Effect Of Processing On Proximate, Energy, Anti-Nutritional Factor, Amino Acid And Mineral Composition Of Lablab Seed

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Abstract: A study was conducted to assess the effect of various techniques of processing (decortication, toasting and boiling in tap water) on proximate, anti-nutritional factor (ANF), amino acid and mineral composition of Highworth, variety of Lablab purpureus seed. Processing reduced the levels of all the ANFs evaluated in the present study. Boiling in water, was determined to be the best method, reduced tannins, alkaloids, oxalates, Trypsin inhibitors and HCN by 37, 33, 38, 100 and 89% respectively. Processing also resulted in reductions in crude protein, crude fibre, ether extracts, ash and gross energy by 8, 14, 17, 23, 10 and 8%, while NFE increased by 10%. The levels of nutrients in boiled lablab, however, compared favourably with feed grade soybean, while being likely to be much cheaper.

KEY WORDS: Highworth, Minor-legumes, Unconventional-feed-ingredient.

1 INTRODUCTION

HUMAN and livestock populations continue to increase, so does the cost of feed, due to increased pressure on the conventional animal feed ingredients, such as soybeans, groundnuts and maize. These are also human food staples in the less developed countries. Consequently, there is an equally perpetual effort by researchers to determine the suitability of alternative plants to serve as sources of protein, energy and other nutrients for non-ruminant animals and aquaculture species (Shaahu et al., 2010a; Shaahu et al., 2010b; Okpanachi et al., 2012). The target materials are those that are either unsuitable for human consumption, or that have very low human preference, and therefore very cheap. Many of these materials, however, have organoleptic and/or medicinal uses, depending on the part of the world. A widespread characteristic of the plants targeted to serve as alternative feed ingredients is high content of secondary plant metabolites, commonly called anti-nutritional factors, due to the negative effect most of them have on digestibility and utilisation of many nutrients. The presence of anti-nutritional factors in any material intended for use in non-ruminant animal feeds necessitate some form of processing to eliminate them or reduce their concentration. Processing, however, often affect, negatively, the nature and/or concentration of many nutrients. The lablab bean (Dolichos lablab or Lablab purpureus) is a legume with potential to serve as an alternative plant protein source for livestock. Lablab possesses wide adaptability to the tropics and sub-tropics, it is very drought-resistant when established (Luck, 1965), and also very shade-tolerant. Lablab has low human preference and has no present industrial use. Lablab beans grow well from sea level up to about 1500 meters and it requires well-drained soils. The plant starts flowering at about 3 months of age and continues to produce copious amounts of seed as well as remaining green throughout the year. Reports have shown that lablab seed contain 23-29% crude protein (Murphy and Colucci, 1999; Ogundipe et al., 2003 and Osman, 2007) and 4-11% crude fibre (Kuo, 1967; Ogundipe et al., 2003 and Osman, 2007).Lablab seeds are also reported to contain significant quantities of anti-nutritional factors such as tannins, phytate, and trypsin inhibitors, which would limit its use in monogastric animal feeding (Chav-chifaicheunget al., 1997; Murphy and Colucci, 1999). Lablab, thus, require to be suitably processed to eliminate or reduce these anti-nutritional factors. Heat treatment is a frequent technique employed to reduce or totally eliminate the anti-nutritional factors contained in legume seeds (Cama and Morton, 1950; Ikurior et al., 1993; Marty and Chavez, 1993; Kaankuka et al., 2000; Ikurior, 2003 and Tuleun and Patrick, 2007). Other methods include chemical treatment (Sat and Keles, 2002), decortication of seeds (Singh, 1988; Shaahu et al., 2010); fermentation of seeds (Lee et al., 1972) and sprouting of seeds (Peer and Leeson, 1985; Ramakrishna et al., 2006). The present work is aimed at investigating the effect of various processing techniques on the chemical composition of Lablab purpureus seed.

