Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.6, No.21, 2016

Review on: Bio Active Substance of Legume Forages and Their Feeding Effect on Nutrient Intake, Growth Performance and Nutrient Digestibility of Livestock

Denbela Hidosa
Southern Agricultural Research Institute, Jinka Agricultural Research Center, P. O. Box 96
Jinka, Ethiopia

Abstract
In tropics and subtropics livestock production challenged by the many factors and among them, the availability and quality of feed resource is a critical and major cause for such low a production particularly during dry seasons. It is important to advice the livestock producer to overcome the nutritional deficiency phenomena and many researchers has reported that understanding the role legume forage supplementation in livestock production, due to forage legumes are being utilized valuable supplementary sources of protein, energy, minerals and vitamins to the livestock production system. The valuable legume forages are important, however, the forage legume have contained bioactive substance that generated mostly in leguminous feed stuff that either beneficially or determinant effect on livestock performance. On the other hand, the availability of information on bioactive substance and knowledge on feeding practice of livestock are limited. This literature review is focused on bioactive substance that prevailed in legume forages and the feeding effect of these bioactive substances on total Nutrient intake, Growth performance and Digestibility of nutrients by ruminant and mono gastric livestock. Finally in this review also attention was give to beneficial effect of bioactive substance such as role of bioactive substance recycling nutrients, improving microbial efficacy and health aspect were discussed vividly.
Keywords: Bioactive substance, Growth performance, Nutrient intake and Nutrient digestibility

1. INTRODUCTIONS

Different studies confirmed that livestock production in tropics and subtropics hindered by the many factors. Among the factors, the feed shortage both in quality and quantity is a critical and major cause for a low production particularly during dry seasons (Mengistu, 2002; Mengistu and Amare, 2003; Zegeye, 2003; Amede et al., 2005; Duguma et al., 2012; Seyoum and Zinash, 1995; Ørskov, 1998; Tolera, 2007; Solomon, 2010 and Alemayehu, 2004). On the other hand, livestock production especially in Pastoral and Agro pastoral production system, livestock population which is totally has been depended on the feed from natural pastures is estimated to covers 80-90% of the livestock feed resource (Mengistu, 2006) and hence, the nutrient bioavailability to the livestock production from a such feed resource is very poor and to such an extent that livestock may not fulfill the energy requirement to maintain their bodyweight. This has been resulted in body weight loss and reduction of production and productivity (Galmessa et al., 2013) and made the communities that have been relied on livestock production made less benefit from prevailed production system. To overcome the nutritional deficiency, many researchers had been reported that understanding the role legume forage and livestock production has been played a significance role in livestock production due to forage legumes are being utilized valuable supplementary sources of protein, energy, minerals and vitamins to the livestock production system and boosted production(Barry *et al.* 1986; Goodchild and Mcmeniman, 1994; Makkar *et al.* 1996; Dana *et al.* 2000; Tolera and Sundstøl, 2000a; Schultze-Kraft & Peters, 1997; Savon, 2005). Even though, supplementing livestock (ruminant livestock and mono gastric livestock) with valuable legume forages are imperative, however, the forage legume (Herbaceous and tree legumes) has been contained bioactive substance (Gatehouse & Boulter, 1983; Price *et ai., 1980;* Bressani, 1985). Bioactive substance is a substance that generated mostly in leguminous feed stuff that either beneficially or adversely affects livestock performance (Reed et al., 1990; Mueller-Harvey and McAllan, 1992; Gatehouse & Boulter, 1983; Price *et ai., 1980;* Bressani, 1985; Gül et al., 2005). It is clear that the inclusion level of feed resource legume based on animal diets brings about a number of undesirable effects such as reduced protein deposition, altered digestibility and absorption of nutrients and impairment of the immune response, which have been attributed due to the presence of various bioactive substance and to a poor sulfur amino acid content (Martinez et al., 1992; Mahmood and Smithard, 1993; Marzo et al., 2002). On the other hand, the availability of information on bioactive substance and knowledge on feeding practice of livestock (ruminant livestock and mono gastric livestock) are limited. Therefore, review the baseline information and research output available on the bioactive substance is so important to readers or livestock producers in order attain goals of high animal productivity and production (Crowder and Chheda, 1982) because the attainment of production goals depends upon the feeding value of feed resource (Humphreys, 1991). Therefore the objective of this paper is reviewed with following objectives.

