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A REVIEW

Antinutritional factors in plant based foods

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Abstract : Plants have the potential to create chemical molecules that operate as a defense mechanism against pests, bacteria, and other animals. When consumed by humans or other animals, these chemical substances can have a negative effect on the body. There are a number of antinutritional factors such as saponins, polyphenols, phytic acids, lathyrogens, alpha amylase inhibitors, lectins are found in plant-based diet particularly in different cereals and pulses consumed by Indian population in their day-to-day life. Anti-nutrients are one of the main factors that lower the bioavailability of nutrients. Micronutrient deficiency and mineral deficiencies can be caused by these compounds. To minimize the levels of these anti-nutrient elements, a variety of traditional approaches and technology can be applied. Fermentation, germination, milling, autoclaving, soaking, and other processing procedures and technologies are used to lower anti-nutrient content in foods. It is feasible to minimize the amount of anti-nutrients in foods by adopting a variety of approaches alone or in combination. The toxic and anti-nutrient properties of these chemicals in their natural state are of concern but there are also some beneficial effects reported about these compounds on human body at low concentrations. Therefore, this review highlights the different antinutritional factors found in Indian crops and their negative and positive impacts on health along with various approaches and technologies applied for reduction of these compounds from food.

Key Words : Antinutrients, Secondary metabolites, Approaches, Health

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INTRODUCTION

Many plant species have been blessed by nature with the ability to create a variety of chemical compounds that operate as a defensive strategy against insects, bacteria, and animals that consume them. As a result, many of these chemical compounds may have a negative effect on the human body when taken, and these chemical compounds are referred to as antinutrients or sometimes as secondary metabolites. They are extremely bioactive, capable of both negative and positive health effects in people, and they are predominantly found in plant-based foods (Awulachew *et al*., 2022). These antinutritional factors are the compounds or substances that inhibit nutrient intake, digestion, absorption, and utilization, as well as have other negative consequences in human body (Akande *et al*., 2010). However, depending on the amount taken, some of these chemical components may offer beneficial benefits such as antioxidant, prebiotic,

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or immunostimulatory properties (Nath *et al*., 2022). Undernutrition, lower palatability, growth suppression, inappropriate gut function, respiratory distress, impaired body weight gain, anorexia, weakness, apathy are all possible negative effects of these chemical substances (Krogdahl, 2010 and Joshi, 2020). Antinutrients, on the other hand, may have health benefits at low concentrations. High levels of macronutrients, micronutrients are found in legumes and cereals. These are considered staple food but also contain antinutritional compounds (Samitya *et al*., 2020). Toxic amino acids, saponins, cyanogenic glycosides, tannins, phytic acid, gossypol, oxalates, goitrogens, lectins (phytohaemagglutinins), protease inhibitors, chlorogenic acid, and amylase inhibitors are among the most common antinutrients (Akande *et al*., 2010).

Antinutrients in plant sources are responsible for a variety of negative impacts on nutrient and micronutrient absorption (Veer *et al*., 2021). Phytic acid, lectins, tannins, saponins, amylase inhibitors, and protease inhibitors have been demonstrated to restrict nutrient availability and inhibit growth. Phytate, lectins, tannins, amylase inhibitors, and saponins, when administered at low doses, have been proven to lower blood glucose and insulin responses to starchy foods, as well as plasma cholesterol and triglycerides. Phytates, tannins, saponins, protease inhibitors, goitrogens, and oxalates have also been linked to a lower risk of cancer. This suggests that anti-nutrients, despite their lack of nutritional content, may not always be harmful. Regardless, the balance between positive and harmful effects of plant bioactive and anti-nutrients is determined by their concentration, chemical structure, time of exposure and interactions with other dietary components. As a result, they can be classified as either anti-nutritional factors with harmful health consequences or non-nutritive chemicals with beneficial health effects (Gemede *et al*., 2014).

