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Popular Article

Anti-Nutritional Factors in Livestock feeds and its Mitigating Strategies

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Abstract

Anti-nutritional factors (ANF) present in plants can diminish feed intake and nutrient utilization, influencing the suitability of these plants as fodder for livestock. Leguminous fodder, in particular, contains a diverse array of anti-nutritional factors. While legumes and cereals offer high amounts of macronutrients and micronutrients, they also harbor anti-nutritional factors such as saponins, tannins, phytic acid, gossypol, lectins, protease inhibitors, amylase inhibitors, and goitrogens. The interaction of these anti-nutritional factors with nutrients is a major concern due to diminished nutrient bioavailability. Notably, trypsin inhibitors and phytates, prevalent in legumes and cereals, can reduce protein digestibility and mineral absorption. Various traditional methods and technologies can be employed to mitigate the levels of these anti-nutrient factors. Processing techniques like fermentation, germination, debranning, autoclaving, and soaking are commonly utilized to decrease anti-nutrient content in foods. Through the application of these methods individually or in combination, it is feasible to lower the levels of anti-nutrients in food products. This review focuses on different types of anti-nutrients and explores potential processing methods that can effectively reduce their presence in food items.

Keywords: Antinutritional factors, livestock, processing techniques

Introduction:

Nutrition plays a pivotal role in shaping the efficiency, effectiveness, and progression of livestock systems. In today's ruminant production landscape, key challenges include the need to reduce feeding costs, improve product quality, and minimize the environmental impact of production. The utilization of unconventional feed sources offers a potential solution to decrease feeding expenses and mitigate environmental concerns, particularly in lowering methane emissions. Anti-nutritional factors encompass chemical compounds naturally produced in food or feed, stemming from normal species metabolism or various mechanisms. These factors, which include nutrient inactivation or hindered digestive processes, can impede optimal nutrition (Soetan and Oyewole, 2009). Animal feed or water may contain anti-nutritional factors (ANFs), either individually or through their metabolic by-products, resulting in a decrease in the accessibility of one or more nutrients. In plants, starch polysaccharides and non-starch polysaccharides (NSPs) are present, some of which can function as anti-nutritional factors.

Anti-nutrients can be categorized into two main groups depending on their sensitivity to heat: the heat-stable group and the heat-labile group (Felix and Mello, 2000). Anti-nutrients possessing heat-stable properties, such as Phytic acid, Condensed Tannins, Alkaloids, and Saponins, exhibit resistance and can endure high temperatures. On the other hand, anti-nutrients belonging to the heat-labile group, such as lectins, Cynogenic Glycosides, Protease inhibitors, and Toxic amino acids, are sensitive to normal temperatures and are lost when exposed to elevated heat (Kyriazakis and Whittemore, 2006).

Classification of antinutritional factors:

i) According to their chemical properties

Group 1	Proteins	Protease inhibitor Lectins
Group 2	Glycosides	Saponins Cyanogens Glucosinolates
Group 3	Phenols	Gossypol Tannin
Group 4	Miscellaneous	Antimetals Antivitamins

ii) On the basis of nutrients, they affect

a) Substances depressing the digestion or metabolic utilization of proteins
   Protease inhibitor, Lectin, Saponins and Polyphenolic components
b) Substances reducing the solubility or interfering with the utilization of minerals
   Phytic acid, Oxalic acid, Glucosinolates and Gossypol
c) Substances increasing the requirements of certain vitamins

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Ant-vitamin ADEK and B

d) Substances with a negative effect on the digestion of carbohydrates

Amylase inhibitor, Phenolic compounds and Flatulence factors

Common feedstuffs and their anti-nutritional factors:

Feed stuffs	Anti-Nutritional factors
Grains	
Rye, Triticale	Trypsin inhibitors
Sorghum	Tannins
Grain amaranths	Oxalates, Saponins
Protein Supplements	
Soyabeans	Trypsin inhibitors, lectins, goitrogens, Saponins, Phytates
Cottonseed	Gossypol, tannins, cyclopropenoid fatty acids
Kidney bean	Antivitamin E
Rapeseed	Glucosinolates , tannins, erucic acid, sinapine
Linseed meal	Linatine, linamarin, Antivitamin b6
Legumes	
Alfalfa	Saponins, phytoestrogens
White Clover	Cyanogenic, phytoestrogens
Red clover	Phytoestrogens
Sweet clover	Coumarin Antivitamin K
Subabul	Mimosine

Toxicological effects of Anti-nutritional factors:

1. Phytotoxins

The diverse chemical structures of phytotoxins result in a wide array of toxic effects in animals. Within the plant kingdom, inhibitors targeting almost all essential biological processes in animals can be found.

