

Quality Evaluation of Finger Millet Chocolate Biscuits with Different Recipes.

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Abstract

This research study was carried out to produce quality biscuits using finger millet and cocoa powder with different recipes of the following ingredients. Biscuits prepared from different recipes vs: T1- Wheat flour + Cocoa powder, T2- Finger millet + Wheat flour + Cocoa powder, T3- Finger millet + Soaked Kasakasa seeds + Cocoa powder, T4- Finger millet + Green apple puree + Cocoa powder and T5- Finger millet + Grated coconut + Cocoa powder, were subjected to analysis of nutritional, physical, organoleptic and microbial qualities to evaluate the suitability of these biscuits for consumption. The nutritional qualities of the freshly prepared finger millet chocolate biscuits revealed that moisture, ash, protein, fat, fibre and total sugar content were significantly different from different treatments. The physical properties of biscuits revealed that there were significant differences between the treatments of biscuits at 5% level of significance. According to Tukey's test, the mean scores for all assessed organoleptic characters varied significantly ($P < 0.05$) in freshly made chocolate biscuits. No harmful micro-organisms were observed in the freshly made biscuits.

Based on the nutritional and organoleptic qualities of freshly made finger millet chocolate biscuits, most preferred treatments such as T2, T3 and T4 were selected and subjected to storage studies at ambient conditions for one month to evaluate the shelf life of these biscuits. Nutritional qualities of each treatment were tested at one-week intervals for one month. The results of the nutritional analysis showed that there were significant differences ($P < 0.05$) between the tested treatments. These results revealed the difference in moisture, ash, fat, fibre, protein and total sugar of the chocolate biscuits. The organoleptic analysis carried out at the end of four weeks revealed that there were significant ($P < 0.05$) differences for the organoleptic characters between the formulations. From overall acceptability rating, the biscuit sample prepared from

Finger millet with Green apple puree had the highest mean value compared with other treatments. Microbial analysis was done after one month of storage. Products were not affected by any microbial activities because of low moisture content. Based on the nutritional, organoleptic and microbial qualities, the biscuit sample prepared from Finger millet with cocoa powder and green apple puree was the best treatment compared to other combinations at the end of one month storage period.

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Keywords—Malnutrition, FingerMillet, Organoleptic, Puree, Biscuit.

1. Introduction

Most of the people in rural areas in Sri Lanka are suffering from malnutrition due to lack of nutritious especially protein, energy, fibre and minerals. Nowadays, there are many problems with the consumption of wheat flour. The protein in wheat is Gluten. Many people are unable to properly digest gluten. It is very low in essential amino acids and also prevents the absorption of minerals into the body like calcium, zinc, iron and magnesium. Finger millet forms the staple food for a large segment of the population in South Asia and African countries and it contains 65-75% starch, 11-12% dietary fibre and has high levels of calcium. Millet-based preparations are believed to elicit a lower glycemic response and are therefore recommended for individuals with diabetes. Finger millet is full of minerals. Calcium, Phosphorus, Iron and Potassium is found in it. The use of millet flour is becoming more and more common in baked products especially in bread, cookies and crackers that are targeted at consumers who are gluten sensitive or diabetic (Lovis, 2003; Rai et al., 2014). Biscuits are nutritive snacks produced from unpalatable dough that is transformed into appetizing product through the application of heat in an oven. The principal ingredients are flour, fat, sugar and water, while other ingredients include milk, salt, flouring agent and aerating agent. Most of the Chocolate biscuits are prepared from wheat flour and Cocoa powder. Chocolate biscuits are predominantly based on refined wheat flour and the replacement of refined wheat flour with finger millet will upgrade the nutritional quality of such products. KasaKasa seeds rich in essential oil, Beta carotenoid, Vitamin A, C and K. It also contains high amount of Potassium, Magnesium, Copper, Calcium, Iron. Green apple is rich in minerals such as Iron, Zinc, Copper, Magnesium, Potassium and rich in anti-oxidant. Coconut is considered as a 'functional food' because it provides nutritional and health benefits. It contains high amount of fibre, protein, mineral-like Potassium, Phosphorus, Iron, Calcium, Magnesium and vitamin C. Finger millet is easily cultivated in our countries which contains high nutrient than wheat. Also KasaKasaseeds, Green apple and Coconut enhance nutritional value by replacing wheat flour. Therefore, an attempt was made to develop finger millet based nutritious chocolate biscuits and their sensory and nutritional evaluation were carried out with following objectives

