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Quality Evaluation of Acha-Semolinacouscous As Affected By Pulse Flour Addition

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Abstract: *Flours were obtained from Bambara groundnut (B), Soybean (S), Lima bean (L), and Acha (A), these were blended with commercial wheat semolina (W) in the ratio of 50:30:20 to produce ABW, ASW, ALW blends while Wheat- semolina(100:0) and Acha-wheat semolina (70:30) were the control blends. These blends were used to produce couscous applying agglomeration process followed by steaming and drying. The raw materials (flours), modified and the control couscous (C). ABWC, ASWC, ALWC, WC and AWC were subjected to physical, functional, chemical, microbiological and sensory evaluation using approved procedures. The moisture of the refined flours, crude Protein, crude fat, total ash, crude fibre and the carbohydrate contents varied significantly($p<0.05$): 9.32-11.29%, 7.69-36.27%, 1.32-21.91%, 0.90-4.50%, 1.12-3.37% and 24.59-74.47% respectively. The legume flours had higher crude fibre, ash, crude fat,and crude protein contents than the wheat-semolina and acha flour.The granular size distribution of the various couscous were of medium sized category with mass fraction in 0.75mm-1.00mm range, asfor the functional properties, the solubility indices (1.36-5.09%) were generally low, the water absorption capacity (1.78-3.07g/g) and swelling power (1.33-1.81g/g) were higher in the legume flour treated couscous. The proximate composition of the various couscous reflected the nutrient profile of the raw materials with legume flour treated couscous having more crude protein, fat, fibre and ash more in the soybean treated couscous than in others. Dominant mineral elements in the couscous were Potassium and Phosphorous while Iron and Zinc were scarce, the mineral contents of the couscous with legume flour addition were higher especially in bambara groundnut treated couscous. Post-steaming drying reduced the moisture contents of the various couscous which in turn reduced the bacterial and fungal loads, thereforedid not exceed the permissible limits. The sensory attributes of soybean flour-treated couscous and wheat-semolina (100:0) couscous were higher and the lima bean treated and acha- wheat semolina couscous received the least scores for the sensory attributes investigated. The work demonstrated conclusively that a blend of acha flour, pulse flour andsemolina in the ratio of 50:30:20 can be successfully used to produce couscouswith enhanced nutritive valueand without impairing the sensory properties associated with couscous.*

Keywords:couscous, composite flour, pulses, acha,wheat semolina, alimentary paste.

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I. Introduction

Couscous issteamed and dried dough pasta thought to have originated from the traditional food cuisines of the Barbers of North Africa but it is now produced and consumed on a world-wide scale. Wheat is the grain of choice for its production however other cereals and non-cereal crops are currently being included, however semolina a refined product of durum wheat with coarse granulation is indispensable in the production of couscous because of its high gluten content that provides rigid viscoelasticity for the couscous dough. Northern Nigeria is the epicenter of couscous consumption in Nigeria perhaps due to her long contact with North Africa and near East for centuries therefore local variants of couscous exist produced from readilyavailable cereals such as millet, sorghum or achaand the production process involves the agglomeration, steaming, drying operations typical of couscous production however lack of standardization in production, packaging and distribution have localized such products for centuries. Mutual complementation is achieved when grain legumes are blended with cereals in right ratio providing protein of high quality and quantity needed for tissue growth and maintenance. Ghalawat and Segal (1992) noted that protein-energy-malnutrition especially in poor families have continued to cause enormous worldwide human suffering, traceable to dependence on single crop for nitrogenous substrates and calorie or their prolonged deprivation(Dougher et al.,2002). Globalization with its attendant urban living and quest for convenient, ready-to-eat or cook nutritious foods have called for modification and fortification of existing food products for nutritional completeness and provision offunctional foods for abating emerging diseases as a result of lifestyle changes.

