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Effect of Steam Parboiling Time on Corn Grits (*Zea Mays*) Drying Time, Proximate, Minerals and Functional Properties with Differently Cooked Meal ("Egbo") Re-Cooking Time and Acceptability

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Abstract

"Egbo" a traditional Nigerian corn grit meal takes longer time to cook on firewood stoves and this study aimed to reduce the cooking time. Maize (White variety) was weighing, milled into grits and divided into 6 portions with 5 portions steam parboiled at varied time (15, 30, 45, 60 and 75 minutes) and the 6th portion not parboiled as the control. Parboiled samples were dried in an electric dehydrator and drying time, quality attributes (proximate composition, minerals and functional properties) were determined using standard methods. The 6 samples were portioned and each were re-cooked to "Egbo" meal by different cooking methods (Charcoal, Gas, Steam, Pressure cooker and Microwave cooker) and re-cooking time was determined by 10 trained panelists using 7 points texture profile (too hard and too soft). Acceptability was determined by 30 consumer panelist using 9 points Hedonic scale. Results show that drying time ranged from 3hrs 30minutes to 5hrs increasing as the parboiling time increased. Moisture, protein and ash decreased as the parboiling time increased ranging from 4.07-9.25%; 3.64-8.02%; 0.38-1.05% respectively but, Fat, fiber and carbohydrates increased significantly ranging from 5.77-21.50%; 0.04-0.09%; 67.79-80.25% respectively. Ca and Mg decreased as the parboiling time increases ranging from 15.32 -22.07mg/100gm and 127.39-144.51mg/100gm respectively, but Fe, Zn, and Pb increased significantly while Mn values were not significantly different ($P>0.05$) among samples. BD, SI and OAC increased while WAC decreased as the parboiling time increases, but SC values were not significant different ($P>0.05$) among samples. Re-cooking time decreased as the parboiling time increases with 75 mins sample having lowest values (45mins, 45mins, 55mins) in charcoal, steam and pressure cooker respectively, but under Gas and microwave cooking methods it was 2hrs 10mins and 3hrs respectively. Control sample took longer time to cook in all the cooking methods, but was the most acceptable followed by 75mins sample. This study shows that pre-parboiling will improve nutritional value, functional properties and using charcoal or steam or pressure cooker re-cooking time is reduced, thus it will assist household economy on its meal preparation.

INTRODUCTION

Maize is an important cereal in the world after wheat and rice with regard to cultivation areas and total production [1]. Maize contains carbohydrates, protein, fiber, minerals and fats [2]. While mechanical mills (hammer mill or disc attrition mill) have been used to separate whole grain into it anatomical features (bran, germ and its endosperms) in order to increase its surface areas [3-5]. Processing grains into grits or flour has different nutritional value with grits almost retaining its nutritional composition but degree of sieving gives its flour varied values of fiber and mineral like Vitamin A [4-6]. Maize grits has been shown to contain high fiber which could assist human health by increasing bulkiness in stools, reduce blood pressure and heart related diseases [7-9]. In Nigeria, traditional processing method of turning corn into grits is by using pestles and mortal [10] but today improved technology has been using disc attrition or hammer mill /torso milling machines. Traditionally, the grits is moist cooked in earthen pots placed on fire wood stoves under atmospheric condition which could take more than 6hrs.to expose the endosperm into white creamy meal called "Egbo" which is often consumed with stew ingredients (grounded pepper, onion, tomatoes, ground shrimps, smoked fish and palm oil) or with addition of cooked cowpeas to improve its nutritional quality [10].

The drudgery of cooking maize grits into meal ("Egbo") using firewood under atmospheric pressure takes longer time and consumed much energy and wood burning could constitute environmental hazards leading to climate change. Today's family are looking for short cooking time to prepare third meals that reduces energy and government are making laws to prevent tree felling and burning due to hazardous effect on environment. However, studies has been made to reduce cooking time for grains meals especially rice which has becomes a common food in developing nations by using a pre-gelatinization method (steam parboiling) and drying before re-cooking [11]. While water parboiling methods has been shown could causes loss of nutrients but steam parboiling retains more nutrients [12]. The effects of thermal cooking methods like firewood, charcoal, gas, steam, pressure cooking and microwave cooking and their severity has been studied on tubers, grains, fruits and vegetables of which severity could cause damage to protein, carbohydrates, loss of vitamin C, etc., [12-16]. However, there is inadequate information of effects of using steam parboiling, drying and recooking by these cooking methods on maize grits to it meal ("Egbo"). Therefore, this study aimed at evaluating quality changes of parboiled, dried corn grits and re-cooking time and acceptability of it's differently cooked of grits to it meal ("Egbo").

