

REVIEW



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Comparative assessment of biomedical and nutritional status of dry fruits; A reviewZahed Mahmood¹, Aqsa Mashooq¹, Sarmad Ahmad Qamar², Naveed Munir^{1,3}, Muhammad Jahangeer^{1*}, Ghazia Fatima¹, Shoukat Hussain¹, Ayesha Zulfiqar¹.¹Clinical Biochemistry Lab, Department of Biochemistry, Government College University Faisalabad-38000, Pakistan.²Industrial Biotechnology Lab, Department of Biochemistry, University of Agriculture, Faisalabad-38040, Pakistan.³College of Allied Health Professionals, Directorate of Medical Sciences, Government College University Faisalabad-38000, Pakistan.***Corresponding Author**Muhammad Jahangeer (rajahangeer@gcuf.edu.pk)

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Abstract

Nuts as dry fruits are nutrients rich foods that have high amount of phytochemicals like unsaturated fatty acids, proteins, fibers, carbohydrates, flavonoides, phytosteroides and antioxidants. Other nutritional components that are also present in nuts include vitamins, minerals, and phenolic compounds. Nuts have been proposed as an important component of optimal diets for reducing the risk of chronic heart disease. Anti-inflammatory properties present in nuts, maintain the weight and increase insulin sensitivity. Phytosterols present in nuts have a role in regulating the blood cholesterol level. The essential elements omega 3 and omega 6 fatty acids are also present in walnut and these elements have a more beneficial effect on heart brain and neurotransmitters. Polyunsaturated fatty acids like linolenic acid and monounsaturated fatty acid are also present in nuts which have a potential role in the human body to maintain the low-density lipoproteins and high-density lipoproteins for proper arterial function. Both pine nuts and cashew nuts have antioxidant potential due to the presence of a wide range of phytoconstituents, so this review article has been compiled to summarize the health benefits of dry fruits, phytochemical constituents and their mechanism of actions.

Keywords: optimal diet, vitamins, minerals, phenolic compounds, phytosterols, antioxidants

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Copyright © 2019 Mahmood et al. This is an open-access article distributed under the **Creative Commons Attribution License**, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.**Introduction**

Fruits and vegetables are natural elements having antioxidant properties and help to decrease the effect of free radical on the body (1, 2). Free radicals have more harmful effects on the body such as DNA mutation, lipid peroxidation and cross-linking proteins which could be prevented by antioxidation. Nuts as dry fruits are nutrient-rich foods that contain rich amount of unsaturated fatty acid and other compound likes protein, fiber, carbohydrate and antioxidants properties (3). Nutritional compounds that are also present in nuts are vitamins (e.g. tocopherols, niacin, folic acid, and vitamin B6), minerals (e.g., magnesium, potassium, calcium, iron) and phenolic compounds (4). Some bioactive components of nuts i.e. Phytosterols, selenium, folic acid, tocopherols, phenolic compounds, and magnesium, are reported to have antioxidant, anticarcinogenic or anti-inflammatory properties (4). Anti-oxidation properties play an important role to preserve the chronic disease and reduce the risk of cancer. It is described that trend of

obesity is increasing which might be the major cause of cardiovascular diseases and type 2 diabetes mellitus, could be prevented by fruits and vegetables (5).

Phytosterols are present in nuts, fruits and vegetable, and their structure are related to the cholesterol played role in maintaining of blood cholesterol level and it was reported that consumption of 2 g of phytosterols per day reduced LDL cholesterol level by 10%, and are considered to protect cardiovascular complications. Nuts consumption effect on the serum lipid and decreases the low-density lipoprotein and improves the ratio of HDL (6). G-tocopherol and vitamin E are also present in all nuts which also have cardioprotective roles as well as to reduce the risk of heart diseases, hypertension, cancer and Alzheimer's disease (7).

Omega 3 and omega 6 fatty acids are present in walnut and these elements have a more favorable effect on heart, brain, and neurotransmitters. Walnut is the rich source of polyunsaturated fatty acids, basically linolenic acid

and linoleic acid. The particular lipid profile of nuts in general and walnuts, in particular, is likely to be an important contributor to the beneficial health effects of frequent nut consumption. Walnuts improve the blood lipid and potential benefit for oxidative stress and inflammatory marker. Walnuts act as an anti-inflammatory and affect endothelial functioning. Walnuts improve metabolic syndrome and maintain body weight. Nuts are the great source of iron and are mainly determine hemoglobin level in the body. Iron is the most important element for the production of blood. Additionally, iron boosts metabolic processes, essential for growth and development, normal cellular function and also play an important role in the formation of hormones and connective tissues (8).

