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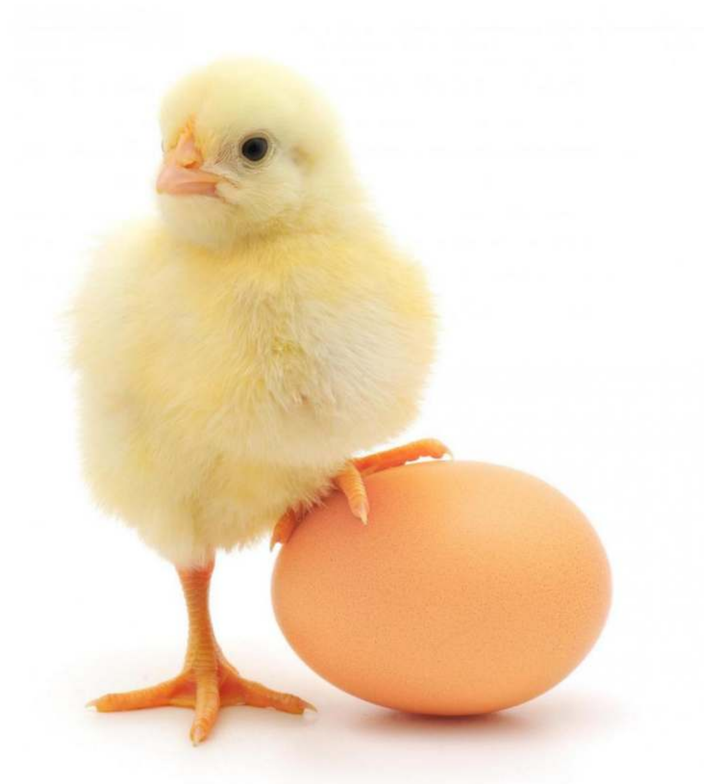

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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Strategies to Improve the Utilization of Tannin-Rich Feed Materials by Poultry

C.I. Medugu[1], B. Saleh[2], J.U. Igwebuike[2] and R.L. Ndirmbita[3]
[1]Borno State Agricultural Development Programme, P.M.B. 1452, Maiduguri, Nigeria
[2]Department of Animal Science, University of Maiduguri, P.M.B. 1069, Maiduguri, Nigeria
[3]Borno State Ministry of Agriculture and Natural Resources, Poultry Production Unit, Maiduguri, Nigeria

Abstract: Tannins are well known as anti-nutritive factors that hinder the utilization of feeds by monogastric animals especially poultry. Tannins depressed growth rate and feed utilization by forming complexes with proteins and carbohydrates or inhibition of digestive enzymes. Unlike ruminant animals, poultry do not have microbes in their gastrointestinal tract to detoxify or reduce the effect of tannins, but several methods have been used to reduce the tannin content of poultry feeds for better utilization. These methods are mainly physical and chemical in nature. The physical methods are cooking, dehulling, autoclaving, toasting / roasting and soaking, while the chemical methods include, use of wood ash, addition of tallow, use of tannin binding agents, use of enzymes, germination and urea treatment. The choice of method(s) will depend on their effectiveness in reducing tannin and the cost involved.

Key words: Poultry feed, tannin, processing methods

INTRODUCTION

Tannin is one of the anti-nutritional factors common in most cereal grains and legume seeds. Tannins bind proteins, thus impairing protein digestion (Olomu, 1995). The adverse effects of some toxic factors in plants (Phytotoxins) or anti-nutritional factors found in poultry feeds are well known (Leuschuer *et al*., 1995). Ibrahim *et al*. (1988); Elkin *et al*. (1990) and Douglas *et al*. (1993) reported depressed growth rate and reduced feed efficiency in poultry fed diets containing tannins. Begovic *et al*. (1978) reported maximum dietary tannin level that poultry can tolerate to be 1%. There are several methods which can be used to reduce or neutralize the negative effects of tannins in poultry feeds so as to increase the efficiency of feed utilization. This paper therefore, reviews some of these used to improve the utilization of tannin-rich feed materials by poultry.

