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Effect of *Detarium microcarpum* seed gum on acceptability of wheat-sorghum composite noodles

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Abstract
The work was aimed at investigation on the effect of *Detarium microcarpum* seed gum on the cooking properties and sensory characteristics of wheat-sorghum composite noodles. Flour was obtained from, 16 h soaked seeds, gum was extracted from de-fatted flour using propane -2-ol. Whole wheat-sorghum composite noodles were formulated from the following ratios: 100:0, 90: 10, 80: 20, 70:30, 60:40 and 50.50; with the addition of 1% gum. The cooking properties and sensory attributes of noodles were analyzed. The cooking time of the noodles reduced from 8.05 min. to 7.95 min. with increase in the level of addition of sorghum flour while the cooking loss and rehydration rate increased from 1.56 % to 9.34% and 89.67% to 99.74% respectively. The mouth-feel of the noodles from whole wheat flour was 6.47 and this reduced to 3.37 at 50% level replacement with sorghum flour. Averagely, consumers showed likeness (5.71) for the composite noodles up to 50% level of sorghum addition. Acceptable noodles were produced from wheat-sorghum composite flour up to 30% level of sorghum addition.

Keywords: *Detarium microcarpum*, sorghum, flour, gum, noodles, cooking properties, sensory evaluation

Introduction

Pastas such as spaghetti, macaroni and noodles are usually made from amber durum wheat that is milled into semolina and mixed with water, salt, eggs, vegetable oil, and most often vegetable colouring. Recently, because of high cost of wheat importation, wheat related illnesses/allergy, advances in technology, high demand and consumers requirements, un-conventional raw materials such as gluten-free flours, composite flours and starches are being incorporated in pasta formulation for enrichment, reduction in usage of wheat flour and creation of varieties [1]. As a result of the absence and reduction in the percentage of gluten in the non-wheat and composite flours, the resultant dough usually lacks properties such as high level of extensibility. Hydrocolloids in form of food gums and starches are usually added to improve the dough characteristics which will in turn improve the cooking behaviour and the sensory attributes of the resultant pasta [2].

Despite regional, economical, and habitual differences in consumption, cereal-based foods such as sorghum (*Sorghum bicolor*) cover the greatest portion of the world's food supply. Sorghum is highly resistance to pests and diseases, short growing season and productivity under drought conditions compared to major cereals [3]. In the human diet, cereals are considered excellent sources of fiber and nutrients (e.g. starches, proteins, vitamins, and minerals). In many developing countries, cereals provide as much as 75% of human dietary energy. As economical and abundant raw materials, cereals have long been used for the production of a wide range of food and non-food products, including breads, cookies, pastas, breakfast cereals, snack foods, malted cereals, pharmaceuticals, and adhesives [4].

Detarium microcarpum is a member of the *Caesalpinioceae* special family of the larger *Leguminosae*. It is a rain forest and savannah tree of tropical Africa. It is locally called 'ofor' by the Ibos; 'ogbogbo' by the Yorubas and 'taura' by the Hausas. Some species of *Detarium* (Ofor) includes *Detarium microcarpium; Detarium senegalense* and *Detarium hendelotianium.* It is among common soup thickeners commonly used in the South-Eastern part of Nigeria. The seed gums could serve as natural hydrocolloids, when crushed to flour and in powdered form they have the ability to swell in water and thus are able to influence the flow and consistency of the liquid.

The mechanisms of food products thickening involve: starch gelatinization, protein coagulation and emulsification [5]. Among the Ibos in South-eastern Nigeria, it is mythically conceived to be a chip of the primal tree that grows in God's own compound. It symbolizes truth and honesty [6]. In African ethno-medicine, the plant and the closely related species *Detarium senegalense are* used in the treatment of syphilis, dysentery, bronchitis, leprosy, sore throat, pneumonia, diarrhoea, malaria and meningitis. Its antifungal and acetyl cholinesterase inhibitory activities have been reported [7]. The matured seeds of *Detarium microcarpum* are shown in (Plate 1). The objective of the study is to investigate the effects of the gum extract from *Detarium microcarpum* seeds on the cooking properties and sensory characteristics of wheat-sorghum composite noodles.

