Quality evaluation of pasta produced from wheat-african yam beans flour blends

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Abstract: Fortification of pasta which is largely energy rich food with moderate amount of protein and minerals will provide a meal with adequate nutrients dense product. Quality evaluation of pasta produced from wheat and African Yam Beans, AYB, flour was evaluated. AYB was processed into flour and blended with wheat flour in ratio of 100:0, 85:15, 80:20, and 75:25 to give four samples. Proximate composition, functional properties, minerals profile, antinutritional factors, and sensory properties of "macaroni", a pasta product produced from the blends were determined using standard methods. The result of proximate composition showed that values for moisture content, protein, fat, fibre, ash, and carbohydrate ranged from 9.33 – 9.89%; 8.94 – 14.39%; 3.59 – 5.08%; 2.34 – 2.38%; 1.35 – 1.47%; and 67.09 – 74.43%, respectively. Water absorption capacity and oil absorption capacity significantly ($p<0.05$) increased compared to control (WTA) sample as a result of legume addition which enhance trapping of water in wheat flour starch mesh. Swelling power decreased significantly as AYB substitution increase, while solubility index increased significantly compared to WTS sample. Least gelation concentration shows no significant differences among samples except sample with 25% AYB substitution. Percentage amylase inhibitor decreased as AYB substitution increase in the samples, while trypsin inhibitor increased vice-versa. Sensory attributes result showed that samples with 20% AYB inclusion level is most accepted, apart from whole wheat flour "macaroni". Results obtained in this study shows that pasta made with 20% AYB flour will enhance pasta nutrition density and sensory attributes.

[Olayinka, R. Karim Prof, Akinjide O. Akinsola PhD, and Grace O. Akanbi PhD. **Quality evaluation of pasta produced from wheat-african yam beans flour blends.** *Nat Sci* 2018;16(11):149-157]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 20. doi:10.7537/marsnsj161118.20.

Keywords: African yam beans, fortification, macaroni, nutrient dense product, pasta, sensory attributes

1. Introduction

Pasta is generally becoming a staple food in developing countries, and is typically made from unleavened dough of durum wheat flour mixed with egg or water and formed into sheets or various shapes, then cooked by steaming or boiling, and can also be made with flours from other cereals or grains (Gapalakrishman *et al*., 2011). Durum wheat is considered the best material for making high quality pasta products due to its unique gluten protein presence. Gluten is considered to be most significant factor related to wheat flour cooking and pastry quality, because it contain gladin and glutenin which are responsible for its elasticity and chewability, this in turn make wheat inevitable in pasta production (Animasahun et al., 2017). Pasta is a good source of low glycemic index (GI) carbohydrates, a tight network of gluten proteins which entrap starch granules during the mixing and extrusion process which is very important in the formation and rheology of the dough, and it is the main determining factor of the pasta cooking quality (Gimenez *et al.,* 2013; Sissons *et al.,* 2007). Extrusion cooking of starchy materials had become a widely used technique to obtain a wide range of product such as snacks, breakfasts, cereals, special flours (Kuuku and Beta, 2014; Bruneel *et al.,* 2010; Cocci *et al*., 2008). Research has shown that cereal protein is deficient in two important amino acids (lysine and trytophan), but very rich in legume.

Fortification of cereal grains with various plant proteins such as African yam bean flour will enhance the nutritional quality of its products. African yam bean (AYB) is tuberous legume producing both tubers and seed, and among underutilized legume grown in West Africa. Adewale and Odoh (2013) reported that it is the most important and prominently used tuberous legume in Africa; well ranked among the neglected crops and can reduce the problem of food insecurity in Nigeria and Africa (Adewale *et al*. 2012). AYB is classified as an underutilized legume because of lack of adequate information on its composition and utilization rather than shortage (Adebowale *et al*., 2009; Balogun and Fetuga, 1986). Underutilized legumes would contribute immensely to food security in a many ways, due to increasing demand for plant proteins in lieu of expensive animal protein (Adebowale *et al*. 2009). It is imperative therefore that incorporation of different food ingredients into pasta could increase the nutritional value of its products; but at the same time when pasta dough is fortified with others than traditional raw materials, such as cereals, it behaves differently (Petitot *et al*., 2010; 2009; Sadehi and Bhygya, 2008). There is dearth information on the application of extrusion cooking on processing of wheat-AYB, hence a need to explore the possibility of applying extrusion cooking for creating diversified increased consumption in AYB. Therefore, the aim of the study was to examine the quality evaluation of pasta produced from wheat and African yam bean flour blends.