However, there are a number of traditional approaches as well as modern technology that can be utilized to minimize the levels of these anti-nutrient compounds. Fermentation, germination, milling, autoclaving, soaking, drying, irradiation, and other processing methods are used to lower anti-nutrient content in foods (Joshi, 2020). Combinations are frequently used since a single strategy is generally insufficient for effective treatment. Nutritional value of any food is mostly determined by their nutritional and antinutritional content. Therefore, this emphasis the different antinutrients found in food items with their beneficial and harmful effects on body. This review also highlights the processing techniques that can be employed in order to reduce the antinutritional factors from different food items.

Antinutrients found in plant sources :

Antinutrients are most abundant in grains, beans, legumes, and nuts, but they can also be found in the leaves, roots, and fruits of other plant sources (Popova and Mihaylova, 2019). Following are commonly found antinutrients in plant sources :

Lectins :

Lectins also known as hemagglutinins are proteins/ glycoproteins with at least one non-catalytic domain that binds to specific monosaccharides oligosaccharides in a reversible manner. They can attach to the carbohydrate moieties on the surface of erythrocytes and agglutinate them without changing the carbohydrate's characteristics (Sze and Tzi, 2010). Plant lectins are found throughout the plant kingdom and can be found in a variety of foods such as legumes, seeds (including oilseeds), nuts, fruits, and vegetables (Nachbar and Oppenheim, 1980). They can be found in most of the beans which includes soybean, common bean, jack bean, chickpea, faba bean, pea, lentil, and peanut.

When it comes to molecular interactions vital to human nutrition, the clinical consequences of lectins must be taken into consideration. (Singh *et al*., 2014). Lectins can induce IgG and IgM antibodies, leading to food allergies and other immunological responses; they can cause significant intestinal damage, interrupting digestion, and nutrient deficiencies when ingested in excess by sensitive people (Felix and Mello, 2000) and they can bind to erythrocytes simultaneously with immune factors, causing hemagglutination and anemia. Panhemagglutinins, which clump all blood types, make up roughly half of the 119 known dietary lectins. The rest are particular to blood types. In general, affect host resistance to infection, induce failure to thrive, and mortality in experimental animals (Fereidoon, 2014).

In order to treat and diagnose cancer, lectins are known to have an effect on cancer cells. Recently, the use of lectins in targeted nano-vaccines for cancer immunotherapy has been investigated (Gupta *et al*., 2020). In an elaborate study, a dietary lectin known as Wheat Germ Agglutinin (WGA) was found to target leukemia cells and agglutinate them when consumed in modest doses, with no effect on normal cells (Ryva *et al*., 2019). Banana lectin, a dietary lectin from bananas, is reportedly able to limit 's ability of HIV- 1 to reverse transcriptase, which offers hope for positive outcomes.

Saponins :

Saponins are steroid or triterpenoid aglycone molecules linked to one or more sugar chains, which gives bitter taste to the plants (Shanthakumari *et al*., 2008). They have the following general characteristics: a bitter taste, froth when exposed to different solutions, and induce hemolysis in red blood cells (Sethy *et al*., 2021). Many plant species, including peanut, lupin, and oil seeds, generate them naturally as foam-producing triterpenes or glycosides (Kiranmayi, 2014). Saponins can be found in a variety of foods, including legumes (soya, peas, and beans), root crops (potato, yams, asparagus, and alliums), oats, sugar beet, tea, and a variety of medicinal herbs (such as ginseng). The saponin concentration of grain legumes varies between 0.5 and 5% dry weight, with soybean being the most important dietary source (Khokhar and Chauhan, 1986).

Saponins have a negative impact on growth and reduces food intake due to saponin's throat irritating activity and bitterness (Gemede *et al*., 2014). Saponins with a bitter taste are poisonous in large quantities and can interfere with nutritional absorption by inhibiting enzymes (metabolic and digestive) and binding to nutrients like zinc. They can also cause hypoglycemia (Barky *et al.,* 2017) and can affect protein digestion, vitamin and mineral absorption, and the formation of a leaky gut (Johnson *et al*.,1986).