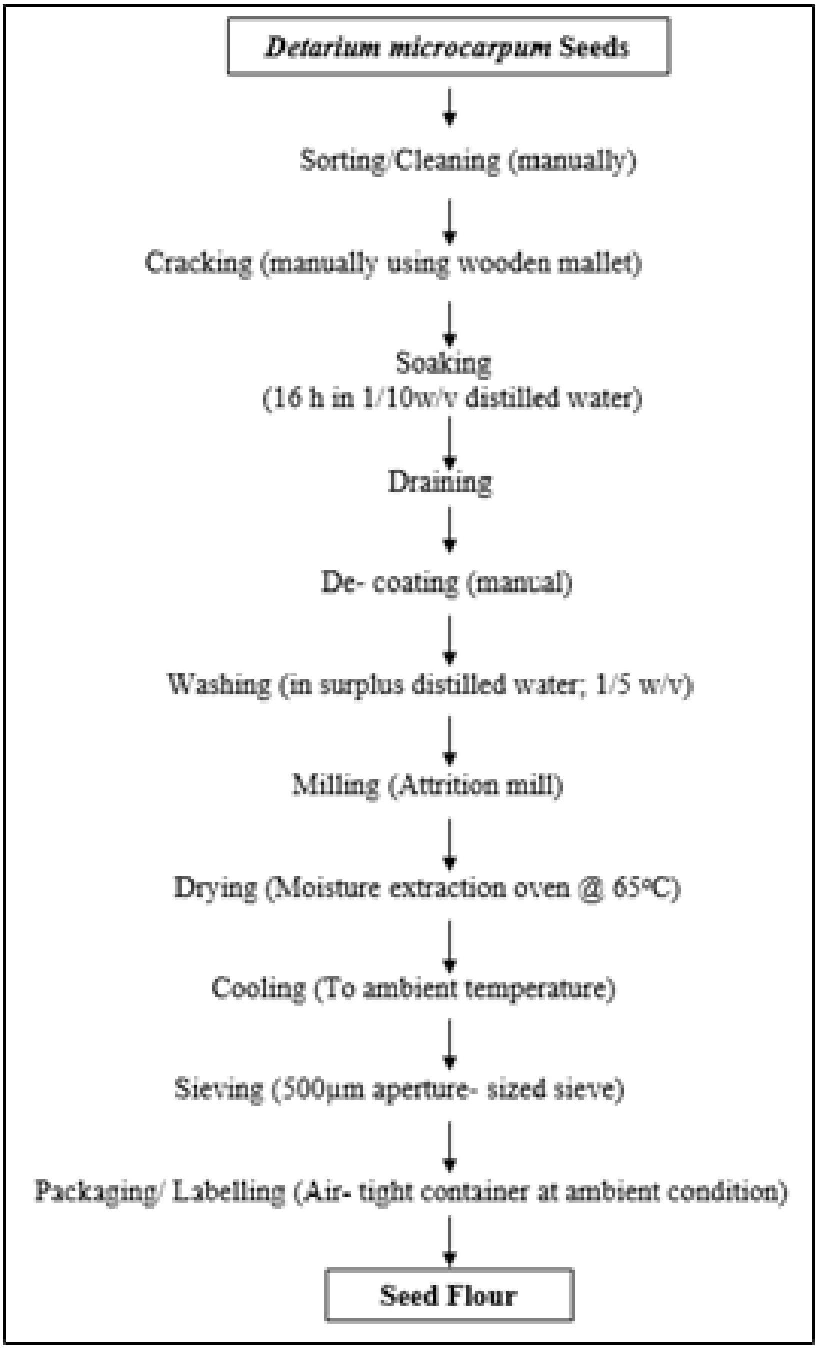
Plate 1: Matured *Detarium microcarpum* (Ofor) Seeds

Materials and Methods Raw Materials
Detarium microcarpium (ofor) and sorghum (*Sorghum bicolor* L.) seeds were obtained from Ekeikpa market in Ihitte/ Uboma, Imo state, Nigeria.

