NUTRITIONAL EVALUATION OF ACHA (*Digitaria Exilis*) AND MALTED LIMA BEANS (*Phaseolunstus*) BASES BISCUITS

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Abstract: Biscuits are important in human diet and are usually eaten with tea and are also used as weaning food for infants. The aim of the study was to evaluate the nutritional composition of Lima beans –acha flour blend biscuits. Biscuits samples were prepared from varying compositions of (0:100, 5:95, 10:90, 15:85, 20:80, and 25:75) of added malted Lima beans to acha flour. The proximate, physical, functional, anti-nutrient and sensory properties of the biscuits were analyzed using standard methods. The average proximate composition for ash, crude protein and fat, (5.50 to 6.23, 6.53 to 20.73, 17.21 to 32.23, 1.6 to 1.9% respectively) except moisture and carbohydrate which decreases (3.45 to 2.45 and 65.93 to 40.34, with increase in the added malted Lima beans. The anti-nutrient which are saponins and flavonoid has negative result From 0% to 50% as they are naturally not present in Lima beans and acha grain.. The weight of the biscuit increases (46.13 to 53.10) while that of the volume, break strength and spread ratio of the biscuits decreases from 6.65 to 5.19, 17.75 to 11.75, 2419 to 192 g, respectively with increase in added malted Lima beans. The functional properties of the biscuit which are water absorption has the highest mean score at sample 50:50% and lowest mean score at 0:100%, the oil ability ranges between 1.30 to 1.75cm^3/g (0:50%).The bulk density of the flour ranged between 0.56 to 0.41g/cm^{3}with lowest value in sample (50:50) (0.43cm^3).The bulk density decreased as the level of substitution of malted Lima bean increased. The addition of malted Lima beans flour decreased the average mean Scores of the taste, colour and aroma increased from 6.00 to 6.40 and 6.00 to 6.60, 5.80 to 6.40 respectively with increase in the added malted Lima beans (0–25%) and further Increased cause a decrease. The average mean scores of general acceptability increased from 5.30 to 593 with increase in the added malted Lima beans up to 25% and further addition caused a fall in the average mean scores. This rresearch work has shown that acceptable biscuits product could be produced from blend of malted Lima beans and acha flour. The biscuit product is most acceptable and preferred at 25% added malted Lima beans which has correspondingly improved the nutrient content: 46% protein, 50% fiber, 19% calcium, 15% phosphorus and 15% magnesium.

Keywords: Evaluation, Acha (*digitaria exilis*), lima bean (*phaseolus lunatus*), biscuit

Introduction

Biscuits are important in human diet and are usually eaten with tea and are also used as weaning food for infants. The school going children use them as snacks while at school (Javaid *et al.*, 1995). They have been reported to be rich in carbohydrate and fat; hence they can be referred to as energy giving food as well as good sources of protein and minerals (Kure *et al*., 1998).The primary ingredients of simple biscuits include wheat flour, water, sugar, fat and eggs (Javaid *et al*., 1995). Other ingredients may include shortening, leavening agents, salt and flavour (Adebowale *et al*., 2012).

Acha (*Digitaria exilis*) also known as hungry rice is one of the indigenous and underutilized African cereals (Jideani and Akingbala, 1993). The cereal is uniquely rich in methionine and cystine and evokes low sugar on consumption (Ayo *et al.*, 2007). Lasekan (1994) reported that acha contains high pentosans, which gives it the property of absorbing water to produce very viscous solution, an attribute recognized for good baking operation. Findindg of the unique property of acha in diminishing biood glucose level and subsequent reduction of diabetic populace have made this crop an attractive research focus (Jideani, 1999; Ayo and Okoliko, 2003). Several works have been done on the baking potential of acha either as whole or composite flour with appreciable level of acceptance (Ayo and Nkama, 2004; Ayo *et al*., 2007; Olapade *et al*., 2011; Olapade and Oluwole 2013). Like most cereals, acha is deficient in essential amino acids such as lysine and tryptophan, therefore enrichment of cereal based foods with other protein source such as legumes has received considerable attention (Mensah and Tunkins, 2003). It is evident that when cereals and legumes are judiciously selected and combined, desirable pattern of essential amino acids of high biological value is obtained (Jideani, 1999).