Pine nuts are most beneficent and protect the body against the diseases of heart, brain, and cancer. Most essential fatty acid like monounsaturated fatty acid and polyunsaturated fatty acid are present both in pine nuts and cashew nuts (7). The body can't synthesize the carotenoids, so carotenoids entered into the body through diet and high amount of lutein and zeaxanthin carotenoids are present in pine nuts which are necessary for healthy eyes and muscles. Cashew nuts also contained antioxidants, anti-inflammatory and cardioprotective substances (9). Comparison of nutritional values per 100 gram of walnuts, pine nuts, and cashew nuts have listed in Table 1

Nutritional status of walnuts

Walnut plays a significant role in medicines which are used to cure heart diseases (10). Walnuts have great antioxidant potential basically due to the presence of phenolic compounds and tocopherols. Omega 3 fatty acids like DHA (docosahexaenoic acid), ALA (alpha linoleic acid), EPA (eicosapentaenoic acid) and omega 6 fatty acids have a beneficial effect on the body (7).

These compounds have a more beneficial effect for heart, brain and blood vessels. Polyunsaturated fatty acids reduce LDL and increase HDL concentration, consequently decreasing the risk for development of heart diseases. Walnuts improve metabolic syndrome and maintain body weight (11).

Health benefits

Antioxidant and anti-inflammatory properties are present in walnut that protect against chronic disease. Walnut consumption has both acute and chronic beneficial effects on vascular integrity (7).

1- Fights depression

Depression remains a serious health problem with significant associated mortality, morbidity, and economic cost. It is stated (12) that omega 3 is present in walnuts and its important function is to protect the brain and help the neurotransmitter functioning. Omega 3 fatty acid is used in healthy diets that reduce the risk of depression. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are polyunsaturated fatty acids. EPA is an omega 3 fatty acid and plays an important role in the treatment of depression. The higher amount of docosahexaenoic acid (DHA) in the membrane and a higher concentration of eicosapentaenoic acid (EPA) in plasma, help to reduce the rate of depression (13).

Mechanism

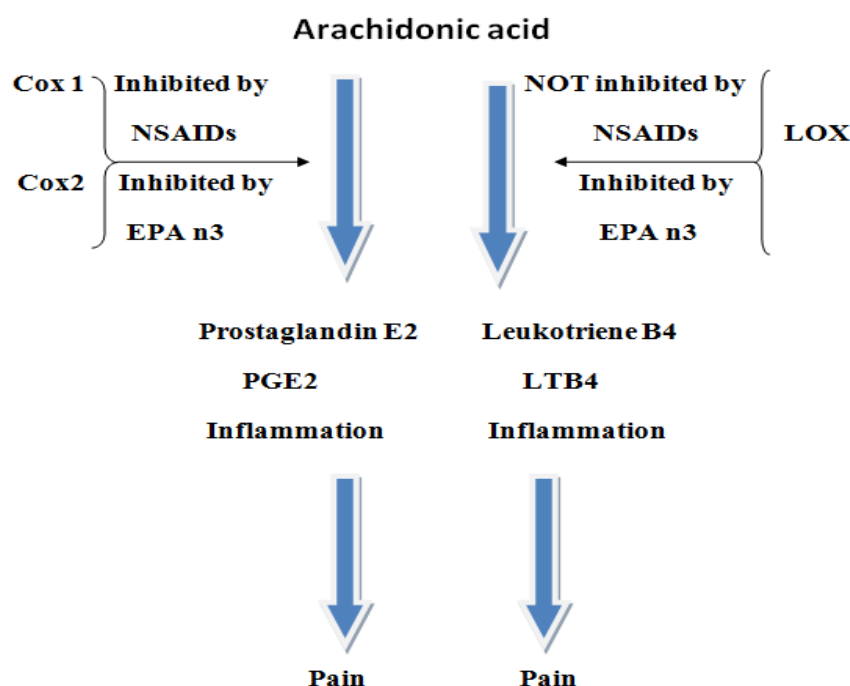
Many mechanisms have been suggested for the omega 3 fatty acid in antidepressant effect (Fig. 1). Such as: *First*, the function of omega 3 fatty acid in signal transduction is to regulate the dopaminergic and serotonergic neurotransmitter (14).

