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Quality Evaluation of Noodles Produced from Wheat Flour (*Triticum spp*.), Sorghum Flour (*Sorghum bicolar*) and Pumpkin Seed Flour (*Cucurbita pepo*) Enriched with Eggyolk Powder

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Abstract
This research was carried out to evaluate the quality of noodles produced from wheat, sorghum and pumpkin seed composite flour. The flour and the noodles sample were produced using the standard method. The products were subjected to chemical and sensory analysis. The result obtained showed that the proximate analysis value for protein content increased significantly from 12.36%-14.84%, fiber, fat and energy also increased from 1.33%-2.56% and 14.09%-24.06% and 402.59k/cal-455.25k/cal respectively with an increase in substitution of wheat with sorghum and pumpkin seed, while a decrease in moisture content and carbohydrate from 12.80%-11.40% and 52.89%-45.68%. Calcium, iron, potassium and zinc ranged from 125.68-170.06mg/L, 2.12-3.85mg/L, 308.8-360.5mg/L and 10.58-16.15mg/L respectively. Vitamin A and C ranged from 7.97-8.07µg/100g and 2.64-2.69µg/100g respectively. In conclusion, Sorghum and pumpkin seed can be substituted in noodles production as this would improve noodles' nutrients and variety and reduce dependency on wheat importation.
Keywords: noodles, sorghum, pumpkin, egg yolk, textural properties, mineral, vitamin, proximate, and substitution

Introduction

Noodles are slender strips of unleavened dough which is stretched, extruded or rolled flat and cut into one or variety of shapes (Wikipedia, 2024). Noodles are food made by extrusion process from unleavened dough whose basic ingredients are flour, water and common salt. It is popular in many countries including Nigeria, but is a staple food of Southeast Asia where it originates from. About 40 % of the total wheat produced in the Asian countries are used in production of noodles (Ojure and Kadiri, 2012). The dough is passed through steel rollers after mixing to make it into a flat sheet of desired thickness and then cut into thin strips (Shere *et al*., 2018). The common type of noodles are wet or boiled noodles ("Hokkien style"), fresh noodles ("Cantonese" style), dried noodles, raw noodles that contain egg (wonton or wantan) and instant noodles (Chin *et al.,* 2012). Among the various types of noodles, the "instant" types continue to be popular as it is easier to prepare, more economical and tasty (Akanbi *et al.,* 2011).

Noodles is an important and popular food commodity worldwide. In 2018, 103.620 million servings was reported by the World Instant Noodles Association as the noodles consumed worldwide (World Instant Noodle Association, 2019). According to Food and Agricultural Organization (FAO, 2009) the world would require an estimate of 840 million tons of wheat by 2050 from its current production level of 642 million tons, in order to meet this demand, developing countries need to increase their production level by 77 %. Importation of wheat has led to incredible drain on the economy of Nigeria, leading to the underutilization of indigenous cereals, thereby causing poverty (Dambazau *et al.,* 2021). To tackle the high cost of wheat importation on the economy, the Federal Government mandated flour mills to partly or wholly substitute wheat flour (Ammar *et al*., 2009). The adoption of this policy brought about the production of food products using different composite flours. Other cereals and legume flours can be used to complement wheat flour and also enhance the nutrient content of noodles thereby decreasing the importation of wheat flour (Onwurafor *et al*., 2020). Noodles sometimes are made with composite flour to improve certain properties of the product. Composite flour is a combination of different flours produced from tubers, cereals, and legumes without or with the addition of wheat flour (Shittu *et al*., 2007). The fundamental components of noodles are flour, water, and salt. Consequently, noodles are high in carbohydrates and fats, however, they lack the essential nutrients required in the human diet, which includes; fiber, vitamins, and minerals, and are therefore regarded as unhealthy.

However, this research tends to evaluate noodles produced from wheat flour, sorghum and pumpkin seed enriched with egg yolk powder.

