Short Communication
Effect of processing on the qualities of noodles produced from corn grit and cassava flour

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Abstract: The effect of supplementing 'noodles' with cassava flour and corn grit on physicochemical properties of the products was studied. Cassava flour and corn grit were supplemented at 33% level and mixed with 67% wheat flour. Consumer acceptability of supplemented 'noodles' with corn grit was high compared to cassava supplemented noodles. Fibre content increased to 1.50% for cassava supplemented noodles and 3.8% for corn grit noodles. Colour and texture of supplemented noodles were more attractive compare to that from cassava. Noodles supplemented with cassava flour showed a high swelling power with a higher degree of gelatinization than corn grit supplemented noodles; this might quite not be unconnected with the low level of amylase and high amylopectin content. It can also be concluded that noodles supplemented with corn grit or a mixture of these flours may be attractive as health food or as an economical high protein source food.

Keywords: Cassava, noodles, corn grit, physicochemical properties

Introduction

Pasta products come in many forms (Ranken and Kill, 1992). They may be stored at frozen, chilled or ambient temperature. There is probably no other food from a single common source (wheat) which offers such a variety of shapes and sizes as macaroni, spaghetti, vermicelli, tagliatelli, noodles and lasagna which are but a few of the names given to different shapes. The use of pasta products in manufactured mixtures has increased markedly over the years. These include ravioli (pasta envelopes with meat or other fillings, Lasagna (Sheets of pasta interleaved with cooked meat and a cheese source) and pot noodles in which pasta shapes are mixed with dried peppers, onion, meat pieces and other ingredients to form a dehydrated snack base (Ranken and Kill, 1992). Noodles are a product, produced from wheat (*Triticum* spp.), one of the most important foods of mankind, with about 37% of the world population relying on it as their main cereal. It accounts for some 20% of the total food calories consumed by man, and global wheat production has risen to over 500 million tones, more than a third of the total cereal output (Langer and Hill, 1991).

Wheat, *Triticum aestivum* is divided into classes on the basis, principally of kernel characteristics and growth habits. These classes include hard red winter, hard red spring, soft red winter, white, durum and club wheat. Wheat is used principally as food because of its relatively high protein content, but it is also used as feed for livestock (Langer and Hill, 1991). However, for the production of noodles from wheat, the type of wheat and the properties, functional must be considered. Mostly, considered best for pasta, spaghetti and noodles is durum wheat with high protein content enhanced viscoelastic properties (Langer and Hill, 1991). Moreover, among the cereals in nature, are sorghum, barely, rice, oats, millets and wheat. But though each can be used in place of the other depending on the intention of use, the viscoelastic properties of the protein content differs. For the purpose of this project, an attempt was made at using corn grits and cassava flour in place of 100% wheat for noodles production.

Even though, not much research has been done on the usage of corn grits and cassava flour in noodle production, it is a desirable addition for manufacturing as a wheat substitute because of its lower cost and high accessibility in many markets. Corn or maize is one of the principal global cereal crops (Kent, 1992). Maize was a dominant staple food for early civilizations in the western hemisphere and today it still plays an important role in the diet of millions of people because of its capacity to produce a large amount of dry matter per hectare, its ease of cultivation, and its versatile food uses and storage characteristics (Asiedu, 1989). Maize has been known to be deficient in some amino acids and micronutrients, such as lysine, tryptophan, vitamin B1 (thiamin) and riboflavin. It contains niacin, but 50-80% of it occurs in a bound form, which is biologically unavailable, and therefore renders the maize deficient in niacin (Mason *et al*., 1997). Alkalizing agents such as lime water and potash have been known to be efficient in unbinding the bounded niacin.

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Maize on the other hand, provides a major starch source (Hui, 1991). It is a high calorific food crop because of its high percentage of carbohydrate content which is released as amylase and amylopectin during processing. The role of indigestible fibre or roughage in the maize in maintaining health (Burkitt, 1973) is now considered as important nutritionally. In Western countries, maize for human food is generally industrially processed, whereas food products from maize are still often prepared at home or at the village level in developing countries. The cultivated species grown for food feed or industrial purposes have been classified as *Zea mays*. The most important maize varieties are flint corn, dent corn, flour or soft corn and pop corn. Other varieties of minor importance include sweet corn, waxy corn and starch-sweet corn (Asiedu, 1989). It has been estimated that some 100 million people in the world consume maize in the form of thin, round unleavened cakes or snacks.

