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THERMAL PROCESSING METHODS AND THEIR INFLUENCE ON NUTRIENTS AND ANTI-NUTRIENTS COMPOSITION OF FLAMBOYANT SEEDS *DELONIX REGIA*

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ABSTRACT

The effect of different thermal processing methods on nutrients and anti-nutrients composition of Delonix regia (DR) seeds was investigated. The raw seeds were sorted to ensure homogeneity of product; raw samples were collected, crushed and tagged T1. At boiling point (100oC), another sample of the seeds was poured into tower aluminum pot containing 25litres of water; samples were taken after 40 minutes of boiling and tagged T2. The third sample (T3) was toasted using open pan for 40 minutes and crushed. Each sample of the treatments was replicated 3 times; the prepared samples were then taken for analyses. The results showed that cooking produced better ($P<0.05$) crude protein value of 35.49% while crude fibre was reduced significantly ($P<0.05$) compared to the raw; the concentration of lysine (0.39%) and tryptophan (0.73%) were significantly ($P<0.05$) higher when toasted compared to the other treatment methods. Similarly, ash content was significantly ($P<0.05$) higher in raw (7.99%) and cooked (7.64%) compared to the toasted seeds. Cooking and toasting significantly ($P<0.05$) reduced acid detergent fibre, acid detergent lignin and cellulose. Cooking also significantly ($P<0.05$) increased trypsin inhibitor activity, TIA (12.06 mg / 100g) but reduced phytate (0.11 vs. 0.14 mg / 100g) for T2 and T3, respectively. In view of the findings of this study, cooking and or toasting DR seeds can serve as an alternative protein source for most monogastric animals considering its rich nutrient composition.

Keywords: *Thermal processing methods, nutrients, anti-nutrients, Delonix regia*

INTRODUCTION

Food and Agriculture Organization (1991) identified population pressure rising at 3.3% annually, poor food security and poor management of natural resources as the bane of African food crisis. Hence, the food demands of Africans have been estimated to be growing at an alarming rate of 3.5% annually. Consequently, the problem of inadequate animal protein intake is a challenge that calls for a two approach which are the intensification of research on short-generation interval animals like rabbits, poultry and other monogastric animals that have high reproductive efficiency and the increasing use of non-conventional feeds for animal feeding.

In order to ameliorate the food crisis situation, it has become imperative therefore, that animal nutritionists turn their attention to identification and exploitation of legumes especially those indigenous to the tropics. Among the thousand known legumes, only few have been extensively promoted and used for animal feeding.

Delonix regia (DR), otherwise known as "flame of the forest", is one of those underutilized legumes; tones of these seeds are wasted every year since they are neither consumed by any animal nor utilized for any medical purpose. Like most legumes, DR seeds contain anti nutrients such as phytic acid, cyanide, trypsin inhibitors, oxalate and haemagglutinins which unless removed or reduced by processing are capable of exerting deleterious effects when ingested by animals.

Heat treatments generally inactivate protein inhibitors, volatile and off-flavor compounds. A better understanding of the effects of different processing methods on the nutritive value may lead to a wider use of this legume in the food industry. The objective of this study was to investigate the effect of different thermal processing methods on nutrients and anti-nutrient composition of DR seeds.

MATERIALS AND METHODS

Study area

The experiment was carried out at the Nutrition and Biochemistry laboratory of Animal Science Department, Nasarawa State University, Keffi, Shabu-Lafia Campus. It is located in the Guinea Savanna zone of Nigeria. It is found on latitude $08^0$35'N and longitude $08^0$33'E. The mean monthly maximum and minimum temperatures were 35.06^0C and 20.16^0C respectively at the time of the experiment while the mean monthly relative humidity and rainfall were 74.67% and 168.90mm respectively (NIMET, 2008).

Procurement and thermal treatment of Delonix regia seeds

Mature pods were collected from different locations from within Ombi II community of Lafia town during the dry season. The pods were split manually using hard sticks and stones to release the seeds and cleaned to ensure homogeneity of product. Raw samples were crushed and tagged T1; at boiling point (100^0C) another sample of the seeds were poured into tower aluminum pot containing 25litres of water. Samples were taken after 40 minutes of boiling and tagged T2. The third sample (T3) was toasted using open pan for 40 minutes and crushed. Each sample of the treatments was replicated 3 times; the prepared samples were then taken for analyses.

