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Review Article

Pharmacology and Medicinal uses of Quinoa

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Received Date: July 28, 2024 **Accepted Date**: August 20, 2024 **Published Date**: September 09, 2024.

Citation: Muhammad Akram, Fahad Said Khan, (2024), Pharmacology and Medicinal uses of Quinoa, *Clinical Research and Clinical Reports,* 4(5); **DOI:**10.31579/2835-8325/090

Abstract

Quinoa (Chenopodium quinoa) is a very nutritious pseudocereal that has sparked widespread interest due to its remarkable nutritional profile and potential health advantages. Quinoa, which was traditionally grown in the Andes, is now known around the world for its health-promoting and disease-prevention properties. This study tries to consolidate current understanding about quinoa's pharmacology and medical uses, with an emphasis on its bioactive components and therapeutic potential. The purpose of this review is to give a thorough analysis of quinoa's pharmacological qualities, including nutritional benefits, medicinal applications, and mechanisms of action. This review aims to emphasize the evidence that supports quinoa's function in health promotion and illness prevention, as well as to recommend areas for future research. A systematic review of the literature was conducted utilizing databases like PubMed, Scopus, and Web of Science. The papers were chosen for their relevance to the pharmacological qualities, medical uses, and health advantages of quinoa. Clinical and preclinical research publications were collected to provide a thorough review. The review identifies various important pharmacological and therapeutic properties of quinoa. Quinoa is high in important amino acids, fiber, vitamins (particularly vitamin B), and minerals (magnesium, iron, zinc). Its high protein content and low glycemic index make it useful for diet control and metabolic health. Quinoa includes potent antioxidants such flavonoids (quercetin and kaempferol) and saponins, which have been demonstrated to lower oxidative stress and inflammation.

Quinoa eating has been linked to a reduction in inflammation indicators, which may help with disorders including cardiovascular disease and arthritis. Quinoa has great pharmacological and therapeutic potential due to its high nutritional content and bioactive chemicals. Its antioxidant, anti-inflammatory, and glycemic management characteristics promote overall health and aid in the treatment of chronic disorders. More research is required to fully understand its mechanisms of action and possible therapeutic applications. Existing data supports quinoa's use as a functional food in health promotion and illness prevention, making it an important addition to dietary recommendations.

Key words: quinoa; pharmacology; therapeutic usage; antioxidant; anti-inflammatory; glycemic control; nutritional profile

Introduction

Malnutrition, food insecurity, and other health issues are prevalent in many parts of the world right now. (Headey et al.,2023) As a result, there is a need to find a superfood that can help with all of the aforementioned difficulties.

Quinoa has been recognized as a natural source of a variety of pharmacologically active chemicals, which are regarded as a free gift from God to humanity due to the abundance of biological components included in this plant. (MOUDJAHED et al.,2006) Chenopodium quinoa, an Amaranthaceae pseudo-cereal, has become famous in recent years due to its high nutritional value. It includes a high concentration of minerals, phenolic compounds, saponins, and antioxidants. Several investigations have been carried out to identify compounds of interest from quinoa with health advantages and nutritional value.This chapter discusses the quinoa plant's anti-ulcer, gastro-protective, anticardiovascular, and neuroprotective properties both in vitro and in vivo. Scientific research in this field shows that the plant has a wide range of applications in medicine and therapeutics.Quinoa (Chenopodium quinoa) is regarded as a superfood since it contains a good amount of complete protein, unsaturated fats, minerals, nutrients, fiber, and cell reinforcement. It is a pseudograin found in South America and belongs to the Chenopodiaceae family. Quinoa is available in drops, grains, and flours, as well as in products like as energy bars and noodles, and its grains can be cooked in boiling water.(Sezgin et al.,2019) Quinoa has been viewed as a comprehensive nourishment because of an assortment of nutrients, significant measurements of dietary fiber, proteins blooming, unsaturated fats, minerals, and outstanding parity of basic A.A. by the United Nations, and the year 2013 was designated as international quinoa year.Quinoa has grown and become popular all around the world in the last ten years. It has a similar supplement structure to seeds grass since the seed is too small to contemplate processing to isolate the quinoa anatomical elements that are remembered for the full grain class. (Valz et al.,2018) Despite its high bland starch content, quinoa is a good gluten protein source, but unlike oats, it contains a stable amino corrosive outlook; unsaturated fats, phytochemicals, and fibers support the use of quinoa as a gluten-free option when compared to basic grains. Cardiovascular diseases (CVD) continue to be the leading cause of morbidity and mortality around the world, including in China, accounting for approximately 33% of all deaths. (Chen et al.,2017) This review article discusses the activity of quinoa as an anti-ulcer agent, which is attributable to the presence of plant polysaccharides in it that exhibit a variety of biological actions. In particular,

