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Production and Evaluation of Peanut Biscuits with or Without the Addition of Wheat Flour

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Abstract:
In other to prevent wastage of the peanut cake after the oil have been extracted, peanut flour can be made from it. Peanut flour is a protein-dense plant based flour derivative. It can be used to improve the protein content of convenient foods such as biscuit. The aim of this study was to produce 100% peanut biscuits from defatted peanut flour. The flour was defatted using n-hexane at a concentration of 1:2g/ml. The flour was then used in the production of biscuits with or without the addition of wheat flour. Different proportions of flours used were: 100% peanut, 100% wheat, peanut 90% wheat 10%, peanut 70% wheat 30%, wheat 90% peanut 10%, and wheat 70% peanut 30%. The biscuits were analysed to determine their nutritional composition, mineral composition, microbial content and physical characteristics. The sensory components of the biscuits were also evaluated with 15 panellists using a 9-point hedonic scale to determine their degree of likeness and acceptability. The results obtained showed a decrease in moisture and carbohydrate content and an increase in protein and fat content with greater proportions of peanut flour in the biscuit. According to the results obtained from sensory analysis, the most acceptable samples in terms of taste and overall acceptability was the sample made from 90% peanut 10% wheat flour. There was no significant difference in the physical characteristics of all the biscuit samples.

Keywords: *Peanut flour, peanut biscuit, wheat biscuit, proximate composition*

1. Introduction

The consumption of biscuit and other western-styled bakery product such as bread and cake prepared from wheat flour is very popular in Nigeria, especially among children (Ayo, et al., 2003). The low protein content of wheat flour when compared to other plant sources of protein (such as peanut) is of major concern in its utilization. Fortification of wheat flour with high protein vegetable flours in an attempt to increase the nutritional quality of baked products has been under investigation for many years. However, the use of high protein biscuits has been given less attention because they are not universally consumed and because of the reluctance of nutritionists to promote snack or dessert items as a source of protein. Nevertheless, interest still does exist in fortifying the protein content and improving the overall quality of biscuits through the addition of alternative flour other than wheat.

In most countries it has been seen that peanuts are usually processed for oil and the residual meal, which possess a rich amount of protein is used either as animal feed or as fertilizers. On the other hand, most of developing countries are facing a problem of various forms of protein energy malnutrition (Serrem et al., 2011). Hence peanuts as a cheap source of protein has aroused recently in traditional foods. A study has shown that, peanut flour which is most commonly used for fortification contains protein ranging in between 40% - 55% (Singh and Singh, 1991), whereas wheat flour contains between 9-14% protein (USDA Nutrient Database, 2014). Peanut flour has been reported by the USDA (2014) to contain all the 20 amino acids. Therefore, its use will substitute for the amino acid not present in wheat and thus producing a protein dense biscuit. Despite this important findings, no research has been conducted on the production of biscuit from 100% peanut flour. Therefore, the present study was undertaken to compare the organoleptic and physical properties, as well as the nutrient composition of biscuits produced from 100% peanut flour with that produced from 100% wheat flour as well as the products of mixing the two flours in varying proportions. The success of this work could help to induce foreign exchange conservation by means of local material utilization such as substituting peanut flour for wheat flour in biscuit manufacture.

2. Experimental

2.1. Materials

Peanuts used to produce the peanut flour was obtained from Oja-Oba market in Ibadan city, Oyo state in Nigeria. The wheat flour, sugar, butter, and other ingredients used in the preparation of the biscuits were also purchased from Oja-Oba market in Ibadan.

2.2. Methods

2.2.1. Peanut Flour Production

Peanut flour was obtained from whole peanuts which were first roasted at 350^{o}C for 40-60mins over an open fire. The peanuts were then milled using a blender in order to reduce size and enhance the de-fatting process. The milled peanuts were then soaked in n-hexane (in the ratio 1:2g/ml seed to solvent ratio) for 12-16 hours (overnight) in order to remove most of the oil contained in peanuts to yield a free-flowing flour.

