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Systematic Review

Adverse effects of antinutrients on human health: a systematic review

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ABSTRACT

Antinutrients are naturally occurring compounds found in various foods that can interfere with the absorption or utilization of nutrients in the body. There are many studies about various antinutrients and or on some particular antinutrients. The aim of our systematic review is to provide wholesome information about most of the antinutrients. Many plants and vegetables contain a variety of harmful compounds (cyanide, nitrate, phenols, etc.) and anti-nutrients (phytate, oxalate, etc.). The detrimental effects on the absorption of minerals and micronutrients in diet are caused by anti-nutrients. Chemicals known as "anti-nutrients" lower the body's ability to use certain nutrients, including proteins, vitamins, and minerals. This prevents the nutrients in food from being used to their full potential and lowers the meal's nutritional value. A systematic search was done using various search engines like Google Scholar, PubMed, science direct. Database was collected between the years of 2010 to 2023 for the English literature using different keywords like antinutrients, lectins, phytates. A total number of 80 articles selected during search out of them 15 studies were taken after screening in the review with experimental and non-experimental study design. Our study suggests that we can reduce the antinutrient content in food by different methods like soaking, fermentation, boiling, and washing.

Keywords: Antinutrients, Digestion, Lectins, Heat, Oxalates, Phytates

INTRODUCTION

Nutrition has profoundly impacted your life, which is the study of food nutrients and how they affect the body.[1,2] You might indulge in food choices multiple times a day that affect the wellness of your body. The effects of our daily food choices may only be tiny, but over time, they have a significant impact on our health.[3-6] A Nutrient is an ingredient in food that an organism uses and that is required for existence, development, maintenance, tissue repair, and reproduction.[7-10] There are six types of nutrients: water, proteins, lipids, carbohydrates, vitamins, and some minerals.[11-12] It has been suggested that eating foods made from plants is a good way to prevent a number of chronic diseases; however, plant chemicals known as antinutrients have historically been thought to be unhealthy for human health because they have the potential to reduce the bioavailability of vital nutrients.[13-16] However, in recent years, it has come to light that these allegedly called anti-nutrients have positive effects and therapeutic promise for a number of disorders.[17-21] These compounds were developed by plants to serve as defense mechanisms and ward off predators.[22-24] However, some of these poisons can accumulate in the body in hazardous amounts if the diet is not diversified. Antinutritional elements may damage some vitamins in the diet. These anti- nutritional elements need to be neutralized or eliminated.[9,25]

It has been determined that a variety of antinutritional elements in food are either heat-labile or heat-stable. Phytic acid, saponins, tannins, lectins, protease inhibitors, amylase inhibitors, antivitamin factors, and more are among these compounds.[26-28] Some of them are as:

Lectins

Plant, bacterial, fungal, animal, and algae lectins are different types of glycoproteins having carbohydrate binding sites that are not catalytic that are arranged according to their species of origin.[17]

The majority of these anti-nutrients are present in foods that are eaten uncooked.[26,29,30]

Saponins

A diverse variety of plants, such as oil seeds and pulses like beans, peanut, sunflower and lupin both have saponins, a heterogeneous group of naturally occurring foam- producing triterpenes.[9,31-33]

Tannins

Tannins are naturally occurring antioxidants that can be found in plant-based foods and beverages.[34-36] Because of their amphiphilic character, they may be effective for stabilizing emulsions and preventing the oxidation of unsaturated lipids.[37-39]

The complicated and non-specific interactions between proteins and tannins are influenced by the structure of both proteins and tannins.[40-42]

Oxalate

Oxalate interferes with the process of calcium and metabolism reacts with protein to create intricated that hinder digestion process.[40-45] In plants, oxalate is a ubiquitous metabolic byproduct. Most items in the normal diet of the west have shown to have minimal to moderate levels of oxalate. Nonetheless, it is known that certain plants can collect a lot of oxalate.[46-48]

Phytates (Phytic Acid)

Natural antioxidants like phytic acid (IP6) can be found in foods such as nuts, vegetables, legumes, cereals, and natural oils.[49-51] It also decreased the bioavailability of minerals. Many studies have shown that IP6 has both preventive and therapeutic effects in conditions marked by endocrine and mineral imbalances, chronic inflammation, and the emergence of cancer.[47]

