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PHYSICO-CHEMICAL PROPERTIES AND SENSORY EVALUATION OF EXTRUDED SPICED SNACKS PRODUCED FROM RICE AND GROUNDNUT CAKE BLENDS

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Abstract

The study was conducted to generate data and compare the combined effect of formulations on the physico-chemical properties and organoleptic attributes of extruded spiced snacks produced from rice at varying levels of moisture and groundnut cake blends using standard techniques. The formulations designs were: $G_1G_2G_3$= 10 %, 15 %, 20 % groundnut cake; $R_1R_2R_3$= 90 %, 85 %, 80 % rice; and $W_1W_2W_3$= 15 %, 20 %, 25 % water. Data were statistically analyzed using Turkey's test method. Significant differences existed in the nutrient composition of the blends formulated from the different levels of feed composition and moisture. Water absorption capacity decreased proportionately in all the formulated samples with increased feed moisture level while viscosity decreased with increased groundnut levels. The wettability was less than 15 sec. Bulk density increased with increased in groundnut cake whilefeed moisture increased from 16 % to 26 %. Expansion ratio and bulk density showed an inverse relationship. Samples I, J, K and L extruded at 26 % feed moisture showed lower water swelling capacity values. Each control sample (A, E and I for R_{100}/W_{16}, R_{100}/W_{21} and R_{100}/W_{26} respectively) at different moisture levels had highest values for carbohydrates and moisture content but lower protein content.The fat and ash contents increased as the groundnut levels increased. Sample I (R_{100}/W_{26}) was most acceptable, though it had similarities with samples A (R_{100}/W_{16}), B($G_{10}/R_{90}/W_{16}$), C($G_{15}/R_{85}/W_{16}$), and E(R_{100}/W_{21}). However, sample J ($G_{10}/R_{90}/W_{26}$) had the least overall acceptability. The process variables suitable for processing of ready-to-eat extrudates from rice-groundnut cake blends based on optimum nutritive value obtained were found to be samples H ($G_{20}/R_{80}/W_{21}$) and D ($G_{20}/R_{80}/W_{16}$).

1.0 INTRODUCTION

For some time now, a good proportion of the household food budget in Nigeria is spent on snack food items. Snacks producing industries are growing continually with new products becoming available every year. Most of these snacks such as cookies, chin-chin, etc, are carbohydrate-based with low nutritional value [1]. Nutritious foods for these purposes can be best made from a mixture of locally grown cereals and locally available oil seeds. Groundnut (*Arachis hypogea*), a leguminous plant, contains high levels of protein and important amino acids that are lacking in cereals. It is a good source of niacin, folate, fiber, vitamin E, magnesium and phosphorus. The chemical composition of unshelled groundnut consists of 4-13% water, 36-54% fat, 21-36 % protein, 12-45% carbohydrate and 2-3 % ash [2]. Moreover, legume proteins are rich sources of lysine and threonine [3] [4] which are limiting in a single cereal based product. Therefore, fortification of rice with groundnut would go a long way in enhancing the protein quantity and quality of snack which is usually made from rice solely.

Extrusion cooking technology is a high temperature short-time (HTST) process which retains many heat sensitive components, reduces microbial contamination and inactivates enzymes. It is the most used technique for the production of snack food [5]. As extrudate properties are a result of different combinations of extrusion conditions such as feed moisture, screw speed and barrel temperature, a wide variety of products could be generated by extrusion process which combines several unit operations including mixing, cooking, kneading, shearing, shaping, and forming. Currently, extrusion cooking is used for the manufacture of many foodstuffs, ranging from the simplest expanding snacks to highly-processed meat analogues [6]. Much important research work has been reported on the extrusion cooking of cereals especially rice[1][7][8][9]. The thrust of this study was to generate data on the physico-chemical properties of the extruded spiced snacks prepared from rice at varying levels of moisture and groundnut cake blends. The sensory evaluation of the extruded spiced snacks would provide information on the acceptance and preference of the best blends.