Lima beans (*Phaseoluslunatus*) are plants producing fruits that are starchy at maturity and need processing before consumption, Lima bean seed contain between 22-25% proteins and make a significant contribution to the protein and energy requirement of many Nigeria (Adebayo *et al*., 2017). Lima beans are rich in niacin, thiamine and riboflavin (Sathe *et al*., 1984). They are said to contain high levels of potassium, phosphorus, calcium and iron (Ologhobo and Fetuga, 1984; Osagie *et al*., 1996). The role of Lima bean as a source of protein is however affected by several factors including low protein digestibility, flatulence and the presence of numerous anti-nutritional constituents which made up the most important single factor affecting its utilization (Sanchez *et al.*, 1966; Aletor and Fetuga, 1984) .

Acha is relatively low in protein quantity while Lima beans though high in protein but underutilize. Lima beans like other legumes contain some anti-nutrient such as trypsin inhibitor phyticacid, oxalate, which interfere with absorption and utilization of important minerals as well as reducing protein digestibility and the nutritive value of foods (El-Gohery, 2021) The acceptability of Lima beans –acha flour blend biscuits could improve the nutrient intake of the consumers, add values to acha food products, improve the commercial production of acha and Lima beans in Nigeria and hence reduce their underutilization (Ayo *et al,*. 2018).

Lima bean (Phaseoluslunatus) is a cheap source of protein to the Nigerians rural dwellers (Ezeagu and Ibegbu 2010). Despite the great potential of the crop, it is highly underutilised in

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Materials and Methods

Materials

The materials that would be used for the experiment are;Acha (*Digetariaexilis*),Lima beans (*Phaseoluslunatus*) seed and wheat flour.The other ingredients include, margarine, sugar, baking powder, salt and water were purchased in Lafia modern market,all chemicals were used on analytic grade.

Production of acha flour: The Acha flour was produced using acha grains, the grains was winnow to remove chaff and dust, adhering dust and stones were remove by washing in water (sedimentation)using local calabashes. The washed and destoned grains was dried in a cabinet drier at 45^{o}C to a moisture content of about (12`/.) The dried grains were milled using attrition milling machine and the flour sieved to pass through 0.4mm mesh size. The acha flour was packaged in air tight containers for use.

Production of germinated Lima bean flour : Lima beans was manually cleaned by hand picking the chaff and other dirt's. The cleaned Lima beans were washed with water in order to remove the adhering dirt. the Lima beans was soaked in water for 8 hours then spread on a jute bag and cover with and another jute bag then it was sprinkle with water after every 4hours ,and when germination starts, it was sun dried. The de-hulled Lima beans was air dried and milled using an attrition mill .The flour was sieve to pass through a 0.4mm mesh size and packaged in polyethylene bags, and stored at room temperature.

Production of Lima beans acha flour blends and biscuits: Production of Lima beans acha flour bends was produced by substituting Lima beans flour at 0,5,10,15,20,25 and 50% into acha flour (Table 1) and was used to produce Lima beans–acha flour blend biscuits. The blends were thoroughly mixed using a Kenwood blender to achieve uniform blending. The flour blends, salt and baking powder would mix together. Another separate mixing bowl was used to mix the butter, sugar and egg sun till the mixture become scream. The creamy mixture was poured in to the flour and mixed thoroughly. Water was added and mixed to obtain dough. The dough was cut in to different sizes and baked at 180°C for 15 minutes. The cookies was removed and allowed to cool before packaging in air tight containers.