- To develop nutritionally enriched chocolate biscuits using finger millet with different recipes of the ingredients vs-. Kasa Kasa seeds, green apple puree and grated coconut.
- To assess the nutritional qualities, microbial stability and consumer acceptability of finger millet chocolate biscuits prepared from finger millet with different recipes.
- To identify the most suitable finger millet chocolate biscuits with extended shelf life.

2. Materials and methods

2.1 Collection of Materials

High-quality Finger millet and KasaKasa seeds, green apple, coconut, were collected from Badulla supermarket. High-quality wheat flour, sugar, baking powder, milk powder, cocoa powder, margarine, salt, vanilla extract and packaging materials were purchased from a supermarket in Badulla.

2.2 Preparation of Raw materials

The stones, dirt and other extraneous materials were removed from finger millet grains. The cleaned grains were thoroughly washed with clean water and was dried under sunlight. Then cleaned grains were ground by a grinder (PRESTIGE RMG 02) and was roasted in a gas cooker. Roasted finger millet flour was sieved (0.3 mm) into fine flour. It was sealed in polythene bags until used. KasaKasa seeds were cleaned to remove dirt and other materials such as stones. Two tablespoons of KasaKasa seeds were soaked in $\frac{1}{2}$ cup of clean water and it was allowed for 10 minutes. High-quality green apple was taken and was cleaned and washed with clean water. The apple was peel-off and seeds were removed. The apple was cut into small pieces and was dipped in saltwater. The green apple was ground by a grinder (PRESTIGE RMG 02).

2.3 Treatments

Different ingredients with Finger millet flour and Wheat flour were mixed to prepare different finger millet chocolate biscuit recipes. Treatments of different chocolate biscuit recipes are given below in Table 1.

Table 1-Treatments of different chocolate biscuit recipes

Treatment	Cocoa powder	Finger Millet flour	Wheat Flour	Soaked Kasakasa seeds	Green Apple Puree	Grated Coconut
T1	10 g	-	300 g	-	-	-
T2	10 g	300 g	$\frac{1}{2}$ cup	-	-	-
T3	10 g	300 g	-	$\frac{1}{2}$ cup	-	-
T4	10 g	300 g	-	-	$\frac{1}{2}$ cup	-
T5	10 g	300 g	-	-	-	$\frac{1}{2}$ cup

These different recipes were used for the preparation of finger millet chocolate biscuits. Those recipes were considered as different treatments. After the preparation of the biscuits, those were packed separately in laminated aluminium foil and polythene according to the treatments and were labelled individually.

Different recipes of finger millet chocolate biscuits were assessed for organoleptic and nutritional qualities. The most preferred three treatments were stored in an ambient condition with the control treatments. The packets of biscuits were stored in 30°C temperature and 70%-80% RH condition for one month to determine shelf-life. These biscuits were assessed for organoleptic characteristics, physical properties and nutritional composition.

2.4 . Nutritional Analysis of Finger Millet Chocolate Biscuits prepared with Different Recipes.

Biscuits prepared from Finger Millet with different recipes were analyzed for nutritional qualities such as moisture content, ash, protein, fat and fibre by proximate analysis according to AOAC (2002) methods and total sugar was determined by the Lane and Eynon methods. The parameters were analyzed initially after formulation and during the storage period. Analyses were carried off for three replicates per each treatment.

2.5 Organoleptic Analysis of Finger Millet Chocolate Biscuits prepared with Different Recipes.

Organoleptic qualities analysis for the chocolate biscuits prepared from Finger millet with different recipes was done after one month of storage period by the panel of thirty (30) semi-trained judges. The panel evaluated taste, colour, texture, flavour and overall acceptability by using the seven-point hedonic scale.

