Improved Mechanized Gari Frying Technology for Sustainable Economic Development in Nigeria

Gbasouzor Austin Ikechukwu, A. I. V. Maduabum

Abstract – **This project studies the manual method of frying processed cassava called "gari" in Nigerian national language and finds out the possible ways of mechanizing the system to achieve advantageous improvements over the existing method; such expected improvements are likely to come over considerable factors like maximum drying time, rate of feed, temperature control, cheap source of energy, scope of maintenance and safety precautions. The ability to meet the above demands requires an approach towards the general procedure in machine design which includes recognition of needs, synthesis, materials selection, design of components, modification, detailed drawings and construction. The standard of the project is justified because comprehensive information was gathered in the area of interested study which is the stages in gari production. Furthermore, all the components of the machine were designed using computer aided design. In general, there are twenty nine parts that made the functional block of the machine excluding the electrical control. We computed the calculation analysis of the machine where the efficiency was arrived at seventy percent.**

Keywords: **Gari frying, maximum drying time, rate of feed, temperature control.**

I. INTRODUCTION

Gari frying is the most critical unit operation in the processing of cassava into gari. It is also a combination of simultaneous cooking and drying processes. 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.

Though a dehydrating process, gari frying is not a straightforward drying process. The product is first cooked with the moisture in it and then dehydrated. The heat intensity during frying affects the quality of the product. The moisture content of dewatered and sieved cassava mash is between 50 to 65% which has to be reduced to 12% after the frying operation. At the end of the frying operation, the product is still hot and a little bit damp, it is then left to cool and dry in a cool dry shade until the moisture content is reduced to 12%. At the villages, gari is fried in shallow iron pans, or in the more traditional areas in earthenware pans, over an open wood fire.

A mechanized system of frying and drying usually appear in the form of a stainless steel drum with rotary conveyor and paddles fixed along the conveyor to a slower rotation in the same axis of the drum.

As has been stated earlier, traditionally, gari is fried by women in shallow earthenware of cast-iron pans (agbada) over a wood fire. The operator sits sideways by the fireplace while frying, and this brings discomfort due to heat and the sitting posture.

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Thus, there arose the need for innovations and improvements to alleviate the problems encountered by these women. Also, while frying, a piece of calabash used to press the mash against the hot surface of the pan must be scraped quickly and stirred constantly to keep the material moving to prevent it from burning until frying is completed. The process takes 30 – 35 minutes, with the moisture content of the final product reduced to about 18%. This is a problem is commercial production. To produce gari at a fast rate and eliminate the problems of the traditional method, the need arise for a mechanized continuous process fryer. However, earlier design on gari production plants did not produce the desired and acceptable cassava product for the consumers, because the designers of those plants did not take into account the specification of the existing local technology. The problem statement therefore is to identify a means of designing a continuous process gari frying machine that will achieve the following;

1. Produce the desired and acceptable cassava product for the consumer.
2. Produce gari in commercial quantity at a faster rate.
3. Be an environmental/ operational friendly machine.

A. Objective of Study

The primary objective of this study is to come up with a sound continuous process of gari frying machine, based on the following points noted from previous research:

- Avoidance of caking of the cassava mash.
- Adequate agitation and processing achieve uniform heat circulation.
- Ensure that the final product is cooked and dehydrated.

In this project, we accept the statement of the researchers at the Federal Institute of Industrial Research Oshodi (FIIRO) in Nigeria that worked on a similar project. The cassava mash will gelatinize while being moved over a metal surface at about 250°C, for about 15 minutes. The gelatinized mash will be further dried and is discharged at about 10% moisture content, suitable for long term storage in plastic bags. The machine will be expected to have an output of 50kg/ hour of dried gari.

