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PHYTOCHEMICAL PROFILE OF CHIA & QUINOA - SIGNIFICANCE OF INCORPORATION IN SNACKS

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Quinoa and Chia are pseudo cereals, fast emerging as 'nutraceuticals'. They are widely known as "super foods" for their high nutritional content. Many developing countries face challenges of malnutrition, undernourishment and micronutrient deficiencies .In addition, many people are allergic to wheat and wheat-based products. To address these nutritional problems in consideration, while improving the physical well-being of consumers and promoting a healthy society an effort was made to develop value added products. In the present study, the proximate and phytochemical analyses were carried out followed by formulation of nutritious sweet and salty cookies with mixtures of Quinoa and Chia. These were compared with similar wheat-based products available in market. Cost constraints may lower acceptability among all strata. Therefore, production of these pseudo cereals in our country on a large scale will benefit farmers too.

Key words: Cookies Nutraceutical, Phytochemical analysis, Pseudo cereals, Quinoa, Chia.

Introduction

In a country like India with a high rate of malnutrition, and increasing urbanization these crops will help curb food insecurity by Food fortification, Supplementation and Dietary diversification. Pseudo cereals[1] such as amaranth, buckwheat, chia and quinoa are non-conventional sources of gluten-free[2] proteins .These pseudo cereals are increasingly being consumed due to high essential amino acid content [3, 4]. Being nutrient-dense, easily digestible and sourced from plants, they may overcome malnutrition and are an alternative food staple in celiac diseases[5].

Chia (*Salvia hispanica* L.) of family Lamiaceae is a biannually cultivated plant, prominently grown for its seeds. Chia seeds are a rich source of proteins, fats, carbohydrates, iron, calcium , high dietary fiber, vitamins, and also antioxidants[6]. It has essential amino acids and fatty acids[7, 8] and has to be supplied in our diet[9]. A native plant of Central and Southern Mexico, it has great potential as a future crop plant. Improvement of human health by introduction of Chia seeds in western diets is revealed recently. A correlation between high-saturated fatty acids (SFA) and low polyunsaturated fatty acid (PUFA) intake and diseases viz. diabetes, and cardiac ailments were broadly covered; also the benefits of chia to human health were demonstrated [10].

Quinoa, botanically known as *Chenopodium quinoa* Willd. belongs to the family "Chenopodiaceae". It is a fruit and not a grain, as understood by laymen. The color of seeds vary from white to grey and black, with shades of rose, red, yellow, purple and violet. Shape of seeds are rounded and flattened and measure about 1.5-4.0 mm in diameter It is tolerant to highly salt, acid or alkaline soils, and grows

in cold (-5°C) or hot climates (up to 35°C)[11] equally well. Quinoa is distributed worldwide and due to its hardy nature, holds great possibility for Rajasthan.

Quinoa protein has a high biological value (73%) [12, 13], similar to that of beef (74%), and higher than several staple cereals. It is a rich source of all essential amino acids and unsaturated fatty acids[14]. Lysine, an essential amino acid which is deficient in many grains[15], is found in high amount in Quinoa. Similarly, another essential amino acid methionine, deficient in many legumes[16], is abundant in it. Keeping in mind the nutritional value of Quinoa, it can be exploited and developed into a variety of nutritive foods and energy drinks. Tables 1, 2 and 3 demonstrate the nutritional content of chia and quinoa seeds.

Table 1: Nutritional composition of quinoa and chia seed (g/100g edible portion)

	Quinoa	Chia
Protein	14.1	21.5
Fat	6.1	35.4
Fiber	7	30.2
Carbohydrate	64.2	8.6
Ash	2.4	4.5
Moisture	13.3	8.4
Kcal/100g	368	439

Table 2: Amino acid composition (g/100g protein)

	Quinoa	Chia
Histidine	2.9	1.37
Leucine	5.9	4.15
Isoleucine	3.6	2.42
Lysine	5.4	2.99
Methionine + Cysteine	3.6	2.78
Phenylalanine + Tyrosine	6.1	3.88
Threonine	3.0	1.8
Valine	4.2	2.85
Tryptophan	1.2	-
Alanine	4.2	2.68
Glycine	4.9	2.28
Proline	5.5	1.99
Serine	4.0	2.62
Glutamic acid	13.2	24.3
Aspartic acid	8.0	7.29
Arginine	7.7	4.23

"-": Indicates not determined or not quantifiable.