MATERIAL AND METHODS

Source of Raw Materials

Maize (white Variety) was purchased from Sango Market Saki West Oyo State. While equipment like electric Steamer (Type: Tesco 800 power 3, Flexible Assembly), electric dehydrator (Type: Bosch BS-6605-1550w Rosewillhom, 5 trays electric food dehydrator), charcoal stoves, gas cooker, pressure cooker, microwave oven, weighing balance, measuring cylinder, disc mills, trays and other equipment were obtained Food Processing Laboratory, Department of Food Science and Technology, Oke-Ogun Polytechnic Saki, Oyo state Nigeria. Chemicals used for analysis were of standard grade obtained from approved suppliers by NAFDAC, Nigeria.

Sample Preparations (Parboiling and Drying) of Corn Grits

Maize (white variety) were weighed and manually sorted to remove stones and other foreign matters. The clean grains [Plate 1.1] were milled into grits [Plate 1.2] by using laboratory disc attrition mill. The milled sample was divided into 6 portions with 5 portion soaked in clean water for 30 minutes before subjecting to steam Parboiling in an electric steamer [Plate 1.3] at varied time (15, 30, 45; 60, 75 minutes). While the sixth portion was not parboiled and was used as the control. The Parboiled samples were dried in a food dehydrator [Plate 1.4]. The drying time was determined when constant weight was reached. The dried samples were packaged in HDPE for storage in the refrigerator until needed for analysis.

Preparation of Corn Grits Meal ('Egbo')

The parboiled and dried maize grits sample with control were soak with water for about 20 minutes and was recooked by using five cooking methods as follows:

Plate 1 Processing of Samples by milling, steaming and drying

(1). **Charcoal stove:** Grits samples were put into aluminum pot with water added and then was placed on charcoal fired stove, allowed to cook under atmospheric condition until doneness.

(2). **Steam cooker:** Moist grist sample was put into a steamer plastic pot and was placed inside the electric steamer (Type Tesco 800 power 3, Flexible Assembly) until doneness.

(3). **Gas fired burner stove:** Grits sample was put into aluminum pot and with water added was then placed in a gas fire burner stove until doneness

(4). **Pressure cooker:** Samples was placed inside the pressure cooker with water added, closed tightly and the cooker was placed on gas burner until doneness.

(5). **Microwave oven**: Sample was put into the microwave plastic cooking pot with water added and it was placed inside the microwave oven set at on high power (Approx. 230^{0}C) until doneness.

Determination of Re-cooking Time of 'Egbo' by Sensory Evaluation method

The recooking time by different cooking methods of the samples was determined by 10 trained panelists drawn from both workers and students of the School of Science, The Oke - Ogun Polytechnic, Saki who were asked to use their teeth to bite the sample drawn during cooking using 7 points textural scale where 1= Very hard and 7= too Soft to determine doneness. The average ranking scale of 6.5 was used as doneness score and the time this occurs was calculated as the re-cooking time.

Determination of Proximate Composition of Maize Grits Samples

Proximate composition (Moisture, Protein, Crude fats and Ash) were determined using methods [17]. Moisture content of the samples was determined by air oven method at 105^{0}C for 4 hours until constant weight is reached. Crude protein of the samples was determined using micro-Kjeldahl and amount of crude protein calculated using the conversion factor of 6.25. Crude lipid was determined by weighing 5 g of dried sample into fat free extraction thimble and plugging lightly with cotton wool. The thimble was placed in the Soxhlet extractor fitted up with reflux condenser. The dried sample was extracted with petroleum

ether and the crude lipid estimated as g/100g dry weight of sample. Ash content was determined by weighing 5g of sample and heated in a muffle furnace (Gallenkamp, size 3) at 550^{0}C for 4 hours and Ash was calculated as g/100g original sample. Total dietary fiber was determined using method [18,19].While total carbohydrate content was obtained by difference.