Cassava mash gelatinizes when it stays on the frying cylinder over a period. Within a specified temperature range of conveying the mash along the cylinder it changes state from forming block of the mash to elastic state of the mash. The changes caused friction between the cassava mash and the conveyor. The accretions help in determining empirically the coefficient of friction of the material. Experiment on this was represented on the table below;

Table 1: Determination of coefficient of friction

Temperature in degrees	Moisture in percentage	Formation	Coefficient of Friction
0°	50 - 60 %	Dewatered cassava mash	Negligible
20°	25 - 30%	Gelatinize into elastic state	0.02
40 - 60°	10 - 12%	Solid particles	Negligible

ISBN: 978-988-19251-9-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

B. Significance of Study

The major essence of this project is to develop a system that will eliminate the time consuming, uncomfortable and health hazards posed to the operator of the village technique of gari frying, and at the same time simulating this village technique in order to obtain a good quality gari. This study is thus significant in the sense that it will bridge the gap between the existing traditional technology and the emerging modern technology, merging the advantages of both to produce a desirable, affordable, available and acceptable product.

II. REVIEW OF PREVIOUS DEVELOPMENTS IN GARI FRYING MACHINES

During gari frying operations, the moisture content reduces and most of the small lumps developed are broken down by constant pressing and agitation, the heat is then increased in order to further cook and dehydrate the product. This product is still hot and a little damp at the end of the frying operation. It is then left to cool and dry in a cool dry shade until the moisture content is reduced to 12%.

Earlier design on gari production plants did not produce the desired and acceptable cassava product for the consumers. The designers of those plants did not take into account the specifications of the existing local technology.

Traditionally, gari is fried by women in shallow earthenware cast-iron pans (agbada, Nigerian Ibo) over a wood fire. Women use spatula-like paddles of wood or calabash sections to press the sieved mash against the hot surface of the frying pan and turn it vigorously to avoid caking. The operator sits sideways by the fireplace while frying. The discomfort due to heat and the sitting posture of the operator have been of concern to researchers.

The UNIBADAN (University of Ibadan) improved gari fryer (Igbeka J. E.) is, made of a fireplace oven with a chimney and a frying pan. The frying pan which is 200cm x 60cm x 10cm is designed to have trapezoidal shape with its side inclined at 60° to the horizontal. The inclination of the sides allows for gradual gravitational flow of gari down the sides of the fryer. It is made from a 4mm thick black steel sheet, which is not easily corroded and does not turn black after heating. The frying pan has an opening or chute on one side for discharging the finished product into a receiving pan. The frying pan sits on a rectangular fireplace built of clay which is 60cm high and has an opening on one side of the breath or width from where firewood is fed into the oven, while the other width carries the chimney. There are two small ventilation openings on one side of the length. The wall thickness of the fireplace is 22.5cm and the effective volume of the heating chamber of the fireplace is 0.72m3. It can use up to 20kg of wood as source of heat. The structure is housed under a shed made of corrugated iron sheets.

The fryer is operated by two people sitting on both ends of the fireplace without ventilation. Details of the construction can be obtained in Egba (1987).

Field tests amongst gari producers showed that the improved models had the following advantages over the village fryer:

a) The nuisance of smoke was totally eliminated.
b) Sweating by the operator was drastically reduced as a result of the improved fireplace.
c) The capacity and rate of frying were increased. (e.g. 5kg dewatered and sieved mash took 20 min to fry as opposed to l hr).
d) Improved working environment.

Mechanized methods

There are few mechanized gari processing plants in the Nigerian market which have found to be performing well as regards the quality of gari. As a result, some new designs and improvements have been made by Nigerian engineers and manufacturers to solve the problems associated with the models already in the market.

Newell Dunford model

This was the first equipment designed jointly by the Newell Dunford Company in London and the Federal Institute of Industrial Research (FIIRO), Oshodi in Nigeria. It is a gari producing plant of which the fryer is just one of the components.

In the frying section, heat from a gas fire is controlled and regulated by thermostats at various points in the process. The fryer structure is a circular stainless steel, heated from outside with the fryers curve linearly lined internally.

The fryer containing the sieved dewatered cassava mash is rotated in such a manner that the mash granules agitate against the sides of the fryer and move along the paths of the line curves. The result of this type of heat treatment is roasting. The product obtained with this model was not very much acceptable to the consumers because it did not have the basic characteristics of gari.