Distribution of tannins: Tannins are reported to be present in most feed ingredients of plant origin. The distribution of tannins in common feed ingredients used in poultry feeding is summarized in Table 1.

Mode of action of tannins

Inhibitory action: Condensed tannins have been shown to inhibit endogenous enzymes activities (Oh and Hoff, 1986; Horigome *et al*., 1988). This inhibitory action of tannins has been reported *in-vivo* (Griffiths, 1981) and *in-vitro* (Longstaff and McNab, 1991). Tannins inhibit enzyme activities by forming indigestible complexes (Butler, 1992; Abeke *et al*., 2003). It has also been shown that the enzymatic oxidation of tannins considerably enhances their enzyme inhibitory effect and toxicity (Awad *et al*., 2001).

Binding action and nutrient interactions: Tannins form complexes with proteins and carbohydrates (Hagerman *et al*., 1998), minerals such as calcium, phosphorus and magnesium (Waghorn *et al*., 1994) rendering them unavailable to monogastric animals (Hagerman *et al*., 1998; Layrisse *et al*., 2000; Parr and Bolwell, 2000). Lacassagne *et al*. (1988) and Longstaff and McNab (1991) reported that condensed tannins interfere with nutrients digestion by binding the proteins in feeds.

Effects of tannin on poultry performance: Tannins are responsible for an astringent taste of the feed that induces a lower feed intake due to reduced palatability (Butler *et al*., 1984). Mohammed and Ali (1988); Gualitieri and Rapaccni (1990); Douglas *et al*. (1993); Hassan *et al*. (2003) and Ravindran *et al*. (2006) all reported that tannins in poultry diets reduced dry matter intake, body weight gain, feed efficiency and nutrient digestibility. Ortiz *et al*. (1994) observed that chicks fed tannin containing diets showed histological changes in the ileal mucosa such as atrophy and shortening of villi with distortion of their architecture. They also reported hydropic degeneration of hepatocytes of the liver. Esonu *et al*. (2001) observed that mucuna seed meal at 15% level of tannin inclusion has a deleterious effect on the blood constituents of weaner pigs. However Medugu *et al*. (2010) reported no adverse effects on carcass components and blood constituents of broiler chickens when high and low-tannin sorghum-based diets were fed as replacement for maize.

Corresponding Author: B. Saleh, Department of Animal Science, University of Maiduguri, P.M.B. 1069, Maiduguri, Nigeria

Table 1: Distribution of tannins in selected feedstuffs

Feed ingredients	Tannin concentration (%)	References
Sorghum grain (white)	0.55	Gowda *et al*. (1984)
Sorghum grain (yellow)	0.2-2.0	Fuller *et al*. (1996)
Sorghum grain (red)	1.54-7.44	Medugu *et al*. (2010)
Castor seed	3.0-5.1	Yashim *et al*. (2007)
Castor seed	0.62-3.68	Yashim *et al*. (2009)
Mango seed kernel	5.47	Diarra *et al*. (2008)
Mango seed kernel	0.22-15.38	Rafiu *et al*. (2009)
Soyabean meal	2.47	Jacob *et al* (1996)
Sunflower cake	2.36	Jacob *et al* (1996)
Sesame seed cake	2.15	Jacob *et al*. (1996)
Pigeon pea	4.3-11.4	Jambunathan *et al*. (1988)
Chick pea	1.9-6.1	Jambunathan *et al*. (1988)
Mucuna beans	0.80	Akinmutimi (2007)

Methods of detoxifying tannins: In order to inactivate or reduce anti-nutrients in non-conventional feeds, some simple processing methods have been proposed (Babour *et al*., 2001; Farran *et al*., 2001). These strategies are broadly classified as physical and chemical methods.

