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Mohammad Nisar
Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathewada Krishi Vidyapeeth, Parbhani, Maharashtra, India

VS Pawar
Department of Food Chemistry and Nutrition, College of Food Technology, Vasantrao Naik Marathewada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Syed Zubair
Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathewada Krishi Vidyapeeth, Parbhani, Maharashtra, India

AR Sawate
Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathewada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Mane RP
Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathewada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Correspondence
Mohammad Nisar
Department of Food Engineering, College of Food Technology, Vasantrao Naik Marathewada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Studies on mineral composition, colour and textural qualities of cookies incorporated with quinoa seed flour

Mohammad Nisar, VS Pawar, Syed Zubair, AR Sawate and Mane RP

Abstract
Present investigation was performed to investigate effects of quinoa seed flour on mineral composition, colour characteristics and textural qualities of cookies. Quinoa is considered as pseudo-cereals crop, it is a broad leaf plant with starchy dicotyledonous seed and therefore not a cereal. Quinoa is protein rich but gluten free hence it considers as a miracle grain. Baked products found a best vehicle for conveying nutrient of quinoa seed to consumer. Four samples of cookies were prepared which were incorporated with quinoa seed flour at proportion of 0, 30, 40 and 50 percent and sample coded as T0, T1, T2 and T3 respectively. It was found that with increasing levels of quinoa seed flour to cookies mineral content of cookies was increased. It was found that with increase in proportion of quinoa seed flour to cookies the colour value changes i.e L* value and b* value decreased and a* value get increased. The hardness of cookies was increased with increased proportion of quinoa seed flour to cookies. From the present investigation it was concluded that use of quinoa seed in cookies resulted in improvement in nutritional, textural and colour characteristics of cookies.

Keywords: Colour value, cookies, mineral composition, quinoa seed flour, textural quality

1. Introduction
Quinoa is one of the seeds considered as pseudocereals; it is a broad leaf plant that has been used like the cereals. This crop was an important food for the Incas and still remains as an important food crop for the Quechua and Aymara peoples of the rural regions. A native of the Andes, quinoa dates back more than 5000 years. It was called ‘‘the mother grain’’ by the Incas; it sustained the Inca community and was considered sacred. This seed was the major crop of the pre-Columbian cultures in Latin America. After the arrival of the Spaniards, its use, consumption and cultivation was almost eliminated and only remained in the farmers’ traditions. Quinoa grains have an established excellent nutritional food quality, and that is the reason for the great recent interest in it. Botanically, quinoa belongs to the class *Dicotyledoneae*, family *Chenopodiaceae*, genus *Chenopodium*, and species quinoa. The full name *Chenopodium quinoa Willd*. (Marticorena and Quezada, 1985; Winton and Winton, 1932). Quinoa is an annual plant found in the Andean region of South America, between sea level and the heights of the Bolivian Altiplano at around 4000 m above sea level. It produces flat, oval-shaped seeds that are usually pale yellow but can range in color from pink to black. Abugoch James. Bolivia and Peru are the greatest exporters with 88% of the worldwide production (Vilche *et al*. 2003). While most quinoa is still grown in South America, it is also cultivated in the USA (Colorado and California), China, Europe, Canada, and India. Quinoa is a complete food with high-nutritional value due mainly to its high content of good quality protein. Besides protein content, many studies have been made of their lipids, starch, minerals and saponins it also contains minerals and vitamins like vitamin B, vitamin C and vitamin E. In 1996, quinoa was catalogued by FAO as one of the most promising crops for the humanity, not only for its great properties and its multiple uses, and it is also considered an option to solve human nutrition problems (FAO, 2011). Quinoa is considered one of the best vegetal protein sources, as its protein levels are similar to those found in milk and higher than those present in cereals such as wheat, rice and maize. This seed has been attracting attention because of the quality and nutritional value of its proteins (Ranhotra *et al*., 1993). It is rich in the essential amino acid lysine, making it a more complete protein than many vegetables. It does not contain gluten, so it can be eaten by people who have celiac disease as well as by those who are allergic to wheat.

Nutritional enrichment is of current interest because of consumer trends, government guidelines and changing demographics. These factors are causing industry to be aware of need for nutritional food products. Protein supplementation is one way to meet the need for nutritious foods, particularly baked products. The nutritional significance of the bakery products is well recognized. Attempts are being made to enrich the products with high quality non-wheat flours. Bakery products can serve as good vehicle for carrying the added proteins to target populations for use in combating the protein malnutrition prevalent in many parts of the world. Cookies are ready to eat, convenient, inexpensive and one of the most popular and widely consumed processed food products in India. Cookies are rich in fat content and sugar content than whole bread, but cookies are low in protein. Lower contents of proteins (lysine), vitamins and dietary fibres are the nutritional problems with most bakery products. to enhance the utilization of quinoa in the daily diet of people, it is highly desirable to develop novel and value added food products of quinoa. So it is considered imperative to develop quinoa flours supplemented wheat flour for development of protein rich and low calorie cookies.