Cassava, which originated in Brazil, South America is one of the most important food crops of West Africa. The tuber is processed into gari, tapioca, and cassava flour for human consumption, while the leaves are cooked and eaten especially in Sierra Leone and Liberia (Komolafe *et al*., 1980). The main industrial use of cassava is in the manufacture of starch and alcohol (Komolafe *et al*., 1980). Where cassava is produced for subsistence, the roots are left in the ground until needed but the starch content and quality deteriorate once the optimum time of harvesting has passed (Ihekoronye and Ngoddy, 1985). The main objective of this work was to study the effect of processing on the quality of "Noodles" from corn grit and cassava flour.

Materials and Method

Cassava (*Manihot utilisima*) roots of local variety was obtained from the University of Agriculture, Abeokuta farm. The cassava was harvested, peeled, and washed before grating. The grated cassava pulp was screw pressed, sundried into flour and this was achieved within 48 hours of harvesting. Already processed corn grit was obtained from Albahamas farms Nig. Limited in Anthony Village, Lagos. Golden penny flour was bought at Oshodi market together with the eggs used. The salt and the manual "extruder" used were improvised by the same company (Albahamas).

Laboratory preparation of noodles

About 2 kg of the wheat flour to 1 kg of cassava flour and corn grit were measured into a sterilized container in a ration of 2:1. Eggs of 3.5 g were properly wiped before mixing it with the constituted flour. The whole content was hand mixed into dough. The kneaded dough was milled in the machine before onward extrusion.

Sensory evaluation on Final production

The two products were boiled with a control of 100% wheat and then subjected through different sensory attributes after production. These attributes include appearance (colour), odour, taste and general acceptability. The sensory evaluation was carried out by untrained panelists of seven assessors made up of students from different departments of the University community who are used to consumption of noodles. Equal amounts of the different noodles were presented to the panelist and the means of the seven assessors were subjected to analysis of variance ANOVA using SPSS package.

Laboratory Analysis

The following physico-chemical, chemical analysis and functional properties – pH, moisture content, ash content, fat content, protein content, crude fibre, amylose/amylopectin content, starch content, starch gelatinization, sugar content were carried out on the products.

pH

Five gram of each sample was homogenized with 50 ml of distilled water in a mortar. The suspension was stirred and the pH of the homogenate was determined using a calibrated pH meter

Moisture content

Moisture content of the cooked noodles was determined by the oven air method (AOAC, 1990). A clean dry glass petri-dish was placed in the oven at 80^{o}C for 30 min, then cooled and weighed. 5 g of the sample was then weighed into the petri-dish (W_1) and placed in an oven at 105^{o}C for 3 hours. The petri-dish and content was removed from oven, cooled in a dessicator and weighed. The dish was returned into the oven and further redried for 30 min. This procedure was repeated until two successive weighing at 1 hour interval did not differ by 0.002 g (W_2). The percentage moisture content was determined.

$$\%\ \text{Moisture content} = \frac{W_1 - W_2}{\text{Original Weight of sample}} \times 100\%$$

Ash content

Ash content was determined using AOAC, 1990. 2 g of the sample was put inside a pre-ashed crucible, and combusted over a low burner flame until no more fume was observed, it was then transferred to the muffle furnace and ashed at a temperature of 600°C. It was later cooled in the dessicator and weighed. The ash content was determined from the weight of the ash left in the crucible after ashing.

Fat content

Crude fat was determined by AOAC method (1990). 1 g of the sample (dried) was weighed into a fat free extraction thimble and placed in the extraction barrel. The soxhlet apparatus with petroleum ether in the pre-tared extraction flask (250 – 300 mL volume) was heated to 30°C for about 5-6 hours. After extraction, the thimble was removed from the extractor barrel and dried. The barrel was replaced and distillation continued until the extraction flask was almost dry. The flask was detached and dried to constant weight in an oven. The percentage crude fat was determined from the weight of oil retained in the flask.