Physical methods

Cooking: The effectiveness of cooking in reducing tannin has been reported by Mbajuwa (1995), who showed that cooking inactivates the activities of tannins. Bressani and Elias (1980) also observed that about 30-40% polyphenols can be removed from *Phaseolus vulgaris* by cooking for 45 min at 100°C and discarding the cooking water solution. Cooking and soaking methods have been used and the stability of anti-nutritional factors could be reduced by up to 15% when cooked for 45 min (Bressani, 2002). Cooking has been found to reduce the anti-nutritional factors and thereby enhance the nutritional value of root and tuber crops including cocoyam (Agwunobi *et al*., 2002; Akpan and Umoh, 2004). Ogundipe *et al*. (2008) reported that 71.91% tannin content was destroyed after 30 minutes of cooking. Balogun *et al*. (2001) also observed that most of the anti-nutritional factors in legume seeds were destroyed after cooking the seeds for a minimum of 30 min. Buba *et al*. (2010) reported that, the anti-nutritional properties in sickle pod (*Cassia tora*) seed were reduced and safe for inclusion in livestock rations for optimum growth and development when the seeds were cooked for 45 min. Uchegbu *et al*. (2008) reported no adverse effect in terms of performance of broiler chickens fed cooked *Napoleona imperialis* diet. However, cooking in water for 60 min at 100°C may denature protein making it unavailable and may induce loss of vitamins and minerals in legumes (Austin *et al*., 1981; Bressani, 1993).

Soaking: Ayenor (1985), Marfor and Oke (1988) and Iyayi and Losel (1999) recommended soaking as processing method to reduce tannin in non-conventional legume and cereal grains. Ahamefule and Odemelam (2008) reported that 24 hrs soaking duration produced better results and would be preferred for tannin and cyanide in feed ingredients. However, some metabolic reactions take place during soaking which will affect some of the constituents compounds (Vidal-Valverde *et al*., 1992).

Germination (Sprouting): Germination has been documented to be an effective treatment to remove or reduce anti-nutritional factors in feedstuffs. According to Esonu *et al*. (1998) sprouting initiates three main types of chemical changes in the seed as follows; I) the breakdown of certain materials ii) transport of minerals from one part of the seed to another, especially from the endosperm to the embryo or from the cotyledons to the growing parts and iii) the synthesis of new materials from the breakdown product. Bvochora *et al*. (1999) reported that depending on variety, total phenolic compounds in sorghum grain decreased upon germination. Investigation carried out by Awika and Rooney (2004) showed decrease in extractable Proanthocyanidins (PAs), a condensed tannin located in the pericarp and testa, after germination. Similarly, Iwuoha and Aina (1997) found a decrease in PAs content after germination. Torki and Farahmand-Pour (2007) concluded that germinated sorghum grain could be better alternative for maize than intact sorghum grain.

Dehulling: It has also been shown that the effect of tannins can be eliminated or neutralized by dehulling (Edwards and Duthie, 1973; Marquardt *et al*., 1977; Ward *et al*., 1977). Bressani (2002) reported that dehulling improved protein quality of *Phaseolus vulgaris* and suggested that this could be due to the removal of the seed coat tannin which may have caused decrease in protein digestibility.

Autoclaving: Autoclaving is a more sophisticated, but effective method of processing seeds for eliminating anti-nutrient (Abeke and Otu, 2008). However, autoclaving is expensive because it requires adequate supply of electricity and technical knowledge. Kessler *et al*. (1990) reported that autoclaving of jackbean was a satisfactory technique for ensuring survival of birds. They however, stated that there was little nutritional advantage in autoclaving of this product for more than half an hour.

Toasting/roasting: Toasting involves dry heat treatment of legume bean seeds and other seeds for incorporation in poultry diets. Sometimes, some quantity of water is sprayed on the seed before they are toasted. Toasting has been reported to effectively reduce the anti-nutritional factors of raw soybean which are associated with growth retardation in chickens (Akpodiete *et al*., 2001). Omoikhoje *et al*. (2009) reported that inclusion of roasted fluted pumpkin pod husk waste increased broiler chicken performance and did not affect palatability of the diets (El-Boushy and Vandal Poel, 2001). However, Abeke and Otu (2008) reported that a major problem of toasting may be that of charring of the seed if not property stirred.

