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Optimisation of Process Parameters of parching, Puffing and Malting for Better Nutritional Quality Products of Quinoa

Mahendra Kumar*, Alpana Singh, Anubha Upadhyay and Ankit Bharti
Department of Food Science & Technology,
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (Madhya Pradesh), India.

(Corresponding author: Mahendra Kumar)*
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ABSTRACT: To increase popularity of quinoa among all masses, certain processing techniques such as parching, puffing and malting can be easily adopted at household and even at cottage level. In this study an attempt have been made to develop a quinoa based processed food with higher nutritive value by optimisation of parching, puffing and malting. Puffed, parched and malted cereals are ready to eat whole cereal foods which having more nutrients than other cereals. All malted products from quinoa were prepared by slight modification of process parameter (Soaking time and germination time) of malting which leads to increase its malting yield. All the processed products by optimisation of puffing showed improvement in puffing yield which was useful for further formulation and product development. Process parameters such as puffing temperature and puffing time were optimised for puffed products of quinoa. All the processed products by puffing and parching showed improvement in final yield by optimisation of parameters. The differences found in the final yield profile of processed quinoa by optimisation studied in this work.

Keywords: Quinoa, Malting, Puffing, Parching, Optimisation, Soaking, Germination.

INTRODUCTION

Quinoa (*Chenopodium quinoa* willd), as an annual herbaceous flowering plant belonging to Chenopodiaceae family. Quinoa is an underutilized food with potential to contribute to food security. Quinoa has a high nutritional value and has recently been used as a novel functional food because of all these properties; it is a promising alternative cultivar. Quinoa is a highly nutritious food product, being cultivated for several thousand years in South America, with an outstanding protein quality and a high content of a range of vitamins and minerals. Other positive aspects of quinoa are the saponins found in the seed hull which can be easily removable and the lack of gluten. Due to absence of gluten, it is tolerable and acceptable to celiac patients. Quinoa is one of the main food crops in the Andean mountains, but during recent times there has been increased interest for the product in the United States, Europe, and Asia. Quinoa has been selected by FAO as one of the crops destined to offer food security in the next century (FAO, 1998). Quinoa is also known as a complete food (James, 2009). In sum, the high nutritional value of quinoa arises from its complete and balanced essential amino acids, high proportion of unsaturated fatty acids, high concentrations of vitamin B complex, vitamin E, and high phenolic and betalain content. In Some other findings, Quinoa and amaranth are a good source of flavonoids and other bioactive compounds with putative health effects (Rastogi & Shukla, 2013; Valencia *et al.*, 2010b). In the last decade the consumption of quinoa and amaranth has growth substantially across the world (Giménez *et al.*, 2013).

Malting involves the limited germination of grains, under controlled conditions. Germination is mainly a catabolic process that supplies important nutrients to the growing plant through hydrolysis of reserved nutrients (Hough *et al.*, 1982).

Parched grain is whole grain that has been cooked by dry roasting. It is an ancient foodstuff and thought to be one of the earliest ways in which gathers ate grains. Parched grain is a compact, nutritious, energy dense food that is easily transported and consumed. Parching quinoa would seem to have considerable potential for home and large scale growers. In parching process, seeds are lightly toasted to keep them from sprouting or germinating.

Puffing is a process where, sudden release of water vapour and expansion of pre-gelatinized kernel (Sullivan & Craig 1984; Hoke *et al.*, 2007) takes place. Superheated vapour is produced inside the grains by instantaneous heating, which cooks the grain and expands the endosperm while escaping with great force through the micro pores of the grain structure and puffing imparts acceptable taste and desirable aroma to

the snacks. Puffing involves roasting grains in hot sand without oil for a short time resulting in a popped type of healthy snack food. Bitterness is present in higher concentrations in the outer layer of the grain. It is necessary to wash out these undesired compounds before quinoa consumption. Thus in the light of the scientific data it may be concluded that nutritional bioavailability and digestibility of quinoa could be improved by reducing its bitter content and in this regards the processing method contribute to enhancing utilization of quinoa based products. Hence, the present study was planned to investigate the nutritional value and sensorial acceptability of malted quinoa for nutritional security.