Brazilian model

The Brazilian mode1 fryer consists of a semi-circular steel plate and operates on a batch process drying. Atop the plate is a large ring gear mashed to an inner annulus which is connected to a vertical shaft with large steel paddles. A specific batch of sieved cassava mash is dropped into the circular plate and the eccentric paddles shift the mass circularly to produce a dry product. An automatic gate is opened at the side of the plate and the dried product falls into a funnel by gravity.

This model, designed and manufactured in Brazil, seems to be better than the Newell Dunford model and the product obtained from it is similar to gari in Nigeria, even though it is not exactly the same. In this model, frying was not evenly spread within a given batch and the product looked more like dried cassava mash than cooked and fried gari.

Fabrico model

The Fabrico model is a simple continuous process plant and consists of a semi-circular steel plate with rotating paddles. 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. Drying occurs during this period. Heat is supplied by either wood or gas-burners.

This mode1 which was designed and manufactured by a Company, FABRICO, in Nigeria, produces an end-product that is closer to gari. The product was not cooked but looked more like roasted gari. This model has been improved upon by the University of Nigeria Nsukka, and the University of Ibadan.

The UNN model

The UNN (University of Nigeria, Nsukka) model was designed by Odigboh and Ahmed (1982) to faithfully simulate the village manual frying operations (Odigboh, 1985).

ISBN: 978-988-19251-9-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

The equipment has a semi-circular 1.7 m long frying trough of 57cm diameter mounted at an inclination variable from 0 to 20^0C to the horizontal. Sixteen spring-loaded paddles are attached to a 1.75m long shaft also mounted axially in such a way as to locate the paddles inside and in permanent contact with the trough. The paddles overlap and are angled relative to the axis of the trough to act as a sort of conveyor. They are driven by an electric motor through several speed reducers and linkage arrangements. As the gang of paddles oscillate through 180^0 at 40 reversals per minute sieved cassava mash is automatically metered into the trough, once in a cycle of the to and fro motion. Swinging to one direction, the paddles press the mash against the hot surface of the trough while in the opposite direction, they scrape, stir and move it slightly forward to the exit end of the trough.

By appropriate adjustments of the trough inclination, the quantity of mash metered and the heating rate, the fryer operates automatically to produce continuous flow of well fried gari at 15% moisture content. An average through-put of 66kg of gari per hour has been reported for this equipment.

The UNIBADAN model

The UNIBADAN model was designed and manufactured in the University of Ibadan (Igbeka and Akinbolade, 1986). It is a continuous flow fryer which is an improvement and modification of the UNN model, hence a modified version of the Fabrico model.

The basic differences are in the feeding device, the heat source and the arrangement of the paddles. The UNIBADAN model is made up of a fryer plate, feeding hopper, power transmission devices, shaft with paddles, pulverizers and an oven on which the fryer sits.

The fryer plate, like in the UNN model, is a semi-circular trough open at the top and both ends. It is inclined at an angle of between 5 and 18^0 with a length of 2.44 m and diameter 0.67 m. The hopper contains a metering device which is one of the basic innovations in the design and the rate of metering is very crucial to the quality of the final product.

Another innovation in this model is in the paddles. Instead of just paddles, as in the UNN model, the central shaft has 28 paddles and pulverizers arranged in such a way that they have a conveyor effect at the same time as they press scoop and agitate. The pulverizers press the sieved cassava mash against the hot pan surface while the paddles scoop and agitate it.

The oven is built with red oven-dry bricks and has air vents at specific points and uses wood or coal as fuel. The vent openings can be reduced or increased according to the heat requirements. Power supply to the fryer could be either a petrol engine or fire wood.

Field tests using this model showed that the final product was acceptable to the public. At 15 rpm, the capacity was 80kg/hr of finished product.

III. COMPONENTS AND MATERIALS SELECTION

Parts and Theoretical Framework

The major components/parts of the machine include: The frame support, Electric motor, Sprocket and chain, Gear box, Connecting rod, Feeder, Hooper, Spiral conveyor, Shaft, Heating chamber/oven, Frying cylinder/trough, Discharge funnel, Paddles, Bearings, Thermometer, Cam and follower, Switch, Gas cylinder, Control valve and Knob and Hose.

