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Effect of Malting on Nutritional and Anti-nutritional Properties of Quinoa (*Chenopodium quinoa*)

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ABSTRACT: The purpose of this study was to assess the effect of soaking and germination on nutritional composition, anti-nutritional factor, mineral content of quinoa grains. During the soaking and germination period increased the protein and fibre content from 14.3±0.02 to 17.4±0.02 % and 4.69±0.02 to 5.02±0.06 %, respectively. Reduced the tannin, phytic acid, and saponin content from 0.048 % to 0.024%, 1.15 % to 0.65% and 0.84% to 0.42% respectively. The anti-nutritional factors reduced during washing and soaking quinoa grains. Germinated quinoa grains produced rich protein and fibre content. Germination is a simple way for reducing phytic acid in quinoa and may also improve its nutritional quality, making it suitable for use in functional foods, bakery items, infant food, and vegetarian diets. This study shows that within which soaking and germination time period quinoa grains sprouts early and can be used quickly.

Keywords: Soaking, germination, pseudocereal, nutritional, antinutritional properties, mineral content.

INTRODUCTION

These possible health advantages led to the development of new dietary recommendations that promote the frequent eating of whole grains in the diet. (Nowak *et al*., 2016). Quinoa is referred to as a pseudo-cereal since, while not being a member of the gramineae family, its seeds may be ground into flour and utilized as a cereal grain. Additionally, quinoa seeds can be fermented to create "chicha," a traditional ceremonial beverage used frequently in South America (Navruz-Varli and Sanlier 2016).

Quinoa outperforms other cereals in terms of dietary fiber, lipids, vitamin B1, vitamin B2, vitamin B6, vitamin C, and vitamin E, as well as minerals like calcium, iron, phosphorus, and zinc. This grain is excellent for the manufacturing and manufacturing of "gluten-free" products because it lacks gliadins and protein fractions that correspond to gliadins, which are present in rye, barley, oats, and malt and are suited to give healthy and nourishing meals for people with celiac disease (Tang *et al*., 2015).

The process by which inactive tissue becomes active tissue involves water penetration, which starts with soaking. In this stage, the metabolic of the grain is turned on in order to prepare it for sprouting (Maisont and Narkrugsa 2010). Additionally, soaking and germination of grains and legumes were observed to reduce the activity of trypsin inhibitors and oligosaccharides that cause flatulence (such as stachyose and raffinose), boosting the digestibility of nutrients and enhancing sensory qualities (Zanabria *et al*., 2006; Osman, 2007).

Germination is a simple and efficient method for increasing the availability of nutrients, reducing the anti-nutritional elements present in cereal grains and legumes, and increasing the amounts of some of the more usable nutrient content (Inyang and Zakare 2008; Maisont and Narkrugsa 2010). (Gupta and Sehgal 1991) as a result of soaking and germination, the phytic acid level of cereal grains used to prepare weaning foods has decreased. Ascorbic acid, riboflavin, choline, thiamine, tocopherols, and nicotinic acid are all abundant in germinated seeds (Sangronis and Machado 2007).

The generally used conventional approach of germination boosts the bioactive components, lowers some antinutritional elements, and increases the digestion of minerals in pulses. Additionally, it increases the content of beneficial substances like flavonoids, reducing power, and total phenolic components and these alterations can vary based on the type of seed used and the germination circumstances. During germination, the sugars stachyose and raffinose, which are typically thought to be the causes of flatulence, decrease (Sangronis and Machado 2007). By removing anti-nutritional elements like phytic acid, tannins, and saponins that are responsible for the binding of macro and micronutrients that are not absorbed by our body, soaking and germination also boost the bioavailability of minerals (Thakur *et al*., 2021).

MATERIALS AND METHODS

Materials. The quinoa seeds used in the present study was procured from Seed Technology Research Unit,

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Treatments. For soaking, quinoa seeds were soaked in tap water for 4, 8 & 12 hr with a ratio 1:5 (w/v) and soaked water changed after every 8 hr at the end of soaking period the soaked water was discarded. The grains were rinsed twice with tap water and dried in cabinet dryer at 65-70°C. The dried malted grains were grinded using mixer grinder and sieved to the obtained particle size of 80 mesh (BSS).

Proximate composition, mineral composition and antinutritional properties analysis. Determination of moisture, protein, fat, ash, carbohydrates, and crude fibre content of the quinoa seeds treatments were determined according to the methods of (AOAC, 2000). Total carbohydrate was calculated by the difference methods.

