NSUK Journal of Science & Technology, Vol. 6: No. 2. 2016. pp. 121 -124 ISSN: 1597- 5527

EFFECT OF HYDROTHERMAL PROCESSING DURATION ON NUTRIENTS AND ANTI-NUTRIENTS COMPOSITION OF FLAMBOYANT SEEDS

ALU, S. E.

Department of Animal Science, Faculty of Agriculture (Shabu-Lafia Campus),
P.M.B.135, Lafia, Nasarawa State University Keffi, Nigeria.

***Corresponding Author: drsamalu@nsuk.edu.ng**

ABSTRACT

The experiment was designed to study the effect of hydrothermal processing duration on nutrients and anti-nutrients compositions of *Delonix regia* seeds (DRS). Raw samples were collected, crushed and tagged T_1; at boiling point (100ºC), another sample of the cleaned seeds were poured into tower aluminum pot containing 25litres of water; samples were taken after 10, 20, 30 and 40 minutes of cooking and tagged T_2, T_3, T_4 and T_5, respectively. Each sample of the treatments was replicated 3 times in a Completely Randomized Design. The results showed thatthere was a significant reduction ($P<0.05$) in the values of crude fibre with increasing duration of cooking; cooking of DRS for 20, 30 and 40 minutes gave the lowest values of 9.03, 10.05 and 11.91%, respectively. However, all the fibre fractions were not affected ($P>0.05$) cooking duration. Cooking DRS for 30 minutes (T_4) gave better ($P<0.05$) crude protein (32.33%) and NFE (40.26%) values compared to the rest of the treatments. The metabolizable energy was significantly ($P<0.05$) reduced with increase in cooking duration, DRS cooked for 10, 20, 30 and 40 minutes had lower ME than the raw group. Cooking DRS for 40 minutes significantly ($P<0.05$) reduced trypsin inhibitor (19.10%) and saponin (0.26%) while cooking that of 30 and 40 minutes reduced ($P<0.05$) tannin (0.03 and 0.02%) however, seeds cooked for 30 minutes, T_4 produced the least value of 0.08% for sodium. In view of these findings, DRS can serve as a useful feed ingredient for most monogastric animals especially in the semi-arid regions of Nigeria where feed is a very important limiting factor to livestock production during the dry season.

Keywords: *Delonix regia* seeds, hydrothermal processing, nutrients, anti-nutrients, cooking duration,

INTRODUCTION

The current global economic downturn is further compelling animal nutritionists to expand their non-conventional feed database as world food insecurity is worsening day by day. In many developing countries like Nigeria, the situation is made worse by factors like climate change, flood, and insurgency. These unfortunate incidences have increased the occurrence of malnutrition in Nigeria (Asogwa and Onweluzo, 2010). Many families depend only on carbohydrate staples like cassava, yam and rice to feed on. Protein foods are taken in such quantities that will not reduce the persistent occurrence of protein malnutrition especially from the plant sources. Therefore, in order to attain a more economically sustainable, environmentally friendly and viable production, research interest has been redirected towards the evaluation and use of unconventional protein sources, particularly from plant products such as seeds, leaves and other agricultural by-products(Siddhuraju and Becker, 2001; Ali *et al.*, 2003; Bake *et al*., 2009).

Delonix regia (DR) is a species of flowering plants from the Fabaceae family noted for its fern-like leaves and flamboyant display of flowers. It is often grown as an ornamental tree and given to the name royal Poinciana or flamboyant. The generic name *Delonix* is derived from Greek *delos* (visible) and *onyx* (Claw) in relation to the conspicuously clawed petals. The specific name *regia* is from the Latin word *regis* meaning royal, regal or magnificent. Most of its common names are derived from its large red flamboyant flowers (Anon., 1986).

The naturally occurring variety *flavida*has yellow flowers; seed pods are dark brown and can be up to 60 cm long and 5 cm wide, the individual seeds however are small weighing around 0.4 g on the average. The compound leaves have a feathery appearance and are a characteristic light green. They are doubly pinnate; each leaf is 30- 50 cm long and has 20- 40 pairs of primary leaflets or pinnae on it and each of these is further divided into 10- 20 pairs of secondary leaflets or pinnules (Anon., 1986).

In Nigeria, however, there is a dearth of information on the use of DR for animal feeding. The abundance of DR trees and their wide distribution in the semi-arid areas of the country emphasize the need for studies in the use of the seeds for animal feeding. Laboratory analysis shows that crude protein of raw DR has a wide range as some investigators reported as low as 7.01% (Ega *et al.*, 1995) while others reported values as high as 61.8 % (Abdullahi *et al.*, 2005). *Delonix regia* is rich in nutrients as well as anti-nutritional factors suggesting that it will require some form of processing to alleviate them. Thermal methods (dry or wet) are known to produce significant results although the time at which these results are met may not be conclusive and exact due to the wide range of variations in the chemical composition that exist among the various oilseed grains.

