DR-2136
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REVIEW ARTICLE Asian Journal of Dairy and Food Research

Nutritional Profiling and its Significance in Groundnut: A Review

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10.18805/ajdfr.DR-2136

ABSTRACT

Groundnut is calorie-dense and packed with vitamins, minerals, antioxidants and other nutrients that are vital for maintaining good health. The human dietary system includes groundnut like energy that could prevent immune-based disorders, decrease chronic disease risk and promote longevity. Also, hunger and malnutrition are serious threats in developing countries which can be reduced by the food supplements like groundnut which are nutrient-rich as well as bioactive compounds for the growth and calorie absorption in living things. With these, groundnut is commercially important crops that contribute significantly to the food and feed industry in the future. This review focuses on the nutritional components of groundnut related to human health exclusively are presented.

Key words: Bioactive compounds, Groundnut nutrients, Health benefits, Nutritional profiles.

Groundnut is otherwise called as *"king of oil seed"* is a species of the legume family (*Fabaceae*) and origin of South America then it is spread all over the world. Groundnut is staple crop grown in more than 20 million hectares worldwide, it stands second position in terms of planting area followed by rapeseed in oil seed crops. Every year groundnut production in the world is about 33 million tons per year. India occupies the first position in an area and second position of production with a cultivated area of 5.34 million hectares and production of 7.46 million tonnes during 2019-20. The top producers of the groundnut among the countries, China (44%) followed India (20%) and Nigeria (11%) holds the shares of 75% of the world's production. With respect to groundnut oil, India contributes 16 per cent share and hold second largest producer (Directorate of Economics and Statistics, 2020). Groundnut commonly coarse in appearance and has wide range of colour (Red to brown). The nutritional importance of groundnuts is recognized mainly as proteins, lipids, carbohydrates, vitamins, minerals and organic compounds. The purine present in the groundnut is known as energy and growth supplementing constituents of the human body (Woodroof, 1983). More than thousands of groundnut varieties grown all over the countries, the most predominate varieties are *Spanish, Runner, Virginia* and *Valencia*. The characters such as differences in flavor, oil content, size, shape and disease resistance decide the preference of selection of variety. Groundnut candy, salted nuts and groundnut butter preparation Spanish groundnuts are used mostly. While groundnut butter preparation runner varieties are suitable Rustom *et al*. (1996). Most groundnuts grown in the world are used for oil production, groundnut butter, confectionaries such as roasted groundnut, snack products, extenders in meat product formulation, soups and desserts Saiz *et al*. (2013). This comprehensive review paper on the nutritional components of groundnut with related to the human wellbeing (Sales and Resurreccion, 2014) and groundnut phytonutrients exclusively Alhassan *et al.* (2017). This review article describes the nutritional composition present in the groundnut and health benefits of these nutrients and scope for the product development in the food manufacturing sectors are discussed.

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How to cite this article: Balasubramanian, P., Subbulakshmi, B., Balmurugan, M., Gurumeenakshi, G., Prasanth, R.C., Deepika, R. and Surya, R. (2023). Nutritional Profiling and its Significance in Groundnut: A Review. Asian Journal of Dairy and Food Research. DOI:10.18805/ajdfr.DR-2136

Submitted: 28-06-2023 **Accepted:** 06-11-2023 **Online:** 19-12-2023

Nutritional profiling of groundnut

Groundnut is the under ground growing crop, the ovary converts in to seed from the groundnut plant. Since the 1800s groundnuts have been known as a valuable protein

source. Because the protein present in groundnut is plant-based and also groundnut contains supplementary components *viz*., fiber and unique bioactive promoting positive health benefits. Groundnut contains moisture 4.9-6.8 per cent, 21-36.4 per cent protein, 36-54 per cent and fat 18 per cent carbohydrate. The ranges of groundnut nutrient constituents as carbohydrate 21-37 per cent, protein 20.7-25.3 per cent, crude fat 31-46 per cent, ash 1.2-2.3 per cent and crude fiber 1.4-3.9 per cent Yadav *et al*. (2018). The constituents of Indian raw groundnut kernel are 17.4 per cent carbohydrate, 25.5 per cent protein, 47.3 per cent fat, 5.6 per cent moisture and 1.8 per cent ash (Woodroof, 1973). Further, groundnuts contribute 10 per cent of the RDA (Recommended Daily Allowance) for vitamin E, phosphorus, potassium, magnesium, copper, folate and niacin. The fatty acid profile was 30-35 per cent polyunsaturated and 40-45 per cent monosaturated fatty acid as oleic acid. Groundnut contains about 10-12 g of fiber per 100 g. Groundnuts contributes the major amount of lipids and carbohydrates that are serve as major energy provider, it balanced the basic energy demands of the human body (Tharanathan *et al*., 1975).

