Effect of fermentation time on the quality, starch content and the proximate values of processed cassava (Garri)

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Abstracts
The changes that occurred in processed cassava (Garri) due to fermentation process were studied for the period of 120hours,the following test such as starch content, moisture content, lipid content, ash content, protein content, carbohydrate test, and iodine reduction test were carried out at each interval, from the investigation the results shows that there was a positive correlation (R= 0.967) between the fermentation time and following parameter: moisture content, iodine reduction, also in parameter such as protein content, lipid content and ash content increased with increase in fermentation time upto 96hours after which their values begins to decrease drastically with correlation values of R =0.65, there was also a negative correlation (R=-0.935) between the fermentation time and the following parameters : starch content and carbohydrate content. From the results the best fermentation period is from between 24hours to 96hours as within this period the nutritional values of the processed cassava (garri) is believed to be intact.

1.Introduction
Cassava (Manihot esculeuta Cranz) is among the top on list of the major food crops in developing regions like Africa most especially the west African countries like Nigeria after rice, wheat and maize (Bokanga, 1999). Cassava is an important root crop in Africa, Asia and Latin America (Achi and Akomas, 2006), providing nutrition and energy for over 800 million people (Bokanga and Oto,1994).
Garri is a creamy-white granular flour with a slightly fermented flavour and a slightly sour taste made from fermented, gelatinized fresh cassava tubers. It is the most common form of cassava consumption in West Africa, especially in Nigeria, Ghana, Cameroun, and Cote d'Ivoire. It is consumed by both young and old, however it is very poor in nutrients especially protein (0.7 -1.2%) (Obatolu and Osho,1992).
Garri is gotten by traditional means or industrial processing of cassava roots or tubers. The tuber processing is made up: peeling, washing and grating, fermentation and dewatering using sacks for few days. After the few days the cassava usually form a cake-like structure which is broken down into smaller lumps, then followed by sieving , and toasting at a temperature of about 80oC until the moisture content is brought to about ten percent. When inadequately processed garri is consumed it causes some illness such as tropical ataxic neuropathy (Osuntokun, 1968), endemic goitre and cretinism (Ekpechi etal, 1966).
Garri, as a fermented cassava food needs to be adequately fermented to produce a very good quality, since it is consumed by large number of people most especially the Africa origin, therefore the quality of the product is important as it is known to have cyanogenic glucosides (Montgomery, 1969).
Fermentation is the gradual decomposition of large molecules like starch into smaller molecules (such as ethanol). The fermentation time of garri may take upto 24-120hours, it may be with addition of water or without addition of water. The grated cassava is quickly detoxified by process of adding water and allowing it for various fermentation periods and this is done because the fermentation process helps to reduce the amount of cyanide content of the garri in respectively of the type of cassava (Asegbeloyin and onyimonyi, 2005). The taste and the quality of the garri depend on the degree of fermentation. The longer fermentation usually more than 72hours results in a poor product quality with unacceptable sour taste.

Material and Methodology

Garri processing from Harvested Cassava

The cassava was obtained from the farm in the University of Port Harcourt, the freshly harvested cassava roots were washed, weighed and were peeled manually using knife and the wooden part of the cassava were cut off, the peeled cassava roots were washed thoroughly with a clean water to remove any dirt and some sands that may be attached to the cassava roots and were weighed second time, the washed cassava root were grated using manually operated grater, the grated cassava mash were packed into five different sack bag and pressure were applied on the sacks by mechanically fabricated presser to reduce the water content of the grated cassava mash and were left to ferment for 12, 24, 48, 72, 96 and 120 hours respectively After the specified period of time the resulting mash were hand sieved and fried over low heat till it was crisp and dry at each interval. And the garri produced were left to cool and the determination of the starch content and the proximate analysis of the composition of the processed garri as a result of fermentation time on a grated cassava were carried out at PSB laboratory university of Port Harcourt.