Protein content

Crude protein content of maize was determined by Macro Kjeldahl method described by Pearson (1981). 1 g of sample was weighed into a Kjeldahl flask, 2 g of catalyst mixture and 30 ml of concentrated sulphuric acid added. The flask content was digested in the block digester in the fume hood until a clear solution was obtained. The solution was then washed with 200 ml of distilled water into a distillation flask containing granule of marble chips. A thistle funnel was fixed to the flask and connected to the distillation set up. The distillate was received into 25 ml of boric acid and 25 ml of distilled water. 60% NaOH solution was then added into the funnel while the flask was heated on a heating mantle. The flow of NaOH was stopped and distillation continued for 15 minutes. The condenser was disconnected to prevent solution from sucking back. The distillate was titrated with 0.1N H_2SO_4. Percentage Nitrogen was calculated and multiplied by a factor of 5.7 (wheat flour) to obtain the crude protein percentage.

Crude fibre content

One gram of defatted sample was added to 100 ml trichloroacetic acid (TCA). The mixture was boiled and refluxed for exactly 40 min at a temperature of 50-60°C beginning at the time boiling started. The flask was removed from the heater, cooled and filtered through a 15 cm No. 4 Whatman filter paper. Residue was washed 6 times with hot water and once with industrial spirit. The filter paper was opened and the residue removed with spatula. The fibre was transferred into a porcelain dish and dried over night at 105°C, it was cooled inside a dessicator, weighed and then put in the muffle furnace for 5 hours at 600°C. It was cooled again and reweighed and the crude fibre content determined.

Carbohydrate content

Carbohydrate content was determined by "difference method" 100 – (% moisture + % Ash + % fat + %protein + % fibre).

Amylose/Amylopectin content

The amylose content for each sample was determined using the rapid colorimetric method (Thriveened *et al*., 1972). Stock iodine solution was prepared by weighing KI (20 g) into a 100 ml beaker with 2 g resublimed iodine. Then dissolved in a minimum amount of water and diluted to 100 ml in a 100 ml volumetric flask. 10 ml of the stock iodine solution was pipette into a volumetric and diluted to 100 ml with distilled water, to get an iodine reagent (B). Starch sample (20 mg) was weighed into a 100 ml beaker. Exactly 10 ml of 0.5N NaOH solution was added. The starch sample was dispersed with a stirring rod until fully dispersed.

The dispersed sample was transferred into 100 ml volumetric flasks and diluted to the mark with distilled water, with careful rinsing of the beaker. An aliquot of the test sample solution (10 ml) was pipetted into a 50 ml volumetric flask, and 5 ml of 0.1N HCl was added followed by 0.5 ml iodine reagent. The volume was diluted to 50 ml and the absorbance was measured at 625 nm after 5 min.

Calculation:

$$\text{Amylose content} = (85.24 \times A) - 13.19$$

Where A = Absorbance

Amylopectin content was determined by difference based on the total starch content described below.

Starch content

Starch content of the cassava flour and maize grit was determined by the method of Dubois *et al*. (1956). 1 g sample was weighed into a 100 ml flask, moisture with 10 ml distilled water and stirred. About 15 ml of 52% perchloric acid solution was added to the sample and left to stand for 2 hours before filling to mark with distilled water. This was filtered and 0.2 ml of the filtrate was pipetted into a test tube. 1 ml of 5% phenol solution and 5 ml of concentrated H_2SO_4 were added. The tube was allowed to stand for 10 minutes, shaken and placed in a water bath to cool for 15 min, and a yellow-orange colour developed. The absorbance of the samples was measured on a spectrophotometer at 490 nm. Glucose solution was used to obtain the standard curve. The concentration of the starch samples were determined from the standard curve and were multiplied by a factor 0.90.