3. Results and Discussion

3.1 Preliminary Study

Nutritional analysis was performed initially for Wheat flour, Finger millet flour, Soaked KasaKasa seeds, Apple puree and Grated coconut. The results are given in Table 2.

Table 2 Nutritional Characteristics of Wheat Flour, Finger Millet Flour, Soaked KasaKasa Seeds, Apple Puree and Grated Coconut

Composition	Wheat Flour	Finger millet flour	Soaked Kasa seeds	Apple puree	Grated coconut
Moisture %	2.93 \pm 0.14	2.06 \pm 0.95	2.93 \pm 0.47	1.95 \pm 0.76	10.75 \pm 0.82
Ash %	1.83 \pm 0.37	3.83 \pm 0.80	3.66 \pm 0.68	3.08 \pm 0.59	3.10 \pm 0.77
Fat %	2.13 \pm 0.20	1.77 \pm 0.52	3.97 \pm 0.24	1.06 \pm 0.15	3.08 \pm 0.94
Fiber %	2.19 \pm 0.76	4.14 \pm 0.69	5.03 \pm 0.18	2.88 \pm 0.69	8.91 \pm 0.13
Protein %	11.19 \pm 0.68	7.00 \pm 0.46	2.06 \pm 0.12	0.75 \pm 0.57	2.74 \pm 0.59
Total Sugar %	3.03 \pm 0.30	1.73 \pm 0.58	11.34 \pm 1.42	15.59 \pm 2.39	5.31 \pm 0.87

The values are means of triplicates \pm standard error

According to the results obtained in the preliminary study, the protein content was higher in wheat flour than other ingredients. The ash content was high in Finger millet flour and fat content was high in soaked KasaKasa seeds. The fibre content and moisture content were high in grated coconut. The total sugar content was high in apple puree

3.2 Nutritional Qualities of Freshly Made Finger Millet Chocolate Biscuits.

The different treatments of biscuits prepared from Finger millet with different recipes are as follows,

T1 = Wheat flour+ Cocoa powder

T2 = Finger millet flour + Wheat flour + Cocoa powder

T3 = Finger millet flour + Soaked KasaKasa seeds + Cocoa powder

T4 = Finger millet flour + Apple puree + Cocoa powder

T5 = Finger millet flour + Grated coconut + Cocoa powder

Nutritional Qualities of Freshly Prepared Finger Millet Chocolate Biscuits are given in Table 3

TABLE 3 Nutritional Qualities of Freshly Prepared Finger Millet Chocolate Biscuits

Trt	Moisture (%)	Ash (%)	Fat (%)	Fiber (%)	Protein (%)	Total Sugar (%)
T1	3.89 \pm 0.37 ^a	1.39 \pm 0.50 ^b	5.04 \pm 0.17 ^a	6.29 \pm 0.50 ^d	10.33 \pm 0.37 ^d	8.07 \pm 0.30 ^a
T2	3.88 \pm 0.58 ^a	2.13 \pm 0.24 ^{ab}	4.30 \pm 0.40 ^b	9.77 \pm 0.78 ^c	16.23 \pm 0.15 ^a	7.57 \pm 0.26 ^{ab}
T3	3.98 \pm 0.10 ^a	3.46 \pm 1.00 ^a	4.54 \pm 0.30 ^{ab}	13.39 \pm 0.62 ^a	12.63 \pm 0.15 ^b	7.28 \pm 0.43 ^b
T4	4.09 \pm 0.34 ^a	2.59 \pm 1.13 ^{ab}	4.56 \pm 0.28 ^{ab}	10.34 \pm 0.39 ^c	11.57 \pm 0.35 ^c	7.57 \pm 0.26 ^{ab}
T5	3.94 \pm 0.11 ^a	1.46 \pm 0.56 ^b	4.97 \pm 0.26 ^a	12.01 \pm 0.53 ^b	12.63 \pm 0.15 ^b	4.72 \pm 0.26 ^c

The values are means of the triplicates \pm standard error. Means values with the same superscript letters within the same column do not differ significantly at 5% level

3.2.1 Moisture Content

Moisture content is one of the most commonly measured properties of food materials. It is important to food scientists for a number of different reasons such as legal and labelling requirement, economic, microbial stability, food quality and food processing operations. According to the results moisture content was high in apple puree and Kasa –Kasa seed contained finger millet chocolate biscuits. Mainly moisture content was less in wheat content biscuits (T1 and T2) than others. Because apple puree and also soaked Kasa seeds have high water retaining ability than wheat flour, therefore moisture content was higher in those biscuits samples.

