SHORT COMMUNICATION

Proximate composition and antinutritional factors of differently processed kidney bean (*Phaseolus vulgaris*) seeds

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Abstract

Kidney bean is an important source of high quality protein, as well as other nutritious substances. The higher the content of these nutritious substances in a given kidney bean, the higher it's quality. Proximate composition and anti-nutritional factors of raw and processed kidney bean seed were investigated with a view to finding alternative and cheaper source of protein. The study was conducted at plateau state college of agriculture livestock farm, Garkawa to investigate the proximate composition and anti – nutritional factors of differently processed kidney bean (*Phaseolus vulgaris*) seeds. The Processing methods investigated were raw, cooked, soaked, fermented and sprouted in (T1, T2, T3, T4 and T5) respectively. The results obtained indicates that Ether Extract (EE), Ash, Moisture contents and calculated Metabolizable Energy (ME) showed no significant difference ($P > 0.05$) between the processed and the raw sample. However, there were significant differences ($P < 0.05$) in the crude protein (CP) and crude fibre (CF) contents for both raw and processed samples. Fermented kidney bean seeds had the highest CP level of 25.00%, compared to sprouted, raw, soaked and cooked with CP % of 22.94, 20.70, 20.31 and 20.13%, respectively. The fermented kidney bean seeds had the highest CF of 10.55% while others did not differ with value of the raw. Anti – nutrients composition showed that fermented seeds had significant reduction in the levels of oxalate, saponin, tannin, cyanide, and trypsin inhibitor, compared to the raw sample. These results suggest that fermentation of kidney bean seeds enhances its usage as proteins source in animal feed due to its increased protein content and reduction in some anti – nutritional factors.

Keywords: Kidney bean seeds, Processing, Anti – nutritional factors, proximate composition.

La Composition immédiate et facteurs antinutritionnels des graines de haricot rouge (*Phaseolusvulgaris*) traitées différemment

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Résumé

Le haricot rouge est une source importante de protéines de haute qualité, ainsi que d'autres substances nutritives. Plus la teneur en ces substances nutritives d'un haricot est élevée, plus sa qualité est élevée. La composition immédiate et les facteurs anti-nutritionnels des graines de haricots rouges crus et transformés ont été étudiés en vue de trouver une autre source de

protein qui seramoins chère. L'étude a été menée à la ferme d'élevage de College d'Agriculture, dans l'état de Plateau, à Garkawa, au Nigeria, pour étudier la composition immédiate et les facteurs anti - nutritionnels des graines de haricot rouge (*Phaseolusvulgaris*) traitées différemment. Les méthodes de traitement étudiées étaient crues, cuites, trempées, fermentées et germées en (T1, T2, T3, T4 et T5) respectivement. Les résultats obtenus indiquent que l'extrait d'éther (EE), les cendres, les teneurs en humidité et l'énergie métabolisable (EM) calculée n'ont montré aucune différence significative ($P > 0,05$) entre l'échantillon traité et l'échantillon brut. Cependant, il y avait des différences significatives ($P < 0,05$) dans les teneurs en protéines brutes (PB) et en fibres brutes (FB) pour les échantillons bruts et traités. Les graines de haricots rouges fermentés avaient le niveau de PB le plus élevé de 25,00%, comparativement aux graines germées, crues, trempées et cuites avec des PB% de 22,94, 20,70, 20,31 et 20,13%, respectivement. Les graines de haricots rouges fermentés avaient le FB le plus élevé de 10,55% tandis que d'autres ne différaient pas avec la valeur de la matière première. La composition anti - nutriments a montré que les graines fermentées avaient une réduction significative des niveaux d'oxalate, de saponine, de tanin, de cyanure et d'inhibiteur de trypsine, par rapport à l'échantillon brut. Ces résultats suggèrent que la fermentation des graines de haricots rouges améliore son utilisation comme source de protéines dans l'alimentation animale en raison de sa teneur accrue en protéines et de la réduction de certains facteurs anti-nutritionnels.

Mots clés : Graines de haricots rouges, Transformation, Facteurs anti - nutritionnels, composition immédiate.

