ISSN : 2350-0743

www.ijramr.com

International Journal of Recent Advances in Multidisciplinary Research
Vol. 10, Issue 08, pp. 8645-8647, August, 2023

RESEARCH ARTICLE

RECOGNITION OF QUINOA AS COMPLETE PROTEIN: ESSENTIAL AMINO ACID CONTENT OF QUINOA

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ARTICLE INFO

Article History:
Received 18th May, 2023
Received in revised form
10th June, 2023
Accepted 26th July, 2023
Published online 15th August, 2023

Key Words:

Quinoa, Complete Protein, Essential Amino Acids, Biological Value and Protein Digestibility.

ABSTRACT

Quinoa is a type of edible seed that comes in various colours including black, red, yellow, and white. It is classified as a whole grain and is a good source of plant protein and fiber. Unlike some plant proteins, quinoa is a complete protein, it contains all nine essential amino acids that our bodies cannot make on their own. Quinoa is also naturally gluten-free and can be eaten safely if one has gluten intolerance. Quinoa is loaded with vitamins and minerals and contains more fiber and protein than most other grains. It is high in lysine, methionine, and cysteine, which are some of the amino acids that plant foods are frequently low in. Quinoa is also a great source of fiber which can prevent or treat constipation and may lower the risk of intestinal cancers. Regularly eating quinoa can help meeting our needs for magnesium, potassium, iron, fiber, and folate, a vitamin that's especially important. This study will provide the information aboutprotein content of quinoaand its balanced composition of amino acids compared to other grains.

INTRODUCTION

Small farmers and organisations currently produce almost all of the world's quinoa. From Colombia to the north of Argentina and the south of Chile, all of the Andean nations have quinoa as a natural crop. Bolivia, Peru, and the United States are the primary producers. Quinoa is grown in France, England, Sweden, Denmark, Holland, and Italy. Quinoa cultivation has no geographical bounds. It is grown in the fields of Ontario in Canada and in Colorado and Nevada in the United States. It has demonstrated great yields in Kenya, and the crop can also thrive in the Himalayas and the plains of northern India. (FAO 2013). Quinoa provides a substitute for those nations experiencing food insecurity when it comes to the problem of increasing the production of high-quality food to feed the world's population in the context of climate change.Therefore, the United Nations General Assembly has proclaimed 2013 as the "International Year of Quinoa" in honour of the Andean people's traditional ways of living in harmony with nature, which have allowed them to preserve quinoa in its natural state as food for the present and future generations (Bazile. D.*et, al.* 2013). Due to its ability to be grown in challenging climate circumstances as well as its nutritional and functional qualities, it has attracted increasing attention on a global scale.

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Quinoa plants can grow on poor soils and are tolerant of drought, salinity, and frost. Therefore, these traits are crucial for regions that frequently experience food insecurity. Due to this crop's exceptional ability to adapt to many environmental circumstances, interest in it has recently surged(Vidueiros S.M.*et.al,* 2015).

Protein and Amino acid content of Quinoa: Quinoa (Chenopodium quinoa Willd.), the 'mother grain' of the Andean peoples, contains gluten-free high-quality protein. The protein of quinoa seed is rich in essential amino acids, particularly methionine, threonine and lysine, which are the limiting amino acids in most cereal grains. For human and animal nutrition the quality of protein is determined by its biological value (BV), which serves as an indicator of protein intake by relating nitrogen uptake to nitrogen excretion. The highest values of BV correspond to proteins of whole egg (93.7%) and cow milk (84.5%).The protein of quinoa has a BV of 83%, which is higher than that of fish (76%), beef (74.3%), soybean (72.8%), wheat (64%), rice (64%) and corn (60%) proteins (Gonzalez *et al.,* 2012). Using the Near-Infrared Spectroscopy method, the total amount of seed storage proteins identified in the different quinoa varieties was estimated. The American variety had the highest value (18.39%), followed by the Wild Egyptian variety (17.16%). The Black variety had the lowest amount of seed storage protein (12.83%), followed by the Rainbow variety with 16.27% **(Ahmed F. *et al.,* 2022).**

These findings support earlier studies on the protein content of quinoa species. (Miranda *et al.* 2011; Nowak *et al.* 2016; Vega-Gálvez*et al.* 2010).The protein content in the grains of quinoa genotypes varied from 13.8 to 16.5%, with an average of 15% dry matter, which surpasses the same contents in wheat (14.8%) and barley (11.0%) (Filho *et al*. 2017).The major storage proteins of quinoa are albumins (35%) and globulins (37%), while the prolamins are present in low concentrations. The globulin 11S is called chenopodin and has become a reference source of leucine, isoleucine, phenylalanine, and tyrosine by the FAO (Hernández-Ledesma 2019).

Table 1. Amino acid composition of Quinoa protein isolate (g/100g protein)

Essential amino acids	g/100g	Non -Essential amino acid	g/100g
Histidine	2.76	Alanine	5.34
Leucine	4.60	Glycine	9.60
Isoleucine	1.30	Proline	0.10
Lysine	17.13	Serine	2.57
Methionine + cystine	1.70	Tyrosine	2.88
Phenylalanine + tyrosine	9.34	Glutamic	12.80
Threonine	1.47	Aspartic	8.54
Valine	2.03	Arginine	0.03

Source: S.A. Elsohaimy*et al.*, (2015).

These findings correspond to those of (Abugoch *et al.,* 2008), who found that quinoa has balanced essential amino acid levels comparable to those of soybean and a similar or high level of histidine, and (Ogungbenle *et al.,* 2009), who found that quinoa has balanced essential amino acid levels superior to those of most cereals such as maize, millet, and sorghum. Quinoa can make an excellent protein supplement, according to the results.