Production of *Detarium microcarpum* Flour
The seeds were cleaned to remove dirt; whole and healthy seeds were weighed separately and manually cracked with the use of a wooden hammer (Mallet). They were soaked in distilled water in the ratio of 1/10(w/v) at ambient temperature for 16 h. The soaking liquors were drained at the elapse of each soaking time and seeds de- coated to obtain the seeds endosperms by scraping the seed coats with a stainless steel knife. The endosperms were washed in surplus water (1/5 w/v) and milled using an attrition mill. The flour were dried in a moisture extraction oven (DHG-9053 Model) at 65 °C to a constant weight, cooled to ambient temperature and sieved through a 500 µm mesh-sized sieved to generate fine flour. They were packaged in airtight containers and stored at ambient conditions for further analysis and application. The processing steps are as shown in (Figure 1).

De-fatting of Seed Flour
Cold (bulk) extraction method of [8] was used for the de-fatting of the flours. The full-fat flour (200 g) were wrapped in a white cotton fabric and soaked in 400 ml of Petroleum ether in an enclosed transparent glass jar and allow for a period of 72 hours. The wrapped flour were removed and rinsed in fresh Petroleum ether and manually squeezed to express out the entrapped solvent. The de-fatted flour was spread on a stainless tray for 4 hours to allow the trapped solvent to volatilize. The flour were sieved through a 500 µm mesh sized sieve, packaged in air-tight container and stored at ambient conditions for further analysis and applications.

Seed Gum Extraction
The method of [9] was adopted for gum extraction from the de-fatted seed flours. Five (5) g of the flour samples were dispersed in 400 ml distilled water and hydrated continuously by means of a magnetic stirrer (FBI 15001, Fischer Scientific, UK) for 6h. Four hundred (400) ml of Propane -2-ol was gradually (drop by drop) added to the hydrated flour solution. The precipitated gums that spools out of the solution were gently separated from the mother liquor with the use of perforated spoon. The clear liquor was decanted while the trapped solvent was removed by filtering under suction in a Buchner funnel. The precipitates were dried in a moisture extraction oven (DHG-9053 Model) at 60oC till a flaky- dried gum could be easily scrapped off the drying tray. The resultant gums were cooled in desiccators to ambient temperature pulverized using the dry section of an electric blender and stored at ambient temperature in a sealed container.



Production of Sorghum Flour

The method reported by [10, 11] with some modifications was adopted in the preparation of the flour. White sorghum grains were sorted, washed in surplus water (1/5 w/v) and dried in a moisture extraction oven (DHG-9053 Model) at 65oC for 15 mins. The dried seeds were cooled to ambient temperature, milled using an attrition mill and sieved through a 500µm mesh-sized sieve. They were packaged in airtight containers and stored at ambient conditions for further analysis and application. The production flow chart is as shown in (Figure 2).

Production of Noodles

Wheat-Sorghum composite flour was formulated as shown in (Table 1). Gum (1%) from 16 h soaked *Detarium microcarpum* seeds were added to each of the flour blends (90:10, 80:20, 70:30, 60:40 and 50:50). A control noodle (100% whole wheat flour) was produced without any gum addition. The methods of [10, 11, 12] were adopted for the laboratory noodle production. Five hundred (500 g) grammes of flour samples were mixed together with 2.5% salt and 0.5% sodium carbonate. The mixture comprising of 20ml edible oil, 5 ml egg white and 200 ml water were gradually added to the flour in the mixing bowl. The mixture was mixed and kneaded in a Kenwood dough mixer for 5 min. and the formed dough was allowed for 30 min rest time. The dough was passed through a single screw manual extruder and cut at 2cm length and allowed for 5 min rest at room temperature after which they were pre-dried in an air dryer at 80oC for 1 h, allowed for 4h sweating inside the dryer chamber and finally dried at 60 °C for 6h to about 12% moisture content (Figure 3). The dried noodles were cooled to ambient temperature, packed and labelled in air-tight container prior to further analysis.