Introduction

The ultimate goal of livestock production is the attainment of sustainable production with minimum cost of production and maximum returns. This has however been difficult to achieve due to high cost of feed and feed ingredients (Adeniyi and Balogun, 2002). The conventional protein ingredients for animal feed production such as soybeans and groundnut cake have become scarce and expensive due to high demand for human consumption (Adedayo, 2012). Therefore, the exploration of other potential feed resources for the industry has become very important research option in order to address the urgent need for alternative replacements that will arrest the high cost of feedstuff. Kidney beans (*Phaseolus vulgaris*) seeds is a native feed stuffs locally available and affordable to the farmers that have potentials to serve as an alternative feed ingredient for animal feeds production. Kidney beans are one of the most important domestic legumes because

of their high concentration of protein, fibre and complex carbohydrates (Kris, 2018). Kidney bean seeds has about 22.7% protein, 3.5% mineral matter, 1% fat, 5.1% crude fibre and 5.7% total carbohydrates (Khali *et al.*, 1986). However, the biological utilization of the nutrients is interfered by various anti-nutritional factors present in the beans. It is noteworthy that use of any grain legumes as feed stuffs for livestock is influenced by factors such as their contribution of nutrients to the diets, the availability of such nutrients to the animals and possible harmful effect of anti - nutritional factors which individually or in association exert negative effects on growth, feed efficiency and health of the animal. The anti-nutritional factors reported in kidney bean seeds are phytohaemagglutinin (Weder *et al.*, 1997), trypsin inhibitor (Angela and Domenico, 2003), saponin (Yao *et al.*, 2006), urease, genistein, alkaloids, cyanogenic glycosides, goitrogen, polyphenolic

compound (tannin), oxalate, phytates, oligosaccharides and antigenic proteins (Weber and Berry, 2010). Therefore, the effects of these toxic compounds include lowering the bio availability of sulphur amino acids with respect to trypsin inhibitors (Kakade *et al.*, 1974). Phytates inhibit energy utilization in birds by binding phosphorus, an element that plays a vital role in energy metabolism. (Udedibie and Carlini, 1998), and lower mineral and vitamin bioavailability (Maga, 1982); Lectins cause haemagglutinating effects (Liener, 1974); tannins form insoluble complexes with protein, thus interfering with the digestion process by inactivating the digestive enzymes (Bate-Smith, 1974) and hydrocyanic acid poisoning is caused by cyanogenic glucosides when the latter is hydrolyzed (Olomu, 2011).

Olomu (2011) and Ari *et al.* (2012) reported that most anti – nutritional or toxic factors of legumes can be eliminated through processing and to improve the nutritional quality and the acceptability of legume seeds, various processing techniques have been employed to reduce or destroy the anti – nutrients present in them. Some of the commonly used processing techniques include soaking in water, boiling at high temperature, toasting, sprouting, alkaline or acid solution, autoclaving, dehulling, microwave treatment, steam blanching and fermentation (Esenwah and Ikenebomeh, 2008; Ari *et al.*, 2012). This research was therefore aimed at investigating the effects of different processing on the proximate composition and antinutritional factors of kidney bean (*Phaseolus vulgaris*) seeds.

Materials and methods

Experimental location

The proximate composition, amino acids profile and anti-nutritional factors (tannin, saponin, oxalate, cyanite and phytic acids) carried out at Zoology department university of Jos and trypsin inhibitor was

carried out at Livestock Analytical Laboratory, Institute of Agricultural Research and Training Moor Plantation, Apata Ibadan Oyo state, Nigeria.

Source of test ingredients

The kidney bean seeds were purchased from Mangu market of Plateau state, Nigeria

Processing of test ingredients

The kidney bean seeds purchased were sorted to remove dirt and contaminants before subjecting to differently processing methods. All the processing of the kidney bean seeds was done during the dry season (January).

Sun-drying (raw seeds)

The clean seeds were sun-dried for 96hours. Constant turning of the seeds was done.

Cooking

The cooking of the kidney bean seeds involved the heating of the water until it began to boil at 100⁰c before turning the seeds into the boiling water. The seeds were then allowed to cook for 60minutes. The cooking time was taken from the moment the seeds were turned into the boiling water. The cooked seeds were drained using a basket and sun-dried for 96hours.

Soaking

The clean seeds were soaked in water for 12hours, after which the first water was drained and fresh water was replaced and left for another 12hours. The soaked seeds were drained and sun-dried for 96hours.

Fermenting

The clean seeds were turned into boiling water and allowed to be cooked for 60minutes. The tampered seeds were drained and put in a plastic container and covered and kept in an air tight enclosure for 96hours for fermentation to take place. The fermented seeds were sun-dried for 96hours.