The concept of food security is hinged on availability, affordability and accessibility of nutritious, wholesome and safe food at all time (FAO, 1997). Grain legumes are sources of inexpensive vegetable protein in the areas of the world where animal protein are either scarce or expensive or prohibited by cultural and religious taboos in such area grain legumes occupy special role in their diet having protein content about 2-3 times greater than in cereals.Soybean (Glycine max) is the world's foremost legume in terms of production, spread, international trade, quality and quantity of protein and also an industrial raw material(Gupta et al., (1987). Ogbemudia et al. (2017) reported soybean seeds contain 37.69% protein, 28.20% crude fat, 4.29% ash, 5.44% crude fibre, 8.07% moisture, and 16.31% carbohydrate. Bambara groundnut (Vignasubterranean (L) Verdc.), on the other hand, is the third most important grain legume in Nigeria and some other West African countries where it originated. In Nigeria this pulse have found use mainly as roasted or boiled snack although it is utilized on a large scale by the Igbos of Southeastern Nigeria for the production of a steamed paste called "okpa"(bambara nut moimoi) The seeds are complete food containing 15-25% protein, 4-9% fat, 50-60% carbohydrate, 3-5% fibre (Brough and Azam-Ali, 1992). Lima beans (Phaseoluslunatus L.) is a native of tropical South America but now cultivated in many ecological systems including the rain forest region of Southern Nigeria where it is grown as an inter crop with cassava, yam, cocoyam, and like bambara groundnut, it is underutilized, hardly considered a research priority. According to Saidu et al. (2018) the seeds contain 29.91-30.29% crude protein, 2.04-2.65% fat, 3.08-3.41% ash, 2.57-2.65% crude fibre, 11-7.45% moisture and 61.68-65.61% carbohydrate. Acha is one of the little known cereal grain that thrives in tropical and subtropical countries, in Nigeria it is grown mainly in Central States, where it is consumed in form of thick or thin porridge (Jideani and Akingbala, 1993; Jideani 1999), alone or with cowpea and frequently used to brew local beer and in some areas it is a grain of choice for local couscous preparation (Ibrahim et al. (1983). The proximate composition of acha is not far from that of wheat grain,but unlike wheat animported commodity in Nigeria, acha is a warm weather crop which lacks the endosperm protein collectively called gluten which is unique to wheat, rye and barley. Acording to Temple and Bassa (1991) acha seeds contain 6-9% protein, 2-3% fat, 1-2% ash, 2-3% crude fibre

Therefore the present study examined the effects of multigrain blends (acha: grain legume: semolina) on the functional, proximate, mineral and sensory properties of couscous.

II. Materials And Methods

2.1 Raw Materials collection and Preparation.

Acha, Soybean, Lima beans, Bambara groundnut and Wheat semolina were purchased at the Kwoi central market, Jabba local government area, Kaduna State, Nigeria. The grains were sorted, winnowed, washed and sun-dried. Acha seeds were ground and sieved (325µm mesh). Soybeans, Bambara nuts, Lima beans were manually dehulled, parboiled, sun-dried ground and sieved (325µm mesh), then packaged separately and left at room temperature(28±2°C), prior to couscous preparation.

2.2 Formulation of the blends for couscous preparation

Acha (A), grain legumes, and wheat semolina (W) flours were blended in the ratio of 50: 30: 20,and wheat semolina (100%) and Acha-semolina (70:30) served as the control. The formulations were: (i) ABW (50: 30: 20) (ii) ASW (50: 30:20), ALW (50:30:20), W (100:0) and AW (70:30) a total of five B= Bambara groundnut, S= Soybeans, L= Lima beans, A=Acha, W=Wheat.

2.3 Couscous preparation with the blends

The traditional method of couscous production as described byGaliba et al. (1988) involves mixing of sieved flour with warm water containing 2% salt to form a hard dough, the latter was passed through a coarse sieve to form agglomerates of approximately uniform sizes which were then steamed for 25 min, placed on a colander mounted on top of boiling water in a pot. The steamed agglomerates were oven-dried for 12h, 85-95°C. Dried couscous were now sieved to obtain couscous of uniform sized granules and then packaged.

2.4 PHYSICOCHEMICAL ANALYSIS

2.4.1 Functional properties of the blends or couscous

Packed bulk density was determined according to the method of Onwuka (2005), solubility and swelling power of the blends or course where determined as described by Leach et al (1959)

Water absorption capacity was determined according to the method of Onwuka (2005). The particle size distribution of the couscous was obtained through sieve analysis placing 100mg on a stack of four sieves (1000µm, 150µm, 500µm and 300µm) placed on the sieve shaker and agitated for 1min percentage retentions on each sieve was obtained.