2.2.2. Biscuit Production

Wheat flour and peanut flour used in the production of the biscuits were composited in the ratios: peanut 90: wheat 10, peanut 10: wheat 90, peanut 70: wheat 30, peanut 30: wheat 70, 100% peanut biscuits, and 100% wheat biscuit was used as control. The biscuits were produced according to the method described by Yadav et al. (2012) with slight modifications.

2.2.3. Proximate Analysis

This was done for the peanut flour, wheat flour, and the biscuits made from the individual and composite flours.

2.2.4. Moisture Content Determination

Moisture content of the samples was determined according to the method described by AOAC(2005). Moisture cans were first dried in an oven set at 105^{o}C for about 15minutes to remove adhering moisture. After drying, the cans were placed in a desiccator to cool. The empty cans were then weighed using an analytical balance and the weight was recorded as W_0. Two grams of sample was then weighed into the cans and the weight of cans and sample was recorded as W_1. The cans were then transferred into the oven at a temperature of 105^{o}C and dried to a constant weight for 2-3hours. The moisture cans were then removed from the oven and put in a desiccator to cool for 20minutes. The cans were then weighed again and the weight was recorded as W_2.

Calculation:

% moisture content = 100

Where; W_0 = weight of empty cans

W_1 = weight of cans + sample before drying

W_2 = weight of cans + sample after drying

2.2.5. Protein Content Determination

Protein content was determined according to the kjedhal block digestion and steam distillation method described by AOAC (2005).Half a gram of sample was weighed into a 250ml digestion tube. 5grams of kjedahl catalyst were then added into the tubes. 20ml of concentrated H_2SO_4 was then added into the digestion tube and the mixture was shaken slightly. The tubes were then placed on racks in the digestion block in a fume cupboard and the samples were digested at 410^{o}C for 4 hours or until solution is clear. After digestion, the digestion rack was removed from the digester and allowed to cool. The digest was then transferred into a 50ml volumetric flask and distilled water was added to up to 50ml mark. The digestion tube was then placed in the distillation unit and 50ml of 40% NaOH was dispensed into the solution. 10ml of receiver solution was then put into a conical flask and the flask was also placed into the distillation unit such that the distillates drops into the receiver solution. The sample was distilled for five minutes. The distillate was then titrated using 0.1N hydrochloric acid until a pink colour change was observed and the end-point value was recorded.

Calculation:

% Nitrogen =

% protein = %Nitrogen × 6.25

Where:

6.25 = conversion factor from nitrogen to protein

Normality of HCL = 0.1N

T = titre value

B = blank value

Atomic mass of nitrogen = 14.007g/mol.

2.2.6. Fat Content Determination

Fat content determination was carried out using solvent extraction method using the soxhlet extraction system (AOAC, 2005). One gram of sample was weighed and recorded as W_1 into each extraction thimble and plugged with cotton wool. The thimble was then placed into the extraction unit, fitted up with a reflux condenser and a 250ml soxhlet flask which has already been oven-dried, cooled and weighed and recorded as W_2. The soxhlet flask was filled to three-quarter of its volume with petroleum ether. The heater was then allowed to run for 6 hours with constant supply of running water from a tap for the condensation of the ether vapour. The ether was left to siphon several times, until it was short of siphoning. The petroleum ether content of the extractor was then carefully drained into the ether stock bottle. The thimble containing the now defatted sample was also removed. The round bottom flask which now contains fat/oil was then detached from the extraction unit, dried to a constant weight in an oven, cooled and weighed and the weight was recorded as W_3.

Calculation:
% fat content =
Where; W_1 = weight of sample(g)
W_2 = weight of empty soxhlet flask (g)
W_3 = weight of flask + residue fat (g)

2.2.7. Ash Content Determination

The ash content was determined according to AOAC (2005). Empty crucibles were cleaned and oven dried in the oven and allowed to cool in the desiccator. The empty crucibles were then weighed using an analytical balance and the weight was recorded as W_0. Two grams of sample was then weighed into the crucible and the weight of the crucible and sample was recorded as W_1. The samples were then pre-ashed in the crucible on a hot-plate placed in a fume cupboard for 10-15 minutes. The crucibles were then transferred into the muffle furnace set at 604$^oC \pm 4^oC$ to ash for 6 hours. After 6 hours, the muffle furnace was turned off and the samples were allowed to cool and then they were transferred into a desiccator for further cooling. The final weight of the crucible and sample was the taken and recorded as W_3.
Calculation:
% Ash content =
Where; W_0 = weight of empty crucible
W_1 = weight of crucible + sample
W_2 = weight of crucible = sample after ashing.