Carbohydrates

Groundnut dependents on cultivar and geographic location and it contain the carbohydrates in varying quantities (Major to minor) of sucrose, fructose, glucose, inositol, raffinose and stachyose (Pattee and Young, 1982). Groundnut carbohydrates flour from whole conventional pod and defatted contain approximately 38 per cent total carbohydrates comprising 18 per cent oligosaccharides,12.5 percent starch, 0.5 per cent hemicellulose A, 3.5 per cent hemicellulose B and 4.5 per cent cellulose (USDA, 2017) (Fig 1). The oligosaccharide fraction comprises 13.9 per cent sucrose, 0.89 per cent raffinose, 1.56 per cent stachyose and 0.41 per cent verbascose. The non-digestible oligosaccharides stachyose, raffinose and verbascose were indigestible in the human digestive system and to bacterial fermentation in the lower gut, which results in abdominal bloating. Starch is a homopolysaccharide made up of a-D glucose residues joined by glycosidic bonds. Salivary and pancreatic amylase catalyzes the hydrolysis of starch to maltose and maltotriose. These disaccharides are then converted to free glucose by the digestive enzyme's maltase, sucrose or sucrose-isomaltose. Roasted dry groundnuts contain nearly 21.51 g of carbohydrates as starch per 100 g (Woodroof, 1983). Carbohydrate is also dependent upon market type and maturation (Pattee *et al.,* 2002). Carbohydrate directly related to increased sweetness content with reduced bitterness and the flavour was improved with the roasting process (Pattee *et al*., 2000).

Proteins

Protein and its important amino acids present in groundnut aids to preventing malnutrition (FAO/WHO/UNU, 2002). Groundnut is protein-rich and primarily used to produce edible oil and is more nutritionally complete than tree nuts (Pele, 2010). The groundnut seed contains 32 different proteins Yusnawan *et al*. (2012) among that there are 18 proteins components identified as allergenic Zhao *et al*. (2011) Groundnut cake after extracted the oil, protein content in the cake will double its content (upto 50%). Groundnut contains 20 amino acids in variable proportions and is the biggest source of the protein called B arginine (Pelto and Armar-Klemesu, 2011). The pictorial representation (Fig 2.) shows the preparation methods of groundnut protein concentrates. However, the methods have some fatal defects. For example, a great deal of waste water produced causes serious environmental pollution and it is also the limited capacity of raw material treatment and high consumption of acid and alkali. Moreover, it is easy to cause protein denaturation. Therefore, it is necessary to explore an alternative extraction approach for groundnut proteins (Iqbal *et al*., 2016). The high proposition of lipids and carbohydrates also present in groundnuts are of complementing the basic energy requirements of the human body. Based on the Protein Digestibility Corrected Amino Acid Score (PDCAAS), groundnut on par nutrition with meat and eggs (Yu *et al*., 2006) and are also used as an ingredient for protein fortification (Wu, 2009). In addition, groundnut proteins exhibits better emulsifying property, good water retention and high solubility and foaming capacity, could