2.0 Materials and Methods

2.1 Materials

The raw materials (wheat flour, salt, egg and vegetable oil) used for this study were purchased at Ajegunle market, Oyo, Oyo State, while African yam beans were obtained from the experimental farm of Federal Polytechnic, Offa, Nigeria.

2.2 Preparation of African yam beans (AYB) flour.

The Africa yam beans, after removing particles and defective seeds were thoroughly washed in clean water. The seeds were boiled for 30 min, drained, cooled and dehulled by hands rubbing within two palms, after which the Africa yam beans cotyledon were dried in a Genlab drying cabinet (Model: DC 500; Serial number: 12B154) at 60±5 °C for 48 hr, winnowed and milled in a laboratory hammer mill (Fritsch, D-55743, Idar-oberstein-Germany). The sample was then sieved using 250 µm screen, packed, and store at room temperature (28 ± 2 ^{o}C).

2.3 Preparation of the extruded composite pasta samples

Two hundred gram of each sample was weighed; 30g of carbon methyl cellulose, a pinch of salt was added to the weighed flour, mixed thoroughly. One egg was beat inside the mixture and it was also mixed thoroughly. The required quantity of water of about 50 to 60 mL was added, mixed thorough with 10 to 15 mL of oil to form dough. The dough was poured in an already oiled nylon and cooked for 15 min. The hot dough was kneaded immediately in a kneading machine, and pass through an extruder machine of small opening by taking advantage of pressure differential that exist between the internal and exterior of the chamber. The machine cut it shapes to the desired, and oven dry at 58 ^{o}C for 30 min. Each of the sample extrudates was cooked; keep for further analysis in tight polyethene nylon.

2.4 Pasta formulation

The formulations of composite flour were done according to the method of Islam *et al*., (2011) with slight modification. AYB flour was mixed with wheat flour in the proportion of 100%, 85:15, 80:20, and 75:25%, and coded as sample A, B, C, and D Each sample were blended using a Kenwood mixer (Model: HC 750D, Kenwood, UK) to produce sample A - D. Sample A served as control and contained 100% wheat flour. Sample B, C, and D consist of wheat flour, AYB flour. Other ingredients for were added equally for the pasta production as shown in Table 4 below, and a pasta-making machine [model: Dolly Mini P3, Italy] was used in this study in which relatively dry dough is forced into the holes in the die under pressure of approximately 6895 kpa. The extruded product from a twines were cut into uniform size, steamed for 3 min, and dried at 60 ^{o}C for 8 hr using hot air oven (Model: Genlab, DC 500; Serial number: 12B15). It was then allowed to cool, and packed in low density polythene nylon for further uses.

Table 1: Wheat-AYB pasta formulation

PARAMETER, %	WTS	WAS	WYS	WBS
Wheat flour	100	85	80	75
AYB flour	00	15	20	25
Water	10	10	10	10
Egg	20	20	20	20
Salt	02	02	02	02
Vegetable oil	06	06	06	06

Islam *et al*., (2011) adapted.

2.5 Chemical composition of the pasta samples

The proximate analysis (moisture content, protein content, ash content, fat content and crude fiber) of the samples were analyzed according the official methods of analysis described by the Association of Official Analytical Chemist (2005), while carbohydrate was calculated by differences.

