

Studies on Acceptability, Chemical Composition and Cost Structure of Nutritious Quinoa Kheer

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(Received 12 May 2021, Accepted 03 July, 2021)

(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The aim of this study was to develop value added kheer using quinoa. Outer layer of quinoa contains antinutritional factors which imparts bitter taste to the final product. In order to reduce the antinutritional factors quinoa is treated with (2%) citric acid. Quinoa and rice was washed and soaked in luke warm water to reduce cooking time and to improve the colour, taste of the final product. Quinoa was blended in rice kheer in the proportion of T₀ (00:100), T₁ (20:80), T₂ (40:60), T₃ (60:40), T₄ (80:20) and T₅ (100:00) was prepared. The product was conventionally cooked and selected based on sensory evaluation and it was observed that T₄ i.e 80:20 (Quinoa:Rice) combination found superior. Prepared kheer was then evaluated for nutritional composition. Selected sample T₄ showed 14.70 per cent of carbohydrate, 3.57 per cent of protein, 3.38 per cent of fat and 0.15 per cent of fiber per 100g of kheer respectively with increased content of protein, fiber when compare to control rice kheer (T₀). The techno economic feasibility of T₄ combination shows preparation cost of rupees 98.60 per kg. Quinoa can be successfully incorporated for the preparation of innovative product quinoa kheer with increased nutritional composition.

Keywords: Quinoa kheer, nutritional composition, sensory evaluation, techno-economic feasibility.

INTRODUCTION

Kheer is one of the simple traditional food, which fits in each circumstance and normal between all community of individuals. Conventionally this is ready by cooking rice with sugar or jaggery in milk till the moment that rice starch gets gelatinized (Chavhan *et al.*, 2019). Changes in food propensities and lifestyle of people moreover requests for the nutritive rich food, with lesser planning time and financially reasonable cost.

Quinoa (*Chenopodium quinoa*) belongs to the family Amaranthaceae, referred as pseudo grain in light of the fact that isn't has a place with Graminaceae family yet its preparing and consumption techniques were like cereals. Quinoa has high concentrations of protein, all essential amino acids, unsaturated fats, it likewise contains minerals and nutrients like vit B, vit C and vit E. also a low glycemic record (GI) (Bastidas *et al.*, 2016). It is considered as gluten free grain as it contains almost no or no prolamin. Quinoa is one of the functional food and is known to bring down the danger of different illnesses, for example, celiac sickness and applying wellbeing advancing impacts (Kavali *et al.*, 2019). In 1996, quinoa was listed by FAO as one of the most promising crops for the mankind, not just for its

extraordinary properties and its different uses, and it is likewise viewed as a choice to solve human nutrition issues FAO, (2011); Sharma *et al.*, (2015). Quinoa's external seed coat (pericarp) is rich in severe bitter saponins, since saponins meddle with quinoa's palatability and edibility, they should be taken out before utilization (Graf *et al.*, 2015). Incorporation of nutritionally rich quinoa in this traditional desert make it more suitable for the growing population.

In previous studies kheer prepared with some of the cereals contained only few amino acids but quinoa contains all essential amino acids with no deficiency of them and having the best amino acid profile by knowing this nutrition profile FAO/WHO pattern suggested quinoa for preschool childrens. Phenylalanine, tyrosine, leucine, and tryptophan contains with good measure in Quinoa (Beatriz and Suzana 2012). The range of lipid content in quinoa is from 5.2 to 9.7 almost around multiple times more than grains like maize and wheat cereals (Alvarez-Jubete *et al.*, 2010).

Fatty acids like linoleic acid (omega-6) ranges from 48.2-56.0 per cent in quinoa. After that oleic acid present in quinoa ranges from 24.5-26.7% and 9.7-11%

palmitic acid, constituting total fatty acids about 14% (Beatriz and Suzana, 2012). Naturally quinoa seeds contains -tocopherol (Vit. E) 0.59-2.6 mg/100gm (Ryan *et al.*, 2007). Along these lines, against the oxidation process the quinoa lipids are more stable (Koziol *et al.*, 1992) and (Schoenlechner *et al.*, 2008). The mineral substance of quinoa is around multiple times the mineral substance in cereals. The minerals like Ca, Mg, Fe, and Zn are adequately high amounts found in quinoa (Repo-Carrasco *et al.*, 2003). Ca, Mg, and Fe are normally inferior in most of the gluten free diets. It is important to educate customers about quinoa utilization with their great properties and let them incorporate into their every day diet. Preferably producing innovative useful items is very important and that are effectively accessible in the local market for consumers and raise them to industrial scale.