Table 1: Recipes for the production of Malted Lima Beans-Acha flour blend biscuit

Materials %	A	B	C	D	E	F	G	H
Wheat flour	-	-	-	-	-	-	-	100
Acha flour	100	95	90	85	80	75	50	-
Lima beans Flour	-	5	10	15	20	25	50	-
Baking powder	1	1	1	1	1	1	1	1
Baking fats	30	30	20	30	30	30	30	30
Sugar	20	20	20	20	20	20	20	20
Salts	09	09	09	09	09	09	09	09
Water	60	60	60	60	60	60	60	60

A: 100%Acha, B: 95% Acha +5%Lima beans, C: 90% Acha + 10%Lima beans, D: 85% Acha + 15%Lima beans, E: 80% Acha +20%Lima beans, F: 75% Acha + 25%Lima beans, G: 50% Acha +50%Lima beans, H: 100% Wheat

Chemical Analysis

The method described in AOAC (2016) was used to analyze the proximate composition of samples for moisture, ash, fibre, fat, protein, while the carbohydrate content was calculated by subtracting the sum of the valve of the nutrient from 100.

Determination of mineral content

Potassium and sodium were determined using modified method of Baylin *et al*., (2003) the ashed sample was digested with perchloric acid and nitric acid, the readings were taken on January digital flame photometer. Phosphorus was determined by vanadolmolybdate colorimetric method. calcium, manganese, phosphorus, and zinc were determined Spectrophotometrically using buck 550 atomic absorption Spectrophotometer (buck scientific, Norwalk) (Essien *et al*,. 1992) and then compared their absorption of standards of these minerals.

Determination of Functional property of malted Lima beans-Acha flour blends.

The swelling capacity was determined as described by Ayo (2017). 100 mL graduated cylinder was filled with the sample to 10 mL mark. The distilled water was added to give a total volume of 50 mL. The top of the graduated cylinder was tightly covered and mixed by inverting the cylinder. The suspension was inverted again after 2 min and left to stand for a further 8 min. The volume occupied by the sample was taken after the 8th min.

The water absorption capacity of the flours was determined as described by Ayo (2018). One gram of sample mixed with 10 mL distilled water and allow to stand at ambient temperature (30 ± 2 °C) for 30 min, the centrifuged for 30 min at 3,000 rpm or 2000 × g. Water absorption was examined as per cent water bound per gram flour.

The oil absorption capacity was also determined by the method as described by Ayo (2018).). One gram of sample mixed with 10 mL soybean oil (Sp. Gravity: 0.9092) and allow to stand at ambient temperature (30 ± 2 °C) for 30 min, the centrifuged for 30 min at 300 rpm or 2000 × g.

Determination of the Physical Property of Malted Lima bean-Acha flour blend biscuits

The weight and diameter of the baked biscuit were determined by weighing on a weighing balance and measuring with a calibrated ruler, respectively (Ayo *et al.*, 2007). The thickness was measured according to AOAC method 10-50D (AOAC, 2000). The spread ratio was determined using the method of Gomez *et al*, (1997). Three rows of five well-formed biscuit were made and the height measured. Also the same were arranged horizontally edge to edge and sum diameter measured. The spread ratio was calculated as diameter/ height. The break strength of the biscuit was determined according to Okaka and Isieh (1990) method. Biscuit of known thickness (0.4cm) was placed between two parallel wooden bars (3.0cm apart). Weights were added on the biscuit until the biscuit snapped. The least weight that caused the breaking of the biscuit was regarded as the break strength of the biscuit.

Sensory Property of Malted Lima bean-Acha flour blend biscuits

Sensory (colour, taste, odour, texture, mouth feel) as described by Ayo *et al*,. (2017). Sensory evaluations of the biscuits were determined using fifteen-member panelist consisting of staff and students of faculty of agriculture, Nasarawa State University Keffi, Nigeria. The panelists were neither regular nor occasionally consumers of biscuits and were not allergic to any food. Biscuits samples prepared from each flour blend were presented in coded white microwavable plastic container. The order of presentation of samples to the panelists was randomized. Sachet water was provided to rinse the mouth between evaluations. The panelists were instructed to evaluate the coded samples for appearance, taste, colour, aroma, mouth feel, after taste, and overall acceptability. Each sensory attribute was rated on a 9-point Hedonic scale (for taste, aroma and 1 = disliked extremely, 5 = neither like nor dislike, while 9 = liked extremely (Ihekoronye and Ngoddy, 1985).