- To review the bioactive substance that prevailed in legume forages;

To review the feeding effect of bioactive substance of legume forage on Nutrient intake, Weight gain and Digestibility of nutrients by ruminant and mono gastric livestock

2. What are bioactive substances?

Bioactive substance is substance that widely distributed and being biologically-active constituents throughout the legumes forages, particularly in legumes that used as livestock feeding stuff and in Human Nutrition and their content in legume forage affected by species, stage of harvesting and morphology of plant (Barry, 1989; Assefa et al., 2008; Igile, 1996 Piluzza et al., 2000; Hearing et al., 2007; Molle et al., 2009; Theodoridou et al., 2010, 2011; Guglielmelli et al., 2011; Piluzza et al., 2000; Molle et al., 2003 and Theodoridou et al., 2010). Generally it is well known that legume plants were acquired bioactive substance from fertilizer, pesticides and several naturally-occurring chemicals (Teguia and Beynen., 2005; Miega, 1987; Duc, 1998; Wiryawan and Dingle, 1999; Igile, 1996; Zenk, 1991). The bioactive substance that found in legume forages are Saponins, Tannins, Flavonoids, Alkaloids, Trypsin (protease) inhibitors, Oxalates, Phytates, Haemagluttinins (lectins), Cyanogenic glycosides, Cardiac glycosides and gossypol and which have been lead to deleterious to animal productivity and production and evidently advantageous to human and animals health if consumed at appropriate amounts (Kersten etal., 1991; Sugano et al; 1993; Oakenfull and Sidhu, 1989; Soetan, 2008).

Table 1: Summarized the bioactive substance presented in different legume forages (Herbaceous and Tree)

Legume forages	Bioactive substance	Plant parts	References
Cow pea	Trypsin inhibitors, Phytic acid and Tannins	Leaf and Seed	[1]; [2]; [3]; [4]; [5]; [6] .
Lablab purpureus	Trypsin inhibitors and Phytate	Leaf	[7];[8] ; [9]; [10];
Cajanus cajan	Typsin, Chymotrypsin, Amylase inhibitors, Tannins, Saponins, Cyanide, Phytic acid and oxalate	Leaf and seed	[11]; [12] [13]
Leucaena leucocephala	Cyanogens, Saponins, mimosine	Leaf	[14]
Ficus polita	Tannin, Saponin, Oxalate, HCN	Leaf and Seed	[15]; [16] ; [17] [18]; [19]
Ziziphus abyssinica	Tannin, Saponin, Oxalate	Leaf and Seed	[20] ; [21] ; [22];[23]
Acacia tortilis	Phenolic and Tannin	Leaf	[24]
Balanites aegypiaca	Phenolic and Tannin	Leaf	[25]
Accacia Nilotica	Tannin	Leaf and Seed	[26]

[1]Makinde et al., 1997; [2]Asante etal. 2006; [3]Ikhlas ibrahim and Sirelkhatim Balla, 2014; [4]Akinyele ,1989; [5]Teguiam and Beynen, 2005; [6] Amaefuil et al., 2005 ; [7]Deka and Sarkar, 1990;[8] Shastry and John, 1991; [9]Ahmed and Nour, 1990; [10]Devaraj and Manjunath, 1995; [11]Farris and Singh, 1990;[12]D'mello1995; [13]Netsant and Yonatan kassu, 2015; [14] Kumar, 2003; [15]Osuga et al., 2006; [16] Le Houerou, 1980; [17]Akinsoyinu [18]Onwuka, 1988; [19]Njidda, 2010; [20] Osuga et al., 2006; [21] Le Houerou, 1980; [22] Akinsoyinu and Onwuka, 1988;[23] Njidda, 2010; [24]James Ombiro et al., 2013; [25]James Ombiro et al., 2013;[26]A Abdulrazak et al., 2005.

3. Effect of Bioactive Substance on Nutrient intake

Bioactive substance which found mostly legume forage either positively or adversely correlated to the nutrient intake by mono gastric and ruminant livestock. The research conducted by the Uguru et al.(2014) to evaluate different level of *Acacia nilotica* pods meal supplementation on daily nutrient intake by growing Red Sokoto Goats demonstrated that the daily nutrient intake by goat declined as the level of Acacia pods inclusion increased from 262.16g in 25% Acacia pods level to 225.30g in 100% Acacia pods level. On the other hand, correspondingly, research finding by Makaranga (2002) who reported that there was reduction in DM intake and CP intake in sheep fed browse diets containing bioactive substance such as tannins when they compared the highest nutrient intake (601.87g) recorded in 25% Acacia pod meals. However, there was controversial idea to Uguru and others study reported by Araya *et al*., (2003) which attested that nutrient intake increased dramatically with an increase in the amount of *A. tortilis* pods in the rations of goats, up to 75% level. The tannin is one of the bioactive substances which has determinant effect in reducing nutrient intake by the ruminant livestock through the formation of the H-bonds, hydrophobic interactions and induce their bitter and astringent taste (Jeroch *et al.*, 1993). Conversely, Waghorn et al.(1994a), observed that bioactive substance presented in *Lotus pedunculatus* decreased ruminal turnover and rate of digestion hence decrease nutrient intake by the sheep fed pure diets of *Lotus pedunculatus* in comparison to those sheep fed on *L. pedunculatus* along with polyethylene glycol. Understanding at what level of bioactive substance can be decreased nutrient intake imperative because Aerts et al.(1999)and Min et al.(2003)