MATERIALS AND METHODS

The current examination work was attempted in the Department of Food Business Management with joint effort of Department of Food science and Nutrition, College of Food Technology, V.N.M.K.V, Parbhani. The methodology taken for this experimentation in the current examination are expressed below.

Procurement of quinoa and other ingredients

The quinoa seeds are procured from Mamta agro (Gujarat). Ingredients like rice, milk, sugar, dryfruits and cardamom was procured from local market of Parbhani.

Pretreatment of raw materials

Quinoa was treated with 2% of sodium bicarbonate and citric acid solution. Soaking the quinoa seeds in 2 percent citric acid was reduced saponin content and eliminating bitterness. Soaked quinoa seeds were washed in running water and allowed to dry.

Methods

Formulation of quinoa kheer: The quinoa kheer was prepared with varying different proportion of quinoa and rice. The formulation presented in Table. 1. The proportion of milk, sugar, Dry fruits, Cardamom kept constant each and every sample.

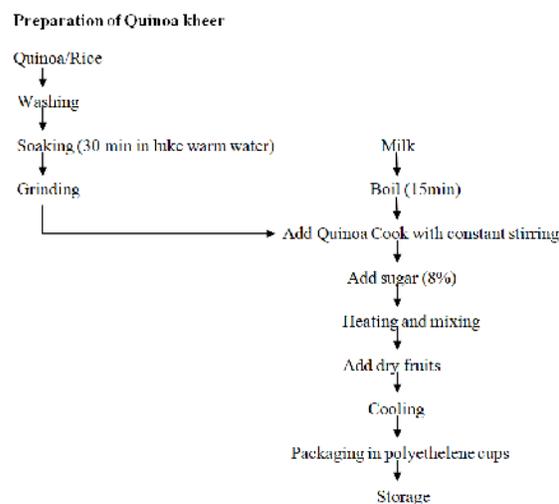
Table 1 : Formulation of quinoa kheer.

Ingredients	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅
Quinoa	0	1	2	3	4	5
Rice	5	4	3	2	1	0
Milk	80	80	80	80	80	80
Sugar	8	8	8	8	8	8
Cradamom	2	2	2	2	2	2
Dry fruits	5	5	5	5	5	5

In present study efforts were made to develop quinoa kheer. Quinoa kheer were prepared from different standardized methods. The T₀ is control which contains 5 per cent of rice without adding quinoa keeping all the ingredients constant. Whereas in T₁, T₂, T₃, T₄ and T₅, the incorporation of rice and quinoa is varied in the proportion 1:4, 2:3, 3:2, 4:1 and 5:0.

Quinoa kheer was garnished with dry fruits and assessed for panel members.

Preparation of quinoa kheer: Saponins are present in the pericarp of quinoa seeds. Saponins are plant glycosides that have a bitter taste and foamy in water. Some saponins can form insoluble compounds with minerals such as zinc and iron, limiting their absorption in the gut (Valencia-Chamorro, 2003). The saponin content of quinoa seed was discovered to be about 0.55 percent. Saponin concentrations were reduced to 0.07 percent following soaking in 2% citric acid respectively. Pretreated quinoa was then used for the preparation of quinoa kheer. Quinoa and rice were soaked in luke warm water to decrease cooking time. Soaked quinoa and rice was subjected to grinding to increase the surface area and later it is added to boiling milk along with 8% sugar. Milk is boiled until the rice starch gelatinizes. Cardamom powder is added to enhance the flavour in last moment. Dry fruits are added to decorate the final product and to increase the nutritional quality of the final product.



Sensory Analysis: Sensory evaluation of quinoa kheer was done on the basis of organoleptic tests by a meritorious panel of 10 semi trained panelists of Department of Food Business Management and Food science and Nutrition, Institute of College of Food Technology, V.N.M.K.V, Parbhani. Samples were given code numbers to avoid bias opinion and individuality. The judges evaluated the samples taking in the consideration of Color, Flavor, texture, Appearance and Consistency of quinoa kheer keeping rice kheer as control. The scoring was done using 9-point Hedonic scale developed by Quarter Master Food and Container Institute, USA (Gupta, 1976).