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Organ/System affected	Causative phytotoxins
Liver	Pyrrolizidine alkaloids, lantana toxin, indospieine, lectins, rapeseed toxin, Tetradymia toxin
Kidney	Pyrrolizidine alkaloids, oxalate, sesquiterpene lactones, erucic acid, glucosinolates, silicic acid
Lungs	3-Methylindole, pyrrolizidine alkaloids, perilla ketones, Tryptamine
Heart	Erucic acid, gossypol, cardiac glycosides, Veratrum alkaloids
Digestive system	Oxalate, tannins, mesquite toxins, saponins, selenium, trypsin and amylase inhibitors, lectins, nitrates, pyrrolizidine alkaloids
Circulatory system	Pyrrolizidine alkaloids, saponins, brassica anemia factor, copper, lathyrogens, oxalate, Veratrum alkaloids, Lectins, fluoroacetate
Nervous system	Atropine, Astragalus toxins, selenium, indolizidine alkaloids, solanine, annual ryegrass toxins, sleepy grass toxins, pyrrolizidine alkaloids, bracken fern antithiaminase
Reproductive system	Estrogenic isoflavones, gossypol, ponderosa pine needles, nitrate

2. Tannins

Tannin is a plant polyphenolic compound characterized by its astringent and bitter qualities. It has the ability to bind or precipitate proteins and a range of organic compounds, including amino acids and alkaloids. Tannins are chemically classified into two main categories: hydrolysable and condensed tannins. Tannins hinder the functions of trypsin, chymotrypsin, amylase, and lipase, diminishing the protein quality of foods and disrupting the absorption of dietary iron. They are recognized for causing reduced feed intake, growth rate, feed efficiency, and protein digestibility in experimental animals. Tannins can additionally create insoluble complexes with proteins, and these tannin-protein complexes might be accountable for the adverse nutritional impacts associated with foods containing tannins (Habtamu and Nigussie, 2014).

3. Saponins

Saponins constitute a diverse category of naturally produced foam-inducing triterpene or steroidal glycosides found in various plants, including legumes and oilseeds like kidney beans, lentils, peas, chickpeas, alfalfa, soybeans, peanuts, lupin, and sunflowers. The intricate structure of saponins gives rise to various physical, chemical, and biological characteristics. These encompass sweetness and bitterness, foaming and emulsifying properties, pharmacological and medicinal attributes, haemolytic properties, as well as antimicrobial and insecticidal activities (Habtamu and Nigussie, 2014). Saponins decrease the absorption of specific nutrients, such as glucose and cholesterol, in the intestinal tract through physicochemical interactions within the lumen. As a result, they are known to exhibit hypocholesterolemic effects.

4. Protease Inhibitors

Protease inhibitors are found extensively across the plant kingdom, present in the seeds of many cultivated legumes and cereals. They represent the most prevalent category of antinutritional factors originating from plants. Protease inhibitors can hinder the function of proteolytic enzymes in the animal's gastrointestinal tract. Despite being prone to denaturation through heat processing, some residual activity may persist in commercially produced items due to their protein nature. The antinutrient effects of protease inhibitors are linked to growth impediment and pancreatic hypertrophy (Chunmei *et al*., 2010).

5. Cyanogens

Cyanogens are glycosides with a sugar or sugars and a glycone containing cyanide. The release of hydrogen cyanide (HCN) occurs through hydrolysis by enzymes present in the cytosol, causing harm to the plant. The hydrolytic process, facilitated by microbial activity in the rumen, makes ruminants more vulnerable to cyanide (CN) toxicity compared to non-ruminants (Smitha *et al*., 2013). Hydrogen cyanide (HCN) is absorbed and swiftly detoxified in the liver by the enzyme rhodanese, converting cyanide (CN) to thiocyanate (SCN). An excess of cyanide ions inhibits cytochrome oxidase, halting ATP formation, leading to energy deprivation in tissues, and ultimately resulting in rapid death. The lethal dose of HCN for cattle and sheep ranges from 2.0 to 4.0 mg per kg of body weight.