The Hopper

Hopper is commonly found in industrial machines, and its basic function is to feed raw materials into the machine. Hopper can come in different shapes depending on the type of the raw material in use; its passage equally may be big or small such that water or solid materials may pass to the machine. The nature of food material we are presently handling made us to select a square type hopper and also chose the hopper material to be stainless steel because stainless steel resists rust and is a good hygienic material. The hopper is positioned above the cylinder and is welded on top of the cylinder where gravitational force acts on the sieved cassava, the hopper comprises of mechanism that closes and opens the passage per cycle operation. The mechanism is designed in form of cam and follower mechanism, and is powered by an electric motor which uses some link bar mechanism to transmit the power.

The Frying Cylinder

The cylinder is part of the machine the conducts heat and uses it for frying the sieved particle over a selected time. It is made with a stainless steel material. Heat is allowed to heat up the cylinder from underneath it through two perforated cylinder pipes which are situated at the left and right sides of the cylinder. The top of the cylinder has rectangular openings through which ventilation and inspection is made possible during frying.

There is an opening at the bottom end of the heating part of the cylinder where dry gari discharge into a basin. The bottom cylinder has bearing seating on both ends and strongly made of thick aluminum material such that applied heat could not affect its structure.

The Conveyor

The conveyor is part of the machine that conveys the sieved particles (grinded cassava) starting from left end of the frying cylinder to right end, it measures 5 cm beyond both ends of the cylinder. There are arrangements of conveyor blade and scooping blade oppositely fixed on the circumference of the conveyer's shaft and they are fifteen pieces respectively. 10 cm away from the left end of the shaft is the formation of a crank that transmits rotary motion of the shaft into reciprocating motion of the hopper slide through the connection of link bars.

Heating Chamber

Heating chamber particularly generates an amount of temperature range that heats the cylinder up to 69^0C. We placed three minimum number of steel burners in a specified rectangular container whose sides are air tight purposely to ensure no leakage of flame. The surroundings of the operable vicinity and the walls of the container are properly lagged. The burner has a control valve for regulating the temperature differences.

Electric Motor

The electric motor drives the system; and the induction type was selected for its strength, with capacity of one horsepower properly analyzed to carry the designed load. Three spur gears, two sprockets and chain mechanism were used for power transmission considerably from a short distance which causes the motor suspension from ground.

ISBN: 978-988-19251-9-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

IV. DESIGN ANALYSIS AND CALCULATIONS

Hopper Size

Hopper was sized using the postulates that Hopper shape & size are not necessary to be larger than the cylinder; and that volume of $0.0126m^3$ cassava mash is needed to pass through the hoper in five times.

$$V_h = \frac{1}{3} BH \quad (1)$$

V_h = Volume of the hopper, B = Base area of the hopper, H = height of the hopper

But, $B = LW \quad (2)$

L = length of the base = 0.21m W = width of the base = 0.18m B = 0.21 x 0.18 = $0.038m^2$

Substituting 0.038 m^2 into equation (1)

$$V_h = \frac{1}{3} \times 0.038 \times 0.20 = 0.00252 m^3$$

$$N = \frac{V}{V_h} \quad (3)$$

N = number of times the mash passes through the hopper

V = volume of mash that passes through the hopper,

V_h = volume of mash in the hopper

$$\therefore N = \frac{0.0126}{0.0252} = 5$$

Cylinder size

The cylinder was sized using the postulates that necessary space (evaporation space) is required above the mash in the cylinder; space is necessary to demonstrate frying process and Length that loud the mash within a specified time.