confirmed that moderate bioactive substance concentrations (<50 g kg DM) enhance forage nutritive value in grazing ruminants by reducing protein degradation by rumen bacteria and increasing protein degradation in the intestine, without depressing rumen fibre digestion or voluntary intake. Likewise, the mono gastric livestock more sensitive to feed that contained more bioactive substance when we compared to ruminant livestock due to absence of micro organism which has played role in reducing size of bioactive substance by cracking and digesting them. Different authors confirmed that mono gastric Livestock such as poultry and pigs feeding experiment the nutrient intake by them was depressed when the rations that contained bioactive substance such as tannin, level from 0.5 to 2% and while levels from 3 to 7% can cause death of them (Kumar and D'Mello, 1995; Ola et al*.,* 2005; Ahmed et al., 1991; Longstaff and McNab, 2007). Moreover on the other hand, the research conducted by B.M. Dousa et al.(2011) in order to evaluate the inclusion of some raw legume grains as Broiler Chicks Concentrates demonstrated that broiler chicks fed ration contained 10% raw legume, the total nutrient intake reduction(2500.62 g/day/chick) was observed when it was compared to control group (3042.64 g/day/chick). This may be attributed to a high level of bioactive substance (inhibitors) in raw legume forages(Ene-Obong,1995).

3.1 Effect of Bioactive substance on Growth performance of livestock

The growth performance is important parameters in livestock nutrition and it is altered by total nutrient intake and availability of nutrients in the livestock diet. Different research report on effect of bioactive substance on growth performance of livestock has demonstrated that feeding livestock with feed that contained high amount of bioactive substance leads to decrease/slow the growth performance of livestock through inducing low total nutrient intake and slow true digestibility of nutrients such as essential amino acid (Tanner et al., 1990). Meanwhile, Reed et al. (1990) demonstrated that animal fed on diet A. *sieberiana* and A. *cyanophylla* pods and leaves exhibited that low total nutrient intake and low growth rates were also observed and this is attributed due to A. *sieberiana* and A. *cyanophylla* pods and leaves have contained high amount of bioactive substance such tannins . Also, Araya *et al*., (2003) reported that growth performances (body weight gains) of Red Sokoto goats increased with an increase in the amount of *A. tortilis* pods in the rations of goats, up to 75% level and the highest WG of 6.22kg recorded in 25% Acacia pods inclusion and similar value 6.23kg also reported by Yahaya (2011) when A. *seyal del.* fed to sheep as supplement. Conversely, also Emiola et al. (2005) reported that they observed poor growth performance of broiler chickens that fed on ration formulated from raw cow pea and however, the improved weight gain in birds that fed on ration formulated from the dehulled - cooked cowpea and dehulled – roasted cowpea that cooking and roasting improves the nutritive value of grain legumes (Ologbobo,1992). On the other hand, Cyanogenic glucoside could be hydrolysis and yields to toxic hydrocyanic acid and cyanide ions inhibit several enzyme systems which have pivotal role in the growth. Then the growth hormone activity and depress growth through interference with certain essential amino acids and utilization of associated nutrients (Osuntokun, 1972).