2.4.2 Proximate composition of the couscous

The moisture, crude protein (%N×6.25), crude fat (soxhlet extraction), ash, crude fibre and carbohydrate were determined according to the approved procedure of AOAC (1980).

2.4.3 Mineral contents of the couscous

The elements determined were Fe, Ca, K, P, Mg and Zn according to the relevant section of AOAC (1980). The samples were wet-digested, filtered and diluted to mark (100ml) in a volumetric flask, the elementalcontents of the aliquots were determined in an atomic absorption spectrophotometer (model SP91 PyeUnicam, UK), results were expressed in mg/100g.

2.4.5 Microbiological status of the couscous after drying and packaging.

Serial dilution as described by the American Public Health Association (APHA, 1992) was carried out with 1% peptone water and 1g of the sample. 1ml 10^{-3} and 10^{-4} dilution were pour-plated on nutrient agar for total plate count and incubated at 48h, 37°C, on potato dextrose agar for fungal counts, 3-5 days incubation room temperature. Viable colonies were enumerated using Gallen Kamp digital colony counter and results were expressed as colony forming unit per gram (CFU/g) taking in consideration of the dilution factors.

2.4.5 Sensory evaluation of the cooked couscous samples

Coded cooked samples were served to a 15-member semi-trained panelists comprising of students and staff of the Food Science and Technology department. The attributes (mouth feel,colour, aroma, appearance, taste) and acceptability were assessed on a 9-point hedonic scale where 9 represents like extremely, and 1 dislike extremely, 5 neither liked nor disliked.

2.4.6 Statistical Analysis

Data generated were subjected to one-way analysis of variance, Means were compared using Duncan multiple range test, significance was accepted at probability value of 5%($p<0.05$). Results were presented as Mean ±SEM (n=3)

III. Results And Discussion

3.1. Granular size of the different couscous

The highest percentage retentions were on 1mm sieve which ranged from 64.22% (ABWC50:30:20) to 71.28% (AWC70:30), indicating that AWC had bigger granules than others, the next was the control (WSC 100:0) while the modified couscous had slightly smaller granules especially ABWC (**Table 1**). Retentions on 0.750mm sieve were between 20.00% (ALWC) and 26.02% (ABWC). Sieving after agglomeration process helped to obtain couscous with approximate uniform size and shape which will ensure uniform doneness due to uniform heat and water diffusivity. The main mass fraction of the different couscous was in the 0.750-1mm range. Benatallah et al. (2008) similarly reported 55.78% retention on 0.8-1mm for hard wheat couscous and the modified with finer granularity. Couscous granular size impacts on its functional properties notably bulk density, water absorption and swelling power.

Table 1: Granular sizes of the differentcouscous

Retentions on the various sieves (%)

Sieve (mm)	ABWC	ASWC	ALWC	WC	AWC
1.00	64.22	65.24	66.96	67.16	71.28
0.75	26.02	25.05	20.00	21.25	19.47
0.53	7.00	6.12	8.00	5.19	5.41
0.30	2.28	3.19	5.04	6.03	3.51
Base	0.48	0.51	0.43	0.37	0.43

Values areMean±SEM (n=3)

ABWC= (Acha- Bambaranut-Wheat Semolina couscous) (50:30:20)

ASWC= (Acha-Soybean-Wheat Semolina couscous (50:30:20)

ALWC= (Acha-Lima bean- Wheat Semolina couscous) (50:30:20)

WC= (Wheat Couscous) (100:00)

AWC= (Acha Couscous) (100:00)

3.2 Functional Properties of the various couscous

The bulk densities (0.53-0.86g/ml) were lower in the modified couscous than in the control and acha couscous reflecting couscous granular size distribution (**Table 2**).The finer nature of pulse flours with greater protein contents provided greater adhesion than acha flour or wheat semolina during dough formation. Bulk density measures the nutrient density in a unit volume, and it is influenced by porosity, particle size and moisture content, knowledge of bulk density of dried material is needed in package design, handling and storage practices as well as in food or feed formulations. The swelling power (1.33-1.81g/g) were higher in the pulse flour treated couscous, this is because hydrophilic constituents of starch and protein jointly contributes to swelling.Amoah and Apeku (2018) observed an increase in swelling power of breakfast cereals with increase in pumpkin flour addition. Steaming, a step in couscous production leads to pre-gelatinization of starch granules; Debbouz (1992) found high positive correlation between starch gelatinization and water absorption index of couscous. Kida (2016) reported a swelling capacity of 31.75-38.88ml/10g/hr for couscous produced from different varieties of sorghum. Tarima (2012) observed a volume increase of 368-457% withoptimum cooking time of 20minutes. High swelling capacity is a desirable consumer quality descriptor for couscous which is dependent on solubility, water absorption, cooking temperature and time.