Statistical Analysis.

The data obtained from the various analysis were subjected to analysis of variance (ANOVA) using statistical package for social sciences (SPSS) version 16.0. Means were separated with Duncan Multiple Range test (DMRT) at 95% confidence level ($p<0.05$).

Results and Discussion

Effect of added malted Lima beans on the proximate acha flour

The effect of added malted Lima beans on the quality of acha biscuit is presented in Table 2. The moisture content of the biscuit decreased from 3.45 to1.90 at (0-5%) with increasing concentration of added malted Lima beans, on further increment the product has the highest moisture content of 3.56 at (20%) and a least mean at (5 -10%).The ash content of the product increased significantly ($p<0.05$) from 5.50 to 7.19. at (0-5%) with an increase in the percentage of added malted Lima beans flour.

The protein content increased significantly ($p<0.05$) from 6.53 to 20.73% it increases simultaneously with increase in the percentage of added malted Lima beans flour. The fat content increased from 17.21 to 32.23% it also increases simultaneously with increase in the concentration of added malted Lima beans flour.

The crude fibre of the product increased from 1.06 to1.9% simultaneously with increase in the added malted Lima beans flour. The carbohydrate content of the product decreased from 65.93 to 37.50 with increase in the percentage of added malted Lima beans. The increase in moisture content is relatively low (not significant) and could be due to the decrease in the carbohydrate content (Ayo *et al.,* 2017; Jideani, 1999). The low moisture content of the product agreed with other composite biscuits acha-soybean, amaranthus-wheat, acha-malted acha, Bambara groundnut-wheat flour, acha-beneseed, wheat-African bread fruit (Ayo and Nkama, 2004; Ayo *et al.* 2018; Ayo *et al*., 2010). This relatively low moisture content could be an advantage in extending the keeping quality (shelf life) of the product as most spoilage organism may not be able to thrive, and the biochemical and enzymatic reactions could be minimal (Ayo *et al.,* 2010).

The increase in ash content could be due to the added malted Lima beans flour this has been noted to be high in the same. High ash content has been related to high mineral content (Ayo and Okoliko, 2003), hence could improve the mineral level of the product and invariably that of the consumer. High ash content is usually as a result of high

Mineral which apart from the nutritional value are good for bones (Ayo *et al*., 2007).The increase in the fibre content could help to improve the digestion, aid waste elimination in the

Body and guide against anthracites (Ayo and Okoliko, 2003). The increase in protein contents

Of the samples could be due to the added malted Lima beans flour which from former work has been observed to contain high protein content (Boateng *et al.,* 2013; Alozie *et al*., 2009). The protein has been confirmed to contain some essential amino acids which are essential for growth and body building. All the assessed qualities compare favorably with that 100% Wheat flour.

Amino acids are of great importance to the body.

The increase in fat content, could be a good Source of energy supply to the body when eaten (Alozie *et al.,* 2009). The relative increase in the fat content of the product could be an disadvantage in extending the shelf life of the Product as the level of rancidity could be increased. The decrease in carbohydrate content could be due to relatively low carbohydrate content of added malted Lima beans flour. Ayo and Okoliko (2003) reported that bambara groundnut has low carbohydrate which relate to this Work because Lima beans is also a source of protein not carbohydrate.

