



Effect of Storage on Dietary Fibre Rich, Multigrain Cookies

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

This study focused on the effect of value addition of multigrain cookies with ripe banana peel powder and date powder during storage. Physical and physicochemical analysis of value added multigrain cookies were determined as per AOAC and evaluate the effect of these parameters during storage. The study firstly optimizes the formulation of multigrain flour, comprising wheat, oats, finger millet and barley flour, by blending these flours in various ratios. Subsequently, based on sensory evaluation, a 70:30 ratio (wheat flour to other flour) was found acceptable. Incorporation of banana peel powder and date powder in ratio of 2.5 to 10 % with shortening, powdered sugar, milk, vanilla essence and baking powder resulted in nutritionally rich cookies compared to control in the manner of protein, crude fiber and carbohydrate. Data obtained from analysis clearly indicated that significant higher score was observed for T₅ cookies containing 60:30:5:5 ratio of wheat flour: multigrain flour: banana peel powder: date powder. The effect of storage time was sustainably significant on cookies quality parameters, indicating that cookies were acceptable up to 1 month stored in polyethylene bags without any preservative under ambient conditions.

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1. INTRODUCTION

“Wheat (*Triticum* spp.) is the second most important winter cereal in India after rice. Bread wheat contributes approximately 95% to total production while another 4% comes from *durum* wheat and *Dicoccumsharein* wheat production remains only 1%. India has witnessed a significant increase in total food grain production to the tune of 233.88 million tonnes with a major contribution of wheat with 80.58 million tonnes (34.5%) during 2008-09” [1]. “The wheat flour serve as a key ingredient in chapatti, bread and a variety of bakery products, including cakes, cookies, crackers, doughnuts, sweet rolls and biscuits” [1]. Its inherent property to forming dough and retaining gases makes wheat flour an essential component in bakery items.

“Oats (*Avena sativa*) are excellent sources of different dietary fibre components of linkage (1-3), (1-4)- β -D glucan arabinoxylans and cellulose” [2]. “Soluble fibre of oats has been reported to reduce elevated blood cholesterol, triglyceride, and glucose levels. Oats also good sources of insoluble fibre functions as a water holding capacity agent and can reduce intestinal transit time when present in adequate amounts in foods” [3].

“Finger millet (*Eleusine coracana*) also known as *Ragi* is mainly used in India and Africa. Finger millet is important millet crop in dry hill area of India. It is rich in protein, calcium, phosphorus, iron, fiber and vitamin content” [4]. “The calcium content is higher than all cereals and iodine content is considered to be highest among all the food grains. Finger millet has best quality protein along with the presence of essential amino acids, vitamin A, vitamin B and phosphorus” [5].

“Tropical forest plants is very rich source of chemical compounds or bioactive efficacious. Many compounds have the potential to serve as raw materials in food processing. One is the banana plant, the most common fruit crops grown in almost all tropical countries, including India. Generally people just consume or eat the fruit and throw banana skin just because it is considered as waste. As industrial by-products, peels represent about 30-40 % of fruit weight, this resulted in 200 tons of waste from banana

peels. The banana peels waste is normally disposed in municipal landfills, which contribute to the existing environmental problems” [6]. “The peel is rich in fiber, proteins, essential amino acids, polyunsaturated fatty acids, potassium, and phenolic compounds” [7,8]. The fruit fibre has a better quality than other fibre sources due to its high total and soluble fibre content, water and oil holding capacities, and colonic ferment ability, as well as a lower phytic acid and caloric value content. Besides using whole grains, the nutritional enhancement of product could be done by replacing the purified sugar with natural traditionally used sweet products like date (*Phoenix dactylifera*) powder [9]. Various investigations justified the use of date powder as a sweetener in dairy products, however investigation related to its utility in bakery product is merely considered.

“Cookie” is chemically leavened product, also known as “biscuit”. “Generally the term biscuit is used in the European countries and cookies in the USA. They differ from other baked products like bread and cakes because of having low moisture content, ensure comparatively free from microbial spoilage and confer a long shelf life of the product” [10]. Aim of this study was to examine the physicochemical properties of value added multigrain cookies and assess the storage stability of cookies.

2. MATERIALS AND METHODS

The experiment was conducted in Department of Processing and Food Engineering, Vaugh Institute of Agricultural Engineering and Technology, SHUATS, Prayagraj, India.

2.1 Procurement of Raw Materials

Good quality of raw materials wheat, Finger millet, Barley, Oats, sugar, shortening, date, banana fruit etc. required to prepare cookies was purchased from local market of Allahabad. Care was taken the flour was creamy white coloured and free from bean fragment. All necessary hygiene and sanitation was maintained during processing.

