Mini review

A brief Review: Anti-nutrient Factors in Cereals and Legumes

Abstract

Cereals and legumes account for substantial amount in the human diet of tropical and sub-tropical regions. Anti-nutrient factors in cereals and legumes are secondary metabolites which can interfere with nutrient digestion and absorption after ingestion. This review will focus on different anti nutrient factors found in cereals and legumes including lectins, protease inhibitors, phytic acid and saponin. It is important to reveal about the treatments which are used to reduce the anti-nutrient factors in cereals and legumes. Therefore, review also summarized the available literature on different control measures used to reduce the concentration of anti-nutrient factors.

Key words: Anti-nutrient factors, Cereals, Legumes

Introduction

In Asian dietaries, cereals and legumes are very important as major staple foods (Oghbaei and Prakash, 2016). They are significant source of nutrients especially protein, dietary fiber, vitamins, minerals, and phytochemicals (Pereira *et al.,* 2002). Therefore, the knowledge regarding various anti-nutritional substances present in foods as well as techniques to reduce them in the diet is essential for health and wellbeing of the population (EI- Hady and Habiba, 2003).

Anti-nutrient factors are considered as secondary metabolites of cereals and legumes. They are produced by plants in order to protect against attack by herbivores, insects, and pathogens or to survive in adverse weather conditions such as droughts (Bora, 2014). However, they can interfere with digestion and absorption of nutrients in digestive track after ingestion (Nadeeem *et al.,* 2010). Therefore, majority of these compounds may be labeled as anti-nutrients in the human diet.

Anti-nutrient factors in cereals and legumes include phytic acid, saponins, polyphenols, lathyrogens, α-galactosides, protease inhibitors, α- amylase inhibitors, and lectins. Different methods are widely employed to reduce or remove anti-nutritional factors from cereals and legumes. Those methods include soaking, cooking, germination, fermentation, selective extraction, irradiation and enzymatic treatment (EI- Hady and Habiba, 2003). Moreover, application of combination of different techniques has been proven more effective with compared with single technique. However, complete removal is impossible (Khokhar and Apenten, 2003).

This article will focus on phytic acid, saponins, protease inhibitors, and lectins which are found throughout grain and forage legumes. It also emphasizes knowledge regarding ways and techniques to lower down or reduce the content of anti-nutritional factors in cereals and legumes before consumption.

Lectins

Lectins can be commonly found in beans and they are proteins or glycoproteins by structure. erythroagglutinating and leucoagglutinating phytohemagglutinins are different types of lectins that can be found in legumes (Lioi *et al.,* 2003). Most of the lectins have ability to agglutinate erythrocytes (Puztai, 1991) In addition to erythrocyte agglutination; they can bind with glycoproteins on the epithelial surface of the small intestine, interfering with nutrient absorption (Sgarbieri, 1982). It has been proven in vitro studies that isolated lectin can induce enlargement of the small intestine and cause damage to the epithelium of the small intestine (Zucoloto, 1991). Although considerable indications are there and these legume lectins can be harmful to humans, virtually no evidence exits of any significant anti-nutritional effect from cereal lectins (Jansman *et al.,* 1998). However, lectins can be easily disintegrated (Mubarak, 2005).

Highest Lectin content was reported for Kidney beans (*Phaseolus Vulgaris*), among soybeans (*Glycine max*), cowpeas (*Vigna unguiculata*), and lupin seeds (*Lupinus augustifolius*) (Grant *et al.,* 1995).

Germination is one method to reduce concentration of lectins in legumes before consumption. During germination concentration is reduced due to proteolysis action of different enzymes taken place inside legumes (Savelkoul *et al.,* 1992). However, it has reported that, after proper thermal treatment, lectins present in the diet do not pose health risks to humans or cause anti-nutritional effects in normal conditions of consumption (Lajolo and Genovese, 2002).

Protease Inhibitors

Protease inhibitors can interfere with the action of proteoloytic enzymes in the digestive track especially with pancreatic trypsin and chymotrypsin. (Birk, 1989).There are two types of protease inhibitors. They are Kunitz and Bowman-Birk. Kunitz type specially act against trypsin, while Bowman-Birk type inhibit both trypsin and chymotrypsin simultaneously (Lajolo *et al.,* 1991). However, protease inhibitors are known to be effective in their ability to suppress carcinogenesis in many different in *vivo* and in *vitro* assay systems, but the mechanisms for the anti-carcinogenic activity of protease inhibitors are unknown and yet to be discovered (Ei Morsi, 2001).

Protease inhibitors have been reduced by using cooking and autoclaving due to the heat sensitivity of proteins. In contrast, there is no significant reduction after germination (Shimelis & Rakshit, 2017).

Phytic Acid

Phytic acid is generally regarded as the major storage form of phosphorous in cereals. Mainly exist in the form of phytates (Wu *et al.,* 2009). It has been reported that phytic acid content of cereals varies from 0.5%- 2.0%. In contrast, phytic acid content of legumes was higher than the cereals in a study conducted in Hungary (Hidvegi & Lasztity, 2002). Phytic acid content in cereals and legumes are indicated in Table 1.

Phytic acid has a strong ability to form complexes with multivalent metal ions, especially zinc, calcium, and iron. In addition, these complexes are insoluble salts (Weaver and Kanna, 2002). Therefore, anti-nutrient phytic acid reduces the bioavailability of minerals (Lesteinne *et al*., 2005).

Germination has been an effective treatment to reduce phytates. During germination, phytates are hydrolyzed by phytase enzyme and release phosphate groups (Pawar and Ingle, 1988).

Table 1: Phytic acid content in cereals and legumes (Adapted from Hidvegi & Lasztity, 2002)

Cereal/Legume	Average phytic acid content (g/100g)
Wheat (MV-4)	0.85
Wheat (Besostaya-19)	0.93
Wheat (durum, GK Basa)	0.72
Maize (yellow dent)	1.02
Maize (flint)	0.90
Maize (sweet)	0.85
Barley	0.97
Oats	1.01
Soybean	1.43
Cowpea	0.42
Common bean	0.55
Peas	1.02

Saponins

Saponins are widely distributed in all cells of legume plants. They have ability to form stable, soap like foams in aqueous solutions. Furthermore saponins are diverse group of compounds, in chemical structure and they contain a carbohydrate moiety attached to a triterpenoid or steroids (Bora, 2014).

Moreover, saponins can bind with cholesterol and therefore reduce absorption (Sidhu and Oakenfull. 1986). However, saponins are not destroyed during cooking or processing (Birk, 1980). Fermentation was reported to reduce their level.Fermented soya product-tempeh in to half with compared to raw soy (Potter et al., 1980).

Table 2: Saponin content in legumes

Source	Saponin content (% dry weight)
Soybeans (*Glycine max*)	5.6
Chickpea *(Cicer arietinum* L.)	3.6
Lucerne (*Medicago sativa)*	2.5

Lupine (*Lupinus angustifolius*)	1.5

(Adapted from Khokhar and Apenten, 2003)

Future research needs

Even though anti-nutrient factors reported to have adverse effects, in vivo studies related to those factors are lacking. Therefore, they should be extensively investigated using human studies. Furthermore, it is vital to carry out studies related to effectiveness of different techniques such as soaking, fermentation, germination and heat treatment etc. in order to find out the best methods to reduce the concentration of anti-nutrient factors in cereals and legumes. In addition, positive impact of these factors such as anticancer, anti-diabetic and anti-cholestremic effects should be investigated using *in vivo* studies.

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