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Formulation and nutritional analysis of biscuits made from quinoa, flax seed and brown rice

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Abstract
In the present fast growing rapid changing global society, attaining good health has become a challenge for all age groups. Consumption of foods made from refined grains has increased and the physical ailments like diabetes, cardiovascular diseases, obesity and high blood pressure has been doubled. The present work has been made by utilising the underutilised, more nutritious whole grains like Quinoa, Flax seed and brown rice in preparing a well-balanced, super nutritious food product. Biscuits were prepared by adding quinoa and brown rice at different levels and keeping flax seed constant (20%) and were compared. These were assessed for their nutritional composition as well as daily values. Biscuits prepared with quinoa, flax seed and brown rice in 40:40:20 was superior in protein (11.27%) dietary fibre (10.4%) Potassium (242.04mg), calcium (70.73mg), Magnesium (117.15mg), and Phosphorous (239.87mg).

Keywords: quinoa, flax seed, brown rice, nutritional composition, physical ailments, daily values

1. Introduction

In India, consumers perspective of selecting foods has changed. They are very particular about the food they consume that will lower the risks of metabolic syndrome and at the same time help them to stay slim, vital and attractive throughout their lifetime. In the present fast growing rapid changing global society, attaining good health has become a challenge for all age groups because of the prevalence of several chronic diseases. Growing awareness about the role of diet and the consequences of inadequate nutrition has led the food industry to develop new products which work like medicine. Consumer demand for nutritious, convenient and safe foods is increasing day by day Consumption of foods made from refined grains (e.g., cookies, pasta, pastries, white bread) has increased and the health risk has been doubled not only to weight gain but to increased risk of insulin resistance and the metabolic syndrome features like low levels of HDL cholesterol, visceral obesity (the "apple shaped" body), high triglycerides, high blood pressure and allergy (gluten intolerance) [1]. Consumption of whole grains have protective action against all these illness. Among all the bakery products, Biscuits are the most popular food stuffs well cherished by all the population due to their long shelf life and low cost [2, 3].

Quinoa pronounced as (keen-wah) is a pseudo cereal of the Andean regions of South America. Quinoa belongs to the *Chenopodiaceae* family, genus *Chenopodium* [4]. It is a good sources of protein (12 - 18 g/100 g on dry weight), fiber, vitamins (such as C, E And B complex) and important minerals (such as Fe, Ca, K, Mg, P and Zn) [5, 6], Quinoa seeds Can be a rich source of essential fatty acids such as linolenic (18:2n-6: 52%) and linolenic (18:3n-6: 40%).

Other compound include polyphenols, phytosterols, flavonoids and a large variety of Antioxidant compounds, such as carotenoids [7] which have a very protective action against Many health disorders and diseases like cancer, allergy and inflammation, cardio vascular Related issues diabetes and Alzheimer's disease [8-10].

The levels up to which quinoa flour can be added as a substitute have been reported as in Bread (10–13%quinoa flour), noodles and pasta (30–40% quinoa flour), and sweet biscuits (60% quinoa flour).

Viewing in the Indian perspective, Quinoa may be classified as "underutilized, despite its wide adaptability, and nutritional superiority. In Andhra Pradesh, the crop has been successfully cultivated in Ananthapur district, a drought-prone area under the name "Project Ananta" in the laboratory in February 2013 and small offshoots planted in March. Despite the severe summer its growth was phenomenal and the crop yielded well [11].

Flax seed, also known as linseed, is originated in the Middle East thousands of years ago which belongs to the family of *Linaceae,* of the genus of *Linum*, and botanically named as *Linum usitatissimum.* These small oilseeds are considered as functional food and are incorporated in human diet because of its abundant omega 3 fatty acids such as *linoleic acid, alpha linolenic acid (ALA) and Arachidonic acids*. Which are required for overall development and maturation of nervous system. The fiber helps regulate blood sugar and cholesterol levels, weight loss, prevent constipation, cancer and other plant compounds thereby promoting overall health and wellness [12-14].

