Research Paper

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Effect of Germination on Nutrient Composition of Gluten free Quinoa (*Chenopodium Quinoa*)

Food Science

KEYWORDS : Quinoa, Germination, Gluten free, Nutrient composition.

Simran Bhathal Department of Food and Nutrition, PAU, Ludhiana

Navjot Kaur Department of Food and Nutrition, PAU, Ludhiana

ABSTRACT

Quinoa is a treasure trove of nutrients. Germination of quinoa was done to see its effect on sensory attributes as well as nutrient composition. Sprouted salad prepared from quinoa was highly acceptable. Moisture, ash, crude fibre, carbohydrates, lysine, tryptophan, methionine, calcium, magnesium, iron and zinc content as well as neutral detergent fibre and acid detergent fibre content was reported to be incresed in sprouted quinoa as compared to control quinoa.

INTRODUCTION

There are a growing number of individuals diagnosed with food allergies and intolerances. Gluten is avoided in celiac disease, gluten intolerance, and gluten ataxia. Gluten-free cereals and pseudo cereals such as amaranth, buckwheat, corn, millet, rice, sorghum and quinoa can be excellent sources of vitamins, minerals, fiber and other important nutrients.

Quinoa was called the mother grain by the Incas in Andes region of ancient South America where it originated. It is small seed which looks like a cross between sesame seeds and millets and it is unrelated to grain family. Quinoa is exceptionally high in protein and quality. Unlike conventional grains such as wheat, rice and corn which are low in lysine quinoa contains a balanced set of essential amino acids making it a complete protein source among plant foods. It is known to reduce bad cholesterol in body and raise good cholesterol due to its omega -3 and 6 fat content. It is a rich source of vitamins and mineral and also found to contain compounds like polyphenols, phytoestrol, phyoestrogens and flavonoids. Quinoa is a good functional foods that helps to lower the risk of various diseases (Khosla, 2014).

Germination activates its natural enzymes, improves its vitamin status and softens the grain. Several nutritive factors such as vitamin concentrations and bioavailability of trace elements and minerals increase during germination. Interestingly quinoa has short germination period of 4-5 hours in comparison to other grains which require at least 12-14 hours germination process overnight. Germination of quinoa has enhances the nutrient content and reduce antinutritional factors like saponoins.

Quinoa can be added to salads, desserts or even can be used to thicken the soups. Sprouting the quinoa can be used for the preparation of various breakfast dishes and nutritious salads (Mehta, 2014).

MATERIALS AND METHODS

SAMPLE SELECTION AND PREPARATION

The samples of quinoa were procured from the local market. Germination of quinoa was done by soaking the seeds of quinoa for half an hour and after that seeds were put in the sprout maker for 4-5 hours to complete its germination process. After that sprouted salad was prepared in which control sample was prepared from whole green gram *dal* and test sample was prepared from quinoa. The developed product was organolepticaly evaluated using nine point hedonic rating scale by a trained panel of 10 judges from Department of Food and Nutrition, College of Home Science, Punjab Agricultural University, Ludhiana. The judges were served salad with one control and one experimental sample. The samples were coded as C and S_1 to avoid any bias. The samples were then weighed, homogenised and oven dried at 60^0C. Dried samples were stored in air tight plastic bags for further nutritional evaluation.

PROXIMATE ANALYSIS

Samples were analysed for their proximate contents using (AOAC 2000) method.

AMINO ACID CONTENT

The amino acid content of samples was done. Three amino acids were studied i.e. tryptophan estimation by using Concon (1975) method and methionine estimation by Horn *et al.* (1946) method. The estimation of available lysine (Carpenter, 1960 modified by Booth, 1971) was done.

MINERAL CONTENT (AOAC 2000)

Minerals like calcium, iron, magnesium and zinc content of samples were estimated by atomic absorption spectrophotometer.

FIBER FRACTIONS

The samples were estimated for neutral detergent fibre and acid detergent fibre by Goering and Van Soest (1970) method.

STATISTICAL ANALYSIS

All determinations were carried out in triplicate and results were expressed as mean ± standard error. To test the significant difference between the control and experimental samples two tail t – test was applied using SPSS 16 software.

RESULTS AND DISCUSSIONS

Organoleptic evaluation

The control sprouted salad (C) was prepared from green gram *dal* and test sample (S_1) was prepared from sprouted quinoa grain. The results in the Table 1 revealed that the test sample have higher scores than the control for different quality attributes. The mean scores for appearance, colour, texture, flavour and taste of control sprouted salad were significantly lower i.e. 7.50, 7.60, 7.30, 7.50 and 7.50 than that of test sample i.e. 8.20, 8.10, 7.90, 8.10 and 8.10. A significant difference was found in all parameters. The mean scores of overall acceptability of test sprouted salad i.e. 8.08 were significantly higher than the control sprouted salad i.e. 7.48 due to its appearance, flavour and taste. Valencia (2003) stated that the quinoa seeds can be ground and used as flour or sprouted. The sprouts need to get green before they can be added to salads.

Table 1 Organoleptic evaluation (Mean±SE)

Product	Appearance	Colour	Texture	Flavour	Taste	Overall acceptability
C	7.50±0.17	7.60±0.16	7.30±0.15	7.50±0.17	7.50±0.22	7.48±0.11
S_1	8.20±0.13	8.10±0.10	7.90±0.10	8.10±0.10	8.10±0.10	8.08±0.08
t-value	3.28**	2.61*	3.29**	3.09**	2.45*	4.25**

*Significant at 5% level
**Significant at 1% level
C - Sprouted whole green gram
S_1 - Sprouted quinoa

Proximate composition
Sprouted salad
The proximate composition of the control sample (C) and test sample (S_1) of sprouted salad on dry matter basis is given in the Table 2. The moisture content of 3.48 percent was observed in control sprouted salad prepared from green gram while the test sprouted salad which was prepared from sprouted quinoa contain significantly more moisture of 3.72%. The crude protein of test and control sample was 7.51 and 11.98percent, respectively. The control sample contains more protein because the green gram is pulse and pulses contain more protein than cereals and pseudocereals.