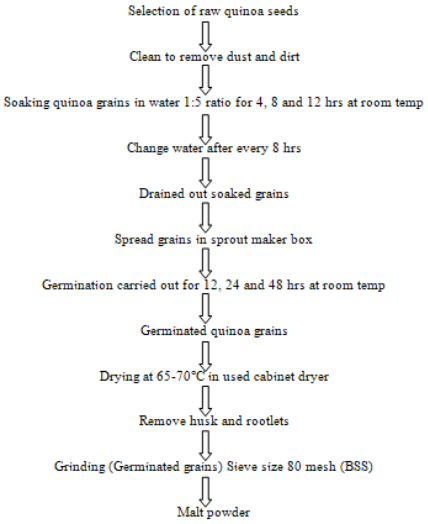
Mineral analysis. The conventional procedure specified by Association of Official Chemists was used for mineral content analysis of the samples (AOAC, 2005). Calcium (Ca), magnesium (Mg), potassium (K), podium (Na), iron (Fe), manganese (Mn) and zinc (Zn) were determined using Atomic Absorption Spectrophotometer (PERKIN – ELMER, 2380) in ppm, all values were expressed.

Determination of saponins. Take 5g of quinoa grains flour was put into 250 ml conical flask and 100 ml of 20% aqueous ethanol was added. The mixture was cooked to a temperature of 55°C over a hot water bath for 4 hours while being constantly stirred. The mixture was strained, the residual was once again extracted, this time using 100 ml of 20% aqueous ethanol, and it was heated for 4 hours at a steady 55°C while being stirred continuously. A 90°C water bath was used to dilute the combined extraction to 40 ml. Transferring the concentrate into a 250 ml separator funnel, 20 ml of diethyl ether was added, and the mixture was violently shaken. While the ether layer was discarded, the saponin-containing aqueous layer was recovered. There were two rounds of cleansing. The butanol extract was twice rinsed with 10 ml of 5% sodium chloride before 60 ml of n-butanol was added. The residual solution was heated in a water bath for 30 minutes after which it was transferred to a crucible and dried in an oven to a consistent weight. The sodium chloride layer was then removed (Obdoni and Ochuko 2001).

Determination of tannin. Utilizing an insoluble substance called Polyvinyl polypirrolidone (PVPP), which binds tannins as explained by Makkar *et al.* (1993). In a nutshell, 100 mg of PVPP were combined with 1 ml of extract dissolved in methanol (1 mg/ml), in which the total phenolics were measured. The mixture was vortexes, left at 4°C for 15 minutes, and then centrifuged for 10 minutes at 3,000 rpm. The non-tannin phenolics in the clear supernatant were calculated in the same manner as the total phenolics. The difference between the total and non-tannic phenolic content was used to compute the tannin content.

Determination of phytic acid. Elegantly ground (40 mesh) sample was taken into a erlenmeyer flask, then in sample 50ml 3% TCA was added and swirled by mechanical shaking for 30 min, then the suspension was centrifuged and 10 ml of aliquot was transferred to 40 ml conical centrifuge tube. Following the addition of 4ml FeQb to an aliquot, the mixture was boiled in boiling water for 45 minutes. Once the supernatant had been removed, 1-2 drops of 3% sodium sulphate in 3% TCA were added to continue the heating. Carefully decanted the clear supernatant after centrifuge. After this precipitate was washed twice with water and thoroughly dissolved in 20–25 ml of 3% TCA, it was rinsed again with a few ml of water and 3 ml of 1.5N NaOH was added. After heating the volume to 30 ml for 30 minutes, the sample was run through whatman No. 2 after washing the precipitate with 60–70 ml of hot water, the filtrate was discarded. After the precipitate from the paper was dissolved in 40 ml of hot, 3.2 N HNOs into a 100 ml volumetric flask, the flask was cooled and then diluted with water. The paper was then washed several times with water and the washings were collected in it. Then, an aliquot of 5 ml was transferred to a 100 ml volumetric flask, diluted to 70 ml, and 20 ml of 1.5M KSCN was added. The color was then read at 480 nm (Wheeler and Ferrel 1971).