Starch gelatinization

Starch gelatinization of the maize was determined by the Thriveened *et al*. (1972), method. The sample was first defatted by soxhlet extraction with high petroleum ether (40-60°C) for 6 hours. 2 g of the defatted sample was macerated in 100 ml water in a laboratory blender for 1 min. The suspension was centrifuged. Duplicate aliquot, 1 ml was taken and diluted to 10 ml with water. The, 0.1 ml of iodine solution was added and mixed to develop colour. The absorbances (i) at 600 nm cells against a reagent blank were read. Another suspension of 2 g of the sample in 95 ml water as described above was prepared. 5 ml of aqueous 10 M potassium hydroxide (KOH) was added to the suspension and allowed to stand for 5 min with gentle agitation for 1 hour, then centrifuged. Duplicate aliquot, 1ml was again taken and 0.1 ml iodine solution added. The mixture was mixed to develop colour. Absorbance (A_2) of the alkali treated sample was taken.

Calculation:

$$\text{Degree of gelatinization} = \frac{A_1}{A_2} \times 100\%$$

Swelling property of starch

Swelling property of the maize starch was determined by Shantha and Siddappa (1970) method. 0.5 g starch was suspended in 30 ml distilled water inside 50 ml graduated centrifuge tubes. Then, heated to different temperatures (55-95°C, at 10°C, temperature intervals), and later maintained at the temperature of 95°C for 15 min. This was followed by cooling to temperature of 26°C. The volume was then made up to 50ml mark and centrifuged at 50 rpm for 10 min. The volume of the starch in the tube was recorded and used for calculation.

$$\text{Swelling Ability} = \frac{\text{Vol. of Centrifuged granules}}{\text{Total Vol. of suspension}}$$

Results and Discussion

Chemical compositions of the two noodles

The results of the chemical composition of corn Noodles, corn grit, cassava noodles and cassava flour are shown in Table 1. Overall chemical composition shows cassava flour as having the highest pH of 6.31, because most of the hydrocyanic acid which would have been formed as a result of the oxidation of the cyanogenic compound that would have buffered down the pH must have been drained away by grating and subsequent sun drying. Cassava pH decreases to 5.16 in cassava noodles showing an increase in acidity and pH decrease in corn grit of 5.73 to 5.58 in corn noodles. The sugar concentration decreases from (3.60 Brix) to 4 (Brix) in corn grit under room temperature 25-26°C. Thus showing a slight acidity but of low sugar content. The moisture content of cassava flour is 14.5%, protein 0.50% and very high carbohydrate thus, it has the highest moisture content. The corn grit has a lower ash content of 0.50% as against cassava flour of 1.4%, which buffer up the ash content of the cassava noodles. Corn grit and noodles are high in fat (0.81 – 1%) and crude fibre (3-4 %) while cassava flour and noodles have low fat (0.1 – 0.4%) and crude fibre (1 – 2%). The carbohydrate of cassava noodles and flour ranges between (70 – 85%) while that of corn noodles and grit is between (60 – 73%).

Table 1. Chemical compositions of corn grit cassava flour, corn noodles and cassava noodles

Chemical composition	Cassava flour	Cassava noodles	Corn grit	Corn noodles
pH	6.31	5.16	5.73	5.58
Moisture (%)	14.50	16.20	14.00	16.00
Ash (%)	1.49	1.50	0.50	0.51
Fat (%)	0.10	0.35	0.80	1.05
Protein (%)	0.50	3.90	9.00	10.50
Crude Fibre (%)	1.00	1.50	3.35	3.65
Carbohydrate (%)	82.41	76.55	72.35	68.09
Amylose (%)	18.00	18.00	29.00	29.00
Amylopectin (%)	82.00	82.00	71.00	71.00
Total Starch (%)	25.00	25.00	60.30	61.30
Sugar (Brix)	3.60	4.00	4.00	4.00

Amylopectin of cassava is within the range of (80 – 82%) with an amylase range of (18 – 20%) while the total starch is between (20 – 30%). Corn grit has amylase content (20 – 24%) while amylopecting is within the range of (70 – 80%) while the total starch content is (60 – 70%). The physical analysis showed changes in the swelling power of starches. The variation is as a result of the difference in the type of starch from the raw material involved. When starches are heated, the thermal energy permits some water to pass through the amorphous portion (amylopectin) of the molecular network. As the temperature increase, hydrogen bonding in the crystalline region (amylase) is disrupted.