2.2.8. Carbohydrate Content Determination

The carbohydrate content was determined according to AOAC(2005) by difference method. The sum of moisture content, protein content, fat content, and ash content was subtracted from 100 to obtain the carbohydrate content. The total carbohydrate was determined without the inclusion of fibre.

2.2.9. Sensory Evaluation

The biscuit samples were coded and served to fifteen semi-trained panellists made up of staff and students of the Faculty of Agriculture, Bowen University, Iwo Nigeria. The sensory evaluation of the samples using 9-points hedonic scale as described by Ihekoronye and Ngoddy (1985) where 1 represent extreme likeness and 9 represents extreme dislike. The judges were to evaluate colour, aroma, taste, texture and overall acceptability. All panellists were regular consumer of biscuits. They were asked to detect or state their degree of like or dislike for each sample.

2.2.10. Physical Properties

The diameter and thickness of biscuits was measured using vernier callipers and the weight was measured using a sensitive analytical balance according to the method described by AOAC (2005). The Commission Internationale de l' Eclairage (CIE) L^*,a^* and b^* parameters were determined using a chrome meter CR-410 (Konica Minolta, Inc., Japan). In detail, it assessed the following colour traits: L^* (lightness), axis – 0 is black, while 100 is white; a^* (red – green) axis - positive values are red while negative values are green and 0 is neutral: b* (yellow – blue) axis – positive values are yellow, while negative values are blue and 0 is neutral. Multiple measurements (10 points) of L*, a* and b* parameters were determined using the colorimeter on the sample.

2.2.11. Microbial Analysis

The methods described by AOAC (2006) were used for total viable and mould count. The total viable and mould counts were carried out using plate count agar (PCA) and Sabarouse dextrose agar (SDA) respectively. All materials where sterilized before use. Peptone water was prepared by dissolving 22.5g of peptone powder in 1000ml of water, it was then sterilized in an autoclave at 121ºC for 15 min. 9ml of sterile peptone water was dispensed into the test tubes under the lamina flow and labelled 10^{-1}. 1 g of each biscuit sample was then dissolved in the 9 ml of peptone water to give 10^{-1} dilution and mixed very well using a vortex. From the 1st dilution, 1ml was pipetted into the next test tube to give 10^{-2} and this was continuously done until the fourth tube to give 10^{-4} dilution. 1ml of the desired dilution was dispensed into sterile petri dishes and 20 ml of the already sterilized and cooled PCA/SDA agar was poured into the plate. Swirling was done clockwise, anticlockwise, forth and back to ensure proper mixing of the bacterial cell. The sample was allowed to solidify and the plates were inverted in the incubator that was set at 37°C. Growth was observed after 24hrs for total viable count and cells were counted. However, for the mould growth, plates were incubated at room temperature for 4-5 days. Growth was observed and cells were counted.

2.2.12. Statistical Analysis

Statistical analysis was performed with SPSS software (SPSS Inc., 1996) and used to test the significant effect of various parameters at 5% level of significance ($P > 0.05$).

3. Results and Discussion

3.1. Proximate Composition of the Flour and Biscuits

The moisture content of peanut flour was observed to be low (2.50%) compared to that of wheat flour which was about 13.95% (Table 1). This may be as a result of exposure of the peanut flour to heat of drying after oil extraction. This low moisture content may enhance the keeping quality of the flour. There was also significant difference at 5% level of significance in the protein, ash, fat and carbohydrate content of the flours. Peanut flour generally had higher protein and ash than wheat flour with a protein content of 40.23% and ash content of 7.53%. The carbohydrate content of wheat flour was shown to be higher in wheat flour than peanut flour. Peanut flour also had higher fat content than that found in wheat flour.