Analytical procedures

The proximate composition of each sample from the three thermally treated seeds was determined according to AOAC (1990) methods while the fibre fractions were determined according to the methods outlined by VanSoest and Robertson (1985). Phytic acid determination was done according to the modified method described by Wheeler and Ferrel (1971) and Steward (1974) while trypsin inhibitor activity was determined according to the methods described by Gupta and Deodhar (1975) and Hammerstrand *et al.* (1981). The methods share the same principles of determining trypsin inhibitors in soybeans products based on the tryptic hydrolysis of synthetic substrate, benzoyl-DL-arginine-nitroanilide (BAPA). The Spectrophotometric method of Brunner (1984) was used for saponin analysis; tannin and oxalate were determined using the methods outlined by Swain (1979).

Experimental design and statistical analysis

The experimental design used for this trial was the Completely Randomized Design (CRD). Data obtained for each parameter were subjected to One Way Analysis of Variance (ANOVA) and where significant differences ($P<0.05$) occurred, the means were separated using Least Significant Difference (LSD) as described by (Aeangwanich et al., 2004).

RESULTS AND DISCUSSION

The result of the effect of cooking and toasting on proximate, fibre fractions and inorganic matter composition of DRS is presented in Table 1. There was significant reduction ($P<0.05$) in the crude protein values; seeds in T2 had the highest crude protein (35.49%) while T1 (29.97%) had the least value. Similarly, there was significant reduction ($P<0.05$) in the crude fibre level across the treatments; cooked seeds, T2 had the least CF (10.28%) compared to those of T3 (11.91%) and T1 (13.57%). There was significant reduction ($P<0.05$) in ash content as toasted seeds had the lowest value (7.15%) compared to the raw (T1) and cooked (T2) seeds. There was no variation ($P>0.05$) in the values obtained for crude fat and nitrogen free extract. All the inorganic matters analyzed were not affected ($P>0.05$) by the different thermal processing methods. The significant increase in the crude protein value could be attributed to the

fact that cooking which is a gradual heating process releases the protein in the seed better than that of toasting. The values obtained in the present study for raw seeds were higher than the earlier reports of Ega and Kaga (1994) of 7.01% while Abdullahi and Abdullahi (2005) reported values as high as 61.8 %. Egena et al. (2008) reported a crude protein content of 18.40 % while Biobaku (1994) reported a value of 14.59%. Fatufe (2009) reported a value of 36.92% crude protein; these differences show that DRS have a wide variety of protein compositions.

Cooking reduced significantly the crude fibre value of DRS compared to toasting methods. The values obtained in the present study were consistent with the earlier findings of Egena *et al.*, (2008) and Fatufe (2009). The authors reported values of 17 and 11.39%, respectively. Ega and Kaga (1994) reported a crude fibre value of 3.97% in raw seed nuts and 4.75% in fermented seed nuts. The crude fat contents which were not significantly affected by the processing methods fell within the normal range and were slightly lower than previous reports. Crude fat of raw DRS ranged between 5.01% (Ega and Kaga, 1994) and 9.50% (Egena *et al.*, 2008). Other investigations revealed 7.6% (Abdullahi and Abdullahi, 2005), 7.89% (Biobaku, 1994) and 4.17% (Fatufe, 2009).

Toasting significantly reduced the ash content of DRS; the values reported in the present study agree with the 5.30 and 15.60% earlier reported by Biobaku *et al.* (2003) and Abdullahi and Abdullahi (2005), respectively. Other values included 8.60% (Egena *et al.*, 2008) and 8.38% (Ega and Kaga, 2001). Ega and Kaga (1994) reported 5.57% ash content in raw seed nuts and 6.09% in fermented seed nuts.

The result of the effect of different processing methods on fibre fractions shows that ADF (20.92vs. 18.18 and 18.99%) and ADL (7.89vs. 6.69 and 7.40%) significantly reduced ($P<0.05$) compared to the raw seeds. Seeds in treatment T2 had the least ADL while those of T2 and T3 had the least values for ADL and cellulose. There was no variation ($P>0.05$) in the value of NDF and hemicellulose due to either cooking or toasting. There is evidence that pre-digestion or any attempt to initiate the hydrolysis of feed components often enhances their digestibility and utilization. One of such techniques is thermal treatments (Bio–Ingredients Ltd, 2004). The values obtained in the present study are in consonance with the earlier reports of Abdullahi and Abdullahi (2005) and Biobaku (1994).

Table 2 summarizes the effect of different thermal processing methods on the amino acids and vitamin concentration of DRS. There was significant ($P<0.05$) increase in the values obtained for lysine (0.39 %) and tryptophan (0.73 %) due to toasting compared to those of raw and cooked seeds. Similarly, the values obtained for vitamin A (544.11 mg / 100g) was significantly higher ($P<0.05$) than those of other treatment methods however, reverse was the case for vitamins B1 and C. The trend observed is consistent with the earlier assertion of Alu (2015), the author noted that vitamins, particularly water-soluble are heat-labile and may be completely lost at certain temperatures.

