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Anti-nutritional factors & its roles in animal nutrition

Abstract

It is known that nutrition is one of the main factors driving the functioning efficacy, efficiency and evolution of livestock system. The main challenges nowadays in ruminant production are to reduce feeding cost, improve products quality. The use of unconventional feedstuffs or browse and shrubs may contribute to decrease feeding cost and environmental impact. The problem of feeding such materials, is that they contain different levels of anti-nutritional factors (ANFs). Their metabolic products could reduce the availability of one or more nutrients. These ANFs including phenolic compound, phytates, tannins, saponins and oxlate, have his own mechanisms in inhibiting the utilization of such substances. However, many methods aimed to reduce their deleterious effect. These methods could include heating, treatment with PEG or fungi and each region can use what is reasonable for his case.

Keywords: nutrition, anti-nutritional factors, metabolic products, saponins, tannins, phytates, peg, fungi

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Introduction

It is well known that nutrition is one of the main factors driving the functioning efficacy, efficiency and evolution of livestock system. The main challenges nowadays in ruminant production are to reduce feeding cost, improve products quality and diminish the impact of production on environment. The use of unconventional feedstuffs may contribute to decrease feeding cost and environmental impact through reduced methane emissions as well. Not only that, but shrubby plants can be used to combat desertification, mitigating the effect of drought, allowing soil fixation an enhancing the restoration of the vegetation and the rehabilitation of rangelands. In the meantime, browsing tree foliage plays an important role in ruminant feeing systems in many tropical and Mediterranean environments around the world.[1] They are chiefly as good, cheap sources of nitrogen and energy, which may reduce feeding cost and raise sheep productivity in arid and semi-arid zone.[2] So, to reach that goal, it must exploit all that is available either unconventional feedstuffs or browse and shrubs. However, the problems of feeding such plants or shrubs (Acacia, Leucaena and Atriplex) that they had different levels of anti-nutritional factors.

Anti-nutritional factors

Anti-nutritional factors (ANFs) are substances that when present in animal feed or water they either by themselves or through their metabolic products reduce the availability of one or more nutrients. Plants contain starch polysaccharides and no-starch polysaccharides (NSPs), and some of them are anti-nutritional factors. NSPs contain sugars other than glucose and/or have linkages other then the linkages common in sugar. An example of an NSP is cellulose, that is a chain of glucose molecules, but the molecules have ß-(1→4) bonds between them. The different orientation of the ß-bonds (compared to α-bonds) makes them resistant to digestion by endogenous digestive enzymes of animals. Cell walls in plants contain cellulose and other polysaccharides or non-carbohydrate materials such as protein and lignin. Plants contain a mixture of both water-soluble and insoluble NSPs; and the ratio changes with type and stage of maturity of the plant. Cellulose is insoluble in water and is considered fiber. Most NSPs adversely affect digestion in animals, as they affect the viscosity of the material in the digestive tract, and in turn, affects the ability of the digestive enzymes to do their effect, in the end they results in reduced feed efficiency. Meantime, the utility of leaves, pods and edible twigs of shrubs and trees is limited as animal feed by the presence of ANFs.

The anti-nutritional factors may be classified on the basis of their effects on the nutritional value of feedstuffs, and on the biological response to them in the animal. Huisman & Tolman[3] divided the anti-nutritional factors into groups:

i. Factors with a depressive effect on protein digestion and on the utilization of protein, such as protease inhibitors, tannins and saponins;

ii. Factors that affect mineral utilization, which include phytates;

iii. Factors that stimulate the immune system and may cause a damaging hypersensitivity reaction, such as antigenic proteins;

iv. Factors with a negative effect on the digestion of carbohydrates, such as amylase inhibitors, phenolic compound and flatulence factors.

Also, it can present as:

a. Non-protein Amino Acids (Mimosine) as in Leucaena,

b. Glycosides (Saponins) as in Acacia

c. Polyphenolic compounds (Tannins, Lignins) as in all vascular plants

d. Alkoaois as in Acacia and Oxalate as in Acacia as well.

