Review Article

Nutraceutical Properties and Pharmaceutical Applications of Grain and Seeds: A Critical Review

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Abstract

Grains and seeds, provide not only the major portion of the energy for human populations throughout the world, but also plays an important role of nutritive and pharmaceutical carriers. These are filled with nutrients vitamins, proteins, minerals, fibers and essential trace elements which grows nutraceutical values and pharmaceutical applications. To increase the human health awareness, we must have to enlighten the importance of easily available seeds and grains in our food.

Keywords: Seeds, grains, nutraceuticals, pharmaceuticals

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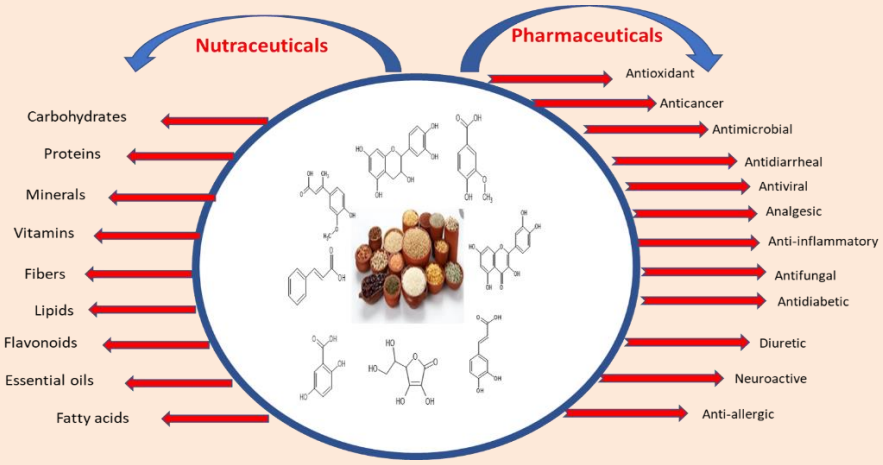

Introduction

Cereal grains provide nutritious food for people around the world. Food nutritive are essential to all living organisms for function, structure, and regulation of the body. People succeeding a plant-based diet need to find nonanimal sources of protein to ensure they are getting enough nutrients such as Vitamins, Proteins, Minerals, Fibers to prepare their body against diseases. Grains used as protein factories to assist the Nutraceuticals and Pharmaceuticals. Seeds and grains enrich in energy as well as factories of essential nutritive fatty acids, flavonoids, bioflavonoids, catechin, epicatechin, quercetin, caffeic acid, coumaric acids, cinnamic acids and many other useful compounds which are used in drug used for the treatment of diseases. Today's generation suffer from infectious, inflammatory, allergic, diabetic, carcinogenic and cardiovascular diseases. Nutraceuticals and drugs are the fastest growing area to cure diseases in humans and other diseases in animals. The production of nutritive elements for nutraceuticals and pharmaceutical applications are very important to save future [1].

Another application for plant-made pharmaceuticals is the production of vaccines. Subunit vaccines are made up of specific macromolecules that induce a protective immune response against a pathogen. Subunit vaccine technology has increased the safety of administering vaccines because it does not involve the use of live or weakened viruses. Currently, it is very expensive to produce subunit vaccines as well as to store them because they are not heat-stable. Because the vaccines are not heat-stable, this limit where they can be sent for use and unfortunately makes them unavailable in the developing countries where vaccines are needed the most. The seeds and grains-based pharmaceuticals are advantageous because the vaccinogenic plant tissue can be administered raw, dried, or in an encapsulated form; all of these forms can be stored and shipped at room temperature [2]. The risk of contamination with animal pathogens during production is also eliminated [3]. Another advantage of seeds-based vaccines can be stored as seeds are advantageous because large amounts of vaccines can be produced in limited time and storage is

less of an issue because the seed is a stable form that will not degrade the nutritive part for long time. The main aim of this review article is to describe the nutraceutical properties and pharmaceutical applications of grain and seeds.

Nutraceuticals Properties and Pharmaceutical Applications

Nutraceutical can be well-defined as a food or part of a food that deliver therapeutic and health aids, with the preclusion and treatment of a disease [4]. Nutraceutical is the hybrid of 'nutrition' and 'pharmaceutical' Nutraceuticals, in broad, are food or part of food playing a significant role in modifying and maintaining normal physiological function that maintains healthy human beings [5].