2.6 Functional properties of the pasta samples

Bulk density of the samples were determined according to Wondimu and Malleshi (1996) method, while oil and water absorption capacity of each sample was determined using the method described by Beuchat (1977). The swelling power and solubility index of each sample was determined as described by Leach *et al*. (1959), while the method described by Kulkarni *et al*. (1991) was adopted for dispersability determination. Least gelatinization concentration was determined according to the method of Onwuka (2005).

2.7 Mineral profile of the pasta samples

The mineral element determination was carried out as described by AOAC (2005) method using an inductively-coupled plasma atomic emission spectrometer (ICPAES, USA, TL6000 Model).

2.8 Antinutritional factors of the pasta samples

The method of Maga (1983) was used to determine phatate of the samples, while total phenols were determined as described by Sofowora (1993) method. The amylase inhibitor activity was determined using the method described by Figueira *et al*. (2003), while trypsin inhibitor activity of the samples was determined by the method of Kakade *et al*. (1977) using casein as substrate. The total oxalates of the samples were quantified according to the procedure of Fasset (1996).

2.9 Sensory attributes of the pasta samples

The method described by Iwe (2002) was used. The sensory panelists consisted of 50 consumers who are familiar with whole wheat pasta products. They were asked to rate the products in terms of colour, appearance, aroma, taste, texture, flavour, crispness and overall acceptability using a 9-point Hedonic scale (1=dislike extremely, 5= neither like nor dislike, 9= like extremely).

2.10 Statistical analysis

All data were statistically analyzed using SPSS version 21.0 for analysis of variance, while Duncan multiple range test (DMRT) was used to separate means where there is a significant difference. For each sample, triplicate determinations were carried out.

3.0 Results and Discussion

3.1 Proximate composition of wheat-AYB pasta samples

Proximate composition of wheat-AYB flour blends was as shown in Table 1. Statistical difference ($p<0.05$) was observed in the proximate composition of the blends, except in moisture content. The moisture content of the sample ranged from 9.33% in control sample to 9.89% in 20% AYB substitution. Moisture content is an indicative of dry matter and good storage ability of the samples. The moisture content of the samples were within the acceptable limit of not more than 10% suggested for long term storage of flour by Onimawo and Akubor (2012). Moisture content is a universal solvent that dissolves other substances, carries nutrients and carry various materials round the body for optimal function of organs (Okeke and Adaku, 2009). Moisture contents are valuable parameter in preservation of food materials. The lower the moisture content of the samples, the lower the growth of mould and other biochemical activities, hence the better its keeping quality. Protein content of the samples ranged from 8.94 – 15.34%. The increase in protein quality of the samples may be due to the addition of AYB flour which is very rich in protein and crude fibre by complementing the wheat flour protein. Protein is an important characteristic in organoleptics properties of food (Aremu *et al*., 2006), boost immune system and play a key role in cell formation and growth (Soetan, 2017; Okeke *et al*., 2008). The fat content ranged from 3.59% in WTS sample to 4.61% in WBS sample. Fat, according to Soetan (2017) are needed for insulation and protection of vital organs and hormone production. Lipids provide very good sources of energy and aids in transport of fat soluble vitamins (ADEK), insulate, protects internal tissues, and contributes to important cell processes (Pamela *et al*., 2005).

The crude fibre of all the samples ranged from 2.34% (WBS) to 2.38% (WAS). The result is lower than that of Soetan (2017), but higher that of Adeyeye *et al*. (1999) who reported crude fibre values of 1.61 – 2.38% in their study. Dietary fibre, as reported by Soetan and Olaitan (2013) has numerous medical importance like lowering blood cholesterol; maintain blood sugar level, and helps in reducing body weight. Ash content of the sample which is an indication of their mineral content was in accession and ranged from 1.35% in WTB to 1.59% in WBS sample. Soetan (2017) reported that dietary ash is useful in maintaining acid-base balance of the body. Carbohydrate content of the samples, a source of energy and other biochemical activities in the body ranged from 66.49% in WBS sample to 74.43% in control (WTS) sample. This shows that that the blends will be a good source of energy, and other biochemical activities needed by the body for its would be consumers.