Chemical methods

Use of wood ash: Wood ash, an alkaline substance (Etiegni and Campbell, 1991), is used by local people of south-Western Uganda to reduce tannins in red, bird resistant sorghum that is cultivated in that region. The effectiveness of the alkali treatment depends on the types and concentration of the alkali and the prevailing conditions (Muindi *et al*., 1981). Kutlu and Unsal (1998) investigated the effects of dietary wood charcoal incorporated with Soybean Meal (SBM) on the performance and fatness of broiler chicks. They reported that, dietary wood charcoal resulted in increased feed intake, weight gain and Feed Conversion Ratio (FCR). Charcoal inclusion did not affect carcass weight and yield, but the abdominal fat reduced slightly. They concluded that wood charcoal in poultry diet increased broiler chicken performance at early age. These improvements could be attributed to increased digestibility and reduced anti-nutritional effects of the diet. Similarly Kyarisiima *et al*. (2004), observed that soaking of high-tannin sorghum in wood ash extract was effective in reducing tannin level without lowering the nutrient content of the grain.

Addition of tallow (fat): Douglas *et al*. (1988) reported that the mean Apparent Metabolizable Energy (AME) values of low-and high-tannin sorghums were 13.4 and 11.9 mg/kg respectively and observed that the nutritional value of high-tannin sorghums can be improved if its AME value is increased by the addition of animal fat. It has been shown that the addition of tallow at 60 g/kg improved Efficiency of Food Utilization (EFU) at the highest dietary tannin content (Pour-Reza and Edriss, 1997). Improvement in the nutritional value of low quality feeds such as barley, wheat bran and sorghum by the addition of tallow has already been reported (Reid, 1985).

Use of Tannin Biding Agents (TBAs): Addition of tannin-binding agents such as activated charcoal, Polyvinyl Polypyrrolidone (PVPP), Compound Polyethylene Glycol (CPEG) has been shown to ameliorate the deleterious effects of tannin by displacing condensed tannin from tannin-protein complexes and forming complexes with tannins which are excreted (Jones and Mangan, 1977). It was also observed by Salunkhe *et al*. (1990) that the addition of chemicals with high affinity for tannins such as polyethylene glycol or gelatine would bind dietary tannins thereby preventing tannins from binding to nutrients.

Use of enzymes: The effectiveness of enzymes to enhance nutrient digestibility has been reported (Choct, 2006). It is well documented that phytase improves phosphorus utilization in poultry (Oyango *et al*., 2005; Ravindran *et al*., 2006). Supplementation of feeds for broiler chickens with phytase has been shown improve growth and bone mineralization and decrease mortality (Qian *et al*., 1996). However, Torki and Farahmand-Pour (2007) observed no significant effect of enzyme supplementation on performance of broiler chickens fed sorghum based diets.

Urea treatment: Feeding with jackbean meal containing tannins treated with urea solution involving young broiler chicks demonstrated that jackbeans so processed could be tolerated by broiler chicks up to 25% inclusion level in the diet without adverse effects on performance (Udedibie and Nkwocha, 1990). Jackbeans soaked in 5% urea solution had the highest True Metabolizable Protein (TMP) of 253.32 mg/g value and also had an appreciable True Metabolizable Energy (TME) of 2.761 kcal/g which become effective and cheap method of processing that can be conveniently practiced at farm site (Akinmutimi *et al*., 2000). Broiler chickens can tolerate dry urea treated jackbean meal containing tannins at up to 20% in their diets (Udedibie *et al*., 1994).

Conclusion: To obtain qualitative poultry meat and products, removal or reduction of tannins in the feed is necessary. Several methods have been discussed in this paper which include cooking, dehulling, autoclaving, toasting, soaking, use of wood ash, addition of tallow and use of tannin binding agents. Also use of enzymes, germination and urea treatment were mentioned. Some of these methods mentioned above are tedious and costly, to achieve better results, the best methods to be adopted will depend on their effectiveness and cost of processing.

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