Materials and Methods

Four equal quantities (15kg) of raw lablab (Highworth variety) seed were subjected to various processing procedures (Fig. 1). One of the samples was left unprocessed (raw), the second sample was decorticated by cracking the seeds in a milling machine to separate the cortex from the cotyledon. The third sample was toasted by pouring the seeds into a heated toasting pot and agitating continuously, to prevent the seeds from charring, till the seed flaked, producing the characteristic aroma of toasted seed. The fourth sample was boiled in water for 40min, by first bringing thirty litres of water to boiling in a 100 L capacity metal drum and adding the 15 kg lablab seed added to it. Timing commenced after the water recommenced boiling. At the end of the period of boiling, the water was drained off, and the cooked seeds were sun-dried to less than 10% moisture by spreading thinly on concrete. The raw and the processed lablab seed were then milled in readiness for chemical analysis. Proximate chemical composition for all samples of lablab seed were determined according to official methods of analysis (A.O.A.C., 1995). Nitrogen free extract (NFE) was obtained by difference, while gross energy was determined using the adiabatic oxygen bomb calorimeter technique. Tannin was determined according A.O.A.C., (1995) using methanol/paraffin impregnated double layered Whatman No 41 filter paper, and Folin-Denis reagent. Trypsin inhibitory activity was determined according to the method of Kakade et al. (1974), according to which one trypsin inhibitor unit

(TIU) is defined as an increase of 0.01 absorbance units at 280nm per 10ml of the reaction mixture under the conditions of the procedure. Saponin was also determined according to the procedures of Kakade et al., (1974), and phytate was determined according to Maga, (1983). Haemagglutinin was determined according to Liener, (1955), Oxalate and Alkaloid according to the methods of Henry, (1993) and hydrocyanic acid using the modified alkaline titration method (A.O.A.C, 1995). Amino acid profile was determined using the methods of A.O.A.C. (1995), and a chemical score was calculated using the concept of Block and Mitchell (1946). Mineral content was determined by wet-ashing, followed by refraction in an Atomic Absorption Spectrophotometer (Model: Philip Analytica PU 9100X).

Results and Discussion

Results of proximate and gross energy analysis for the variously processed lablab seeds are presented in Table 1. In general, the processing methods used in this study resulted in minor reductions in gross energy and proximate fractions, the exception being NFE which showed increases when the seeds were either decorticated or boiled. The NFE fraction is made up of sugars and soluble carbohydrates, non-volatile and is in higher concentrations in the cotyledons than the cortex of the seeds. It is logical for this fraction to increase as a result of decortication and toasting, and to decrease due to the heated aqueous environment of boiling. It is, therefore, difficult to explain its increase in response to boiling observed in the present study. The effect of decortication on ether extract content suggests that the seed cortex is richer in fats than the rest of the seed. This is contrary to other findings, which state that fats are contained mainly in the parenchyma cells of the cotyledon (Wolf and Cowan, 1975). The results of the effect of the various methods of processing on anti-nutritional factor content of seeds are presented in Table 2. The aim of processing is to reduce or eliminate anti-nutritional factors. Decortication is found to be the best method for decreasing tannins and alkaloids, and boiling is best for all other factors. Trypsin and other protease inhibitors are the most potent anti-nutritional factors, because, being anti-enzymes and structurally similar to enzymes in nature and activity, their effect is all encompassing and astronomically high in proportion to the physical amounts present. Boiling practically eliminates these anti enzymes, while decortication, apart from resulting in substantial loss of material, has very limited effect on them. This makes it very easy to make boiling the method of choice for processing lablab seeds. An inspection of the data in Table 3 shows that, with the exception of arginine (1.61%) and histidine (4.37%), the various processing methods lead to substantial (10-19%) losses of essential amino acids. The processed material is still far superior to processed soybeans for most amino acids, making the losses due to processing an acceptable price to pay. Lablab seed content of many essential minerals (Table 4) are lower than those of other oil seeds such as sunflower, cotton seed and soybean (Ikurior and Fetuga, 1991; Larbier and Leclereq, 1994). These authors report a decrease in mineral content due to boiling in water. In the present study as ash content was also reduced by processing. Toasting and boiling caused more reduction in the mineral content of lablab seed than when the seeds were decorticated. It is difficult, though, to explain the route of loss when the material is toasted.