Table 1: Formulation of Wheat-Sorghum (%) Composite Flour Blends

Sample Codes	Wheat	Sorghum
W(Control)	100	0
WS1	90	10
WS2	80	20
WS3	70	30
WS4	60	40
WS5	0	50

Key: W= Wheat
S = Sorghum

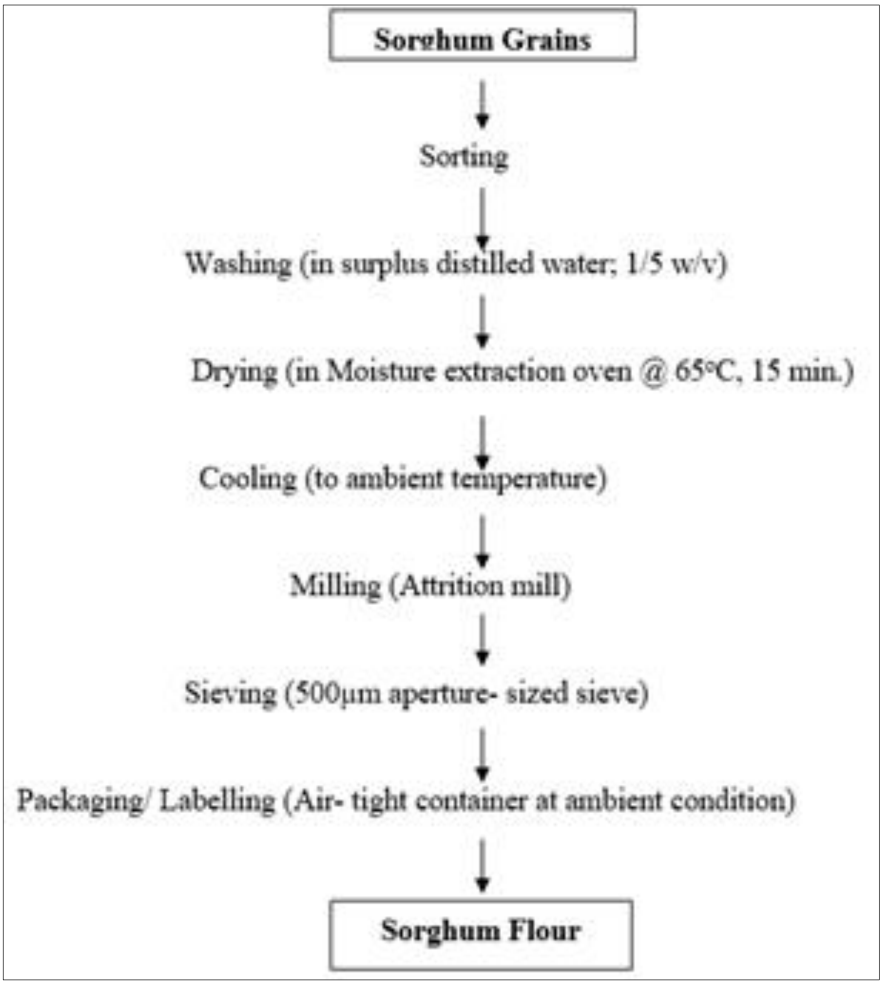


Fig 2: Flow chart for the production of Sorghum Seed Flour (Source:) [11]

Analysis of Cooking Properties of Noodles Optimal Cooking Time Determination

The optimal cooking time for the noodles was determined in accordance with the method described by [13]. A known mass of dry noodles were placed in boiling water (w/v 1:10) and the optimal cooking time was monitored by squeezing it between two transparent glass slides and recorded as the time (min.) taken for the white-opaque core of the pasta samples (visible in cross-section) to disappear.

Cooking Yield (%) Determination

Cooking yield was determines according to the method of [14]. Weighed noodles were placed in boiling water (w/v 1:10) and allowed to cook till the optimal cooking time was attained. They were removed, drained, and weighed after 5 min. Cooking yield was calculated as mass ratio of cooked and raw noodles (g/g) as follows:

$$\text{Cooking Yield (\%)} = \frac{W2}{W1} \; x \, \frac{100}{1} \quad (1)$$

Where

W1 = Weight of Raw noodle W2 = Weight of Cooked noodle

Cooking Loss (%) Determination

The percentage Cooking Loss was determines according to the method of [15]. Weighed noodles were placed in boiling water (w/v 1:10) and allowed to cook till the optimal cooking time was attained. The noodles were removed and drained. The drained water was collected in a tarred beaker, placed in an air oven at 105 oC and evaporated to dryness. The residue was weighed and reported as a cooking loss (%) as follows:

