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PROTEIN AND AMINO ACIDS PROFILE OF LIMA BEAN (*PHASEOLUS LUNATUS*) FOODS IN KADUNA STATE.

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ABSTRACT
This study was conducted to determine the amino acids content of some lima beans (*Phaseolus lunatus*) foods in Kaduna state, so as to provide nutritional basis for increased utilization of lima beans as a value-added product in households. The foods include lima bean porridge, lima bean-benniseed and lima bean-hungry rice. These foods were subjected to proximate and amino acids analysis using standard procedures and analytical methods. Amino acid composition of lima bean-benniseed recorded higher content of essential amino acids leucine (6.97g/100g), lysine (7.10g/100g), methionine (2.60g/100g), threonine (3.81g/100g), and also had higher content of non-essential amino acids, tyrosine (3.45g/100g), alanine (4.54g/100g), serine (3.94g/100g), glutamic acid (12.94g/100g) and aspartic acid (8.68g/100g). Lima bean-hungry rice food had higher content of isoleucine (4.04g/100g), phenylalanine (4.13g/100g), tryptophan (1.26g/100g). Proximate composition shows that the protein content of lima bean-benniseed food (8.33%) and lima bean porridge (8.30%) were significantly ($P<0.05$) higher than lima bean-hungry rice food while lima bean-benniseed food had higher content of crude fat (13.46%), ash (2.28%) and crude fibre (4.09%) compared to other foods. The carbohydrate content (24.58%) of lima bean porridge was significantly ($P<0.05$) higher than other foods. The study shows that lima bean foods have a good nutritional profile therefore; increase in the consumption of foods prepared with lima beans could serve as an addition to food-based strategies used in decreasing malnutrition and its effects.

Keywords: Amino acids, Foods, Lima bean, Malnutrition, Proximate

INTRODUCTION

The existence of micronutrient deficiency is alarmingly high, with children suffering the consequences of poor diets and a failing food system. A report by UNICEF (2019) warns that poor eating and feeding practices start from the earliest days of a child's life and as children begin transitioning to soft or solid foods around the six-month mark, too many are introduced to the wrong kind of diet. This eventually leads to malnutrition which is not only an important cause of childhood mortality and morbidity, but also leads to permanent impairment of both physical and mental growth of those who survive. Nigeria is the most populous country in Africa, with about 40 million children, of which 11 million under 5 children are stunted and approximately 1.7 million are acutely malnourished (Manyike *et al.,* 2014). Nigeria has the highest burden of stunted children in the world with a national prevalence rate of 37 percent of children under five (NDHS, 2018). NDHS (2018) puts the number of Moderate Acute Malnourished (MAM) children under five years in Kaduna state at 4.8% and stunted children at 48.1%. This figure represents the number of children under five, whose future is bleak due to the devastating effects of malnutrition. Research shows that stunting has serious and irreversible consequences (NNHS, 2018).

Dietary diversification has been advocated internationally for the improvement of micronutrient intake and status (Hedwig *et al.,* 2012) which can curb the menace of malnutrition but the limiting factors affecting dietary diversification include; poverty, ignorance on dietary pattern, preferences, taboos and the work load of caregivers (Adam, 2005). Most people especially in poor or developing countries base their diets on starchy staples, lacking in important minerals and vitamins which are found in abundance in vegetables, flesh foods and legumes. Lima beans, an important source of protein and dietary fiber (Oboh *et al.,* 2000), is underutilized in many parts of tropical Africa probably due to lack of information on its potential as a good food source or its hard-to cook phenomenon (Subuola and Taiwo, 2012). Therefore, as efforts are being made to incorporate food-based strategies in the fight against malnutrition, there is a need to determine the nutritional composition of lima bean foods in order to increase awareness of their nutritional composition. Also, it will be an addition to existing food database.

MATERIALS AND METHODS

Collection of Lima Bean Seeds

Dry Lima beans *(Phaseolus lunatus)* seeds and all ingredients were purchased from Sabo market in Kaduna South Local Government Area of Kaduna State, Nigeria. The seeds were then identified at the herbarium of Department of Botany,

Ahmadu Bello University, Zaria, Kaduna state, Nigeria, and voucher number (2403) was deposited. The seeds were cleaned and sorted by hand, then kept at room temperature until use.

Lima Bean Foods Recipe

Recipe for the three foods were prepared according to the method described by Olumuyiwa *et al.,* 2020.