Second, the higher level of prostaglandins is related to mood disorder which is caused by inflammation. Prostaglandin E2 and leukotrienes are driven by arachidonic acid, prostaglandin is derived by cyclooxygenase (COX1&COX2) and leukotrienes are driven by lipoxygenase both resulted to produce inflammation and pain.

Non-steroid anti-inflammatory drug (NSAIDs) only inhibit prostaglandin E2 but don't inhibit the lipoxygenase pathway. This condition causes several problems such as bleeding, cell damage, and death. It is described that EPA as a reducer of prostaglandins E2 and leukotrienes significantly reduces the pain and inflammation (Figure 1) (15).

Table No. 1: Comparison of nutritional values per 100 gram of walnuts, pine nuts, and cashew nuts

Nutritional value	Walnut	Pine nut	Cashew
Saturated fatty acid	6g	4.9g	8g
Poly-unsaturated fatty acid	47g	34g	8g
Mono-unsaturated fatty acid	9g	19g	24g
Dietary fiber	7g	3.7g	3.3g
Carbohydrate	14g	13g	30g
Protein	15g	14g	18g
Potassium	491g	0.597g	0.66g
Iron	16g	30g	37g
Vitamin B6	25g	5g	20g
Magnesium	39g	62g	73g

**Figure 1:** Eicosapentaenoic acid and non-steroid anti-inflammatory drugs are inhibitors of inflammation.

2- Improves brain health and Alzheimer's disease

Alzheimer's disease is a neurodegenerative disease that results in loss of memory. Enzymes act on the APP (amyloid precursor protein) and cut it into fragments (Figure 2) by the β site cleavage enzyme 1 (BACE1), then plaque formation occurs (16). Plaques are found in the brain between the dying cells - from the build-up of a protein called beta-amyloid (the term "amyloid plaques"). The overproduction of β amyloid lead due to oxidative stress-free radical produces and cell death. Amyloid-beta fibril process is a multi-step that is produced by oligomerization and aggregation of monomeric then conformational changes occur in alpha-helical and beta-pleated sheet structure (17).

Mechanism

The mechanism of plaque formation causes cell damage and effects on neurotransmitter and brain size is shrinkage in Alzheimer's patients.

Antioxidation properties such as gamma tocopherol, melatonin, and phenolic contents are present in walnuts that significantly reduced the risk of brain disease (18). DHA has a more favorable effect on memory, improve brain health and reduce Alzheimer's disease. DHA (docosahexaenoic acid) increases the hippocampus region of the brain. (These regions more adversely effect in Alzheimer's disease) (19). When plaque formation occurs then DHA activates the glial cells, these cells secrete the cytokines and break the peptide bonds of amyloid plaque. Walnut can inhibit the fibrillization of amyloid-beta synthesis and also solubilize amyloid-beta fibrils. So, omega 3 (DHA) could also have a positive effect on Alzheimer's disease (20).

3- Heart disease

It is stated (21) that omega 3 fatty acids like DHA and EPA reduced the risk of hypertension, high cholesterol, and heart disease. Omega 3 fatty acids decrease the level of triglyceride in the body,

consequently, reducing the risk of heart attack and death (22). Low-density lipoproteins are a significant cause of atherosclerosis and cause other disorder such as genetic hyperlipidemias and other familial hypercholesterolemia (FRH) (23). The other several risk factors such as smoking, diabetes, and hypertension are also leading causes of atherosclerosis (24).