MATERIAL AND METHODS

Good quality of quinoa were collected and cleaned properly. Preliminary studies were performed for the purpose of identifying the appropriate method of malting, parching and puffing sample preparation was done by removal of bitterness and accordingly percentage of processed quinoa was established through sensory evaluation (Amerine *et al.*, 1965).

A. Parching

Parching of quinoa increases nutritional profile and bioavailability of quinoa nutrition. Optimization process variables for parching included the heat treatments (160, 170, 180 and 190°C for 15, 20, 25 and 30 s).Before optimization grains were washed with tape water to remove bitterness of the seed and dried properly.

B. Puffing

Puffing of quinoa done by using hot sand method and optimization of puffing parameter includes puffing temperature, puffing time and yield of puffed quinoa. Puffing process included overnight soaking prior to conditioning (moisture upto 19 % for grain) and heating in hot sand. Optimization of puffing variable for grain included temperature (210, 220, 230 and 240°C) and Puffing time (15, 20, 25 and 30 s).

C. Malting

The critical steps involved in the process of malting includes soaking, germination and kilning. It was observed that different soaking and germination treatments could influence on nutritional as well as functional characteristics of quinoa malt. Hence, during present investigation the efforts were made to optimize the parameters for the development of malted quinoa products on the basis of soaking time (ST), germination time and malting yield. The potential of different soaking and germination treatments on yield of quinoa malt were observed and the obtain results elaborated.

RESULTS AND DISCUSSION

On the basis of triplicate analysis, data is obtained and presented as result whish in line with various previous research and trails. Optimization characteristics of raw grains and processed products of quinoa are presented in Table 1.

It could be observed from the Table 1 that at a soaking time of 12, 24, 36 hrs with increase in germination time (from 48 hrs to 144 hrs) showed increase in malting yield from 61.30 to 81.55 %. It was also reported that decrease in malting yield with increase in soaking period in all the malted samples with soaking period of 36 hrs. It was represented the maximum malting yield (81.55 %) found on 24 hrs soaking period with 144 hrs germination time and minimum yield (60.10%) reported in 36 hrs soaking time with 48 hrs germination period.

Table 1: Optimization parameters for malting of quinoa at room temp.(27±2°C).

Samples	Soaking Time (hrs)	Moisture (%)	Germination Time (hrs)	Malting Yield (%)
Malted Quinoa	12	26	48	61.30
			72	61.60
			96	62.10
			120	65.72
			144	69.30
	24	37	48	63.15
			72	65.10
			96	70.25
			120	74.27
			144	81.55
	36	45	48	60.23
			72	61.29
			96	63.56
			120	64.52
			144	66.78

Grains were soaked for 12, 24, 36 hrs and germinated for 48, 72, 96, 120 and 144hrs respectively at 27±2°C. Soaking and germination significantly affects the malting yield of quinoa and the results shows significantly improved quality of malted products. Soaking is required to remove the bitter saponins as suggested by Pappier *et al.* (2008). The malt yield in the present study ranged from 60.23 to 81.85 per cent.

Similarly a study conducted by Begum, (1998) on malting of different varieties of finger millet showed that the malt yield ranged from 59 to 66 percent on 12 hrs with 36 hrs soaking period. The research findings of Pawar and Pawar, (1997) also showed that the malt yield was around 85 per cent in case of foxtail millet.

Results obtained from the Table 2 elaborated puffing yield of all samples which was varies from 60.35 % to

72.25 %. It was observed that at a puffing temperature of 210°C with increase in puffing time (15, 20, 25 and 30 s) resulted puffing yield as 62.16 %, 65.17 %, 68.70 % and 69.05 % respectively whereas at a puffing temperature of 220°C with increase in puffing time resulted puffing yield varies from 65.16 % to 70.48 %. It was reported that at a puffing temperature of 230°C with increase in puffing time resulted yield was ranged from 65.56 % to 72.25 %. Puffing yield decreases after 230°C temperature and at a puffing temperature of 240°C with increase in puffing time puffing yield reduces from 71.65 % to 60.35 %. Results observed in Table 2 clearly shows the highest puffing yield 72.25 % at 230°C temperature for 30 s time whereas lowest puffing yield (60.35%) found on 240°C temperature for 30 s puffing time. These results shows significant increase in puffing yield from 210°C to 230°C and slightly decrease at 240°C.

