



ISSN (E): 2277- 7695

ISSN (P): 2349-8242

NAAS Rating: 5.23

TPI 2021; SP-10(6): 82-86

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www.thepharmajournal.com

Received: 10-04-2021

Accepted: 12-05-2021

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Quinoa bar a novel food: A review

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Abstract

In recent years, the consumption of fast food and snack has increased, there has been increased trend for healthy food and functional food is at high rate. Due to change in lifestyle people move towards ready to eat foods like cereal bar that offers a fast, convenient food that require little preparation, having long self-life and no refrigeration. Cereals are the good source of carbohydrates, protein, fat, fibre, nutraceuticals and functional components. Quinoa is considered a pseudocereal having protein of high biological value, carbohydrates of low glycemic index, phytosteroids and omega-3 and 6 fatty acids that bring benefits to the human health. Several studies shows that the cereal bars can offers high concentration of protein, fibres, vitamins and minerals being a practical and convenient way to ingest nutrients considered essential for good functioning and thus preventing and controlling certain diseases such as malnutrition (children), obesity, celiac disease, CVD, cancer, diabetics. This review presents the nutritional composition and health benefits of cereal bar from quinoa that helps to make a good choice as it cater the several nutritional deficiencies in developing countries.

Keywords: quinoa, cereal bar, ready-to-eat, nutritional composition, health benefits

Introduction

Cereal bars introduced about a decade ago and represent an alternative food that is easy to consume while simultaneously possessing functional properties (Silva *et al.*, 2009) [45]. The category of snacks, defined as fast foods that can be eaten between main meals, is growing significantly in relation to other types of food products (Paiva, 2008) [38].

Several types of cereal bars are available, including high energy, high protein and high fibre bars. Moreover other snack bars like granola bar, chewy bar, crunchy bar, low-calorie bar, and diet bars and furthermore, bars with chocolate and bars with potentially functional additives such as probiotics are also available (Lobato *et al.*, 2011) [31]. Cereal bars are high in protein, bioactive compounds and is a major supplier of energy to every day and it can be eaten from the breakfast table to any time of the day (Dutcosky *et al.*, 2006) [14]. Thus, carefully designed nutritious bar could help in decreasing malnutrition problems and can provide an increased dietary intake of fibers, essential amino acids and other nutrients for developing countries.

The most recent research shows that the consumers are becoming more aware of the relationship between diet and diseases (Horn, 2006; Hollingsworth, 1997) [21, 22] and shift their food preference from animal-derived to plant-derived meals (Sloan, 1994) [46]. Cereals have been playing an important role in today's lifestyles for their various uses as ready-to-eat products, instant products, cereal bars and energy bars (Freitas and Moretti, 2006) [18]. Busy life styles and the increasing demand from consumers for meals and snacks that are quick sources of good nutrition have prompted the food industry to develop foods like nutrition bars that combine convenience and nutrition (Izzo and Niness, 2001) [24]. The diet based on whole grains are increasing day by day due to various health benefits as they are good source of dietary fibres, antioxidant and vitamins. Cereal are the good source of carbohydrates, protein, fat, fiber, nutraceuticals and functional components, but the protein content of cereals is deficient in essential amino acid, lysine. (Padmahree *et al.*, (2012).

The previous research demonstrated that the bar prepared from quinoa has significant impact on biochemical, anthropometric and blood pressure profile in persons which help in reduction of total cholesterol values, triglycerides and LDL-c, showing that the use of quinoa in food may be considered beneficial in the prevention of these risk factors related to cardiovascular diseases (Farinazzi-Machado *et al.*, 2012) [17].

Nutritional profile of quinoa

Quinoa (*Chenopodium quinoa* Willd.) is considered as complete food with high-nutritional

value due to its high content of good quality protein and the several studies have been made of their lipids, starch, minerals and saponin. Quinoa contain protein vary from 13.8% to 16.5% (Vega-Galvez *et al.* 2010) [47] with an average of 15%. Oil content in quinoa ranges from 2% to 9.5% being rich in essential fatty acids such as linoleic and α -linolenic, and contains high concentrations of natural antioxidants such as α - and γ -tocopherol (Maradini-Filho *et al.*, 2017) [32]. Quinoa contains about 10% of total dietary fibre (Lamothe *et al.*, 2015) [30]. In 1996, FAO catalogued quinoa as one of the most promising crops for the humanity, not only for its great properties but also considered an option to solve human nutrition problems (FAO, 2011) [16]. Quinoa which is considered a pseudo-cereal (Romero *et al.*, 1998) [40]. It has remarkable nutritional properties; not only from its protein content (15%) but also from its great amino acid balance (Sharma *et al.*, 2015) [43].