Boiling is the act of cooking food in water that is bubbling vigorously, this processing treatment is also effective in eliminating anti-nutritional factors in foods (Nzewi and Egbuonu, 2011). Cooking time is a salient property of food processing which in most cases is not adhered to. Heat, which is applied during cooking, does not have an instant impact or influence on the food being cooked; it takes time for heat to make the desired effect that is required of it on food generally. However, heat has its adverse effect on the nutritional values of food in that protein is denatured, lipids is coagulated, starch which is the source of carbohydrate is broken down into simpler components when cooked for a period of time. Several anti-nutritional factors are found in *Delonix regia* seeds (DRS) which include tannins, phytic acids, haemagglutinins, hydrogen cyanide and protease inhibitor which are known to have negative effects on the animal's performances (Alu *et al.*, 2015).

To this end, time is indeed a very important factor to be considered when processing food and indeed DRS to obtain its optimum benefit for animals. Hence, the effect of

cooking time on the nutritional parameters of DRS is of great importance to analyze. The objective of this study was therefore, to investigate the effect of cooking duration on nutrient and anti-nutrient compositions of DRS.

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. The study area is located in the Guinea Savanna zone of North Central 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 trees in Ombi II Community of Lafia town during the dry season. The pods were split manually using hard sticks and stones to release the seeds. The raw seeds were sorted to ensure homogeneity of product. Raw samples were collected, crushed and tagged T_1; at boiling point (100ºC), another sample of the cleaned seeds were poured into tower aluminum pot containing 25litres of water; samples were taken after 10, 20, 30 and 40 minutes of boiling and tagged T_2, T_3, T_4 and T_5, respectively. Each sample of the treatments was replicated 3 times; the samples were crushed and then taken for analyses.

Analytical procedures

Proximate composition

The proximate composition of each of the treatment samples were determined according to the methods outlined by AOAC (1990) while the fibre fractions were determined according to the methods outlined by VanSoest and Robertson (1985).

Anti-nutritional factors

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 soyabeans 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 designs and statistical analysis

The experimental design used for this trial was the Completely Randomized Design (CRD). Each sample served as a treatment and was replicated thrice. Data obtained for each parameter were subjected to Analysis of Variance (ANOVA) and where significant differences occurred, the means were separated using Duncan's Multiple Range Test (DMRT) as outlined by Steel and Torrie (1980).

RESULTS AND DISCUSSION

The result of the effect of hydrothermal processing duration on proximate composition of DRS is presented in Table 1. The results show that there was a significant reduction ($P<0.05$) in the values of crude fibre with increasing duration of cooking. Cooking of DRS for 20, 30 and 40 minutes gave the lowest values of 9.03, 10.05 and 11.91%, respectively. However, all the fibre fractions were not affected ($P>0.05$) by the cooking duration. Cooking DRS for 30 minutes (T_4) gave better ($P<0.05$) crude protein (32.33%) and NFE (40.26%) values compared to the rest of the treatments. Similar trend was earlier reported (Kaankuka *et al.*, 1998; Tuleun *et al.*, 2009). Tuleun *et al.* (2009) noted a significant reduction in nutrients of boiled velvet beans as compared to those of raw seeds. The values recorded in the present study were higher than that of Egena *et al.* (2008) who reported a crude protein of 18.10% of lyle treated DRS. The authors reported a close value of 11.00% for crude fibre but higher value of 7.50% for ether extract. Generally, it has been reported that heat treatment reduces or denatures the structural arrangement of chemicals in food, this chemical rearrangement is mostly observed to release bound nutrients in feeds.

The metabolizable energy was significantly ($P<0.05$) reduced with increase in cooking duration, DRS cooked for 10 (2640.22 kcal/kg, ME), 20 (2849.73kcal/kg, ME), 30 (2765.72 kcal/kg, ME) and 40 (2725.60 kcal/kg, ME) minutes had lower ME than the raw group (3687.42 kcal/kg, ME). The reduction in energy content of the seeds shows a downward trend as the time of cooking increased; this observation is in line with the earlier assertion of McDonald *et al.* (2008) that heat applied on any organic matter reduces the energy content of the matter.