Table 1: Lima Bean Foods Recipe

Lima bean porridge Recipe		Lima bean-hungry rice Recipe		Lima bean-benniseed Recipe	
Ingredients	Quantity	Ingredients	Quantity	Ingredients	Quantity
Limabeans (g)	640	Limabeans(g)	320	Lima beans(g)	640
Beef(g)	500	Hungryrice(g)	330	Benniseed (g)	201
Curry (g)	2	Beef(g)	500	Beef (g)	500
Thyme (g)	4	Curry (g)	4	Curry (g)	2
Salt (g)	9	Thyme (g)	4	Thyme(g)	4
Water(ml)	340	Salt (g)	14	Salt (g)	9
Tomatoes(g)	262	Maggi (cubes)	5	Water (ml)	340
Onions(g)	272	Water(ml)	900	Tomatoes (g)	262
Palmoil(ml)	400	Palmoil (ml)	220	Onions (g)	272
Red Pepper (g)	37	Tomatoes(g)	291	Palmoil (ml)	400
Maggi (cubes)	4	Onions(g)	251	Pepper (g)	37
Groundnutoil(ml)	320	Pepper (g)	37	Maggi (cubes)	5
		Groundnutoil (ml)	320	Groundnut oil (ml)	320
Preparation		**Preparation**		**Preparation**	
Step 1 Rinsed beans		Step 1 Cleaned and rinsed hungry rice		Step 1 Rinsed beans and Par-boiled beans for 1 hour	
Step 2 Par-boiled beans for 1 hour		Step 2 Par-boiled beans for 1 hour		Step 2 Seasoned beef with magi cubes, thyme, curry, onions, salt and cooked for 40 minutes	
Step 3 Seasoned beef with maggi cubes, thyme, curry, onions, salt and cooked for 40 minutes		Step 3 Seasoned beef with curry, thyme, maggi cubes, onions, salt and cooked for 40 minutes		Step 3 Drained beans and par-boiled a second time for 20 minutes after which the beans was drained	
Step 4 Drained beans and par-boiled a second time for 20 minutes after which the beans was drained		Step 4 Drained beans and parboiled a second time for 20 minutes after which the beans was drained		Step 4 Roasted benniseed for 3 minutes	
Step 5 Poured groundnut oil into frying pan and heat for 2 minutes then fried beef for 15 minutes		Step 5 Poured groundnut oil into frying pan and heat for 3 minutes then fried beef for 15 minutes		Step 5 Grinded benniseed	
Step 6 Sliced tomatoes, pepper and onions		Step 6 Sliced tomatoes, pepper and onions		Step 6 Poured groundnut oil into frying pan and heat for 2 minutes then put beef into oil and fried for 15 minutes	
Step 7 Poured palmoil into the pot and heat for 2 minutes then added the sliced ingredients and fried for 10 minutes		Step 7 Poured palmoil into the pot and heat for 2 minutes then added the sliced ingredients and fried for 10 minutes		Step 7 Sliced tomatoes, pepper and onions	
Step 8 Added 340mls of broth from cooked beef and brought to a boil		Step 8 Added 900ml of water (broth water inclusive) and brought to boil		Step 8 Poured palmoil into the pot and heat for 2 minutes then added the sliced ingredients and fried for 10 minutes	
Step 9 Added beans and allowed to cook 20 minutes		Step 9 Added hungry rice and cooked for 10 minutes		Step 9 Added 340mls of broth from cooked beef and brought to a boil	
				Step 10 Added beans and allowed to cook for 20 minutes	

Protein and Moisture Determination

Proximate analysis was done using the methods described by AOAC (2000). The moisture content of the food recipes was determined after drying at 105^{o}C until a constant weight was obtained. The micro-kjeldahl method was employed to determine the total nitrogen and the crude protein estimated by multiplying the total nitrogen (N) by 6.25.

Amino Acid Analysis

The Amino Acid profile in the known sample was determined using methods described by Zhoalai *et al.,* (2014). The known sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Applied Biosystems PTH Amino Acid Analyzer.

Statistical Analysis

The results were expressed as mean ± standard deviation except where otherwise stated. The data was analyzed using descriptive statistics and Analysis of Variance (ANOVA) using Statistical Package for the Social Sciences (SPSS) version 20. Duncan multiple range test was used for multiple

mean comparison tests and P values less than 0.05 (P<0.05) was taken as significant.

RESULTS

The Protein and Moisture Content of Commonly Consumed Lima Bean (Phaseolus lunatus) Foods in Kaduna State

The protein and moisture content of lima bean foods is shown in Table (2). The result shows that all prepared foods had significantly (P<0.05) higher moisture than raw lima bean. The protein content of lima bean porridge and lima bean-benniseed foods are significantly (P<0.05) higher than lima bean-hungry rice food.