Materials and Method

Sources of Raw Material

High grade quality Sorghum (*Sorghum bicolar*) and pumpkin (*Cucurbita pepo*) was gotten from a local market in Dutsin-ma, Katsina State. The wheat flour, guar gum and eggs were gotten from ABIS supermarket in Dutsin-ma local government area of Katsina State. Equipment, other chemicals (reagents) and facilities were of analytical grade and were acquired from the Department of Food Science and Technology, Federal University Dutsin-ma, Katsina State, Nigeria.

Preparation of the composite flours

Wheat, sorghum and pumpkin seeds were prepared and blended into composite flour for the production of noodles, these were enriched with egg yolk powder. The flours were then blended into different percentages and coded as follows: WSP1= 80 % wheat, 10 % sorghum, 5 % pumpkin seed, 5 % egg yolk; WSP2= 70 % wheat, 15 % sorghum, 10 % pumpkin seed, 5 % egg yolk; WSP3= 60 % wheat, 20 % sorghum, 15 % pumpkin seed, 5 % egg yolk; WSP4= 50 % wheat, 25 % sorghum, 20 % pumpkin seed, 5 % egg yolk.

Determination of Proximate Composition

The noodles samples were analyzed for moisture, ash, protein, crude fibre, crude fat and carbohydrate content according to the method described by the Association of Official Analytical Chemist (AOAC, 2016).

Determination of Mineral and Vitamin Composition

The mineral content of the products were determined using methods described by AOAC (2012), for Calcium (Ca), Potassium (K), Zinc (Zn) and Iron (Fe) while Vitamin A and Vitamin C was determined by the method described by Okwu (2004).

Determination of Textural Properties

Textural properties analysis was achieved following the technique described by Hou GG (2010) via a texture analyzer.

Sensory Evaluation of Chin Chin

Twenty (20) semi-trained panelists was selected among the students from the department of food science and technology, Federal University Dutsin-ma (FUDMA). They analysed the quality attributes of the cooked noodle samples such as the mouth feel, taste, texture, aroma colour and general acceptability using a 7-point hedonic scale anchored by: 1 = 'Strongly disliked'; 2 = 'Moderately disliked'; 3 = 'Slightly disliked'; 4 = 'Indifferent'; 5 = 'Slightly liked'; 6 = 'Moderately liked' and 7 = 'Strongly liked' (Granato *et al*., 2010).

Statistical Analysis

Data from the result were subjected to analysis of Variance (ANOVA) using Statistical Package for Social Sciences (SPSS) version 20 software and Duncan multiple range test was used to compare the means.

Results and Discussion

Proximate composition of noodles produced from wheat, sorghum and pumpkin seed flour blends