$$V_c = \pi r^2 h \quad (4)$$

V_c = cylinder volume R = cylinder radius L = cylinder length

$$V_c = 3.142 \times (0.1)^2 \times 1.24 = 0.039 m^2$$

Volume of cassava mash in the cylinder

Assuming the cassava mash in the cylinder is third the volume of thin cylinder, then

$$V_m = \frac{1}{3} V_c \quad (5)$$

Where, V_m = volume of mash in the cylinder

V_c = volume of the cylinder

$$\therefore V_m = \frac{1}{3} \times 0.039 = 0.013 \ m^3$$

Mass of cassava mash in the cylinder

$$m = \frac{\rho}{V_m} \quad (6)$$

$\rho =$ density of cassava mash = $1509kg/m^3$

V_m = volume of the cylinder = $0.013m^3$

$$\therefore m = 1509 \times 0.013 = 19.61 kg$$

Heat required for the drying

$$Q = MC\Delta T \quad (7)$$

Where, Q = Quantity of heat required

M = Mass of cassava mash in the cylinder

C = specific heat capacity of he mash = $1.59J/kg^0C$

ΔT = Temperature range = 60^0C

Q = 19.61 x 1.59 x 60 = 1871.5W

Time required for the drying

$$\frac{\Delta Q}{\Delta t} = \frac{KA(T_2 - T_1)}{L} \quad (8)$$

$\frac{\Delta Q}{\Delta t}$ = Heat rate of transfer

K = thermal conductivity of the mash = 0.2

S = surface area of the cylinder

T_1 = Temperature change = $60^0C - 30^0C$

$T_2 = 30^0C$ (25^0C ambient temperature)

L = thickness of the mash in the cylinder = 0.05m

$$A = 2\pi rh + 2\pi r^2 \quad (9)$$

$$A = 2 \times 3.142 \times 0.1 \times 1.24 + 2 \times 3.142 \times (0.1)^2$$

$$= 0.78 + 0.06 = 0.84 m^2$$

$$\therefore \frac{\Delta Q}{\Delta t} = \frac{0.2 \times 0.84 \times 30}{0.05} = 100.8 W/s$$

Relating the heat rate of transports to the mass of the cassava mash to be dried with time Δt

$$\frac{\Delta Q}{\Delta t} = \frac{\Delta m}{\Delta t} L_h \quad (10)$$

Where, L_h = latent heat of transformation

$$\Delta t = \frac{Q}{m}$$

$\Delta t =$ time required to dry the mash

$$\therefore \Delta t = \frac{\Delta m L_h}{\frac{\Delta Q}{\Delta t}} = \frac{1871.5W}{100.8} = 18.57s = 19 \text{ seconds}$$

Power required to convey the mash

$$P = \frac{W}{T} \quad (11)$$

Where, P = power required to convey the mash

W = workdone in convening the mash

T = time taken in competing the mash

$$W = \Sigma F x \quad (12)$$

Where ΣF = sum of forces involved in doing work

x = distance through which work was done along the cylinder

$$F_x = ma \quad (13)$$

M = mass of the cassava mash a = acceleration of the mash along the

$$a = \frac{\Delta v}{\Delta t} \quad (14)$$

$\Delta v =$ velocity of the mash along the cylinder

$\Delta t =$ time taken in the same direction

$$V = \frac{x}{\Delta t} \quad (15)$$

x = distance covered by the cassava mash

$\Delta t =$ time taken to cover the distance

$$V = \frac{1.24}{19} = 0.065 m/s$$

$$a = \frac{0.065}{19} = 0.003 m/s^2$$

From equation (13)

F_x = 19.67 x 0.0034 = 0.0669N is force causing the mash to move over the distance (x)

$$F_r = \mu N \quad (16)$$

Where, μ = coefficient friction of the mash = 0.47

N = normal force acting on the mash

$F_r =$ frictional force experienced in moving the mash

$$N = mg \quad (17)$$

Where, g is acceleration due to gravity = $9.81m/s^2$

ISBN: 978-988-19251-9-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

$N = 19.67 \times 9.81 = 192.96$
$F_r = 0.47 \times 192.96 = 90.69N$
$\Sigma F = F_x + F_r = 0.0669 + 90.690N = 90.76N$
From equation (12)
= 90.76 x 1.24 = 112.54Nm
From equation (11)
$= \frac{112.54}{19} = 5.92 = 6 watts$
But,
746watts = 1hp
6watts = X
$Xhp = \frac{6w}{746w} = 0.008 = 0.008hp$