Conclusion

The findings of this study would serve as valuable assets for feed manufacturing. It will also encourage the use of the relatively cheap and less competitive legume seeds as feed ingredients. This will further reduce the cost of feed in the livestock sector, save foreign earnings; improve the profit margin of farmers and livestock producers.

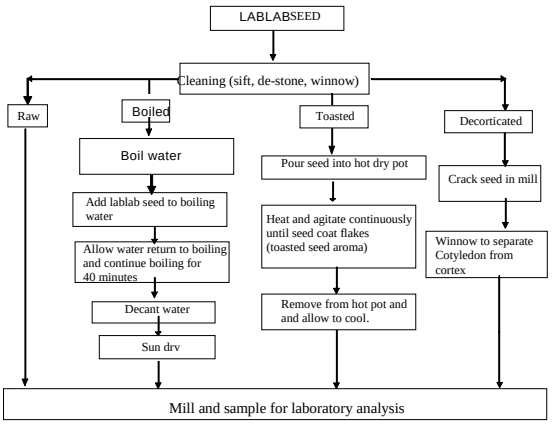

Figure 1: Seed Processing Flow Chart

Table 1*: Effect of processing on proximate chemical composition and gross energy content of Lablab purpureus seed (highworth)

Nutrients	Raw	Decort.	Toasted	Boiled	Mean	SD	CV (%)
Dry matter	90.27	89.27	91.47	89.06	90.02	1.10	1.23
Crude protein	34.33	29.72	33.21	29.19	31.61	2.54	8.04
Crude fiber	7.22	5.83	8.15	6.97	7.04	0.95	13.55
Ether extract	5.87	3.99	5.70	5.02	5.15	0.85	16.58
Ash	4.77	3.95	6.22	3.87	4.70	1.09	23.19
NFE	47.81	56.51	46.72	54.95	51.50	4.95	9.61
GE (kcal/kg)	3755	3241	3701	3229	3481	285.53	8.20

*Each value represents a mean of three determinations on air dry samples
Decort Decorticated
SD Standard deviation
CV Coefficient of Variation

Table 2*: Effect of processing on anti-nutritional factor content of Lablab purpureus seed(Higworth)

%	Raw	Decort	Toasted	Boiling	Mean	SD	CV	CD
Tannin	1.95	1.22B	1.42	1.35	1.49	0.32	0.22	0.37
Saponin	0.96	0.79	0.81	0.64B	0.80	0.13	0.17	0.33
Alkaloids**	2.25	1.51B	1.96	1.71	1.86	0.32	0.17	0.33
Oxalates	0.88	0.67	0.77	0.55B	0.72	0.14	0.20	0.38
Phytate mg/kg	1.25	0.91	0.77	0.65B	0.90	0.26	0.29	0.48
TI	29.64	21.76	0.00B	0.00B	12.85	15.18	1.18	1.00
HCN	81.75	68.85	17.94	9.37B	44.48	36.15	0.81	0.89

*Each value represents the mean of two determinations; **Includes Saponin; B Best processing method; SD Standard deviation; CV Coefficient of variation; CD Coefficient of detoxication [calculated as (value for raw sample – value for best method/value for raw sample)100]; HG Heamaglutinin; Decort Decorticated; TI Trypsin inhibitor; HCN Hydrogen cyanide

ıle: 3: Effect of processing on essential amino acid profile of Lablab purpureus seeds

	Raw	Decort.	Toasted	Boiled	Mean	SD	CV (%)	*FFSB
ine	5.78	4.15	4.45	5.64	5.01	0.83	16.49	2.64
idine	2.99	2.99	3.21	2.90	3.02	0.13	4.37	1.02
inine	6.64	6.73	6.90	6.73	6.75	0.11	1.61	3.16
eonine	3.03	2.89	3.47	2.73	3.10	0.35	11.15	1.62
line	3.05	3.76	3.05	2.95	3.20	0.37	11.70	-
ne	4.82	3.14	3.49	3.81	3.82	0.72	18.97	1.99
eucine	4.02	2.69	2.88	2.98	2.39	0.60	19.01	2.00
ıcine	6.80	5.65	5.81	6.90	6.29	0.65	10.35	3.20
ınylalanine	4.62	3.85	4.20	3.51	4.05	0.48	11.76	-
hionine /stine	2.49	2.49	2.61	3.56	2.79	-	-	1.29

ɜB=full fat soyabean-
urce: Larbier and Leclereq (1994) for comparison

Table: 4.*Effect of processing on mineral compositions of Lablab purpureus Seed.