Rice (*Oryza sativa*) is a major staple cereal all over the world, especially in many Asian countries. Removal of the outer most layer, hull produces Brown rice. Brown rice's High magnesium content the body has been shown in studies to be helpful for reducing the Severity of asthma, lowering high blood pressure, reducing the frequency of migraine Headaches, and reducing the risk of heart attack and stroke by preventing calcium from Rushing into the nerve cell and activating the nerve. Manganese in brown rice helps produce Energy from protein and carbohydrates and is involved in the synthesis of fatty acids, which are important for a healthy nervous system. Brown rice is an excellent grain choice for people with diabetes. The Fiber helps by keeping blood sugar levels under control and can also help to protect against colon and it can help normalize bowel function, reducing constipation [15-16]. It contains no trans-fat or

cholesterol. It has only trace amounts of fat and sodium. Thus, brown rice is recognized to belong to whole-grain food category and is regarded as a natural gluten-free and hypoallergenic ingredient [17-18].

The present study is to include these less utilised, more nutritious raw materials quinoa, flax Seed and brown rice in preparing a well-balanced, super nutritious and benefited food product suitable to all age groups and evaluation for its nutritional value.

2. Materials & Methods

2.1 Raw materials Collection and Preparation

Quinoa, Roasted Flax seed powder, brown rice were procured from the local market. The other consumable products were obtained and they were as follows-fat, sugar.

2.1.1 Preparation of Quinoa flour

Quinoa seeds are washed in running water until no foam is seen since the outer layers contain saponins which impart bitter taste. The water is allowed to drain for some time and the seeds are dried in a hot air oven maintained at 50˚c.The dried grains were ground to fine powder using electric grinder stainless steel and sifted through 60 mesh. The above prepared flour is used in required quantities for preparation.

2.2 Biscuit formulation and preparation

Three formulations of quinoa, brown rice and flax seed biscuit were prepared. Each formulation varied by ratio of quinoa to brown rice. Flax seed was kept as constant. For the preparation of biscuits, Fat and sugar were mixed until creamy. Next, quinoa flour, flax seed powder and brown rice flour were put into the mixture of fat and sugar. They were uniformly mixed to obtain a consistent dough. The dough was rolled out and cut using biscuit cutter. The biscuits were baked in Traditional Brick oven for 20 min. After baking, biscuits were cooled to room temperature, packed in polypropylene pouches and sealed for further analysis.

Treatments

- T1 - 20g Quinoa flour,60g brown rice flour,20g flax seed powder (20:60:20)
- T2 - 30g Quinoa flour,50g brown rice flour, 20g flax seed powder (30:50:20)
- T3 - 40g Quinoa flour,40g brown rice flour, 20g flax seed powder (40:40:20)

2.3 Nutritional Analysis

The moisture, ash, protein and fat of the biscuits were determined according to the standard AOAC methods [19].The carbohydrate content was determined by calculated difference and calorie value was estimated by multiplying proportion of protein, fat and carbohydrate by their factors. Crude Fibre was determined using AOAC method. Total dietary fibre (TDF) was analysed by following enzymatic gravimetric method. Vitamin C was determined using 2, 6, dichloro indophenol method. Minerals were analysed using ICP-OES.

2.4 Daily value of the product

The daily value is used for nutrition labelling which help the consumer make informed food choices. This represents both the terms Daily Reference Value (DRV) and Reference Daily Intake (RDI).These are developed by USFDA. This provides guide to the nutrients in one serving of food. These are based on a 2000 calorie diet for healthy adult.

The nutrients in the formulations are calculated for their Daily value.

3. Results and Discussion

The nutritive values of the three formulations were represented in the Table 1, Table 2 and Table 3. Moisture, Ash content, Fat, Protein, Crude fiber and Carbohydrates were represented in g/100g.Energy in kcal and Vitamin c in mg/100g.minerals are represented in mg/100g.

Table 1: Proximate composition of biscuits (per 100g)

Sample	Moisture (g)	Minerals (g)	Protein (g)	Fat (g)	Crude fiber (g)	Carbohydrates (g)	Energy (kcal)
T1	2.46±0.05	1.20±0.02	10.12±0.07	23.38±0.05	1.42±0.04	62.86±0.01	502±0.10
T2	3.09±0.07	1.24±0.06	10.74±0.06	24.54±0.06	1.81±0.08	60.4±0.14	506±0.71
T3	3.28±0.04	1.28±0.06	11.27±0.05	25.12±0.07	1.95±0.09	59.07±0.09	508±0.71

Table 2: Dietary fiber and Vitamin c of biscuits (per 100g)

Sample	Dietary fiber (g)	Vitamin-C (mg)
T1	8.68±0.09	7.7±0.08
T2	9.52±0.06	9.3±0.08
T3	10.4±0.08	11.93±0.09

Table 3: Mineral analysis of biscuits (per 100g)