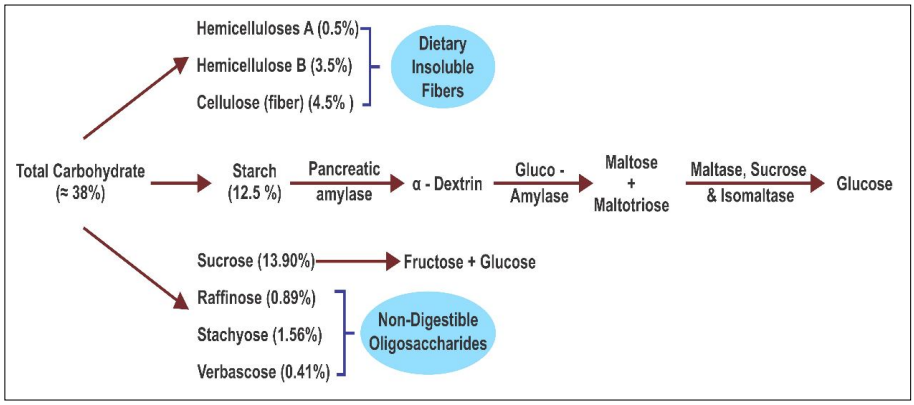

Fig 1: Composition of groundnut.

serve as high quality protein component in food product development and protein formulation in the different food industries (Kris- Etherton *et al.,* 2011). Groundnuts contains an amino acid of arginine is a precursor to nitric oxide that helps in blood vessels expansion. Incorporation of more groundnuts in the diet increase the protein intake which is prevent the occurrence of chronic diseases, improve blood flow in the vein and increase the life expectancy. Further consumption of peanut in the diets reduced triglyceride levels (Yu *et al*., 2007). Researchers are focus on separate groundnut proteins. The main competent of protein in the groundnut is separated in different methods and incorporated as supplements and other products during product development. Conventionally groundnut protein is separated by the methods of alcohol precipitation, isoelectric precipitation, hot water extraction, combining isoelectric precipitation with alcohol precipitation and alkali solution with isoelectric precipitation methods (Liu *et al*., 2001).

Lipids in groundnut

Macro nutrient category of lipids is present in groundnut in the form of different fatty acids. One gram of fat provides 9 Kcal of energy due to its low oxygen molecule in their chemical structure whereas carbohydrates and proteins serve 4 Kcal of energy due to the high oxygen in their structure. They compose sufficient levels of Mono Unsaturated Fatty Acids (MUFA), especially oleic acid, which helps lower “bad cholesterol (LDL)” and increases “good cholesterol” (HDL) levels in the blood. Research studies suggest that the Mediterranean diet which is rich in monounsaturated fatty acids helps prevent coronary artery disease and stroke risk by favoring a healthy serum lipid profile. Groundnut lipids contain about 50 per cent Mono Unsaturated Fatty Acids (MUFAs), 33 per cent Para Form Aldehyde (PFAs) and 14 per cent saturated fatty acids. When compared to low-fat diets, different forms of groundnut *viz*., raw groundnut, groundnut butter and groundnut oil are more beneficial to heart health. The high monounsaturated fat of groundnut diets is whispered to lower the total body cholesterol by 11 per cent and LDL cholesterol by 14 per cent. When comparing the cholesterol level both groundnut diet and olive oil diet. There is a strong similarity found between monounsaturated fat as well as overall nut intake. Thus, it is decline in the risk of coronary heart disease (Fishman *et al.,* 2003).

Vitamins in groundnut

Vitamins are play as protective role in the human diet. Generally vitamins are make up of a group of organic compounds which are not synthesized by our body and it should come from the diet for the maintenance of normal health and metabolic activity (Settaluri *et al.,* 2012). The nuts are packed with both water soluble and fat-soluble vitamins. Water-soluble B complex groups vitamins namely thiamine, riboflavin, niacin, pantothenic acid, pyridixine and folic acid has specific biochemical role by acting as coenzymes that assist the enzyme in converting a substrate into a product. Riboflavin (Vitamin B_2) in the form of Flavin Mono Nucleotide (FMN) and Flavin Adenine D nucleotide (FAD), is involved in electron transfer and hydrogen transfer reactions in the human body. Folic acid is the synthetic form of folate that is useful for human growth and helps the mechanism of normal nerve function and brain function. Various research results suggest that 100 g of groundnuts provide about 85 per cent of daily allowance of niacin play a major role to the health as maintaining the blood flow of the brain (Derise *et al.,* 1974).