Vanilla essence, Ether, Sodium bicarbonate, Ammonium bicarbonate was used for preparation and analysis purpose. All chemicals used were of analytical grade.

Table 1. Formulation of multigrain flour in the cookies

Sample	Wheat Flour	Multigrain Flour
T ₀	100	0
T ₁	80	20
T ₂	70	30
T ₃	60	40

Table 2. Formulation of value added cookies

Sample	Wheat flour	Multigrain flour	Banana peel powder	Date powder
T ₄	65	30	2.5	2.5
T ₅	60	30	5	5
T ₆	50	30	10	10

2.2 Methods

2.2.1 Formulation of multigrain flour

Firstly same amount of various flours (Finger millet, Barley and Oats) were mixed in a bowl as shown in Table 1. Then replace the wheat flour with the multigrain flour in the ratio of 100:0, 80:20, 70:30 and 60:40. Multigrain flour was mixed with the other ingredients, after that dough was kneaded and rested for 10 min. The dough were rolled and chopped with the cookie cutter and baked at 175°C for 15 min. Sensory evaluation will be carried out for superior sample and the best sample will further incorporated with banana peel powder and date powder.

2.2.2 Preparation of value added multigrain cookies

On the basis of sensory evaluation 70:30 ratio (wheat flour and other flour) was found acceptable. Banana peels powder and date powder in ratio of 2.5 to 10 % with shortening, powdered sugar, milk, vanilla essence and baking powder was incorporated and formulation of value added cookies are shown in Tables 1 and 2.

2.3 Physical Evaluation of Cookies

2.3.1 Weight, diameter and thickness

The weight, diameter and thickness of cookies were calculated as per AACC [11] methods.

2.3.2 Spread ratio (D/T)

Spread ratio of cookies was calculated by AACC [11] method. It was estimate as ratio of diameter to thickness of cookies.

$$\text{Spread ratio} = \frac{\text{Diameter of cookie}}{\text{Thickness of cookie}} \quad \text{Equation 1}$$

2.3.3 Volume of cookies (cm³)

Volume of cookies is defined as area of the cookie multiplied by thickness.

$$\text{Volume} = \pi r^2 \times T \quad \text{Equation 2}$$

2.3.4 Density of cookies

After calculating volume, density of cookies is obtained by ratio of weight of volume.

$$\text{Density (g/cm}^3\text{)} = \frac{\text{Mass of sample}}{\text{Volume of sample}} \quad \text{Equation 3}$$

2.4 Evaluation of Physicochemical Composition

Prepared cookies were evaluated for moisture, crude fat, crude protein, crude fibre, ash content and carbohydrate using standard methods [12].

2.5 Statistical Analysis

Experiments were conducted in triplicate. Data were expressed as the means of these values ± the standard deviations (SD). Analysis of variance (ANOVA)- one way ANOVA was used to assess data.

3. RESULTS AND DISCUSSION

The value added cookies were stored in low density polyethylene pouches at room temperature and stored for 30 days.

3.1 Physical Properties of Value Added Multigrain Cookies during Storage

There was slight decrease in spread ratio of cookies during storage and it decreased from 2.39 to 3.1 at the end of 30 days. Fig. 1 shows decrease in spread ratio with increased banana peel powder and date powder, showed that

starch polymer molecules are tightly bound with granules and swelling is limited in the cookies with wheat flour when heated. On cooling the starch formed a rigid gel with capacity characteristics of large molecular aggregates and there was a slight decrease in spread ratio during the storage because of the degradation of the starch in cookies during the storage. Similar result was obtained by Mc Watters [13] where spread ratio decreased significantly with increased in proportion of soya flour and wheat sorghum composite biscuit.

The sample shows slight decrease in volume during storage. The decrease in the volume of the banana peel flour and dates powder are due to decrease in the mass of the cookies prepared, the mass decreased due to the loss of protein, fat and other nutrient content of the sample

(Fig. 2). There was also a decrease in the volume during incorporation of banana peel powder and date powder is due to decrease in spread ratio because they are interrelated to each other as spread ratio is decreasing the volume is also decreasing. Likewise the same result was obtained by Rufeng et al. [14] in defatted soy flour.

The decrease in the density is due to the increase in the banana peel powder and date powder because these two contains fat retaining capacity during baking and it is decreasing during the storage because fat, protein and vitamins present in the cookies loss during the storage (Fig. 3). Likewise same result was obtained by Rufeng et al. [14] in defatted soy flour.