Table 2. Proximate Composition(%) of Malted Lima Bean-Acha Flour Blend Biscuits

Material	MD	ASH	CP	FAT	CF	carbohydrate
0:100	3.45±0.21^{b}	5.50^{a}±0.01	6.53^{a}±0.04	17.21^{a}±0.01	1.06^{ab}±0.02	65.93^{d}±0.05
5:95	1.90^{a}±0.02	7.19^{c}±0.13	12.26^{b}±0.07	25.01^{e}±0.14	1.15^{c}±0.01	57.71^{a}±0.23
10:90	1.90^{a}±0.01	5.50^{a}±0.14	17.40^{e}±0.14	25.51^{b}±0.14	1.01^{a}±0.01	54.44^{c}±0.01
15:85	3.03^{b}±0.02	5.80^{a}±0.02	18.20^{c}±0.12	26.23^{c}±0.02	1.05^{b}±0.02	49.44^{b}±0.01
20:80	3.56^{b}±0.01	6.06^{b}±0.08	19.74^{c}±0.28	28.40^{c}±0.01	1.08^{b}±0.04	45.81^{b}±0.07
25:75	2.45^{b} ± 0.02	6.23^{b}±0.48	20.73^{c}±0.12	32.23^{c}± .12	1.09^{b}± 0.03	40.34^{b}± .05
100:0	1.05^{a}±0.01	6.13^{b}±0.05	13.11^{d}±0.02	30.86^{d}±0.14	1.12^{b}±0.02	37.50^{a}±0.07

Values are expressed as mean ± standard deviation). Means within each column with different superscript are significantly (p< 0.05) different. A: 100%Acha, B: 95% Acha +5%Lima beans, C: 90% Acha + 10%Lima beans, D: 85% Acha + 15%Lima beans, E: 80% Acha +20%Lima beans, F: 75% Acha + 25%Lima beans, G: 50% Acha +50%Lima beans, H: 100% Wheat

Effect of added malted Lima beans on the mineral composition of acha flour Blend Biscuits

The effect of added malted Lima beans flour on minerals composition of acha biscuit is shown on Table 3. The calcium in the samples decreases from 791.50 to 759.00 at (0 to 5%), but increases with the increase in the added malted Lima beans flour with the highest mean of 863.00 at (25%), and a least mean score of 755.00 at 100% wheat flour. The magnesium in the samples decreases from 59.50 to 51.00 at (0 to 10%), with further increase in the added malted Lima beans flour magnesium has the highest means score of 62.50 at (25%) and a least mean score of 51.00 at (10%) Lima beans flour increment.

The zinc in the sample decreases from 1.15 to 0.85 at (0% -5%), but on further increase in the added malted Lima beans zinc has the highest mean score of 3.12 at (25%) added malted Lima beans flour, and the least mean of 0.80 at (10%) added malted Lima beans flour. While phosphorous increase with the increase in the quantity of added malted Lima beans flour from 1.52 at (0%) to 1.72 at (50%), Respectively with increase in the added malted Lima beans (0-25%).

The increase in the nutrient content are significant ($p<0.05$). The increase could be due to the relative high Content of these nutrients in the added Lima beans. The consumption of these nutrient particularly calcium, magnesium and phosphorous have been identified to be of importance in the building of bones, cartilage and skeletal of human being. While zinc is of importance in the hair growth and enzymes build up in the body. All the assessed qualities compare favorably with that 100% wheat flour.

Table 3. Mineral Composition (g/Kg) of Malted Lima Bean-Acha Flour Blend Biscuits

*MLB:Acha	Ca	Mg	Zn	P
0:100	791.50^{a}±2.12	59.50^{a}±2.12	1.15^{a}±.21	1.52^{a}±0.03
5:95	759.00^{d}±1.41	55.00^{bc}±1.41	0.85^{ab}±0.07	1.45^{a}±0.02
10:90	779.00^{b}±1.41	51.00^{cd}±1.41	0.80^{cd}±0.14	1.51^{ab}±0.01
15:85	799.00^{b}±1.41	53.00^{cd}±1.41	0.90^{cd}±0.14	1.52^{ab}±0.01
20:80	813.00^{c}±4.24	58.50^{d}±0.71	2.85^{cd}±2.29	1.53^{b}±0.01
25:75	863.00^{c}±4.54	62.50^{d}±0.21	3.12^{d}±0.032	1.72^{c}± 0.03
100: 0	755.00^{d}±1.41	52.00^{cd}±2.82	1.35^{d}±0.21	1.48^{a}±0.02