Table 2: Functional properties of different multigrain couscous

Couscous	Solubility (%)	WAC(g/g)	SP (g/g)	BD (g/g)
ABWC	2.22 ± 0.03^{c}	1.78 ± 0.14^{cd}	1.81 ± 0.05^{a}	0.69 ± 0.04^{ab}
ASWC	5.69 ± 0.22^{a}	2.46b±0.09^{b}	1.69 ± 0.07^{b}	0.71 ± 0.66^{ab}
ALWC	1.79 ± 0.01^{d}	3.07 ± 0.14^{a}	1.61 ± 0.05^{b}	0.53 ± 0.99^{b}
WC	3.13 ± 0.01^{b}	3.04 ± 0.22^{a}	1.49 ± 0.01^{bc}	0.74 ± 0.49^{ab}
AWC	1.36 ± 0.02^{e}	1.98 ± 0.22^{c}	1.33 ± 0.07^{c}	0.81 ± 0.08^{a}

Values aremean±SEM(n=3)
Means within the same column with similar superscripts are not significantly different ($p<0.05$)
WAC= Water Absorption Capacity, SP= Swelling Power, BD= Bulk Density.
ABWC= (Acha- Bambaranut-Wheat Semolina couscous) (50:30:20)
ASWC= (Acha-Soybean-Wheat Semolina couscous (50:30:20)
ALWC= (Acha-Lima bean- Wheat Semolina couscous) (50:30:20)
WC= (Wheat Couscous) (100:00)
AC= (Acha Couscous) (100:00)

3.3. PROXIMATE COMPOSITION OF THE VARIOUS FLOURS USED FOR BLEND FORMATION

Pulse flours had slightly smaller moisture contents than semolina and acha flour, moisture contents ranged from 9.32% for soybean flour to 11.29% in acha flour, these levels of moisture will ensure storage stability.(Table 3) There were greater amounts of crude protein, crude fat, crude fibre and ash in the pulse flours than in the cereal flours (wheat semolina and acha flours). Soybean flour had the highest level of protein (36.27%), fat (27.91%) and acha flour with the least amount of crude protein (7.39%). Significant ($p\leq0.05$) higher levels of carbohydrate (by difference) were observed in the cereal flours. The crude protein contents of Bambara nut and lima bean were not significantly different 23.78% and 22.87% respectively. The crude fat contents varied from 1.32% (Lima bean flour) to 21.91% (Soybean flour), the semolina had the least ash contents (0.90%) while the pulse flours had significant higher ash and fiber contents than the acha flour and semolina. A moisture content of 13% or less will ensure storage stability for long term storage. Dehulling and sieving after grinding reduced the ash and fibre contents of acha flour different from the values for seeds reported by Yellavilla et al. (2015). The semolina (usually made from hard wheat) used in this study had higher protein, fat, moisture and fibre than those of soft wheat flour reported by Oppong et al. (2015). Lower moisture and protein contents were reported by Aremu et al. (2006) for two varieties of bambara nut seeds. The values reported by Alghamid et al. (2017) for soybean cultivars were comparable, moisture contents of the pulse flours were higher than the reported values for their seeds due to largerflour surface area exposure.

Table3. Proximate composition(%) of the flour used in blend formulation

Flour	Moisture	Crude Protein	Crude Fat	Ash	Crude Fibre	Carbohydrate
Bambaranut	9.55 ± 1.25^{c}	23.78 ± 1.15^{b}	5.76 ± 0.71^{b}	3.64±0.04b	2.81 ± 0.07^{b}	54.55 ± 1.11^{d}
Soybean	9.37 ± 2.12^{c}	36.27 ± 0.63^{a}	21.91 ± 2.30^{a}	4.50±0.05a	3.37 ± 0.51^{a}	24.59 ± 1.06^{e}
Lima bean	10.25 ± 0.30^{b}	22.87 ± 1.38^{b}	22.87 ± 1.38^{a}	4.16±0.07ab	3.27 ± 0.09^{a}	58.22 ± 1.88^{c}
Semolina	10.75 ± 0.71^{ab}	14.22 ± 0.89^{c}	2.74 ± 0.89^{c}	0.90±0.04d	1.12 ± 0.42^{d}	70.26 ± 1.15^{ab}
Acha	11.29 ± 0.55^{a}	7.39 ± 1.09^{d}	1.89 ± 0.32^{d}	2.69±0.06c	2.22 ± 0.50^{c}	74.47 ± 1.17^{a}