Table 3: Compositional analysis of mineral and vitamins present in quinoa and chia seed (mg/100g edible portion)

	Quinoa	Chia
Minerals		
Calcium	47	631
Magnesium	197	350
Potassium	563	407
Phosphorus	457	860
Iron	4.6	7.72
Copper	0.6	1.4
Zinc	3.1	4.58
Sodium	5	16
Vitamins		
Thiamin B1	0.36	0.62
Riboflavin B2	0.32	0.17
Niacin B3	1.52	8.82
Folic acid	78.1	-
α-Tocopherol	2.44	-
β-Carotene	8	-

"-" Indicates not determined or not quantifiable.

Globalization and urbanization are responsible for changes in lifestyle and food habits among communities all over the world. Modern food habits of diets rich in refined carbohydrates, animal fats and oils have replaced traditional food patterns rich in complex carbohydrates, micronutrients, fiber and phytochemicals. Some chronic diseases[17-19] have become ubiquitous as a consequence of this situation.

Vegetarianism is often assumed as the norm in India, encouraged or imposed by ideologies of religions and caste. However, a survey conducted by the National Family Health Survey, 2015-16 reveals otherwise. 63-77 % of Indians are non – vegetarian across the country with Rajasthan, Haryana and Punjab having the highest percent of vegetarians. Contrarily, people in the West are evolving deliberately to become vegetarian.

Nowadays, more and more people are having allergies from wheat and wheat products. Replacement of wheat as a staple by gluten-free maize is a substitute for celiac

patients providing essential nutrients and preventing nutrition related diseases while improving physical well being of consumers. Several steps like bio-fortification, value-added products and product development have been suggested to get rid of all these consequences[20, 21]. Mixing flours made from various sources like plant crops such as maize, soybean, cassava, flaxseeds, ragi along with pulses like beans, peas, to provide vitamins and amino acids are required by vulnerable sections of society[22].

Keeping in mind the various socio economic status, diverse populations, food habits of Rajasthan, selection of various food items have been adapted to develop an admixture which will enhance the nutritive value of final products along with cost-effectiveness, so that they can be availed by various vulnerable population groups of the country[23-25]. In addition to its highly nutritive nature, the mucilaginous properties of chia make it an excellent inclusion in gluten-free foods as a binding agent as well as a vegetarian substitute for eggs.

Sweet and savory cookies using chia seeds and quinoa flour prepared were compared with similar, most readily available varieties in the market.

Material and Methods

Quinoa was procured from Agriculture University, Mandore while other ingredients like Chia seeds, jaggery, salt, butter were obtained from local market of Jodhpur. Sweet and savory cookies were hygienically prepared, cooled and stored in zip pouches for further analysis.

Proximate composition, including determination of moisture, carbohydrate, protein, fat (ether extract), ash, fiber and energy contents were determined. Moisture (electronic moisture analyzer), protein (Micro Kjeldahl method; x nitrogen value by 6.25), crude fat (Soxhlet method), ash and crude fiber were estimated[26]. The carbohydrate content was obtained by the difference of 100 to the other components. The energy content of the sample was determined by using the fuel value of protein, fat and carbohydrate using the equation[27]**:**

Physiological Energy value (kcal /100g) = 4 x crude protein (%) + 4 x Carbohydrate (%) + 9 x Crude fat (%)

Mineral estimation**:** The minerals including calcium, iron, sodium and zinc were estimated using an atomic absorption spectrophotometer[26]**.** Mineral solutions of selected samples were prepared by the wet ashing method. For this, 1g of moisture-free sample was taken in a digestion tube and 5ml of concentrated nitric acid was added into it and left overnight. The next day, digestion tube was placed in a digestion rack for heating process for 30min and cooled down at ambient temperature. Later, 5 ml of perchloric acid was added into it and again heated over the digestion rack for the next 40min. After that particles were completely digested and the solution became clear. Later, the volume of the digested matter was made up to 100 ml with double distilled water, and an aliquot from this solution was used for the estimation of calcium, iron, sodium and zinc. Sodium was estimated by using a flame photometer.

