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Profiles Contents of Antinutrient (Phytate and Oxalate) in Plant Based Foods; A Review

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Abstract:

Plant-based food products, specifically legumes and cereals, are important staple foods in developing countries. Some of the major anti-nutritional components present in plants are stannins, phytic acid . The aim of this review paper was to assess contents of phytate and oxalate of plant foods.

Keywords : **Plant Based Foods, Phytate, Oxalate, Antinutrient**

Introduction:

The definition of plant-based diets is widely used, and its main focus is consuming raw or minimally processed vegetables, fruits, whole grains, legumes, nuts and seeds, spices, and herbs. Besides that, these diets often minimize or exclude all animal products [1]. A well-balanced plant-based diet is useful [2,3]

Plant phytochemicals carry some important properties such as antioxidants, anticarcinogenic, and antimicrobial activities and have displayed possible protective benefits toward cardiovascular disorders, cancer, hormonal imbalance, and osteoporosis [3,4]. Various plantbased foods such as cereals and legumes contain an appropriate number of oligosaccharides and dietary fibers [5,6]. These oligosaccharides are non-digestible carbohydrates, therefore, possess the ability to improve certain physiological properties. Moreover, oligosaccharides act as prebiotics and help in promoting the growth of gut microbiota selectively. β-glucans add some health benefits by reducing the level of cholesterol and help in improving the sensory traits of the end product [7-9].

Plant antinutrients directly interact with the minerals and micronutrients and lead to harmful effects on zinc and iron bioavailability as demonstrated *in vitro* [10,11] and *in vivo* conditions [12-14]. Moreover, an inadequate amount of micronutrient level is found in the diet of people who are vegetarian or vegan and they are at higher risk of micronutrient deficiency and associated disorders. Plant-based products, raw, or vegan diets often contain antinutrients associated with them as they are accumulated naturally within the plant tissues [13,14].

2.Antinutrient contents:

Antinutritional factors are primarily associated with compounds or substances of natural or synthetic origin, which interfere with the absorption of nutrients, and act to reduce nutrient intake, digestion, and utilization and may produce other adverse effects. Antinutrients are frequently related to plant-based, raw or vegan diets and are naturally synthesized in plants [15]. Some of the common symptoms exhibited by a large number of antinutrients in the body can be nausea, bloating,headaches, rashes, nutritional

deficiencies, *etc*. [16]. Although people's sensitivity to antinutrients widely differs adequate food processing is initially recommended to
reduce antinutritional factors [17]. A person cannot eliminate antinutrients once they have been introduced to the body. Eliminating and reintroducing specific foods that contain antinutrients can clear the correlation between symptoms and effects on human health. In this regard, the biochemical effects of the anti-nutritional factors are an object of research interest[18 – 20].
grains, beans, legumes and nuts, but can also be found in leaves, roots and fruits of certain varieties of plants. The major antinutrients found in plant-based foods are phytates, tannins, lectins, oxalates, *etc*. Antinutrients in vegetables, whole grains, legumes and nuts are a concern only when a person's diet is composed exclusively of uncooked plant foods. Oxalate, for instance, prevents calcium from being absorbed in the body by binding with it [13]. Raw spinach, kale, broccoli and soybeans usually contain oxalates [14]. When consuming excessive tannins, which are associated with tea, wine, some fruit, and chocolate, enzymes responsible for protein absorption may be inactivated. Phytates are present in grains, nuts and seeds, while peppers, eggplants, and tomatoes contain lectins. Phytates consumption may lead a lower mineral absorption and lectins are able to cause various reactions to the body [15].

Table 2.1 Antinutrients in different foods [29, 68 - 80].

Source	Type	Amount
Legumes (soya, lentils, chick peas, peanuts, beans)	Phytic acid Saponins Cyanide Tannins Trypsin inhibitor Oxalates	386-714 mg/100g 106-170 mg/100g 2-200 mg/100g 1.8-18 mg/g 6.7 mg/100g 8 mg/kg
Grains (wheat, barley, rye, oat, millet, corn, spelt, kamut, sorgho)	Phytic acid Oxalates	50-74 mg/g 35-270 mg/100g
Pseudo-grains: quinoa, amaranth, wheat, buckwheat, teff	Phytic acid Lectins Saponins Goitrogens	0.5-7.3 g/100g 0.04-2.14 ppm
Nuts: almonds, hazelnut, cashew, pignola, pistachio, brazil nuts, walnuts, macadamia, *etc*.	Phytic acid Lectins Oxalates	150-9400 mg/100g 37-144 µg/g 40-490 mg/100g
Seeds: sesame, flaxseed, poppy seed, sunflower, pumpkin	Phytic acid Alpha-amylase inhibitor Cyanide	1-10.7 g/100g 0.251 mg/mL 140-370 ppm
Tubers: carrot, sweet potato, Jerusalem artichoke, manioc (or tapioca), yam	Oxalates Tannins Phytates	0.4-2.3 mg/100g 4.18-6.72 mg/100g 0.06-0.08 mg/100g
Nighshades: potato, tomato, eggplant, pepper	Phytic acid Tannins Saponins Cyanide	0.82-4.48 mg/100g 0.19 mg/100g 0.16-0.25 mg/100g 1.6-10.5 mg/100g