Proximate analysis: All samples were dried and powdered. Then the different treated samples were performed for moisture, protein, fat, ash, fiber and carbohydrates substance as indicated by their separate standard strategies as described in (AOAC, 2000).

RESULTS AND DISCUSSION

A. Sensory Evaluation

Sensory analysis was carried out using 9-point hedonic scale. Sensory quality of whole quinoa kheer on the basis of color, appearance, flavour, texture, taste and overall acceptability. Sensory evaluation of quinoa kheer with different treatments was done on the basis of organoleptic test by a panel of 10 semi trained panalist members. Samples were given with code numbers ($T_0, T_1, T_2, T_3, T_4, T_5$) to avoid bias opinion. The evaluation was done by taking consideration of Appearance, colour, Taste, Flavour, Consistency and overall acceptability by using 9 point Hedonic scale. Data indicated above Table. 2. The sensory score of

color for T_0 obtained highest (8.3) and laest for T_5 sample. T_4 sample obtained highest score (8.7), while T_0 obtained lowest score (8.3). The quinoa kheer sample T_4 obtained highest score (7.4) while T_0 obtained lowest score (6.5) for flavour. For consistency T_0 obtained highest score (8.8) while T_5 –btained lowest score (8.3). Organoleptically accepted T_4 sample received highest score i.e. 8.1 in case of all sensory attributes when compare to other samples. Results showed that finally 4% of quinoa and 1% of rice sample is selected out of 6 samples. Selected sample used for further analysis. The average sensory score result was presented in graphical representation (Fig. 1).

Table 2: Sensory evaluation of quinoa kheer.

Samples	Appearance	Colour	Taste	Flavour	Consistency	Overall Acceptability
T_0	7.8	8.3	8.3	6.5	8.8	7.94
T_1	7.6	8.2	8.3	6.8	8.7	7.92
T_2	7	8.1	8.4	6.9	8.7	7.82
T_3	7.2	8.0	8.5	7.0	8.6	7.94
T_4	8	8.0	8.7	7.3	8.5	8.1
T_5	7.4	7.8	8.4	7.4	8.3	7.86
SE_{\pm}	0.0382	0.0394	0.0306	0.0222	0.0253	0.0148
$CD@5\%$	0.1119	0.1157	0.0898	0.0652	0.0743	0.0434

*Each value represents the average of three determinations.

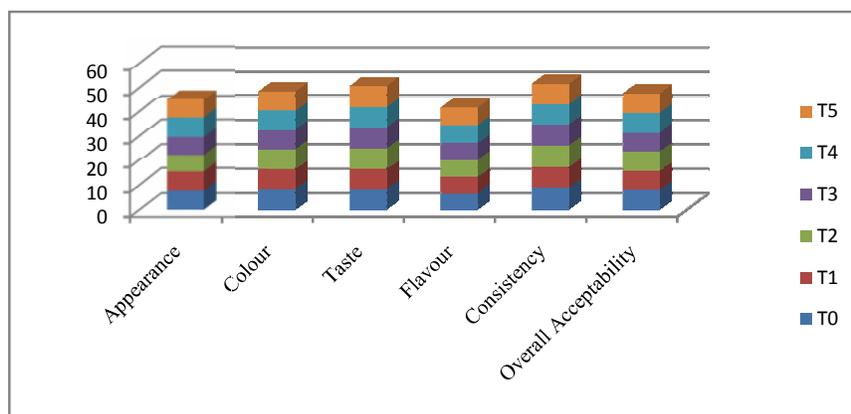


Fig. 1. Sensory evaluation of quinoa kheer.

B. Physico chemical properties of Quinoa kheer

The physico-chemical parameters includes color, density, total solids, pH, reducing sugars and titrable acidity content for control and selected quinoa kheer sample was analysed and obtained results are tabulated in the Table 3. The color of Quinoa kheer T_4 creamy white while T_0 control was white. Density of T_4 and T_0 sample was 1.150 and 0.91 g/ml. Obtained values was found similar to the results found by (Jha *et al.*, 2002). T_0 contained 28.75 percent total solids whereas T_4 had 24.89 percent total solids according to results tabulated in Table 3. T_0 and T_4 had pH values of 6.52 and 6.75 respectively. pH increased as the amount of rice in the kheer decreased. T_0 contained 6.47 percent reducing

sugars and T_4 had 6.41 percent reducing sugars which were close to the results published by (Shelke, 2015)^[17] in his research work. T_0 had a titrable acidity of 0.30 percent whereas T_4 had a titrable acidity of 0.35 percent. These values were discovered to be comparable to those reported by (Kumar *et al.*, 2020).