Quinoa contain good source of proteins with high biological value, carbohydrates with low glycemic index, vitamins (thiamine and vitamin E) and minerals (magnesium, potassium and zinc). Quinoa is also a rich source of phytosteroids, omega-3 and 6 fatty acids. In addition to these characteristics, it can also be consumed by people with celiac disease since it is gluten free. (Abugoch *et al.*, 2008; Abugoch, 2009; Ruales and Nair, 1994) [1, 2, 41]. Quinoa is not only as a good source of proteins and minerals but also as good source of antioxidants (Debski *et al.*, 2013) [12]. It has highest content of bioactive compounds compared to other cereals and pseudocereals. (Hirose *et al.*, 2010) [20].

Nutritional composition of quinoa bar

Protein

Kaur *et al.*, (2018) [28] developed gluten free cereal bar from quinoa and reported that the bar had 10.50% protein content. Padmashree *et al.*, (2018) [37] studied about the nutritional composition of coco-quinoa nutria bar. The bar had 14.43% crude protein. Choco quinoa nutri bar contained very good amounts of branched chain amino acids i.e isoleucine (688.80 mg/100g), leucine (892.10 mg/100g) and valine 530.40 mg/100g) and lysine (561.01 mg/100g). Bar showed 388.90 mg/100g of threonine and other essential amino acids were found between the ranges of 110 - 181 mg/100g. L-Aspartic acid was found in higher amounts (596.26 mg/100g) among the non-essential amino acids identified in the bar followed by L-Alanine (301.50 mg/100g) and L-Proline (308.40 mg/100g). L-Cysteine was found in a very meagre amount i.e., 30.01 mg/100g in the bar. Garg and Brar (2017) [19] reported the amino acid content of nutritious peanut bar and soy bar. The obtained pea nut bar had highest methionine (224.3 mg/100g) and cystine (35.51 mg/100g) content and soy bar contained 134.2 mg/100g of methionine and 28.76 mg/100g of cysteine content. Verma *et al.*, (2018) [48] developed sorghum based cereal bars. The bar prepared bar had highest value of protein i.e. about 24.09 to 25.97% on dry weight basis.

Carbohydrates

Padmahree *et al.*, (2012) reported the nutritional composition of composite cereal bar. The bar had 30.6% total sugar and 16.9% carbohydrate. The snack bar with high soy protein and isoflavones had 14.30% of carbohydrates and no-fibre (Lobato *et al.*, 2011) [31]. The cereal bars developed from cereals had high value of carbohydrates ranging from 51.07 to 55.59gm/100gm, due to high amount of cereals and both

glucose and invert sugar (Covino *et al.*, 2015) [10]. The proximate composition of developed flaxoat nutty bar had 46.15% total sugar and 16.73% carbohydrate (Padmashree *et al.*, 2013) [36].

Fatty acid

Shinde *et al.*, (2019) [44] developed energy bar using flax-seeds and studied about the chemical composition of bar. The prepared bar had 26.6% fat. It flaxseed has rich source of omega-3 fatty acids. Mridula *et al.*, (2011) [34] prepared omega-3 rich energy bar. The bar had omega-3 as alpha-linolenic acid content of about 22.50% on fatty acid basis. Eke-Ejiofor and Okoye (2019) prepared cereal bar based on cereal and nuts and carried out nutritional evaluation of bar. The bar had Fat content ranged from 23.27 to 29.38%. Lipid profile showed a significant difference in the control and the newly developed cereal bars in terms of essential fatty acids (EFA). The highest linoleic acid content was found in millet bar with 4% and the lowest in white maize bar with 2.11%. Eicosarienoic acid and docosahexanoic acid had 6.51 and 11.68% respectively with millet bar as the highest. Oleic and erucic acids content ranged from 1.64 to 11.68% and from 3.11 to 20.47% with the control having the highest values in both cases. Paula *et al.*, (2013) [39] developed cereal bar enriched with dietary fibre and omega 3 fatty acid by incorporation of linseed and its flour. The prepared bar had 11.3 to 15.5gm/100gm fatty acid which is higher than control. The concentration of α -linolenic fatty acid (ω -3) increased from 0.30 to 4.4gm/100gm and the linoleic fatty acid (ω -6) reduced from 3.9 to 2.6gm/100gm.