Table 1: Proximate composition of wheat-AYB pasta samples

PARAMETER, %	WTS	WAS	WYS	WBS
Moisture content	9.33±0.13	9.42±0.02	9.89±0.14	9.63±0.12
Crude protein	8.94±0.04	12.20±0.11	14.36±0.03	15.34±0.05
Crude fat	3.59±0.11	3.89±0.13	4.17±0.07	4.61±0.03
Crude fibre	2.36±0.00	2.38±0.01	2.35±0.00	2.34±0.01
Ash	1.35±0.01	1.41±0.02	1.48±0.10	1.59±0.00
Carbohydrate	74.43±0.32	70.70±0.04	67.75±0.13	66.49±0.15

Mean values with different superscripts within the same row are significantly different at $p<0.05$.
WTS = 100% wheat flour, WAS = wheat flour enriched with 15% AYB, WYS = wheat flour enriched with 20% AYB, WBS = wheat flour enriched with 25% AYB.

3.2 Functional properties of wheat-AYB pasta samples

Table 2 shows the functional properties of the wheat-AYB pasta samples. There was no significant difference ($p<0.05$) in the bulk density of the blends. This may be due to the fact that all the sample blends were sieved through a 250 µm mesh to obtain fine flour for the pasta production. Bulk density is an indication of particle size and starch structure of the raw materials used. Low bulk density could be an advantage in foods where high nutrients density is desire, and it is also an indication of packaging convenience and handling of finishing product. Water absorption capacity, WAC and oil Absorption capacity, OAC of all the samples significantly increase from 7.91 – 10 04 g/cm^3 and 3.86 – 5.30 g/cm^3, respectively. WAC is the ability of flour to absorb water and swell for improved consistency in food, it is desirable in food systems to improve yield, consistency, and give body to the food (Osundahunsi *et al*., 2003).

The high WAC observed in the samples could be due to the high protein content of the blends with the addition of processed AYB flour, which has high affinity for water molecules. It has been suggested that flours with such high water absorption capacity as seen in this study will be very useful in bakery products, as this could prevent staling by reducing moisture loss (Yusuff *et al*., 2008), while OAC is attributed mainly to the physical entrapment of oils by the samples, and it is an indicator of the rate at which the protein binds to fat in the food formulation (Singh *et al*., 2005). Swelling power of the samples ranged from 2.73 g/cm^3 in WTS sample to 2.94 g/cm^3 in WAS. There was significant difference between the samples. Decrease in swelling power was observed as AYB substitution increased, except for sample with 15% ATB substitution. Moorthy and Ramanujam (1986) reported that the swelling capacity of flour granules is an indicator of the extent of associative forces within the granule. This also explains the amount of water needed to change a given amount of flour from its powered form to its viscoelastic form (Daramola and Osanyinluyi, 2006).

Swelling and water absorption capacities are important parameters which ultimately determine sample consistency and are dependent on the compositional structure of the sample (Ayo-Omogie and Ogunsakin, 2013). In terms of Solubility, values ranged from 0.39 g/cm^3 in WTS to 0.61 g/cm^3 in WBS sample. The increase in the solubility of the sample blends might be due to increase in the protein content of the flour blends. Solubility is an index of protein functionality such as denaturation and its potential applications (Omueti *et al*., 2009). The result of this study is however in agreement with the work of Omueti *et al.* (2009) titled "Solubility of complementary diets developed from soybean, groundnut and crayfish". Least gelation concentration, the lowest protein concentration at which gel remains in the inverted tube, ranged from 62.50^{o}C to 64.25^{o}C in WTS/WAS and WBS samples, respectively. It was observed that there was no significant differences ($p<0.05$) in gelation temperature as AYB substitution increase, except in 25% AYB substitution. Mbaeyi *et al*. (2013) is of the opinion that this might be due to break down of starch into high amount of amylose and amylopectin molecules as well as protein hydrolysis during various processing methods employed.