When studying on textural property of kheer using brookfield viscometer. The viscosity of quinoa kheer (T_4) was 0.175 ± 0.04 , while the viscosity of rice kheer (T_0) was 0.180 ± 0.01 . There is no significant variation in viscosity between the T_0 and T_4 samples. The acquired values were found to be comparable to the results obtained by (Singh *et al.*, 2017).

Table 3: Physico-chemical composition of quinoa kheer.

Parameters	Value	
	T ₀	T ₄
Color	White	Creamy white
Density	0.91	1.150
Total solids	28.75	24.89
pH	6.52	6.75
Reducing sugars	6.47	6.41
Titration acidity	0.30	0.35
Viscosity (Pa.s)	0.180±0.01	0.175±0.04

*Each value represents the average of three determinations

C. Proximate composition of quinoa kheer

The proximate properties of quinoa, such as moisture content, protein, fat, carbohydrate, crude fibre and ash content were investigated and the results are shown in Table 4.

Table 4: Proximate composition of quinoa kheer (100g).

Parameters	value	
	T ₀	T ₄
Moisture	75.25	76.11
Protein	3.34	3.56
Fat	3.16	3.37
Ash	0.82	0.95
Fiber	0.01	0.15
Carbohydrates	16.20	14.70

*Each value represents the average of three determinations

From Table 4, data indicates (T₀) control rice kheer contained 75.25 per cent of moisture and T₄ accepted quinoa kheer contained 75.11 per cent moisture. T₀ contained 3.34 per cent protein and 3.56 per cent protein in T₄. Results revealed that protein content was increased with increase in quinoa in kheer. 3.37 per cent of fat was found in T₄ which was little similar when compare to T₀ contained 3.16 per cent. The ash content in T₄ was 0.95 per cent and T₀ showed that 0.82 per cent, this obtained values was found similar with the results obtained by Shelke, (2015). T₀ contained 0.01 per cent of fiber and T₄ contained 0.15 per cent of fiber. Carbohydrate content was more in T₀ i.e 16.20 when compared to T₄ which contained 14.70 per cent because rice contains more carbohydrate when compare to quinoa.

D. Mineral composition of kheer

Table 5 Summarizes the results of calcium (Ca), magnesium (Mg), iron (Fe) and Zinc (Zn) calculations. Minerals are microcomponents that play a significant role in the regulation of many physiological functions as well as structural components (Wang *et al.*, 2011).

Quinoa kheer contained 100.46mg of calcium, 28.4mg of magnesium, 0.61mg of iron and 3.48mg of zinc from the results represented in Table 5. The minerals like Ca, Mg, Fe, and Zn are adequately high amounts found in quinoa (Repo-Carrasco *et al.*, 2003).

Table 5: Mineral composition of quinoa kheer (mg).

Parameters	Mean value
Ca	100.46
Mg	28.4
Fe	0.61
Zn	3.48

E. Cost of production

The present investigation entitled “Studies on Development of Nutritious Kheer from Quinoa” was carried out. The cost involved for preparation of kheer on account of raw material used i.e, cost of Quinoa, cow milk, Rice, sugar, Dry fruits, labour, fuel and miscellaneous charges etc were taken into account for calculating the cost of production of kheer for different treatments.

The data in respect of this is recorded and presented in Table 6. It may be seen from Table 6 that the cost of production of 1kg kheer ranged from Rs. 89.2 to 100.95. The production costs for treatments T₀ : (Control) Kheer prepared by rice (5 %) + quinoa (0%), T₁ : Kheer prepared with rice (4 %) + quinoa (1%), T₂ : Kheer prepared with rice (3 %) + quinoa (2%), T₃ : Kheer prepared with rice (2 %) + quinoa (3%), T₄ : Kheer prepared with rice (1%) + quinoa (4%), and T₅ : Kheer prepared with rice (0%) + quinoa (5%) were Rs. 89.2, Rs. 91.55, Rs.93.9, Rs.96.25, Rs.98.6, and Rs.100.95, respectively.

The cost of producing quinoa kheer increased as the amount of quinoa in the kheer increased. The cost of producing kheer with 4 percent quinoa and 1 percent rice (T₄) was Rs.98.6.

