

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

Abstract

Cereals and legumes are substantial 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 saponins. It is important to show the treatments which are used to reduce the anti-nutrient factors in cereals and legumes. Therefore, this review sought to summarize the available literature on different techniques that have been 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 tract after ingestion (Nadeem *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, lathrogens, 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. These methods include soaking, cooking, germination, fermentation, selective

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

34 This article focused on phytic acid, saponins, protease inhibitors, and lectins which are found
35 in almost in all grains and forage legumes. This article also investigated some techniques that
36 could be used to inactivate the activities of these anti-nutrients before consumption of the
37 constituent grains.

38 Lectins

39 Lectins are proteins or glycoproteins which are commonly found in beans. They are known to
40 have erythroagglutinating and leucoagglutinating factors (Lioi *et al.*, 2003). Most lectins have the
41 ability to agglutinate erythrocytes (Puztai, 1991). Besides, they can bind with glycoproteins
42 on the epithelial surface of the small intestine, interfering with nutrient absorption (Sgarbieri,
43 1982). It has been proven *in vitro* that isolated lectins can induce enlargement of the small
44 intestine and cause damage to the epithelium (Zucoloto, 1991). Although legume lectins can be
45 harmful to humans, there is no evidence/indication of the anti-nutritional effect of cereal lectins
46 (Jansman *et al.*, 1998, Buul *et al.*, 2014). However, some lectins can be easily disintegrated
47 (Mubarak, 2005).

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

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

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55 Protease Inhibitors

56 They are agents that block protease ability to hydrolyze proteins. They are typically applied in the
57 pharmaceutical industry as anti-viral drugs used in the treatment of HIV/AIDS. Protease inhibitors
58 can interfere with the action of proteolytic enzymes in the digestive tract especially with
59 pancreatic trypsin and chymotrypsin (Birk, 1989). There are two types of protease inhibitors,
60 namely Kunitz and Bowman-Birk. Kunitz type especially acts on trypsin, while Bowman-

61 Birk type **inhibits** both trypsin and chymotrypsin (Lajolo *et al.*, 1991). However, protease
62 inhibitors are known to be effective in **suppressing** carcinogenesis in many different **in vivo**
63 and **in vitro** assay systems, but the mechanisms for the anti-carcinogenic activity of protease
64 inhibitors are unknown and yet to be discovered (Ei Morsi, 2001).

65 **It has been reported that germination did not have a significant effect in reducing protein**
66 **inhibitors in grains (Shimelis and Rakshit, 2017).**

67 **Phytic Acid**

68 Phytic acid is generally regarded as the major storage form of phosphorous in cereals which
69 occur mainly in the form of phytates (Wu *et al.*, 2009). Phytic acid content of cereals vary
70 from 0.5% - 2.0%. Besides, legumes have been reported to contain more phytic acids than
71 grains as (Hidvegi and Lasztity, 2002). Phytic acid contents **in some** cereals and legumes are
72 indicated in Table 1.

73 Phytic acid has a strong ability to form complexes with multivalent metal ions, especially
74 zinc, calcium, and iron. These complexes which are insoluble salts (Weaver and Kanna,
75 2002) subsequently **reduce** the bioavailability of minerals in **such foods** (Lesteinne *et al.*,
76 2005).

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

79 Table 1: Phytic acid content in cereals and legumes

Cereal/Legume	Average phytic acid content (g/100 g)
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

80 (Hidvegi and Lasztity, 2002).

81 Saponins

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

84 Moreover, saponins can bind to cholesterol and therefore reduce inserted absorption (Sidhu
85 and Oakenfull. 1986). However, saponins are not destroyed during cooking or processing
86 (Birk, 1980). Fermentation has been reported to reduce the levels of saponin. Tempeh, a
87 fermented soy product has been found to contain half the saponin content present in the
88 unfermented soybean seeds (Potter et al., 1980).

89 Table 2: Saponin content in legumes

Source	Saponin content (% dry weight)
Soybeans (<i>Glycine max</i>)	5.6
Chickpea (<i>Cicer arietinum</i> L.)	3.6
Lucerne (<i>Medicago sativa</i>)	2.5
Lupine (<i>Lupinus angustifolius</i>)	1.5

90 (Khokhar and Apenten, 2003)

91 Conclusion and recommendation:

92 Even though anti-nutrient factors reported to have adverse effects, *in vivo* studies related to
93 those factors are very few. Furthermore, it is vital to carry out studies related to the
94 effectiveness of different techniques such as soaking, fermentation, germination and heat
95 treatment to find out the best methods to reduce the concentration of inserted anti-nutrient
96 factors in cereals and legumes. In addition, the positive impact of these anti-nutrient factors
97 resulting from their anti-cancer, anti-diabetic and anti-cholesterolemic effects should be
98 investigated using *in vivo* studies.

99 **Ethical approval: NA**

100 **Consent: NA**

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