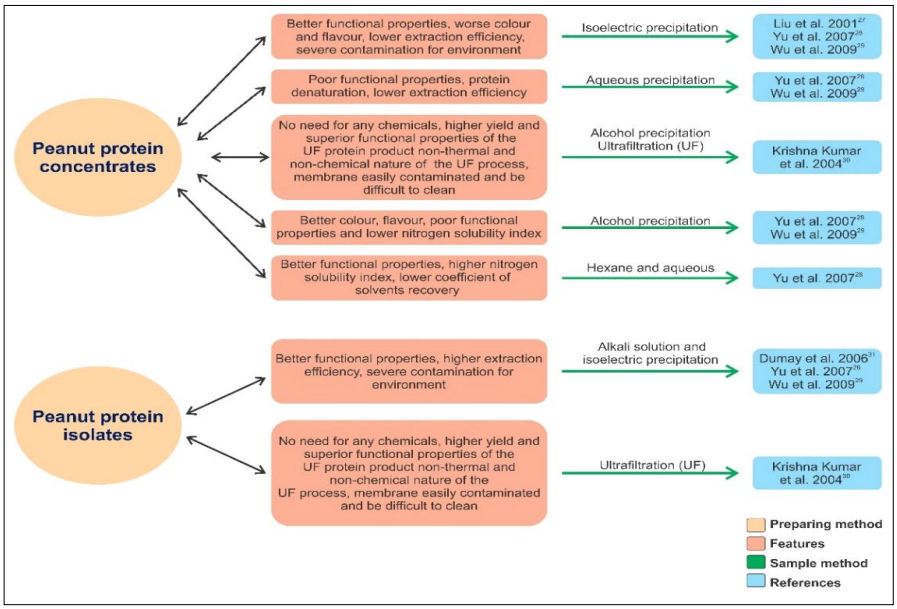

Fig 2: Methods of groundnut protein for processing (Ros, 2010).

Minerals in goundnut

Groundnuts are a good dietary source of macro minerals (King, 2005 and Song *et al.,* 2005). Groundnut consumption is fulfilling the majority part of Recommended Daily Allowance (RDA) several elements that are essential for good health and proper maintenance of metabolic activities in the human body. Groundnut 100 g could serve 28 per cent energy, 55.5 per cent vitamin E, 54 per cent phosphorus, 42 per cent magnesium, 127 per cent copper, 84 per cent manganese and 57 per cent iron of recommended daily allowance consumption to decrease inflammation (Larsson and Wolk, 2007) (Fig 3) and a lower risk of developing metabolic syndrome (Morris, 2002), type II diabetes (Duggan *et al*., 2002).

There are number of bioactive compounds present in the groundnut which helps to regulate the body function. The details of bioactive compounds as follows:

Arginine

Groundnut contains the highest concentration of arginine (Ragab *et al.,* 2006). An amino acid arginine also known as L-arginine, is vital element for the health of liver, skin, joints and muscles. With respect to arginine functions, it act as precursor to nitric oxide, which keeps the arteries calm and improves blood circulation. Arginine, protect the gastrointestinal tract and speed up the thymus gland which boosting the flow of T lymphocytes (T-cells) and improves the bodily tissues functions. Recent research has emphasis the potential of arginine to cure cancer, AIDS and other immune-related disorders. Arginine aids in liver detoxification through counteracting the ammonia toxin effects and other toxins in the human system (Aggarwal, 2004).

Resveratrol

Resveratrol is rich in groundnuts, mainly in the root and skin (Gagliano *et al*., 2010) and is to possess anti chemo properties (Juan *et al*., 2002). Resveratrol (3, 52, 4-trihydroxystilbene) is a type of polyphenolic chemical compound, which have act as anticancer effects (Chen *et al.,* 2005), heart disease (Bramley *et al.,* 2010), alzheimer's complications, neurodegenerative disorders (Kang *et al*., 2010), tumor (Jeandet *et al*. 2012). and inflammation (Lopes *et al.,* 2011). A fat-soluble substance called resveratrol is found in both trans fatty acids and cis fatty acids. Both cis- and trans-resveratrol present in the form of glucosides (bound to a glucose molecule). Resveratrol-3-O-beta-glucoside and resveratrol found to be reduce stroke risk by altering molecular mechanisms in the blood vessels through reducing susceptibility of vascular damage and decreased activity of angiotensin, which the hormone responsible for blood vessel constriction. The hormone stimulate the production of vasodilator hormone by which elevate blood pressure (Woyengo *et al.,* 2009).