Significant variations existed in the proximate composition of the various grain flours
Values areMean±SEM(n=3)
Means within the same column with similar superscripts are not significantly different ($p<0.05$)

3.4 PROXIMATE COMPOSITION OF THE VARIOUS COUSCOUS

The protein, fat, crude fibre and ash of pulse flour treated couscous were higher; therefore lower carbohydrate contents were expected than inacha and semolina couscous,(**Table 4**). The semolina couscous had the least moisture content (9.82%) and acha couscous the highest (11.49%). The differences in moisture contents could be linked to the ability of each couscous type to lose moisture during drying after steaming, which is a function of their chemical constituents. Lower moisture contents are beneficial for long term storage. The fat (4.31%) and protein (13.61%) contents of soybean flour treated couscous were higher; the least amounts of protein and fat were observed in wheat semolina and acha couscous respectively (1.74% and 6.74%). Ash contents (0.58-0.93%) and the crude fibre contents (2.05-2.61%) were generally low indicating deeper flour refinement however higher in the treated couscous than in the untreated. The carbohydrate contents of the couscous varied from 67.89% in soybean treated couscous to 77.36% (acha couscous). Damir et al. (2010) enhanced the protein and mineral contents of couscous by addition of chickpea flour in graded amounts. Celik et al. (2004) enhanced the nutritive value couscous by adding soybean and oat flours. Pulses in general are richer sources of macro-and micro nutrients than cereals therefore they are used in enriching existing food products.

Table 4: Proximate composition of the various couscous types

Couscous	Moisture (%)	Fat (%)	Ash (%)	Protein (%)	Fibre (%)	Carbohydrate (%)
ABWC	10.48±0.06^{b}	1.88±0.69^{b}	0.87±0.05^{ab}	11.12±0.015^{c}	2.61±0.05^{a}	72.96±0.42^{b}
ASWC	11.09±0.07^{ab}	4.31±0.63^{a}	0.67±0.07^{b}	14.61±0.33^{a}	2.33±0.08^{ab}	66.89±0.59^{c}
ALWC	11.40±0.23^{a}	1.92±0.58^{b}	0.93±0.05^{a}	12.24±0.42^{b}	2.44±0.11^{ab}	71.05±0.35^{b}
WC	9.82±1.41^{c}	1.74±0.14^{c}	0.61±0.05^{b}	10.83±0.19^{c}	2.49±0.08^{ab}	75.47±0.73^{ab}
AWC	10.30±0.00^{b}	1.96±0.70^{b}	0.58±0.03^{c}	6.74±0.19^{d}	2.05±0.21^{b}	77.36±0.24^{a}

Values are Mean±SEM(n=3)
Means within the same column with similar superscripts are not significantly different ($p<0.05$)
ABWC= (Acha- Bambaranut-Wheat Semolina couscous) (50:30:20)
ASWC= (Acha-Soybean-Wheat Semolina couscous (50:30:20)
ALWC= (Acha-Lima bean- Wheat Semolina couscous) (50:30:20)
WC= (Wheat Couscous) (100:00)
AC= (Achacouscous) (100:00)

3.5. MINERAL CONTENTS OF THE VARIOUS COUSCOUS TYPES

Significant variation was observed in the mineral contents of the different of couscous (**Table 5**). Pulse flour (30%) treated couscous especially bambaranut had greater levels of most of the minerals investigated than the controls, semolina and achacouscous, the increasing order of the concentration (mg/100g) of the mineral elements in the various couscous was K<P<Ca<Mg<Fe<Zn indicating that the most abundant elements was K the next was P and Fe and Zn were rare: Zn 0.49-0.81, Fe 1.78-6.18, Mg 10.17-19.33, Ca 22.40-44.21, P 159.26-214.57, K 188.13-249.7. Similar observation was reported by Celik et al. (2004) for couscous produced from oats and soybeans flours and Demir et al. (2010) for chickpea flour treated couscous. The levels of these minerals will vary depending on the level of refinement of the flours used for couscous production