Determination of Starch Content

0.25g of garri sample was weighed with electronic weigh balance and put in a test tube, 0.2g sterilized sand was added to the garri, and 5ml of water was added and was properly mixed with a stirring rod. The test tube was heated in a boiling water bath for 15minutes to gel, and the gelled starch was cooled to 20-350C, 5ml 60% per chloric acid was added rapidly to the gelled starch while mixing and the starch was dissolved in the test tube with stirring rod for 20 minutes. The sample was transferred to 100ml volumetric flask and diluted to volume, mixed properly and allowed to settle for 10minutes. An appropriate aliquot was transferred to a 15ml volumetric flask and a range of standards from (0.1-2.5) mg starch was transferred to a 50ml volumetric flask. A few drops of indicator solution and sodium hydroxide were added to the standards and samples until it turns red. Acetic acid of 10% v/v was added to remove the colour a further 2.5ml of acetic acid was added, 0.5ml potassium iodide solution and 5ml potassium iodate solution was added mixed well and diluted to volume. The absorbance was measured for standard at 680nm and a graph was plotted and its scale was determined. The scale gotten was used to multiply the absorbance value of the sample and a calculated value was gotten which was substituted in the percentage of starch formula and it was used to determine the starch content in the garri.

The blank determination was carried out in the same way

Calculation:

If C = mg of starch obtain from the graph

Then starch content $= \frac{C(mg) \times solution\ volume(ml)}{10 \times aliquor(ml) \times sample\ wt(g)}$ 1

Estimation of quality of garri using rapid iodine reduction method

The quality of garri was estimated using rapid iodine. 1gram of garri was treated with distilled water to obtain a supernatant fluid which was then mixed with 0.1ml of 0.4% iodine in 2% potassium iodide. The time taken for the reduction of the brown colour of iodine to potassium iodide to the characteristic purple colour of the starch to iodine complex was recorded.

Proximate analysis determination

Proximate analysis involves the determination of the following; moisture content, protein content, carbohydrate content, lipid content and ash composition of the sample and these were determined by the AOAC (2010) methods. The experiment was carried out in the Plant Science and Biotechnology (PSB) Laboratory, university of Port Harcourt.

Carbohydrate test

0.1g of sample was weighed into a 25mls volumetric flask, 1ml distilled water and 1.3mls of 62% perchloric acid was added and shaking for a period of 20 minutes to homogenize completely. The flask was made up to 25mls mark with distilled water and stopper. The solution formed was filtered through a glass filter paper or allowed to sediment and decanted. 1ml of the filtrate was collected and transferred into a 10ml test tube this was diluted to volume with distilled water. 1ml of working solution was pipette into a clean test tube and 5mls Anthrone reagent was added. 1ml distilled water 5mls Anthrone reagent was mixed. Similarly and the whole mixture were read at 630nm wave length using the 1ml distilled water and the 5mls Antrone reagent prepared as blank. Solution glucose of 0.1ml was also prepared and was treated as the sample with Anthrone reagent.
Absorbance of the standard glucose was read and the value of carbohydrate as glucose was calculated using the formula below.
Calculation

$$\% \text{ CHO as glucose} = \frac{25 \times absorbance\ of\ sample}{absorbance of\ standard\ glucose \times 1} \quad (2)$$

Fig.1 Carbohydrate Determination set up

Moisture content (air oven method)
1gram of the sample was weighed into a clean dried porcelain evaporating dish. This was placed in an oven to maintain a temperature of 105^0C for six hours. The evaporating dish was cooled in desiccators to room temperature then it was re-weighed and recorded.
Calculation:

$$\% \text{ Moisture} = \frac{weight\ of\ fresh\ sample - weight\ of\ dried\ sample}{weight\ of\ sample\ used} X100 \quad (3)$$

Determination of moisture content
The moisture content of the samples was determined using the hot oven method of AOAC (2010). 2grams of each of the samples was put into a washed and dried crucible and placed in oven at temperature 200^0C until there was no more change in the weight. The samples were cooled and weight. The loss of weight was obtained as moisture content was calculated as:

$$\text{MOISTURE CONTENT} = \frac{M_{2-M_3}}{M_{2-M_1}} \times 100 \quad (4)$$

Where
M_1 = Initial weight of empty crucible
M_2 = Weight of crucible + sample before drying

M_3 = final weight of crucible + sample after drying

Lipid content

2gram of sample was inserted into a filter paper and was placed into a soxhlet extractor. The extractor was placed into a pre- weighed dried distillation flask. Then the solvent (acetone) was poured into the distillation flask through the condenser and attached to the soxhlet extractor. The set up was held in place with a retort stand clamp. Cooled water jet was allowed to flow into the condenser and heated solvent was refluxed as result. The lipid in the solvent chamber was extracted in the process of continuous refluxing. When the lipid was observably extracted completely from the sample under test, the condenser and the extractor was disconnected and the solvent was evaporated to concentrate the lipid. The flask was then dried in the air oven to constant weight and re-weighed to obtain the weight of the lipid.