Mechanism

Five steps that are involved in this mechanism; (i) chronic endothelia injury, (ii) accumulation of lipoprotein, (iii) monocytes adhesion to the endothelia, (iv) platelet adhesion and (v) lipid accumulation. When a high amount of LDL present on the surface of the endothelial cells it

breaks the endothelial barrier and cross the surface where low-density lipoprotein becomes oxidized. When oxidized LDL came to contract with the arterial wall it damage and made deposits on the surface of intima which stimulated the monocytes to the intima. Macrophages in the tissues unable to degrade LDL which further attract the platelets and platelets release the platelet-derived growth factor (PDGF). The growth factors activate the smooth muscle cell. The high amount of lipid contains macrophages that are deposited in the surface of the intima and then plaque formation occurs (Figure 3). Omega 3 fatty acid can reduce LDL by increasing HDL in return (22).

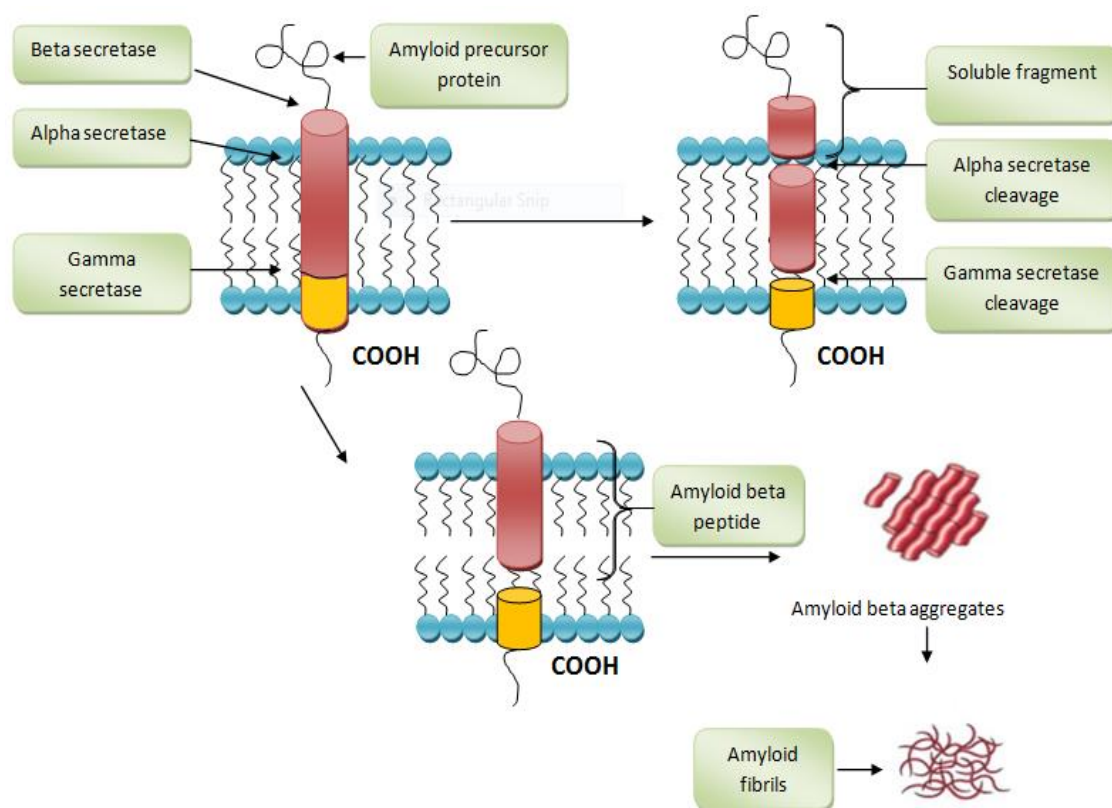


Figure 2: Enzymes act on the APP (amyloid precursor protein) and cut it into fragments. The beta-amyloid fragment is crucial in the formation of senile plaques in AD.