2. Material and method

2.1 Raw materials

Good quality raw materials quinoa seed were purchased from Mamta Agro (Gujrat). Maida, sugar, shortening etc. were procured from local market of parbhani.

2.2 Methods

2.2.1 Determination of Minerals

Minerals content like calcium, phosphorus, and iron, zinc were determined by using titration and spectrophotometric method respectively.

2.2.2 Mineral solution preparation

The ash obtained by above procedure was moisture with glass distilled water (0.5-1 ml) and concentrated HCl was added and evaporated to dryness on a boiling water bath. Again 5 ml concentrated HCl was added and evaporated to dryness as before. Lastly 4 ml of HCl and 5 ml of distilled water were added. This solution was warmed over a boiling water bath and filtered into the 100 ml of volumetric flask using Watman No.4 filter paper. After cooling the volume was 32 made to 100 ml using distilled water and suitable aliquot was used for the estimation of Calcium and Iron.

2.2.3 Determination of Calcium

25 ml mineral solution was diluted to 150 ml with distilled water and neutralized with ammonia solution using methyl red as indicator till pink colour changes to yellow. Further the solution was boiled and 10 ml of 6 percent ammonia oxalate was added. This mixture was boiled for few minutes and added with concentrated glacial acetic acid (99.9 percent) till the colour change was distinctly pink. The mixture was kept aside in warm place (overnight) and when precipitate settled down, the supernatant was tested with a drop of ammonium oxalate to ensure the completion of precipitation. The content were filtered through what man No.4 filter paper and given washings of warm distilled water. The precipitate was transferred to a beaker by making a hole in the centre of filter paper and by giving washings of H_2SO_4 (2 N, 5 ml) twice. Then solution was heated to 70 ^{0}C and titrated against N/100 $KMNO_4$, simultaneously a blank was also run.

1ml of 0.01N $KMNO_4$ = 0.2004 mg calcium

2.2.4 Determination of Phosphorus

Phusphorus contents were determined by the colorimetric method. To an aliquot (0.1 ml) of the mineral solution of ammonium molybdate, 1 ml of hydroquinone and 1 ml of sodium carbonate solutions were added in this order. The volume was then made to 15 ml with distilled water and the solution was mixed thoroughly. After 30 min the optical density of this solution was measured in a photoelectric colorimeter, against a reagent blank (prepared in the same way as the test except that the test solution was omitted) using a red filter (660 nm). The phosphorus content of the sample was read from a standard curve prepared with standard phosphate solution (range 0.01 - 0.1 mg P) following the same procedure as described above.

2.2.5 Determination of Iron and Zinc

The iron and zinc content of cookies were estimated by using AAS (Atomic Absorption Spectrometry) in soil science and agriculture chemistry department, college of agriculture, VNMKV, Parbhani.

2.3 Textural analysis of cookies fortified with quinoa seed flour

Stable Micro System *TAXT2 plus* Texture Analyser was used for texture profile analysis (TPA) cookies. The test was confugured so that the hardness calculated at the time of the test by determining the load and displacement at predetermined points on the TPA curve. Hardness (h) was the maximum lad expressed in kg applied to the sample during the first compression.

S-5 probe with 10 mm/sec. of pre-test and post test speeds; and 75 percent compression was taken for TPA analysis. TPA is “one-Bite” test, which includes the compression cycle. Cycle indicate the force vs. time data during the compression of the product by instrument probe.

Hardness (kg) = F1

2.4 Color characteristics of *cookies* fortified with quinoa seed flour

All color data are expressed as Hunter L*, a*, and b* values corresponding to lightness, redness, and yellowness, respectively.

3. Results and discussion

3.1 Mineral composition of *cookies*

Mineral content of wheat and quinoa seed flour is essential in justifying its food value. Calcium, Iron, Phosphorus, and zinc are the minerals of interest in current study. Minerals play a key role in various physiological functions of the body especially in the building and regulation processes. The data pertaining to mineral content is presented in Table-1.

Table 1: Effect of different level of quinoa seed flour on mineral composition of cookies (T_2)

Treatments	Mineral content (mg/100 g)			
	Calcium	Phosphorus	Iron	Zinc
T_0	32.46	120.30	2.61	1.18
T_2	45.82	203.67	2.73	2.30
S.E ±	0.245	0.249	0.007	0.004
C.D at 5%	0.521	0.531	0.015	0.010

*Each value an average of three determinations

Result obtained from table-1 showed that calcium, phosphorus, iron and zinc content of control cookies was

32.46, 120.30, 2.61, and 1.18 mg per 100 g respectively. The calcium, phosphorus, iron and zinc content of *cookies* fortified with quinoa seed flour (T_2) was 45.82, 203.67, 2.73, and 2.30 mg per 100 g respectively. It was found that with increasing levels of quinoa seed flour to *cookies* mineral content of *cookies* was increased. Similar results were obtained with Galvez A.V. *et al*. (2011).