2.0 Materials and Methods

The rice grain (5 kg), groundnut cake (3 kg), ginger (1 kg) and cloves (1 kg) used were obtained from King's Market, Ado Ekiti, Nigeria. The raw food materials, except groundnut cake were cleaned using a laboratory aspirator (Gvari Kossuth LU 33 TIP OB 125, Hungary) to remove stalks, chaff, leaves and other foreign matter. They were then washed with clean water, sun dried at 40 ºC for 10hrs, milled using a laboratory attrition mill (Model R175A), sieved (500 mm mesh screen) and packed in polythene bag until required. The extrusion was performed in twin-screw extruder (Model SLG 65, China) at 110^{0}C. The formulation and production of the spiced snacks are presented on Table 1 and Figure 1 respectively.

2.1 Physical Analysis

Water absorption capacity was determined using the method described by [10]. One gram of sample was mixed with 10ml of distilled water and then allowed to stand at room temperature for 30 minutes after which it was centrifuged at 500rpm for 30minutes. The volume of absorbed water (i.e. total volume use, free volume left) was multiplied by the density for conversion of grain of water absorbed per gram sample. Viscosity was determined using the method of [11]. Ten grams of sample was weighted into a beaker (250 ml), 20 ml of distilled water was added and stirred with a stirrer to have a homogeneous mixture. 80ml of boiling water (98 ^{0}C) was added and was stirred manually to attain a temperature of about 60 ^{0}C – 70 ^{0}C. Brook field viscometer was used to measure the viscosity. Wettability was determined according to [10]. One gram of each sample was placed in a 25 ml graduated cylinder with a diameter of 1cm. a finger was placed over the open end and the cylinder was inverted and clamped at a height of 10 cm from the surface of a 600 ml beaker containing 500ml distilled water. The finger was removed to allow the test material to be dumped, and the time required for the sample to become completely wet was recorded. Triplicate measurements were made and the average result taken. Bulk density of flour and extrudates were determined using the method of [12]. Ten grams pulverized extrudates and flour samples were measured in 25 cm^2 graduated cylinder. The cylinder was firmly tapped 30 times on a bench top to settle the sample volume. Measurements were made in triplicate. Expansion ratio (Puff ratio)was determined as described by Sanni*et al* 2001 [13]. This was determined by dividing the average cross-sectional area of the extrudates by the cross-sectional area of the extruder nozzle. 10 readings were determined for each sample and their mean recorded. Water swelling capacity was determined by the method described by [14]. Fifty (50) ml measuring cylinder was filled with sample up to 10 ml mark. Distilled water was added up to 50 ml. The top of the cylinder was tightly covered and the content mixed by inverting again. The cylinder was then left to stand and final volume occupied by the sample was measured after 0, 10, 20,30,40,50, and 60 minutes. Triplicate determinations were made and the average result taken.

2.2 Chemical Analysis

Moisture content was determined by drying two grams of the samples in an oven at 105^{0}C to a constant weight as described by [15]. Crude fat was estimated by extraction with petroleum ether using Soxhlet method of [15]. The micro-kjeldahl method described by [16] was used to estimate the crude protein. The value obtained was multiplied by nitrogen factor (N x 6.25%) to get the percent crude protein content of the sample. Total ash was estimated by incinerating 2g of the sample at 550^{0}C for about 8hrs until the content was carbon free as described by [15] while total carbohydrate was obtained by difference as described by [16].

2.3 Sensory Evaluation

2.3.1 Instrument for Data Collection

The samples were coded and validated questionnaire made up of sensory evaluation for appearance/colour, texture (smooth, loose and gummy), taste (sweet, salty and bland) and general acceptability was used. Ratings were based on a 9-point descriptive hedonic scale with 9 (like extremely) being the maximum and 1(dislike extremely) the minimum in accordance with method described byIwe 2002[17].

2.3.2 Panel of Judges

The population was made up of five (5) academic staff, five (5) third year and five (5) fourth year students of Food Science and Technology Department, Federal University Oye-Ekiti. The purposive sampling technique was adopted in the selection of the panel of judges

3.0 Statistical Analysis

Statistical software, Statistix 9.1[18] was used for the project design. Data was analyzed using pair comparison test method ofIwe 2002[19]. Test of significant ($P<0.05$) difference among the samples were determined by Analysis of Variance (ANOVA) as described by steel eta l 1997[20] while Turkey's Least Significant Difference Test was used to separate the means as given by Iwe 2002 [19].