Preparation of quinoa malt



RESULTS AND DISCUSSION

It is a complete food with high nutritional value, mainly due to its high content of good quality protein. Protein content ranges from 13.8 to 16.5 per cent with an average 15 per cent (Koziol, 1992, Ogungbenle, 2003 and Kousalya 2019). The composition of moisture content is dehulled (12.61%), protein content (18.95 g), fat (5.44 g), fiber (2.73 g), ash (2.25 g), carbohydrate (57.99 g) and energy (356.81 Kcal). These findings are comparable to the results reported by Chauhan and Sarita (2018); Beniwal *et al*. (2019); (Valencia *et al*., 2010; Milovanovic, 2014) Showed that the 11.52 per cent and 10.1 per cent of moisture content in quinoa grains. Quinoa protein quantity and consistency are usually superior to those of other cereal grains, thus providing high digestibility and gluten free properties. Dehulled grains represents the highest protein content as it was stored in embryo and also may be due to the removal of the saponins, other anti-nutrient (Chukwuma *et al*., 2016; Bhathal *et al*., 2017).

Table 1: Nutritional, anti-nutritional and mineral composition of quinoa seeds.

Parameters	Value
Moisture (%)	10.3±0.10
Protein (%)	14.3±0.02
Fat (%)	6.22±0.02
Carbohydrates (%)	60.0±0.04
Ash (%)	4.60±0.44
Fibre (%)	4.69±0.02
Tannin (mg/100g)	0.048±0.02
Saponin (g/100g)	0.84±0.02
Phytic acid (mg/100g)	1.15±0.20
Calcium (mg/kg)	58.4±0.15
Iron (mg/kg)	14.6±0.17
Zinc (mg/kg)	4.71±0.03
Phosphorus (mg/kg)	470±0.10
Potassium (mg/kg)	1180±0.20
Magnesium (mg/kg)	121±2.00

*Each value in an average of three determinations

Table 1 revealed the nutritional composition such as moisture, protein, fat, carbohydrates, ash and fibre of quinoa seeds. The quinoa seeds had 10.3±0.10 moisture, 14.3±0.02 protein, 6.22±0.02 fat, 60.0±0.04 carbohydrates, 4.60±0.44 ash and 4.69±0.02 fibre. Similar results for nutritional composition of quinoa seeds were reported by (Maradini-filho, 2017; Galvez *et al*., 2010). Determined and analysed antinutritional factor of such as tannin, saponin and phytic acid of quinoa seeds. The quinoa seeds had tannin 0.048±0.02 (mg/100g), saponin 0.84±0.02 (g/100g), phytic acid 1.15±0.20 (mg/100g). Similar results for anti-nutritional composition of quinoa seeds were assessed the (Padmashree *et al*., 2019). Found that the noted results analysed mineral composition quinoa seeds such as calcium, iron, zinc, phosphorus, potassium and magnesium of quinoa seeds. The quinnoa seeds had calcium, iron, zinc, phosphorus, potassium, magnesium. The similar results for mineral composition of quinoa seeds were evaluated (Miranda *et al.*, 2010)

Table 2: Effect of malting characteristics on nutritional composition of quinoa seeds.

Sample	Run	Nutrients %					
		Moisture	Fat	Protein	Carbohydrates	Ash	Fibre
Quinoa malt powder	T_0	10.3±0.10	6.22±0.02	14.3±0.02	60.0±0.04	4.60±0.44	4.69±0.02
	T_1	9.83±0.02	6.13±0.01	16.4±0.20	57.6±0.03	4.42±0.02	4.74±0.02
	T_2	9.68±0.01	6.08±0.01	17.2±0.10	57.5±0.03	4.35±0.03	4.81±0.02
	T_3	8.40±0.02	5.88±0.01	17.5±0.10	57.3±0.02	4.33±0.02	4.84±0.02
	T_4	9.63±0.01	6.00±0.07	16.3±0.02	56.7±0.01	3.97±0.01	4.86±0.01
	T_5	9.33±0.02	6.01±0.02	16.4±0.02	56.5±0.03	3.87±0.01	4.88±0.02
	T_6	8.44±0.06	5.97±0.02	16.6±0.01	56.3±0.01	3.76±0.02	4.91±0.03
	T_7	8.14±0.13	5.95±0.06	16.9±0.02	55.7±0.01	3.74±0.02	4.93±0.01
	T_8	8.09±0.09	5.87±0.01	17.4±0.02	55.4±0.04	3.61±0.01	4.17±0.02
	T_9	8.02±0.06	5.62±0.02	17.4±0.02	55.1±0.04	3.49±0.01	5.02±0.06

*Each value in an average of three determinations

$T_{1=}$ 4 hr soaking & 12 hr germination, T_2= 4 hr soaking & 24 hr germination, T_3= 4 hr soaking & 48 hr germination T_4= 8 hr soaking & 12 hr germination, T_5= 8 hr soaking & 24 hr germination, T_6= 8hr soaking & 48 hr germination, T_7= 12 hr soaking & 12 hr germination, T_8= 12 hr soaking & 24 hr germination, T_9= 12 hr soaking & 48 hr germination.