Alemayehu *et al*. (2016) reported that addition of nettle (*Urtica simensis*) leaves on wheat flour significantly (p<0.05) increased the amount of crude protein, ash, dietary fiber, Ca, Fe and Zn.

3.2 Color characteristics of *cookies* fortified with quinoa seed flour

All color data are expressed as Hunter L*, a*, and b* values corresponding to lightness, redness, and yellowness, respectively. Hunter-lab color values of *cookies* fortified with quinoa seed flour are given in Table-2.

Table 2: Effect of quinoa seed flour on color characteristics of *cookies*

Treatments	Color characteristics		
	L* (Lightness)	a* (Redness)	b* (Yellowness)
T_0	78.42	1.52	20.46
T_1	66.33	2.83	18.84
T_2	60.59	3.41	17.37
T_3	55.21	3.67	16.20
S.E±	0.0354	0.0187	0.249
C.D at 5%	0.1064	0.0562	0.530

*Each value an average of three determinations

The data obtained from table-2 reveals the effect of different level of defatted soybean flour on color characteristics of *cookies*. It was observed that with increase in level of quinoa seed flour to *cookies* L* value (lightness) gets reduced from 78.42 to 55.21 up to 30 percent of quinoa seed flour slight changes in color were found. With increasing level of quinoa seed flour to *cookies* a* (redness) of *cookies* get increased from 1.52 to 3.67 where as b* (yellowness) of *cookies* get decreased from 20.46 to 16.20. Similar results were obtained with Isabelle (2015) in the present study lightness of cookies decrease with increase of quinoa flour and quinoa flakes, which have larger grain size than corn starch. Moreover, the high protein content, sugars and phenolic compounds of formulations with higher proportions of quinoa flour and quinoa flakes, may have contributed to decrease the lightness values of the cookies, due to the Maillard reaction, with a consequent increase of melanoidin formation, resulting in a darkening of the product (Secchi *et al*. 2011; Zucco, *et al*. 2011; Bassinello *et al*. 2011; Singh and Mohamed 2007).

3.3 Textural properties of *cookies* fortified with quinoa seed flour

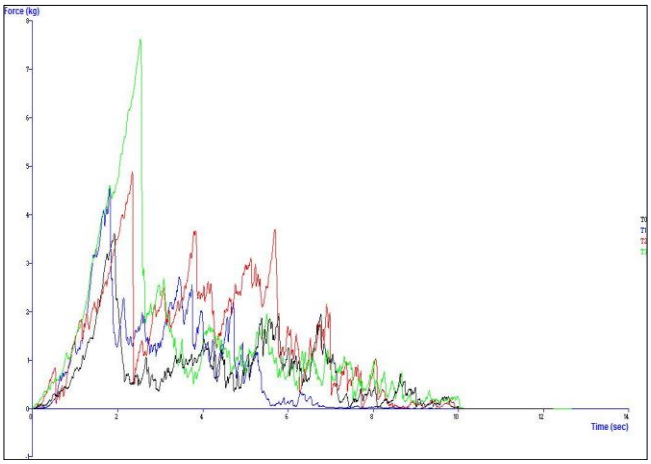
The textural profile analysis of *cookies* fortified with quinoa seed flour samples are presented in Table-3. The texture of any product plays a very important role in determining the acceptability. Texture Profile Analysis (TPA) of *cookies* fortified with quinoa seed flour using a texture analyzer. The values are summarized in table-3. The values of all the textural parameters are strongly dependent on the final moisture content of the samples and different level of quinoa seed flour. With increase in proportion of quinoa seed flour to *cookies* the hardness of *cookies* gets increased.

Table 3: Effect of different level of quinoa seed flour on textural characteristics (Hardness value) of *cookies*

3	Treatment	4	Hardness (kg)
5	T0	6	3.629
7	T1	8	4.616
9	T2	10	4.911
11	T3	12	7.635
13	S.E ±	14	0.068
15	C.D at 5%	16	0.146

*****Each value an average of three determinations

Data obtained from table-3 showed that effect of different level of quinoa seed flour on textural characteristics of *cookies*. It was found that hardness for sample T0, T1, T2 and T3 were 3.629, 4.616, 4.911 and 7.635 kg respectively. It was found that with increasing levels of quinoa seed flour to *cookies* hardness of *cookies* get increased. Similar results were observed with Patel and Rao (1996) reported that there is increased hardness of biscuits incorporated with untreated Bengal gram flour at level of 25 percent wheat flour. Singh *et al.* (1996) reported increased hardness in biscuit with increasing levels of DSF up to 50 percent. Gandhi *et al*. (2001) also reported increased hardness of cookies prepared by replacing wheat flour up to 40 percent level with defatted soya bean flour.



Graph 1: Representative graph of TPA of overall sample.

4. Conclusion

From the present investigation it was concluded that use of quinoa seed in cookies resulted in improvement in nutritional, textural and colour characteristics of cookies.

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