arabinan and arabinan-rich pectic polysaccharides found in quinoa seeds have been demonstrated to have anti-ulcer and gastro-protective properties in various invivo and invitro experiments. Furthermore, clinical trials and advanced scientific research are required to improve the health benefits of quinoa. (Haspula et al.,2018) Special highlights were highlighted on the cardiovascular and neuroprotective properties of the quinoa plant.Some indigenous cultures in South America, including the Aymara, Quechua, Tiahuancota, Mapuche, and Chibcha, commonly used quinoa. Quinoa seeds can be extended into rice, organized into soup, or puffed for use as a breakfast grain. Quinoa leaves are edible in the same way that spinach is, and the matured quinoa seedlings were added to plates of mixed greens. Furthermore, quinoa seeds can be ripened to produce beer or a traditional styled mixed beverage known as "chicha" by South Americans. (Krogel et al.,2006) Every portion of quinoa has been used as a food source for domesticated animals such as cows, pigs, and chickens. (Schmidt et al.,2023)

Ingredients

Quinoa contains unique amino acids, carbohydrate, unsaturated fat, and micronutrient elements, making it an excellent supplement that consistently outperforms nutrients found in other grain products. Despite the fact that quinoa's phytochemicals and micronutrients play an important role in its biological applications. Furthermore, quinoa's auxiliary metabolic products may provide illness defense, supporting optimal health. Its seeds contain critical measures of bioactive mixes, comprising polyphenols (primarily phenolic acids, including vanillic acid, ferulic acid, and their subordinates, as well as flavonoids, comprising quercetin, kampferol, and their glycosides), tocopherols (Vitamin E), tocotrienols, and carotenoids.Previous research discovered that a bioactive ingredient in Quinoa can change cell reinforcement status in living beings by avoiding oxidative pressure and also reduces the risk of several chronic diseases, such as relaxing, immunomodulatory, and anti-carcinogenic. Quinoa has around 29 polyphenolic corrosive analogs. As indicated by the accompanying highlights, phenolic compounds can be classified as benzoic corrosive analogs and cinnamic corrosive analogs. Benzoic corrosive was derived from cinnamic corrosive in planta via the phenolic acid biosynthetic route. A higher concentration of phenolic acids indicated more grounded cell reinforcement and inhibition of -glucosidase and pancreatic lipase. Flavonoids have a fifteen-carbon structure composed of two benzene rings joined by a heterocyclic pyrene ring.

It demonstrates anticoagulant movement. Quinoa contains mostly monoterpenoids and triterpenoids, which are biosynthesized by the isoprenoid metabolic cycle. Monoterpenoids, for the most part, function as an Allechemical in Quinoa. Wheat's seed coat contains triterpenoids. They have a distinctive harsh or astringent taste to defend them against winged predators or creepy crawlies. They also have distinctive cleaning properties. Saponin Glycosides are a significant adjuvant, and saponin-containing antibodies are found in industry. These are chargeable for anti-provocation and antagonistic to hypercholesterolemia. They have metabolic as well as pharmacological effects on warm-blooded animals. According to carbon relativity, Quinoa Steroid is classified as C27-, C28-, and C29-steroids. A study revealed hypocholesterolemic movement. Quinoa has good dietary and restorative properties, and its gluten-free nature benefits a few vulnerable buyer populations, including children, the elderly, elite competitors, lactose-intolerant consumers, osteoporosis-prone women, and people suffering from weakness, diabetes, dyslipidemia, obesity, or celiac disease. The lipid-lowering benefits of quinoa have also been documented in humans. Consumption of quinoa grain bar for 30 days reduced triglyceride, low density lipoprotein cholesterol, and total cholesterol levels in twenty-two mature participants (18-45 years old). Corn, wheat, rice, grain, oat, rye, and sorghum are among the most important nutrients consumed by humans. Quinoa is more preferred than other grains due to its high protein, fat, and fiber content. The protein content of dryquinoa seeds ranges from 13.8% to 16.5%. In any case, it is accounted for at 15% overall. Quinoa's total protein content is higher in rice, rye, grain, corn, and wheat. The edibleness of protein or A.The bioavailability of quinoa varies according to the variety taken, and it improves significantly when cooked .In everyday life, the presence of dietary fiber in grains ranges from 7 to 9.7%, while solvent fiber content ranges from 1.3% to 6.1%. The sugar content of quinoa is approximately 3%. Mostly, galactose D, ribose D, and maltose cannot resist low levels of fructose and glucose. Quinoa's smooth texture is attributed to the quality and quantity of its lipid component. The oil content ranges from 2.0% to 9.5%, and it contains a lot of fundamental unsaturated fats such alpha linolenic and linolenic acid. In high fixations, cancer-prevention compounds such as tocopherol and alpha are present. Quinoa has 100 grams of riboflavin, which covers 80% of children's and 40% of adults' requirements. Different grains, such as wheat (1.8%) and rice (0.5%), have higher debris concentration than quinoa (3.4%). Quinoa seeds contain more nutrients. Iron and calcium concentrations are also higher than in other cereals. In addition to wheat and corn, quinoa seeds contain 0.26% magnesium. Because magnesium, potassium, and calcium in quinoa are contained in organically right structures, their quantities in seeds are considered adequate for an acceptable eating routine. (Kruger et al.,2003)