Values are expressed as mean ± standard deviation). Means within each column with different superscript are significantly (p< 0.05) different. A: 100%Acha, B: 95% Acha +5%Lima beans, C: 90% Acha + 10%Lima beans, D: 85% Acha + 15%Lima beans, E: 80% Acha +20%Lima beans, F: 75% Acha + 25%Lima beans, G: 50% Acha +50%Lima beans, H: 100% Wheat

Effect of added malted Lima beans on the Physical property of acha flour biscuits

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Shown in Table 4. The weight of the samples increases from 46.13 to 57.25 with little fluctuation in the mean ratio. the volume of the samples decreases from 6.65 to 5.19.The spread ratio of the samples increased from 17.75 to11.75 with increase in the percentage of Lima beans flour (0 to 25%),1.75 also The effect of added malted Lima bean-on acha Flour increased the break strength of the biscuit from 984 to 192 g (table 4). The Increase in the weight of the sample could be due to the increase in the added malted Lima Beans and a decrease in the acha flour. Then the decrease in the volume of the sample could be due to the decrease in carbohydrate.

The relatively increase in the spread ratio Could be due to the increase in the oil and protein content in the added Lima bean flour, these Dilute the mass hence increase the spread. This agrees with the work of Ayo and Andrew, (2016) and Mazahib *et al.*,(2013) which find out an increase in the spread ratio of bambara Groundnut flour, which could enhance the same attribute. The decrease in break strength could be due to the poor structure formed from the high protein content of Lima beans and Carbohydrate content from acha. This could be a disadvantage as it will increase breaking of the biscuit during transportation and post handling of the biscuit (Ayo *et al.*, 2010; Nwosu 2013). However, this could also improve digestibility of the biscuits. All the assessed qualities compare favorably with that 100% wheat flour based biscuits.

Table 4. Physical Property of Malted Lima Bean-Acha Flour Blend Biscuits

***MLB:Acha**	**Weight**	**Volume**	**Spread ratio**	**Break strength**
0:100	46.13^{ab}±0.75	6.65^{c}±0.21	17.75^{f}±0.35	2419.50^{h}±0.71
5:95	44.37^{a}±1.44	5.83^{b}±0.78	16.75^{e}±0.35	984.00^{g}±1.41
10:90	46.10^{ab}±0.85	5.60^{b}±.078	15.75^{d}±0.35	807.00^{e}±2.82
15:85	57.25^{d}±0.40	5.79^{b}±.145	14.75^{c}±0.35	782.50^{d}±3.54
20:80	57.25^{b}±0.40	5.84^{b}±.078	14.25^{bc}±0.35	349.50^{b}±2.12
25:75	56.85^{b}±1.48	5.80^{b}±1.14	13.75^{b}±0.35	263.00^{c}±1.41
50:50	53.10^{a}±1.41	5.19^{b}±0.07	11.75^{a}±0.35	192.00^{a}±2.82
100%wheat	48.00^{d}±2.83	5.84^{a}±0.07	16.65^{f}±0.49	915.00^{f}± 7.07

Values are expressed as mean ± standard deviation). Means within each column with different superscript are significantly (p< 0.05) different. A: 100%Acha, B: 95% Acha +5%Lima beans, C: 90% Acha + 10%Lima beans, D: 85% Acha + 15%Lima beans, E: 80% Acha +20%Lima beans, F: 75% Acha + 25%Lima beans, G: 50% Acha +50%Lima beans, H: 100% Wheat

Effect of added malted Lima beans on the functional properties of acha flour

The functional properties of malted Lima beans are shown in Table 5. The water Absorption capacity was highest in sample (50:50%) and lower in sample (0:100%), the level Of water absorption capacity increased from 1.75 to 2.15cm^3/g as the level of the added malted Lima beans increased (0-50%).The effect is significant at p<0.05. Water absorption Capacity is the ability of flour particles to entrap large amount of water such that exudation Is prevented, this also has implication on viscosity (Niba *et al*., 2001).