Protease inhibitor

Protease inhibitors are widely distributed protein-based compounds found in the kingdom of plants, containing the seeds of the majority of grown legumes. They possess the capacity to prevent animals' gastrointestinal tracts from being activated by proteolytic enzymes. Heat easily destroys them; the extent of inactivation or destruction depends on temperature, heating time, particle size, and moisture content.[9-52]

Amylase inhibitor

Amylase inhibitors, often known as starch blockers, can prevent amylase activity. A flavone type that can inhibit aldose reductase, -glycosidase, and -amylase was found by researchers.[48]

METHODS

This review mainly focused on a systematic review of adverse effects of various antinutrients on human health. To reach the cumulative conclusions of antinutrients effect on human health the following methodology were considered for this study. The database was prepared for the search from 2010 to 2023.

Inclusive and exclusive criteria

Eligible studies include the research articles from 2015 to 2023 with relevant information related to antinutrients and their types and uses. Articles with only abstracts were also taken. Research papers other than 2015 to 2023 were excluded even with the relevant information about the topic

Information sources

Articles published prior to 2010 and reviews were not included in the identification process. To improve dieticians' understanding, the article's inclusive aspect should be a methodical overview of English-language literature about anti nutrients and their various types. PRISMA guidelines were used for this review. And multiple databases and gray literature were used to find the research during the search time in September 2023. The sources are as PubMed, Scopus, Google Scholar, Google Books, Science Direct, Web of Science, food research journals, Wiley Online Library.

Search strategy

Articles were included in the review if the study focused on antinutrients, their types, their sources, and their effects on the human body were indicated by the abstract, title, or keywords. The systematic review assessed the most recent research on antinutrients, their applications in everyday life, and their findings.

Selection process

After eliminating duplicates and selecting and screening the studies, all citations obtained through electronic searching were downloaded to a Zotero library. Every abstract and title were carefully reviewed by researchers to ensure relevancy. Complete articles were acquired for those that satisfied the inclusion requirements or in cases of doubt.

After that, full-text reports were independently reviewed considering the inclusion requirements.

Data source and collection process

Researcher extracted the data using a data extraction form; no disparities were discovered. After that, information from each data extraction form was added to an Excel spreadsheet to get it ready for analysis. There was no analysis of raw data for this systematic review. Nonetheless, study authors were contacted in cases where data might be obtained in a more pertinent format. The systemic review is registered with PROSPERO, CRD42023480718. The number of articles taken from different sources are as ScienceDirect (19), Google Scholar (19), PubMed (12), Research Gate (5), Wiley Online Library (4), Biomed Central (4), MDPI (3), Springer (3), Journal of Applied Biology and Biotechnology (2), Google Books (2), Taylor and Francis + NEJM (4), The Pharma Journal (1), Elsevier (1), Current Opinion in Structural Biology (1).