3.2 Effect of Bioactive substance on Nutrient Digestibility

The digestibility of a nutrient is most accurately defined as the proportion that is not excreted in the faeces and that is, therefore, assumed to be absorbed by the animal. It is commonly expressed in terms of dry matter and as a coefficient or a percentage. When present in large quantities of bioactive substance in the ruminant ration (>50 g kg^{-1}), it can be induced determinant effect on nutrition of ruminant livestock by reducing protein digestibility (by inhibiting digestive enzymes or by direct systemic toxicity), leading to a reduction in feed intake, adverse effects on rumen fermentation and significantly depressed digestibility of almost all nutrients (Barry, 1989). According to Iji et al. (2004) report demonstrated that the ideal digestibility of nutrients such energy (Carbohydrate), protein, Amino acids especially Arginine and Leucine by broiler chickens were reduced as dietary tannin level rose to 20g/kg diet and beyond. Moreover, amino acids such as Methionine and Phenylalanine were negatively affected at tannin content in the ration was at 25g/kg. Similarly, other study reported by Oke et al. (2004) confirmed that protein efficiency ratio (PER) and net protein ratio are adversely correlated with bioactive substance. Feed conversion efficiency increased with increasing level of tannin up to 15g/kg diet while pancreatic and jejenal enzymes activities were not disturbed (Iji et al., 2004). Different authors reported that present of more Tannins content livestock ration could be reduced protein digestibility through the formation of complexes and the inhibition of activities of proteolytic enzymes in digestive secretions (Ahn et al., 1989; Kumar and D'Mello, 1995; Grosjean et al., 1999). The affinity of tannins for protein has been observed to increase with increase in molecular size of tannin. However tannin with extremely large molecular weight lose their affinity for protein and become insoluble (Kumar and Horigome, 1986). According to Steendam *et al.*(1998) study to evaluate the feeding effect of Pigs fed a tannin-rich feed had been demonstrated that a lower apparent ileal digestibility of Nitrogen, but there was no significant decrease in true ileal nitrogen digestibility. Conversely also, Nobuyoshi et al.(2005) and Ozturk et al.(2005) reported that the livers of chicks which fed on legume forages caused only sinusoidal dilatations, vascular disorders, hepatic lesions and increased arterial flow. In swine feeding tannins depress protein utilization, damage the mucosal lining of the digestive tract, alter the excretion of certain cat ions and increase excretion of proteins and essential amino acids. Pigs fed a tannin-rich feed had a lower apparent ileal digestibility of nitrogen, but there was no significant decrease in true ileal nitrogen digestibility (Steendam *et al.*, 1998; Makkar, 2007; Cannas, 2008).

On the other hand, Trypsin and chymotrypsin inhibitors inhibited the digestibility of protein by binding with trypsin and Chemotrypsin in the small intestine, preventing protein digestion and similarly, impart bitter or unacceptable taste to the legumes, causing decreased digestibility and absorption of divalent metal ions such as F2+, Zn2+ (Abdu et al, 2008). Phytate is on the other hand, regarded as the primary storage form of both phosphate and inositol in legume seeds and grains as a potent natural anti-oxidant (Mueller I, 2001). Mono gastric animals are unable to digested feed that contain phytate due to lack of phytase enzyme in their stomach (Harold, 2004), which leads to result in minerals such as zinc, calcium, and magnesium deficiency, reduction and absorption(Rimbach *et al.*, 2008).The intestinal apparent digestibility of phytate in pigs varies widely, between 0 and 25% (Rubio *et al.*, 2006). Lectins are sugar-binding glycoprotein, which are classified as toxic and in line with growth inhibitory (Grant, 1989), or essentially non-toxic or beneficial (Grant *et al.*, 1995). Toxic lectins generally coagulate the erythrocytes, which can affect the immune system (Jeroch *et al.*, 1993), or disrupt nutrient absorption in the intestines by shedding the brush border membrane of the entrecotes (Makkar, 2007). They act in the small intestine by interfering in the absorption of the end-products of digestion by binding and disrupting the epithelial cells (Dixon et al., 1992). They also induce pancreatic enlargement and increase protein secretion, causing lower N retention, lower growth and lower feed efficiency in mono gastric animals (Perrot, 1995). Phytate Non-protein amino acids occur in un conjugated forms in many plants, especially in legumes seed, which binds to minerals and pyridoxalphosphate (Makkar, 1991), decreasing the activity of the enzymes that require them as co-factors, and ultimately inhibiting metabolic pathways (Sastry & Rajendra, 2008; Kumar, 2003). Oxalates, which is high concentration in some tropical legume forages and grass and has limited the availability minerals such as calcium, magnesium, and iron (Weiss, 2009; Rahman *et al.*, 2011).

