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Studies on development of technology for preparation of cookies incorporated with quinoa seed flour and its nutritional and sensory quality evaluation

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Abstract
Present investigation was performed to prepare cookies incorporated with quinoa seed and to study its effects on physico-chemical and sensory quality attribute of cookies. Malnutrition is a condition resulting from inappropriate nutrition. It includes both inadequate and excessive dietary intakes of nutrient and calories. Insufficient protein intake causes kwashiorkor and excess intake of calories resulting occurrence of various life threatening diseases. 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. The physical analysis of cookies showed that there was increased in weight, height and thickness with increasing proportion of quinoa seed flour. Chemical analysis showed increased moisture, fat, protein, fiber, ash and decreased in carbohydrate contents. The sensory evaluation revealed that sample T2 got highest score for overall acceptability. From the present investigation it was concluded that sample T2 was acceptable and got good score for sensory attributes and proceeded for further analysis. The incorporation of quinoa seed flour results in increasing nutritional quality of cookies.

Keywords: quinoa seed, cookies, sensory evaluation, proximate composition

Introduction
Nutritional imbalance can cause growth problems, specific diseases, and even death. Nutritional imbalances, deficiencies, and excesses are becoming more apparent as causes of health problems worldwide. Nutritional deficiencies can cause grave intellectual and physical impairments as well as affect an individual's overall well-being. Malnutrition continues to be a major public health problem throughout the developing world, particularly in southern Asia and sub-Saharan Africa. Malnutrition can be defined as "condition resulting from inappropriate nutrition" it includes both inadequate and excessive dietary intakes of nutrient and calories. Insufficient protein intake cause kwashiorkor in children, and a diet deficient in all nutrient cause marasmus. Excess energy lead to cause life threatening diseases like high blood pressure, diabetics, obesity and chances of cancer. Among these celiac disease is more common. Celiac disease (CD) is an autoimmune disease characterized by intestinal damage resulting from the ingestion of products containing gluten, or other prolamin (storage) proteins found in cereal grains (Alvarez-Jubete, 2010) [2].

For combating all type of diseases an individual need to take food which provide all nutrient in appropriate amount, containing essential amino acid profile, essential fatty acid, vitamins, mineral and dietary fiber etc. In health concerning era people are skipping food rich in gluten and energy and trying to use low gluten food. A gluten free food fetched the national and international market in big cities, shopping malls etc. Pseudo cereals are plants that produce fruit or seed which are used or consumed as grains, though botanically pseudo cereal are neither grasses nor true cereal grains. Pseudo cereal are typically high in protein and other nutrients, gluten free and are considered whole grains called pseudo cereal. Some important grains are quinoa, amaranth, buckwheat etc.

Quinoa is considered as pseudo-cereals crop, it is a broad leaf plant with starchy dicotyledonous seed and therefore not a cereal. Quinoa grains have an established excellent

nutritional food quality and were also called "the mother grain". Botanically, quinoa belongs to the class *Dicotyledoneae*, family *Chenopodiaceae*, genus *Chenopodium*, and species *quinoa*. 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. There are some gluten-free products without good baking properties for celiac groups, and quinoa provides an opportunity to develop gluten-free cereal-based products (Gallagher *et al*, 2004) [8]. Dogan and Karwe (2003) [6] showed that quinoa can be used to make novel, healthy, extruded, snack-type food products.

It has been realized that diet-based therapies are among the most effective and sustainable ways to overcome various maladies. However, development of successful food-based strategy requires knowledge of nutrients dense sources, target communities and indeed selection of suitable vehicle (Fiedler *et al.*, 2008; Steyn *et al.*, 2008) [7, 16]. Functional foods are important components in such interventions aiming to provide health benefits beyond their basic nutrition (Gidding *et al.*, 2005; Bárta *et al.*, 2006) [9, 5]. Wheat based baked products are considered suitable vehicles for incorporation of functional ingredients that can easily be accessible to masses especially in countries like India where wheat is staple diet (Jacob and Leelavathi, 2007) [10].

"Cookies" is chemically leavened product also known as "biscuit". Generally the term biscuit is used in the European countries and cookies in the US. Biscuit and biscuit like products have been made and eaten by man for centuries. Therefore this study investigated the effect of fortifying quinoa seed flour with wheat flour in preparation of cookies and studying its impact on physico-chemical and sensorial quality characteristics of cookies.

Material and Method

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.

Methods:

Physical analysis of cookies

Physical analysis of cookies such as height, thickness and spread ratio were carried out by using dernier caliper.