Table 2: Functional properties of wheat-AYB pasta samples

PARAMETER	WTS	WAS	WYS	WBS
Bulk Density g/cm^3	5.29±0.13	5.32±0.02	5.78±0.12	5.52±0.12
WAC, g/cm^3	7.91±0.04	9.03±0.11	9.75±0.04	10.04±0.00
OAC g/cm^3	3.86±0.11	4.58±0.13	5.11±0.03	5.30±0.02
Swelling Power, g/cm^3	2.73±0.00	2.94±0.01	2.41±0.00	2.02±0.01
Solubility index, g/cm^3	0.39±0.01	0.40±0.05	0.46±0.12	0.61±0.00
LGC ^{o}C	62.50±0.03	62.50±0.15	62.60±0.22	64.25±0.08

Mean values with different superscripts within the same row are significantly different at $p<0.05$.
WAC: Water absorption capacity; OAC: Oil absorption capacity; LGC: Least gelation concentration; WTS = 100% wheat flour, WAS = wheat flour enriched with 15% AYB, WYS = wheat flour enriched with 20% AYB, WBS = wheat flour enriched with 25% AYB.

3.3 Mineral profile of wheat-AYB pasta samples

The mineral profile of wheat-AYB pasta samples is as shown in Table 3. Stastistical differences were observed calcium content of the samples the highest value was sample WAS (15% substitution) having 34.14 mg/g, while the least value was WBS sample of 25% AYB inclusion. There was decrease in calcium level with increase in AYB substitution with except of WAS sample. Calcium functions in bone formation and blood coagulation (Seidu *et al*. 2014). Weaver and Heaney (2006) reported that calcium is a micronutrient essential to health and wellbeing, which performs diverse biological function in the human body. It serves as a second messenger for nearly every biological process, stabilizes many protein and in deficient amounts is associated with a large number of disease. The Food and Nutrition Board (1980) recommended a dietary allowance of 360mg and 1200mg calcium for infants and young adults. Iron values ranged from 0.30 mg/g in WTS sample to 0.65 mg/g in WBS sample. Iron is an important constituent of succinate dehydrogenase and is also a part of the haeme of haemoglobin (Hb), myoglobin and the cytochromes (Antia *et al.* 2006).

Soetan (2017) reported that iron has several functions in the human body which includes; being a constituent of the haemoglobin molecule - 70%, myoglobin stored in muscles, an activating molecule of several enzymes and found in storage molecules such as ferritin and hemosiderin. Iron deficiency anemia - characterized by small red cells (microcytosis) with low haemoglobin (hypochro mia). The values obtained in this study are more than the recommended daily allowance of 18mg reported by Ikpeme-Emmanuel *et al.* (2010). Zinc value ranged from 012 to 0.13 mg/g in WTS and WBS samples, respectively. Ikpeme- Emmanuel *et al.* (2010) reported that zinc positively influences tissue growth and healing and participates in insulin formation and spermatogenesis. Zinc deficiency causes growth retardation, impaired immune functions, loss of appetite and skin, nail and hair change (white spots on nails), acrodermatites enteropathica (hair loss, diarrhoea, anorexia). The values obtained for zinc are more than the recommended daily allowance of 15mg and maximum allowable intake of 11mg.