Vitamins and Minerals

Padmashree *et al.*, (2013) [36] prepared flaxoat nutty bar from flax and oats. The bar had 7.29 mg/100g of vitamin C, 0.4 mg/100g of vitamin B1 and 0.21 mg/100g of vitamin B2. The corresponding vitamin values after fortification of flaxoat nutty bar were 28.73, 0.72 and 1.08 mg/100g respectively. Padmahree *et al.*, (2012) reported the nutritional composition of composite cereal bar. They found that the bar had 4.1 mg/100 g of vitamin C, 0.05 mg/100 g of Vitamin B₁ and 0.08 mg/100 g of Vitamin B₂ respectively. The bar was fortified with vitamins to increase the content of vitamin as per guided by RDA. Ahmad *et al.*, (2017) [3] prepared high energy cereal and nut granola bar. The prepared bar had highest value of Zn (2.49 mg), Fe (3.54 mg), Mg (97.87 mg), Mn (3.73 mg) and Ca (15.00 mg). Alla and Jithendran (2018) [4] developed nutri bar enriched with zinc using pumpkin seeds. The bar showed high content of Zinc value 1.663 mg/100gm. Sobana (2018) prepared millet based composite sports bar. The bar had calcium content 159.5mg and iron content 2.93mg per 100gm. Eke-Ejiofor and Okoye (2019) prepared cereal bar from cereal and nuts and carried out mineral analysis. The results showed that the oat bar had potassium and magnesium ranged from 10.08 to 18.94mg/kg and 12.88 to 22.82mg/kg respectively, comparing with control has the highest values in both cases. White maize bar had Phosphorus and zinc ranged from 5.70 to 8.01mg/kg and from 6.17 to 12.32mg/kg respectively, which is highest comparing with control and guinea corn bar has the lowest in both cases. The calcium content ranged from 38.47 to 59.93mg/kg in millet bar as the highest and yellow maize bar as the lowest.

Dietary fibres

Shinde *et al.*, (2019) [44] reported the average value of crude

fibre of flaxseed based energy bar of about 8.9% per 100gm. Lobato *et al.*, 2011^[31] prepared soy snack bar and carried out nutritional evaluation of bar. The bar had high amount of dietary fibre i.e. 9.88 g/100 g. The cereal bar prepared by incorporation of pineapple peel had high crude fibre levels ranging from 2.02 to 3.39% due to the incorporation of pineapple peel flour (Damasceno *et al.*, 2016)^[11]. The flax-seeds date bar had Maximum value for crude fibre (9.89/100g) was observed in bar containing 20g flaxseed flour (Mohammed and Ingle 2015)^[6]. The bar prepared by incorporation of linseed and its flour increase the total dietary fibres from 4.7 to 12.8g/100gm. (Paula *et al.*, 2013)^[39].

Energy value

Yadav and bhatnagar (2016)^[50] prepared cereal bar with defatted soy flour. The results obtained revealed that the bar having defatted soy flour had highest value of energy value (440.37 ± 0.19 kcal/100g). The bar prepared from puffed cereals provided 386.6 Kcal of energy/100g (Mogarkar and Morable 2018)^[33]. The cereal bar prepared from two varieties of sorghum which are HC308 and HJ513 had energy values of 452.30 and 453.25kcal/100gm respectively (Verma *et al.*, 2018)^[48].

Therapeutic benefits of quinoa bar

Gluten free diet for celiac patient

Zevallos *et al.*, (2014)^[51] conducted study on 19 celiac patients who consumed 50 g/day of quinoa for 6 weeks as part of their usual gluten-free diet. The results showed a positive trend toward improved histological parameters (the ratio of villus height to crypt depth improved from slightly below normal values 2.8:1 to normal levels 3:1, surface-enterocyte cell height improved from 28.76 µm to 29.77 µm and the number of intraepithelial lymphocytes per 100 enterocytes decreased from 30.3 to 29.7 and serum total cholesterol. They concluded that consumption of quinoa as part of their diet was well-tolerated and did not exacerbate the clinical presentation of celiac disease.

Another study revealed that quinoa grain was free of gluten and the bar prepared from quinoa and all other ingredients was consumed by celiac disease patients. (Jancurova *et al.*, 2009)^[25].

Berti *et al.*, (2005)^[7] conducted study on 15, 14 and 12 healthy male volunteers, who participated in bread, pasta and in quinoa study, consumed GI food containing quinoa. The results showed that quinoa represented a potential alternative for celiac patients. In addition, the consumption of quinoa products suggested that quinoa induced a lower desire to eat and higher fullness and satiety sensation.