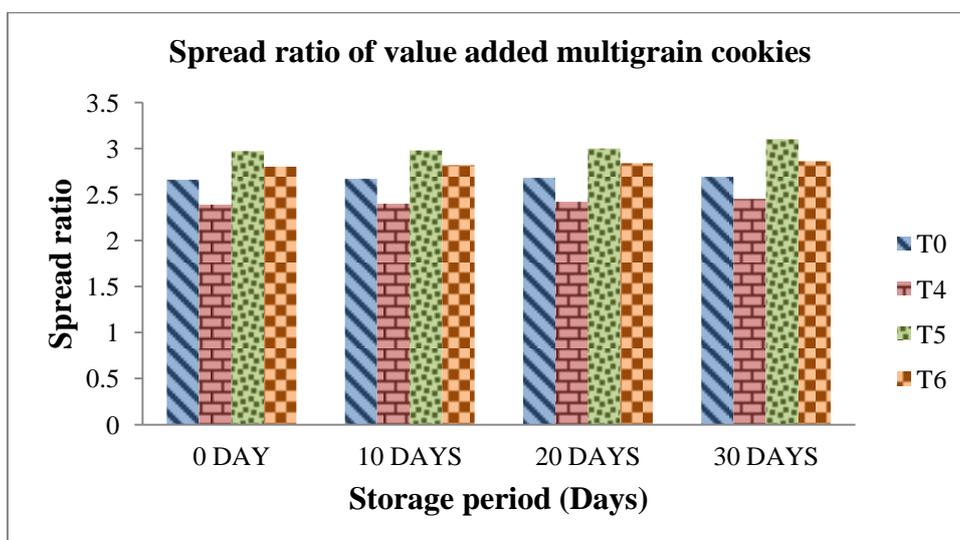


Fig. 1. Study of changes in spread ratio of value added multigrain cookies during storage

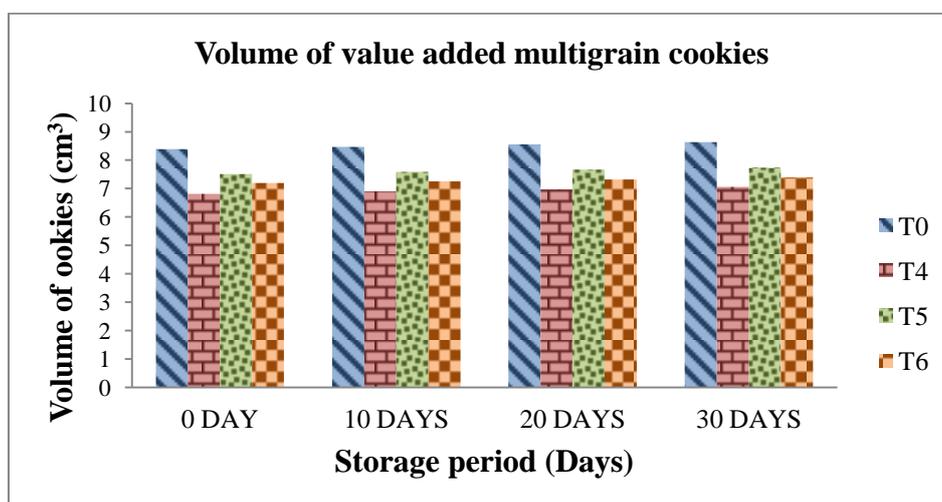


Fig. 2. Study of changes in volume (cm³) of value added multigrain cookies during storage