Table 1 shows the result of the proximate composition of the noodles produced from wheat, sorghum and pumpkin seed flour blends. The moisture content of the noodles ranges from 11.40 % to 12.80 % with sample WSP4 having the least value (11.40%) while sample WSP1 had the highest value (12.80%). Moisture content is a crucial factor in determining food quality and preservation, it is an important parameter used in determining microbial growth and hence estimating the shelf life of the noodles. The moisture content decreases with increase in the substitution of wheat in the composite flour, although, there was no significant difference ($p<0.05$) between the samples. The increasing trend in the result corroborated with Akajiaku *et al.,* (2017) which shows increase in moisture with increase in substitution of wheat flour with sorghum, this increase may be due to the packaging material used or the initial moisture content of the composite flour before production. The Ash content of the noodles ranges from 2.29 % to 3.50 %. Sample WSP2 had the least values (2.29%) while Sample WSP4 had the highest value (3.50%). The differences in their ash content could be attributed to the difference in composition of sample. Ash content indicates the quantity of mineral content in food substance (Nasiru *et al*., 2020; Onwuka, 2005). The ash result obtained was similar to that of Kiin- Kabari and Eke- Ejiofor (2013). The fat content of the noodles ranges from 14.09 % to 24.06 %. Sample WSP1 had the least values (14.09%) while sample WSP4 had the highest value (24.06%) respectively. The fat content of the noodles samples was augmented with increase in the substitution of wheat flour. The increase in fat content of noodles with substitution of composite flour was in line with that observed in Adebowale *et al*., (2012) and Omeire *et al*., (2014) report. The upsurge in fat content may be due to the increase in the composition of pumpkin seed, according to The United States Department of Agriculture National Nutrient Database (2019), 100g of pumpkin seed contains 21.43 g of fat. The increased fat in the samples is an indication of higher energy supply from the product due to substitution with pumpkin (Nasiru *et al*., 2020). Product with high fat content promotes rancidity, responsible for off flavor and odor leading to food spoilage (Smith and Smith, 2016). Also, ingesting of fatty foods may result to obesity and other ill health conditions. The protein content of the noodles ranges from 12.36 % to 14.84 %. Sample WSP1 had the least value (12.36%) while sample WSP4 had the highest value (14.84%). The protein content of the samples increased as the percentage of pumpkin seed incorporated into the sample increased, this increase in protein is in agreement with that of Rani *et al*., (2019). It was perceived that the protein content was lower than the carbohydrate content but the results of the protein content are similar to that postulated (12 %) by Effiong *et al*. (2009). The protein percentage is high enough to avert protein energy malnutrition (PEM) for those who depend on this meal for protein. From the result, the fiber content ranges from 1.33 % to 2.56 %. Sample WSP1 had the least value while sample WSP4 had the highest value. Dietary fiber is very important in prevention of constipation, reducing of blood sugar, defense against heart diseases and prevention of certain forms of cancer (Rajpurohit, 2018). Crude fiber improved with increase in substitution of sorghum and pumpkin seed, this corroborates with the increasing trend earlier recorded by Adebayo *et al*., (2018). The report of Akajiaku *et al.,* (2019) pointed a decrease in percentage crude fiber with increase in substitution of sorghum with wheat flour. The differences in crude fiber content could be due to the differences in composition of the samples. The carbohydrate content of the noodles samples ranges from 45.68 % to 55.53 %. Sample WSP4 had the least value while sample WSP1 had the highest value. Carbohydrate content decreases with an increase in sorghum and pumpkin seed. This trend was observed by Akajiaku *et al.,* (2019) as increase in substitution of sorghum flour with wheat increased the carbohydrate content of sorghum-wheat noodles. The reduction could be due to the low carbohydrate content of pumpkin seed which leads to increase in protein content of the noodles.

Mineral and Vitamin composition of noodles produced from wheat, sorghum and pumpkin seed flour blends

The calcium content of the noodles ranges from 125.68 mg/L to 170.06 mg/L. The calcium content of the samples increase with increase in the substitution of wheat with sorghum and pumpkin seed composite flour, this is due to the fact that pumpkin seeds are good source of mineral and it has a higher calcium content compared to wheat flour. Calcium is essential for growth, development and repair of bones and teeth to maintain electrochemical balance that allows muscle to contract neurons to transmit impulse. Calcium is also associated with the synthesis of vitamin D and also with the development of teeth and bone (NIH, 2022). The iron content of the noodles ranges from 2.12 mg/L to 3.85 mg/L. sample WSP1 had the least value while sample WSP4 had the highest value for iron content. The iron content increased with increase in the substitution of wheat with sorghum and pumpkin seed composite flour. The increase in iron content can be attributed to the increased fraction of sorghum which is higher in iron content compared to wheat flour. Iron supports the formation of blood and also assists in the transmission of oxygen and carbon dioxide from one nerve to another. Inadequate quantity of iron results in anemia which interferes with muscle metabolism leading to reduced learning ability and behavioral problems in children. The potassium content of the noodles ranges from 308.8 mg/L to 360.5 mg/L. The potassium content increased with increase in the substitution of wheat with sorghum and pumpkin seed composite flour. The increase in potassium content can be attributed to the increased proportion of pumpkin seed which is a rich source of potassium. The zinc content of the noodles ranges from 10.92 mg/L to 16.15 mg/L. Sample WSP2 had the least value while sample WSP4 had the highest value. The zinc content increased with increase in the substitution of wheat with sorghum and pumpkin seed composite flour. The increase in zinc content can be attributed to the increased proportion of pumpkin seed which are a good source of mineral. Zinc is essential for immune and overall health. The increasing trend in mineral content which are iron, zinc, potassium and calcium with pumpkin seed substitution was also reported in the study of Kumari *et al*., (2020) and Hussain *et al*., (2022). The vitamin A content ranged from 7.93 to 8.07%, indicating that sample WSP1 had higher vitamin A content than others. While the vitamin C content ranged from 2.64 to 2.69 exhibiting no significant difference between the samples.