Sprouting

The kidney bean seeds were broadcasted in woven basket containing sand and saw dust. The broadcasted seeds were watered daily

for 48hour and allowed to be sprouted. The sprouted seeds were removed and thoroughly washed, drained and sun-dried for 96hours. A sample of the kidney bean seeds from each of the processing methods were finely grounded and taken to the laboratory to analyze for its proximate composition, amino acids profile and anti-nutritional (saponin, oxalate, tannin, phytic acid and trypsin inhibitor) factors to determine the effect of processing on each of these chemical components

Proximate and antinutritional factor analysis

The proximate composition and anti – nutritional factors (saponin, tannin, phytic acid, oxalate, nitrogen cyanite and trypsin inhibitor) of Kidney beans (*Phaseolus vulgaris*) samples were carried out using method outlined by AOAC (2006); tannin, saponin, nitrogen cyanite were by Harborne (1973); oxalate was by Abeza *et al.* (1968); phytic acid was by Lucas and Marhaka (1975) and trypsin was by Kakade *et al.* (1969).

Results and discussion

The results of the proximate composition of the raw and differently processed kidney bean (*Phaseolus vulgaris*) seeds are presented in Table 1. The crude protein of fermented kidney bean seeds (25.00%) were significantly ($P < 0.05$) higher than that of sprouted seeds (22.94 %) raw (20.70%), cooked (20.13%) and soaked (20.31%). The crude protein content of the raw, cooked and soaked did not differ significantly ($P > 0.05$). This agreed with the finding of Damang (2016) who reported the percentage values of fermented, boiled and toasted kidney bean seeds (24.75, 22.94 and 22.70%) respectively. This also agrees with the earlier findings of Olomu (2011) and Anon (2012) who reported the crude protein levels of sprouted and fermented kidney bean seeds as 23.9 and 24.0%, respectively. It also agreed with the finding

of Ari and Ayanwale (2012) that the crude protein of African locust beans ranges from 22.00-22.75% The crude protein levels of the cooked and soaked (20.13 and 20.31%) falls in line with the report of Banerjee (2009) with the value of 20.5% of kidney bean seeds. No significant ($P > 0.05$) difference was registered for ether extract in both raw and processed kidney beans seeds. However, the values for soaked, fermented and sprouted seeds decreased when compared to raw seeds, except cooked seeds which were slightly higher than raw. The ether extract levels of the soaked and fermented kidney bean seeds fell within the range of the findings of Audu and Aremu (2011) who reported the ether extract level of 3.1% in cowpea. The ether extract values (3.55, 3.66, 3.16, 3.15, and 3.38% of raw, cooked, soaked, fermented and sprouted respectively) of the raw and processed kidney bean seeds were lower. This observation disagreed with the report of Kingsley (1995) that cooking and fermentation enhanced the level of ether extract in African oil beans. There were no significant ($P > 0.05$) difference in the ash content of the raw and differently processed kidney bean seeds. There were significant ($P < 0.05$) differences in the dry matter content of the raw and processed kidney bean seeds. The sprouted and soaked kidney bean seeds were significantly ($P < 0.05$) higher than the raw, cooked and fermented seeds. The raw, sprouted and fermented seeds were similar to each other. Significant ($P < 0.05$) differences existed for nitrogen free extract of both raw and differently processed seeds. The soaked seeds were significantly ($P < 0.05$) higher than the cooked, fermented and sprouted, but were similar to the raw seeds. The value 57.26% of Nitrogen free extract for raw, sprouted and cooked (57.26, 56.45, 55.34%) respectively falls within the percentage value of Banerjee (2009), who reported 57.8%. Fermented kidney bean

seeds Nitrogen free extract of the beans seeds in all the processing methods in this study agreed with the findings of Audu and Aremu (2011) who reported boiled, cooked, roasted sprouted and fermented 58.5, 61.1, 50.3, 59.7 and 49.7%, respectively of red kidney bean seeds.