Table 2 Proximate composition of developed product using sprouted quinoa (on dry weight basis)

Product	Moisture (%)	Crude protein (%)	Crude fat (%)	Ash (%)	Crude fibre (%)	Carbo-hydrate (%)	Energy (Kcal)
Sprouted salad							
C	3.48±0.06	11.98±0.58	0.45±0.06	1.22±0.06	0.82±0.01	82.05±0.67	380
S_1	3.72±0.05	7.51±0.05	1.45±0.05	1.30±0.05	4.54±0.06	84.48±0.09	381
t-value	2.94*	7.70**	12.25**	0.93^{NS}	12.41**	4.21*	1.03^{NS}

Values are Mean±SE
NS- Non-significant
*Significant at 5% level
**Significant at 1% level

The crude fat and fibre of test sample i.e. 1.45 and 4.54 percent, respectively was significantly higher than that of control sprouted salad in which crude fat was 0.45 and 0.82 percent, respectively. A non-significant difference was found in the ash content of test sprouted salad and control sprouted salad. The ash content in control sprouted salad was 1.22 and 1.30 percent was in test sample. The carbohydrate content was observed in control as 82.05 percent and test sprouted salad with 84.48 percent. A non-significant difference was found in the energy content of test sprouted salad and control sprouted salad. The energy content of test sprouted salad was 381 Kcal and control sample contain 380 Kcal. After germination there is a decrease in the caloric content of the seed. Hence, the nutrient-energy ratio of some vitamins is higher than in the original seed (De Ruiz, 1990).

Amino acid content
The result of amino acid content of salad which is developed from sprouted quinoa and control prepared from sprouted *moong dal* (C) is presented in the Fig 1. The results revealed that the test sprouted salad (S_1) contain lysine, tryptophan and methionin content of 2.08, 0.32 and 0.72g/100g protein, respectively which was significantly higher than the control sprouted salad (C) that had lysine content of 0.60, 0.10 and 0.18g/100g protein, respectively.

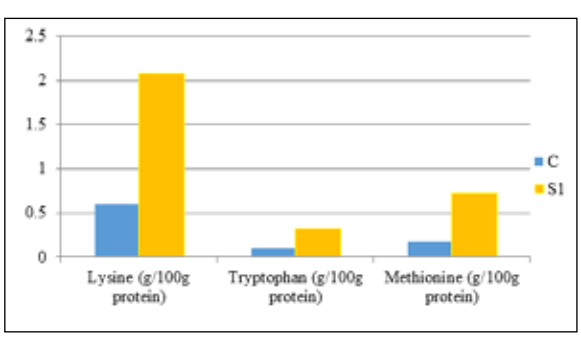

Fig 1. Amino acid content of sprouted quinoa (g/100g protein on dry weight basis)

Mineral content
Sprouted salad
The results of mineral content of the control (C) and test sample (S_1) of sprouted salad revealed that calcium content of 52.78mg was observed in control sprouted salad while the test sprouted salad contains non-significantly higher calcium content of 53.87mg than control. The iron content in test sprouted salad 1.75mg was significantly higher than control sprouted salad 1.49mg. The magnesium content of test sprouted salad 52.50mg was significantly higher than the magnesium content of control 34.50mg. The zinc content of test sprouted salad with 1.13mg was significantly higher than the control with 0.80mg. Quinoa may be germinated in its raw form to boost its nutritional value. Germination activates its natural enzymes and multiplies its vitamin and mineral content. In fact, quinoa has a notably short germination period. Raw quinoa germs are very suitable to be added to salads and other cold foods.

Enrichment of various essential trace elements during germination of wheat (*Triticum aestivum*), buckwheat (*Fagopyrum esculentum*), and quinoa (*Chenopodium quinoa*) seeds in order to improve their nutritional role as a source of bioavailable trace elements was studied. The time-dependent uptake for most elements was characterized by a significant absorption during soaking of the seeds followed by a lag phase during the first day of germination and an increased uptake during the second and third day (Lintschinger, 1997).

Fibre fractions
Sprouted salad
The neutral detergent fibre and acid detergent fibre content of test sprouted salad 66.70 and 25.90 percent, respectively was found to be significantly higher than control sprouted salad with neutral detergent fibre 13.20 percent and acid detergent fibre content 22.90 percent. Germination can be used to improve the sensory and nutritional properties of cereal and pseudocereal grains. Oat and quinoa malts were produced and incorporated in a rice and potato based gluten free formulation. Germination of oat led to a drastic increase of α- amylase activity from 0.3 to 48 U/g, and minor increases in proteolytic and lipolytic activities (Makinen, 2013).

CONCLUSION
Germination is use to naturally fortify and enrich gluten free foods and has great potential. It was concluded that the sprouting practice increases the nutrient content. The fiber fractions amino acids, mineral content were found to be increased. Therefore, sprouting practice can be boon for celiac patients and spouting of quinoa can be incorporated into various food products to enhance its nutritional importance. Although there are many benefits to germinated seeds in food, more research must be done to improve texture and sensory properties to gain wider consumer acceptance.

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