Table 5: Mineral contents of the different couscous

Couscous	Zn	Ca	Mg	K	Fe	P
ABWC	0.81±0.03^{ab}	44.21±0.79^{a}	19.33±1.41^{a}	249.71±3.22^{a}	2.91±0.11^{c}	214.57±2.04^{a}
ASWC	0.49±0.02^{c}	39.08±1.02^{b}	17.16±0.94^{ab}	238.85±4.13^{ab}	3.89±0.32^{b}	181.80±4.29^{c}
ALWC	0.55±0.05^{c}	35.66±1.21^{bc}	15.09±0.94^{b}	215.07±5.29^{b}	6.18±0.17^{a}	197.22±1.90^{b}
WC	0.72±0.04^{b}	28.15±1.39^{c}	12.39±1.41^{c}	188.13±2.05^{d}	1.78±0.61^{d}	178.31±2.50^{d}
AWC	0.96±0.07^{a}	22.40±0.73^{d}	10.17±0.39^{d}	191.08±2.35^{c}	2.50±0.58^{c}	159.26±3.60^{e}

Values are Mean±SEM(n=3)
Means within the same column with similar superscripts are not significantly different ($p<0.05$)
ABWC= (Acha- Bambaranut-Wheat Semolina couscous) (50:30:20)
ASWC= (Acha-Soybean-Wheat Semolina couscous (50:30:20)
ALWC= (Acha-Lima bean- Wheat Semolina couscous) (50:30:20)
WC= (Wheat Couscous) (100:00)
AC= (Acha couscous) (100:0)

3.6 MICROBIOLOGICAL STATUS OF THE VARIOUS DIFFERENT COUSCOUS LEFT AT ROOM TEMPERATURE

The total aerobic plate counts and total fungal counts were low and ranged from (1.03 - 6.55×10^{3}cfu/g) and (1.63 - 3.94×10^{2} cfu/g) respectively (**Table 6**) Fungal counts were low and pose no safety concern being a ready-to-cook food product, moreover the pre-cook bacterial and fungal loads were below the permissible limits for dried products (ICMSF,1996) contaminations must have originated during post processing handling and storage especially from food contact surfaces. There was no detectable growth on agar plates for coliform bacteria, hygiene level indicator organisms which invariably ruled out the possibility of fecal contamination. The level of moisture contents would permit short term storage without lipid oxidation or bacterial proliferation however for long term storage the water activity of the couscous must be lowered enough (<0.75) and maintained with appropriate packaging and storage to avoid fungal invasion thereby impairing physical, chemical and microbial quality.

Table 6: Microbial statusof different multigrain couscous left at room temperature (2 weeks)

Couscous	Total Plate count $\times10^3$ (cfu/g)	Total Fungal Count $\times10^2$ (cfu/g)	Coliform Count
ABWC	6.55 ± 0.27^a	3.94 ± 0.34^a	NG
ASWC	1.03 ± 0.81^{cd}	1.63 ± 0.41^e	NG
ALWC	5.56 ± 0.22^{ab}	2.81 ± 0.29^c	NG
WC	1.28 ± 0.60^c	2.05 ± 0.11^d	NG
AWC	2.17 ± 0.31^b	3.27 ± 0.07^b	NG

Values are Mean±SEM (n=3)
Means within the same column with similar superscripts are not significantly different (p<0.05)
ABWC= (Acha- Bambaranut-Wheat Semolina couscous) (50:30:20)
ASWC= (Acha-Soybean-Wheat Semolina couscous (50:30:20)
ALWC= (Acha-Lima bean- Wheat Semolina couscous) (50:30:20)
WC= (Wheat semolina couscous) (100:00)
AWC= (Acha-Wheat semolina couscous) (70:30)