The result of the effect of cooking and toasting on anti-nutritional factors of DRS is presented in Table 3. The result shows that there was significant reduction ($P<0.05$) in the TIA as toasted seed had the least value (21.17mg / 100g) compared to those of the raw (19.10mg / 100g) and cooked (25.06mg / 100g). Similarly, toasting and cooking significantly reduced ($P<0.05$) phytate concentration. Cooked and toasted seeds had the least values (0.11 and 0.14mg / 100g) respectively. There was no significant variation ($P>0.05$) in the values obtained for oxalate, saponin and tannin although the values tended to reduce due to the processing methods. The reduction in TIA is an indication of their high nutritive value; the highest level of trypsin inhibitors was found in the raw seeds followed by the cooked seeds. Abdullahi and Abdullahi (2005) reported a reduction in TIA content by 9.62% in DRS boiled for 60minutes. This finding agrees with Vdal Vilverde et al. (1994) who found that heat treatments partially or completely inactivate TIA in legumes. This result was similar to those observed by Collins and Sanders (1976) and Rahma et al. (1987). The various treatments caused a decrease in phytic acid, the numerical decrease ($P>0.05$) in phytic acid content being best observed in the cooked seeds. This is probably due to the combination of the cooking and sun drying; cooking and sun drying cause greater reduction on phytic acid (Egena et al., 2008). Again, this is similar to the findings of Abdullahi and Abdullahi (2005) who reported a 7.55% decrease in phytic acid with boiling for less than 1 hour.

The non significant variation in the values obtained for oxalate, saponin and tannin is an indication of their low levels in the seeds. The values obtained are close to the ones earlier reported by Abdullahi and Abdullahi (2005).

Table 1. Effect of processing methods on proximate, fibre fractions and inorganic matter of *Delonix regia* seeds (%)

Parameters	T1	T2	T3	SEM	LOS
Proximate composition					
Crude protein	29.97^{c}	35.49^{a}	32.88^{b}	0.30	*
Crude fibre	13.57^{a}	10.28^{c}	11.91^{b}	0.18	*
Crude fat	2.60	3.08	2.60	0.16	NS
Ash	7.99^{a}	7.64^{a}	7.15^{b}	0.07	*
NFE	36.97	36.37	36..59	0.57	NS
Fibre fractions					
Neutral detergent fibre	41.62	37.51	38.50	0.84	NS
Acid detergent fibre	20.92^{a}	18.18^{c}	18.99^{b}	0.07	*
Acid detergent lignin	7.89^{a}	6.69^{b}	7.40^{b}	0.02	*
Cellulose	13.03^{a}	11.50^{b}	11.59^{b}	0.03	*
Hemicelluloses	20.71	19.33	19.51	0.77	NS
Minerals					
Calcium	0.49	0.30	0.40	0.035	NS
Phosphorus	0.42	0.26	0.31	0.038	NS
Magnesium	0.54	0,42	0.47	0.038	NS
Potassium	0.92	0.71	0.82	0.060	NS
Sodium	0.10	0.09	0.09	0.003	NS

NS-No significant difference (p>0.05), a, b, c- means on the same row bearing different superscript differ significantly (P<0.05), *- significantly different (P<0.05), SEM- standard error of means, LOS – Level of significance.

Table 2. Effects of processing methods on some essential amino acids and vitamins of *Delonix regia* seeds

Parameters	T1	T2	T3	SEM	LOS
Amino acids **(%)**					
Methionine	2.80	2.84	2.88	0.50	NS
Lysine	0.30^{c}	0.33^{b}	0.39^{a}	0.01	*
Tryptophan	0.67^{c}	0.70^{b}	0.73^{a}	001	*
Vitamins **(mg/100g)**					
A	483.88^{b}	504.97^{b}	544.11^{a}	1.57	*
B_1	30.54^{a}	23.08^{b}	13.50^{c}	0.10	*
C	6.81^{a}	5.61^{b}	3.60^{c}	0.18	*

NS-No significant difference (p>0.05), a, b, c- means on the same row bearing different superscript differ significantly (P<0.05), *- significantly different (P<0.05), SEM- standard error of means, LOS – Level of significance

Table 3: Effect of processing methods on anti-nutritional factors of *Delonix regia* seeds (mg/100g)

Parameter	T1	T2	T3	SEM	LOS
Trypsin inhibitor activity	19.10^{c}	12.06^{a}	11.17^{b}	0.070	*
Phytate	0.16^{a}	0.11^{b}	0.14^{ab}	0.003	*
Oxalate	0.06	0.04	0.05	0.040	NS
Saponin	0.31	0.11	0.16	0.010	NS
Tannin	0.09	0.08	0.04	0.010	NS