Table 2: Proximate Composition of Some Lima Bean (*Phaseolus lunatus*) Foods in Kaduna State.

	Raw Lima bean	Lima bean foods		
Proximate content (%)		Bean porridge	Bean-hungry rice	Bean-benniseed
Moisture	10.80±0.06[a]	54.28±0.02[b]	67.22±0.02[d]	55.26±0.05[c]
Crude Protein	19.45±0.05[c]	8.30±0.06[b]	4.66±0.04[a]	8.33±0.05[b]
Crude Fat	1.60±0.02[a]	10.61±0.02[c]	8.29±0.00[b]	13.46±0.02[d]
Crude Fibre	6.01±0.01[d]	3.05±0.01[b]	2.25±0.01[a]	4.09±0.02[c]
Ash	4.86±0.05[d]	2.20±0.02[b]	1.58±0.01[a]	2.28±0.02[c]
Carbohydrate	63.29±0.03[d]	24.58±0.05[c]	18.25±0.03[a]	20.70±0.03[b]

Values are mean ± S.D; values with different superscript across the rows are significantly (P < 0.05) different.

Amino Acids Composition of Some Lima Bean (*Phaseolus lunatus*) Foods in Kaduna State

The essential and non-essential amino acids content of lima bean foods is presented in Tables 3 and 4 respectively. The result shows that lima bean-benniseed recorded significantly (P<0.05) higher content of the essential amino acids leucine (6.97g/100g), lysine (7.10g/100g), methionine (2.60g/100g) and threonine (3.81g/100g) while lima bean-hungryrice food recorded higher content of isoleucine (4.04g/100g), phenylalanine (4.13g/100g), tryptophan (1.26g/100g). Valine (4.30g/100g) and histidine (3.27g/100g) were significantly (P<0.05) higher in lima bean porridge. Table 4 shows that lima bean-benniseed food had higher values of non-essential amino acid tyrosine (3.45g/100g), glutamic acid (12.94g/100g), alanine (4.54g/100g), serine (3.94g/100g) and aspartic acid (8.68g/100g).

Table 3. Essential Amino Acid Composition of Some Lima Bean (*Phaseolus lunatus*) Foods in Kaduna State.

Amino acid (g/100g)	Raw Lima bean	Lima bean Foods		
		Bean porridge	Bean-hungry rice	Bean-benniseed
Leucine	6.66±0.06^{c}	6.29±0.11^{b}	6.09±0.10^{a}	6.97±0.02^{d}
Lysine	6.97±0.13^{b}	7.05±0.01^{b}	5.51±0.15^{a}	7.10±0.28^{b}
Isoleucine	4.00±0.06^{b}	3.63±0.03^{a}	4.04±0.05^{b}	4.02±0.09^{b}
Phenylalanine	3.74±0.02^{b}	3.93±0.03^{c}	4.13±0.05^{d}	3.52±0.03^{a}
Tryptophan	0.97±0.02^{b}	1.01±0.04^{b}	1.26±0.10^{c}	0.67±0.01^{a}
Valine	3.90±0.10^{a}	4.30±0.00^{b}	4.04±0.05^{a}	4.02±0.13^{a}
Methionine	0.88±0.03^{a}	1.09±0.03^{b}	0.82±0.02^{a}	2.60±0.20^{c}
Histidine	3.34±0.06^{c}	3.27±0.07^{c}	2.83±0.15^{a}	3.08±0.05^{b}
Threonine	3.52±0.10^{c}	2.93±0.10^{a}	3.31±0.10^{b}	3.81±0.11^{d}

Values are mean ± S.D of two determinations; abcd= mean values with different superscript across the rows are significantly ($P < 0.05$) different.

Table 4. Non-Essential Amino Acid Composition of Some Lima Bean (*Phaseolus lunatus*) Foods in Kaduna State.