4. Important role of Bioactive Substance

Different research finding has demonstrated that bioactive substance important advantage even though, well know with determinant effect. Woodward (1988) and Robbins et al. (1987) reported that bioactive substance may increase the efficiency of urea recycled through the lower the rate of protein degradation and damnations. The plasma urea Nitrogen, NH3, and urinary N loss was lower in which ruminant animals are fed on legumes that contained bioactive substance such as tannin may increase the glycoprotein content and excretion of saliva, which could lead to more N recycled (Woodward, 1988). On the other hand, bioactive substance has played significant role in microbial efficiency through may be increase microbial yield and non-ammonia nitrogen flows to the duodenum greater than Nitrogen intake for forage legumes that contain tannins (Reed et al., **1990)**. Pertaining to livestock health aspect, over the last few years ago, the dietary role of bioactive substance such as tannins is receiving increasing interest as they may reduce the number of gastrointestinal parasites in mammals (Athanasiadou et al., 2000). Elizondo et al. (2010) and Hara (1997) demonstrated that condensed tannins have proven to have antimicrobial and anti gastrointestinal bacteria colonization in chickens and pigs. Multiple reports suggested that the efficacy of bioactive substance (tannins) in the control of zoonotic pathogens like *Campylobacter* and *Salmonella*. The antimicrobial activity of various hydrolysable and condensed tannin-rich extracts against *Campylobacter jejuni* reveals that tannins inhibit the growth of this bacterium (Anderson et al., 2012). It has been observed that condensed tannins may be less efficient than hydrolysable tannins in controlling *Campylobacter jejuni* when high concentrations of amino acids and soluble proteins are present (Anderson et al., 2012). Subsequent results from this research group confirm the *in vivo* effects of tannins in a broiler necrotic enteritis model reducing the incidence and severity of gross lesions and improving the productive performance of broiler chickens (Redondo et al., 2013b) due to its strong bactericidal activity against *Clostridium perfringens*, most ingested tannin do not remain in the feces because it is hydrolyzed and degraded in the intestinal tract. The ingestion of tannic acid causes constipation so it can be used to treat diarrhoea in the absence of inflammation (Phytolab, 2007). Moreover, tannins are anti-oxidants and can improve resistance to heat stress (Liu et al., 2011).

VII. Summary and Conclusions

Legume forages are used as protein feed sources for feeding livestock contributes to improved sustainability of animal productivity and production performance. However, they have the potential to precipitate adverse effects on the livestock performance due to they contain some certain bioactive substance such as Saponins, Tannins, Trypsin inhibitors, Oxalates, Phytates, Haemagluttinins (Letins), and Cyanogenic glycosides. These biologically active substance has determinant effect the livestock production in line with reduced protein deposition, altered feed intake and digestibility, absorption of nutrients and impairment of the immune response when the inclusion of these legume in animal diets beyond the recommendation level of inclusion in diets. Conversely, bioactive substance have proven beneficial effect on which enhance the performance of animals' through enhancing urea recycling, activating microbial efficiency in rumen of ruminant livestock and has played an important role animal health protecting aspect. Further research is should be focused on the definition of appropriate strategies to better exploit bioactive substance in livestock feeding, improving animal husbandry and contributing to environmental sustainability.

5. References:

[1] AlemayehuMengistu (2003). Pasture and forage resource profiles of Ethiopia. EDM printing Press, Addis Ababa, Ethiopia

[2] Ahmed, A.H.R. and A.A. Nour, 1990. Protein quality of common Sudanese leguminous seed. Labensm Wiss U. Tec., 23: 301-304

[3] Akinyele, l.O., 1989. Effects of traditional methods of processing on the nutrient content and some antinutritional factors in cowpeas *(Vigna unguiculata). Fd. Chern.* 33, 291. AOAC, 1984. Official methods of analysis

[4] Aletor VA (1993). Allelochemicals in plant foods and feeding Stuffs. Part I. Nutritional, Biochemical and Physiopathological aspects in animal production. Vet. Human Toxicol. 35(1): 57-67

[5] Amaefule, K.U. and F.C. Obioha, 2001. Performance and Nutrient utilization of broiler starters fed diets containing raw, boiled or dehulled pigeon pea seeds (*Cajanus Cajan*). Nig. J. Anim. Prod., 28: 31- 39.

[6] Asante IK, Adu-Dapaah H and P Addison Seed weight and protein and tannin contents of 32 cowpea accessionns in Ghana. Journal of Tropical Science. 2006; 44 (2):77–79.

[7] Aletor VA , 1999. Anti-nutritional factors as nature's paradox in food and nutrition securities. Inaugural lecture series 15, delivered at The Federal University of Technology, Akure (FUTA), on Thursday,August 12, 1999.

[8] Aletor, V. A. and Fetuga, B. L. (1998). Dietary interaction of lima bean (phaseolus lunatus) Trypsin inhibitor, haemagglutinin and cyanide: effect on growth performance, Nitrogen utilization and physiopathology on growing Albino Rats. *Journal of Animal Physiology and Animal Nutrition* 60; 113-112.

[10] Bennet-Lartey S. O. and Ofori I. 1999. Variability studies in some qualitative characters of cowpea (*Vigna unguiculata* (L.) Walp) accessions from four cowpea- growing regions of Ghana. Ghana J. Agric. Sci. 32: 3-9.

[11] Cannas, A. (2008). Tannins: fascinating but sometimes dangerous molecules. Cornell University NY, USA.

[12] Deka, K.R. and C.R. Sarkar, 1990. Nutrient composition and antinutritional factors of Dolichos lablab L. seeds. Food Chem., 38: 239-246 .