Ananga *et al*; 2017 [6] reported that grapes seeds show very nutritive values. Grape seeds contain bioactive metabolites (polyphenols), such as proanthocyanins, flavonoids (catechin, epicatechin and quercetin), and anthocyanins. They have non-flavonoids such as hydroxycinnamic acids (p-coumaric, cinnamic, caffeic, gentisic, ferulic and vanillic acids). Grape seeds also have hydroxy benzoic acids: trihydroxy stilbenes, resveratrol and polydatin. Nutraceuticals from grape seeds have cardio-protective, anti-cancer, antioxidant, anti-inflammatory, antiviral, hepatoprotective and antimicrobial properties.

Lin et al; 2019 [7] enlightened that Quinoa possesses a large number of secondary metabolites, such as phenolic acids, flavonoids, terpenoids, steroids, and nitrogen-containing compounds. These metabolites play various physiological and ecological roles. Quinoa is a whole grain that is rapidly growing in popularity due to its many health benefits. The proteins in quinoa offer a wide range of amino acids. Amino acids are vital for supporting muscle development and immune activity, among other essential functions. According to the Academy of Nutrition and Dietetics, consuming enough fiber can help reduce the risk of several health conditions, including constipation, high cholesterol, high blood pressure, and diverticulosis. Quinoa provides vitamin E. This is an antioxidant compound that may help reduce the risk of coronary heart disease, certain cancers, and several eye disorders. Quinoa contains the plant compounds quercetin and kaempferol. Kaempferol may help protect against infection, heart disease, diabetes, and several cancers, including those of the skin and liver and Quercetin may also help boost the body's defenses against infection and inflammation [8], recently [9] publish an article entitled 'Quercetin and Vitamin C: An Experimental, Synergistic Therapy for the Prevention and Treatment of SARS-CoV-2 Related Disease (COVID-19)' in this useful article they explained the role of Quercetin that it has been investigated for its possible antiviral effect and able to block SARS-Coronavirus entry into Vero E6 cells with a half-effective concentration (EC50) of 83.4 μM and with low cytotoxicity (CC50 3.32 mM).