Amino acid (g/100g)	Raw Lima bean	Lima bean Foods		
		Bean porridge	Bean-hungry rice	Bean-benniseed
Proline	3.44±0.02^{c}	3.01±0.04^{b}	2.94±0.10^{b}	2.84±0.01^{a}
Arginine	5.51±0.01^{ab}	5.65±0.04^{a}	5.87±0.15^{b}	5.46±0.05^{a}
Tyrosine	3.11±0.01^{a}	3.26±0.01^{b}	3.15±0.05^{a}	3.45±0.01^{c}
Cysteine	1.51±0.01^{c}	1.33±0.01^{b}	1.29±0.10^{b}	0.92±0.01^{a}
Alanine	3.46±0.05^{a}	3.99±0.01^{c}	3.69±0.10^{b}	4.54±0.09^{d}
Glutamic acid	12.61±0.04^{b}	12.70±0.53^{b}	11.40±0.05^{a}	12.94±0.09^{b}
Glycine	3.22±0.03^{a}	3.67±0.04^{b}	4.26±0.15^{c}	3.56±0.02^{b}
Serine	4.25±0.04^{d}	3.68±0.11^{b}	3.14±0.05^{a}	3.94±0.04^{c}
Aspartic acid	8.55±0.14^{b}	7.66±0.19^{a}	7.64±0.10^{a}	8.68±0.00^{b}

Values are mean ± S.D of two determinations; abcd= mean values with different superscript across the rows are significantly ($P < 0.05$) different.

DISCUSSION

Beans are commonly consumed throughout the world because these economical foods have the potential to improve diet quality and long-term health of those who consume them regularly (Garden-Robinson, 2013). Lima beans have a lot of nutritional potentials and could easily be utilized in many food recipes (Obiakor-Okeke, 2014). The utilization of benniseed and hungry-rice in the preparation of lima beans recipes as elucidated in this research, is an added advantage to combating malnutrition. This is because hungry-rice and benniseed have significant amount of macronutrients, with benniseed being an oil seed. These cereals provide important minerals that compares favorably with other cereals (Robert *et al.*, 2013). The use of plant foods is being encouraged as a

means of dietary diversification in combating micronutrient deficiencies (Bamigboye and Adepoju, 2015).

The moisture content of the prepared foods was higher than the raw beans but lima bean-hungryrice had a higher moisture content compared to the other foods, which implies that it will have a shorter shelf-life because, the higher the moisture content of a food, the lower its shelf-life as commonly observed with processed food (Zeki, 2018). Processing of raw lima beans into lima bean foods resulted in significant reduction of nutrient values of the proximate composition except for crude fat. The percentage loss of nutrients may depend on destruction of the nutrients by heat and chemical changes such as oxidation (FAO, 1990). The increase in crude fat is due to addition of palm oil during recipe preparation which has a total fat value of 153% and about 50% saturated fatty acid (Imoisi *et al.*, 2015). Lima bean-benniseed food had higher fat content (13.46%) this is due to the high fat content (49.51%) of raw benniseed as reported by Adegunwa *et al.*, (2012). Also, lima bean-benniseed and lima bean porridge foods can serve as good sources of plant protein since they recorded higher protein content. This justifies their use as a cheap source of protein especially amongst poor populace in Nigeria who consume less of animal protein (Bamigboye and Adepoju, 2015).

The protein quality of a food depends on its essential amino acid content; these essential amino acids must be provided in the diet. Lima bean-benniseed had the highest chemical score which was calculated using the scoring pattern suggested by FAO/WHO/UNU (2007). This study shows that lima bean-hungry rice food has significantly higher content of isoleucine (4.04g/100g), phenylalanine (4.13g/100g), tryptophan (1.26g/100g), and arginine (5.87g/100g) than the other foods. Histidine, isoleucine and valine values of all the other foods were higher when compared to FAO/WHO/UNU (2007) requirements for children 2-5 years old except for phenylalanine. Leucine (6.97g/100g), lysine (7.10 g/100g), threonine (3.81g/100g) and methionine (2.60g/100g) content were higher in lima bean-benniseed food while valine (4.30g/100g) and histidine (3.27 g/100g) content were higher for lima bean porridge food. Lysine is a limiting amino acid in most cereals, it is (0.147g/100g) in hungry rice as reported by Robert *et al.*, (2013) and (1.55g/100g) in guinea corn/millet pap (Anigo *et al.*, 2009) but it is (5.51g/100g) in lima bean-hungry rice food, this suggests that lima bean is a good alternative to be used when preparing cereal based diet. Glutamic (12.61g/100g) and aspartic acids (8.55 g/100g) are most abundant non-essential amino acids in the three foods. This is not surprising as most seed proteins have high glutamic and aspartic acids content with limited methionine content (Ezeagu and Ibegbu, 2010). Generally, the three foods had high amounts of essential amino acids which make them potential sources of high quality protein.

CONCLUSION

Protein, moisture and amino acid content of Lima beans foods as consumed in Kaduna state has been established and it suggests that lima bean foods possess good nutritional profile to aid in averting malnutrition and its debilitating effects.

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