Mineral	Raw	Décort	Cooked	Toasted	Mean	SD	CV(%)	**FFSB
K(%)	0.485	0.396	0.314	0.310	0.38	0.08	21.96	1.68
Na(%)	0.030	0.022	0.018	0.013	0.02	0.01	34.61	0.01
P(%)	0.335	0.307	0.294	0.286	0.31	0.02	7.03	0.64
Ca(%)	0.164	0.154	0.147	0.142	0.15	0.01	6.28	0.28
Mg(%)	0.087	0.072	0.067	0.064	0.07	0.01	14.51	0.33
mg/kg								
Fe	56.00	54.20	47.00	43.15	50.09	6.01	12.06	-
Mn	38.45	36.05	33.40	31.75	34.91	2.95	8.45	-
Cu	12.45	10.70	9.25	8.20	10.15	1.84	18.17	-
Zn	62.65	59.65	51.35	48.40	55.51	6.73	12.13	-
Cl	2.22	2.09	1.00	1.99	2.08	0.11	30.58	0.02%

**Sources: Larbier and Leclereq (1994) for comparison
*Each value represents a mean of three determinations on air dry samples
Decort Decorticated
SD Standard deviation, CV Coefficient of Variation

References

[1] Shaahu, D.T., Ayoade, J.A. and Babatunde, I.B (2010a) Effect of graded level of groundnut testa on the growth performance of growing rabbits. Proceedings of the 36th annual conference of the Nigerian Society for Animal Production. A.A. Adeniji, E.A. Olatunji and E.S.Gana (eds) University of Abuja, March 13-16, 2011 pp351-353

[2] Shaahu, D.T., Ikurior, S.A. and Tiough, S.M (2010b) Effect of replacing full fat soybean with raw, decorticated and cooked lablab seed on the performance of weaner rabbits. Proceedings of the 36th Nigerian Society for Animal Production- A.A. Adeniji, E.A. Olatunji and E.S.Gana (eds) University of Abuja, March 13-16, 2011 pp315-317.

[3] Okpanachi, U., Adejoh, M. Omede, A.A. and Shaahu, D.T. (2012) The effect of graded levels of enzyme supplemented bovine blood rumen content mixture on the growth performance of broilers. Proceedings of the 1st ASAN-NIAS Joint Annual Meeting, September 9-13 2012.

[4] Luck, P. E. (1965) Dolichos lablab - A valuable grazing crop. Queensland Agricultural Journal, May:308-309.

[5] Murphy, A.M and Colucci, P.E (1999) A tropical forage solution to poor quality diets. A review of lablab purpureus. Livestock Research for Rural Development 11 (2) htt://www.c.pav.org.co//rrllrrd11/2/colu.112.ht

[6] Ogundipe, S.O, Abeke, F.O, Sekoni A.A, Dafwang, I.I. and Adeyinka I.A. (2003) Effect of cooking duration on the utilization of lablab purpureus beans by pullet chicks. In Proceedings of the 28th Annual Conference of Nigeria Society for Animal Production. 28: 233 – 234

[7] Osman, M.A (2007) Effect of Different Processing Methods, on Nutrient Composition, Antinutrional factors, and in vitro Protein Digestibility of Dolichos Lablab Bean [Lablab purpuresus (L) Sweet] Pakistan Journal Of Nutrition 6 (4): 299-303.

[8] Kuo, L. H. (1967) Animal feeding stuffs compositional data of feeds and concentrates (Part 3) The Malaysian Agricultural Journal. 46(1):63-70.