$$\text{Cooking Loss (\%)} = \frac{W2}{W1} \; x \, \frac{100}{1} \quad (2)$$

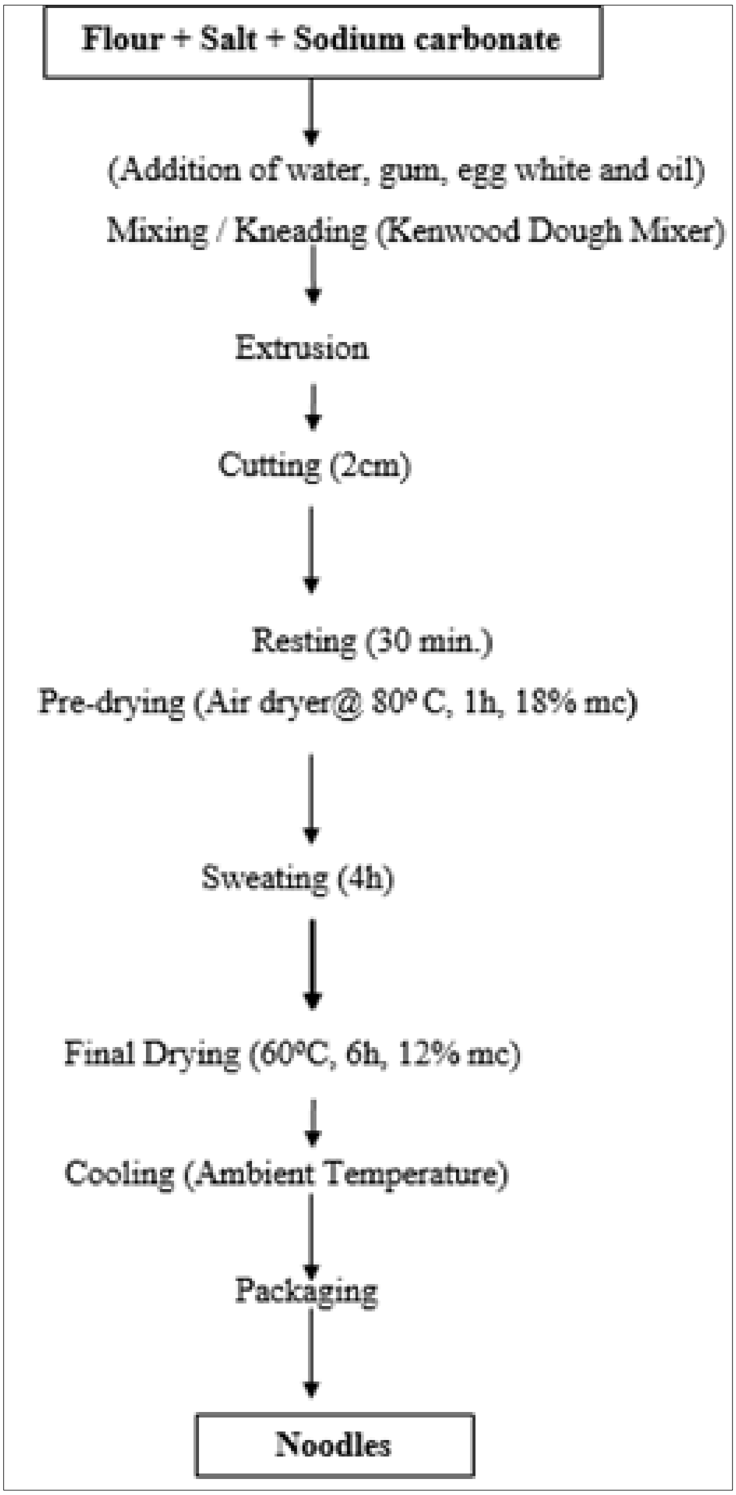


Fig 3: Flow Chart for Noodle Production (Source:) [10-12]

Where
W1 = Weight of Raw noodle W2 = Weight of dried residue

Expansion Ratio Determination
The method of [12] was adopted for expansion ratio determination. The cross section/diameter of the raw and cooked noodles was measures with a pair of Venier calipers as D1 and D2 respectively.