Calculation:

$$\% \text{ LIPID} = \frac{weight\ of\ flask\ and\ extract - weight\ of\ empty\ flask}{weight\ of\ sample\ extracted} X100 \quad (5)$$

Ash analysis (by furnace method)

1gram of the dried sample was weighed into porcelain crucible which was previously pre heated and weighed. The crucible was inserted into a muffle furnace and regulated to a temperature of 630^0C for three hours and allowed to cool to room temperature and re-weighed.

Calculation:

$$\% \text{ ASH} = \frac{weight\ of\ crucible + ash\ sample - weight\ of\ crucible}{weight\ of\ sample} \times 100 \quad (6)$$

Fig.2 Muffle furnace

PROTEIN ANALYSIS(BY KJELDAHL METHOD)

This method involves three stages in determination of protein content of the processed garri.

Stage 1: Digestion

0.1g of the sample was weighed into a clean conical flask 250ml capacity, 3g of digestion catalyst was added into the flask and 20mls concentrated sulphuric acid was also added and the sample was heated to digest. The content changed from black to sky-blue coloration. The digest was cooled to room temperature and was diluted to 100ml with distilled water.

Stage 2: Distillation

20mls diluted digest was measured into a distillation flask and the flask was held in place on the electro-thermal heater or hot plate. The distillation flask was attached to Liebig condenser connected to a receiver containing 10mls of 2% boric acid indicator. 40ml NaOH was injected into the digest through a syringe attached to the mono-arm steelhead until the digest became strongly alkaline. The mixture was heated to its boiling point and the ammonia gas was distilled via the condenser into the beaker. The colour of the boric acid change from purple to greenish as ammonia distillate was introduced into the boric acid.

Stage 3: Titration.

The distillate was titrated with standard 0.1N hydrochloric acid (HCl) solution to purple from greenish. The volume of hydrochloric acid added to effect, this change was recorded

Calculation:

$$\% \text{ organic Nitrogen} = \frac{titre\ value \times 1.4 \times 100 \times 100}{1000 \times 20 \times 0.1} \qquad 7$$

Results and Discussions

The results of the fermentation time on the quality of garri, starch contents and the proximate analysis were presented in tables and charts as shown below

Table.1 : Showing fermentation time the starch content and proximate analysis at each interval

Fermentation time(hr)	Protein content(%)	Lipid content(%)	Fibre content(%)	Ash Content(%)	Moisture content(%)	Starch(%)	Iodine reduction	%CHO
12	1.313	0.40	11.907	0.75	7.85	80	5	77.68
24	1.750	0.50	12.011	0.80	9.03	79.2	7	75.60
48	2.188	0.70	15.570	0.89	11.83	78.4	12	70.83
72	2.457	0.80	18.200	0.94	12.54	77.3	16	66.08
96	2.625	1.00	21.660	1.0	13.34	75.1	20	65.48
120	2.212	0.92	24.292	0.9	14.97	74.6	26	64.50