Phytochemicals

Thirteen cinnamic corrosive analogs have been identified from quinoa. Cinnamic corrosive subsidiaries include caffeic and chlorogenic corrosive ferulic corrosive, as well as their analogues, sinapinic corrosive, rosmarinic corrosive, cinnamic corrosive, coumaric corrosive, and ferulic corrosive. Ferulic corrosive and its associated subsidiary are very prevalent polyphenols identified in the binding structure of quinoa seeds. Cinnamic acid. In several studies, analogues have been shown to have neuroprotective effects. Quinoa produces four essential flavones: vitexin, orientin, isovitexin, and acacetin. Flavone levels were significantly higher in grows than in other types of quinoas. Quinoa grown in murky conditions contained a substantial level of isovitexin and vitexin. While those formed in light isovitexin is just present.It is remarkable that no isovitexin was found in quinoa seeds to exert neuroprotective effects. Vitexin sprouts and seeds are responsible for neuroprotective effects. Approximately 21 flavanols have been identified in quinoa. Quercetin and kaempferol are two significant flavonoids. They are glycosides found in quinoa that have been shown to have neuroprotective properties in numerous studies. Quinoa seeds contain three major flavanones: naringin, hesperidin, and neo-hesperidin. Quinoa sprouts contain both neo-hesperidin and hesperidin. Other plant species contain flavanones isolated from them, which have been tested for a variety of chemical activities, including neuroprotection. Meroterpenoids are common byproducts of blended biosynthetic roots that are partially derived from terpenoids. Each of the four tocopherols found in quinoa seeds has been identified, with - tocopherol being the most prevalent, followed by - tocopherol, - tocopherol, and - tocopherol being the least. They exhibit antioxidative, antihypercholesterolemic, anti-cancer, and neuroprotective properties. The principal c29 steroids found in quinoa include stigmasterol, sitosterol, avenasterol, and their subordinates. They are all detected in quinoa lipid concentrate. Several studies have found that they have a neuroprotective effect. (Molyneux et al.,2007)

Pharmacology

Quinoa has been demonstrated to protect against cyclophosphamide (CPA), a cardiotoxic medication that causes direct cardiac endothelial damage and devastation of myocardial cells, as seen by elevated blood lactate dehydrogenase, creatine kinase, and aspartate transaminase (AST) activities. Similarly, CPA is a hepatotoxic substance that is converted into a fatal metabolite (acrolein) that can compromise cell integrity and film penetrability of hepatocytes, resulting in the spillage of hepatic AST and alanine transferase into the circulatory system. Quinoa ethanolic extract (QEE) may be promising as a potential therapy in the prevention of cardiovascular dysfunction caused by chemical agents such as CPA. (Satoskar et al.,2020).

QEE exerts its effects through an antioxidant-dependent mechanism, scavenging free radicals and stabilizing membranes.

In vivo investigation demonstrates changes in CVD markers as a result of daily administration of quinoa as an enriched bread containing 20gm of quinoa per day in comparison to refined wheat bread for a 4-week period, using a randomized hybrid trial framework. The results showed that administering quinoa bread had no effect on metabolic parameters when compared to refined wheat bread. Despite a drop in LDL cholesterol (about