Determination of Minerals in Maize Grits Samples

Minerals of Phosphorus and iron were determined by vanadomolybdate colorimetric method. While calcium, magnesium, zinc, and manganese were determined using method [20,21] spectro-photo-metrically by using Buck 200 atomic absorption spectrophotometer (Buck Scientific, Norwalk) and absorption of the sample mineral compared with absorption of standards of these minerals.

Determination of Functional properties

Bulk density: The bulk density (BD) of the maize grits samples was measured using method [17]. About 10 g of flours were weighed and put into 25 mL measuring cylinder and the volume was recorded as a loose volume. The bottom was tapped on a bench until a constant volume was observed. The packed volume was recorded. The loose BD and packed BD were calculated as the ratio of the flour weight to the volume occupied by the flour before and after tapping using equation

Density = g/cm3 (weight /volume).

Water and oil holding capacities: Water holding capacity (WHC) was determined by centrifugation with modification [4]. Samples (5gmm) were suspended in 30ml distilled water or oil with stirring at room temperature was allowed to settle and the suspension was centrifuged at 2000 rpm for 5 minutes. Supernatants were carefully discarded and the volume of supernatant was determined. . WHC was expressed as mL water/g sample. Oil holding capacity (OHC) was determined with the same conditions as WHC using sunflower oil (1.0054 g/mL density), and was expressed as mL oil/g sample expressed as V1 – V2/W0.

Solubility index and Swelling Capacity: Solubility and swelling capacity was determined using the method [22] with modifications. One gram of flour sample was weighed into 100ml conical flask, hydrated with 15ml of distilled water and shaken for 5min on a wrist action shaker (Burrel Wrist action Shaker model 75, Pittsburgh PA, USA).the conical flask with its contents was put in a shaking water bath maintained between 80 and 85^{0}C for 40min. after heating, the sample was quantitatively transferred into centrifuge tube by washing with 7.5ml distilled water and centrifuge at 2,200 rpm for 20min. the supernant was decanted into a pre-weighed moisture can and dried at 105^{0}C to a constant weight. The sediment was weighed and solubility was calculated. Swelling capacity was determined using 10g of the flour dispensed in a calibrated 100ml measuring cylinder, 100ml of distilled water was added and the volume was noted, the cylinder was left to stand undisturbed for 1hr. The volume which the sample then occupied was recorded. The swelling capacity was determined by the calculation as follows: Swelling capacity =V2/V1; where V1 = initial volume occupied by the sample, V2=volume occupied by the sample after swelling.

Sensory Acceptability of Corn grits Meal ("Egbo") Samples Cooked Differently: A consumer acceptability test was conducted using 25 untrained panelists from workers and student of the Oke-Ogun Polytechnic Saki, Oyo state who were familiar and regular consumer of "Egbo" without any report of allergy to the meals were asked evaluate appearance, texture, taste, aroma, consistency, mouth feel and overall acceptability of the "Egbo" meal samples using 9-point hedonic scale rating where 9= like extremely and 1= Dislike extremely.

Statistical Analysis

The data obtained was analyzed using SPSS for window version 16.0. The mean and standard error of mean of the triplicate analyses was calculated and analysis of variance (ANOVA) was performed to determine the significant difference between the mean. The means was separated using Duncan multiple range test at $P<0.05$.

RESULT AND DISCUSSION

Table 1: Drying Time of Corn Grits Samples.

Discussion

The results in Table 1 shows drying time for steam parboiled corn grits samples. Result shows drying time increased as the parboiling time increases and it ranged between 3hrs 30minutes to 5hrs. The 75 minutes sample had the longest drying time (5 hours) and 15 minutes sample the lowest time (3hrs 30 minutes). 30, 45, and 60 minutes samples dried at 4hrs, 4hrs 10 min, 4hrs 30 min respectively. Drying is a means of reducing availability of water in foods and in grains it is usually dried to 10% which has been shown to hinder microbial and enzymatic actions which prolong the keeping quality except if not well packaged or exposed to atmospheric conditions [23].