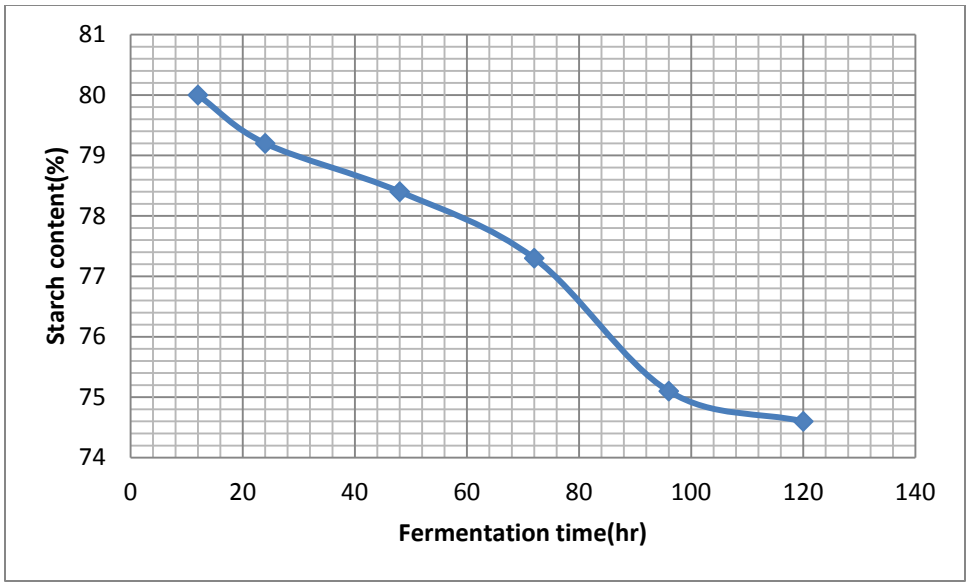

Fig. 3: graph of starch content (%) against fermentation time

From the figure 3 above it shows that as the fermentation time is increasing there is reduction in the starch content. That is to say that there is a negative correlation between the fermentation time and the starch content of the processed garri, it shows that garri that fermented for 2days will be heavier when consumed than the one that is fermented for 5days or 120hours.

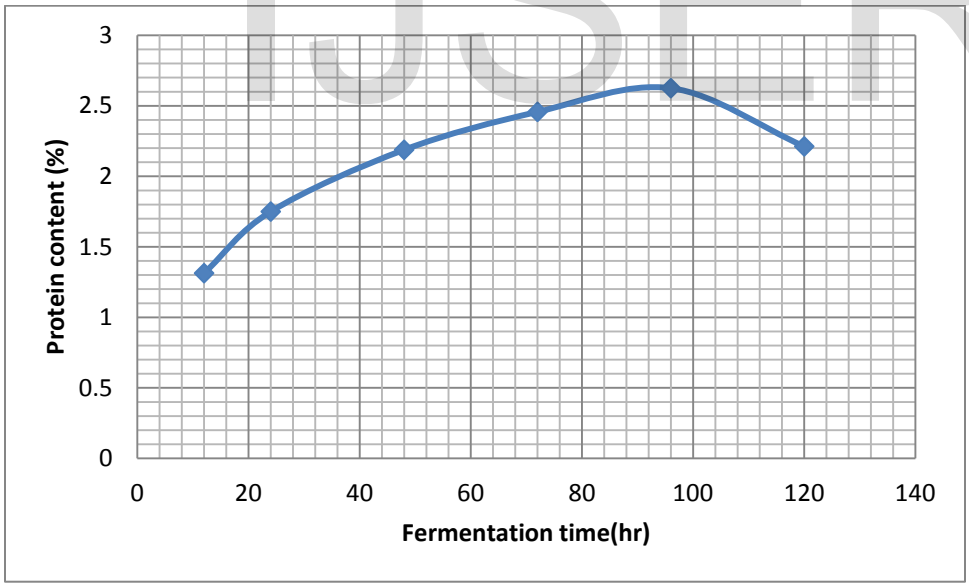

Fig. 4: graph of protein content (%) against fermentation time

Figure 4 shows that as the fermentation time increases there is an increase in the protein contents reaching its peak after 96hours. And there is reduction further time from 96hours