4.0 Results and Discussion

Table 1 shows the formulation of sample bends while the results of physical properties of extruded spiced snacks are presented in Table 2.

Table 1: Formulation of the Sample Blends

Samples	Blends (%)
A	R_{100}/W_{16} (Control)
B	$G_{10}/R_{90}/W_{16}$
C	$G_{15}/R_{85}/W_{16}$
D	$G_{20}/R_{80}/W_{16}$
E	R_{100}/W_{21} (Control)
F	$G_{10}/R_{90}/W_{21}$
G	$G_{15}/R_{85}/W_{21}$
H	$G_{20}/R_{80}/W_{21}$
I	R_{100}/W_{26} (Control)
J	$G_{10}/R_{90}/W_{26}$
K	$G_{15}/R_{85}/W_{26}$
L	$G_{20}/R_{80}/W_{26}$

Key: G = Groundnut cake, R = Rice, W = Water

Table 2: Physical properties of the extrudates

Samples	Blends	Viscosity (mPas)	WAC (gH_2O/g sample)	Wettability (sec)	B/Density (g/cm^3)	Expansion ratio
A	R_{100}/W_{16}	80.40 ± 0.20^c	5.70 ± 0.10^e	8.5 ± 0.5^b	0.30 ± 0.00^d	41.00 ± 1.5^d
B	$G_{10}/R_{90}/W_{16}$	52.60 ± 1.10^d	6.20 ± 0.10^b	6.0 ± 0.0^c	0.30 ± 0.00^d	46.58 ± 2.2^b
C	$G_{15}/R_{85}/W_{16}$	38.60 ± 5.70^{fg}	5.25 ± 0.05^f	8.5 ± 0.5^b	0.30 ± 0.00^d	43.83 ± 1.3^c
D	$G_{20}/R_{80}/W_{16}$	33.40 ± 1.80^g	6.75 ± 0.05^a	8.5 ± 0.5^a	0.30 ± 0.00^d	51.08 ± 3.1^a
E	R_{100}/W_{21}	79.05 ± 0.35^c	5.25 ± 0.05^f	2.0 ± 0.0^e	0.50 ± 0.00^a	41.33 ± 4.0^d
F	$G_{10}/R_{90}/W_{21}$	47.40 ± 3.70^{de}	6.05 ± 0.15^{bcd}	3.0 ± 0.0^d	0.40 ± 0.00^b	51.33 ± 1.0^a
G	$G_{15}/R_{85}/W_{21}$	30.45 ± 5.45^g	5.10 ± 0.10^f	6.5 ± 0.5^c	0.40 ± 0.00^b	49.33 ± 4.7^a
H	$G_{20}/R_{80}/W_{21}$	36.85 ± 1.05^{fg}	6.25 ± 0.15^b	9.0 ± 0.0^b	0.35 ± 0.05^c	51.58 ± 2.7^a
I	R_{100}/W_{26}	120.85 ± 0.25^a	6.10 ± 0.10^{bc}	2.0 ± 0.0^e	0.50 ± 0.00^a	34.75 ± 3.2^f
J	$G_{10}/R_{90}/W_{26}$	93.30 ± 1.50^b	5.90 ± 0.10^{cde}	2.0 ± 0.0^e	0.50 ± 0.00^a	40.33 ± 4.1^d
K	$G_{15}/R_{85}/W_{26}$	44.15 ± 1.25^{ef}	5.80 ± 0.00^{de}	2.0 ± 0.0^e	0.50 ± 0.00^a	37.50 ± 1.7^e
L	$G_{20}/R_{80}/W_{26}$	36.35 ± 3.35^{fg}	5.75 ± 0.05^e	2.0 ± 0.0^e	0.50 ± 0.00^a	36.75 ± 10.1^{ef}

Values are means of ± standard deviation of triplicate determinations. Means with the same superscript within the same column are not significantly ($p >0.05$) different.
Key: G = Groundnut cake; R = Rice; W = Water