Proximate Composition Of Samples

Discussion

The result of proximate composition of samples shown in Table 2 indicates that protein and ash decreased as the parboiling time increases. While moisture values of samples were not significantly different ($P>0.05$). Fat, fiber and carbohydrates

Table 1: Drying Time of Corn Grits Samples

Sample Parboiling Time (Minutes)	Steam Parboiling Temperature (^{0}C)	Drying Time (Hours)
15 Min.	100^{0}C	3 hrs.30min
30Min.	100^{0}C	4hrs
45 Min.	100^{0}C	4hrs 10 min
60 Min.	100^{0}C	4hrs 30mins
75 Min.	100^{0}C	5 hrs.
Control	Nil	Nil

Table 2: Proximate Composition of Samples

Sample	Moisture (%)	Fat (%)	Protein (%)	Fiber (%)	Ash (%)	Carbohydrates (%)
15 minutes	5.42±1.45^{b}	8.85±0.36^{cd}	4.36±1.06^{ab}	0.09±0.02^{b}	0.38±0.02^{b}	80.25±2.89^{a}
30 minutes	5.46±2.06^{a}	17.25±1.77^{b}	7.82±0.84^{a}	0.05±0.01^{b}	0.76±0.04^{a}	68.68±1.08^{b}
45 minutes	5.47±0.52^{a}	7.50±0.71^{d}	6.72±1.56^{ab}	0.06±0.01^{b}	0.78±0.01^{a}	79.55±±0.26^{a}
60 minutes	4.07±0.02^{a}	10.60±0.85^{c}	4.20±1.98^{ab}	0.54±0.16^{a}	0.77±0.04^{a}	79.83±2.69^{a}
75 minutes	5.23±0.17^{a}	21.50±0.71^{a}	3.64±1.10^{b}	0.06±0.01^{b}	0.78±0.07^{a}	68.79±1.71^{b}
Control	9.25±0.16^{e}	5.77±0.01^{c}	8.02±1.12^{c}	0.04±0.00^{c}	1.05±0.04^{c}	67.79±2.18^{c}

Means of triplicates are superscript at significantly level of (P<0.05)

increases as the parboiling time increases. The value of moisture in samples are less than 10% (standard M.C. for grains) which indicates a more higher possibility of keeping longer if not exposed to the atmospheric conditions [23]. Fat content increased compared to the control and 75 minutes sample had highest value (21.50%) compared to the control value (5.77%). Fat values in maize varies based on varieties from 4.98 to 7.22% [24], but the values here increased which might be as the result of increased dry matter as result of drying. Fatty acid profile plays vital roles in storage, nutritional, health, labeling and energy of foods [25].

Protein decreased as the parboiling time increases even at a significant level (P<0.05) compared to the control sample values (8.02%) with 75 minutes sample the lowest value (3.64%). Protein decreases might be as a result of severity of heat which could have cause damage to the native protein lowering availability [6,26]. Crude fiber content varied, with the control sample had the lowest value(0.04%) with slight increases among parboiled samples ranging between 0.05 – 0.09%) with 15minutes ample the highest value which shows heat severity having slight effects but increased dried matters. Dietary fibers consumption health related matters like diabetes, obesity and reduce blood and heart pressure [7,8,27] while consumption of maize (whole, grits or unsaved flour) has been shown could assist in maintaining energy homeostasis, reduce food intake and increasing satiety [25,28]. In all the samples **a**sh reduction was noticed compared to the control with highest value (1.05%) and parboiled sample range between 0.038 – 0.78%) with 15 minutes sample the lowest value and 45 and 75 minutes sample the highest value (0.78%). Ash contains minerals, which influences metabolism in human dieting. Carbohydrates value increased as the parboiling time increases with the control value (67.79%) the lowest and 15 minutes sample value (80.25%) the highest but decreased as the parboiling time increases. Carbohydrates in maize ranged between 72-73% (Asp, 1994) contributing energy and level of glycemic index which depends on the sectional structure of maize and other carbohydrates like glucose, sucrose and fructose which are 1 to 3 % in Maize kernel [29,30].

