Mini review

A brief Review: Lectins, Protease Inhibitors and Saponins in Cereals and Legumes

Abstract

Cereals and legumes account for the 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 the different content factors found in cereals and legumes including lectins, protease inhibitors, and saponin. It is important to reveal about the treatments which are used to reduce the anti-nutrient factors in cereals and legumes. Therefore, this review also summarised the available literature on different techniques that used to reduce the concentration of anti-nutrient factors in foods.

Keywords: Anti-nutrient contents, Cereals, Legumes

Introduction

In Asian dietaries, cereals and legumes are very important major staple foods (Oghbaei and Prakash, 2016). They are significant sources of nutrients especially protein, dietary fibre, vitamins, minerals, and phytochemicals (Pereira *et al.,* 2002). It is important to know that various anti-nutritional substances are present in foods which could be reduced/removed by different techniques (EI- Hady and Habiba, 2003).

Anti-nutrient factors are considered as secondary metabolites of cereals and legumes. Some of them are produced by the plants to protect themselves against attacks by herbivores, insects, and pathogens or to survive adverse weather conditions such as droughts (Bora, 2014). However, they can interfere with digestion and absorption of nutrients in the digestive **trac**t after ingestion (Nadeeem *et al.,* 2010). Therefore, the majority of these compounds may be labelled 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

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Comment [IWO2]: Replace with "are substantial"

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extraction, irradiation and enzymatic treatment (EI- Hady and Habiba, 2003). Moreover, a combination of different techniques has been proven more effective compared with single techniques. However, complete removal is impossible (Khokhar and Apenten, 2003).

This article will focus on phytic acid, saponins, protease inhibitors, and lectins which are found almost in all grains and forage legumes. It also elucidates some that could be used to reduce them before consumption of constituent grains.

Lectins

Lectins are proteins or glycoproteins which are commonly found in beans. They include erythroagglutinating and leucoagglutinating (Lioi *et al.*, 2003). Most lectins have the ability to agglutinate erythrocytes (Puztai, 1991). Besides, 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* that isolated lectin can induce enlargement of the small intestine and cause damage to the epithelium of the small intestine (Zucoloto, 1991). Although legume lectins can be harmful to humans, there is no evidence/indication of the anti-nutritional effect of cereal lectins (Jansman *et al.,* 1998). However, lectins can be easily disintegrated (Mubarak, 2005).

Lectin contents had been reported to be higher in Kidney beans (*Phaseolus Vulgaris*), soybeans (*Glycine max*), cowpeas (*Vigna unguiculata*), and lupin seeds (*Lupinus augustifolius*) (Grant *et al.,* 1995).

Germination can be used to reduce the concentration of lectins in legumes before consumption. The reduction is due to proteolytic action of different enzymes taken place inside legumes (Savelkoul *et al.,* 1992 (Lajolo and Genovese, 2002).

Protease Inhibitors

Protease inhibitors are a class of antiviral drugs that are widely used to treat HIV/AIDS and hepatitis C. Protease inhibitors can interfere with the action of proteolytic enzymes in the digestive tract especially with pancreatic trypsin and chymotrypsin (Birk, 1989). There are two types of protease inhibitors. They are Kunitz and Bowman-Birk. Kunitz type especially acts against trypsin, while Bowman-Birk type inhibits both trypsin and chymotrypsin simultaneously (Lajolo *et al.,* 1991). However, protease inhibitors are known to be effective in suppressing carcinogenesis in many different *in vivo* and in *vitro* assay systems, but the

Comment [IWO8]: article focused

Comment [IWO9]: This sentence is very unclear.
Suggested: "This article also investigated some techniques that could be used to inactivate the activities of these anti-nutrients before consumption of the constituent grains".

Comment [IWO10]: ..are known to have erythroagglutinating and leucoagglutinating factors.

Comment [IWO11]: …lectins…

Comment [IWO12]: Delete

Comment [IWO13]: This statement is far-fetched. There are copious data that show adverse effects of cereal lectins. A case in point is wheat germ agglutinin (WGA). Pls refer to "sciencedirect.com/science/article/pii/S0733521014000228" and make amends. It is more current.

Comment [IWO14]: However, some lectins …

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Comment [IWO16]: This narration appears to be a functional definition. Though it is correct, it would have been more appropriate to say "It is an agent that blocks a protease ability to hydrolyze proteins. They are typically applied in the pharmaceutical industry as antiviral drugs to treat HIV/AIDS"

Comment [IWO17]: delete

Comment [IWO18]: Please use transition word/words to link the two statements.

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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 cooking and autoclaving due to the heat sensitivity of proteins. However, it has been reported that germination did not have a significant effect in reducing protein inhibitors in grains (Shimelis and Rakshit, 2017).

Comment [IWO22]: Please interrogate this statement carefully. If you can cite to support it , it would be better.

Phytic Acid

Phytic acid is generally regarded as the major storage form of phosphorous in cereals which exists mainly in the form of phytates (Wu *et al.*, 2009). Phytic acid content of cereals varies from 0.5% - 2.0%. Besides, legumes are found to contain more phytic acids than grains as reported by in Hungary (Hidvegi and Lasztity, 2002). Phytic acid contents in some cereals and legumes are indicated in Table 1.

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Phytic acid has a strong ability to form complexes with multivalent metal ions, especially zinc, calcium, and iron. These complexes are insoluble salts (Weaver and Kanna, 2002) which reduce the bioavailability of minerals in such foods (Lesteinne *et al.*, 2005).

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

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Table 1: Phytic acid content in cereals and legumes

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

Comment [IWO31]: g/100 g

Common bean	0.55
Peas	1.02

(Hidvegi and Lasztity, 2002).

Saponins

Saponins are widely distributed in all cells of leguminous plants. They have ability to form stable, soap-like foams in aqueous solutions (Bora, 2014).

Moreover, saponins can bind to cholesterol and therefore reduce their absorption (Sidhu and Oakenfull. 1986). However, saponins are not destroyed during cooking or processing (Birk, 1980). Fermentation had been reported to reduce their levels. Tempeh, a fermented soya product had been found to contain half the saponin contents present in the unfermented soybean seeds (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

(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. Furthermore, it is vital to carry out studies related to the effectiveness of different techniques such as soaking, fermentation, germination and heat treatment etc. to find out the best methods to reduce the concentration of these anti-nutrient factors in cereals and legumes. In addition, the positive impact of these anti-nutrient factors resulting from their anti-cancer, anti-diabetic and anti-cholestremic effects should be investigated using in vivo studies.

Ethical approval: NA

Consent: NA

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Comment [IWO35]: is it soy or soya?

Comment [IWO36]: This narration is difficult to understand.

Comment [IWO37]: Please delete

Comment [IWO38]: inserted

Comment [IWO39]: cholesterolemic ?

References

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Comment [IWO40]: Inconsistency, are you using the long name of the journal or short name?

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Comment [IWO41]: Long name or short name, Inconsistency!

Comment [IWO42]: Italicize , short name or long name

Comment [IWO43]: Italicize

Comment [IWO44]: Long name or short name

Comment [IWO45]: same

Comment [IWO46]: same

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Comment [IWO48]: incomplete, is it lunatus or vulgaris what?

Comment [IWO49]: Inconsistency: long name or short name

Comment [IWO50]: same

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