Table 2 shows the effect of hydrothermal processing duration on anti-nutritional composition of DRS. Cooking DRS for 40 minutes significantly ($P<0.05$) reduced trypsin inhibitor (19.10%) and saponin (0.26%) while cooking for 30 and 40 minutes reduced ($P<0.05$) tannin (0.03 and 0.02%), respectively. This observation is in agreement with the earlier findings of Abdullahi *et al.* (2005) who reported a reduction in trypsin inhibitor activity, TIA content by 9.62% in *Delonix regia* seeds boiled for 60minutes. Similarly, the findings of the present study further supports the earlier reports of Vdal-Vilverde *et al.* (1994) who noted that heat treatment partially or completely inactivate TIA in legumes. These observed values are close to those earlier reported by Tuleun *et al.* (2009), who reported a value range of 17.77-33.59 TU1/mg for velvet beans cooked for varying period of times. Similarly, saponin and tannin values reported in the present study support the earlier findings of Egena *et al.* (2008) and Gabriel *et al.* (2016) when DRS were lyle treated and toasted, respectively.

The results of the effect of cooking duration on the mineral concentration of DRS are summarized in Table 3. The results show that cooking of DRS significantly ($P<0.05$) reduced Mg and Na. *Delonix regia* seeds cooked for 30 minutes, T_4 produced the least value of 0.08% for Mg and Na. However, calcium, phosphorus and potassium were not affected ($P>0.05$) by the cooking duration. These observations are in agreement with the earlier report of Elisa-Noemberg *et al.* (2010) who investigated the effect of soaking and cooking on phytate concentration and mineral profile of soybean and observed non-significant variation in calcium, phosphorus and zinc content. However, Mg and Na were affected by the processing which may be

Table 1: Effect of hydrothermal processing duration on proximate composition of *Delonix regia* seeds (%)

Parameters	T_1	T_2	T_3	T_4	T_5	SEM	LOS
Nutrients							
Crude fibre	12.93[a]	13.79[a]	9.03[c]	10.05[bc]	11.91[ab]	0.23	*
Ether extract	2.60	2.71	2.77	2.52	2.60	1.05	NS
Crude protein	29.97[d]	31.55[c]	32.33[b]	33.93[a]	32.88[b]	0.45	*
Ash	7.99	6.90	6.98	7.55	7.15	0.19	NS
NFE	36.97[b]	35.32[b]	40.26[a]	36.82[b]	36.59[b]	1.42	*
[a]Energy (kcal/kg, ME)	3687.42[a]	2640.22[b]	2849.73[b]	2765.72[b]	2725.60[b]	131.74	*
Fibre fraction							
Neutral detergent fibre	41.62	40.90	38.76	38.29	38.50	0.68	NS
Acid detergent fibre	20.92	20.87	19.52	18.76	18.99	0.38	NS
Acid detergent lignin	7.89	7.65	7.28	7.18	7.40	0.17	NS
Cellulose	13.03	13.22	12.24	11.58	11.59	0.26	NS
Hemi cellulose	20.71	20.04	19.25	19.53	19.51	0.63	NS

[a]Calculation from Pauzenga (1985), **NS**-No significant difference (p>0.05), **a,b,c**- means on the same row bearing different superscripts differ significantly (P<0.05), *- significantly different (p<0.05), **SEM**- standard error of means, **LOS**—Level of significance

Table 2: Effect of hydrothermal processing duration on mineral composition of *Delonix regia* seeds (%)

Inorganic matter	T1	T2	T3	T4	T5	SEM	LOS
Calcium	0.49	0.41	0.27	0.29	0.40	0.040	NS
Phosphorus	0.42	0.33	0.23	0.23	0.31	0.030	NS
Magnesium	0.54[a]	0.51[b]	0.36[d]	0.35[e]	0.47[c]	0.025	*
Potassium	0.92	0.82	0.69	0.69	0.82	0.060	NS
Sodium	0.10 [a]	0.09[b]	0.09[b]	0.08[c]	0.09[b]	0.004	*

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

Table 3: Effect of hydrothermal processing duration on anti-nutritional factors of *Delonix regia* seeds (%)

Anti-nutritional factors	T_1	T_2	T_3	T_4	T_5	SEM	LOS
Trypsin inhibitor	23.53[a]	22.95[ab]	21.17[bc]	19.91[c]	19.10[c]	5.87	*
Phytate	0.16	0.13	0.12	0.14	0.14	1.07	NS
Oxalate	0.11	0.09	0.09	0.10	0.10	0.40	NS
Saponin	0.31[a]	0.29[b]	0.13[e]	0.114[d]	0.26[c]	11.12	*
Tannin	0.07[a]	0.05[b]	0.04[c]	0.03[cd]	0.02[dc]	4.74	*

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

explained by the fact that some elements have high rate of bioavailability than others thus, tend to respond to heat treatment more than other elements.

CONCLUSION AND RECOMMEDATION

Delonix regia seeds can serve as a useful feed ingredient for most monogastric animals especially in the semi-arid regions of Nigeria where feed is a very important limiting factor to livestock production during the dry season. It can also serve as a close substitute for soybeans due to the similarities in their nutrient composition.