Germination changes the nutritional composition of quinoa grains with the different soaking and germination period. Hence the nutritional composition such as moisture, fat, protein, carbohydrates, ash and fibre content were investigated after soaking and germination of quinoa grains and obtained results were presented in Table 2. The moisture content of quinoa seeds was found to be reduced from 10.3±0.10 % to 8.02±0.06, due to the drying. The protein content of quinoa seeds were increased on germination period. Fat content of quinoa seeds was reduced on germination period. The quinoa seeds was analysed for fat content and found reduced from 6.22±0.02 to 5.62±0.02 %. The protein content increased during the germination period of quinoa grains. The protein content in germinated quinoa was found from 14.3±0.02 to 17.4±0.02 %. The carbohydrates content was decreased on soaking and germination period found results from 60.0±0.04 to 55.1±0.04 %. The ash content in quinoa grains was found to be decreased on germination results from 4.60±0.44 to 3.49±0.01 %. The reduced ash content represents loss in mineral due to the rootlets and washing of quinoa grains. The fibre content of quinoa grains increased during the soaking and germination period. Analysed from 4.69±0.02 to 5.02±0.06 %. The results obtained for the nutritional composition of quinoa grains were similar to the results reported by (Padmashree *et al*., 2019).

In quinoa grains the tannin content decreased represented in Table 3 from 0.048 % resulting in a 0.024% reduction in tannin content after the soaking and germination of grains results are similar with the Modgil and Sood (2017). Moreover new complex components are also formed and some losses are also due to the decreased phytic acid and saponin content after during soaking, washing and germination. The results obtained in present study similarly, the phytic acid and saponin content reduced significantly 1.05 % to 0.65% and 0.64% to 0.42% respectively with the results reported by Demir and Bilgicli (2020); Ruales and Nair (1993).

Table 3: Effect of malting characteristics on anti-nutritional components of quinoa seeds.

Sample	Run	Antinutrients %		
		Tannin (%)	Saponin (%)	Phytic acid 9%)
	T_0	0.048 ±0.02	0.84±0.02	1.15±0.20
Quinoa malt powder	T_1	0.043±0.002	0.64±0.02	1.05±0.02
	T_2	0.042±0.001	0.62±0.01	0.95±0.03
	T_3	0.039±0.002	0.60±0.01	0.85±0.01
	T_4	0.036±0.002	0.58±0.01	0.80±0.02
	T_5	0.033±0.002	0.54±0.02	0.81±0.02
	T_6	0.031±0.002	0.51±0.02	0.78±0.02
	T_7	0.029±0.001	0.50±0.02	0.76±0.01
	T_8	0.027±0.002	0.46±0.01	0.69±0.02
	T_9	0.024±0.002	0.42±0.02	0.65±0.02

*Each value in an average of three determinations

$T_{1=}$ 4 hr soaking & 12 hr germination, T_2= 4 hr soaking & 24 hr germination, T_3= 4 hr soaking & 48 hr germination T_4= 8 hr soaking & 12 hr germination, T_5= 8 hr soaking & 24 hr germination, T_6= 8hr soaking & 48 hr germination, T_7= 12 hr soaking & 12 hr germination, T_8= 12 hr soaking & 24 hr germination, T_9= 12 hr soaking & 48 hr germination.

CONCLUSION

The present investigation was planned with the study effect of soaking and germination period increased protein and fibre content but it decreased the antinutritional properties (saponnin, tannin and phytic acid) and improved nutritional value also bioavailability of minerals (Ca and zinc) and protein digestibility.

FUTURE SCOPE

Now a days peoples demands for gluten-free diet is an absolute necessity and quinoa is certified gluten free grains. The quinoa malt utilized for making different functional food products, infants food products. Quinoa malt can be used to make beer, ceremonial alcoholic beverages, and bakery items (cookies, breads, biscuits, noodles). Salads have been made with germinated quinoa seedlings (quinoa sprouts).

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Conflict of Interest. None.

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