Table 3: Minerals Composition of Steam Parboiled and Dried Corn grits samples

Discussion

Minerals of samples determined are indicated in Table 3. Result shows that calcium decreased compared to the control having value highest values (22.07mg/100g) while among parboiled sample, value increased as the parboiling time increased ranged between (15.32 – 18.57g/100g sample) Fe, Zn, Mg, Mn and P increased compared to the control with lowest values) but among the parboiled and dried samples, values increased in Fe, Zn, Mg and decreases in Mn and P as the parboiling time increased. Calcium is needed for strong bones and teeth and can be obtained from the nixtamalized maize [31]. While Iron deficiency is a worldwide problem that is directly correlated with poverty and insecurity [32] of which values here does not meet daily iron required for adult health. Zinc assist in hair growth and assist in metabolism, but content in maize is not sufficient to avoid the risk of Zn deficiency, especially in young Children [31,33,34]. Magnesium played role in over 300 enzymes reactions in the human body by helping the muscle and nerve, support the immune system and deficiency could worsen insulin resistance, etc. [31]. While manganese acts as catalysis for the split of water in metabolism. Phosphorus is the second most important macronutrients in plant metabolism, cellular energy transfer, respiration and photosynthesis and human nutrition [35].

Table 4: Functional Properties of Samples

Discussion

Functional properties of the samples shown in Table 4 shows that comparing the control with parboiled samples, bulk density values is not significant different (P>0.05) but 15 minutes sample had highest value (1.10g/cm3) and the rest parboiled sample decreasing slightly from the control value. Water absorption capacity decreased as the parboiling time increase compared

Table 3: Minerals Composition of Steam Parboiled and Dried Corn grits samples

Sample	Ca (mg/100gm)	Fe (mg/100gm)	Zn (mg/100gm)	Mg (mg/100gm)	Mn (mg/100gm)	Pb (mg/100gm)
15 minutes	15.32±0.47^{d}	21.95±0.43^{d}	1.91±0.04^{c}	127.39±0.64^{e}	12.72±0.05^{a}	21351.92±1.36^{a}
30 minutes	20.95±0.16^{a}	23.88±0.32^{c}	1.52±0.04^{d}	138.32±0.08^{b}	11.01±0.08^{c}	20109.35±3.53^{d}
45 minutes	18.52±0.13^{c}	30.25±042^{a}	2.02±0.02^{b}	134.89±0.18^{c}	12.01±0.07^{b}	21318±65±2.55^{a}
60 minutes	19.72±0.04^{b}	26.80±0.07^{b}	1.98±0.02^{b}	130.98±026^{d}	10.57±0.25^{d}	21113.05±6.22^{b}
75 minutes	18.57±0.02^{c}	29.76±0.02^{a}	2.11±0.03^{a}	144.51±0.76^{a}	10.53±0.06^{d}	21020.05±51.31^{c}
Control	22.07±0.30^{e}	18.38±0.17^{e}	1.68±0.01^{e}	135±0.03^{t}	11.00±0.28^{e}	20354±2.38^{e}

Means of triplicates are superscript at significantly level of (P<0.05).

Table 4: Functional Properties of Samples

Sample	Bulk Density g/cm^3	Water Absorption cm$^{3/}$ /gm.	Swelling Capacity (V/V)	Solubility Index (V/V)	Oil Absorption cm$^{3/}$ /gm.
15 Minutes	1.10±0.01^a	118.00±1.73^a	6.70±0.12^a	8.00±0.00^b	92.33±3.21^a
30 Minutes	0.91±0.01^a	99.00±2.65^b	5.92±0.15^b	7.00±0.00^a	76.67±6.35^b
45 Minutes	0.90±0.01^a	123.00±1.73^a	5.70±0.12^a	4.00±0.00^b	86.33±3.21^a
60 Minutes	0.90±0.01^a	92.00±2.65^b	4.92±0.15^b	6.00±0.00^a	66.67±6.35^b
75 Minutes	0.91±0.01^a	115.67±2.52^b	5.04±0.02^b	13.33±1.15^a	83.00±6.25^a
Control	0.93±0.02^a	125.67±2.89^a	5.74±0.41^a	5.67±0.58^b	90.67±3.79^a

Means of triplicates are superscript at significantly level of (P<0.05).