Saponins, on the other hand, have been linked to red blood cells damaging, enzyme inhibition and thyroid function intervention [16]. There are several approaches to oppose antinutritional factors. Modern biotechnology`s techniques could reduce the level of certain allergens and antinutrients in food. Genome editing biotechnology can create mutations and substitutions in
plant and other eukaryotic cells based on nuclease-based forms of engineering such as the TALENS (Transcription Activator-Like Effector Nucleases) or the CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats)/CRISPR-Associated Systems (CAS) [17, 18]. Providing an enhanced level of prebiotic in the body can positively influence the effects of antinutrients [19]. A classic approach to

remove antinutrients is to treat the product thermally, use methods such as extrusion, autoclaving, hydrotechniques, enzymatic and harvest treatments,
etc. [20]. The nutritional value of foods strongly depends on their nutritional and antinutritional composition.

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2.1 Phytate

Phytates or phytic acids occur naturally in the plant kingdom. Phytate is generally known as *myo*-inositol-1,2,3,4,5,6-hexakis dihydrogen phosphate, which is present in foods at various levels ranging from 0.1 to 6.0% [21].Phytic acid is a secondary compound, which concentrates naturally in plant seeds, mainly in legumes, peanuts, cereals, and oilseeds and generally found in all plant-based foods[22,23]. In several cases, phytates contain about 50 to 80% of the total phosphorous in seeds [24,25] Because plant-based foods contain more amount of phytic acids than animal-based foods, the vegetarian diets culture in developing countries contribute to high ingestion levels [26;27]. According to a previous report, phytic acid hinders the activity of enzymes, which are necessary for protein degradation in the small intestine and stomach [28]. Generally, phytic acids affect the bioavailability of minerals and has a strong effect on infants, pregnant and lactating women when large portions of cereal-based foods are[29;30]. During germination of seeds, some native enzymes are activated, which degrade the phytic acid [31;32]. In wheat and rice, which are generally recognized as monocotyledon crops, phytates are present in the bran or aleurone layer and can be easily separated during milling. On the other hand, in diacotyledons such as legumes, oilseeds and nuts, phytates are found in close association with proteins, which reduces ease of separation by a simple processing method like milling [33]. Phytic acid is generally a negatively-charged structure, which generally binds with positively-charged metal ions such as zinc, iron, magnesium and calcium to make complexes and reduce the bioavailability of these ions through lower absorption rates. Mainly due to this chelating property, phytic acid is considered as a most effective anti-nutrient in foods, and a cause of mineral ions deficiencies in animal and human nutrition.

2.2 Oxalates

Oxalate is salt form of oxalic acid such as calcium oxalate which is broadly distributed within the plant kingdom. Between oxalic acid and several other minerals strong bonds forms and this chemical combination leads in the development of oxalate salt [34]. Oxalate act as antinutrient. Under normal condition do not possess adverse effect but when it is processed or digested then in gastrointestinal tract in come in contact with the other nutrients [35]. Some oxalate salts like potassium oxalate and sodium oxalate are soluble while calcium oxalate is insoluble. In the urinary tract or in the kidney the insoluble calcium oxalate salt has propensity to solidify and this lead to formation of sharp edge crystals of calcium oxalate and in the urinary tract these crystals of calcium oxalate helps in the formation of kidney stone when in urine acid is excreted [34].
When Oxalic acid is released in the body it binds with other nutrient making them reduction in bioavailability in the body. This is the reason that nutrition deficiency occur if there is too much amount of oxalic acid in the food. Irritation occurs in the lining of gut due to high amount of consumption of oxalic acid in the diet [36] Oxalates are present in high amount in some of the commodities such as radishes, cauliflower, broccoli, spinach, beets, black peeper, berries, nuts e.t.c.[37]. If the oxalate is present in normal amount in the diet then most people can take it although oxalate intake should be lowered for those people who have ailment like enteric and primary hyperoxaluria. In sensitive people consequences like burning or irritation in the ears, mouth, throat and eyes can happen even by small amount of oxalate intake

and if the large amount is taken then consequences such as muscle weakness, abdominal pain, nausea and diarrhea may happen [38].

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