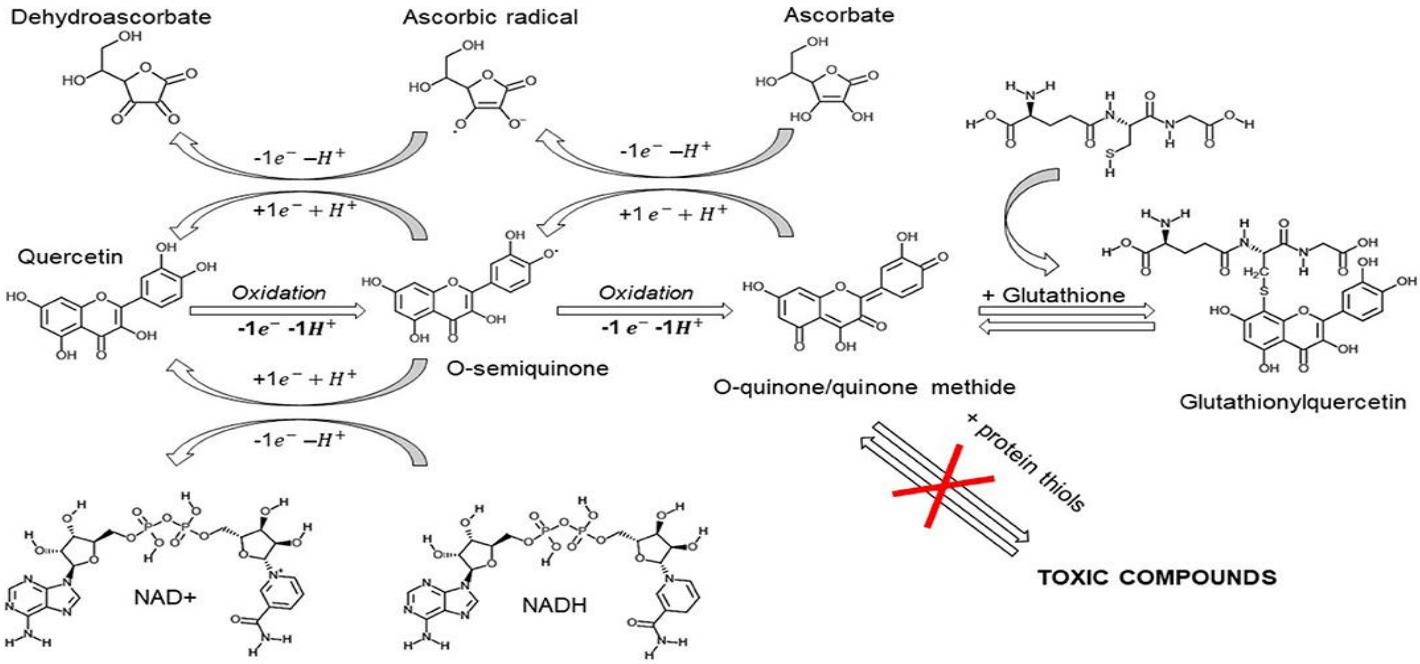

Figure 1. Mechanism shows the effectiveness of quercetin and ascorbic acid in prevention of SARS-CoV-2 Related Disease (COVID-19) [9].

'Food for life' is the health awareness newsletter which enlightened the era of nutritive values of seeds such as cereal grains (high in proteins, fibers, essential fatty acids and carbohydrates), Annato oil seeds (high in tocotrienol, a

form of vitamin E), Chia seeds (rich in omega-3 fatty acids), linseeds (linolenic acid, fiber, protein, thiamin, vitamin B6, manganese), sesame seeds (dietary fiber, protein, vitamin B, copper, manganese, calcium, and magnesium).

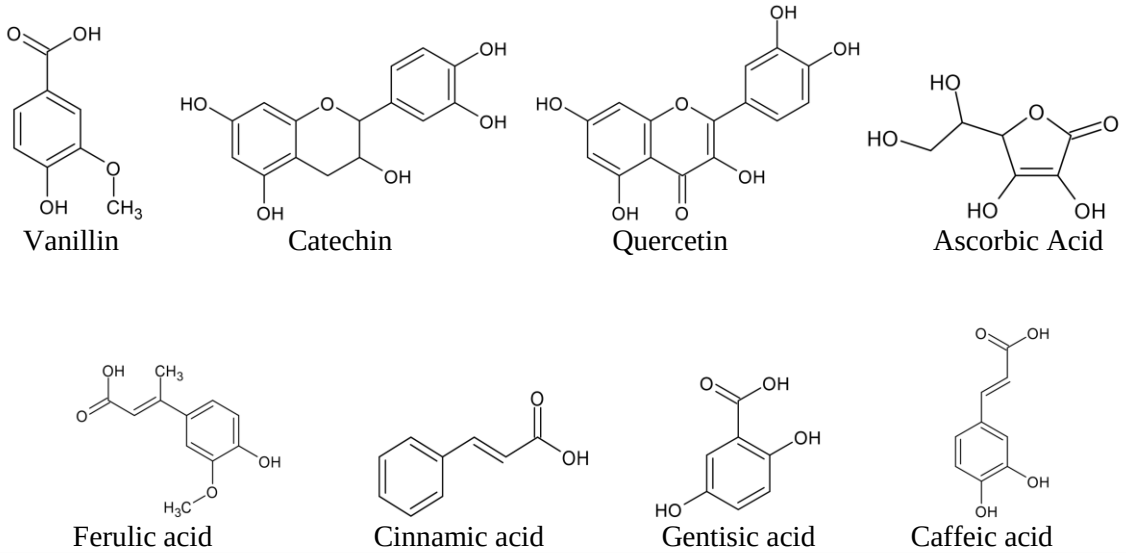

Figure 2. Chemical structures of some nutraceutical compounds.

In this modern era, crops are turning into factories which don't produce food but also participating in the production of monoclonal antibodies, drugs, vaccines and enzymes. For the production of protein which are pharmaceutical active firstly we have to synthesize/isolate the genes that are responsible for pharmaceutical proteins and transformation of those genes into the desired crops then transfer of those genes into the DNA of desired crops. Different plant species, an animal (a human being) or a bacterium can be the sources of these genes or transgene which are to be transferred into the desired host. The genetically modified crops are then cultivated, harvested and pharmaceutical protein produced by crop is extracted, purified and possibly modified prior it is given to humans or livestock. According to [2] in some cases crops are being engineered in this way that a vaccine can be delivered through the direct consumption of leaves, fruits or other plant parts, without extracting the proteins and delivering them via pills or injections. According to [10-13] now a day's scientists are focusing on genetic engineering of crops to increase the quantity and quality of protein as a means of quickly producing large quantities of drugs and vaccines, with the hope that this technology can reduce costs and increase the availability of much-needed pharmaceuticals.