Water absorption capacity (WAC) across the extrudatesranged from 5.10 g/g to 6.75 g/g with sample G having the least value while sample D had the highest value. It decreased proportionately in all the formulated samples with increased feed moisture level. The decrease in the WAC could be attributed to the dispersion of starch in excess water. The WAC dispersion is increased by the degree of starch damage due to gelatinization and extrusion-induced fragmentation, i.e. molecular weight reduction of amylose and amylopectin molecules [21]. The WAC measures the volume occupied by the extrudate starch after swelling in excess water, which maintains the integrity of starch in aqueous dispersion [22]. The viscosity of the extrudates ranged from 30.45 mPas for sample G to 93.30 mPas for samples I and J. It decreased proportionately in all the formulated samples with increased groundnut level. This may be attributed to the oil content of the groundnut which might consequently decrease the shear effect as a result of lubrication in the metering zone. Viscosity depends on to a large extent on the degree of gelatinization of the starch granules and the rate of molecular breakdown. Its profile can be thought of as a reflection of the granular changes in the starch granule that occur during gelatinization [23]. The wettability of the extrudates ranged from 2.0 sec to 9.0 sec with samples E, I, J, K, and L having the least value while sample H had the highest value. The wettability of all the extrudates was less than 15 sec. It took a very short time for samples to absorb water completely. The bulk density of the extrudatesranged from 0.30g/cm^3 to 0.50g/cm^3 with samples A, B, C, and D having the least while sample E, I, J, K and L had the highest values. The bulk density increased as the feed moisture increased from 16% to 26%. The increase is in perfect agreement withNwabuezeand Iwe (2006) [24]. Bulk density is important in the design and selection of packaging materials. The expansion ratio of the extrudates ranged from 34.75 to 51.58 with sample I having the least value while sample H had the highest value. It decreased proportionately in all the formulated samples with increased groundnut level. This may be attributed to the higher amount of protein in the groundnut cake than the rice flour. Protein was reported to reduce expansion ratio during extrusion cooking [24]. The expansion ratio also tends to decrease with increase in the feed moisture of the extrudates.

Water swelling capacity (WSC) of the extrudates is shown in Table 3.

Table 3: Water swelling capacity of the extrudates

Sam Ple	Blends	Bulk Vol. (ml)	Time (min)						
			0	10	20	30	40	50	60
A	R_{100}/W_{16}	28.0	32.0 ± 0^{b}	38.5 ± 0.5^{c}	40.1 ± 0.1^{c}	40.95 ± 0.1^{c}	41.95 ± 0.1^{b}	42.9 ± 0.1^{b}	43.2 ± 0.1^{b}
B	$G_{10}/R_{90}/W_{16}$	31.0	42.0 ± 0^{a}	45.0 ± 0^{a}	46.1 ± 0.1^{a}	47.10 ± 0.1^{a}	47.20 ± 0.2^{a}	47.2 ± 0.2^{a}	47.2 ± 0.2^{a}
C	$G_{15}/R_{85}/W_{16}$	20.0	28.0 ± 0^{f}	37.5 ± 0.5^{c}	39.2 ± 0.2^{d}	40.30 ± 0.3^{c}	42.40 ± 0.4^{b}	43.3 ± 0.3^{b}	$43. \pm0.3^{b}$
D	$G_{20}/R_{80}/W_{16}$	27.0	29.0 ± 0^{d}	43.5 ± 0.5^{b}	45.0 ± 0.0^{b}	45.90 ± 0.1^{b}	46.90 ± 0.1^{a}	46.9 ± 0.1^{a}	46.9 ± 0.1^{a}
E	R_{100}/W_{21}	17.0	28.0 ± 0^{f}	33.1 ± 0.1^{e}	36.1 ± 0.1^{f}	37.90 ± 0.1^{e}	40.00 ± 0.0^{d}	40.9 ± 0.1^{c}	41.4 ± 0.6^{c}
F	$G_{10}/R_{90}/W_{21}$	18.0	30.0 ± 0^{c}	36.0 ± 0.0^{d}	38.9 ± 0.1^{d}	39.50 ± 0.5^{d}	40.90 ± 0.1^{c}	41.5 ± 0.5^{c}	41.5 ± 0.5^{c}
G	$G_{15}/R_{85}/W_{21}$	20.5	25.0 ± 0^{g}	35.0 ± 0.0^{d}	36.9 ± 0.1^{e}	38.25 ± 0.3^{e}	38.90 ± 0.1^{e}	40.0 ± 0.0^{d}	40.0 ± 0.0^{d}
H	$G_{20}/R_{80}/W_{21}$	17.0	28.5 ± 0^{e}	35.5 ± 0.5^{d}	37.2 ± 0.2^{e}	38.20 ± 0.2^{e}	39.00 ± 0.0^{e}	40.0 ± 0.0^{d}	40.1 ± 0.1^{d}
I	R_{100}/W_{26}	12.0	25.0 ± 0^{g}	30.5 ± 0.5^{f}	32.4 ± 0.4^{h}	33.30 ± 0.3^{gh}	34.30 ± 0.3^{h}	35.4 ± 0.4^{f}	35.9 ± 0.1^{g}
J	$G_{10}/R_{90}/W_{26}$	13.0	21.0 ± 0^{i}	28.0 ± 0.0^{g}	33.1 ± 0.1^{g}	34.10 ± 0.1^{f}	36.00 ± 0.0^{f}	38.0 ± 0.0^{e}	39.1 ± 0.1^{e}
K	$G_{15}/R_{85}/W_{26}$	13.0	23.0 ± 0^{h}	28.0 ± 0.0^{g}	32.5 ± 0.5^{h}	33.90 ± 0.1^{fg}	35.00 ± 0.0^{g}	36.1 ± 0.1^{f}	37.1 ± 0.1^{f}
L	$G_{20}/R_{80}/W_{26}$	12.0	17.0 ± 0^{j}	25.9 ± 0.1^{h}	30.0 ± 0.0^{i}	33.10 ± 0.1^{h}	35.10 ± 0.1^{g}	37.4 ± 0.4^{e}	38.9 ± 0.1^{e}