The expansion ratio is as shown:

$$Expansion\ Ratio = \frac{D1}{D2} \quad (3)$$

Rehydration Rate (%) Determination
The method of [16] was used in the determination of rehydration rate**.** Weighed noodles were placed in boiling water (w/v 1:10) and allowed to cook till the optimal cooking time was attained. The noodles were removed, completely drained onto a sieve for 2 min. without shaking and then weighed. The rehydration rate is as shown:

$$Rehydration\ rate\ (\%) = \frac{(W2-W1)}{W1}\ x\ \frac{100}{1} \quad (4)$$

Where:

W1 = Weight of Raw noodles W2 = Weight of Drained noodles

Sensory Evaluation of the Noodles

The cooked noodles were evaluated for taste, appearance, aroma, mouth-feel and overall acceptability (average of the first four parameters) immediately after production by a semi-trained thirty member panellists drawn from the staff and students of Food Science and Technology of The Federal University of Technology, Owerri. A 7-point hedonic scale(7 = very much liked, 6 = moderately liked, 5 = liked, 4 = neither liked nor disliked, 3 = slightly disliked, 2 = moderately disliked,1 = very much disliked) as described by [17, 18] was used.

Statistical Analysis

The data obtained from the different analyses were subjected to statistical analyses such as: simple descriptive mean and standard deviation, Analysis of variance (ANOVA), using General linear Model (GLM) procedure. A comparison test (LSD) was used to separate means where significant differences exist.

Results and Discussions

Cooking Properties of Whole wheat-Sorghum Composite Noodles

The results of cooking properties of the noodles are shown in (Table 2). From the results, the cooking loss of the whole wheat noodle was 1.42% while that of the composite noodles increased from 1.56% to 9.34% as the level of addition of sorghum flour increased from 10% to 40% respectively. Table 2 showed that cooking time of the noodles from wheat flour was 8.08 min. and this significantly reduced with increase in the level of addition of sorghum flour in the noodle formulation. The values increased from 8.05 min to 7.54 min at 10 % and 50% level addition respectively. These results are in agreement with the report of [19] on his production of noodles from wheat-soybean composite noodles.

The whole wheat noodles had the highest cooking yield (98.58%) and this value progressively reduced to 90.66% as the level of replacement with sorghum flour increased to 50 %. Cooking loss however increased as the level of sorghum flour in the noodles increased. The value ranged from 1.42% to 9.34 % with the noodles from the whole wheat flour having the lowest and that from 50% replacement with sorghum having the highest. With the exception of the noodles from the 50% sorghum flour replacement, the cooking loss for all the noodles formulated were within (≤ 9%) the acceptable level [20, 11] in pastas. Cooking loss being the major criteria in the measuring of the quality of noodles is the amount of dry matter in the cooking liquor of an optimally cooked noodle. According to [21], high cooking loss is in an undesirable quality in noodles; it is an indication of high solubility of starch that results to turbidity of the cooking liquor and sticky mouth-feel. According to [22], addition of non-wheat flour in noodle production results to the weakening of gluten network, thereby allowing more solid to be leached out of the noodles during cooking.

Increase in the addition of sorghum flour resulted to significant reduction in the expansion ratio of the noodles. The expansion ratio of whole wheat noodle was 3.26 while that from 50% sorghum supplemented noodles was 2.12. These results were in agreement with the report that substitution of wheat with fibre - rich material resulted in increased cooking loss and reduced expansion ratio [12]. According to them, the reduction in the expansion ratio could be as a result in the decrease in the level of gluten and amylose in the flour blends.

The rehydration rate of the noodles increased with increase in the level of sorghum flour in the blends. The value for the whole wheat noodle was 87.24% while that from 50% sorghum flour supplemented noodle was 99.74%. According to [23], sorghum starch contains more of amylopectin and this could be attributed to the increased solubility of the noodles during cooking leading to increased rehydration rate.