Results from the proximate analysis carried out on the biscuit samples are summarized in Table 2. The results from the moisture content analysis showed significant difference at 5% level of significance between the biscuit samples. The range of the moisture content was between 2.00% to 7.15%. The highest moisture content was observed in biscuits containing 100% wheat flour while lowest moisture content was observed in biscuits containing 100% peanut flour. The observed trend was that moisture decreased with increase in the proportion of peanut flour. The low moisture content of peanut flour may be as a result of drying that was carried out after fat extraction to remove residual n-hexane from the peanut flour. Similar results were observed by Kaushal et al.(2012). There was also an increase in protein content of the biscuit from 9.25% to 34.63% with increase in the peanut flour content. This correlates with the findings of Yadav, et al.(2012). These authors stated that with higher proportion of peanut, there is higher protein content as peanut flour is very protein dense. The range of ash content was between 5.35% to 8.14%. There was significant difference at 5% level of significance between the ash content of the samples and it was observed that ash content increased with higher levels of peanut flour in the biscuits. This may be as a result of peanut being rich in minerals compared to lower amounts found in wheat (Khalil et al., 1984).The fat content of biscuit samples ranged from 10.86% - 24.42%. The highest fat content was observed in 100% peanut biscuit and the lowest value of fat was observed in 100% wheat biscuits. The proportion of fat in the biscuits increased as peanut proportion increased. The carbohydrate content determined by difference method (excluding fibre because its amount was negligible), showed that biscuit made from 100% peanut flour had lowest carbohydrate content (31.38%) while biscuit made from 100% wheat biscuit had the highest carbohydrate content (71.40%). The carbohydrate content reduced with higher amounts of peanut. This suggests that it may be suitable for people who are concerned about their sugar intake.

3.2. Physical Properties of the Biscuits

The physical properties of biscuit samples are summarized (Table 3). The L (lightness) values of the biscuits range from 45.60 in 100% peanut biscuits to 83.57 in 100% wheat biscuit, low L^* values were observed in samples containing a greater proportion of peanut flour. Chevalier et al. (2000) suggested that protein content negatively correlated with lightness of cookies indicating that maillard reaction played a major role in colour formation. Thus, it is suggested that higher protein content in 100% peanut biscuit results in greater maillard browning which is responsible for the lower lightness values. However, a reverse trend was observed in the a^* (redness to greenness)values. The a^* value ranged between 2.27 in 100% wheat biscuits to 12.91 in 100% peanut biscuits. The values were observed to reduce with greater proportions of wheat. However, the b values (yellowness to blueness) was between the range of 21.43 in 100% peanut biscuits to 24.77 in 100% wheat biscuits. The weight of the biscuit samples was between 4.56 g to 6.80 g. There was significant difference between the weight of the biscuit samples, although biscuits made from $W_{90}P_{10}$ had the highest value. There was no significant difference between the diameter and thickness of all the biscuit samples.

Sample	Moisture(%)	Protein (%)	Ash(%)	Carbohydrate(%)	Fat(%)
WF	$13.95{\pm}0.34^b$	$11.45{\pm}0.09^a$	$4.47{\pm}0.02^a$	68.89±0.27	1.24±0.39
PF	$2.50{\pm}0.05^a$	$40.23{\pm}0.10^b$	$7.53{\pm}0.85^b$	34.29±0.54	8.45±0.97

Table 1: Proximate Composition of Peanut and Wheat Flour Used in Baking

- Each value is the mean ±SE, mean values having different superscript (a, b, c) are significantly different at $P{\leq}0.05$
- WF – wheat flour
- PF – peanut flour