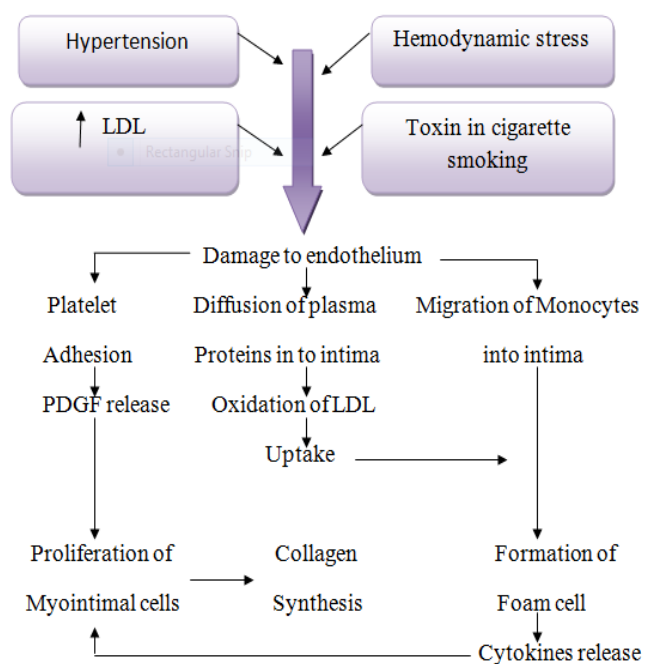


Figure 3: Mechanism of arterial plaque formation.

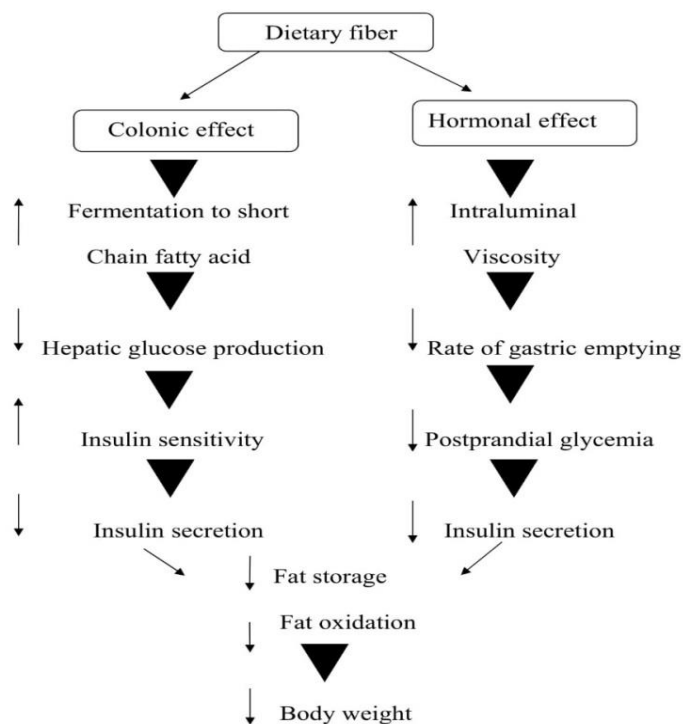


Figure 4: Mechanisms through which dietary fiber may aid in body weight regulation.

4-Weight maintenance

Fibers help to decrease the body weight by three mechanisms such as fiber displaces available calories and nutrients from the diet; fiber increases the chewing process and increase the level of secretion of saliva and gastric juice, and then satiety level increase; and fiber reduces the level of absorption in small intestine as described diagrammatically in figure 4 (25).

5- Skin protection

Skin is the most important organ in the human body that protects against chemical and mechanical stress, ultraviolet radiation and bacterial infections. The Anti-oxidant properties of Nuts are due to the presence of vitamin C (ascorbic acid), Vitamin E and other phytoconstituents and their role formation and maintenance of skin health by promoting the synthesis of collagen. Oresajo *et al*, (26) stated the Vitamin C as a cofactor for prolyl 3-hydroxylase 1 (P3H1) and lysyl hydroxylase enzymes catalyzed the cross-linking and stabilized the collagen fibers and collagen fibers ultimately stabilized the structure and function of the skin (27). Vitamin C stabilized the mRNA and increased the gene expression of collagen along with preventing the collagen degradation. Higher intake of Vitamin C decreased the risk of dryness of the skin; skin roughness and ascorbic acid also have an effect on the Trans-epidermal water loss (TEWL) (28). Environmental factors such as pollution and ozone depletion produce free radicals and damage the skin. Vitamin C provide anti-oxidation and anti-inflammatory properties that reduce the risk of free radical formation (29). Chen *et al*. (27) stated that oxidative stress occurs when high wavelength UV radiation passes through the skin. UVA (wavelength 320–400 nm) indirectly cause DNA mutation and UVB (280–310nm) are directly damaging DNA by generating reactive oxygen species (ROS) that are developing skin cancer. It is described by Tuong *et al*, (29) UV irradiation is produced pro-inflammation cytokines growth factor then activates the AP-1 and NF- κ B activation as described below. Increase the MMPs expression resulting in degraded collagen and elastin in the skin (30). Increase the productions of ROS effect on the TGF-B growth factor that cause degradation of the collagen synthesis and structural integrity of the skin. Oxidation stress produced aging, wrinkle and pigmentation. Anti-oxidation properties of Vitamin C protect the skin and synthesis of the collagen.