Sensory Attributes of Wheat-Sorghum Composite Noodles

Results in Table 3 showed that the taste, appearance and aroma of all the noodles were acceptable to the panelist while their mouth-feel was not acceptable beyond 30 % inclusion of sorghum flour. Increase in the addition of sorghum flour in the blend significantly ($p \leq 0.05$) increased the level of acceptance of the taste of the noodles. The taste of the noodle from whole wheat flour was rated 6.4 while that from 30% sorghum flour addition was 6.83. The appearance of the noodle from whole wheat flour was rated 5.67 and this value was significantly ($p \leq 0.05$) different from those of the composite noodles which increased to 6.9 (liked very much) with increase in level of sorghum flour inclusion. The increase in the level of acceptance of colour could be associated with the changes in the physical appearance of the composite flour [24]. However, no significant ($p > 0.05$) difference was observed in the appearance assessment of noodles from 20% to 50% sorghum flour inclusion.

The aroma of noodles from the composite flours was more acceptable than for the one from whole wheat flour (6.17). However, as was also observed in taste assessment, beyond 30% inclusion of sorghum flour, the aroma acceptability significantly ($p \leq 0.05$) reduced. According to [20], this could be due to their irregular shape, dilution of gluten, gummy mouthfeel and sorghum characteristics. On the other hand, the rating of the mouth-feel of the noodles from the composite flour (6.27-3.37) were lower than that from the whole wheat flour (6.47).Though increase in the ratio of sorghum flour in the blends resulted to significant ($p \leq 0.05$) reduction in the consumers acceptability of the mouth-feel, the noodles from up to 30% inclusion were all acceptable. The reduction in scores for mouth-feel for noodles from above 30% sorghum flour addition could be related to sticky mouth-feel resulting from reduction in the gluten content of the composite flour [21]. As was observed in the assessment of mouth-feel, increase in the addition of sorghum in the flour blend resulted to significant ($p \leq 0.05$) reduction in the overall acceptability of the noodles; the composite noodles were liked by the panelist. The rating for the whole wheat noodle was 6.27 while that from 50% sorgum inclusion was 5.71. No significant difference existed between the acceptability level of noodles from 10% and 20% sorghum inclusion.

Table 2: Cooking Properties of Whole wheat-Sorghum Composite Noodles

Samples	Wheat: Sorghum	Cooking Time (min.)	Cooking Yield (%)	Cooking Loss (%)	Expansion Ratio	Rehydration (%)
W	100: 0	8.08d	98.58f	1.42a	3.26e	87.24a
WS1	90: 10	8.05cd	98.44e	1.56b	3.23de	89.67b
WS2	80: 20	8.02c	98.36d	1.64c	3.20d	93.23c
WS3	70: 30	8.04c	95.55c	4.45d	2.78c	94.01d
WS4	60: 40	7.95b	93.34b	6.66e	2.50b	95.30e
WS5	50: 50	7.54a	90.66a	9.34f	2.12a	99.74f

Means on the same column with different superscripts are significantly different ($p \leq 0.05$) from each other Keys: W= Wheat S= Sorghum

Table 3: Sensory Attributes of Wheat-Sorghum Composite Noodles

Samples	Wheat: Sorghum	Taste	Appearance	Aroma	Mouth-feel	Overall Acceptability
W	100: 0	6.40a	5.67a	6.17a	6.47e	6.27d
WS1	90: 10	6.73bc	6.37b	6.67c	6.27e	5.83cd
WS2	80: 20	6.77 bc	6.60c	6.73c	5.80d	5.97cd
WS3	70: 30	6.83c	6.70c	6.70c	5.40c	5.77c
WS4	60: 40	6.63abc	6.90c	6.53bc	4.50b	3.83b
WS5	50: 50	6.5a b	6.70c	6.30ab	3.37a	2.40a

Means on the same column with different superscripts are significantly *different* ($p \leq 0.05$) from each other

Conclusion

Noodles with acceptable sensory and cooking characteristics could be produced with inclusion of 1% gum extract from 16 h soaked *D. microcarpum* seeds gums. Noodles produced from beyond 30% inclusion of sorghum flour were not acceptable to consumers. There should be further exploration of the inclusion of *Detarium microcarpum* seed gum in commercial pasta and baked product production.

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