Phytosterols

The substances sterol and stanol esters, naturally present in plant cell membranes has more health benefits general called as phytosterols, Since phytosterols are structurally matching with human cholesterol, while we include in the diet it act as cholesterol for absorption in the digestive system. Consuming phytosterols in the correct amounts as part of a heart-healthy diet has been proven to reduce total cholesterol by up to 10 per cent and LDL, or bad cholesterol, by up to 14 per cent. More and more research is showing that reintroducing plant-based foods that contain phytosterols in the formulated foods can enhance serum lipid (cholesterol) profiles and lower the prevalence of heart disease. Groundnuts containing phytosterols (Beta-sitosterol, campesterol and stigmasterol) which prevent the absorption of cholesterol from food. Recent research the inflammation and slow the development of some cancers, particularly lung, stomach, ovarian, prostate, colon and breast cancer (Duncan *et al*., 2006).

Phenolic acids and flavonoids

Functional compounds such as phenolic acids and flavonoids are very high in inner and outer skin of groundnut. Groundnut is an excellent source of functional compounds, including phenolic acids (FAO/WHO/UNN 2011). It recent studies groundnut has high levels of polyphenolic antioxidants, especially in p-coumaric acid levels, boosting its overall antioxidant content by as much as 22 per cent

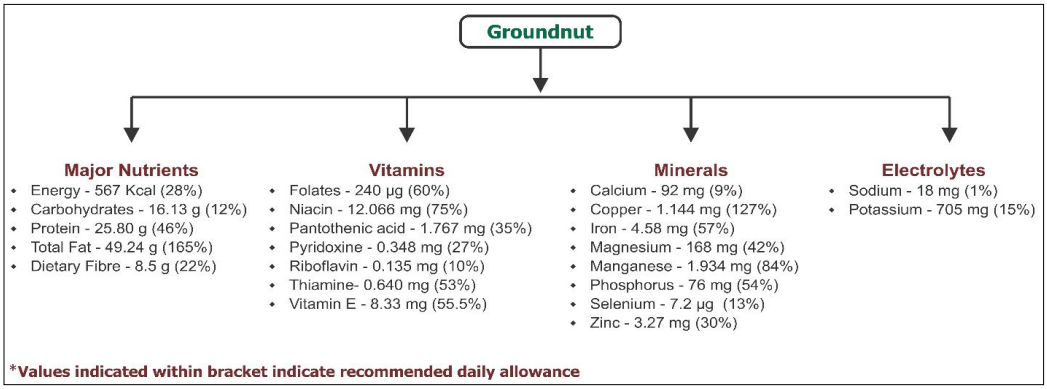

Fig 3: Nutrient contents of groundnut (100 g^{-1}).

(Sales *et al*., 2009). Furthermore, the antioxidant content of roasted groundnut skin is higher than that of roasted groundnut (Yu *et al*., 2007).

By-products of groundnut

Groundnut seed and groundnut oil extractions are generally known as "groundnut products". The average production of crushed groundnut around the world is about 14.1 million tons. About 5.78 million metric tonnes of groundnut meal were produced globally (Woodroof, 1983). Groundnut has the lectin, resveratrol and piceid component s which are act as functional components. The different oil extraction procedures for groundnut by-products reported (Sobolev and Cole, 2004). Hot groundnut meals are crushed by two and three-phase centrifugation extraction procedures among these cold crushing groundnut meals contain higher moisture and lower oil content (Wang and Xu, 2008).

Groundnut skin

Kernels to make groundnut butter, roasted groundnut snacks, groundnut confections and groundnut oil. According to estimates, per kg of shelled groundnut kernels, 35 to 45 g of groundnut skin is produced. Most of the skins are discarded as trash from the processing of groundnuts and are used to extract polyphenolic chemicals or manufacture animal feed (Du and Fu, 2008). Groundnut skins are known to have powerful, rich in antioxidants. The nation's health can benefit from using groundnut skins as a cheap source of polyphenols for functional components in foods or dietary supplements (Wu *et al.,* 2009).