Sample	Moisture(%)	Protein(%)	Ash(%)	Carbohydrate(%)	Fat(%)
$W_{90}P_{10}$	$6.50{\pm}0.20^c$	$22.77{\pm}0.22^c$	$7.78{\pm}0.60^{bc}$	$51.66{\pm}0.37^d$	$11.28{\pm}0.03^b$
$W_{70}P_{30}$	$6.81{\pm}0.28^c$	$27.47{\pm}0.36^d$	$5.83{\pm}1.13^{ab}$	$40.33{\pm}0.83^c$	$19.55{\pm}0.07^d$
$P_{90}W_{10}$	$4.53{\pm}0.84^b$	$31.03{\pm}0.19^e$	$8.14{\pm}0.03^c$	$35.04{\pm}0.56^b$	$21.26{\pm}0.05^e$
$P_{70}W_{30}$	$5.16{\pm}0.07^b$	$19.80{\pm}0.23^b$	$5.34{\pm}0.06^a$	$51.12{\pm}0.19^d$	$18.58{\pm}0.04^c$
W_{100}	$7.15{\pm}0.26^c$	$9.25{\pm}0.75^a$	$5.84{\pm}0.22^{ab}$	$71.40{\pm}0.41^e$	$10.86{\pm}0.04^a$
P_{100}	$2.00{\pm}0.00^a$	$34.63{\pm}0.44^f$	$7.56{\pm}1.31^{bc}$	$31.38{\pm}0.98^a$	$24.42{\pm}0.03^f$

Table 2: Proximate Composition of Peanut and/or Wheat Biscuits

- Each value is the mean ±SE, mean values having different superscript (a, b, c) are significantly different at $P{\leq}0.05$
- $W_{90}P_{10}$ - 90% wheat and 10% peanut biscuits

- $W_{70}P_{30}$ - 70% wheat and 30% peanut biscuits
- $P_{90}W_{10}$ -90% peanut and 10% wheat biscuits
- $P_{70}W_{30}$ - 70% peanut and 30% wheat biscuits
- W_{100} - 100% wheat biscuit (control)
- P_{100} – 100% peanut biscuits