With the entire granule structure now more "loose", water uptake proceeds readily as heating continues, resulting in rapid swelling of starch granules. So under the same condition when starches are heated equally, increase in amylase content will restrict the swelling power of the starches since the swelling power of starch would depend on the amount ant solubilisation of amylase content (i.e. "looseness of amylase granules). As a result more energy would be required to cause complex swelling in starches with very high amylase content. The swelling power of starch is higher in cassava noodles (2.16) and lowers in corn noodles (1.46), this is due to the fact that cassava flour has a lower amylase content while corn grit has a higher amylase content.

It was observed during the analysis that the degree of gelatinization of starches vary with the source. This is because the gelatinization temperature (range) is distinctive for different type of starch. At this temperature, some of the smaller molecules of amylase are leached into the surrounding water (Ihekoronye and Ngoddy, 1985). The range over which the swelling of the granules takes place is known as the gelatinization range. It then implies that swelling power is directly proportional to the degree of gelatinization of starch. And as a result increase in amylase content would reduce the degree of gelatinization of starch since more energy would be needed to solubilise amylase content which is the major controlling factor. So, starch with very high amylase content would gelatinize later (i.e. at elevated temperature range). Cassava noodles have a higher degree of gelatinization (33.33%) and lower in corn noodles (25.00%). This is due to the fact that cassava flour has lower amylase content while corn has a higher amylase content (Table 1).

With the corn noodles used as a reference, it could be seen in Table 2 that noodles produced from corn is much more acceptable (i.e. has the higher mean score, this is probably because the starch-amylose released during boiling is in optimum quantity. As amylase has been known to increase the flavor or texture of starch produce, the effect that could be linked to the linear structure of amylose which is less susceptible to damage at gelation when a permanent coarse network is formed.

Table 2. Means sensory scores of cassava and corn noodles

Sensory Attributes	Corn noodles	Cassava noodles
Colour	+0.40a	-0.40b
Odour	+0.08a	-0.08a
Taste	+0.40a	-0.40a
Overall Acceptability	+0.40a	-0.40b

Values followed by the same subscript are not significantly different

Table 2 shows the results of most acceptable sensory attributes (colour, odour, taste) in noodles produced from corn grit and cassava flour. It is seen that the colour of corn noodles is more acceptable which could be due to the fact that corn has the higher amylase content that leaches out from swollen starch granules in the form of a colloidal dispersion (sol) to lubricate the noodles. The odour of corn noodles is more acceptable followed by noodles from cassava. This could be because corn has a higher amylose content preferred by panelist. The taste of corn noodles was also more preferred than cassava noodles which could be because of the amylose that crystallizes more slowly. The extent of amylose crystallization is known to be an inhibiting factor in the enzymic digestion of starch and hence, a determinant of the resistance of starch to digestion (Morris, 1990). Thus, hydrolysis of starch component to sugar that could improve taste was most affected. Thus, the amylose content of the noodles from corn would have been very susceptible to crystallization so that it becomes difficult to hydrolyse.

The ranking test showed that corn noodles and cassava noodles posses no significant difference in odour and taste at both the 5% and 1% levels but showed a significant difference in taste at 5% significance level. The swelling power and the degree of gelatinization are inversely proportional to the level of amylase in the raw material; hence starch swelling power and degree of gelatinization increase with decrease in amylase content. This shows that the principal constituent of all cereals (maize) and root crops (cassava) is the biopolymer starch (Harper, 1981a). Thus, the percentage of starch in the feed ingredients as well as the type of starch has significant effects on the extrusion process and product characteristics (Sanni *et al*., 1998). The result from sensory evaluation shows that noodles from corn grit is more acceptable than that from cassava flour, thus corn grit is a better substitute to wheat in noodle production.

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