Results and discussion

Sweet and savory cookies prepared in the laboratory (Fig. 1 and 2) were compared to a leading brand of similar wheat based sweet and savory cookies readily available in the market**.**

Fig 1: Sweet cookies

Fig 2: Salty cookies

Comparison of prepared and market bought similar sweet cookies (Table 4):

It was observed that prepared cookies contained 25.6% more Energy, 15.72% less Fat, 63.32% more Protein, almost 55% less Carbohydrates and 25% less Total Sugars. Dietary fibres were present. 6.8% less Saturated Fatty Acids and Cholesterol was a drastic 95% less, also 34.6% lower Sodium was found in prepared cookies. Calcium, Iron and Zinc was not mentioned in market variety.

Comparison of prepared and *market* bought similar savory cookies:

While the prepared cookies contained 8.2% less Energy and 29% less Carbohydrates and also 11.9% less Fat they contained almost 94% more Protein and a whopping 220% more Calcium. Total sugars were less by 80.7% and Cholesterol was less by 45.8%. There was only a marginal difference in Saturated Fatty Acids, i.e., 4.8% less. Poly Unsaturated Fatty Acids were 26% more than market bought cookies. (Table 5)

Vitamin A was detected in prepared cookies whereas it was absent in market varieties. Curiously, Trans Fatty Acids, Mono Unsaturated Fatty Acids and Poly Unsaturated Fatty Acids were not mentioned in market bought varieties. This seems to be some market gimmick so that people unknowingly consume foods unlimitedly which may not be good for their health in a long run. Therefore, it is of utmost importance to provide better nutritional options with actual nutrient compositions mentioned clearly on the packages.

Table 4: Sweet cookies
Acceptable taste and flavor, free from odor

S.No.	Parameter	Cookies Prepared	Popular cookies available in market
1.	ENERGY, kcal/100g	578.82	461
2.	FAT g/100g	18.54	22
3.	PROTEIN g/100g	11.58	7.09
4.	CARBOHYDRATE g/100g	35.16	78.01
5.	TOTAL SUGAR g/100g	18.59	24.82
6.	DIETARY FIBER g/100g	2.93	0
Fatty acid profile	SATURATED FA g/100g	10.25	11
	TRANS FA g/100g	1.73	-
	MUFA g/100g	7.91	-
	PUFA g/100g	1.38	-
	CHOLESTEROL mg/100g	4.3	6.5
Minerals	SODIUM mg/100g	185.65	283.69
	CALCIUM mg/100g	693.81	-
	IRON mg/100g	2.93	-
	ZINC mg/100g	1.48	-
	VITAMIN A mcg/100g	290.80	-

It was found that wheat flour can be fully replaced by chia flour in gluten free baking, the only disadvantage being the colour of

the flour, which is slightly brownish. 89% incidence of seeds with black colour were observed[33], a fact that was proved in colour analysis. Lipid content of the chia flour cookies was significantly higher compared to the control cookies, but 60% of the lipids present in chia flour are PUFA. The omega-6-fatty acids , a type of PUFA present in whole chia flour is in the range of 17.6-20.4% [34-36]. Quinoa is considered to be a source of good quality protein due to its balanced amino acid composition, with Lysine as a dominant amino acid.

Table 5: Savoury cookies
Acceptable taste and flavor, free from odor

S. No.	Parameter	Cookies prepared	Popular cookies available in market
1.	ENERGY, kcal/100g	461.06	502
2.	FAT g/100g	22.9	26
3.	PROTEIN g/100g	12.93	6.66
4.	CARBOHYDRATE g/100g	50.81	71.66
5.	TOTAL SUGAR g/100g	3.54	18.33
6.	DIETARY FIBER g/100g	2.86	0
	SATURATED FA g/100g	12.37	13
	TRANS FA g/100g	0.57	-
	MUFA g/100g	6.13	-
	PUFA g/100g	3.40	2.7
	CHOLESTEROL mg/100g	2.17	4
	SODIUM mg/100g	706.41	-
	CALCIUM mg/100g	660.84	206
	IRON mg/100g	3.31	-
	ZINC mg/100g	1.86	-
	VITAMIN A mcg/100g	439.89	-

The protein content in quinoa was stated to be 14.5 percent on dry weight basis and the nitrogen to protein conversion factor used were 5.96 for quinoa seeds[37].

This result was similar to that found in this study. Quinoa has a good balance of the amino acids that make up its protein content[38] as compared to other grains such as amaranth, barley, rice , corn and wheat. However, it can be used in mixed form with other grains to improve the protein balance in various formulations .It is also a good complement for legumes, which are often low in methionine. This is in accordance with another study[39]. So, the quinoa grains may provide a good alternative for preparation of gluten-free bakery products.

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