further time from 96hours

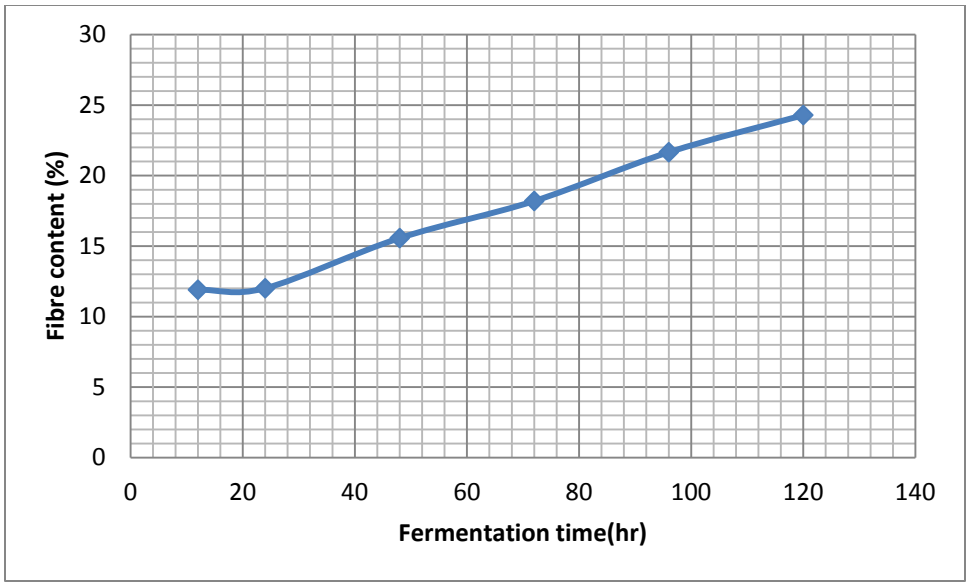

Fig. 5: graph of fibre content (%) against fermentation

From figure 5 it can be deduce that there is an increase in fibre content as the fermentation time increases.

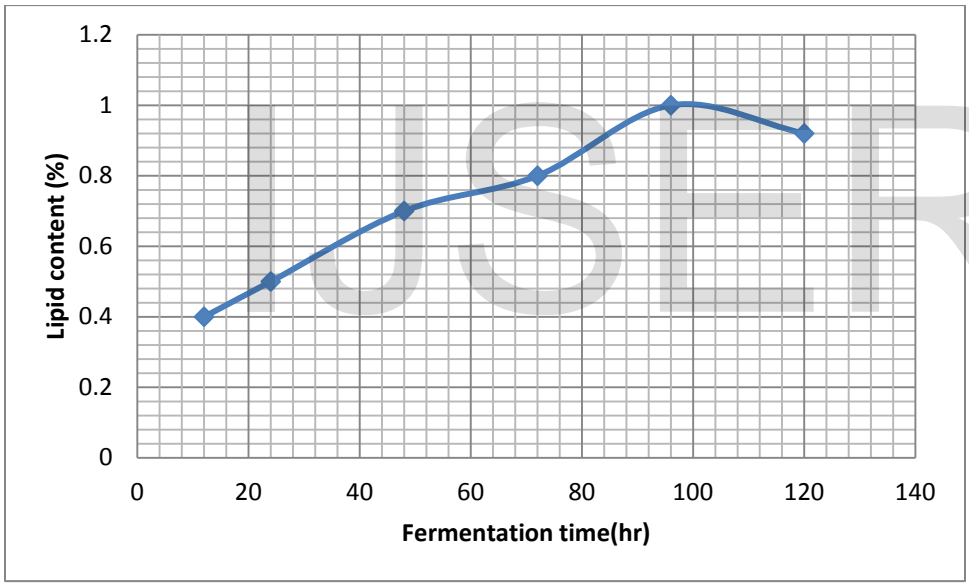

Fig.6: graph of lipid (%) against fermentation

Figure 6 shows a positive correlation between lipid content and fermentation time that is as the fermentation time increases the lipid content increases.