The mechanism of action of mimosine is not clear, but it may act as an amino acid or make a disruption of the catalytic, trans-aminases, or may complex with metal such as Zinc.[4] To come over to the minomsine problem when feeding Leucaena, is to restrict to 30% of the green forage with cattle and buffalo, and 50% for goats.[5] Saponins are a heterogenous group of naturally occurring foam producing steroidal glycosides that occur in a wide range of plants,

including oilseeds such as kidney bean, lentil, pea, chickpea, alfalfa, soybean, groundnut and sunflower.[6,7] They reduce the uptake of certain nutrients including glucose and cholesterol in the gut through intralumenal physicochemical interaction. Hence, they have been reported to have hypocholesterolemic effects.[8] Meantime, they have distinctive foaming characteristics with white clover and alfalfa; they can cause bloat, hemolysis and inhibit microbial fermentation and synthesis in rumen.[9] However, it has varied biological effects due to structural differences in their sapogenin fractions.

Tannins, are water soluble phenolic compounds, they are the most common type found in forage legumes, trees and shrubs.[10] They have the ability to precipitate proteins from aqueous solution. Tree and shrub leaves contain the two different groups (hydrolysable & condensed Tannins (CT)). Tannins have more effect in reducing digestibility than hydrolysable tannins. However, the mechanism effect of tannins came from their ability to form strong H bonds with nutrients resulted in inhibitions of digestive enzymes and rumen microbial activity,[11] and their effect can increased with the increase of the tannins molecular significantly. Concentrations of 2-4% of DM increase N utilization due to increased bypass, Concentrations >7% usually reduce nutrient utilization.

Tannins are present in the NDF and ADF of the tree leaves, which are bound to the cell wall & cell protein and can resulted in decreasing digestibility,[12] they also cause decreased palatability, feed intake, reduced growth rate[13] or loss in weight, poor utilization and decrease iron absorption. But, on the other hand, tannins have some advantages due to their efficiency on animal health, as it had other properties such as, anti diarrhea, anti bacterial, anti oxidant, free-radical, scavenging ant proliferative activity in liver cells. Not only that but it can work as protein protection during ensilage.

Alkaloids cause gastrointestinal and neurological disorders.[14] The glycoalkaloids, solanine and chaconine present in potato and Solanum spp.[15,16] are toxic to fungi and humans. Some plant alkaloids are reported to cause infertility.[17] Anti vitamin factors there are some anti-vitamin factors in some plants, especially leguminous plants. Anti-vitamin E has also been noted in isolated soya protein, which is suspected to be tocopherol oxidase. Anti-metals Phytates bind minerals like calcium, iron, magnesium and zinc and make them unavailable.[18] Anemia and other mineral deficiency disorders are common in regions where the diet is primarily a vegetarian.[19] Oxalate is considered an anti-nutrient because it inhibits calcium absorption and can increase the risk of developing kidney stones.[20]

Methods of reduce the deleterious effect of ANF's

A number of methods have been tried to overcome the deleterious effect of such anti-nutritional factors and tannins is came at the head. These are through making hay, silage with inoculants, using PEG;[21,22] urea[23] or biological treatment with fungi[24,25] can be applied to either take off or minimized and decrease anti-nutritional factors concentration.

It is will know that alkali treatment includes polyethylene glycol (PEG), which a tannins-binding agent,[26] was shown to be a powerful tool for isolating the effect of tannins on various digestive function.[27–29] But it may not be economic. Although the incorporation of polyethylene glycol (PEG), which binds with and inactivates tannins, is quite effective, success of its adoption depends on the cost: benefit ratio.[30,31] Russsell & Olley[23] suggest feed animals with 1% urea. In that system, urea not only provides extra N but also deactivates the leaf tannins.

Conclusion

For increasing the utilization of dietary nutrients, reducing environmental contamination and decrease feeding cost, the optimum use of unconventional feedstuffs as well as any local sources (shrubs, browsing tree) has big potential. Each region can select what is reasonable and suitable for his case to optimize all feed resources in order to reach its goal.

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Conflict of interest

Author declares that there is no conflict of interest.

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