Proximate composition of cookies

Proximate compositions of cookies were carried out by method given by AOAC (1990) [1].

Sensory evaluation

Sensory evaluation of cookies was carried out by using 9 point hedonic scale (Preference method).

Methodology for preparation of quinoa seed flour

Selection of good quality quinoa grains is carried out. The grain cleaned to remove the unwanted material such as dust, dirt, stone, mud particles, leaf etc. The cleaned grain soaked in sodium bicarbonate solution or citric acid acid solution for 6 hours (for removing bitterness of seed due to presence of saponin). Soaked and drained grains was washed with running tap water and then allowed to dry. After drying the dried grain was finely milled to obtain a quinoa seed flour.

Quinoa
↓
Cleaning
↓
Soaking in sodium bicarbonate solution/ citric acid
↓
Washing in water
↓
Drying
↓
Grinding
↓
Quinoa seed flour

Flow chart. Preparation of quinoa seed flour

Composite flour preparation

Blend was prepared by mixing Maida and quinoa seed flour fortified in the different ratios.

Table 1: Standardization of formulation of composite flour given below

Sample	Maida (g)	Quinoa seed flour (g)
T0	100	0
T1	70	30
T2	60	40
T3	50	50

Preparation of cookies

Blends were prepared by mixing quinoa seed flour and refined Maida in different ratios on dry weight basis as per the recipe. These blends were standardized for product's acceptable physical characteristics as well as better nutritive value in the final product.

The dry ingredients i.e. composite flour, baking powder etc. were mixed together with the help of commercial sigma blender for 8 minutes with medium speed**.** A homogenous paste of fat and sugar was prepared in stainless steel pan. The dry mix and homogenous paste of sugar and fat was mixed thoroughly at high speed in commercial sigma blender to obtain uniformly mixed dough.

The prepared dough was rolled in a uniform shape of 6 mm thickness and cut into round shape cookies with the help of cutter. These cookies were baked at 175^0C for 15 min.

Technology for cookies from Maida and quinoa seed flour

Composite flour and dried mix cream preparation
↓
Mixed thoroughly the dried mix and pasted
↓
Dough
↓
Rolled into proper shape and size
↓
Cut with cutter
↓
Baked at 175^0C for 15 minute
↓
Cooled to room temperature
↓
Packed in polyethylene bags

Results and Discussion

Proximate composition of quinoa seed

Proximate composition generally represents the nutritional quality of product. It is necessary to determine the proximate composition of quinoa seed so as to judge its effect on final product after utilization as a novel ingredient. The proximate composition of quinoa was determined and presented in Table-2.

Table 2: proximate composition of quinoa

Sr. No.	Parameters (%)	Contents
1	Moisture	5.32
2	Ash	3.38
3	Crude fat	6.81
4	Crude protein	15.89
5	Crude fiber	3.50
6	Carbohydrate	65.10

*Each value an average of three determinations

It was being observed from the data depicted in table-2 that the quinoa flour contained 5.32 percent of moisture. This is expected since the sample has been subjected to drying to reduce the moisture content. Ash content of quinoa flour contained about 3.38 percent. Ash content is an indication of the level of minerals present in food material this suggests that quinoa can help in boosting the mineral content of prepared product. Crude fat, crude protein, crude fiber and carbohydrate of quinoa flour were observed 6.81 percent, 15.89 percent, 3.50 percent and 65.10 percent respectively.

The obtained results for the proximate composition of quinoa flour were found similar to that of results of Maradini-filho (2017) [12] and Galvez *et al.* (2010). The observed differences may be due to environmental factors like climate and location etc.

Proximate composition of wheat flour (Maida)

The quality of final product is a function of raw material quality and the base ingredient used in preparation of *cookies* with wheat flour and quinoa seed. It is necessary to study the proximate composition of wheat flour to assess its suitability in preparation of cookies. The present investigation was initiated to study of proximate composition of wheat flour and the data is summarized in table-3.

Table 3: proximate composition of wheat flour (Maida)

Sr. No.	Parameters (%)	Contents
1	Moisture	12.40
2	Ash	1.61
3	Crude fat	1.80
4	Crude protein	11.81
5	Crude fiber	1.85
6	Carbohydrate	70.53

*Each value an average of three determinations

It is observed from the table-3 that obtained wheat flour found to contain 12.40 per cent of moisture. The lower moisture content of wheat flour justifies the suitability for long term storage without deterioration (Peter and James, 2000) [13]. The protein content was recorded to be 11.81 per cent. The higher protein content is important for strong elastic dough which having high water absorptive capacity. The observed values for crude fat and ash content were 1.80 and 1.53 per cent respectively which are in line with the findings of Zeleny (1954) [18]. The crude fiber and carbohydrate were found 1.85 percent and 70.53 percent respectively. The results obtained in the present study for the analysis of wheat flour are also in close agreement with Yun *et al.* (1996) [17].