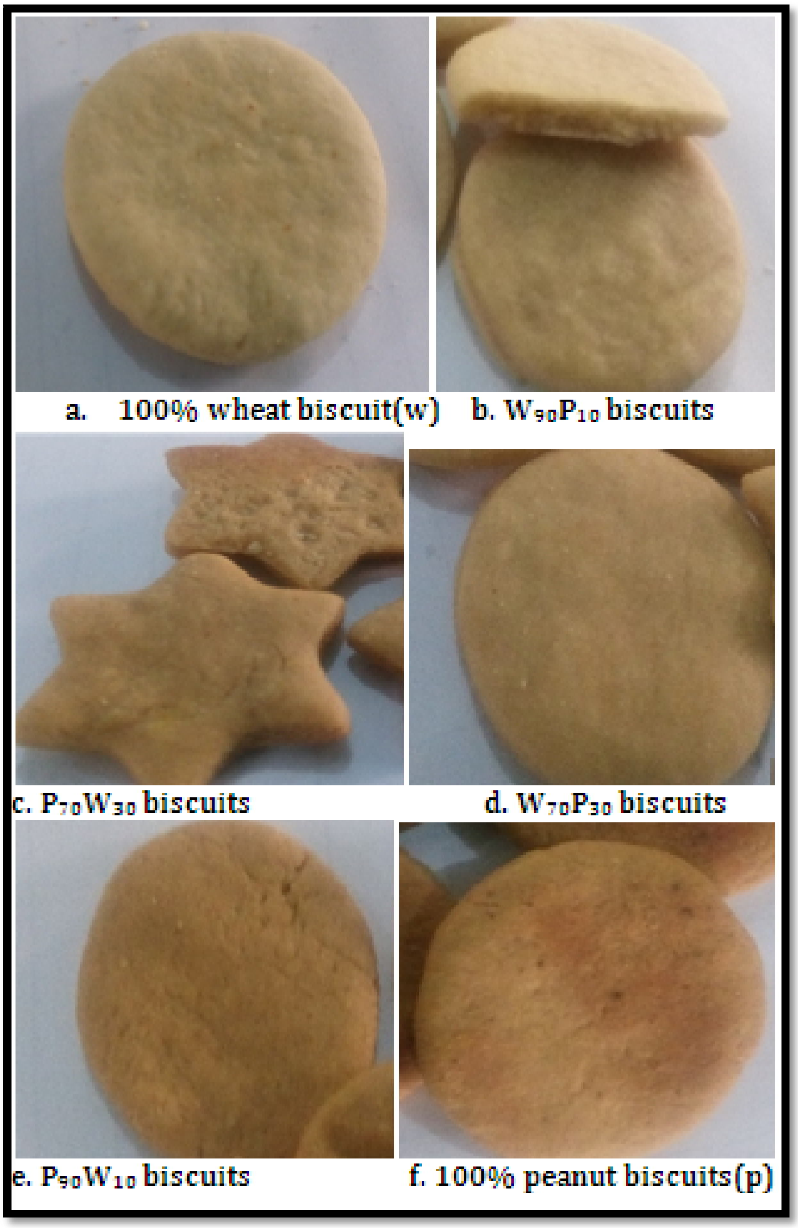

Figure 1: Biscuits Produced from Peanut and/Wheat Flour

Colour						
SAMPLES	L*	a*	b*	Weight(g)	Diameter(mm)	Thickness(mm)
$W_{90}P_{10}$	76.55±0.44^{e}	2.41±0.26^{a}	24.53±0.11^{c}	6.80±0.42^{b}	2.20±0.17^{a}	0.50±0.01^{a}
$W_{70}P_{30}$	69.59±0.33^{d}	4.87±0.20^{b}	23.81±0.04^{b}	4.56±0.64^{a}	2.30±0.10^{a}	0.42±0.01^{a}
$P_{90}W_{10}$	58.55±0.35^{b}	8.63±0.90^{c}	24.77±0.07^{c}	5.05±0.55^{a}	2.27±0.06^{a}	0.46±0.01^{a}
$P_{70}W_{30}$	59.47±0.23^{c}	8.97±0.15^{d}	24.76±0.22^{c}	4.70±0.90^{a}	2.30±0.10^{a}	0.48±0.06^{a}
W_{100}	83.57±0.10^{f}	2.27±0.14^{a}	24.61±0.32^{c}	5.11±0.32^{a}	2.40±0.10^{a}	0.60±0.00^{a}
P_{100}	45.60±0.37^{a}	12.91±0.22^{e}	21.43±0.25^{a}	5.60±0.63^{ab}	2.33±0.15^{a}	0.60±0.01^{a}

Table 3: Physical Properties of the Biscuits

- Each value is the mean ±SE, mean values having different superscript (a, b, c) are significantly different at $P \leq 0.05$
- W90P10 - 90% wheat and 10% peanut biscuits
- W70P30 - 70% wheat and 30% peanut biscuits
- P90W10 -90% peanut and 10% wheat biscuits
- P70W30 - 70% peanut and 30% wheat biscuits

- W100 - 100% wheat biscuit (control)
- P100- 100% peanut biscuits
- L = Lightness,
- A = redness to greenness
- B = yellowness to blueness.

3.3. Sensory Analysis

The results from sensory analysis is summarized in Table 4. There was significant difference at 5% level of significance between the judgments of colour, crunchiness and after-taste. The sample with the most acceptable colour was the 100% wheat biscuit with a mean score of 2.07. It was observed that the crunchiness of the biscuit was most acceptable in 100% peanut biscuit. This may be as a result of the significantly low moisture content in the peanut biscuits. However, 100% peanut biscuit was the least acceptable in terms of colour, taste, after-taste, aroma and overall acceptability with mean scores of 4.73, 3.87, 4.13, 3.53 and 3.73 respectively. The low acceptability maybe as a result of the strong nutty flavour produced by peanuts in the biscuits. However, the most acceptable sample in terms of taste and overall acceptability was the sample containing 90% peanut and 10% wheat with a mean score of 2.87 and 2.53 respectively. There was no significant difference between the judgements of taste, aroma, hardness and overall acceptability of all the biscuit samples.

3.4 Microbial Analysis

The results of the microbial analysis are summarized in Table 5. Whitish to cream filamentous growth was observed on the SDA plate, some black filamentous (tree-like) growth was also observed. Yeast growth is suspected and black mould growth. However, on the PCA plate, numerous whitish spots were observed. Although 100% wheat biscuits had the highest total viable count TVC and fungi count, all the biscuit samples did not follow a particular pattern. It is therefore suggested that the microbes were introduced accidentally after baking or during storage of the biscuits.