On the other hand, a diet rich in saponin-containing dietary legumes lowers the risk of heart disease in humans (Xia and Liao, 2013). Cholesterol and bile acids can be bound by saponins. Saponins' biological characteristics suggest that they may have anticarcinogenic effects through a variety of ways. They have also been demonstrated to boost immunological responses and have thus been employed as adjuvants in oral vaccinations (Thompson, 1993). Balanites Egyptiac fruit contain seven phenolic compounds and five steroidal saponins, which may be useful in the treatment of type 2 diabetes. The saponin and phenolic extract of this fruit was found to be helpful in regulating blood glucose levels and lipid profiles in persons with type 2 diabetes in a randomized controlled clinical experiment (Rashad *et al*., 2017). The extract was administered 400 mg daily, and the research lasted 8 weeks.

Oxalates :

An Oxalate is a salt made from oxalic acid, such as Calcium oxalate, which has been discovered to be widely dispersed in plants. Oxalic acid forms strong connections with a variety of different minerals, including Calcium, Magnesium, Sodium and Potassium. Oxalate salts are formed as a result of this chemical reaction. Some oxalate salts, such as sodium and potassium, are soluble, but calcium oxalate salts are insoluble. When levels of insoluble calcium oxalate are high enough, it tends to precipitate (or solidify) in the Kidneys or Urinary tract, generating sharp-edged calcium oxalate crystals. When acid is expelled in the urine, these crystals contribute to the production of kidney stones in the urinary system (Nachbar and Oppenheim, 1980).

Foods high in oxalates include cruciferous vegetables (kale, radish, cauliflower, broccoli), chard, spinach, parsley, beets, rhubarb, black pepper, chocolate, almonds, berries (blueberries, blackberries), and beans (Mamboleo, 2015). Most people may consume normal amounts of oxalate-rich foods, but people with disorders like enteric and primary hyperoxaluria must limit their oxalate consumption. Small levels of oxalates can induce burning in the eyes, ears, mouth, and throat in sensitive people; high amounts can cause abdominal pain, muscle weakness, nausea, and diarrhea (Natesh *et al*. 2018).

Phytic acid :

Phytate, also known as phytic acid (PA) or myo-inositol hexaphosphate (IP6), is another well-known "anti-nutrient" found throughout the plant kingdom. It primarily functions as a phosphate storage system, an energy source, and an antioxidant for developing seeds (Buades *et al*., 2017). Phytate is formed during seed development and can make up 60–90% of total phosphorus in cereal grains, nuts, seeds, and legumes (Bohn *et al*., 2008). By binding to minerals such as calcium, magnesium, copper, iron, and zinc, phytates have a significant impact on the functional and nutritional qualities of food (Feil, 2001). As a result, their bioavailability will be reduced. Because phytates have a high binding capacity, they can form complexes with proteins and multivalent cations, which can obstruct digestion. Indeed, most phytate metal complexes are insoluble at physiological pH, preventing minerals from becoming bioavailable (Mellef *et al*., 2010). However, not all minerals have the same affinity for phytates, so if the phytate/mineral equilibrium is disrupted, there may be competition. As a result, phytate stability and affinity for cations differ by Fe< Ca< Mn< Co< Cu< Zn [23]. The ingestion of phytates in excess might be hazardous to one's health. Mineral deficiencies are one of the most common side effects, affecting women of childbearing age, children, and patients with chronic blood loss (Erdman, 1979). The suppression of digestive enzymes such as protease and alpha amylases has also been linked to phytic acid (Mudgil, 2013).