Copper value of all the samples ranged from 0.05 mg/g in WTS sample to 0.07 mg/g in WBS sample. Copper acts as an antioxidant by protecting the brain and nervous system. Although, copper is an essential metal, it can also produce toxic effects when the metal intake is excessively high (Murray *et al.* 2000). Phosphorus ranged from 16.03 – 20.02 mg/g in WAS and WTS samples, respectively. Phosphorus regulates essential biochemical processes like regulation of enzyme activity, formation skeletal structures (bones and teeth) and in neuromuscular irritability (Kalita *et al*. 2007). Magnesium, values ranged from 12.66 – 18.16 mg/g in WBS and WTS samples, respectively. Magnesium is essential for all biosynthetic processes including glycolysis, formation of cyclic AMP, energy dependent membrane transport and transmission of the genetic code. Greater than 300 enzymes are known to be activated by magnesium ion (Weaver and Heaney, 2006). Magnesium regulates diverse biochemical reactions in the body, including protein synthesis, muscle and nerve functions, blood glucose control and blood pressure regulation. It also keeps bones strong and heart rhythm steady (Murray *et al.* 2000). Potassium ranged from 24.91 mg/g in WTS sample to 29.32 mg/g in WBS sample. Potassium is the principal cation in intracellular fluid. It functions in acid-base balance, regulation of osmotic pressure, conduction of nerve impulse, muscle contraction particularly the cardiac muscle, and cell membrane function (Murray *et al*. 2000).

Table 3: Mineral profile of wheat-AYB pasta samples per mg/g

PARAMETER	WTS	WAS	WYS	WBS
Calcium	32.95±0.06	34.14±0.02	29.12±0.15	29.05±0.03
Iron	0.30±0.03	0.36±0.00	0.47±0.03	0.65±0.10
Zinc	0.12±0.02	0.13±0.01	0.13±0.00	0.13±0.01
Copper	0.05±0.00	0.06±0.01	0.06±0.00	0.07±0.00
Phosphorus	20.02±0.13	16.03±0.12	17.98±0.22	18.97±0.12
Magnesium	18.16±0.01	14.68±0.04	13.72±0.00	12.66±0.10
Potassium	24.91±0.22	26.52±1.03	27.95±0.11	29.32±1.01

Mean values with different superscripts within the same row are significantly different at $p<0.05$.
WTS = 100% wheat flour, WAS = wheat flour enriched with 15% AYB, WYS = wheat flour enriched with 20% AYB, WBS = wheat flour enriched with 25% AYB.

3.4 Antinutritional content of wheat-AYB pasta samples

Table 4 shows the values of phytate, total phenols, oxalates, amylase inhibitor and trypsin inhibitor of the formulated pasta samples. Phytate ranged from 0.47 to 6.21 mg/g in WTS sample and WBS sample, respectively, while total phenols ranged from 47.65 to 52.11 mg/g in WTS and WAS samples, respectively. Phytates form stable complexes with mineral ions like Ca, Fe, Mg and Zn and lower their bioavailability for intestinal absorption (Walter *et al*. 2002; Banso and Adeyemo, 2007). According to Singh and Krikarian (1982), phytic acid is one of a number of anti-nutrients in cereals and legumes that blocks mineral phosphorus which is not readily bioavailable in human. It is also known as chelating agent that form a compound which is referred to as phyate and which inhibits trypsin needed for protein digestibility in the small intestine. Presence of large quantity of total phenol is not desirable for human consumption.

Phenolics compound were reported by Liener (1994) to decrease the digestibility of proteins, carbohydrate and the availability of vitamins and minerals. Total phenol also decreased the activity of digestive enzymes such as and α-amylase, trypsin, chymotrypsin and lipase and may cause damage to the mucosa of digestive tract and also reduced the absorption of nutrient such as vitamins (Doss *et al.,* 2011). According to Osagie (1998), phenolic compounds found in food crops have significant effect on the nutritional and sensory qualities of food products which have been associated with the enzymatic browning reactions of phenolic substances.

Oxalates ranged from 44.24 mg/g in WAS sample to 68.37 mg/g in WBS sample. Oxalates complex with calcium forming calcium crystals which get deposited as stones and are associated with blockage of renal tubules (Banso and Adeyemo, 2007). Oxalates also prevent the body's absorption of calcium ions by forming insoluble calcium-oxalate complex (Adeniyi *et al*. 2009). There were significant differences ($p<0.05$) in amylase and trypsin inhibitor components of the formulated pasta samples. The amylase inhibitor ranged from 14.09% g in WAS sample to 30.57% in WBS sample. Amylase inhibitor has been found to inhibit the action of pancreatic and salivary amylases, thereby increasing the amount of undigested starch in the faeces and subsequently decreasing the nutritional value of the foodstuffs. The result showed that level of AYB substitution significantly ($p<0.05$) affected antinutritional factors of the Formulated pasta samples. Trypsin inhibitors ranged from 16.53% in WTS sample to 34.68% in WBS sample. Trypsin inhibitor in large quantities disrupts digestive process and may lead to undesirable physiological reactions. Trypsin inhibitors cause hypertrophy and hyperplasia of the pancreas (Ologhobo *et al*. 2003).