Values are means of ± standard deviation of triplicate determinations. Means with the same superscript within the same column are not significantly ($p > 0.05$) different.

Key: G = Groundnut cake, R = Rice, W = Water

There was significant variation ($P>0.05$) among the samples' means. The WSC was influenced by the time taken to swell to maximum volume. The samples that stood for 60 min showed the highest WSC in all the treatments. However, samples I, J, K and Lextruded at 26 % feed moisture showed lower WSC values in all the treatments.

The results of chemical properties of extruded spiced snacks are presented in Table 4.

Table 4: Chemical properties of the extrudates

Samples	Blends	Carbohydrate (%)	Moisture Content (%)	Crude Protein (%)	Ash (%)	Crude Fat (%)
A	R_{100}/W_{16}	80.10±0.20^{a}	9.85±0.15^{cd}	7.25±0.15^{e}	2.70±0.10^{ef}	0.65±0.05^{g}
B	$G_{10}/R_{90}/W_{16}$	77.55±0.35^{b}	9.00±0.20^{f}	9.00±0.10^{d}	2.90±0.10^{cd}	1.50±0.10^{f}
C	$G_{15}/R_{85}/W_{16}$	76.15±0.15^{cd}	8.45±0.15^{g}	9.65±0.15^{c}	3.40±0.10^{b}	1.90±0.10^{de}
D	$G_{20}/R_{80}/W_{16}$	75.10±0.10^{de}	8.25±0.15^{g}	10.80±0.10^{ab}	3.80±0.10^{a}	2.25±0.15^{abc}
E	R_{100}/W_{21}	78.35±0.15^{b}	11.15±0.05^{a}	7.15±0.05^{e}	2.60±0.20^{f}	0.75±0.05^{g}
F	$G_{10}/R_{90}/W_{21}$	76.35±0.55^{c}	9.70±0.10^{de}	9.10±0.20^{d}	2.85±0.05^{cde}	1.60±0.10^{ef}
G	$G_{15}/R_{85}/W_{21}$	75.05±0.25^{e}	9.40±0.20^{ef}	9.85±0.05^{c}	3.40±0.10^{b}	1.95±0.15^{cd}
H	$G_{20}/R_{80}/W_{21}$	73.00±0.90^{fg}	9.35±0.05^{ef}	10.95±0.20^{a}	3.80±0.10^{a}	2.30±0.10^{ab}
I	R_{100}/W_{26}	77.55±0.45^{b}	11.35±0.15^{a}	7.15±0.05^{e}	2.75±0.05^{def}	0.65±0.05^{g}
J	$G_{10}/R_{90}/W_{26}$	75.20±0.10^{de}	11.30±0.10^{a}	9.05±0.15^{d}	3.00±0.10^{c}	1.55±0.05^{f}
K	$G_{15}/R_{85}/W_{26}$	73.65±0.65^{f}	10.40±0.10^{b}	9.90±0.10^{c}	3.30±0.10^{b}	2.10±0.20^{bcd}
L	$G_{20}/R_{80}/W_{26}$	72.15±0.85^{g}	10.25±0.05^{bc}	10.55±0.10^{b}	3.75±0.15^{a}	2.50±0.30^{a}