The addition of PA (0.2-9%) to rats' diets lowered plasma cholesterol and triglyceride levels considerably (Sharma, 1980; Jariwalla *et al*., 1990). This has been linked to PA's ability to bind to Zn and so lower the plasma Zn to copper (Cu) ratio, which has been linked to a higher risk of cardiovascular disease in humans (Klevay, 1977). Furthermore, the effect could be linked to PA's capacity to lower plasma glucose and insulin levels, which could lead to a reduced stimulus for hepatic lipid production (Thompson, 1988; Wolever, 1990). One study found that phytic acid and other polyphenols can protect cells from alcohol-induced oxidative stress by inhibiting ROS, which suggests that phytic acid may be helpful for alcoholics (Lee *et al.,* 2012).

Goitrogens :

Goitrogens are a type of chemical compound present in plant-based foods like groundnuts and soyabeans. Goitrogen-rich foods include vegetables from the genus Brassica, such as broccoli, cabbage, cauliflower, Brussels sprouts, and kale (Latté *et al*., 2011). It is responsible for expansion of thyroid gland. Goitrogens have been discovered to be the cause of decreased thyroid hormone secretion and synthesis (Akande, 2010). Thyroid hormone is one of the most essential hormones produced by our bodies, and it aids in the regulation of a wide range of genes that play important roles in our bodies (Brent, 2012). Thyroid hormone insufficiency causes a reduction in growth and reproductive ability (Olomu, 1995).

Glucosinolates are dietary goitrogens found largely in the Brassica family, as well as other plant diets (Fahey, 2001). They constitute a varied class of over 120 chemicals. The enzyme myrosinase (produced by human microflora and activated in damaged plant tissue) transforms glucosinolates to a range of different chemicals, including thiocyanates, nitriles, isothiocyanates and sulforaphane, during mastication and ingestion (Felker, 2016). The potential of glucosinolates and related analogues to prevent cancer, stimulate phase II detoxification enzymes, promote apoptosis, regulate redox processes, and inhibit Phase I detoxification enzymes has been the focus of much research.

Tannins :

Tannins are known to be found in food items, inhibiting the actions of trypsin, chemotrypsin, amylase, and lipase, lowering food protein quality, and interfering with dietary iron absorption (Felix and Mello, 2000). Tannins are secondary compounds formed in the leaves, fruits, and bark of plants (Timotheo and Lauer, 2018). Tannins, specifically proanthocyanidins or catechins, are present in cocoa beans, tea, wines, fruits, juices, nuts, seeds, legumes, and cereal grains. Proanthocyanidins are found in the highest concentrations in dark and baking chocolate (828–1332 mg/100 g) (Smeriglio *et al*., 2016). Catechins are also found in nuts (almonds, walnuts, pecans, and pistachios), common beans, and various cereals, such as sorghum (Arts, 2000). Tannins are heat stable, and they reduced protein digestibility in animals and humans, most likely by rendering protein partially accessible or blocking digestive enzymes, resulting in an increase in faeces nitrogen.

Tannins are chemically reactive due to their phenolic composition, creating intra- and intermolecular hydrogen bonds with macromolecules such as proteins and carbohydrates. This explains their antioxidant, anticarcinogenic, immunomodulatory, detoxifying, and cardioprotective properties. Tannins may operate as antioxidants by scavenging free radicals, but their potential to act as chelators has been shown to interfere with the absorption of dietary minerals such iron, copper, and zinc (Gemede *et al*., 2014).

Protease inhibitors :

Protease inhibitors can be found in a variety of plants crops, including the seeds of most cultivated legumes and grains especially soyabean. Protease inhibitors trypsin inhibitor and chymotrypsin inhibitor are found in raw legume seeds. Many plant species, primarily grain legumes, have trypsin inhibitors, which restrict protein digestion by inhibiting the activity of the enzyme's trypsin and chymotrypsin in the gut. Trypsin inhibitors are a special type of protein present in raw soybeans that bind to food protein and inhibit protease enzymes in the digestive tract. Even in the presence of large numbers of digestive enzymes, these complexes are indigestible. Protease inhibitors decrease the activity of trypsin and, to a lesser extent, chymotrypsin, affecting protein digestion in monogastric and immature ruminant animals (Gemede *et al*., 2014).