3.2.2 Ash Content

The ash content is a measure of the total amount of minerals present within a food, whereas the “mineral content” is a measure of the amount of specific inorganic compounds present within a food, such as Ca, Na, P, K, Cl and Fe. According to DMRT, Ash content was high in T3 biscuits. Because Kasa –Kasa seeds which used to prepare T3 biscuit sample was high in mineral content such as Fe and Ca. T₁ biscuits content which made from wheat flour had the least mean value of ash content.

3.2.3 Fat Content

Lipids are usually defined as those components that are soluble in organic solvents but are insoluble in water. This group of substances includes triacylglycerol, free fatty acids, phospholipids, sterols, carotenoids, vitamin A and D. In many foods, the lipid component plays a major role in determining the overall physical characteristics such as mouthfeel, texture, flavour and appearance. According to DMRT, T₁ biscuits which contain wheat flour had the highest mean value of fat content. When compared with control (treatment 1), fat content was high in T5 biscuits which prepared from Finger millet with grated coconut. The least mean value of fat content was obtained from T2 biscuits which prepared from Finger millet with wheat flour.

3.2.4 Fibre Content

Crude fibre is a mixture of substances which make up the framework of plant and composition of cellulose, hemicellulose, pectin and lignin of cell wall. These components have little food value but provide the bulk necessary for proper peristaltic action in the intestinal tract. According to DMRT, the highest mean value of fibre content was shown in T3 biscuits which were prepared from Finger millet with Kasa seeds. Because Kasa seeds and Finger millet contain high fibre content compared to others. The least mean value of fibre content was shown in T₁ biscuits which prepared from wheat flour.

3.2.5 Total Sugar

Normally sugar is added as a sweetener. It is important for making cream and enhances the taste of biscuits. Finger millet contains a very low amount of sugar. Comparatively apple puree is rich in sugar. Therefore total sugar content was high in T4 biscuits than T3 and T5. According to DMRT, mean value of total sugar content was high in T₁ (Control). There was no significant difference in mean value between T2 and T4. But the least mean value was obtained from T5.

3.2.6 Protein Content

The protein content of Finger millet is relatively better balanced. It contains more lysine, threonine and valine than other millets (Singh *et al*, 2012). Also, Kasa seeds and Coconut are rich in protein. According to DMRT, T2 biscuits which prepared from Finger millet with wheat flour. The other mean values were lower than T2. But T3, T4 and T5 biscuits samples had a considerable amount of protein content.

3.3 Physical Properties of Freshly made Finger Millet Chocolate Biscuits

The physical properties of biscuits such as diameter, thickness, volume, density and spread ratio of the freshly made finger millet chocolate biscuits revealed that there were significant differences between the treatments of biscuits at 5% level of significance as shown in Table 4.

Table 4: Physical Properties of Freshly made Finger Millet Chocolate Biscuits.

Trt	Diameter (cm)	Thickness (mm)	Volume (cm ³)	Density (g cm ⁻³)	Spread ratio
T1	5.03 \pm 0.15 ^a	4.00 \pm 0.20 ^a	7.94 \pm 0.11 ^{ab}	1.19 \pm 0.03 ^a	12.61 \pm 1.01 ^a
T2	5.00 \pm 0.01 ^a	3.96 \pm 0.15 ^a	7.78 \pm 0.30 ^{ab}	1.21 \pm 0.12 ^a	12.61 \pm 0.40 ^a
T3	5.03 \pm 0.25 ^a	3.93 \pm 0.11 ^a	7.83 \pm 0.85 ^{ab}	1.27 \pm 0.13 ^a	12.80 \pm 0.60 ^a
T4	4.60 \pm 0.40 ^a	4.00 \pm 0.10 ^a	6.67 \pm 1.09 ^b	1.45 \pm 0.17 ^a	11.51 \pm 1.15 ^a
T5	5.03 \pm 0.20 ^a	4.16 \pm 0.25 ^a	8.32 \pm 1.16 ^a	1.19 \pm 0.17 ^a	12.08 \pm 0.24 ^a