Water absorption Capacity is also important in bulking and on consistency. The increase in the water absorption capacity could help to retain the freshness of baking product; however, it could also encourage the growth of microorganisms there by reducing the shelf stability of the product. The oil absorption capacity ranged between 1.50-1.75 cm^3/g with increase in the level of Malted lima beans (0:50%). This shows that the blends could be useful in bakery products where hydration is required to improve handling and in ground meat, doughnut and pancakes were oil absorption capacity property is of prime importance (Mepha *et al*.,2007). Sample (50:50) has the highest oil absorption capacity.

The bulk density of the flour ranged between 0.56 to 0.41g/cm^{3}with lowest value in sample (50:50) (0.43cm^3).The bulk density decreased as the level of substitution of malted lima bean increased. Bulk density is of paramount importance in the packaging and transportation of food products. It has also been proved that bulk density of food could affect the rate of digestion of food. High bulk density takes more time to undergo digestion, with more retention time in the small intestine and could result in to constipation. All the assessed qualities compare favourably with that 100% wheat flour.

Table 5. Functional property of malted Lima bean-acha Flour blend biscuits

*MLB:Acha	Swelling capacity	Water absorption	Oilabsorption	Bulkdensity
0:100	17.25^{b}±0.35	2.75^{a}±0.35	1.50^{a}±0.14	0.56^{a}±0.01
5:95	10.25^{a}±0.35	1.40^{a}±0.14	1.40^{a}±.14	0.53^{abc}±.035
10:90	21.00^{b}±1.41	2.20^{a}±0.28	1.65^{a}±0.21	0.53^{a}±0.01
15:85	19.00^{b}±1.41	2.10^{b}±0.14	1.65^{a}±0.35	0.50^{bcd}±0.01
20:80	18.50^{b}±2.12	2.15^{ab}±0.21	1.65^{a}±0.21	0.47^{bc}±1.49
25:75	17.50^{b}±2.12	2.15^{ab}±0.21	1.75^{a}±0.21	0.44^{de}±0.01
50:50	21.00^{b}±1.41	2.25^{ab}±0.35	1.75^{a}±0.07	0.41^{e}±0.01
100%wheat	18.00^{b}±2.83	2.15^{ab}±0.21	1.85^{a}±0.07	0.49^{bcd}±0.02

Values are expressed as mean ± standard deviation). Means within each column with different superscript are significantly (p< 0.05) different. A: 100%Acha, B: 95% Acha +5%Lima beans, C: 90% Acha + 10%Lima beans, D: 85% Acha + 15%Lima beans, E: 80% Acha +20%Lima beans, F: 75% Acha + 25%Lima beans, G: 50% Acha +50%Lima beans, H: 100% Wheat

Effect of added malted Lima beans on the sensory quality of acha flour biscuits

The effect of added malted Lima beans on the sensory quality of acha biscuit is Summarized in Table 6. The addition of malted Lima beans flour decreased the mean score of the taste from 8.00 at (0%), with increasing concentration of malted Lima beans flour (5%) and then decrease to 6.27 with further increase to 15%. The addition of malted Lima beans flour increased the mean score of the texture of the samples from 6.27 to 6.5 with increasing percentage (25%) of malted Lima beans flour and decreased (from 6.53 to 6.40).

Mean score for colour of the samples decreased from 7.80 to 6.27 with increase in the percentage (0 to 5%) of added malted Lima beans flour, on further increase in the percentage of malted Lima beans flour to 50% it increases to 7.13. The addition of added malted Lima beans flour increased the mean score for aroma from 6.13 to 6.53 with a means 5.4 as the least mean at 25% and 7.18 as the highest mean. Increased in the added malted Lima beans flour decreases the mean appearance from 7.53 to 6.67 (0 to 5%) and on further addition malted Lima beans flour the appearance has the highest mean score of 7.33 at 50% and a least mean score of 6.67 at 5% added malted Lima beans flour.