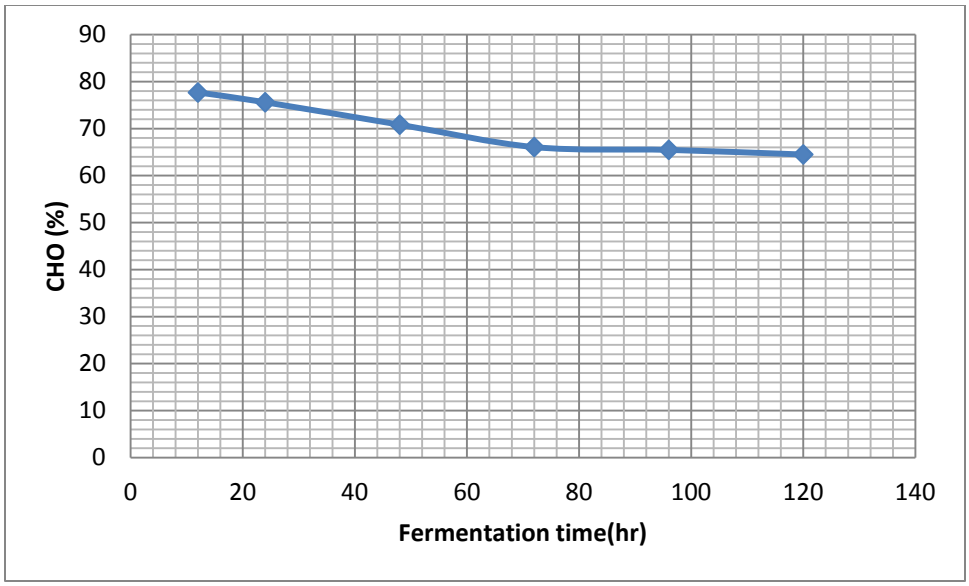

Fig.7: graph of carbohydrate content (%) against fermentation time

Figure7 shows that as the fermentation time increases the carbohydrate content decreases.

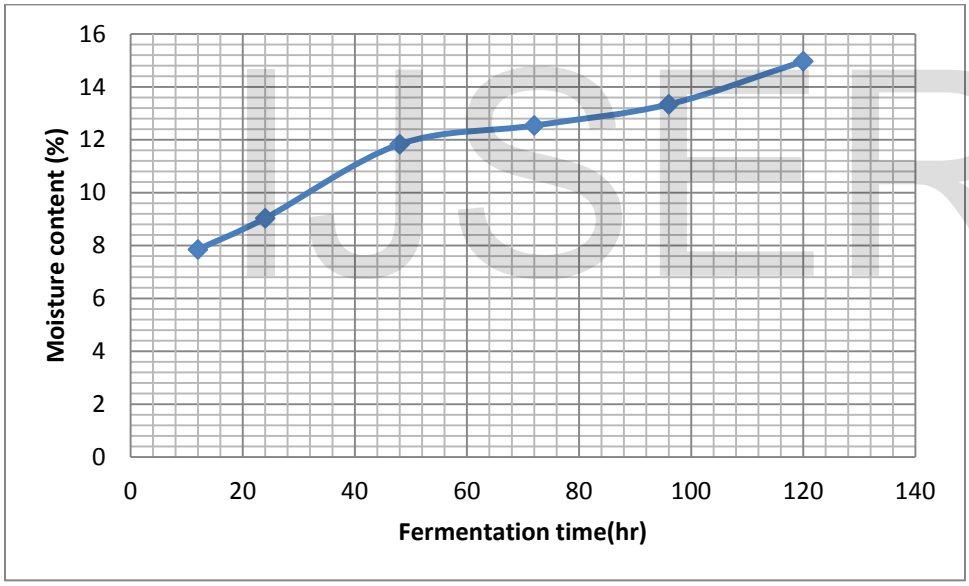

Fig. 8: graph of moisture content (%) against fermentation time

The figure 8 shows that there is a relationship between fermentation time and the moisture content of the processed .