The values are the means of triplicates \pm Standard Error. Means values with the same superscript letters within the same column do not differ significantly at 5% level

3.3.1 Diameter

There was nearly same mean diameter value 5.03 cm obtained in control biscuit which containing wheat flour (T1), Finger millet with Kasa-Kasa seeds containing treatment (T3) and Finger millet with grated coconut containing treatment (T5). According to the results, the least mean diameter value (4.6 cm) was obtained in treatment that contains Finger millet with apple puree (T4) and treatment which containing Finger millet with wheat flour (T2) was 5 cm.

3.3.2 Thickness

According to DMRT highest mean thickness (4.16 cm) was obtained in T5 which contains Finger millet with grated coconut. Also same mean thickness values (4 cm) were obtained in two treatments T₁ (control) and T₄ (which contain Finger millet with apple puree). 3.93 cm mean thickness value was obtained in treatment which contains Finger millet with Kasa-Kasa seeds (T3). 3.96 cm mean value was obtained in biscuits prepared from Finger millet with wheat flour (T2).

3.3.3 Volume

There was a significant reduction in the mean volume of the biscuits with different treatments according to following order T5 > T1 > T3 > T2 > T4, 8.32 cm³, 7.94 cm³, 7.83 cm³, 7.78 cm³ and 6.67 cm³ respectively. According to the DMRT highest mean volume was obtained from T5 biscuit which prepared from Finger millet with grated coconut. The lowest mean volume was obtained from T4 biscuit which prepared from Finger millet with apple puree.

3.3.4 Density

According to DMRT highest mean density 1.45 gcm^{-3} was obtained in T4 which prepared from Finger millet with apple puree. The least mean density 1.19 gcm^{-3} was obtained in T1(control) and T5 (Finger millet with grated apple). According to the results, 1.21 gcm^{-3} and 2.27 gcm^{-3} densities were obtained from T2 and T3 respectively.

3.3.5 Spread Ratio

The mean spread ratio was high in T3 biscuit prepared from Finger millet and Soaked Kasa –Kasa seeds (12.80). The mean spread ratio was low in treatment 4 biscuit prepared from Finger millet with Apple puree (11.51). Other treatments mean spread ratio values were 12.61 (T1 and T2) and 12.08 in T5. Because of the high moisture-retaining ability of Kasa –Kasa seeds T3 has a higher spread ratio than other treatments.

3.3.6 Organoleptic Qualities of Freshly Made Finger Millet Chocolate Biscuits

The organoleptic qualities analysis of biscuits revealed that there were significant differences between the treatments when Finger millet with different recipes for taste, colour, texture, flavour and overall acceptability at the 5% level of significance according to ANOVA. Mean values of treatments according to Tukey's test are shown in Table 5.

Table 5: Organoleptic Qualities of Freshly Made Finger Millet Chocolate Biscuits

Treatments	Taste	Colour	Texture	Flavor	Overall Acceptability
T1	5.66 \pm 1.09 ^a	5.90 \pm 0.99 ^a	5.60 \pm 1.22 ^a	5.96 \pm 0.88 ^a	5.83 \pm 0.85 ^a
T2	5.80 \pm 0.88 ^a	6.23 \pm 0.72 ^a	5.40 \pm 1.16 ^a	5.96 \pm 0.88 ^a	5.76 \pm 0.94 ^a
T3	4.63 \pm 1.54 ^b	4.10 \pm 1.39 ^b	4.46 \pm 1.35 ^b	4.73 \pm 1.33 ^b	4.63 \pm 1.32 ^b
T4	4.56 \pm 1.27 ^b	4.43 \pm 1.04 ^b	4.26 \pm 1.04 ^b	4.46 \pm 1.13 ^b	4.40 \pm 1.06 ^b
T5	3.20 \pm 1.18 ^c	3.83 \pm 1.26 ^b	3.60 \pm 0.89 ^c	3.96 \pm 1.47 ^b	3.53 \pm 1.10 ^c

The values are means of 30 replicates \pm Standard Error. The means with the same letters are not significantly different from each other at a 5% level based on Tukey's test.

