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

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Authors’ contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AFSJ/2019/v10i430044

Received 05 September 2018
Accepted 14 November 2018
Published 25 July 2019

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 summarise 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.

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1. INTRODUCTION

In Asian dietaries, cereals and legumes are very important major staple foods [1]. They are significant sources of nutrients especially protein, dietary fibre, vitamins, minerals, and phytochemicals [2]. It is important to know that various anti-nutritional substances are present in foods which could be reduced/removed by different techniques [3].

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 [4]. 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, 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. These methods include soaking, cooking, germination, fermentation, selective extraction, irradiation and enzymatic treatment [3]. Moreover, a combination of different techniques has been proven more effective compared with single techniques. However, complete removal is impossible [5].

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

2. LECTINS

Lectins are proteins or glycoproteins which are commonly found in beans. They are known to have erythroagglutinating and leucoagglutinating factors [6]. 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 [7]. It has been proven in vitro that isolated lectins can induce enlargement of the small intestine and cause damage to the epithelium [8]. Although legume lectins can be harmful to humans, there is no evidence/indication of the anti-nutritional effect of cereal lectins [9, Buul et al. 2014]. However, some lectins can be easily disintegrated [10].

Lectin contents had been reported to be higher in Kidney beans (Phaseolus Vulgaris), soybeans (Glycine max), cowpeas (Vigna unguiculata), and lupin seeds (Lupinus augustifolius) [11].

Germination can be used to reduce the concentration of lectins in legumes before consumption. The reduction is due to proteolytic action of different enzymes [12,13].

3. PROTEASE INHIBITORS

They are agents that block protease ability to hydrolyse proteins. They are typically applied in the pharmaceutical industry as anti-viral drugs used in the treatment of HIV/AIDS. Protease inhibitors can interfere with the action of proteolytic enzymes in the digestive tract especially with pancreatic trypsin and chymotrypsin [14]. There are two types of protease inhibitors, namely Kunitz and Bowman-Birk. Kunitz type especially acts on trypsin, while Bowman-Birk type inhibits both trypsin and chymotrypsin [15]. However, protease inhibitors are known to be effective in suppressing 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 [16].

It has been reported that germination did not have a significant effect in reducing protein inhibitors in grains [17].

4. PHYTIC ACID

Phytic acid is generally regarded as the major storage form of phosphorous in cereals which occur mainly in the form of phytates [18]. Phytic acid content of cereals vary from 0.5% - 2.0%. Besides, legumes have been reported to contain more phytic acids than grains as (Hidvegi and Lasztity, 2002). Phytic acid contents in some 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. These complexes which are insoluble salts [19] subsequently reduce the bioavailability of minerals in such foods [20].
Germination has been an effective treatment to reduce phytates. During germination, phytates are hydrolysed by phytase to release phosphate groups [21].

### Table 1. Phytic acid content in cereals and legumes

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

(Hidvegi and Lasztity, 2002)

### Table 2. Saponin content in legumes

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

[5]

5. SAPONINS

Saponins are widely distributed in all cells of leguminous plants. They have ability inserted form stable, soap-like foams in aqueous solutions [4].

Moreover, saponins can bind to cholesterol and therefore reduce inserted absorption [22]. However, saponins are not destroyed during cooking or processing [23]. Fermentation has been reported to reduce the levels of saponin. Tempeh, a fermented soy product has been found to contain half the saponin content present in the unfermented soybean seeds [24].

6. CONCLUSION AND RECOMMENDATION

Even though anti-nutrient factors reported to have adverse effects, in vivo studies related to those factors are very few. Furthermore, it is vital to carry out studies related to the effectiveness of different techniques such as soaking, fermentation, germination and heat treatment to find out the best methods to reduce the concentration of inserted 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-cholesterolemic effects should be investigated using in vivo studies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


