

IS BIO ACTIVE COMPOUNDS IN PLANTS AS ANTI NUTRITIONAL FACTORS

P. KIRANMAYI

Department of Biochemistry, Acharya Nagarjuna University, Nagarjuna Nagar- 522 510, A.P., India.
Email:kiranmayikodali@rediffmail.com

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ABSTRACT

Compounds or substances which act to reduce nutrient intake, digestion, and absorption and may produce other adverse effects are referred to as antinutritional factors. The major anti nutrients include: tannins, saponins, oxalates, protease inhibitors etc. The concentration of these compounds varies with species of plant, cultivar and post-harvest treatments. The aim of this review is to highlight the adverse and beneficial effects of antinutritional factors towards animals and human beings.

Keywords: Antinutritional factors, Secondary metabolites, Plants.

INTRODUCTION

There is a wide distribution of biologically active constituents throughout the plant kingdom, particularly in plants used as animal feeding stuff and in human nutrition [1]. The knowledge that these compounds elicit both toxic and advantageous biological responses has given rise to several investigations in recent times as to their possible physiological implications in various biological systems [2]. In order to survive during evolution, plants have developed defenses against herbivorous animals, microorganisms and viruses. The production of secondary metabolites (including lectins and toxic peptides) is of ultimate importance as a defense strategy in this context [3, 4, 5, 6]. Some of these chemicals are known as "secondary metabolites" and they have been shown to be highly biologically active [7]. They include saponins, tannins, flavonoids, alkaloids, trypsin (protease) inhibitors, oxalates, phytates, haemagglutinins (lectins), cyanogenic glycosides, cardiac glycosides, coumarins and gossypol.

Plants are also known to have high amounts of essential nutrients, vitamins, minerals, fatty acids and fiber [8]. They often contain significant amounts of "anti-nutritive" factors (ANF), such as lectins, protease inhibitors, non-protein amino acids, alkaloids, cyanogenic glycosides, erucic acid or phytates [9, 10]. The antinutritional factors (ANFS) may be defined as those substances generated in natural food stuffs by the normal metabolism of species and by different mechanisms (e.g. inactivation of some nutrients, diminution of the digestive process, or metabolic utilization of feed) which exert effects contrary to optimum nutrition [11]. In some cases, antinutrients are simply toxic or cause undesirable physiological effects such as flatulence. On the other hand, it has recently been discovered that some antinutrients may have beneficial effects when ingested in small quantities and can even help in the prevention of certain illnesses such as cancer and coronary disease. As a result, they are now called nonnutritional compounds, since they have no direct nutritional value but are not always harmful [12].

The antinutritional factors may be classified on the basis of their effects on the nutritional value of feed stuffs, and on the biological response to them in the animal. Huisman and Tolman [13] divided the antinutritional factors into the following groups:

- Factors with a depressive effect on protein digestion and on the utilization of protein, such as protease inhibitors, tannins, saponins and lectins;
- Factors that affect mineral utilization, which include phytates, gossypol pigments, oxalates and glucosinolates;
- Factors that stimulate the immune system and may cause a damaging hypersensitivity reaction, such as antigenic proteins;
- Factors with a negative effect on the digestion of carbohydrates, such as amylase inhibitors, phenolic compound and flatulence factors;

- Miscellaneous substances, such as mycotoxins, mimosine, cyanogens, nitrates, alkaloids, photosensitizing agents, phyto-oestrogens and sponins.

Toxicological affects of anti nutritional factors

The biochemical and toxicological of plant's secondary metabolites (antinutritional factors) have been reviewed by several authors [14, 15, 16, 17, 18].

Alkaloids

Alkaloids cause gastrointestinal and neurological disorders [16]. The glycoalkaloids, solanine and chaconine present in potato and Solanum spp. [19, 20] are haemolytically active and toxic to fungi and humans. Some plant alkaloids are reported to cause infertility [21].

Tannins

Tannins are a group of phenolic nonnitrogenous organic constituents, which are chemically classified into two broad categories namely hydrolysable and condensed tannins [22]. Tannins bind to proteins through hydrogen binding and hydrophobic interactions, thereby reducing their nutritional quality [23] and combine with digestive enzymes thereby making them unavailable for digestion [24]. They also cause decreased palatability and reduced growth rate [25].

Saponins

Saponins are a heterogenous group of naturally occurring foam producing triterpene or steroidal glycosides that occur in a wide range of plants, including pulses and oilseeds such as kidney bean, lentil, pea, chickpea, alfalfa, soybean, groundnut, lupin and sunflower [26, 27]. Saponins reduce the uptake of certain nutrients including glucose and cholesterol at the gut through intraluminal physicochemical interaction. Hence, it has been reported to have hypocholesterolemic effects [28, 29].