Hypocholesterolemic effect

Farinazzi-Machado *et al.*, (2012)^[17] conducted study to investigate the effects of quinoa on the biochemical and anthropometric profile and blood pressure in humans, parameters for measuring risk of cardiovascular diseases. The study was carried out on 22 students having age between 18 and 45, were treated daily with quinoa in the form of a cereal bar for 30 days. The result showed that reductions in levels of total cholesterol, triglycerides, and LDL-c. It was concluded that the use of quinoa in diet can be considered beneficial in the prevention and treatment of risk factors related to cardiovascular diseases. This is due to its vitamin E content, polyphenols, phytosterols and flavonoids, compounds that have an antioxidant capacity and may be related to the

reduction of plasma lipids found in these individuals.

However, in another study that conducted on double-blind human clinical trial among 35 post-menopausal women with excess weight. The women consumed 25 g quinoa flakes per day for 4 weeks. The results showed that after consumption of quinoa flakes there was significant reduction in serum triglycerides, a tendency of reduced total cholesterol and LDL and increased glutathione (GSH, a marker of antioxidant defense) (Carvalho *et al.*, 2014)^[13].

Navarro-Perez *et al.*, (2017) conducted randomized clinical trials on 50 overweight and obese participants over a 12 week to investigate the effect of 25 and 50 g quinoa consumption per day. The results showed that serum triglyceride (TG) level was reduced in the 50gm quinoa group from 1.14 to 0.72 mmol/L at 12 week and metabolic syndrome (MetS) was also reduced by 70% in the same group. The MetS was reduced by 40% in the 25gm group.

Another study revealed that higher concentrations of plasma betaine were associated also with lower non-HDL cholesterol, Triglycerides, homocysteine and markers of inflammation. (Ross *et al.*, 2011).

Prevent type 2 diabetes

The study conducted to investigate the effect of low glycemic index diet on 210 diabetic for 6 months, who consumed diet with low GI containing quinoa. The patients were divided into 2 groups (high cereal fibre diet or low GI diet). The study showed that the greater decrease of Hemoglobin A1c (HbA1c) in the low GI diet (-0.50%) and HDL-C increased in the low glycemic index diet group by 1.7 mg/dl. It was concluded that quinoa in diet helps to prevent type 2 diabetes (Jenkins *et al.*, 2008)^[26].

Ruiz *et al.*, (2017) conducted study on 30 pre-diabetic patient which were divided in two study arms: Kuska Active product (processed quinoa) and placebo (maltodextrin) with an intake period of 28 days. BMI, HbA1c and FPG were determined before and after treatment of 28-day intake. The results obtained that, the quinoa group shows a significant decrease in BMI and HbA1c values and an increase in the satiation and fullness (complete) degree and maintains FPG levels in pre-diabetic patients

The study conducted on 30 healthy adults who consumed Macaroni and cheese dish prepared with quinoa flour for up to 28 days, the results showed that the significant Increase of the peak glycemic response following meal ingestion. (Johnston *et al.*, 2017)^[27].

Child growth and development

Ruales *et al.*, (2002) carried out childhood nutrition study among boys aged 50-60 months from Ecuador. The Child fed with 200gm quinoa porridge or beverage per day. The results showed that significant increased plasma IGF-1 levels in infant who consumed quinoa porridge, but the IGF-1 levels remain unchanged in control group. IGF-1 is hepatic peptide that promotes growth, increasing body weight and bone length. IGF-1 has been suggested as a marker of malnutrition or a measure of response to nutritional therapy. They also observed that the quinoa porridge consumption group were attributed to the complete essential amino acid profile and it has high digestibility (95.3%). This research also indicates that porridge derived from quinoa provides good protein and other essential nutrients which helps in reducing child malnutrition.

Reduce obesity

Faucault *et al.*, (2012) conducted short period experiment on rats. The rats was ingested with quinoa extracts rich in 20-hydroxy ecdysone with diet induced obesity. They observed the beneficial effects of quinoa extracts on fat mass. The results indicated that extracts acts by reducing fatty acid uptake and esterification in adipocyte.

Conclusion

In this paper, we reviewed the nutritional composition of bar prepared from quinoa along with their therapeutic benefits. Recently the nutritious energy bars have gained more importance and popularity in the global market. The market is flooded with cereal and fruit bars of high protein, high energy, high fibre values but there is wide scope for further nutrient enrichment of bar through addition of other essential nutrient rich ingredients. This will not only provide health benefits but also cater the several nutritional deficiencies in the developing countries. To provide more and more 'busy' consumers with a choice of healthy and processed or ready-to-eat food is one of the major challenges for food processors.

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