Groundnut hull

Peanut kernels and hulls are produced when graded groundnut are run through machinery that shells them and they are a common agricultural byproduct worldwide. The hulls from groundnuts are plentiful, affordable and a renewable resource. It's fascinating that groundnut hulls are becoming more and more valued as a useful product since it is rich source of dietary fiber and other biological activity components (Du and Fu, 2008), therefore groundnut hulls are one of the main ingredients in the market. However, groundnut hulls inconvenient to be transported efficiently and cost-effectively over great distances to locations where it fully utilized (FAO, 1991).

Groundnut vine

The groundnut vines include leaves, stems, roots and flowers. Groundnut vine is produced each year as a byproduct of the groundnut than the groundnut kernel, skin and hull combined. The production of groundnut vine from harvested groundnut has calculated to be been 60-65% of the groundnut production. Groundnut vines are abundant in flavonoids and health-promoting fibres (Yu *et al*., 2005).

Groundnut butter

Groundnut butter has made a mark in several countries. It is high amount in calories and it contains vitamins, minerals, protein, fiber, fat and phytochemicals. The number of vitamins in groundnut butter is either small or unaffected by its manufacture because groundnut butter is made from roasted groundnut by grinding into a paste while incorporating other ingredients. The two main processes that can cause vitamin loss during the manufacturing of peanut butter are blanching and roasting (Nepote *et al.,* 2004).

Groundnut polyphenolic compounds

Groundnut skins are tremendous nutraceutical property used as main ingredient to product preparation (Craft *et al*., 2010), a rich source of phenolic compounds, including various procyanidins (Hammerstone *et al.,* 2000). Groundnut potentially represents a rich source of natural procyanidin, owing to the large number of groundnut byproducts produced. Procyanidin, a natural antioxidant found in fruits, vegetables, grape seeds and grape skin, has been thoroughly researched for its health-promoting properties, including its ability to fight cancer, cardiovascular disease and inflammation. Before eating groundnuts or adding them to snacks and confections, they are normally removed (Bao *et al*., 2013).

Health benefits of groundnut

Groundnut have the favourable lipid profile, because of its higher in unsaturated fatty acids content. Natural trans-fat, cholesterol and saturated-fat-free groundnut oil exhibit a wide range of advantageous health effects. Recent studies suggested that boiling increases the number of antioxidants in groundnuts. According to research, the antioxidant isoflavones genistein and biochanin both have a two- and four-fold increase in content when groundnuts are cooked, respectively (Luu *et al.,* 2015).

Reduce mortality

Some studies have shown that consumption of nuts (including groundnuts) was inversely associated with total and cause-specific mortality regardless of race and gender (Eslamparast *et al.,* 2017; Chen *et al.,* 2017; Amba *et al.,* 2019; Fraser *et al.,* 1992). Specifically, nut consumption has been reported to be significantly associated with reduced risk of cancer, cardiovascular, respiratory, infectious, renal and liver disease mortality (Gonzalez and Salvado, 2006). Good monounsaturated fatty acids, plant proteins, magnesium, potassium, fiber arginine and many other bioactive components may all be found in groundnuts and groundnut butter and it has been shown that people who consistently consume these foods have lower blood pressure (Awad *et al.,* 2000).

Groundnut and cancer

A groundnut kernel contains unrefined lipids, certain vitamins and minerals and bioactive substances that have been demonstrated cancer-preventive properties (Fazel *et al.,* 2014). In particular, the phytosterols in groundnuts that act against cancer have been reported to reduce prostate tumor growth by over 40 per cent and cut the occurrences of cancer spreading to other parts of the body by almost 50 per cent

(Jiang *et al.,* 2002). Resveratrol has to prevent cancer cell proliferation and cut off the blood supply to developing tumors, similar to phytosterols (King *et al.,* 2007).

Diabetes and inflammation

Groundnuts were regularly included in the diet, diabetes risk was lowered by a fourth (Gartside *et al.,* 1998) Magnesium (Nettleton *et al*., 2006) and undigested fibres Salas-(Salvado *et al.,* 2008) have been cited as the primary causes of the improvement in health status. C-Reactive Proteins (CRP), an indicator of inflammation in the blood, have been linked to heart disease. Dietary factors may play a role in reducing inflammation (Tsai *et al.,* 2004). There is evidence that certain lipids, antioxidants, dietary fiber, arginine and magnesium can help control inflammation (Mattes, 2008).