Calculated metabolizable energy using Pazuenga, (1985) value of raw kidney bean seeds were statistically similar, irrespective of other methods, however, soaked and sprouted beans were slightly higher in metabolizable energy compared to other processing methods. The energy content of kidney beans in this study showed that it has energy concentration than some cereals. The result of the antinutritional factors of the raw and processed kidney bean (*Phaseolus vulgaris*) seeds are presented in Table 2. The result showed that cooking and fermentation reduced the levels of oxalates, saponin, tannins, hydrocyanic acids and trypsin inhibitors, except phytic acid. This agreed with the report of Kingsley (1995); Balogun *et al.* (2001) and Olomu (2011) who found that most antinutritional or toxic factors of legumes can be eliminated by

proper application of heat. In sprouting method, the levels of oxalates, tannins and phytates were similar to that of the raw kidney bean seeds, but the levels of saponin and cyanide increased compared to the raw kidney bean seeds. That of trypsin inhibitor reduced compared to the raw. The level of trypsin inhibitor in sprouting method agreed with the findings of Laurence (2002) who reported that trypsin inhibitor and phytates decrease during the sprouting of kidney bean seeds. The high levels of oxalates, saponin, tannins, cyanide and phytates in soaking method showed there were no reductions in the anti - nutritional factors. This agreed with the findings of Alu and Ahiwe (2018) who reported a progressive increase in the value of acids content of kidney bean seeds as the time of soaking increases. However, fermented kidney bean seeds had the lowest concentration of anti – nutritional factors. This reduction is beneficial because high content of anti – nutritional factors in raw bean reduce nutrient intake, digestion, absorption and utilization of nutrient by monogastric animals.

Table 1: Proximate composition of raw and processed kidney beans (*Phaseolus vulgaris*) seeds

Parameters	Experimental Treatments					
	T1	T2	T3	T4	T5	SEM
Dry matter (%)	95.09	95.17	95.84	95.18	96.23	0.98*
Crude protein (CF)%	20.70 ^c	20.13 ^c	20.31 ^c	25.00 ^a	22.94 ^b	0.53*
Ether extract (EE)%	3.55	3.66	3.16	3.15	3.38	0.08 ^{ns}
Ash (%)	4.81	6.48	5.48	4.65	5.54	0.15 ^{ns}
Crude fibre (CF)%	8.85 ^{ab}	9.52 ^{ab}	6.48 ^b	10.55 ^a	7.84 ^{ab}	0.11*
Moisture content (%)	4.91	4.83	4.16	4.82	3.77	0.16 ^{ns}
Nitrogen free extract (NFE)%	57.26 ^{ab}	55.34 ^b	60.51 ^a	51.86 ^c	56.45 ^b	0.85*
*ME Kcal/kg	3083.20	3007.25	3159.01	3023.33	3126.33	23.70 ^{ns}

a, b, c = means on the same superscript are significantly different, ns = not significant, T1 = Raw kidney beans, T2 = Cooked Kidney beans, T3 = Soaked kidney beans, T4 = Fermented kidney beans, T5 = Sprouted kidney beans, SEM = Standard Error of Mean, ME Kcal/kg = Metabolizable energy, (*) ME Kcal/kg = Pazuenga (1985) ME (kcal/kg) = 37x%cp+81.8x%EE+35.5x%NFE)

Table 2: Antinutritional factors analysis of kidney bean (*Phaseolus vulgaris*) seeds

Parameters	Experimental Treatments					SEM
	T1	T2	T3	T4	T5	
Oxalate (mg/100g)	115.59 ^a	93.93 ^b	109.95 ^a	53.41 ^c	99.03 ^a	6.56*
Saponin (%)	1.65 ^b	0.39 ^b	1.83 ^{ab}	0.76 ^c	1.95 ^a	0.17*
Tanins(mg/100g)	112.59 ^a	58.76 ^b	112.29 ^a	59.74 ^b	120.61 ^a	7.59*
Cyanide(mg/100g)	0.61 ^b	0.48 ^b	0.77 ^b	0.53 ^b	1.36 ^a	0.10*
Phytate(mg/100g)	341.80 ^{ab}	374.80 ^a	291.44 ^b	316.94 ^{ab}	324.53 ^{ab}	9.84*
Trypsin Inhibitor(mg/100g)	15.53 ^b	5.88 ^d	29.82 ^a	0.00 ^c	8.05 ^c	2.70*

a, b, c = means on the same superscript are significantly different, ns = not significant, T1 = Raw kidney beans, T2 = Cooked Kidney beans, T3 = Soaked kidney beans, T4 = Fermented kidney beans, T5 = Sprouted kidney beans, SEM = Standard Error of Mean

Conclusion

The proximate composition revealed the nutrient content of kidney bean seeds as a good protein source for animal feed. Processing methods such as cooking, soaking, and fermentation had beneficial effects in reducing some anti – nutritional factors. Therefore, fermentation for 72 hours as a processing method is recommended, if kidney bean seeds are to be used for the production of feeds for monogastric animals. However, significant reductions were observed in trypsin inhibitor, oxalate and saponin, respectively.

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