Factor of safety (n) for the electric motor
n = maximum power/design power,
When (n) = 3
$3 = \frac{P_m}{0.008}$
$P_m = 0.02hp$ (This power can carry the load without failure).
But, Torque $T = P/W$, where W is angular velocity = $2\pi N/60$
N = 40rpm, Therefore, W = 4.2rad
$T = 6/4.2 = 1.43$N-m

Gear connected on the motor

$$\frac{N_1}{N_2} = \frac{T_2}{T_1} \quad (18)$$

N_1 = speed of the motor = 100rpm N_2 = speed of the middle shaft = 40 rpm
T_1 = numbers of teeth on the gear (1) = 32 T_2 = numbers of teeth on the gear (2)
$T_2 = \frac{100}{40} \times 32 = 80$

Driven gears

$$M = \frac{\Delta}{T} \quad (19)$$

m = module = 1.5 (differs for differences sizes of gear) D = pitch circular diameter.
T = number of teeth
$T_1 = 32$, $D_1 = 32 \times 1.5 = 48$mm, $T_2 = 80$, $D_2 = 80 \times 1.5 = 120$mm
Again,
Let $\frac{N_2}{N_3} = \frac{T_3}{T_2}$
Where, N_2 = 40rpm, N_3 = 16rpm
$T_3 = 20$, $T_3 = 40 \times 20/16 = 50$
Therefore,
$T_2 = 20$, $D_2 = 20 \times 1.5 = 30$mm $T_3 = 50$, $D_3 = 50 \times 1.5 = 75$mm

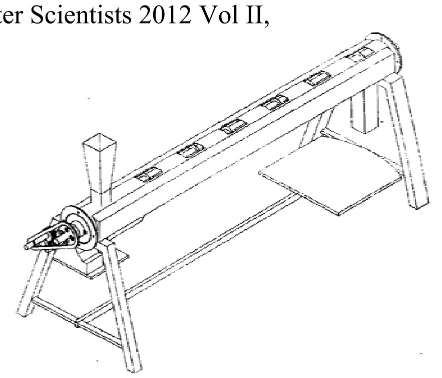

Fig. 1: The Mechanized Gari Frying Machine

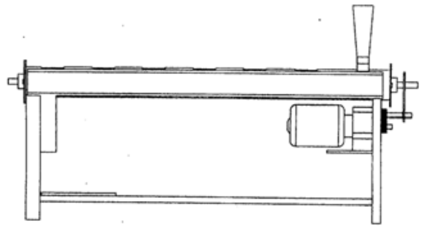

Fig. 2: The front view

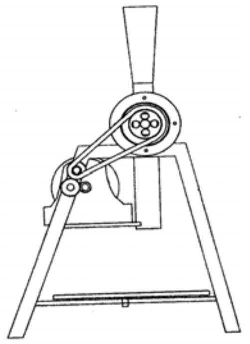

Fig.3: The end view

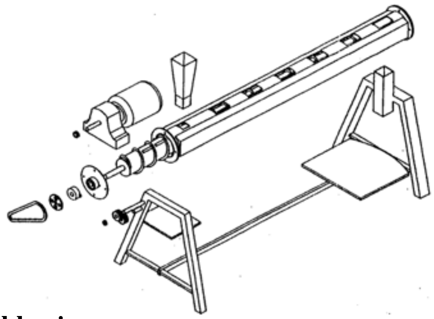

Fig. 4: Assembly view

V. TESTING AND CHARACTERIZATION

The gas cylinder was connected to a control valve, and the control valve fastened to a burner while the heating cylinder was insulated. The electric motor was connected to a conveyor. After all these, the machine was tested.

The drying efficiency which is the degree of dryness of a given quantity of gari produced from the frying machine was determined. The exercise was carried out as follows; 3kg of mash collected from source was manually dried under fire and it weighs 2kg after 50sec. The same amount of sample 3kg was dried with the heating cylinder and it weighs 2.3kg after 50sec. Thus, 2.3kg was below the standard for dryness quality, and therefore the efficiency is determined by ratio of under-standard dried sample to standard dried sample multiplied by 100.