Values are means of ± standard deviation of triplicate determinations. Means with the same superscript within the same column are not significantly (p >0.05) different.

Key: G = Groundnut cake; R = Rice; W = Water

The carbohydrate content of the overall extrudates ranged from 72.15 for sample L to 80.10% for sample A. Each control samples had highest values for carbohydrates. This could be attributed to the 100% rice in the feed composition of the blends. The definite trend noticed showed proportional increase in the extrudates with decreased groundnut level.The moisture content of the extrudates ranged from 8.25 % for sample D to 11.35 % for sample I. However, each of the control samples had highest moisture values. The values of moisture obtained could be attributed to the variation in the feed composition of the blends. Addition of groundnut cake or whole groundnut to low protein sources has been reported to decrease moisture [25]. Moisture is an important attribute in the storage of food products. The moisture content of the extrudates in this work is generally low enough for the products to store properly at ambient temperature if properly packaged.

The protein content of the extrudates ranged from 7.15% for samples E and I to 10.95% for sample H. However, each of the control samples had the lowest values. The least value of protein obtained in samples A, E, and I could be attributed to the 100% rice in the feed composition of the blends. Protein content of the extrudates generally increased as the groundnut levels in the feed increased. This could be attributed to the fortification of the extrudates with groundnut.The fat content of the extrudates ranged from 0.65% for samples A and I to 2.50 % for sample L. It increased as the percent groundnut cake in the extrudate increased. This can be explained by the higher amount of fat in the groundnut cake than the rice flour. The ash content ranged from 2.60 % for sample E to 3.80 % for samples D and H. The per cent ash content in the extudates tends to increase as the amount of groundnut cake in the feed increased. This can also be attributed and agreed with the work of Umoh*et al* (2013) who reported increased ash content as a result of food supplementation and fermentation.The ash content is an indication of the amount of minerals in a food material. The results of sensory evaluation of the extrudates are presented in Table 5.

Table 5: Sensory Evaluation of the extrudates

Samples	Blends	Colour	Taste	Overall acceptability
A	R_{100}/W_{16}	7.78 ± 0.32^{a}	7.61 ± 0.82^{abc}	7.33 ± 0.72^{ab}
B	$G_{10}/R_{90}/W_{16}$	6.89 ± 0.42^{abc}	6.78 ± 0.16^{bcde}	6.55 ± 0.57^{ab}
C	$G_{15}/R_{85}/W_{16}$	6.92 ± 0.84^{abc}	7.42 ± 0.18^{abcd}	7.22 ± 0.69^{ab}
D	$G_{0}/R_{80}/W_{16}$	6.12 ± 1.29^{bc}	6.53 ± 0.53^{bcde}	6.9 ± 0.57^{abc}
E	R_{100}/W_{21}	7.19 ± 0.95^{ab}	8.11 ± 0.63^{a}	7.28 ± 0.44^{ab}
F	$G_{10}/R_{90}/W_{21}$	6.33 ± 0.47^{abc}	6.93 ± 0.45^{cde}	6.50 ± 0.68^{bc}
G	$G_{15}/R_{85}/W_{21}$	6.93 ± 0.33^{abc}	7.58 ± 0.69^{abc}	7.16 ± 0.83^{abc}
H	$G_{20}/R_{80}/W_{21}$	6.33 ± 0.27^{abc}	6.69 ± 0.68^{cde}	6.72 ± 0.44^{bc}
I	R_{100}/W_{26}	7.39 ± 0.28^{ab}	8.00 ± 0.27^{ab}	8.17 ± 0.36^{a}
J	$G_{10}/R_{90}/W_{26}$	6.17 ± 0.49^{bc}	5.81 ± 0.95^{e}	5.86 ± 1.39^{c}
K	$G_{15}/R_{85}/W_{26}$	6.33 ± 0.98^{abc}	6.67 ± 0.54^{cde}	7.20 ± 0.41^{bc}
L	$G_{20}/R_{80}/W_{26}$	5.43 ± 0.80^{c}	6.22 ± 0.57^{de}	6.11 ± 0.63^{bc}