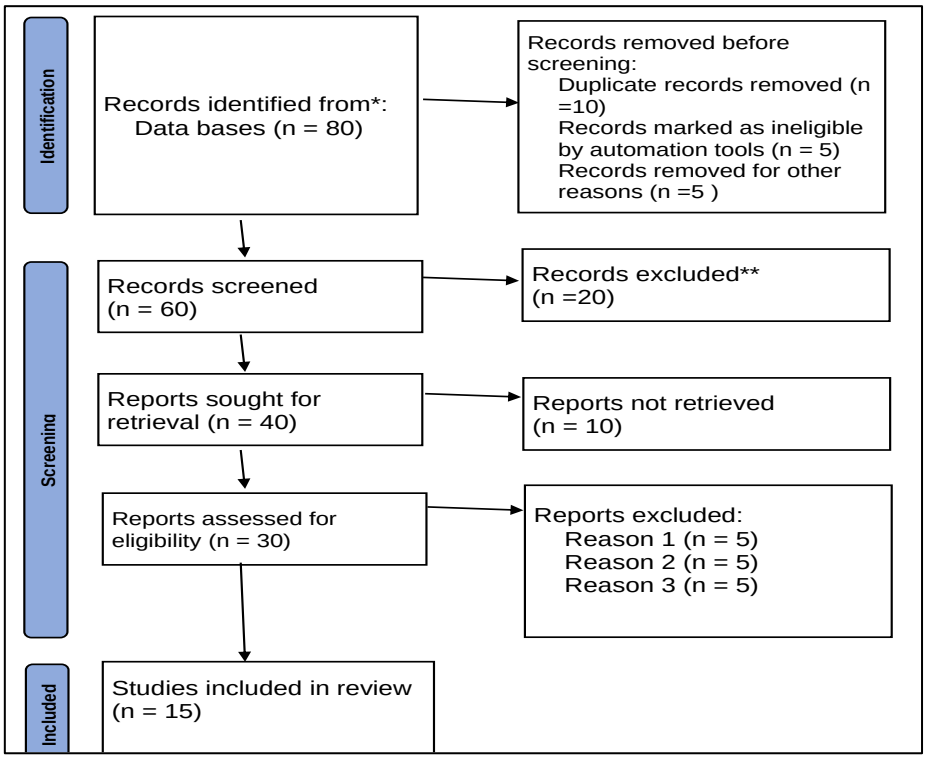

Figure 1: PRISMA 2020 flow diagram, identification of studies via databases and registers.

RESULTS

The search criteria were not met by any non-English and grey literature, thesis, or dissertations. After duplication, searches yielded eighty distinct articles, of which fifteen studies were included for full-text screening and it was published between 2015 and 2023 which was included as a result. Table 1 and 2 shows an overview of every study that has been taken in this systematic review.

These investigations, which may be experimental/non-experimental, primarily focus on the many antinutrients, their antinutritional factors, and various ways in which we can readily identify them.

Table 1: References of different antinutrients, food sources, and action taken to eliminate it.

Antinutrients	Food sources	Antinutrients action	How to eliminate it
Phytic acid	Peanut, brown rice, chickpea	It lowers bioavailability of minerals	Fermentation, sprouting, soaking,
Lectins	Seed, fruits, nuts, and legumes	Modified digestive processes; inflammation	Fermentation, heating, boiling
Tannins	Tea, fruits, nuts, berries, apples, and beans	impair the absorption of iron; adversely affect the iron reserve	Fermentation, soaking, sprouting
Protease inhibitor	Maize, onion, beetroot, wheat, peanuts	suppress the functioning of the digestive enzymes	Fermentation, sprouting, soaking, boiling
Calcium oxalate	Potatoes, almonds, roots, spinach, Swiss chard and sorrel	There could be a rise in the development of calcium kidney stones and a decrease in calcium absorption	Soaking, fermentation, boiling

Continued.

Antinutrients	Food sources	Antinutrients action	How to eliminate it
Phytates	Nuts, cereal grains, and legumes	Potential to impede calcium, iron, and zinc absorption; functions as an antinutrients; antineoplastic properties	Cooking, fermentation, soaking
Saponins	Quinoa seed, soybean, alfalfa	impacts how well fats, vitamin E, and vitamin A are absorbed.	Cooking, washing, fermentation
Enzyme Inhibitor	Legumes, whole grain, seeds	Reduce the digestibility of proteins and impede development	Soaking
Cyanide	Almonds, bamboo, soy, spinach	Inhibitor of respiration	Soaking and then boiling
Uric acid	Organ meat, eggs, dairy	Kidney disease, swelling,	Vitamin C supplement
Alpaamye	Kidney beans	delayed digestion of starch	Peptides and phenolic substances driven by cereals
Oligo saccharides	Wheat, legumes	Create gas and induce flatulence	Soaking
Trypsin inhibitor	Soybeans, grains, cereal	Inhibit the trypsin digesting enzyme	Soaking
Goitrogens	Brussels, sprouts, kale, broccoli, and cauliflower	Hypothyroidism	Cooking
Polyphenol	Fruits, vegetables, legumes, and cereals	Precipitates, macromolecule like proteins and carbohydrates	Frying

Table 2: Detail of articles which is used in review like name of authors, year of publication, country of research, sample size and study design.