These foods are typically regarded as "complete" proteins. Whereas Quinoa being a plant source have high quality protein comparable to milk and egg, with essential amino acids that are not generally present in traditional cereals (Balakrishnan *et al.,* 2022). From a nutritional perspective, a protein's essential amino acids (EAA) are crucial because they have carbon skeletons that humans are unable to synthesise, so they must be obtained through diet. Because of this, the remaining non-essential amino acids are less crucial for growth and maintenance of metabolic requirements than the essential amino acids (Mota, 2016, WHO 2007). Quinoa has garnered attention as a protein source due to the high quality and balanced composition of amino acids content of its protein—superior to wheat, barley, and soybean. Because it is the main source of protein for rural inhabitants and fills the void left by the absence of animal protein, quinoa is valued as a food by Andean populations because of its high nutritional value. Quinoa is also promoted as a dairy-free replacement because of its high protein content and amino acid composition. The nutritional quality of the protein is determined by the proportion of essential amino acids, namely those that must be supplied in the diet because they cannot be synthesized by animals. The digestibility of the protein, the impact of antinutritional agents, and the proportion of tryptophan to neutral amino acids all affect the protein quality. Quinoa proteins have demonstrated good digestibility in animal feeding experiments, and as a result, 91.6% of proteins from raw seeds were absorbable, rising to 95.3% after heat treatment (cooking). The relatively low concentration of trypsin inhibitors in quinoa seeds, which prevent the enzymatic digestion and absorption of protein, contributes to the high protein's bioavailability.

Table 2. Protein and amino acid profile of ancient grains

Ancient Grains	Amaranth	Quinoa	Finger Millet	Foxtail Millet	Proso Millet	FAO/WHO Amino Acid Reference Pattern for Adults (g/100 g Protein)
Protein (g/100 g)	13.6	14.1	9.8	15.9	14.4	
Essential amino acids (g/100 g protein)						
Histidine	3.0	2.7	2.8	2.3	2.4	1.5
Isoleucine	3.9	3.1	5.2	5.1	4.9	3.0
Leucine	6.2	6	11.7	16.0	14.0	5.9
Lysine	5.7	4.8	3.1	1.9	1.7	4.5
Methionine+ Cystine	4.6	3.3	5.9	5.1	5.1	2.2
Phenylalanine + Tyrosine	5.4	6.3	10.3	10.0	10.8	3.8
Threonine	5.1	3.7	5.2	4.5	4.1	2.3
Tryptophan	0.9	0.9	1.3	1.1	0.6	0.6
Valine	5.9	3.7	8.2	6.3	6.4	3.9

Source: Balakrishnan, G. and Schneider, R.G.(2022).

One of the few plant foods that offers all essential amino acids in an amount sufficient for human life is quinoa. Quinoa protein can provide more than 180% of the daily recommended intake of essential amino acids for adult nutrition, per FAO/WHO recommendations (WHO 2007).

Recognition of the importance of Quinoa as a complete protein food: Humans primarily obtain their dietary protein from cereals, but because they typically lack one or more essential amino acids, plant proteins are known as incomplete proteins. Due to the presence of the essential amino acid's isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophane, and valine, quinoa is distinguished more by the quality of protein than the quantity (Vega-Galvez *et al.,* 2010; Escurido *et al.,* 2014). The nine essential amino acids are typically found in animal-derived proteins like milk and eggs, which are also known for having a high protein digestibility score.

Along with the amino acid composition, protein digestibility and absorption also play crucial roles in determining the nutritional quality of a particular product (Angeli, 2020). Aside from the rich amino acid composition, the protein digestibility of quinoa seeds (92%) were comparable to the milk protein casein (100%). The protein digestibility of raw millets also range between 70 and 78%, but it was found to improve significantly (88–92%) after cooking (Balakrishnan *et. al,* 2022). Because of the remarkable protein content and amino acid profile, NASA classified quinoa as an emerging crop with excellent nutritional properties for long-term human space missions. Unlike amaranth and quinoa, millets are deficient in lysine, but they are rich in vital amino acids such as methionine and cysteine that are absent in traditional cereals (Angeli, 2020). Besides the exceptional protein quality and quantity, bioactive peptides from ancient grain proteins have been shown to possess several key health benefits.

Bioactive peptides are a mixture of free amino acids and low molecular weight peptides of varying chain length (2–20 amino acid residues) released from the proteins due to the action of gastrointestinal enzymesunder physiological conditions. Smaller peptides are released from proteins due to the action of digestive enzymes such as pepsin, trypsin, chymotrypsin, and peptidases. Bioactive peptides have the tendency to regulate important physiological processes, and have different biological activities including antioxidant, antihypertensive, antidiabetic, antimicrobial, and hypocholesterolemic effects.

CONCLUSION

It might consume as a part of a balanced meal with many other food types to obtain overall good nutrition. Furthermore, Quinoa seeds contain proteins relatively less than legume seeds, but higher than other cereal grains like rice, It might consume as a part of a balanced meal with many other food types to obtain overall good nutrition. Furthermore, Quinoa seeds contain proteins relatively less than legume seeds, but higher than other cereal grains like rice The use of quinoa is of great nutritional interest owing to its composition. Quinoa has higher nutritional profile especially good protein content. Quinoa can be consumed as a part of balanced meal with many other food types to obtain overall good nutrition. Furthermore, Quinoa seed contain proteins relatively higher than other cereals and gains like rice, wheat, barley and amaranth. This composition and nutritional facts describe their potential for functional properties and human health. In the nutshell, quinoa holds potential to be utilized in cereal base products for best quality and value addition because of its functional properties. It can be considered as a promising crop for fighting global food insecurity and overcome hunger and undernourishment problems of different parts of the world, especially the developing countries like Asia and Africa where food production is threatened by global climate change.

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