to control value (125.67g/cm3) and parboiled samples ranged between 92.00 – 118.00 cm3/g sample with 15 minutes sample higher in value (118.00cm3/g) than 75minutes sample value (115.67cm3/g). While swelling capacity values are not significantly difference (P>0.05) the 15 minutes samples had value (6.70v/v) greater than 75 minutes and control samples (5.04 and 5.74v/v) respectively. Solubility index also show values increased as the parboiling and drying time increases with values ranged between (4.00v/v – 15.33v/v) with 45 minutes value lowest and 75 minutes highest value. The oil absorption capacity values varies ranged between 66.67cm3/g – 92.33cm3andg) with 15 minutes sample having highest value and control higher than the 75 minutes sample.

Bulk density is used predicts the compact of the starch and its expansion when heated of which corn meal have been used extensively as a major ingredient for extruded foods such as ready-to-eat breakfast cereals and snacks. Report by [36] shows that samples prepared and extruded with the lowest moisture content have the largest water absorption capacity. While swelling and solubility provide evidence of the magnitude of interaction between starch chains [37] and defined as the swollen sediment weight (g) per g of dry starch/flour and solubility is expressed as the percentage (by weight) of the starch/flour sample that is dissolved molecularly after being heated in water between 85 and 95^{0}C [38]. Oil absorption capacity measures the amount of oil that can be absorbed by food materials during processing.

Table 5: Recooking Time of Meal ("Egbo") Samples

Discussion

The recooking time of grits samples to "Egbo" meal cooked with different cooking methods is indicated in Table 4. The re-cooking time determined by trained sensory panelist shows decrease in recooking time as the parboiling time increase. The control sample had highest values 2hrs 45 minutes, 3 hrs, 2hrs 30 minutes, 65 minutes and 3hrs 30 minutes under charcoal, gas, steam, pressure and microwave methods respectively. The longest

2.1. Control sample (charcoal method) 2.2. 75mins sample (charcoal method)

Plate 2 Examples of samples recooked by different methods

cooking time was under microwave cooking while the shortest time was recorded under charcoal, steam and pressure cooker. In all the methods, charcoal had lowest values among the parboiled samples. The charcoal method is appropriate for rural dwellers while the steam and pressure cooker should be adequate for the urban dwellers compared to microwave cooking of corn grits to "Egbo". Cooking time is very important to households and food processors economic situation and grains pre-condition, storage and dryness has been shown could influence time of cooking and quality of food products.

