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Effect of processing on the nutritional composition of Chia and Quinoa seeds

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Abstract

The nutritional value of minor crops seeds varies widely depending on the type of crop and variety of seeds. Generally, these seeds are a good source of dietary fibre, protein, vitamins, minerals, and healthy fats. In recent times, chia seeds and quinoa seeds gained popularity due to high nutritional profile. They are a good source of fibre, protein, as well as containing many beneficial minerals such as calcium, iron, magnesium, and phosphorus. In this study analysis of nutritional composition of raw and processed chia and quinoa seeds has been carried out. The proximate analysis evident the germinated chia showed significant increase in crude fibre (32.15%) and protein (18.15%) content. Quinoa during roasting showed significant increase in crude fat (7.69%) and protein (11.94%) content. It is inferred from the results that pre-treatment help in enhancing the nutritional profile of chia and quinoa seeds. While unprocessed seeds of quinoa showed the maximum content of mineral as compared to the processed seeds.

Key words: chia seeds, quinoa seeds, processed, proximate analysis, minerals.

Chia seeds or *Salvia hispanica* belongs to Lamiaceae family. It is a biannual herbaceous plant majorly cultivated in Mexico and Guatemala Ahmed *et al*. (1994) Chia seeds contain approximately 5.80 % moisture, 16.54% protein, 30.74% total lipids, 34.40 % dietary fibre and a good source of macro elements like calcium, phosphorus, potassium, magnesium, and fair amount of sodium, iron and zinc. Chia seeds are one of the nutrient-dense foods with a high concentration of antioxidants, superior quality of fatty acids and also gluten free protein (Ullah *et al*. 2016). Quinoa seeds or *Chenopodium quinoa* belongs to Chenopodiaceae family, dicotyledonous plant, can be cultivated under adverse climate conditions. Over past decades quinoa production has increased. The FAO of UN announced 2013 as the international year of quinoa because of high nutrition. Quinoa seeds have high content of protein which varies from 8 to 22 % which is higher than the other cereals. Crude fat 4 to 8%, approximately 78% of insoluble and 22 % soluble dietary fibre. Both these seeds are gluten free and have low glycaemic index. These seeds also include anti nutrients that prevent their absorption and availability in the body. Some of the major anti nutrients are saponins, tannins, phytates and oxalates.

In, India processing techniques have been used for years to enhance the nutritional value of food products. Different techniques such as roasting, soaking, germination. Roasting can alter the texture, colour, flavour and appearance of grains the resulting product takes on special characteristics of crispness and flavour in comparison to the raw seeds. Nicoli *et al*. (1999) and Brady *et al*. (2007) in their study showed that roasted quinoa seeds degrade saponin content when exposed in high temperature. Germination increases the amount of nutrients that are most readily absorbed and enhances quality of seeds by lowering concentration of anti-nutrients (Inyang and Zakari 2008, Gao *et al*. 2019) and Jinting *et al*. (2023) also reported that germination activates key enzymes of endogenous metabolism, content of anti-nutritional factors such as phytic acid and

lipoxygenase was reduced. This processing technique considered be the most effective to enrich nutrient amount.

Materials and Methods

Procurement and processing of chia and quinoa seeds.

Chia and quinoa were purchased from the whole sale market of Delhi. The seeds were thoroughly cleaned and rendered free from dirt and foreign objects. After that different processing techniques applied to the raw seeds as shown in Figure 1 and 2.

Fig.1. Raw and processed chia seeds

Fig.2. Raw and processed quinoa seeds

Processing techniques

Open pan roasting

Chia seeds were roasted for 10 minutes at 120°C and quinoa seeds at 130°C for 5 minutes.

Soaking

Raw chia seeds were soaked in water (1:10) for overnight, whereas quinoa seeds in water (1:5) and then dried in tray oven at 60°C.

Germination

Chia seeds were kept in muslin cloth at ambient conditions for four days. Germinated seeds were dried in a hot air oven for 2 hours.

Preparation of sample for analysis

For analysing nutritional parameters of seeds, the raw and processed seeds were completely blended in a blender, and weighed sample was collected for examination.

Nutritional analysis

The proximate constituent's viz. moisture, crude fat, crude protein, crude fibre, ash content was analysed using standard methods of AOAC (2010).Total carbohydrates done by difference method. The mineral profiles of samples were determined using Ranganna (2007) method. Samples were digested with di-acid mixture nitric acid and perchloric acid, the extract was re-dissolved in double distilled water and results were analysed using atomic absorption spectrophotometer 4129. Analysis was carried out in triplicates.

Results and Discussion

Proximate analysis

The nutritional properties such as moisture, protein, fat, fibre, ash, carbohydrates, were determined and shown in Table1.