-5.7%) in similar inspections among individuals, quinoa treatment led in lower LDL cholesterol. Postprandial hyperglycemia is a key risk factor for CVD, leading to higher cardiovascular dysregulation and mortality in diabetes individuals. After incorporating two slices of quinoa bread into the individuals' dietary habits for half a year. It was discovered that diabetic patients had a significant drop in fasting blood glucose levels. As a result, quinoa will be an effective dietary supplement for the treatment of diabetes and other cardiometabolic conditions. Quinoa supplementation resulted in a significant drop in cholesterol levels in women but not in males. Similarly, glucose levels reduced significantly in male but not female participants. In the case of hepatic proteins, there was no significant difference in alanine transaminase results across sexes. However, aspartate transaminase activity decreased in both sexes. Triglyceride and urea levels were much lower in the female but not in the male. There was no significant difference in pulse or weight between the sexes before and after therapy.Quinoa-derived sugars with insoluble and dissolvable fibers may be considered nutraceuticals since they lower plasma glucose, triglyceride, and free fatty acid levels. The study found that quinoa can help manage cholesterol and glucose levels. Quinoa includes phenols, phytosterols, and flavonoids. These components are connected with quinoa-mediated glycemic and lipid reduction in patients. Consuming this grain may help to increase the creation of proteins that reinforce liver cells. The growth of these catalysts is associated with a reduction in the damaging effects of free radicals in the human body; it causes a decrease in endothelial dysfunction and oxidation of LDL-C particles, lowering the risk of vascular disease.Quinoa seeds, which have a saponin-rich coating, can be eaten whole or ground into flour for bread and pastries. Other quinoa plant components, including as the leaves and stems, can be utilized as feed. Quinoa seeds contain around 12 nitrogen metabolites, which include the subordinates glycine and tyrosine.Quinoa saponin has incredible potential and uses and may be employed in the pharmaceutical industry as well as to cause changes in intestinal penetrability, which might be advantageous for the ingestion of certain prescriptions and hypocholesterolemia. Truthfully, the neuroprotective effects of 20HE are attributed to the action of GABA receptors, and its hypocholesterolaemia activity is explained by its ability to convert normal cholesterol metabolism into bile corrosive. Previous research on the biological activities of phytoecdysteroids has been linked with increasing anti-diabetic, immunoregulatory, cholesterol-lowering, amelioration of liver and neurological damage, wound healing, energizer, and cell reinforcement activities.The key component and action of 20HE have yet to be identified. 20HE's neuroprotection is mediated by a GABA-dependent pathway, and its cholesterol-lowering properties are linked to its ability to convert cholesterol to bile acids. The importance of tocotrienols for human health in the form of nutritional and bioactive fragments has only recently received the attention and recognition it deserves. Tocotrienols have cholesterol-lowering, anti-malignant growth, and neuroprotective effects.According to current research, distinct pectic polysaccharides found in quinoa seeds are thought to operate as anti-ulcer and gastroprotective agents. These are arabinan and arabinan-rich polysaccharides that are extracted from the seed coat of the quinoa plant and used in ulcerogenic disorders.Sugar study of Chenopodium quinoa pectic polysaccharides found that arabinose, along with galactose and rhamnose, is the most abundant neutral monosaccharide in the seed coat. Further research indicates that arabinan comprises linearly organized α-L-arabinofuranosyl units. Other polysaccharides, such as arabinogalactan, acidic heteroxylan, and galactomannoglucan, have also demonstrated gastroprotective effects, according to several scientific studies. Out of the most regularly caused ulcers, ethanol-induced ulcers are mostly encountered; this type of gastric injury is usually due to disintegration of gastric mucosa, which activates histamine, pepsin, and also production of H+-ions, eventually leading to the creation of dispersed hemorrhagic patches in the stomach.This barrier generated by the mucus lining works as a protective barrier against acute attacks and stops the necrotizing agent from reaching the stomach mucosa.(Pablo et al.,2022)

Conclusion

This chapter have laid several emphases on the nutritive function of quinoa which could be ascribed to the presence of numerous componentsexisting in the quinoa plant.The neuroprotective and cardioprotective potential of quinoa has been documented during several *in vitro* and *in vivo*evaluation. The rich fiber content of quinoa has been shown to be beneficial for weight loss and represents a good supplement for the management of obesity and diabetes. This could be linked to the presence of pharmacologically active constituents that play a vital role towards effective reduction of the cholesterol level which substantiate the cardioprotective effect of quinoa.Moreover, quinoa also contains various phytochemicals which strengthen its neuroprotective capability. Also, it has been stated that quinoa plant has additionalnutritive components like proteins, vitamins and minerals which are the wellspring of vitality for the enhancement of human health. This chapter also established the pharmacological attributes of quinoa plant and their uncountable health benefits has portended then a super food that could play a crucial role toward rapid elimination of food insecurity and maintenance of human health. They application biotechnological techniques could also help towards the improvement of some of these biologically active constituents present in the quinoa plant using techniques such as genetic engineering, bioinformatics, genomics, proteomics and metabolomics.

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