Sensory evaluation of cookies

Organoleptic characteristics are pivotal in judging the suitability of product as consumer point of view. In order to study the effect quinoa seed flour fortification on sensorial quality characteristics, different random trials with wide range of fortification levels has been taken following the unorganized sensorial evaluation. It was observed that *cookies* containing more than 50 per cent of quinoa seed flour fortification were not acceptable by panel members. Hence, for further optimization of quinoa seed flour fortification level in *cookies*, organized trials were taken by incorporating different levels *viz.* 30, 40, and 50 per cent of quinoa seed flour. The data pertaining to organoleptic quality evaluation of prepared cookies is presented in table-4.

Table 4: Effect of different levels of quinoa seed flour on sensory characteristics of cookies

Treatment	Color and appearance	Flavor	Taste	Texture	overall acceptability
T_0	8	8	8	8	8
T_1	8	9	8.5	8.4	8.4
T_2	9	9	8.5	9	8.8
T_3	8	8	7	8	7.7
SE±	0.057	0.059	0.065	0.020	0.055
CD at 5%	0.122	0.126	0.139	0.043	0.124

*Each value an average of three determinations

Control (T_0) Without addition of quinoa seed flour
T_1- With addition of 30 per cent of quinoa seed flour
T_2 - With addition of 40 per cent of quinoa seed flour
T_3 - with addition of 50 per cent of quinoa seed flour

Color is considered as one of the important consumer quality judging parameter in selection of food products. Attractive color of product is a must have in fast moving consumer goods to appeal consumer for consumption. Data from table 4 revealed that sample T_2 obtained higher score for color i.e. (9) then sample T_0 obtained good score (8) for color and appearance. With sample T_3 in level of quinoa seed flour color and appearance found to similar result (8).

Flavor being a combination of taste, smell and mouth feel, has large number of factors it. Sample T_2 obtained highest score for flavor i.e. (9) while sample T_3 obtained less score for flavor i.e. (8). The sample T_2 obtained maximum score for taste (8.5) where as sample T_1 obtained similar score for taste (8.5). When *cookies* fortified more than 40 percent by quinoa seed flour then taste of *cookies* get affected.

Textural characteristics play a pivotal role in judging its consumer acceptability. It could be stated that textural characteristics of *cookies* is basically function of moisture content. The sample T_2 founded good textural characteristics with obtaining highest score for texture i.e. (9), while sample T_3 obtained fewer score about (8). The sample T_2 obtained good score for overall acceptability (8) as compared to control and other sample. However among other treatments T_2 was better and was mostly acceptable after T_1. Thus on overall acceptability score T_2 (40 percent quinoa flour) was considered as standardized and used for further substitution.

Adriana Paucean *et al.* (2016) [14] reported similar result by To optimize recipe of the aglutenic cookies obtained using rice flour (RF) and quinoa flour (QF) the following blends RF/QF, 90:10, 75:25, 55:45 were performed Thus, the biscuits were prepared from the RF/QF blends and evaluated for

physicochemical and sensory properties. However, the usage of quinoa flour as more than 45% of the blend, reduced the overall acceptability and the sensory quality attributes of the cookies.

Banureka and Mahendran (2009) [3] reported that biscuit produced with soy flour substitution up to 25 percent were nutritionally superior to that of the whole wheat flour biscuits. To obtain biscuits of high nutritional and organoleptic qualities, wheat flour could be substituted with 10 percent of soy flour.

Effect of quinoa seed flour on physical characteristics of cookies

Physical properties of cookies are indicative of the quality characteristics. The data pertaining physical parameters of quinoa flour fortified cookies is presented in table-10. It could be observed from the table that weight of cookies remained more or less similar (though slightly high) to that of control sample. Maintaining the constant weight of final product is essential to comply with the regulations and delivering uniform product to consumer. The weight of obtained product though lower to that of control, could be maintained to modifying initial weight of dough before baking.

Physical analysis of cookies is important from both consumers and manufacturers point of view. *Cookies* were analyzed for physical characteristics including weight, thickness and diameter and results are presented in Table-5.