Authors	Year of publication	Country	Sample Size	Study design
López-Moreno et al[15]	2022	Spain	-	Non-experimental
Thakur et al[8]	2018	India	-	Non- experimental
Samtiya et al[24]	2020	India	-	Non- experimental
Kaspchak et al[35]	2020	Brazil	3	Experimental
Avila-Nava et al[44]	2021	Mexico	109	Experimental
Silva et al[45]	2016	France	-	Non- experimental
Manzoor et al[48]	2021	India	-	Non- experimental
Li et al	2021	Chinese	1-10	Experimental
Petroski et al[50]	2020	Oregon, US	-	Non- experimental
Gemede et al[51]	2015	Ethiopia, East Africa	-	Non- experimental
Talabi et al[39]	2016	Nigeria	1	Experimental
Rawat et al[52]	2016	India	2	Experimental
Abifarin et al[26]	2021	Nigeria	1 Sample from diff. latitude	Experimental
Oluremi et al	2018	Nigeria	1	Experimental

This review delivers crucial details on the anti-nutrients and different varieties of antinutrients, when present in excessive amounts, these substances impair the nutritional value of food by decreasing the absorption of minerals and protein, as well as by producing toxicity and health problems.[41] These days, a variety of tactics are employed to counteract the consequences of these anti-nutrient foods. These tactics involve fermentation and different processing methods like milling, soaking, germination, autoclaving, and oven treatment.[55] When compared to all other strategies, fermentation has been shown in numerous prior studies to be among the greatest ways to minimize the anti-nutritional elements in food stuffs. On the other hand, germination and fermentation afterward demonstrated promising outcomes in lowering the anti-nutrient content of food. Therefore, applying different processing techniques, particularly germination and fermentation, can enhance the food crops' quality, such as that of grains and cereals.[28,8] Citrus maxima peel extract has comparatively more antinutritional components healthier than juice, with phytic acid as the most prevalent of the three antinutrients examined.[45] Compounds or chemicals known as antinutrients work to decrease nutrient intake, digestion, absorption, and utilization while also having the potential to have additional negative consequences. Protein and several other chemical molecules, such as amino acids and alkaloids, are bound by tannin and precipitated. Important minerals like calcium, magnesium, iron, and zinc are bound by phytic acid to form insoluble phytates.[6]

It is known that plant oxalate combines with necessary trace metals to form a compound that prevents the metals from serving physiological and biochemical functions. It is crucial to understand that a compound's ability to behave as an antinutrient depends on the animal eating it; it is not an innate property. The quantity consumed affects the antinutritional qualities as well. Furthermore, heat treatment of antinutrients makes them inactive [32]

It is crucial to understand that a compound's ability to behave as an antinutrient depends on the animal ingesting it; it is not an innate property. The quantity consumed affects the anti-nutritional qualities that are favorable. Furthermore, heat treatment of antinutrients makes them inactive.[6]

Plants were examined for soluble oxalate concentration since the soluble form of oxalate in food may be important in determining oxalate absorption in the gut. To what degree insoluble calcium oxalate has to dissociate before being absorbed is still unknown, as is the possibility of entire calcium oxalate being absorbed in the human colon.[56,8]

CONCLUSION

The current analysis made it clear that, in addition to the nutritional advantages of various food crops, there are certain antinutritional variables present that reduce the nutritional quality of food. Using alternative processing technologies can help minimize these anti-nutrients in an efficient manner. Wet heat is more conductive to the anti-nutrients than is dry heat. Potential methods for enhancing mineral extractability and lowering anti-nutrients that bind to minerals and lessen their availability are germination and fermentation. Soaking pulses prior to cooking is the most conventional, cost- effective, and suitable way to minimize anti-nutrients. These days, a fuller understanding of the anti- nutrients' molecular structures can aid in the development of technical methods for processing legume seeds to produce goods free of toxins. Numerous food processing techniques, including genetic modification, heating, soaking, germination, autoclaving, fermenting, and other techniques, can eliminate the majority of these substances' harmful and antinutritional effects. However, more research is required to identify ways to eliminate heat-stable antinutrients found in different foods without compromising the food's nutritional value.

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