[13] D'Mello JPF (2000).Anti-nutritional Factors and Mycotoxins. In: Farm Animal Metabolism and Nutrition, JPF D'Mello (ed.). CAB International, Wallingford, UK, pp. 383 – 403

[14] Duguma B., Tegegne A and Hegde B. P. (2012). Smallholder livestock production system in Dandi district, Oromia Regional State, Central Ethiopia.Global Veterinaria 8(5):472–479.

[15] Elizondo A. M., Mercado E. C., Rabinovitz B. C, Fernandez Miyakawa M. E. (2010). Effect of tannins on the in vitro growth of *Clostridium perfringens*. *Veter. Microbiol.* 145 30831410.1016/j.vetmic.2010.0403

[16] Galmessa U., Dessalegn, J., and Tola, A. (2013). Dairy production potential and challenges in Western Oromia milk value chain, Oromia, Ethiopia. Journal of Agriculture and Sustainability 2(1): 1–21.

[17] Gebremedhin B., Pender J. and Tesfay G. (2004).Collective action for grazing land management in crop–livestock mixed systems in the highlands of northern Ethiopia. Agricultural Systems 82(3): 273–290.

[18] Grant, G. (1989). Anti-nutritional effects of dietary lectins. In J. P. F. D'Mello, C. M. Duffus, &J. H. Duffus(Eds.), *Anti-nutritional factors, potentially toxic substances in plants* (pp. 51–74). Warwick, United Kingdom.

[19] Grant, G., More, L. J., McKenzie, N. H., Dorward, P. M., Buchan,W. C., Telek, L. & Pusztai, A. (1995). Nutritional and haemagglutination properties of several tropical seeds. *The Journal of Agricultural Science*, 124, 437–445.

[20] Hara Y. (1997). Influence of tea catechins on the digestive tract. *J. Cell. Biochem.* 67 52–5810.1002/(SICI)1097-4644(1997)

[21] Igile GO (1996). Phytochemical and Biological studies on some constituents of *Vernonia amygdalina* (compositae) leaves. Ph.D thesis, Department of Biochemistry, University of Ibadan, Nigeria.

[22] Iji PA, Khumalo K, Slippers S and Gous RM (2004). Intestinal Function and Body Growth of Broiler Chickens on Maize-based Diets Supplemented with Mimosa Tannins and a Microbial Enzyme. Journal of Science, Food and Agriculture, 84 (12): 1451 – 1458.

[23] Ikhlas Ibrahim Khalid and Sirelkhatim Balla Elharadallou ,2014. Factors that compromise the nutritional value of cowpea flour and its protein isolates.

[24] Kumar, R., 2003. Anti-nutritive factors, the potential risks and methods to alleviate them.

[25] Kumar R and D'Mello JPF (1995). Anti-nutritional Factors in Forage Legumes. In: D'Mello JPF. and Devendra C (eds). Tropical Legumes in Animal Nutrition. CAB International, Wallingford, Oxon, UK, pp. 95 – 133

[26] Kumar R (1992). Antinutritional factors, the potential risks of toxicity and methods to alleviate them. Proceedings of the FAO Expert Consultation held at the Malaysian Agricultural Research and Development Institute (MARDI) in Kuala Lumpur, Malaysia, 14-18 October, 1991.