6. Mycotoxins

Mycotoxins are fungal secondary metabolites capable of adversely affecting animal health and

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productivity.

Mycotoxins	Impacts
Aflatoxins	Damages liver and causes growth suppression
T-2 toxins	Oral lesions in Poultry
Ochratoxins	Kidney damage Poultry and pigs are prone to ochratoxin, whereas dairy animals can tolerant it even at higher levels because of biotransformation by ruminal microbes.
Vomitoxin	Affect mainly pigs and other animal
Zearalenone	Affects the reproductive organs in pigs, dairy cattle and Poultry
Fumonisins	Cause nervous disorders in horses

Mitigating Strategies:

Different traditional methods and technological processing ways such as soaking, milling, debranning, roasting, cooking, germination and fermentation have been used for reducing the anti-nutritional factors in the foods.

Milling

Milling, the conventional approach for separating the bran layer from grains, involves grinding grains into flour. Through this process, anti-nutrients like phytic acid, lectins, and tannins present in the bran are eliminated. However, a notable drawback of the milling technique is that it also results in the removal of essential minerals.

Soaking

Soaking presents an appealing approach for diminishing the antinutrient content of foods, and it offers the additional benefit of reducing cooking time. This method also promotes the release of enzymes, such as endogenous phytates found in plant foods like almonds, nuts, and grains. By creating favorable moist conditions, soaking supports the germination of nuts, grains, and other edible seeds, leading to a reduction in enzyme inhibitors and other anti-nutrients. This process enhances digestibility and improves the nutritional value of the soaked foods. Commonly, soaking results in a decrease in the content of anti-nutrient phytochemicals like phytate and tannins.

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Autoclave and cooking

The autoclave is a commonly employed tool for heat treatments. When applied to cereals and other plant-based foods, it activates the phytase enzyme and enhances acidity. The boiling of food grains is effective in reducing the content of anti-nutrients, thereby enhancing their nutritional value.

Germination

Germination is recognized as an effective method for diminishing the anti-nutrient components in plant-based foods. During seed germination, the enzyme phytase is typically activated, facilitating the breakdown of phytate and resulting in a reduction of phytic acid concentration in the samples. Germination tends to bring about alterations in the nutritional content, biochemical properties, and physical characteristics of foods. This method is frequently employed to reduce the anti-nutritional content of cereals.

Fermentation

Fermentation is a metabolic process involving the oxidation of sugars to generate energy, and it plays a role in improving the absorption of minerals from plant-based foods. This method is employed in the processing of cereal crops to render them edible and enhance the nutritional quality and safety aspects of these foods. Cereals are often not easily consumable in their natural or raw forms. In cereals, phytic acid typically forms complexes with metal cations such as iron, zinc, calcium, and proteins. Enzymes, facilitated by an optimal pH maintained through fermentation, degrade these complexes. Consequently, this degradation reduces the phytic acid content and releases soluble iron, zinc, and calcium, thereby elevating the nutritional value of food grains.

References:

Chunmei G., P. Hongbin, S. Zewei and Q. Guixin, 2010.Effect of Soybean Variety on Anti-Nutritional Factors Content, and Growth Performance and Nutrients Metabolism in Rat. International Journal of Molecular Science, 2010, 1048-1056; doi: 10.3390/ijms11031048. ISSN 1422-0067

D'Mello, J.F. ed., 2000. Farm animal metabolism and nutrition. Cabi.

Habtamu, F. and Negussie R. (2014). Antinutritional factors in plant foods: Potential health benefits and adverse effects. International Journal of Nutrition and Food Sciences 3(4):284- 289.

Kyriazakis, I. and Whittemore, C., 2006. Appetite and voluntary feed intake. Whittemore's Science and Practice of Pig Production, pp.417-437.

Smitha Patel P.A., S.C. Alagundagi and S.R.Salakinkop, 2013. The anti-nutritional factors in forages - A review. Current Biotica 6(4): 516-526, 2013, ISSN 0973-4031

Soetan, K.O. and Oyewole, O.E., 2009. The need for adequate processing to reduce the anti-nutritional factors in plants used as human foods and animal feeds: A review. African Journal of food science, *3*(9), pp.223-232.