Seeds provide advantages over these systems because they accumulate large amounts of protein in a relatively small volume and provide a stable environment that promotes protein assembly and inhibits degradation, thus facilitating long-term storage [13,14]. For example, antibodies accumulate at high levels in seeds and endure stable for several years with no loss of activity when preserved at room temperatures [15]. In practical terms, this means that cereal seeds containing pharmaceutical nutrients can be stored and disseminated in countries lacking a reliable cold chain. A relatively high protein concentration is achieved because most seeds are small and compact with a simple proteome, which also reduces the number of competing proteins released during processing. Seeds also tend to lack compounds such as phenolics and alkaloids, which are often found in leaves [16]. Cereals such as Rice (*Oryza sativa* L.), wheat (*Triticum vulgare*) and maize are pharmaceutical crops and the major staple food consumed by half of the world's population. Rice seeds have gained recent attention as bioreactors for the production of human pharmaceuticals such as therapeutic proteins or peptides. Rice seed production stages have beneficial over animal cell or microbe systems as it is more economic, scalable, safe and productive. Rice seed-based human pharmaceuticals are expected to become innovative therapies as edible drugs. Therapeutic proteins can be sequestered within natural cellular compartments in rice seeds and protected from harsh gastrointestinal environments [17]. A high nutritive value of maize [18] bound up a valuable book chapter which explains the nutritive agents of macro and micro quantity and their effective health benefits to protects diseases. Maize is a good source of b complex vitamins along with antioxidants such as different types of polyphenols [19].

It is remarkable to salute to oil seeds which are reach in poly unsaturated fatty acids, vitamin E, omega-3- fatty acids, flavonoids, other organic acids. Those important and valuable constituents play a bank agency role to cure multi health diseases and backbone in pharmaceutical industries. Prasad *et al*; 2012 [20] reported the nutritional and nutraceutical properties of Sesame oil seeds, and explained the role of sesame seeds as antioxidant, cardiovascular, regulator of blood pressure, dermatological agent and highly effective against Alzheimer's disease. Oilseeds are rich

in protein, and in addition they contain a high level of fat and essential fatty acids. Hence, they are also concentrated source of energy [21]. Oilseeds can be accompanied in the food products. Assimilation of oilseeds in minor amounts can be an effective measure in treating various ailments. Adding the routine diet with oilseeds will assuredly make us healthier [22].

Verado *et al*; 2015 [23] extracted and analysed that the pomegranate oil is a rich source of punicic acid, linoleic acid and oleic acid which signifies more effective health regulation such as kidney, heart, skin and nerve system. In addition, pomegranate seed oil was a good source of γ-tocopherol (from 616 to 2400 μg/g) which protects the body from harmful oxidizing compounds. Recently a review article published by [24] reported that seed oils are essential for human health due to highly enriched nutrients. Seed oils can be used in the Nano formulations to improve the nutraceutical values of these compounds for high efficacy.

Conclusion

The pharmaceutical and nutraceutical values of seeds to human health need to be essential areas of current research. Promised research should focus on potential effects of bewildering factors that may be correlated with the use of nutritive and medicinal values of seeds. This is because above cited data suggest that seeds have valuable applications in the prevention and treatment of several human diseases. Hence, it is important to explore not only bioavailability and chemical composition of seeds but also to characterize biological properties to determine the mechanism as well as their synergistic properties to ensure the nutrition values for human health and make ready to overcome from pandemic and steady diseases in future.

References

[1] K. K. Rogers. The potential of plant-made pharmaceuticals, (2003) published online.

[2] F. Sala, Rigano, M. M. Barbante, A., Basso, B., Walmsley, A. M., & Castiglione, S. Vaccine antigen production in transgenic plants: strategies, gene constructs and perspectives. Vaccine, (2003), 21(7-8): 803-808.

[3] A. M. Walmsley, C. J. Arntzen. Plants for delivery of edible vaccines. Current opinion in biotechnology, 2000, 11(2):126-129.

[4] J. P. A Da Costa. Current look at nutraceuticals–key concepts and future prospects. Trends in Food Science & Technology, 2017, 62: 68-78.