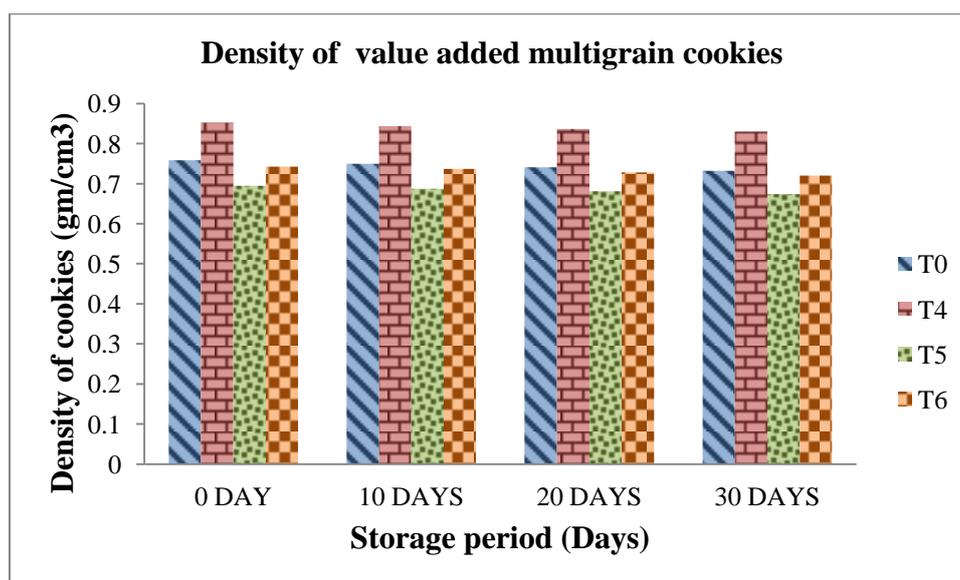


Fig. 3. Study of density of value added multigrain cookies during storage

3.2 Physicochemical Properties of Value Added Multigrain Cookies during Storage

The moisture content of cookies increased with increase in concentration of banana peel powder and date powder and also increased from 2.30 to 3.60 % during storage due to high water binding capacity of ripe banana peel powder and date powder as well as baking powder which retain higher moisture content in ultimate products the moisture content is also increasing during storage due to the permeability of packaging material. The result for moisture content of cookies was similar with the result obtained by researcher who incorporate potato flour in preparation of the cookies and found increased moisture content of the potato flour based biscuit [15].

Table 4 shows the effect of different treatment and storage period on percent fat content of T₀, T₄, T₅ and T₆. The data clearly indicate that there was slight decrease (from 23.76 to 22.18 %) in fat content of all prepared samples. The decrease in fat content in cookies may be attributed to the development of rancidity. The fat deterioration during storage may be the activity of lipase enzyme which split off the fat into free fatty acids and glycogen in the presence of catalyst like moisture, light and heat and there is increase in the fat content during storage is due to fat retaining capacity of banana peel powder and date powder during baking. An increase in the fat content of cookies by Tyagi et al. [16] was reported and explained to be largely due to the incorporation of defatted mustard flour.

Table 3. Effect of moisture content (%) on value added multigrain cookies during storage

Sample	0 Day	10 Days	20 Days	30 Days
T ₀	2.30± 0.83	2.65± 1.66	2.90± 0.94	3.15± 0.48
T ₄	2.49± 0.66	2.85± 0.32	3.10± 0.45	3.60± 0.75
T ₅	2.53± 1.05	2.75± 0.58	3.30± 0.89	3.55± 0.67
T ₆	2.65± 0.87	2.80± 1.12	3.25± 0.62	3.50± 0.49

Table 4. Effect of fat content (%) on value added multigrain cookies during storage

Sample	0 Day	10 Days	20 Days	30 Days
T ₀	22.35± 0.22	22.30± 1.21	22.23± 0.34	22.18± 0.52
T ₄	23.52± 0.56	23.45± 0.79	23.39± 1.08	23.33± 0.84
T ₅	23.61± 0.25	23.59± 0.86	23.25± 0.69	22.25± 0.75
T ₆	23.76± 0.96	23.65± 0.53	23.57± 0.78	23.50± 0.72

Protein content justifies the suitability of banana peel powder and date powder in making nutritionally enhanced cookies. The protein content of cookies found to increase (8.10 to 11.30 %) linearly with increase with the banana peel powder and date powder because banana peel powder and date powder contains good amount of protein (Fig. 4). There was a significant decrease in protein content from 7.70 to 11.30 % during storage at the end of 30 days; it is due to denaturation of protein during storage and processing, non-enzymatic reaction may cause foods deterioration and reduce the shelf life [17]. The result obtained about the protein content of cookies is similar with Padmaja & Jisha [18], incorporating legumes in cassava based composite flour.

Crude fiber content justifies the suitability of banana peel powder and date powder in making nutritionally enhanced dietary fiber rich multigrain cookies. The crude fiber content of cookies found to increase linearly with increase with the amount of banana peel powder and date powder because banana peel powder and date powder contains good amount of crude fiber as well as added multigrain also have a good amount of crude fiber (Fig. 5). There was a slight decrease in crude fiber content during 30 days storage. Reactions during processing may affect the dietary fibre and formation of resistant starch is the reason [19]. It was not showing significant difference which proves sustainability of crude fiber content of dietary fiber rich multigrain cookies.