Means with the same superscript within the same column are not significantly (p >0.05) different.

Key: G = Groundnut cake, R = Rice, W = Water

5.0 Conclusion

The study has shown that rice/groundnut can be blended to produce acceptable and nutritionally rich spiced snacks. The nutrient values obtained from samples H ($G_{20}/R_{80}/W_{21}$) and D ($G_{20}/R_{80}/W_{16}$) were found to have the highest protein and mineral values, which can be exploited for the development of ready-to-eat food products. However, sample I(R_{100}/W_{26}) was the most acceptable with respect to sensory characteristics while sample J ($G_{10}/R_{90}/W_{26}$) was the least acceptable.

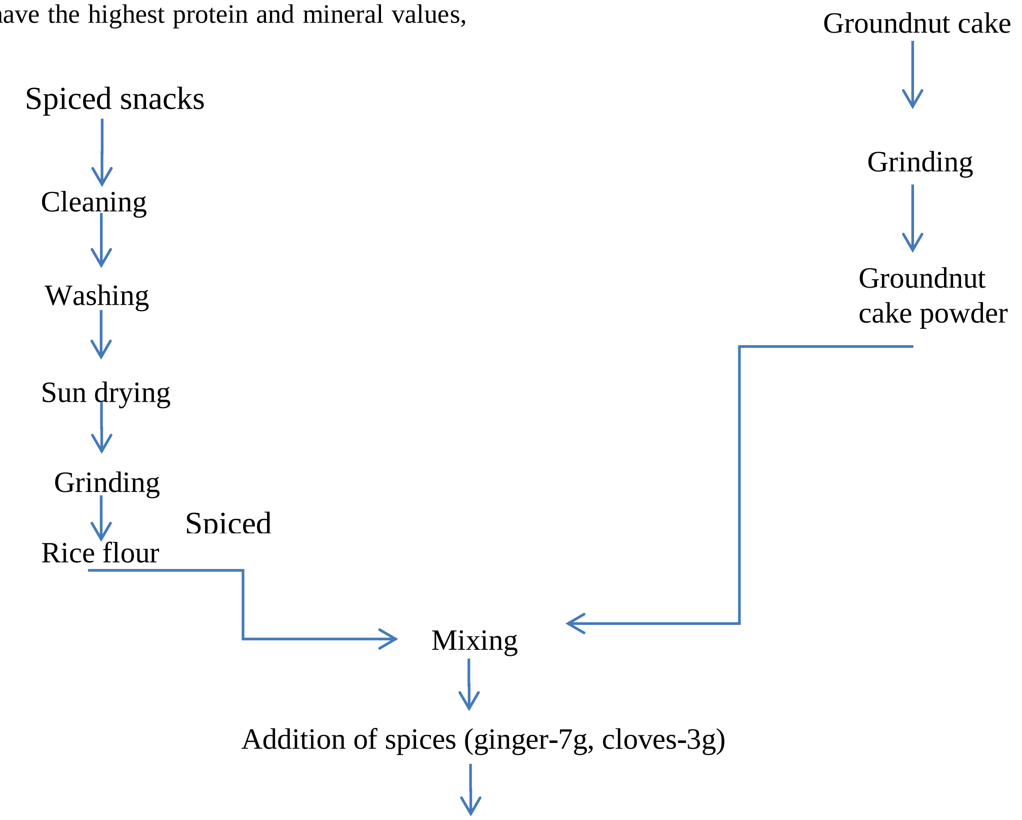

Fig.1: Production of Spiced Snack

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