[5] Das, L., Bhaumik, E., Raychaudhuri, U., & Chakraborty, R. Role of nutraceuticals in human health. Journal of Food Science and Technology, 2012, 49(2):173–183.

[6] Ananga, A., Obuya, J., Ochieng, J., & Tsolova, V. Grape seed nutraceuticals for disease prevention: current status and future prospects. Phenolic Compounds–Biological Activity, 2017, 119-137.

[7] M. Lin, P. Han, Y. Li, W. Wang, D. Lai, L. Zhou. Quinoa secondary metabolites and their biological activities or functions. Molecules, 2019, 24(13):2512.

[8] L. Yao, J. Yao, C. Han, J. Yang, M. T. Chaudhry, S. Wang, Y. Yin. Quercetin. Inflammation and Immunity. Nutrients, 2016, 8:167.

[9] R. M. L Colunga Biancatelli, M. Berrill, J. D. Catravas, P. E. Marik. Quercetin and vitamin C: an experimental, synergistic therapy for the prevention and treatment of SARS-CoV-2 related disease (COVID-19). Frontiers in immunology, 2020, 11:1451.

[10] R. Fischer, E. Stoger, S. Schillberg, P. Christou, R. M. Twyman. Plant-based production of biopharmaceuticals. Current opinion in plant biology, 2004, 7(2):152-158.

[11] G. Giddings, G. Allison, D. Brooks, A. Carter. Transgenic plants as factories for biopharmaceuticals. Nature biotechnology, 2000, 18(11):1151-1155.

[12] M. E. Horn, S. L. Woodard, J. A. Howard. Plant molecular farming: systems and products. Plant cell reports, 2004, 22(10): 711-720.

[13] J. K. Ma, P. M. Drake, P. Christou. The production of recombinant pharmaceutical proteins in plants. Nature Reviews Genetics, 2003, 4(10):794-805.

[14] E. Stoger, J. K. Ma, R. Fischer, P. Christou. Sowing the seeds of success: pharmaceutical proteins from plants. Current Opinion in Biotechnology, 2005, 16(2):167-173.

[15] E. Stoger, C. Vaquero, E. Torres, M. Sack, L. Nicholson, J. Drossard, R. Fischer. Cereal crops as viable production and storage systems for pharmaceutical scFv antibodies. Plant molecular biology, 2000, 42(4), 583-590.

[16] S. C. Lourenço, M. M. Margarida, D. A. Vitor. "Antioxidants of natural plant origins: From sources to food industry applications." *Molecules*, 2019, 24(22): 4132.

[17] Y. Wakasa, F. Takaiwa. The use of rice seeds to produce human pharmaceuticals for oral therapy. Biotechnology Journal, 2013, 8(10):1133-1143.
[18] S. Bathla, M. Jaidka, R, Kaur. Nutritive Value. In Maize-Production and Use. Intech Open, (2019).
[19] L. X. Lopez-Martinez, R. M. Oliart-Ros, G. Valerio-Alfaro, C. H. Lee, K. L. Parkin, H. S. Garcia. Antioxidant activity, phenolic compounds and anthocyanins content of eighteen strains of Mexican maize. LWT-Food Science and Technology, 2009, 42(6):1187-1192.
[20] M. N. Prasad, K. R. Sanjay, D. S. Prasad, N. Vijay, R. Kothari, S. S. Nanjunda. A review on nutritional and nutraceutical properties of sesame. J Nutr Food Sci, 2012, 2(2), 1-6.
[21] J. Rohini, G. Kiran, S. Neerja. Oilseeds for better health. Seed, 2013, 14:2012.
[22] M. F. Sarwar, M. H. Sarwar, M. Sarwar, N. A. Qadri, S. Moghal. The role of oilseeds nutrition in human health: A critical review. Journal of Cereals and oilseeds, 2013, 4(8), 97-100.
[23] V. Verardo, P. Garcia-Salas, E. Baldi, A. Segura-Carretero, A. Fernandez-Gutierrez, M. F. Caboni. Pomegranate seeds as a source of nutraceutical oil naturally rich in bioactive lipids. Food Research International, 2014, 65:445-452.
[24] C. Vergallo, Nutraceutical Vegetable Oil Nano-formulations for Prevention and Management of Diseases. Nanomaterials, 2020, 10(6):1232.

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