Alzheimer's and gallstone disease

Niacin and vitamin E, which are abundant in groundnuts and are both protective against Alzheimer's disease and age-related cognitive dysfunction, are both found in high concentrations. Several studies are enlightening that consumption of vitamin E as supplements did not affect the incidence (Johnston *et al.,* 2007). Alzheimer's disease incidence was 70% lower in individuals who were in the top fifth of intake. Resveratrol has also been shown to help treat diseases that cause nerve degeneration, such as alzheimer's disease (Pelkman, 2004). This was discovered in the subjects who consume groundnuts and groundnut butter five times or more per week have a risk reduction of up to 25% for gallbladder disease (Kirkmeyer and Mattes, 2000).

Groundnuts and weight loss

Groundnuts and groundnut butter does not cause weight gain or an increase in body weight (Johnston *et al.,* 2007). Another study that focused only on schoolchildren revealed that the groundnut-fed group lost weight while the control group gained weight for two years (Pelkman, 2004). Numerous further epidemiological studies with similar findings that groundnuts lowered total and LDL cholesterol levels (Alpher and Mattes, 2002).

Hunger management

According to research, eating similar amounts of groundnuts and groundnut butter increased consumers' feelings of fullness and satiety more than eating the same number of carbohydrate-based snacks like rice cakes (Schwartz *et al.,* 2008). One of study revealed that groundnut consumption provide fullness effect after the meal (Patel *et al.,* 2005). A hormone that aids in feeling content after eating may be stimulated by the type of beneficial monounsaturated fat found in groundnuts (Diop *et al.,* 2003).

Malnourishment

Despite not being extremely popular, groundnut milk is frequently used in emergencies and cases of malnutrition to speed up recovery and improve health. In the past, products made of groundnuts, such as RUTFs (Ready-to-Use Therapeutic Foods), were developed to treat severe malnourishment. RUTF in children has proven the better-quality recovery rates within the shorter duration to reach weight for growth (Tamanna *et al.,* 2015). Chang *et al*. (2016) study result shows that moderately malnourished RUTF-users had a higher intake of energy, fat, iron and zinc compared to a group consuming maize/soybean. Additionally, vegetable oil, powdered milk, sugar, vitamins and minerals are included. When using groundnuts as the foundation for RUTF, it is possible to offer the whole balanced lipids profile, vital amino acids, minerals and vitamins that growing children need more effectively (Pelkman, 2004).

Losses during groundnut processing

Groundnut processing aims a wholesome and safer to consumer products. It improves the colour, flavor and texture of the groundnut. Industrial groundnut processing involves blanching, roasting and groundnut butter making. Groundnut is blanched after shelling to simply remove the reddish skin covering the kernels. It prolongs shelf life by preventing enzymatic reactions that interfere with flavour development, which helps to reduce quality loss over time. To improve the colour, flavour, taste, scent and crunch of groundnuts, they are typically roasted. Groundnuts are roasted to enhance their color, flavor, taste, aroma and crunchy texture (Ostadrahimi *et al.,* 2014 and Stuetz *et al.,* 2017).

CONCLUSION

Groundnuts provide essential nutrients to the human body, in the form of proteins, carbohydrates, fats, vitamins, minerals and fiber. Groundnut are great and economical source of nourishment. In the prevention of diseases or some immune-based disorders in human can be prevented by the consumption of protein-rich foods like groundnut which provides energy-rich nutrients and bioactive compounds which regulates the human immune system. Groundnut serve as cofactors for numerous enzymes and vitamins that the body cannot produce, as well as polyunsaturated and monounsaturated fatty acids that can raise levels of HDL cholesterol, a heart-healthy fat. Groundnuts can supply vital amino acids that the body cannot synthesize yet are necessary for the production of proteins and carbohydrates, the body's primary energy source. The serious problem encountered across the world is hunger and malnutrition, especially in developing countries instead, world food supply and demand remain a serious matter. Hence, including groundnuts in your diet could give all essential nutrients and keep you healthy and disease-free. With respect to the commercialization of groundnut, products have enormously positive factors. In consequence, standardization of new products (value-added products) using groundnut industry will make a noteworthy contribution in all those areas in the years to come.

Conflict of interest: None.

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