Sample	Colour	Taste	After-taste	Hardness	Crunchiness	Aroma	Overall Acceptability
$P_{70}W_{30}$	2.60 ± 1.18^{ab}	3.07 ± 1.16^{a}	3.07 ± 1.03^{ab}	3.07 ± 1.22^{a}	2.87 ± 1.25^{ab}	2.47 ± 1.19^{a}	2.87 ± 1.30^{a}
$P_{90}W_{10}$	3.27 ± 1.49^{b}	2.87 ± 0.99^{a}	3.07 ± 1.33^{ab}	3.00 ± 1.22^{a}	2.93 ± 1.39^{ab}	2.67 ± 1.05^{a}	2.53 ± 1.06^{a}
P_{100}	4.73 ± 2.09^{c}	3.87 ± 2.10^{a}	4.13 ± 1.64^{b}	3.20 ± 1.27^{a}	2.40 ± 1.06^{a}	3.53 ± 2.30^{a}	3.73 ± 2.15^{a}
$W_{90}P_{10}$	2.60 ± 1.40^{ab}	3.47 ± 2.13^{a}	3.13 ± 1.64^{ab}	3.73 ± 1.67^{a}	3.87 ± 1.96^{b}	2.93 ± 1.28^{a}	3.27 ± 1.62^{a}
$W_{70}P_{30}$	2.27 ± 0.70^{ab}	3.20 ± 1.78^{a}	2.87 ± 1.19^{a}	3.60 ± 1.68^{a}	3.53 ± 2.32^{ab}	3.20 ± 2.00^{a}	3.27 ± 1.91^{a}
W_{100}	2.07 ± 1.34^{a}	2.93 ± 1.87^{a}	3.13 ± 2.07^{ab}	2.67 ± 1.35^{a}	2.73 ± 1.87^{ab}	3.40 ± 1.88^{a}	2.73 ± 1.67^{a}

Table 4: Sensory Attributes of Biscuits

- Each value is the mean ±SE, mean values having different superscript (a, b, c) are significantly different at $P\leq0.05$
- $W_{90}P_{10}$ - 90% wheat and 10% peanut biscuits
- $W_{70}P_{30}$ - 70% wheat and 30% peanut biscuits
- $P_{90}W_{10}$ -90% peanut and 10% wheat biscuits
- $P_{70}W_{30}$ - 70% peanut and 30% wheat biscuits
- W_{100} - 100% wheat biscuit (control)
- P_{100} – 100% peanut biscuits
- A 9-point hedonic scale was used with 1 = extreme likeness and 9 = extreme dislike.

Sample	Total Viable Count (CFU/g)	Fungi (CFU/g)
$W_{90}P_{10}$	1.47×10^{6}	1×10^{4}
$W_{70}P_{30}$	1.21×10^{6}	1×10^{4}
$P_{90}W_{10}$	1.76×10^{6}	1×10^{4}
$P_{70}W_{30}$	1.47×10^{6}	1×10^{4}
W_{100}	1.81×10^{6}	2×10^{4}
P_{100}	1.60×10^{6}	1×10^{4}

Table 5: Microbial Analysis of Biscuit Samples

- W90P10 - 90% wheat and 10% peanut biscuits
- W70P30 - 70% wheat and 30% peanut biscuits
- P90W10 -90% peanut and 10% wheat biscuits
- P70W30 - 70% peanut and 30% wheat biscuits
- W100 - 100% wheat biscuit (control)
- P100 – 100% peanut biscuits

4. Conclusion

Peanut biscuits with acceptable nutritional quality was successfully produced in this study.Though biscuits made from 100% peanut flour received the lowest acceptability score in terms of colour and its characteristic aroma, biscuits made from 90% peanut flour and 10% wheat flour was generally the most preferred biscuit sample in terms of overall acceptability. Therefore, the prospects of using peanut flour in place of wheat flour in the future is promising. This will not only increase the nutritional content of the biscuit but will also help to save revenue on importation of wheat. It will also ensure that the protein-dense peanut meal obtained after extraction of oil is not wasted.

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