Table 5: Effect of different level of quinoa seed flour on physical characteristics of cookies

Treatment	Weight (g)	Thickness (cm)	Diameter (cm)	Spread ratio
T0	10.5	0.84	5.8	7.07
T1	11.7	0.85	5.8	6.94
T2	12.4	0.86	5.9	6.96
T3	12.9	0.86	6.0	6.96
S.E±	0.035	0.154	0.019	0.164
C.D at 5%	0.106	0.328	0.0588	0.116

*Each value an average of three determinations

The data from table-5 reveals that weight, thickness, diameter and spread ratio for control *cookies* (T_0) were 10.5g, 0.86 mm, 5.8 cm and 7.07 respectively. It was found that increase in weight of *cookies* from 10.5 to 11.7 g with increase in levels of quinoa seed flour. Treatment T_3 observed with highest weight among other treatments (12.9). Increase in weight of *cookies* observed because of property of quinoa seed flour to absorb more water and retain it.

The data pertaining to thickness indicated gradual increase with increase in quinoa seed flour incorporation. Random results were observed in case of quinoa seed flour cookies.

Maximum spread factor was observed in case of sample T_3 of quinoa seed flour, followed by T_2 quinoa seed flour incorporated cookies. The spread factors of all other sample remained more or less similar. On the basis of obtained results, it is difficult to establish any relationship between the spread factor and levels of different quinoa seed flour constituents. However, it could be concluded that spread factor is not much affected by the incorporation of quinoa seed flour. Similar results were founded with Paucean *et al*. (2015) [14] He was prepared cookies fortified with quinoa flour.

Effect of quinoa seed flour on chemical parameters of cookies

The chemical composition of cookies regarding moisture, ash, crude fat, crude protein, crude fiber and carbohydrate are presented in table-6.

Table 6: Effect of different level of quinoa seed flour on chemical characteristics of cookies

Sample	Moisture (%)	Ash (%)	Crude fat (%)	Protein (%)	Fiber (%)	Carbohydrate (%)
T0	2.96	0.73	18.63	7.85	0.42	69.63
T1	4.24	2.14	21.94	13.15	2.16	56.43
T2	4.87	2.31	24.08	16.43	2.47	49.54
T3	5.53	2.49	27.78	20.04	2.62	41.54
SE±	0.0276	0.065	0.087	0.063	0.024	0.054
CD at 5(%)	0.588	0.471	0.662	0.572	0.598	0.481

*Each value an average of three determinations

The table-5 reveals that with the increase in quinoa seed flour at different level in *cookies* there was significant increase in protein, ash, crude fat, crude fiber and moisture content and decrease in carbohydrate content. The moisture content was increased from 2.96 percent to 5.53 percent because of high moisture retention capacity of quinoa seed flour than wheat flour. The protein content and fat content of *cookies* increased from 7.85 to 20.04 percent and 18.63 to 27.78 percent respectively, with increasing formulation of quinoa seed flour in cookies from 20 to 50 percent. The protein content of cookies blended with quinoa seed flour was significantly higher than that of control cookies. The crude fiber and ash contents increased from 0.42 to 2.62 percent and 0.73 to 2.49 percent respectively, thus being significantly higher in *cookies* prepared from quinoa seed compared to that of control.

Increase in protein, crude fat, crude fiber, and ash content of *cookies* supplemented with quinoa seed flour might be due to their appreciably higher contents in quinoa seed flour than wheat flour. The carbohydrate content of cookies was found to be significantly decreased from 69.63 to 41.54 percent with increasing levels of quinoa seed flour in *cookies*. The lowered carbohydrate content in *cookies* might be due to their lower contents in quinoa seed flour than wheat flour.

Sathe *et al*. (1981) [15] reported that increased protein content in crackers prepared by replacing wheat flour with soy flour. They reported that the high protein content was associated with the water binding properties of soy flour. Barnwal *et al*. (2013) [4] prepared biscuits incorporated with de oiled maize germ cake, and reported increased in protein, fat, ash, crude fiber with increase in proportion of de oiled cake flour. Kumar *et al*. (2010) [11] developed Soy based biscuits by incorporation of millet flour at 70, 80, 90 and 100 percent level for increasing protein content, and reported that with increase in soy flour significantly increase in protein and fat content.

Conclusion

From the present investigation it was concluded that sample T2 was acceptable and got good score for sensory attributes and proceeded for further analysis. The incorporation of quinoa seed flour results in increasing nutritional quality of cookies.

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