Textural characteristics of noodles produced from wheat, sorghum and pumpkin seed flour blends

Texture analysis is the main benchmark for measuring overall food quality of cooked noodles (Manthey and Dick 2012). From the result, the hardness ranges from 20718.50 g to 9597 g, with noodles produced from 50 % wheat, 25 % sorghum and 20 % pumpkin seed flour blend having the highest value and that produced from 80 % wheat, 10 % sorghum and 5 % pumpkin seed having the lowest value. The addition of sorghum and pumpkin seed flour resulted in a substantial change in the hardness as it increases progressively with increase in the substitution of wheat with sorghum and pumpkin seed. Similar increasing trend was seen in noodles produced by Xu J *et al*., (2020) which was enriched with apple pomace. Sorghum is rich in fiber just like apple pomace and could be the reason for the improved noodle hardness. However, this report did not corroborate with Makhlouf *et al.* (2019), who recounted lower firmness or hardness for fiber-enriched formulations. Ma D *et al*., 2009 reported positive effect of protein content on the hardness of cooked noodles. Springiness refers to how quickly a noodle returns to its original shape after being compressed. The value of the result obtained ranged from 0.68 to 0.36 with WSP1 (80 % wheat, 10 % sorghum and 5 % pumpkin seed) having the highest and WSP 4 (50 % wheat, 25 % sorghum and 20 % pumpkin seed) having the least value. There was no significant difference ($p > 0.05$) among the samples, although the value decreases with increase in substitution of the composite flour. This is attributed to inadequate gluten content in sorghum and pumpkin seed flour. Similar trend was observed in the report of Orlu *et al*., (2022) on noodles produced from wheat-plantain flour. Gumminess refers to the measure of stickiness when chewing the noodles. The value obtained from the result ranged from 14743 to 5475.50 with WSP4 as the highest value while WSP1 (80 % wheat, 10 % sorghum and 5 % pumpkin seed) the least. There was no substantial difference ($p > 0.05$) in the gumminess of the noodles. The increase in gumminess with increase in sorghum and pumpkin seed may be because they lack some elastic as gluten. The increasing trend corroborate with the reports from the substitution of wheat flour with plantain flour by Orlu *et al*., (2022) and substation with unripe banana flour by Ritthiruangdej *et al*., (2011). Resilience measures the ability of noodles to return to their original shape after deformation. The value obtained ranges from 0.68 % to 0.35 %, with WSP1 having the highest and WSP4 the least value. There was no significant difference (p> 0.05) among the samples although the resilience decreases with increase in the proportion of sorghum and pumpkin seed flour, this could be due to poor gluten network. Similar trend was observed in the report of Orlu *et al*., (2022) on noodles produced from wheat-plantain flour.

Adhesiveness refers to how noodles stick together or to the palate. The value for adhesiveness ranges from 0.46 to 0.71, with WSP4 (50 % wheat, 25 % sorghum and 20 % pumpkin seed) having the highest value and WSP1 (80 % wheat, 10 % sorghum and 5% pumpkin seed) the least value although there was no significant difference (p> 0.05). Adhesiveness increases with increase in substitution of sorghum and pumpkin seed flour. Cohesiveness measures how well the component of the noodles stick together, it specifies the strength of internal bonds in the noodle samples (Trinh and Steve 2020). The value ranged from 0.71 to 0.33 with WSP1 as the highest value while WSP4 had the least value. There was no significant difference (p> 0.05) among the samples. Although the value for cohesiveness decreased with increased substitution of sorghum and pumpkin seed flour, this may be due to lack of gluten in sorghum and pumpkin seed. There was no substantial difference (p> 0.05) among the samples for chewiness as the values obtained ranged from 9445.50 to 3966, with WSP 1 as the highest value of and WSP4 as the least. Chewiness decreases with increase in ratio of sorghum and pumpkin flour for wheat substitution. This may be because of the decrease in gluten content as gluten content provides elasticity and chewiness to noodles. These trends corroborate with the reports of Orlu *et al*., (2022) and Ritthiruangdej *et al*., (2011) who substituted wheat flour with plantain flour and unripe banana flour respectively.