NS-No significant difference (p>0.05), a, b, c- means on the same row bearing different superscript differ significantly (P<0.05), *- significantly different (P<0.05), SEM- standard error of means, LOS – Level of significance

CONCLUSION

Toasted or cooked *Delonix regia* seeds can also serve as a close substitute for soybeans due to the similarities in their nutrient and amino acids composition. The major anti-nutritional factors identified in the seeds are tannin, phytic acid, trypsin inhibitors and saponin, which are known to impair feed utilization by animals. Cooking or toasting for 40 minutes has reduced the concentration of all the anti-nutrients and improved some of the nutrient content of the seed. Other processing methods to further reduce the anti-nutritional factors and perhaps completely eliminate them should be investigated.

REFERENCES

Abdullahi, S. A. & Abdullahi, G. M. (2005). Effects of boiling on the proximate, anti-nutrients and amino acid composition of raw Delonix regia seeds. *Nig. Food J.,23*(2005),128-132.

Aeangwanich, W., Simarakas, S. & Chinrasri, O. (2004). Haematological erythrocytes and serum biochemical values of the Thaii indigenous chickens (Gallus domesticus) in North-Eastern Thailand. *Songkalanakanrian J. Sci. Technol., 26*(3), 425-430.

Alu S. E. (2015). Advance in fibre Nutrition. In: Primer of Animal Nutrition and Biochemistry . 1st edition. Nasarawa State Nigeria: Pp.158-159.

AOAC (1990). Official methods of Analysis of the Association of Analyticals Chemists. 15th edition, Washington D.C.

Biobaku, W. O. (1994). Effect of feeding raw and cooked Delonix regia seed bean on the performance of rabbit. *J. Agric. Tech., 2*, 281- 308.

Bio – Ingredients Ltd. (2004). Practical use of Nutrase Xyla® in animal feeding seminar. May 2004. Rony M. Ombaerts – Nutrex Behgium. Pp. 10 – 16.

Brunner, J.H. (1984). Direct Spectrophotometer determination of Saponin. *Anal. Chem., 34*, 1314 - 1326.

Ega, R. A. & kaga, B. I. (1994). Comparative proximate and amino acid composition of *Delonix regia* seeds, Adanosonia, Albizzia and sesamum seeds. A paper presented at the Nigerian Institute of Food Science and Technology Conference at Ilorin.

Egena, S. S. A., Usman, A., Shiawaya, E. I., Yahaya, S. K. & Ogunlowo, D. H. (2008). Performance of Starter broilers fed anaerobically fermented and lyle treated Delonixregia seed meal. *Pak. J. Nutri., 7*, (3), 489-492.

FAO / WHO (1991). Ahdhoc expert committee on "energy and protein requirement". World Health Organization Technical Report, 522, 34-50.

Fatufe, A. A. (2009). Evaluation of flamboyant seed meal as alternative feedstuffs protein sourcefor livestock feeding. http : / / uyoccima. Org.

Gupta, A. K. & Deodhar, A. D. (1975). Variation in Trypsin inhibitor activity in soybean (Glycine max). *Indian J. Nutr. Diet, 12*, 81-84.

Hammerstrand, G. E., Black, L. T. & Glover, J. D. (1981). Trypsin inhibitor activity in soybean products modification of standard analytical procedure. *Cereal Chem., 58*, 42-45.

NIMET (2008). Nigerian Meteorological Agency, Lafia, Nasarawa state.

Rahma, E. M., EL- Bawey, A. A., El –Adawy, T. A. & Guma, M. A. (1987). Changes inchemical and anti-nutritional factors and functional properties of faba beans during germination. Lebenesm. *Wiss. Tec., 20*, 271- 276.

Steward, E. (1974). Chemical analysis of ecological materials. Blackwell Scientific, Oxford. Pp.298-312.

Swain, T. (1979). Tannins and Lignins. In: Rosenthal, G.A and Janzen, D.H (eds) Herbivores :their interaction with plant metabolites. Academic press, New York. Pp. 234-245.

VanSoest, P. J. & Robertson, J.B. (1985). Analysis of forages and fibrous foods. As 613 manual. Department of Animal Science, Cornell University, Ithaca. Pp. 105- 106.

Vdal- Vilverde, C., Frias, J., Estreella, I., Gorospe, J.M., Ruiz, R. & Bacon, J. (1994). Effect of processing on some anti-nutritional factors of lentils. *J. Agri. Food. Chem., 42*, 2291.

Wheeler, E. L. & Ferrel, R. E. (1971). A method for phytic acid determination in wheat and wheat fractions. *Cereal Chem., 48*, 312-320.