[9] Chav-chifaicheung, P.C.K, Wang-Yunshingchan, C.F. and Wang, Y.S. (1997) Effect of cooking on content of amino acids and anti nutrients of three Chinese indigenous legume seeds, Journal of Science, Food and Agriculture, 75: 447 – 452

[10] Cama, H.R. and R.A Morton, (1950) Changes occurring in the protein as a result of processing groundnut under selected industrial conditions. Brazilian Journal of Nutrition. 4; Pp 154-160

[11] Ikurior, S.A, Torbee, S.A and Anthony, T. I. (1993) Effect of cooked or roasted full fat soyabean and soyabean meal on performance and carcass characteristics of growing- finishing pigs. Journal Science Food and Agriculture, 69: 309 – 314

[12] Marty B.J and Chavez, E. R (1993) Effect of heat processing on digestibility of energy and other nutrients of full fat soyabeans fed to weaner, grower and finisher pigs. Can. J. Anim. Sci. 73; 441 – 449

[13] Kaankuka, F.G., T.F. Balogun and I.D.I. Yaakugh, (2000) Effect of duration of cooking raw full fat soybeans on organic matter digestibility and energy utilization by young pigs. Procedings of the annual conference of the Nigerian Society for Animal Production held at Michael Okpara University of Agriculture Umudike, Nigeria. 191-193.

[14] Ikurior, S.A. (2003) Replacement of dietary soyabean meal protein with that from roasted or cooked full-fat soyabean for weaner-grower pigs. Trop. Oilseed J. 1(2): 90-97

[15] Tuleun C.D. and Patrick, J.P. (2007) Effect of duration of cooking Mucuna utilis seed on proximate analysis, levels of anti-nutritional factors and performance of broiler chickens. Nigerian Journal of Animal Production. 34(1):45-53

[16] Sat, I.J. and Keles, F. (2002) The effect of soaking and cooking on the oligosaccharide content of sekker, a dry bean Variety (Phaseolus vulgaris, L.) grown in Turkey. Parkistan Journal of Nutrition. 1 (5)

[17] Singh, U. (1988) Anti – nutritional factors of chickpea and pigeon pea and their removal by processing. Plant Foods in Human Nutrition 38; 251 – 261

[18] Lee, Y.H., Kim, S.H and Oho, M.J. (1972) Improvement of nutritive value of soyabean by fermentation. Korean J. Nutri 591): 33 – 42

[19] Peer, D.J and Leeson, S. (1985) Nutrient and trypsin inhibitor content of hydroponically sprouted soybeans. Animal Feed Science Technology. 13 (3); 203 – 214

[20] Ramakrishna, P., Jhansi, R. And Ramakrishna, R (2006) Anti-nutritional factors during germination in Indian bean (Dolichos lablab) seeds. World Journal of Dairy and Food Sciences 1(1);06-11

[21] A.O.A.C. (1995) Association of Official Analytical Chemists. Official method of analysis 16thed: William Tryd Press washinton D.C. USA. Chapter 4 pp 17-34.

[22] Kakade, M.L. Hooffa, D.E. and Liener, I.E. (1974) Contribution of trypsin inhibitors to the deleterious effect of unheated soyabeans fed to rats. Journal of Nutrition 103: 1772-1779

[23] Maga, J. A. (1983) Phytate: Its' Chemistry: Occurrence, Food Interactions, Nutritional Significance and Method of Analysis.

[24] Liener, I. E. (1955) The photometric determination the hemagglutinin activity of soyin and soyabean. Extract Archives of Biochemistry Biopys 5: 223 – 231.

[25] Henry, T.A. (1993) –The plant Alkaloids pg 6-466 Allen's commercial organic Analysis, 1992, Vol. Vi: 167 – 170

[26] Block, R.J. and Mitchell, H.H. (1946) The correlation of the amino acid composition of proteins with their nutritive value. Nutr. Abst. ROK, 16: 249-278

[27] Wolf, W.J. and Cowan, J.C. (1975). Soybeans as a Food Source. CRC Press Inc. Cleveland Ohio.

[28] Ikurior, S.A. and Fetuga, B.L.A (1991) Evaluation of sunflower seed meal as protein feed for non-ruminant animals. Journal of Agriculture, Science and Technology. 1(2):114-118

[29] Larbier, M. and Leclereq, B. (1994) Nutrition and Feeding of Poultry. Nottingham University Press 62-69.