Table 2: Optimization parameters for puffing of quinoa.

Samples	Puffing Temp.(°C)	Puffing Time (s)	Puffing Yield (%)
Puffed Quinoa	210	15	62.16
		20	65.17
		25	68.70
		30	69.05
	220	15	65.16
		20	66.10
		25	69.20
		30	70.48
	230	15	65.56
		20	67.12
		25	71.96
		30	72.25
	240	15	71.65
		20	69.30
		25	64.45
		30	60.35

Hoke *et al.*, (2005) reported that in India, the most frequent way is, puffing in hot sand (temperature of sand is about 250°C). Due to sudden thermal gradient, the moisture inside the grains vaporizes and tries to escape through the micropores, expanding the starchy endosperm in size in this process (Chinnaswamy and Bhattacharya, 1983).

Results obtained from the Table 3 represented the parching yield which was varies from 56.96 % to 78.40 % on different parching temperature and time. It was observed that at parching temperature of 160°C with increase in parching time (15, 20, 25 and 30 s), parching yield ranged from 70.95 % to 78.40 %. It was reported that further increase in temperature (170, 180 and 190°C) resulted significantly decreased parching yield from 77.10 % to 56.96 %. These results clearly shows the maximum parching yield (78.40 %) was observed at 160°C for 30 s parching time whereas minimum parching yield (56.96%) was found at 190°C temperature for 30 s time. Processing quinoa grain to dried edible quinoa products were developed by Scanlin and Burnett (2010). The edible quinoa product was processed through pre-conditioning (abrasion and washing), dry heating (Puffing and parching), and post-production treatment. As for sweet quinoa product, germination and malting processing were applied.

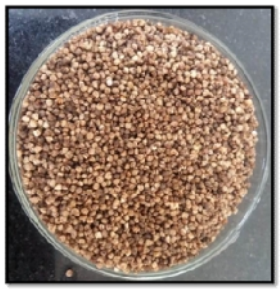
Table 3: Optimization parameters for parching of quinoa.

Samples	Parching Temp. (°C)	Parching Time (s)	Parching Yield (%)
Parched Quinoa	160	15	70.95
		20	74.36
		25	76.57
		30	78.40
	170	15	77.10
		20	75.25
		25	73.63
		30	70.10
	180	15	69.30
		20	67.42
		25	63.58
		30	60.49
	190	15	61.25
		20	59.27
		25	57.36
		30	56.96

The popping yield at 240°C to 260°C for 15 to 25 s time of pearl millet ranged from 8.3 to 77.1 percent in a study conducted by Hadimani and Malleshi (1995). Similar trend was observed in popped grains under study (31 to 76 percent).

Malted quinoa (Soaked for 24 hrs & 144 hrs germination)

Puffed quinoa (230ºC for 30 s)



Parched quinoa (160ºC for 30 s)

Plate 1: Processed products of quinoa.

CONCLUSION

With high nutritional value, quinoa is recognized as significant place in food security and treating malnutrition issue in developing countries In this study, the effects of soaking and germination duration on the malting yield of quinoa was evaluated and optimized. Soaking and germination significantly affects the malting yield of quinoa and the results shows significantly improved quality of malted products. Quinoa malt was optimized based on barley malt specifications, which are considered appropriate in the malt production industry for optimal processing. Under the present study optimization of process parameters for puffing includes puffing time, puffing temperature and puffing yield. Undoubtely optimization of puffing increases nutritional quality as well as functional properties of quinoa. Parching was similar processing method and the optimization parameters include parching time, parching temperature and parching percentage. Protein and carbohydrate in the processed products (*i.e*. Puffed and parched quinoa) were increased on processing. The addition of these products in the daily food could help to alleviate the deficit in protein and carbohydrate in the malnutrient population.

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Conflict of Interest. None.

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