4- Hypertension, cell growth, and others

Potassium helps to regulate the body fluid, sugar level and maintain the blood pressure. Fluctuation, in potassium level, may cause hypertension by influencing the reabsorption capability of kidneys (31). As described by Stolarz-Skrzypek *et al*, (31) that potassium ion present in walnut is the most prevalent cation that has a significant role in normalizing the blood pressure by regulation blood volume.

Folate as coenzymes present in walnut are important for the synthesis of nucleic acid from the precursor of purine and thymidine. Three enzymes are involved in Thymidylate (dTMP) biosynthesis pathway: Dihydrofolate reductase (DHFR), serine hydroxymethyltransferase (SHMT), and Thymidylate synthase (TYMS). Pyridoxal 5 phosphate (PLP), a vitamin B6 coenzyme is required by serine hydroxymethyltransferase (SHMT) which use serine as a one carbon donor for the generation of 5, 10 methylenetetrahydrofolates from THF (32). The latter molecular is one carbon donor for the generation of dTMP from the dump by Thymidylate synthase.

Nutritional Status of Pine nut

Pine nut has a wide range of vitamins such as Vitamin B1, B2, Vitamin E, carotenoids; minerals like phosphorus, magnesium, iron, sulfur, potassium, copper, sodium, zinc, manganese and calcium; and essential macromolecules like carbohydrates, proteins, lipids for maintaining the body's normal health (33). Linoleic acid is more abundant form in pine nuts and is more favorable in maintaining the blood lipid, cholesterol, and blood pressure. It is described by Cabanillas *et al*, (33) that anti-oxidation and anti-inflammation properties are present in pine nuts that protect the brain and heart from many disorders.

Health benefits

Essential fatty acids present in pine nut that reduce the risk of heart diseases, pancreatic cancer and maintain the blood pressure and also maintain eye health. As described by Champagne *et al*, (34) high magnesium reduces the risk of high blood pressure, that high blood pressure causes negative effects in heart, kidney and another important organ in the body. Magnesium maintains the blood levels in veins and arteries. High fats deposit in blood vessels and made a plaque, due to plaque formation blood vessels may rupture. Pine nut is reducing the plaque formation that reduces the risk of cardiovascular disorders. Due to calcium arteries and veins muscles contracts normally. Deficiency of calcium cause muscles not to contract that cause high blood pressure and gradually hypertension.

1- Improves eye health

High energy light (blue light) have a negative effect on the retina which causes stress due to the formation of oxidative free radicals. Blue light causes damage to the photoreceptor and muscular degeneration. Two types of Carotenoids like Lutein and zeaxanthin carotenoids, present in pine nuts have anti-oxidant potential which reduces the muscular degeneration. Lutein reduced the inflammation in eyes by scavenging the free radical's body cannot synthesize these nutrients, so the body gets these nutrients through diet and supplement. Retinal pigment epithelium (RPE) transfers the LUT in the blood of eye by the xanthophyll-binding protein (XBP). And a large amount

of lutein present in pine nuts also protects the eyes by absorbing harmful blue light (35).

2- Lowers risk of pancreatic cancer

Magnesium present in pine nuts reduces the proliferation of cancer cells by reducing the acylation of DNA. Uncontrolled expression of Insulin-like growth factor (IGF) which causes pancreatic cancer but magnesium ions from the dietary sources influenced the expression of this growth factor. So, magnesium has a role to reduce the IGF level then cell proliferation is halted (36).