Chia seeds

A significant variation in the parameters was

Table 1. Nutritional composition of raw and processed seeds

Seeds	Treatments	Parameters (%)					
		Moisture	Fat	Fibre	Protein	Ash	Carbohydrates
Chia	Raw	4.24	30.00	24.73	15.03	5.08	20.92
	Roasted	2.80	33.44	29.83	16.72	2.37	17.64
	Soaked	3.87	30.12	31.81	15.72	3.43	15.05
	Germinated	4.85	31.76	32.15	18.15	4.51	8.58
Quinoa	Raw	3.25	3.22	2.46	11.69	3.33	76.05
	Roasted	1.24	7.69	1.76	11.94	2.11	75.26
	Soaked	5.26	3.02	1.96	10.71	2.31	76.74
CD at 5%	Chia	0.51	0.19	1.03	0.73	0.36	0.67
	Quinoa	0.39	0.82	0.52	0.98	0.37	NS

Note: CD calculated at 5% level of significance
NS-Non- significant

observed after processing. The moisture content of roasted chia seeds was reduced to 2.80 % while the raw seeds had 4.24%. Crude fat content of roasted seeds was observed highest 33.44%. Agume *et al*. (2017) studies revealed that increase of fats might be related to the concentration of lipids caused by leaching of soluble components or by breakdown of cellular structures which would release stored fat at high temperature. Decrease in crude fat in germinated and soaked seeds from 31.76% to 30.12% was observed. A well-defined phenomena that occurs during seed sprouting which is by endogenous lipases which reduces lipid content. The findings concur with those of Mostafa *et al*. (1987) and Kylen and Mccready (1975). Germinated chia seeds had 18.15% crude protein, which was higher than soaked and roasted seeds. Gomez-Favela *et al*. (2017) observed in his studies that germinated seeds protein content was 20.90% and it was because the time and temperature affects the content. A positive balance between protein breakdown and protein biosynthesis during germination could be observed after sprouting. These results agreed with the findings of Benincasa *et al*. (2019) and Mayer *et al*. (1982). Carbohydrate content was observed maximum in raw seeds 20.92% followed by roasted 17.64% and soaked 15.05%.

Quinoa seeds

Proximate analysis of the different processing treatment of quinoa seeds showed significant difference in moisture, crude fat and crude protein. Soaked quinoa seeds contained maximum amount of moisture i.e.5.26 % and the minimum amount was found in roasted i.e. 1.24%. Crude fat and protein amount in roasted seeds was observed as highest i.e. 7.69% and 11.94% respectively. Mariod *et al*. (2012) in their study reported that changes in sunflower seeds. Raw quinoa was found to have highest ash content 3.33% than other forms. A significant increase in the carbohydrates (76.64%) observed in soaked seeds. Valencia (2003) and Mariod *et al*. (2012) also reported 3.8% and 3.83% ash content on dry weight basis.

Mineral analysis

Table 2 shows the results of mineral analysis of unprocessed and processed chia and quinoa seeds.

Chia seeds

Environment factors such as temperature, light, soil, and variety play a crucial role in mineral concentration in the seeds Ixtaina *et al*. (2018). Unprocessed seeds were observed highest in minerals i.e. Magnesium, (178.96%), iron (16.06%), calcium (352.73%), potassium (666.96%), and phosphorus (655.66%). Haripriya and Aparna (2018) showed almost same results of mineral content. Roasting significantly decreases the mineral content, whereas germination, compared to soaking and roasting, increases the mineral amount. Calvo-Lerma *et al*. (2020) reported that germination helps in breaking of chia proteins to make them entirely digestible as a result increase calcium concentration in germinated seeds. There was significant increase shown in zinc

Table 2. Mineral content of raw and processed seeds

Seeds	Treatments	Parameters (mg/100g)					
		Magnesium	Zinc	Iron	Calcium	Potassium	Phosphorus
Chia	Raw	178.96	6.65	16.06	352.73	666.96	655.66
	Roasted	121.58	5.34	11.97	286.16	655.30	557.66
	Soaked	118.83	5.85	9.17	168.66	604.90	510.00
	Germinated	112.41	22.83	13.48	311.16	537.28	571.66
Quinoa	Raw	65.22	3.38	10.00	90.00	440.73	275.33
	Roasted	64.76	3.63	7.13	58.53	437.03	270.30
	Soaked	42.78	3.24	8.00	42.00	103.33	117.66
CD at 5%	Chia	2.31	0.82	1.58	7.00	3.96	8.57
	Quinoa	2.02	NS	0.83	1.81	11.13	7.8

Note: CD calculated at 5% level of significance NS-Non- significant

content of germinated seeds (22.83%). Powell and Matthews (1981) in their investigation observed that zinc leaches out while germination and that leached zinc could be absorbed again by sprouts.

Quinoa seeds

Magnesium, iron, calcium, potassium, phosphorus content of the quinoa seeds decreased during processing with maximum decrease in showed in soaking. The decrease during roasting might be due to heat treatment. Similarly Valencia *et al*. (2010) reported negative affect on mineral values of quinoa seeds. Alvarez- Jubete *et al*. (2009) resulted that pseudo cereals amaranth, quinoa and buckwheat are good source of minerals. On the other hand raw quinoa magnesium, iron, calcium, potassium, and phosphorus showed maximum retention i.e. 65.22%, 10.00%, 90.00%, 440.73% and 275.33% respectively.

Conclusion

Based on the results obtained, it was concluded that roasting and soaking enhanced the crude fat, fibre and protein amount in chia and quinoa seeds also germination in chia seeds showed better results in enhancing the nutrients especially crude fibre and protein. Raw chia and quinoa seeds found rich in mineral content than the processed seeds. Among all the minerals, zinc amount was increased during processing of seeds. Hence it is inferred from the results that processing of seeds substantially improved the nutritional profile.

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