The average mean score for the mouth feel of the malted Lima beans -acha biscuit decreased from 7.80 to 6.13 with increase in percentage of added malted Lima beans flour (0 to 25%) and increased to 6.50, on further increase in the added malted Lima beans flour to(50%) it decreases to 6.40. the mean score of the after taste decrease from 7.80 to 5.73 at (0 to 5%) on further increased in the added malted Lima beans flour it has the highest means score of 5.80 at(20%) and the least mean score of 5.33at (25%,50% and 100).

Mean scores for overall acceptability increased from 7.99 to 5.60 with increase in the percentage of added malted Lima beans flour (0 to5%) and increased to 5.93 at 25% added malted Lima beans flour.The general reduction in the average mean scores could be due to the colour and inherent odour of the added malted Lima beans. It could be said that the malted Lima beans-acha flour blend biscuits is most preferred and acceptable at the addition of 25% malted Lima beans flour. However the malted Lima beans–acha flour blend biscuits are generally acceptable (with above 5.00 average mean scores for all the assessed quality) and also compare favourably with 100% wheat flour biscuits.

Table 6. Sensory Evaluation of Malted Lima Bean-Acha Flour Blend Biscuits

MLB:Acha	Appearance	Taste	Colour	Aroma	Mouthfeel	After taste	General acceptability
0:100	7.53^{a}±1.25	8.00^{d}±0.93	7.80^{d}±1.40	7.80^{b}±1.02	7.80^{b}±1.01	7.80^{b}±0.77	7.99^{b}±0.80
5:95	6.67^{a}±1.45	6.27^{a}±1.10	6.27^{a}±1.10	6.13^{ab}±1.55	6.13^{a}±1.56	5.73^{a}±1.67	5.60^{a}±1.91
10:90	6.87^{a}±0.83	6.30^{a}±2.81	6.67^{a}±1.35	6.23^{ab}±2.40	6.03^{a}±2.40	5.40^{a}±2.41	5.66^{a}±2.35
15:85	6.67^{a}±1.50	6.30^{a}±1.91	6.40^{a}±1.30	6.07^{ab}±2.67	6.07^{a}±2.66	5.73^{a}±2.10	5.73^{a}±2.71
20:80	7.07^{a}±2.12	6.40^{ab}±2.32	6.73^{ab}±1.03	6.53^{ab}±2.03	6.47^{ab}±2.00	5.80^{a}±2.51	5.73^{a}±1.84
25:75	7.17^{a}±2.12	6.53^{ab}±2.13	6.60^{ab}±1.30	5.40^{a}±2.41	6.50^{ab}±2.20	5.33^{a}±2.41	5.93^{a}±2.06
50:50	7.33^{a}±1.41	6.40^{ab}±1.80	7.13^{abc}±1.13	5.73^{a}±2.58	6.40^{ab}±1.92	5.33^{a}±2.41	5.83^{a}±2.52
100 % wheat	7.33^{a}±2.83	6.33^{c}±1.84	7.47^{c}±0.92	5.27^{a}±2.60	6.20^{ab}±2.20	5.33^{a}±2.70	6.13^{a}±2.00

Values are expressed as mean ± standard deviation). Means within each column with different superscript are significantly (p< 0.05) different. A: 100%Acha, B: 95% Acha +5%Lima beans, C: 90% Acha + 10%Lima beans, D: 85% Acha + 15%Lima beans, E: 80% Acha +20%Lima beans, F: 75% Acha + 25%Lima beans, G: 50% Acha +50%Lima beans, H: 100% Wheat

Conclusion

The research work has shown that acceptable biscuit products could be produced from blends of malted lima beans and acha flour. The biscuit product is most acceptable and preferred at 25% added malted lima beans which has correspondingly improved the nutrient content: 46% protein, 50% fiber, 19% calcium, 15% phosphorus and 15% magnesium. The acceptability of the malted Lima beans has added value to baked products and increase its marketability.

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