Antinutrient activity of proetease inhibitors is linked to growth suppression and pancreatic hypertrophy. Although there have been reports of lower pancreatic cancer incidences in populations with higher soy and soy-derived food consumption, the beneficial benefits of protease inhibitors are still unknown (Giri *et al*., 2004). While animal studies have linked protease inhibitors to pancreatic cancer, they may potentially work as anticarcinogenic agents. Chemically-induced cancers of the liver, lung, colon, mouth, and oesophagus have been demonstrated to be inhibited or prevented by Bowman-Birk inhibitors produced from soybean (Finotti *et al*., 2006).

Alkaloids :

Nicotine (tobaccao), cocaine (leaves of the coca plant), quinine (cinchona bark), morphine (dry latex of the opium poppy), and solanine are some of the more well-known alkaloids (unripe potatoes and potato sprouts). They are commonly found as salts of organic acids of plant origin such as tartaric acid, malic acid, citric acid, or oxalic acid, are one of the greatest classes of chemical compounds generated by the plant kingdom. These complexes are indigestible even when a higher number of digestive enzymes are present (Gemede, 2014). Some alkaloids have antinutrient properties. If consumed in excess amounts (20mg/100g), solanine, an alkaloid present in potatoes, can induce neurological problems as well as gastrointestinal problems. High tropane alkaloids cause rapid heartbeat, paralysis, and, in the worst-case leads to death. When a high dose of tryptamine alkaloids is ingested, it causes a staggering gate and death. Glycoalkaloids, which also produce neurological symptoms, significantly block cholinesterase. Disruption of the cell membrane in the gastrointestinal system is another toxicity (Fernando, 2012). Lower doses of alkaloids, for example, mediate key pharmacological effects such as analgesic, blood pressure reduction, tumour cell killing, and circulation and respiration stimulation (Simee, 2011).

Cyanogenic glycosides :

Cyanogenic glycosides, often known as cyanoglycosides, make up over 90% of the cyanogens group of plant toxins. Some legumes, such as linseed, lima bean, kidney bean, and red gram, contain cyanogenic glycosides, which can be hydrolyzed to generate hydrogen cyanide (HCN) (Akande *et al*., 2010). By attaching to the Fe3+/Fe2+ present in the enzyme, hydrogen cyanide inactivates cytochrome oxidase in the mitochondria of cells. This results in reduced upatke of oxygen in th tissues. Cyanide raises blood glucose and lactic acid levels while lowering the ATP/ADP ratio, indicating a switch from aerobic to anaerobic metabolism. Hydrolysis of cyanogenic glucoside produces hazardous hydrocyanic acid (HCN). The cyanide ions block various enzyme systems and reduce growth by interfering with the metabolism of some important amino acids and other nutrients. Acute toxicity, neuropathy, and death are other possible side effects.

Techniques used to reduce antinutritional factors form food :

One of the most important factors in the reduction of antinutrients in foods is processing. Pressure cooking, boiling, soaking, germination, dehulling, and fermentation aid in the decrease of antinutrients in foods such as phytic acid, protein inhibitors, phenolics, tannins, saponins, and lectins (Das *et al*., 2022). Some of the techniques that can be applied for the reduction or removal of antinutrients from food are shown in Fig.1.

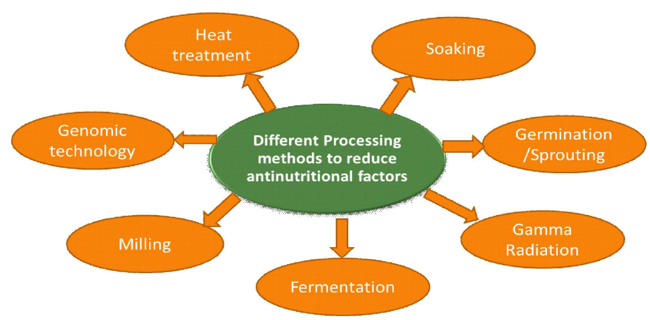

Fig 1: Different processing methods to reduce antinutritional factors

Soaking :

Traditionally, the soaking procedure was to shorten the cooking time. This is a technique for hydrating seeds by enabling anti-nutrient diffusion and disintegration into the aqueous phase. Soaking aids digestion and increases the body's absorption of contained nutrients (Fernandes *et al*., 2010). The duration of soaking has an effect on the content of ANFs. An average soaking time of 8 to 12 hours at room temperature is required (Andrianirina, 2015).