Sensory analysis of noodles produced from wheat, sorghum and pumpkin seed flour blends

The mean score of the sensory properties which includes taste, aroma, color, mouth feel /texture and general acceptability are shown in Table 4. From the result, there was significant different (p<0.05) in the samples. Color is an important organoleptic property because it influences the decision of its consumer. The value for the color ranges from 3.70% to 5.70% with WSP1had the highest value while WSP4 had the least value. The variation in color may be attributed to the increase in the fraction of sorghum and pumpkin seed flour added as the acceptability noodles color decreased as the fraction increased. The value for the taste of the various sample of noodles ranges from 3.30 % to 4.85 %, with WSP1 had the highest value of 4.85 % and WSP4 with the lowest value of 3.30 %. The disparity in taste could be attributed to discrepancy in noodles composition (Anggraeni *et al*., 2018) There was significant different (p<0.05) in the samples. For aroma, there was no significant difference between all samples of noodles. The value recorded for aroma ranges from 5.30 % to 4.50 %, with WPS1 having the highest value while WPS3 recorded the lowest value of 4.50 %. The value for mouth feel ranges from 4.85 % to 3.35 % with WPS1 having the highest value of 4.84 %, while WPS4 (50 % wheat, 25 % sorghum and 20 % pumpkin seed) recorded the lowest value of 3.35 %. The value for texture ranges from 5.00 % to 3.00 % with WPS1 as the highest with a value of 5.00 %, while WSP4 recorded the lowest value of 3.00 %. There was no significant alteration in the four samples. The relatively low texture score obtained as sorghum and pumpkin seed flour increased was probably due to the intrusion of composite flour in gluten development. The overall acceptability shows that WSP1(80 % wheat, 10 % sorghum and 5 % pumpkin seed) which recorded a value of 5.50 % is most preferred followed by WSP2(70 % wheat, 15 % sorghum and 10 % pumpkin seed) with a value of 4.70 %, then WSP3 (60 % wheat, 20 % sorghum and 15 % pumpkin seed) with a value of 4.35 % and WSP4 (50 % wheat, 25 % sorghum and 20 % pumpkin seed) which recorded 3.40 % was the least preferred. The samples fluctuated significantly (p<0.05) from each other. General acceptability decreases with increase in replacement of wheat with composite flour, this may be due to the fact that panelists are used to 100 % wheat noodles. The decreasing trends in sensory attributes of the noodles corroborate with the reports of (Chepkosgei and Orina, 2021), who substituted wheat flour with soy-carrot and that of Akajiaku *et al*., (2017) who substituted it with sorghum flour.

Conclusion

The study reveals that noodles with higher percentage of sorghum and pumpkin seed significantly increased some nutrient such as fat, protein, fiber and energy, there was a decrease in carbohydrate and in the moisture content which is of an advantage as it gives product good keeping quality. Increase in substitution of wheat with flour blend of sorghum and pumpkin seed increased the mineral content of the noodles but a decrease in vitamin content was observed, the cooking time of the noodles increased from 6:55 min to 7:19 minutes, while the water absorption increases, the cooking loss and cooking yield decreased. Hardness, adhesiveness and gumminess increased while chewiness, resilience, cohesiveness and springiness reduced with increase in flour blend substitution. Sensory evaluation result shows that noodles with higher percentage of sorghum and pumpkin seed had low sensory acceptability.