Table 4: Antinutritional content of wheat-AYB pasta samples per mg/g

PARAMETER	WTS	WAS	WYS	WBS
Phytate	4.70±0.00	5.38±0.01	6.10±0.00	6.21±0.03
Total Phenol	52.11±0.01	47.65±0.02	52.06±0.10	49.34±0.00
Oxalate	56.08±0.01	44.24±0.03	48.16±0.11	68.37±0.00
Amylase inhibitor %	17.15±0.03	14.09±0.26	20.72±0.03	30.57±0.02
Trypsin inhibitor %	16.53±0.00	28.31±0.02	30.45±0.00	34.68±0.01

Mean values with different superscripts within the same row are significantly different at $p<0.05$.
WTS = 100% wheat flour, WAS = wheat flour enriched with 15% AYB, WYS = wheat flour enriched with 20% AYB, WBS = wheat flour enriched with 25% AYB

3.5 Sensory attributes of wheat-AYB pasta samples

The sensory attributes of macaroni from wheat-AYB flour blends is shown in Table 5. The mean score for colour ranged from 6.23 – 7.32. Control (WTS) sample had the highest mean score (7.32) followed by WYS sample produced with 20% AYB inclusion. The chewiness and firmness of the samples ranged from 6.13 – 8.14 and 5.78 – 7.83, respectively. In terms of glossiness, WTS sample had the highest value followed by WAS sample with values of 7.70 and 6.85, respectively. Overall acceptability mean score ranged from 5.95 – 8.26 for WBS and WTS samples, respectively. Based on the sensory result, it was observed that with the degree of incorporation of AYB flour, there was decrease in all the sensory attributes mean score, except for WAS sample (80% wheat flour: 20% AYB flour) which most times had higher score than all other samples that was substituted with AYB flour. This result shows that pasta with 20% AYB inclusion level would be most acceptable because of its chewiness and firmness.

Table 5: Sensory attributes of wheat-AYB pasta samples

Sensory attributes	WTS	WAS	WYS	WBS
Colour	7.32±0.05	6.45±0.03	6.68±0.00	6.23±0.02
Chewiness	8.14±0.00	6.73±0.02	7.03±0.01	6.13±0.01
Firmness	7.83±0.03	6.98±0.03	7.02±0.00	5.78±0.00
Glossiness	7.70±0.01	6.85±0.01	6.73±0.10	5.72±0.04
Overall acceptability	8.26±0.02	7.10±0.00	7.18±0.02	5.95±0.03

Mean values with different superscripts within the same row are significantly different at $p<0.05$.
WTS = 100% wheat flour, WAS = wheat flour enriched with 15% AYB, WYS = wheat flour enriched with 20% AYB, WBS = wheat flour enriched with 25% AYB.

4.0 Conclusion

The study investigated the fortification of whole wheat flour with AYB flour for the production of pasta. Blending of wheat-AYB flour for the production of pasta significantly ($p<0.05$) enriched it nutritional quality, improved water and oil absorption capacity of the samples. The study revealed that nutritionally dense pasta could be produced with the addition of 20% AYB to whole wheat flour to make acceptable and safe pasta products. Rancidity, shelf-life, and sorption isotherm of the flour blends and its pasta products needs to be investigated before full bloom commercialization could be done.

Funding and conflict of interest

The project was self-funded; there was no direct funding for the research, and authors declare no conflict of interest

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10/26/2018