Total phenols, ortho-dihydroxyphenols, tannins, and phytates were reduced by 33, 41, 35, and 21 percent, respectively, after soaking in distilled water, with 1 percent NaHCO3, and mixed salt solutions (Devi *et al*., 2018). Soaking soybean flour reduced total protein, soluble sugar, and tannins (Agume *et al*., 2017). Enzyme inhibitors can be deactivated by soaking and sprouting grains, nuts, seeds, and beans (Shi *et al*., 2017). This form of deactivation, however, has no effect on lectin. The minerals (potassium, calcium, magnesium, and iron) may also get lost in the soaking water (Souilah, 2015). To avoid excessive losses of minerals and water-soluble vitamins in the soaked water, it is critical to consider dipping food as anti-nutritional factors control method while managing the time of the operation.

Germination/Sprouting :

Germination is defined as a series of actions that begin with the absorption of water by a mature dry seed and end with the emergence of the radicle or, more broadly, a piece of the embryo through the seed envelopes **(**Rajjou *et al*., 2012). It enhances the nutritional value of grains and legumes by improving protein digestibility, essential amino acid content, and vitamin content while lowering antinutrients (Sibian, 2017). Germination is a traditional way of processing that plays an essential role in lowering antinutrient levels, particularly phytate, in pulses and cereals (Patterson, 2017). With sprouting, the trypsin inhibitory activity, amylase inhibitory activity, and phytate concentration of the MACS-13 soy bean variety got reduced (Dikshit *et al*., 2003). According to Kanensi *et al.*, 2011 germinated amaranth seeds have a reduced antinutrient content. Tannins and phytate levels were negligible. Chauhan *et al*. (2018) confirm that germination increases nutritious content while decreasing anti-nutrient content in plant-based diets.

Fermentation :

Fermentation is a simple, cost-effective, and nutritionally advantageous household process (Mehas, 1989). Fermentation enhances food safety and shelf life while also improving nutritional value (Ochanda *et al*., 2010).

This is a treatment that begins with the hydrolysis of starch by enzymes. Lactic acid bacteria are required for the production of metabolites, the degradation of cyanogenic glucosides, the production of enzymes, the development of probiotic characteristics, and the production of a variety of other compounds in fermentations (Kohajdová, 2007). Fermentation is an important process that reduces the amount of anti-nutrients in grains such as phytic acid, tannins, and polyphenols (Simwaka *et al*. 2017). Fermentation also creates ideal pH conditions for enzymatic phytate breakdown, which is found in grains as complexes with polyvalent cations such Fe, Zn, Ca, Mg, and proteins. The amount of soluble Fe, Zn, and Ca may increase by many folds as phytate levels are reduced. (Gupta *et al*., 2015). Raw cassava was found to have 86.29, 29.81, 12.3 and 23.75 mg/kg on average of cyanogen, tannin, oxalate and phytate, respectively. When cassava was fermented for 21 days after cooking for 10 minutes, the highest reduction of anti-nutrients—cyanogen (65.5 %), tannin (94.57%), oxalate (80.49%), and phytate (99.99%)—was noted (Dahal *et al*., 2021).