Graph 1: Histogram of the Acceptability Rating

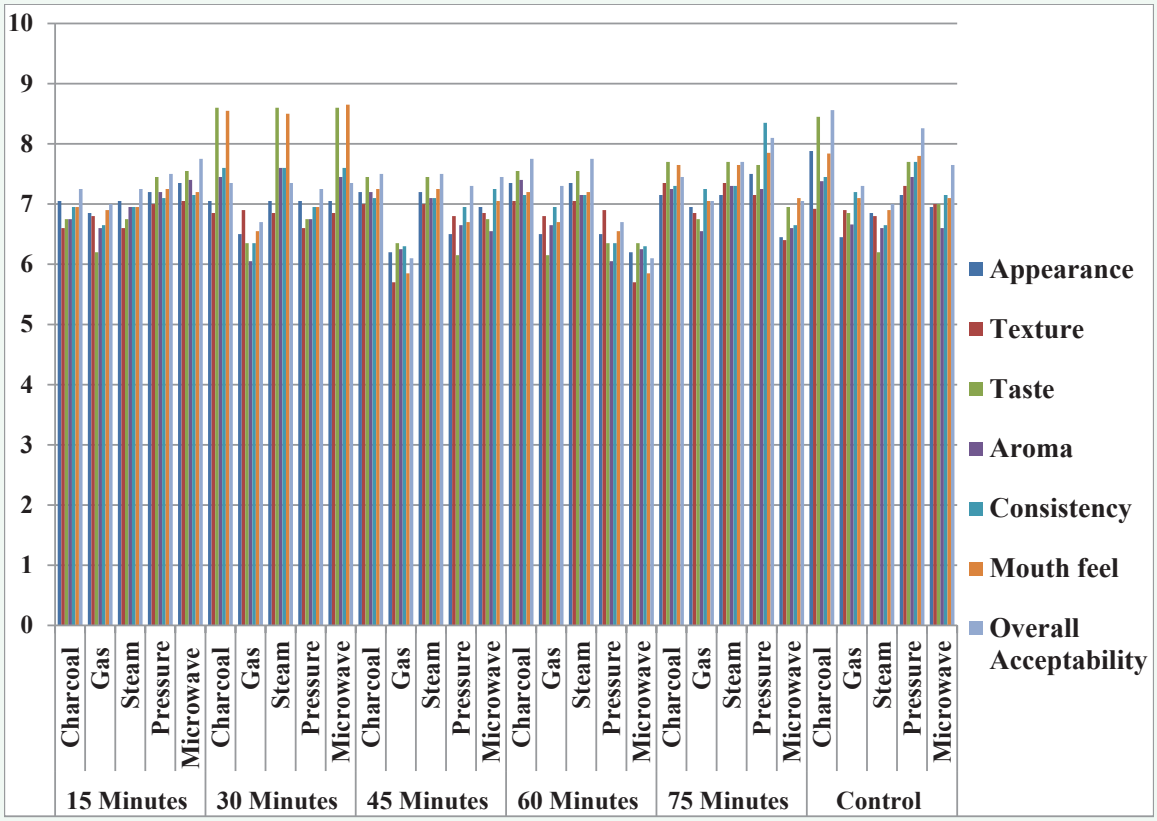
Discussion

The histogram of the consumer acceptability of the differently cooked corn grits into "Egbo" meal is indicated in Graph 1. In terms of appearance, texture, taste, aroma, consistency, mouth feel and general acceptability, microwave cooking method was highly accepted which is followed by pressure cooking method. 30 minutes sample had the highest rating in terms of taste and mouth feel under microwave and charcoal cooking method. While 75 minutes sample in terms of appearance, texture, taste, aroma, consistency, mouth feel and overall acceptability had highest rating under pressure cooker, charcoal, and steam. The

Table 5: Recooking Time of Meal ("Egbo") Samples

Sample (Time)	Charcoal Cooking Time	Gas Cooking Time	Steam Cooking Time	Pressure Cooking Time	Microwave Cooking Time
15 Minutes.	1hr 75min	2hrs 35 min	2hrs	2hrs	3hrs 25min
30Minutes	1hr 30min	2hrs 25min	1hr 45 min	1hr 40min	3hrs 20min
45 Minutes	1hr 15min	2hrs 17 min	1hr 30min	1hr 20min	3hrs 15 min
60 Minutes	60mins	2hrs 15min	1hr 15min	1hr	3hrs 10 min
75 Min.	45 min.	2hrs 10min	45 min	55 min.	3hrs
Control	2hrs 45min	3hrs.	2hr 30min	65 min.	3hrs 30 min

Means of triplicates are superscript at significantly level of (P<0.05).



Graph 1 Histogram of the Acceptability Rating

control sample had the highest rating in terms of appearance, texture, taste, aroma, consistency, mouth feel and overall acceptability had highest rating under charcoal, pressure cooker, and microwave cooking method. In terms of overall acceptability rating, the control sample under charcoal cooking and pressure-cooking method had the highest ranking followed by 75 minutes sample under pressure cooking method.

CONCLUSION

This study shows that fat, fiber, carbohydrates increased but moisture, protein and ash decreased. With increase blanching time. Calcium decreased but Fe, Zn, Mg, Mn and Pb increase with increased parboiling time. The control sample had higher value than the parboiled samples in terms of functional properties. These results indicate that nutritional improvement can be achieved if the grits is pre-parboiled and dried before cooking compared to the control. Also the parboiled sample reduced the cooking time while the recooking time also varied based on the types of cooking method used with the charcoal, steam and pressure cooker showing shortest cooking time than gas and microwave method with longest recooking time. In overall acceptability, the control had the longest cooking time and 75 minutes the shortest re-cooking time, which shows that pre-parboiling in steam, had appreciable effects on corn grits meal "Egbo". While steam cooking is among the healthiest cooking techniques and is an energy efficient heating operation in the food processing industry [15] which could assist urban dwellers. While the use of charcoal should be able to reduce cost of energy and adaptable to rural areas.

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