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Table 1: Proximate composition of noodles produced from wheat, sorghum and pumpkin seed flour blends

Properties	WSP1	WSP2	WSP3	WSP4
Moisture (%)	12.80±0.80[a]	12.11± 1.10[a]	11.42±0.13[a]	11.40±0.08[a]
Ash (%)	3.11±0.17[ab]	2.29±0.25[b]	2.48±0.61[ab]	3.50±0.41[a]
Fat (%)	14.09±0.58[c]	17.52±0.68[b]	22.72±1.10[a]	24.06±1.32[a]
Protein (%)	12.36±0.71[b]	13.48±0.69[ab]	14.00±0.31[ab]	14.84±0.71[a]
Fiber (%)	1.33±0.14[b]	1.36±0.12[b]	2.23±0.15[a]	2.56±0.15[a]
Carbohydrate (%)	52.89±0.81[a]	55.53±0.72[a]	46.33±2.41[b]	45.68±1.39[b]
Energy (k/Cal)	402.59±5.71[c]	418.64±0.06[b]	449.12±3.13[a]	455.25±5.15[a]

Values are mean ± standard deviation of duplicate determination. Mean with different superscripts in the same row are significantly different (p<0.05).

KEY:

WSP1= 80 % wheat, 10 % sorghum, 5 % pumpkin seed, 5 % egg yolk

WSP2= 70 % wheat, 15 % sorghum, 10 % pumpkin seed, 5 % egg yolk

WSP3= 60 % wheat, 20 % sorghum, 15 % pumpkin seed, 5 % egg yolk

WSP4= 50 % wheat, 25 % sorghum, 20 % pumpkin seed, 5 % egg yolk

Table 2: Mineral and Vitamin composition of noodles produced from wheat, sorghum and pumpkin seed flour blends

SAMPLES	Calcium (mg/L)	Iron (mg/L)	Potassium (mg/L)	Zinc (mg/L)	Vitamin A (µg/100g)	Vitamin C (µg/100g)
WSP1	125.68±0.14[c]	2.12±1.25	308.8±0.04	10.92±0.01	8.07	**2.69**
WSP2	145.39±0.13[b]	2.53±0.01	340.9±0.07	10.58±0.01	8.02	**2.66**
WSP3	145.58±0.14[b]	3.36±0.41	344.0±0.06	14.10±0.21	7.97	**2.64**
WSP4	170.06±0.04[a]	3.85±0.01	360.5±0.03	16.15±0.03	7.93	**2.67**

Table 3: ***Textural characteristics of noodles produced from wheat, sorghum and pumpkin seed flour blends***

Treatment	WSP1	WSP2	WSP3	WSP4
Hardness (g)	9795.00±0.49[b]	13096.50±0.49[ab]	14481.51±0.51[ab]	20718.50±0.48[a]
Springiness (%)	0.68±0.13	0.64±0.12	0.50±0.26	0.36±0.09
Gumminess	5475.50±0.58	6496.50±0.12	7426.00±0.59	14743.00±0.53
Resilience (%)	0.68±0.34	0.48±0.02	0.43±0.03	0.35±0.00
Adhesiveness(g.s)	0.46±0.62	0.52±0.07	0.51±0.27	0.71±0.12
Chewiness	9445.50±0.95	4432.00±0.48	4075.50±0.19	3966.00±0.23
Cohesiveness (%)	0.71±0.04	0.50±0.04	0.54±0.10	0.33±0.18

Table 4: Sensory analysis of noodles produced from wheat, sorghum and pumpkin seed flour blends

Properties	WSP1	WSP2	WSP3	WSP4
Color	5.70±0.80[a]	4.80±0.76[b]	4.25±1.37[bc]	3.70±1.59[c]
Taste	4.85±1.42[a]	3.95±1.19[ab]	4.25±1.61[a]	3.30±1.26[b]
Aroma	5.30±1.12[a]	4.70±1.08[a]	4.50±1.39[a]	4.65±1.42[a]
Mouthfeel	4.85±1.22[a]	4.30±1.12[a]	4.05±1.66[ab]	3.35±1.53[b]
Texture	5.00±1.58[a]	4.30±1.38[a]	4.10±1.33[a]	3.00±1.41[b]
General acceptability	5.50±1.43[a]	4.70±1.21[ab]	4.35±1.50[b]	3.40±1.57[c]