3- Nutritional status of Cashews

Cashews are a basis nutritional elements and most important role in the human body to cure the heart disease. The cashews (*Anacardium occidentale*) are a light color and kidney-shaped nuts. Cashews present in the antioxidant properties and work against the hearth disease and diabetes. The iron and copper are a help to blood cells, fats can inhibit diabetes, anti-oxidation properties can protect against cancer (37). Cashew nuts are made up of monounsaturated fatty acid (oleic acid) and a smaller quantity of polyunsaturated fatty acid (largely present in linoleic acid). Cashew reduces bad cholesterol and increase good cholesterol and help to decrease blood pressure (38). The high consumptions of plant food such as cashews reduce the risk of heart disease, obesity, and diabetes.

4- Bone metabolism

Cashews improve the bone metabolism due to the presence of mineral (potassium, magnesium, and calcium). Cashews are the rich form of vitamin K. Vitamin K a fat-soluble is needed for the post-translation modification of certain protein (39). Vitamin K1 (phylloquinone) is synthesized by plants and used for blood clotting and Vitamin K2 (menaquinone) produced by bacteria in the large intestine and improve bone metabolism. Osteoclasts present in the surface of the bone responsible for the breakdown of bone and Osteoblasts are responsible for the formation of bone. Osteoblasts and osteoclasts are involved in the repairing of bone. Nutritional diet maintains the bone if not intake the nutrition diet then ruptures the bone cell and causes the osteoporosis. Osteoporosis is a public health issue, especially postmenopausal woman. Osteoporosis patients increase the risk of cardiovascular diseases due to vascular calcification (40).

Calcium deposits in arteries and increase the risk of blood plasma, heart attack, aortic stenosis and ischemia of the lower limbs. Vitamin K maintains the bone structure, function and supports the mineralization. Vitamin K is essential for blood coagulation and regulating of bone metabolism (39). Vitamin K2 increases the activity of osteoblasts, modulates the target gene of bone mineralization in osteoblast (41) and induces the osteoclast apoptosis. Vitamin K is needed

for the chemical modification of certain protein the process is called carboxylation (42).

5- Lowers the risk of diabetes

Cashews have a great amount of monounsaturated fats and maintain the glucose level in the body. Kim *et al.* (43) stated that monounsaturated fatty acid takes beneficial foe type 2 diabetes mellitus and maintain the glucose level. The saturated fatty acid affects in enzyme activity, gene expression and glucose metabolism (44). The high amount of monounsaturated fatty acids and polyunsaturated fatty acids has an effect on lipogenic gene expression and binding nuclear receptor such as peroxisome proliferator-activated receptor. The free fatty acids played a significant role in glucose homeostatic. GPR40 and GPR120 are particularly effected in insulin secretion, and short chain fatty acid is activating the GPR41 and GPR43 (45). This receptor is a target for diabetes prevention and treatment.

6- Maintains healthy skin

The skin acts as a protective barrier against the environment and plays an impotent role to prevent infection and maintain the body temperature. Cashews acted as a high source of copper, which help to maintain the skin and hair color called melanin (46). Melanins are producing by melanocytes are only present in cuproenzyme called tyrosinase. Intake the copper can help to protect the skin eyes and hair color. Copper synthesize the plasma proteins, collagen, and myelin. Myelin sheath protects the neurons (46).

7- Prevention from cancer

Cashews are a good source of anti-oxidant compounds and prevent the body from free radicals. The free radicals cause oxidation stress and DNA damage so it may cause tumor formation. Cashews nut shell liquid having anacardic acid with anti-cancer and anti-oxidation properties (47). Anacardic acid acts as a mitochondrial decouple of oxidative phosphorylation and inhibition of histone acetyltransferase activity, this is because cancer cells not produce (48).

Conclusion

Dry fruits are natural nutritive sources rich in unsaturated fatty acid and other compound like protein, fiber, carbohydrate, and anti-oxidant compounds. Other nutritional compounds that are also present in nuts such as vitamins (e.g., tocopherols, niacin, folic acid, and vitamin B6), minerals (e.g., magnesium, potassium, calcium) and phenolic compounds. Nuts have been proposed as an important component of optimal diets that reduces the risk of cardiovascular diseases, hypertension, neurodegenerative disorders, bone demineralization, skin disorders, eyes diseases, and many other health-related issues. Dry fruits are a very important component of the human diet as it contains

very high nutritional values as well as biomedical important phytochemical constituents. This review article has described the nutritional and biomedical importance of components of cashew nut, pine nut, and walnuts.

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