3.7 SENSORY ATTRIBUTES OF THE VARIOUS COUSCOUS SAMPLES

The color of wheat semolina couscous (WSC) was more attractive therefore receiving the highest score of 7.55 on a 9-point hedonic scale and others had lower color scores below especially Acha-Lima bean-Wheat-Semolina (ALW) couscous,(**Table 7**). The usual intense attractive yellow color of commercial couscous must have influenced the test panelists' assessments unlike lighter yellow or cream colored modified couscous. Soybean flour treated couscous (ASWC) and the control (WSC) couscous had better taste respectively 7.21and 7.50 respectively with the control being tastier but not significantly different from ASWC while bambara nut flour couscous had the least taste score (5.08) indicating neither liked nor disliked. Objectionable beany flavor of legume flour was responsible for the lower tastescores of the modified couscous. The aroma score of the entire couscous varied from 5.94 (ALWC) to 7.08 (ASWC). Soybean and Bambara nut flour treated couscous had better aroma, next was the control (WSC), and the lima bean couscous scored the least aroma score (5.94) i.e. slightly liked. The mouth feel of a food product is a function of its texture and taste with the exception of soybean treated couscous with significant ($P\leq0.05$) higher mouth feel score (7.48), others like lima bean couscous scored less than 6, this same couscous had the least score of the attributes investigated and although the overall acceptability score was not different from Acha and Wheat semolina couscous (AWC) however they were not rejected by the test panelists while soybean treated couscous and the control, semolina received the best overall acceptance score which was not significantly different from each other. Benatallah et al. (2008) similarly reported higher acceptability score for pulse flour-treated couscous. Coskun(2013) noted that durum wheat couscous is lighter and more yellow than sorghum couscous, that couscous color depends on the level of grain decortication and inclusion of egg. Debbouz and Donnelly (1996) used extrusion cooking to improve couscous physical, functional and sensory properties.

Table7: Sensory attributes of the various couscous

Couscous	Mouth feel	Aroma	Color	Taste	Overall acceptability
ABWC	6.41 ± 1.88^{bc}	6.89 ± 1.25^b	6.28 ± 1.34^b	5.08 ± 1.59^c	6.45 ± 1.11^{ab}
ASWC	7.48 ± 1.60^a	7.08 ± 1.87^a	6.28 ± 2.02^b	7.21 ± 1.52^{ab}	6.88 ± 2.00^a
ALWC	5.58 ± 1.47^c	5.94 ± 2.25^d	5.61 ± 11.68^c	5.54 ± 2.20^c	5.58 ± 2.30^c
WC	6.56 ± 1.36^b	6.68 ± 1.95^{bc}	7.55 ± 1.40^a	7.50 ± 1.36^a	6.80 ± 1.78^a
AWC	5.55 ± 2.10^c	6.41 ± 2.24^c	6.00 ± 2.24^{bc}	6.65 ± 1.88^b	5.81 ± 1.66^b

Values are Mean±SEM (n=3)
Means within the same column with similar superscripts are not significantly different (p<0.05)
ABWC= (Acha- Bambaranut-Wheat Semolina couscous) (50:30:20)
ASWC= (Acha-Soybean-Wheat Semolina couscous (50:30:20)
ALWC= (Acha-Lima bean- Wheat Semolina couscous) (50:30:20)
WC= (Wheat semolina couscous) (100:00)
AWC= (Acha-Wheat semolina couscous) (70:30)

IV. Conclusion

Couscous is an alimentary pasta of North African origin originally made from wheat semolina but now can be produced from other readily available and cheap cereal grains such as sorghum, millet and achaetc especially in West Africa with non-temperate climate unsuitable for wheat cultivation; therefore the motives behind the production of couscous from non-wheat sources include nutritional enhancement and affordability. The refined flours used for blend formulation indicated higher protein, fat, ash and fibre contents in pulse flours than in acha or semolina.Soybean flour treated couscous had better sensory attributes, nutritional value and functional property, while the mineral profile of the bambara nut flour treated couscous was better than others yet the most dominant mineral elements were Potassium and Phosphorous more in the treated couscous. Acha-wheat semolina(70:30)and Acha-Lima beans couscous (50:30:20) had poorer sensory scores although Lima treated couscous had better nutritional enhancement than acha-wheat couscous. The granular sizes of the different couscous were in the range of 0.75mm-1.00mm, low moisture level in the couscous led to acceptable level ofbacterial and fungal load. The study had successfully proved that the nutritional value of pulse flour treated couscous(50% acha 30% pulse flour and 20% wheat semolina) can be enhanced without altering traditionally well-cherished sensory attributes of the couscous.

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