[27] Longstaff M. A., McNab J. M. (2007). The effect of concentration of tannin-rich bean hulls (*Vicia faba* L.) on activities of lipase (EC 3.1.1.3) and α-amylase (EC 3.2.1.1) in digesta and pancreas and on the digestion of lipid and starch by young chicks. *Br. J. Nutrit.* 66 13910.1079/BJN19910017 Andrew Speedy and Pierre-Luc Puglise (eds).
[28] Perrot, C., 1995. Pea proteins: from their function in the seed to their use in animal feeding. Inra Prod. Anim., 8 (3): 151-164.
[29] Phytolab (2007). Phytochemicals Polyphenols – Tannic Acid. Retrieved July 6, 2007.
[30] Liu, H.W., Dong, X. F., Tong, J. M.&Zhang, Q. (2011). A comparative study of growth performance and antioxidant status of rabbits when fed with or without chestnut tannins under high ambient temperature. *Animal Feed Science and Technology*, 164, 89–95.
[31] Makkar, H. P. S. (2007). Plant secondary metabolites as antinutrients in monogastric nutrition. In P. Leterme, A. Buldgen, E. Murgueitio,& C. Cuartas (Eds.), *Fodder banks for sustainable pig production systems* (pp. 67–85). CIPAV. Cali, Colombia.
[32] Makkar, H. P. S. (1991). Ant nutritional factors in animal feedstuffs - mode of actions. *International Journal of Animal Sciences*, 6, 88–94 .
[33] Makinde, M. O.; Umapathy, E.; Akingbemi, B. T.; Mandisodza, K. T.; Skadhauge, E., 1997. Differential response of legumes and creep feeding on gut morphology and faecal composition in weanling pigs. Comparative Biochemistry and Physiology. A, Physiology, 118 (2): 349-354.
[34] Marzo, F., E. Undaneta and S. Santidrian. 2002. Liver proteolytic activity in tannic acid-fed bırds. Poult. Sci. 81(1):92
[35] Mengistu, A. (2002). Forage production in Ethiopia: A case study with implication for livestock production. Ethiopian Society of Animal Production (pp. 1–125). Addis Ababa, Ethiopia:
[36] Mengistu, A. (2006). Country pastures / forage resource profiles, Ethiopia. FAO, 1–36.
[37] Mueller I. (2001).Analysis of hydrolysable tannins. Anim Feed Sci Technol 91:3-20.
[38] Nobuyoshi, O., N. Hisaya, I. Kazuo, N. Saori, I. Yoshinoro, O. Makoto and O. Isao. 2005 Telangiectatic focal nodular hyperplasia of the liver in the perinatal period: Case report.Pediatr.Dev.Pathol.8:581-586.
[39] Oakenfull D, Sidhu GS (1989). Saponins: In Toxicants of plant origin, Vol. II, Glycosides, (Eds). PR Cheeke, CRC. Press Inc. Florida. p. 97.
[40] Oke DB, Oke MO and Adeyemi OA (2004). Protein Quality of Autoclaved Cowpea Varieties as Influenced by Anti-nutritional Factors. Nigerian Journal of Animal Production, 31(1): 17 –21.
[41] Osagie AU (1998). Ant nutritional Factors. In: Nutritional Quality of Plant Foods. Ambik Press Ltd, Benin City, Nigeria, pp. 1-40; 221-244.
[42] Osuntokun BO (1972). Cassava diet and cyanide metabolism in Wistar rats. Brit. J. Nutr. 24: 797-805.
[43] Ola SI, Shobooye OO and Daramola EA (2005). Preliminary Studies on the Metabolism of Vegetative Parts of *Terminalia catappa* (Almond tree) in Chicken. Proc., 1st Nigeria International Poultry Summit (NIPS) February 20 – 25, 2005, Otta, Ogun State, pp. 152 – 154.
[44] Ozturk, H., A. Gezici and H. Ozturk. 2005. The effect of celecoxib, a selective COX-2 inhibitor, on liver ischemia/reperfusioninduced oxidative stres in rats. Hepatol. Res. 34(2):76-83.
[45] Ørskov, E.R., 1998. Feed evaluation with emphasis on fibrous roughages and fluctuating supply of nutrients: A Review. Small Rumin. Res. 28, 1–8
[46] Pedersen, M. W., Anderson, J. O., Street, J. C., Wang, L. C. & Baker, R. (1972). Growth response of chicks and rats fed alfalfa with saponin content modified by selection. *Poultry Science*, 51, 458–463.
[47] PRICE, M.L., HAGERMAN, A.E. & BUTLER L.G., 1980. Tannin content of cowpeas, chickpeas, pigeon peas and mung beans. *J. Agric. Food Chern.* 28, 459.
[48] Purseglove J W 1968 Tropical Crops, Dicotyledons. Vol L London, UK; Longmans Greens and Company Ltd. pp 273-276..
[49] Rahman, M. M., Nakagawa, T., Niimi, M., Fukuyama, K. & Kawamura, O. (2011). Effects of Feeding Oxalate Containing Grass on Intake and the Concentrations of Some Minerals and Parathyroid Hormone in Blood of Sheep. *Asian-Australasian Journal of Animal Sciences*, 24 (7), 940–945.
[50] Reed, J. D., H. Soller, and A. Woodward. 1990. Fodder tree andstraw diets for sheep: Intake, growth, Digestibility and the effects of phenolics on nitrogen utilisation. h i m . Feed Sci.Techno]. 30:39.
[51] Redondo L. M., Fernandez Miyakawa M. E., Fortunato R., Salvat A., Chacana P. (2013b). Eficacia de aditivos alimentarios basados en extractos vegetales para disminuir la excreción de *Salmonella Enteritidis* en pollitos BB. *II Seminario Internacional de Salmonelosis aviar*. Medellin, Colombia.
[52] Rimbach, G., Pallauf, J., Moehring, J., Kraemer, K. & Minihane, A. M. (2008). Effect of dietary phytate and microbial phytase on mineral and trace element bioavailability - a literature review. *Current Topics in Nutraceutical Research*, 6, 131–144.
[53] Robbins, C. T., T. A. Hanley, A. E. Hagerman, 0. Hjeljord, D. L. Baker, C. C. Schwartz, and W. W. Mautz. 1987. Role of tannins in defending plants against ruminants: reduction in protein availability. Ecology 68:98.