The major anti nutritional factors identified in the seeds are tannin, phytic acid, trypsin inhibitors, saponin andoxalates which are known to impair feed intake, nutrient digestibility and growth of young animals however, cooking DRS for up to 40 minutes can alleviate significantly, the presence of anti- nutrients.

REFERENCES

Abdullahi, S. A. and Abdullahi, G. M. (2005). Effects of boiling on the proximate, anti-nutrients and amino acid composition of raw *delonixregia* seeds.*Nigerian Food Journal*, 23: 128- 132.

Ali, A., Al-Asgah, N. A., Al-Ogaily, S. M. and Ali, S. (2003). Effect of feeding different levels of alfalfa meal on the growth performance and body composition of Nile tilapia (*Oreochromis niloticus*) fingerlings. *Asian. Fish. Soci*. 16: 1-2.

Alu, S. E., Ari, M. M. and Ogah, D. M. (2015). Thermal processing methods and their influence on nutrients and anti-nutrients composition of Flamboyant seeds (*Delonix regia)*. *FULafia Journal of Science and Technology*, 1(1): 33-39

Anon., (1986). The useful plants of India.Publications and informationdirectorate, CSIR, New Delhi, India.

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

Asogwa, I. S. and Onweluzo, J. C. (2010). Effects of processing methods on the chemical composition of flour, moinmoin and akara from *Mucunapruriens. J. Trop. Agric. Food. Environ. Ext.*, 9(3): 200-208.

Bake, G. G., Endo, M., Akimoto, A. and Takeuchi, T. (2009). Evaluation of recycled food waste as a partial replacementof fishmeal in the diets for first feeding Nile tilapia, *Oreochromis niloticus. Fish. Sci*., 75, 1275- 1283.

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

Egena, S. S. A., Usman, A., Shiawaya, E. I., Yahaya, S. K. and Ogunlowo, D. H. (2008). Performance of Starter broilers fed anaerobically fermented and lyle treated *Delonix regia* seed meal. *Pakistan Journal of Nutrition* 7(3): 489-492.

Gabriel, G. B., Ibrahim, Y. and Suleiman, O. E. S. (2016). Evaluation and nutrient quality of toasted Flamboyant seed (*Delonix regia*) meal in the diet of *Clarias gariepinus* fingerlings. *Journal of Agriculture and Ecology Research International* 5(2): 1-9.

Ega, R. A. I., Gyuse, V. K., Kago, B. I. I. and Bundipo, N. (1995). Evaluation of *Delonix regia* as a protein source for mice.*Nig. Inst. of Food Sci. and Tech*. Book of Abstracts.19th Annual Conference pp. 23- 25.

Elisa-Noemberg, L. K. dan Adelaide, B. (2010). Effect of soaking and cooking on phytate concentration, minerals, and texture of food-type soybeans. *Ciênc. Tecnol.Aliment, Campinas*, 30(4): 1056-1060.

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

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

Kaankuka, F. G., Balogun, T. F. and Tegbe, T. S. B. (1996). Effects of duration of cooking of full fat soyabeans on proximate analysis, levels of antinutritional factors, and digestibility by weaner pigs. *Anim. Feed Sci. Tecnol*. 62: 229-237.

McDonald, P., Edward, R. A. and Green Halgh, J. F. D. (2008). *Animal nutrition*, 4th #dition, Longman Group Limited.

NIMET (2008). Nigerian meteorological Agency, Lafia, Nasarawa State.

Nzewi, D. C. and Egbuonu, A. C. C. (2011). Effect of boiling and roasting on some anti-nutrient factors of asparagus bean (*Vigna sesquipedalis*) flour. *African J. Food Sci. Tech*. 2(3): 075-078.

Siddhuraju, P., Vijayakumari, K., and Janardhanan, K. (2001). Chemical composition and Protein quality of the little known legume, velvet beans (*Mucuna pruriens*). *Journal of Agriculture and Food Chemistry*, 44: 2636-2641.

Steel, R. G. D. and Torrie, J. A. (1980). *Principles and Procedures of statistics. A biometrical Approach*. 2nd edition, New York, McGrew Hill Book Co. Inc. 633 p.

Steward, E., (1974). *Chemical analysis of ecology material.* 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.

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

Tuleun, C. D., Patrick, J. P. and Tiamiyu, L. O. (2009). Evaluation of raw and boiled velvet bean (*Mucuna utilis*) as feed ingredient for broiler chickens. *Pakistan Journal of Nutrition* 8(5): 601-606.

Vdal-Viverde, C., J. Frias, I. Estreella, J. M. Gorospe, R. Ruiz and Bacon, J. (1994). Effect of processing on some antinutritional factors of lentils. *J.Agri.Food.Chem.*, 42: 2291.

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