Stated mathematically;
3kg - 2kg = 1kg (desired sample i.e. input) 3kg - 2.3kg = 0.7kg (undesired sample i.e. output)
But,
Efficiency = $\frac{\text{output}}{\text{Input}} \times 100 = \frac{0.7}{1} \times 100 = 70\%$

ISBN: 978-988-19251-9-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

$\therefore$ If 0.7kg can be produced in 50sec, then the quantity (X) that will be produced in an hour will be: 0.7kg = 50sec
X = 60 x 60 = 3600sec
Therefore Quantity/Capacity of the machine X =50.4kg/hr
The mechanized continuous process gari frying machine uses cooking gas as its source of energy.

The oven is turned on and allowed to attain its operating temperature of 60°C; then the mash is poured through hopper to full size.

The electric motor is immediately powered and transmits the power to conveyor shaft with the aid of gears and sprocket mechanism. As the shaft rotates, it opens and closes the feeder through connecting rod linkage and at the same time rotates the paddles. When the hopper is opened, the feeder will allow cassava mash to be fed into the frying cylinder from the hopper. At every interval of 180 degree rotation, paddles presses and scrapes the mash from the contact surface of the cylinder. At this the spiral conveyor continuously moves the mash alongside towards the discharging end of the cylinder. Any gari that gets to the discharge funnel will have a standard moisture content of 12%.

Characterization of Gari Fryer

The gari frying machine has some essential characteristics. The shaft has a rotation speed of 40rpm. If the temperature of the frying trough is more than 60°C, the Gari will be burnt. The electric motor has a rotational speed of 100rpm. Increase in the electric motor rotational speed can change the rotational speed different from the designed shaft rotational speed of 40rpm.

VI. DISCUSSIONS

Our Gari frying machine has a high productivity when compared to former methods and modern gari fryers like the UNN model, the UNIBADAN mechanized model, etc. This gari frying machine is designed to produce 50.4kg of gari per hour which is of higher productivity or quantity when compared to the UNN model capacity of 66kg per hour and the UNIBADAN mechanized model capacity of 80kg per hour with respect to their various sizes.

VII. CONCLUSION

Gari frying is an arduous and intricate operation which is not a straight forward frying operation but that needs good understanding of the factors that affect the quality of the final product. The best quality gari up till date is obtained by the village technique but it is time-consuming and leads itself to health hazard for the operator.

Development in the processes and equipment has been more on the accurate simulation of the village technique. It has been stated that in developing any mechanized gari fryer the following features have to be considered as basic requirements.

1. A continuous operation leading mass to process production of moderate capacity.
2. A regulated temperature mechanism which ensures simultaneous cooking and dehydration, without roasting to a desired moisture content after a specific period
3. A mechanism that provides both stirring and lump breaking actions so that uniform cooking dehydration in the entire mass is ensured and the desired texture produced.
4. 65An arrangement of paddle so as to produce a conveyor effect which will give the product a forward movement during the process.

In putting these basic requirements, this prototype has been designed to ensure that they are adhered to. The prototype is a continuous process that only requires the operator to fill the Hooper with wet cassava mesh, and it produces at moderate capacity of 50.4kg/hr. The temperature is regulated by fixing a thermostat. The continuous action of the double scoop paddle will ensure stirring (by scooping action) and lump breaking (by pressing action). To avoid irregular movement of the product, a spiral conveyor is provided, whose sole duty will be to continually give the product a forward movement during the process.

Recommendations

This prototype design is expected to mass produce good quality of gari at moderate capacity and low cost. Though its installation cost is high, this is duly compensated through its extremely low operating cost over a long period of time. However, effort should be made to adapt this prototype for large-scale processing of gari. We also recommend that frying cylinder be increased by twice its length for a maximum frying efficiency of about 98%.

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ISBN: 978-988-19251-9-0
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)