Heat treatment :

Antinutrients including phytic acid, tannins, and oxalic acid can be reduced by cooking whole grains, beans, and vegetables. Because of their protein composition, protease inhibitors are quickly denatured by heat (Fernando, 2012). Controlled cooking at a temperature less than boiling for at least 15 minutes has been demonstrated to lower antinutrient levels (Udousoro *et al*. 2014). The raffinose content of bambara groundnut seeds is greatly reduced and their protein digestibility is improved after 60 minutes of boiling (Adeleke, 2017). Tannins, phytic acid, hydrogen cyanide, trypsin inhibitors, and oligosaccharides can all be significantly reduced by autoclaving (Soetan, 2009). The term “autoclave” refers to strategy that is used to heat treat items. This application activates the phytase enzyme while also increasing acidity in cereals and other plant-based diets (Ertop and Bektaº, 2018). When consumed following autoclaving, the majority of the items demonstrated health benefits. Boiling cereal grains, reduced anti-nutrient content and improved nutritious value (Rehman and Shah 2005).

Cooking sweet potato leaves in lemon reduced polyphenols by 56% and lowered oxalate levels by 12% (Mwanri, 2011). The trypsin inhibitor activity in soybean meal was also dramatically reduced by the roasting technique (Vagadia *et al*., 2017). Another study found that pressure-cooking lowered anti-nutrients in black grams and mung beans when compared to normal cooking methods (Kataria *et al*., 1989). According to Shah (2001), pressure cooking lowered tannin concentration, resulting in better black gram protein digestibility. Toros *et al*. (2022) applied heat-alkaline treatments for lowering antinutritional factors in three varieties of sesame seeds and found the amount of phytic acid and oxalate in seeds was significantly decreased after 15 minutes of exposure to a 0.7 per cent KOH solution.

Milling :

The most common method for separating the bran layer from the grains is milling. It is the process of grinding grains into flour. The milling procedure removes anti-nutrients (phytic acid, lectins, and tannins) found in the bran of grains, but it also removes vital minerals. However, Gupta *et al*. (2015) showed that no difference was found in semi-refined flour and whole flour except fat content, which was 1.3%. Due to the removal of the bran portion, semi-refined flour was shown to have a lower phytate and oxalate level than whole flour (Suma and Urooj, 2014).

Genomic technology :

Although genomic resources can be employed to interfere with RNA and remove antinutrient factors, this approach has yet to be tested in vivo (Pedrosa, 2004). As corn contains significant quantities of phosphorus stored in the form of phytic acid, Shukla *et al*. (2009), constructed zinc-finger nucleases to modify the IPK1 gene in maize, one of the phytic acid production genes. Although genome editing technology can improve crop quality, there is still a debate about the safety of genetically modified plants (Kim, 2015).

Gamma radiation :

Gamma radiation showed to be an effective method for reducing trypsin inhibitor, phytic acid, and oligosaccharides in broad bean by 5 to 10% (Al-Kaisey *et al*., 2003). Hassan *et al*. (2009) on the other hand, found that a 2 kGy dosage had no effect on the tannin content of two maize varieties. El- Niely (2007) and Fombang *et al*. (2005) both made similar observations. Antinutritional components such as tannin and phytic acid were dramatically reduced in Faba bean seeds after low doses of gamma irradiation (0.5 and 1.0 kGy) (Osman *et al*., 2014). To reduce antinutrients in millet grains, gamma radiation can be used as a safe postharvest technique (Mahmoud *et al*., 2015).

Conclusion:

Antinutrients are one of the major concerns when the selection of plant-based food products for consumption. Plants use antinutrients as a defense mechanism to defend themselves against pests, bacteria, rodents, herbivores, and even humans. Antinutritional substances in foods are responsible for the negative effects on nutrients and micronutrient absorption, which can interfere with the function of specific organs. As a result, foods containing cyanogenic glycosides, protease inhibitors, lectins, tannins, alkaloids, and saponins may cause unfavorable consequences in humans if consumed in excess. These substances have been found to be abundant in leguminous foods, which are major components of the diets of a large portion of the world's population, particularly in developing nations. For the population's health and well-being, knowledge of methods and procedures for lowering or reducing the content of anti-nutritional elements in food should be applied.

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