Sample	Calcium (mg)	Potassium (mg)	Phosphorus (mg)	Magnesium (mg)	Iron (mg)	Manganese (mg)	Zinc (mg)
T1	60.42	237.54	232.88	110.54	1.85	0.99	0.81
T2	68.36	238.51	237.52	112.53	2.32	1.24	1.64
T3	70.73	242.04	239.87	117.15	2.40	1.25	1.66

The moisture content in the three samples increased with the increase in quinoa flour and was found to be 3.28% maximum. This shows that the moisture in biscuits is controlled and is in the range required as per the specification of 5%.Low levels of moisture make the product hard and higher levels effect the shelf life of the product. The ash content which is the inorganic matter remained after the organic matter was removed by heat and which is an index of the mineral matter was found to be in between 1.20-1.28%.The protein content increased from T1 to T3 and was highest in T3 (11.27g).This could be attributed to the addition of quinoa flour which is a richest source of protein. This is in agreement with the work carried by [20]. The dietary fiber content was high in three samples the maximum being 10.4%, this might be due to the addition of brown rice and flax

seed which by nature have highest portions. Vitamin c has increased and this is due to the quiona added. This itself acts like a preservative and helps the product not to spoil quickly. The carbohydrates decreased from 62.86 to59.07%.These results are in agreement with [21] who said that with incorporation of quinoa flour there will be a decreases in the carbohydrate content and Energy has been increased in the samples which provide the highest calories.

The mineral content of the biscuits is remarkably high. The calcium content was 70.73mg/100g. Potassium content was highest in formulation T3 (242.04mg/100g).The phosphorous content was three fold the highest being 239.87mg/100g this is due to the addition of quinoa which has the minerals three folds more than other cereals [22-24].

The magnesium content was outstanding in all the three formulations in the range of 110.54-117.15mg/100g.This is due to the brown rice highest magnesium content. The manganese content was high (1.25mg/100g).

The nutritional values of all the three formulations prepared from quinoa, flax seed and brown rice in different proportions were remarkably greater. Among all the three formulations T3 had the highest mineral content, dietary fiber, protein as well as Vitamin c and was very appreciable.

The daily value for the three formulations are represented in Table 4, Table 5 and Table 6.

Percent daily values are based on a 2,000 calorie diet

Table 4: Daily Value for T1

S. No.	Food Component	Product Contains (Per 100g)	Daily Value %	Nutrient Claims
1	Protein (g)	10.12	20	Excellent source
2	Dietary Fiber (g)	8.68	35	Excellent source
3	Phosphorous (mg)	232.88	23	Excellent source
4	Magnesium (mg)	110.54	28	Excellent source
5	Vitamin c (mg)	7.7	13	Good source

Table 5: Daily Value for T2

S. No.	Food Component	Product Contains (Per 100g)	Daily Value %	Nutrient Claims
1	Protein (g)	10.74	21	Excellent source
2	Dietary Fiber (g)	9.52	38	Excellent source
3	Phosphorous (mg)	237.52	24	Excellent source
4	Magnesium (mg)	112.53	28	Excellent source
5	Vitamin c (mg)	9.3	16	Good source

Table 6: Daily Value for T3

S. No.	Food Component	Product Contains (Per 100g)	Daily Value %	Nutrient Claims
1	Protein (g)	11.27	23	Excellent source
2	Dietary Fiber (g)	10.4	42	Excellent source
3	Phosphorous (mg)	239.87	24	Excellent source
4	Magnesium (mg)	117.15	29	Excellent source
5	Vitamin c (mg)	11.93	20	Excellent source

As per Food and Drug Administration, the nutrient claims are as follows:

- "Good Source of"= Contains, 10% or more of Daily Value (DV) to describe protein, vitamins, minerals, dietary fiber, or potassium per reference amount.
- "High," "Rich In or "Excellent Source of"'= Contains 20% or more of the Daily Value (DV) to describe protein, vitamins, minerals, dietary fiber, or potassium per reference amount.[25]

From the results it is evident that the prepared formulated biscuits T3 is an excellent source of Protein, dietary fiber, Phosphorous, Magnesium and Vitamin C whereas TI, T2 are excellent source of Protein, dietary fiber, Phosphorous, Magnesium and good source of Vitamin C.

This shows a greater way to meet all the dietary deficiencies and thereby attain a healthy balance of all the nutrients in one single food product suitable to wide range of population. This study provides a promising solution to meet the food security and superiority for a nutrient deficient free future.

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