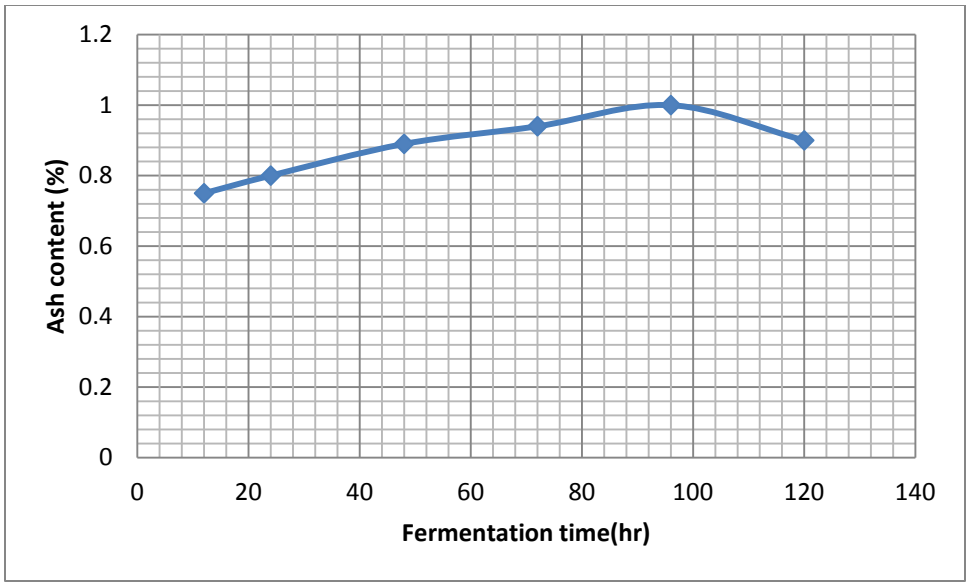

Fig. 9: graph of Ash content (%) against fermentation time

From the figure 9 above as the fermentation time increases there is an increase in the Ash content and it reaches its peak at 96hours. And it starts to decrease.

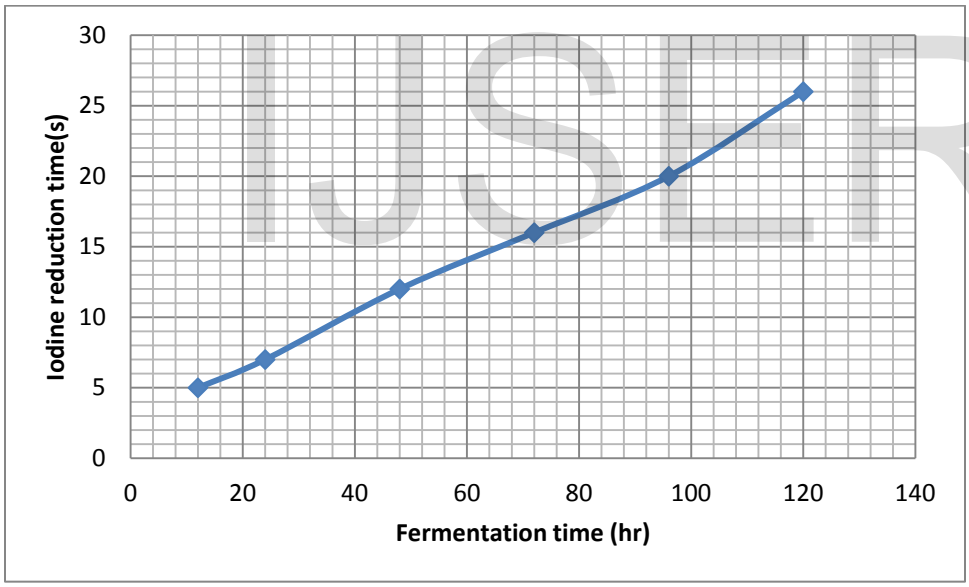

Fig 10: graph of iodine reduction time against fermentation time

Figure 10 above shows clearly that there is a positive correlation between fermentation time and iodine reduction

CONCLUSION

The result of this study shows that the longer the fermentation time of grated cassava mash are very important means of reducing the starch content and improve the quality of the processed garri.,

Therefore the practice of harvesting cassava and processing the same cassava in one day should be discouraged and this is because of the various illnesses such as Endemic goitre and cretinism that is associated in consuming such products. And this illness is capable of killing human being. Any abuse in the processing of cassava into garri will certainly result in poor quality of garri with unacceptable starch level and this will be attributed to incomplete fermentation process.

Recommendation

I recommend that grated cassava mash should always be fermented between 24hours to 120 hours to reduce the acidity, the starch content, and to improve the quality of the processed garri. And also that Regulatory Authorities in Nigeria such as the National Agency for food drugs and Administration Control (NAFDAC), Standard Organisation of Nigeria (SON) and other Farmers Association should carry out awareness campaigns to educate the public on effect of fermentation time on the quality of processed garri product.

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