer shaft, torsional moment = 72 x 350 = 250200kg-mm

on the garifryer shaft torsional moment = 36 x 230 = 8280kg-mm

on the central coupling torsional moment = 60 x 90 = 5400kg-mm

on the main pulley/sprocket torsional moment = 01 x 175 = 1750kg-mm

total torsional moment = 40630kg-mm

Maximum torsional moment, M_t = 25200kg-mmm

Table 6. Physical characteristics of cassava mash average moisture content of 45% w.b

Parameters	range value (cassava)
Thermal conductivity (K)	0.16 – 0.57
Specific capacity, (KJ)	1.636 – 3.26

Specific heat, (KJ/Kg K)	1.205