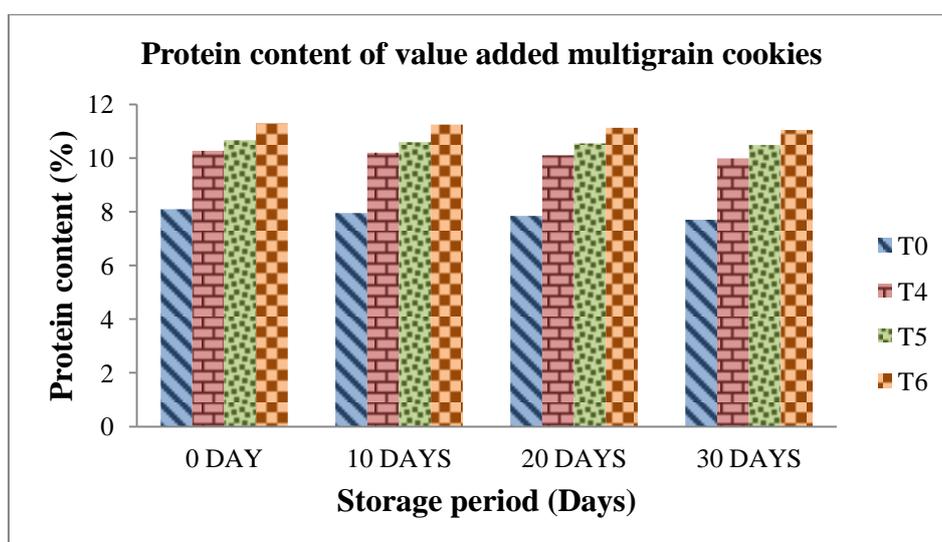


Fig. 4. Effect on protein content (%) of value added multigrain cookies during storage

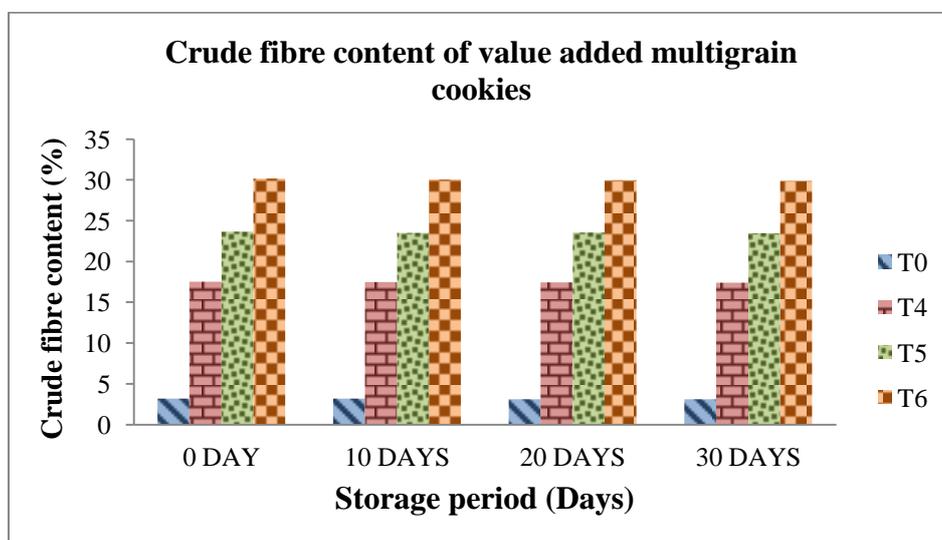


Fig. 5. Effect on crude fibre content (%) of value added multigrain cookies during storage

Table 5. Effect on carbohydrate content (%) of value added multigrain cookies during storage

Sample	0 Day	10 Days	20 Days	30 Days
T ₀	61.50± 0.97	61.47± 0.78	61.47± 0.73	61.20± 1.42
T ₄	42.53± 0.65	42.46± 1.12	42.36± 0.94	42.27± 1.07
T ₅	35.37± 1.34	35.16± 0.64	35.14± 1.05	34.99± 1.18
T ₆	30.25± 1.62	30.11± 0.32	30.19± 0.82	30.10± 0.67

Carbohydrate content of cookies found to decrease linearly with increase with the amount of banana peel powder and date powder because banana peel powder and date powder contains good amount of crude fiber as well as added multigrain also have a good amount of crude fiber, which replaces the carbohydrate which results in decreasing level of carbohydrate as increased level of banana peel powder and date powder. There was a slight decrease in carbohydrate content during 30 days storage; it was not showing significant difference which proves sustainability of dietary fiber rich multigrain cookies.

4. CONCLUSION

In the current study, it is concluded that the cookies prepared with the incorporation of banana peel powder, date powder and multigrain i.e. (barley, finger millet and oats) with wheat flour, at different concentration levels, which were analyzed for their physicochemical, cooking qualities and sensory acceptability. Among the seven samples evaluated, T₅ exhibited higher acceptability based on the mentioned quality parameters. The cookies made from this combination could be stored for 30 days in ambient condition without major quality deterioration.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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