[54] Rubio, L. A., Pedrosa, M. M., Cuadrado, C., Gelencser, E., Clemente, A., Burbano, C.&Muzquiz, M. (2006). Recovery at the terminal ileum of some legume nonnutritional factors in cannulated pigs. *Journal of the* Science of Food and Agriculture, 86, 979–987.
[55] Schultze-Kraft, R. & Peters, M. (1997). Tropical legumes in agricultural production and resource management: An overview. Presented at the Tropentag JLU Giessen 22.-23.5.1997. Pp. 1–17
[56] Savon, L. (2005). Tropical roughages and their effect on the digestive physiology of monogastric species Alimentos fibrosos y su efecto en la fisiología digestive de especies monogástricas. *Cuban Journal of Agricultural Science - Revista Cubana de Ciencia Agrícola*, 39, 475–487.
[57] Sastry, M. S. & Rajendra, S. (2008). Toxic effects of subabul (*Leucaena leucocephala*) on the thyroid and reproduction of female goats. *Indian Journal of Animal Sciences*, 78, 251–253.
[58] Soetan KO (2008). Pharmacological and other beneficial effects of antinutriional factors in plants. –A Review. Afr. J. Biotechnol. 7(25):4713- 4721
[59] Steendam, C. A., de Jong, E. J., Mattuzzi, S. & Visser, G. H. (1998). Comparison of three methods for the measurement of the endogenous N-flow at the terminal ileum of pigs, as affected by dietary quebracho extract. In A. J. M. Jansman, J. Huisman, & A. F. B. van der Poel (Eds.), *Recent advances of research in antinutritional factors in legume seeds and rapeseed. Proceedings of the third international workshop* (pp. 335–339). Wageningen.
[60] Sugano M, Goto S, Yaoshida K, Hashimoto Y, Matsno T, Kimoto M(1993). Cholesterol-lowering activity of various undigested fractionsof soybean protein in rats. J. Nutr., 120(9): pp. 977-985
[61] Seyoum, Bediye, Zinash, Sileshi. 1995. Chemical composition, in vitro digestibility and energy values of Ethiopian feedstuffs. Third National Conference of Ethiopian Society of Animal Production (ESAP). Addis Ababa, Ethiopia. 27–28 April 1997, 307–311 pp.
[62] Tanner, J. C., J. D. Reed, and E. Owen. 1990. The nutritive value of fruits (pods with seeds) from four Acacia spp. compared with extracted noug *(Guiztia abyssinica)* meal as supplements to maize stover for Ethiopian highland sheep. Anim. Prod. 51:127.
[63] Tolera, A., 2007. The role of forage supplements in smallholder mixed farming systems. In: Hare, M.D., Wongpichet, K. (Eds.), Forages: A Pathway to Prosperity for Smallholder Farmers. Proceedings of an International Forage Symposium, Faculty of Agriculture.UbonRatchathaniUnive rsity,Thailand, pp. 165–186.
[64] Uguru, C., Lakpini, C.A.M., Akpa, G.N., And Bawa, G.S. 2014. Nutritional Potential of Acacia (Acacia Nilotica (L.) Del.) Pods for Growing Red Sokoto Goats , IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 7, Issue 6 Ver. I (Jun. 2014), PP 43-49 .
[65] Wang, J., T. H. Holmes, R. Cheung, H. B. Greenberg and X. S. He. 2004. Expression of chemokine receptors on intrahepatic and peripheral lymphocytes in chronic hepatitis C infections:ıts relationship to liver inflammation. Environ. Int. 5:605-609.
[66] Weiss, C. (2009). Oxalic acid. *Ernährungs Umschau*, 56, 636–639.
[67]Woodward, A. 1988. Chemical composition of browse in relation to relative consumption of species and nitrogen metabolism of livestock in southern Ethiopia. Ph.D. Dissertation. Cornell University, Ithaca, NY.
[68] Yahaya, B. (2011). Evaluation of nutritive value of Acacia (Acacia seyal del.) fruits on performance of Yankasa sheep. M.Sc Thesis submitted to animal Sci. Dept. Ahmadu Bello University, Zaria, Nigeria.
[69] Zenk HM (1991). Chasing the enzymes of secondary metabolism: Plant cell cultures as a pot of goal. Phytochemistry, 30(12), pp 3861-3863. Zess NaukUMK Tornu, 13: 253-256.