Anti vitamin factors

There are some antivitamin factors in some plants, especially leguminous plants. Raw kidney beans are believed to contain an antagonist to vitamin E as evidenced by liver necrosis in rats and muscular dystrophy and low concentration of plasma tocopherol in chicks [30]. Antivitamin E has also been noted in isolated soya protein, which is suspected to be tocopherol oxidase. Soybean flour has been found to be deficient not only in Vitamin B12, but it also contains a heat-labile factor that increases the requirement for vitamin B12 [30].

Antimetals

Phytates bind minerals like calcium, iron, magnesium and zinc and make them unavailable [31]. Anemia and other mineral deficiency

disorders are common in regions where the diet is primarily a vegetarian [32]. Oxalate is considered an antinutrient because it inhibits calcium absorption [33] and can increase the risk of developing kidney stones [34].

Cyanogenic glycosides

Some legumes like kidney bean, red gram and linseed contain cyanogenic glycosides from which hydrogen cyanide (HCN) may be released by hydrolysis [35]. HCN can cause disfunction of the central nervous system, respiratory failure and cardiac arrest [36].

Goitrogens

Goitrogenic substances, which cause enlargement of the thyroid gland, have been found in legumes such as soybean and ground nut [35]. They have been reported to inhibit the synthesis and secretion of the thyroid hormone since thyroid hormones play an important part in the control of body metabolism, their deficiency results in reduced growth and reproductive performance [37].

Phenolic compounds

Phenolic compounds have been reported to have high inhibitory effect on iron absorption [38] as well as reduction in protein and carbohydrate digestibility [39].

Lectins

Also called phytohaemagglutinins. Lectins are glycoproteins widely distributed in legumes and some oil seeds (including soy bean) which possess affinity for specific sugar molecules and are characterized by their ability to combine with carbohydrate membrane receptors [40]. Lectins have the capability to directly bind to the intestinal mucosa [41, 42] interacting with the enterocytes and interfering with absorption and transportation of nutrients (particularly carbohydrates) during digestion [42] and causing epithelial lesions within the intestine [43].

Protease inhibitors

Protease inhibitors are widely distributed within the plant kingdom, including the seeds of most cultivated legumes. Protease inhibitors have the ability to inhibit the activity of proteolytic enzymes within the gastrointestinal tract of animals [44]. According to Karl (1987) [45], trypsin inhibitors irreversibly bind trypsin, making the enzyme incapable of performing its role in the breakdown of proteins. This causes the intestine to release cholecystokinin to stimulate the pancreas to enlarge. The amino acids present in trypsin cannot be reabsorbed and thus are lost when the trypsin combining with the trypsin inhibitors.

Advantages of ANF

On the contrary, it has been suggested that consumption of low level of certain antinutrients may produce health benefits while avoiding some of the adverse effects associated with their large intake [46]. L-Dopa, a potentially neurotoxic agent used in the treatment of Parkinson's disease, is found in large amounts in *Mucuna* seeds which have been proposed as a medical source of L-Dopa and even in the treatment of Parkinson's disease [47].

Anti carcinogenic activity

Tannins are reported to have possible anticarcinogenic effects [48]. Haemagglutinins are reported to cause agglutination of malignant cells and induction of mitosis in lymphocytes, and precipitation of polysaccharides and glycoproteins [49]. Saponins are also reported to have anticancer properties, inhibiting about two-thirds the development of azoxymethane induced preneoplastic lesions in the colon [50]. Saponins have been established as cytotoxic agents [51] and that their cytotoxic potency is structure dependent [52]. Isoflavones are being studied for their potential role in the prevention and treatment of cancer [53].

Anti diabetic, anti ulcer and diuretic activities

Saponins from *Vignaradiata*, *Vignamungo* and *Vignasinensis* are shown to have diuretic activities [54]. Saponins are also reported to have antidiabetic activity [55], antiulcer activity [56, 57, 58].

Anti oxidant and anti ageing activity

Tkayama et al. (1984) [59] reported that flavonoids are potent inhibitors of molecular oxygen (O₂), thus acting as free radical scavengers (antioxidant). Flavonoids also scavenge other free radicals as OH and N₃[60]. Flavonoids are used as natural antioxidants in food, medicinal and non nutritive plant materials due to their ability to inhibit and scavenge reactive oxygen species [61, 62]. Saponins are reported to have antiageing activity which is related to their free radical scavenging action [63, 64].

CONCLUSION

The presence of antinutrients in plant protein sources for livestock feeding is a major limitation that reduces their full utilization. To be able to justify complete nutritional value of any plant protein source, proper assessment of the type, nature and concentration of the antinutrients present in the protein source and also the bioavailability of nutrients to the ingesting animal is necessary. Supplementation of some amino acids, vitamins and minerals might help reduce or neutralize the negative effect of antinutritional factors. The concentration or level of antinutritional factors in the protein sources vary with the species of plant, cultivar and processing methods.

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