Bhosale *et al.*, (2020) conducted research on the preparation, sensory assessment, and cost structure of minor millet kheer mixed with paneer. It is assumed that a decent grade kheer made with finger millet flour and paneer shreds may be made using 1.5 percent finger millet flour + 8% paneer shreds + 8% sugar at a cost of production of 124.30 Rs. Per Kg.

Solanki *et al.*, (2018) conducted research on the preparation of finger millet kheer. T₀ has the lowest cost of control kheer at Rs.84.30 per lit. The most expensive treatment was T₃ which cost Rs.108.60 per lit. T₁ and T₂ treatments cost Rs.91.40 and Rs.100 per liter respectively. The cost of manufacturing rises as the amount of finger millet powder in kheer rises.

Table 6: Techno-economic feasibility of quinoa kheer (1kg).

		Particulars								
		Quinoa	Cow milk	Rice	Sugar	Dry fruits	Labour charges	Fuel charges	Miscellaneous charges	Total Cost/lit
Cost(Rs/lit/kg)		275.00	30.00	40.00	40.00	600.00				
T ₀	Qt(per ml/g)	0	800	50	80	50				
	Amount(Rs)	0	24.00	2.00	3.2	30.00	15.00	5.00	10.00	89.2
T ₁	Qt(per ml/g)	10	800	40	80	50				
	Amount(Rs)	2.75	24.00	1.6	3.2	30.00	15.00	5.00	10.00	91.55
T ₂	Qt(per ml/g)	20	800	30	80	50				
	Amount(Rs)	5.5	24.00	1.2	3.2	30.00	15.00	5.00	10.00	93.9
T ₃	Qt(per ml/g)	30	800	20	80	50				
	Amount(Rs)	8.25	24.00	0.8	3.2	30.00	15.00	5.00	10.00	96.25
T ₄	Qt(per ml/g)	40	800	10	80	50				
	Amount(Rs)	11	24.00	0.4	3.2	30.00	15.00	5.00	10.00	98.6
T ₅	Qt(per ml/g)	50	800	0	80	50				
	Amount(Rs)	13.75	24.00	0	3.2	30.00	15.00	5.00	10.00	100.95

CONCLUSION

This it may be concluded from the present investigation of kheer prepared with 4 per cent quinoa, 1 per cent of rice and 8 per cent sugar found nutritionally superior and acceptable based on its sensorial quality. The addition of citric acid treated in case of quinoa, grinding the quinoa and rice improved the cooking qualities in terms of reducing cooking time, increased consistency and reducing the saponin (bitterness causing agent) content in final product. Therefore, utilization of quinoa would improve nutritional qualities of kheer with health benefits. The protein content of the organoleptically accepted final product T₄ contained 3.56 percent in 100 grams of quinoa kheer which is good amount and helps the consumers to overcome protein energy malnutrition. Quinoa kheer contained good amount of minerals which improves the gut health. For the production of 1kg of kheer costs about Rs. 98.6 for organoleptically accepted product T₄.

FUTURE SCOPE

Protein-energy malnutrition (PEM) is a significant public health issue in India. Malnutrition affects more than half of all children under the age of five. India has the highest prevalence of malnutrition with 45 percent of children and 70 percent of pregnant women suffering from malnutrition. Minerals are microcomponents that plays a significant role in the improvement of gut health.

A study project was established with quinoa seeds from Mamta agro (Gujarat) and rice from a local market parbhani because of the importance of quinoa and the necessity to generate a value-added dairy product. As a consequence, the experiment was built.

Acknowledgement. Heartful thanks to Department of Food Business Management, College of Food Technology, VNMKV, Parbhani for supporting this investigation with all possible facilities required. Authors are thankful to College of Food Technology for its financial support to this research and thankful to DR. U. M. Khodke, ADP, College of Food Technology, VNMKV, Parbhani for constant support and encouragement. Whole hearted sense of gratitude to honorable research guide Prof. D. R. More for his constant guidance and support. The laboratory technician of the College of Food Technology and College of Agriculture VNMKV, Parbhani are acknowledged for their technical assistance.

Conflict of interest: The authors declare that there is no conflict of interest in the paper.

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How to cite this article: Praveen B.R., More D.R., Megha K.C., Bawachkar R.R. and Vennela V.R. (2021). Studies on Acceptability, Chemical Composition and Cost Structure of Nutritious Quinoa Kheer. *Biological Forum – An International Journal*, 13(2): 546-551.