Sensory parameters were measured using a seven-point hedonic scale.

3.3.7 Taste

Taste or the perception of gustatory input is the most influential factor in a person's selection of a particular food. Taste is the primary factor which determines the acceptability of any product which has the highest impact as far as the market success of product impact. According to Tukey's test, there were no significant

differences between control and treatment 2 biscuits which prepared from Finger millet with wheat flour. Also, there were significant differences between control and T3, T4 and T5. Among them treatment 5 had least mean value for taste. T3 and T4 had nearly same mean value for taste.

3.3.8 Colour

Colour is a very important parameter in judging the properly baked biscuits not only reflects the suitable raw material used for the preparation but also provide information about the quality product. An attractive colour leads to good demand for the products. The colour of biscuits was changed to light brown to dark brown when using Finger millet with different recipes. According to Tukey's test, there were significant differences between control and other treatments. T2 biscuits which prepared from Finger millet with wheat flour had the highest mean value for colour and T5 biscuits which prepared from Finger millet with grated coconut.

3.3.9 Texture

The texture is one of the most important parameters connected to product quality. The crust texture of biscuits was related to the external appearance of biscuit, which is smoothness or hardness of the biscuit. According to Tukey's test T1 (control) had the highest mean value for texture and also T5 had the least mean value for texture.

3.3.10 Flavour

The sensory impression of food is determined primarily by the chemical senses of taste and smell. There were no significant differences in the control treatment. According to Tukey's test, T1 and T2 had the highest mean value for flavour followed by the biscuits. T5 had least mean value for flavour.

3.4 Overall Acceptability

Overall acceptability includes many implications, which is important in sensory evaluation. There were no significant differences among control treatment and T2 biscuits made from Finger millet with wheat flour. There were significant differences among T1 and T3, T4 and T5. T1 had the highest mean and T5 had the least mean value for overall acceptability.

3.5 Microbial Quality of Freshly made Finger Millet Chocolate Biscuits

Microbiological analysis for freshly made finger millet chocolate biscuits in terms of total plate count revealed that there was no evidence for any microbes observed in the fresh biscuit samples. Processes such as roasting of flour and baking of biscuits at higher temperature destroy a large number of micro-organisms. Therefore, these biscuits were suitable for consumption. The total plate count of biscuits was determined by using nutrient agar containing Petri dishes.

3.6 Storage Studies

Based on the nutritional and organoleptic qualities of freshly made finger millet chocolate biscuits, the most preferred following three treatments were selected for storage studies. They were packed in laminated aluminium foil and stored at the ambient condition of 30°C and 70-80% RH for one month.

Most preferred treatments are as follows;

T2 – Finger millet + Wheat flour

T3 – Finger millet + KasaKasa seeds

T4 – Finger millet + Apple puree

3.7 Changes in Nutritional Qualities of Biscuits during Storage at Ambient Temperature.

3.7.1 Moisture Content

Biscuits are hygroscopic in nature. Therefore, they must be protected from the atmosphere to prevent or delay the moisture pickup. The moisture content of food products is changed when there is a moisture gradient outside and inside of the product. Low and intermediate moisture foods such as bakery products, the ability of proteins to bind water are critical to the acceptability of these foods (Fennema, 1996). According to the DMRT, moisture content was increased significantly ($p < 0.05$) throughout the storage period. There was a significant change in T2, T3 and T4 during the storage period.

3.7.2 Ash Content

The ash content of all treatments was slightly decreased during the storage period. Ash content of the food product is related to mineral composition. Relative changes occurring in the mineral composition resulted in decreasing ash content during storage.

3.7.3 Fibre Content

Plant materials are rich in dietary fibre. Food products which are produced from plant materials also high in dietary fibre. This dietary fibre is resistant to enzymatic digestion which includes cellulose, non-cellulosic polysaccharides such as hemicellulose, pectic substances, gums, mucilages and non-carbohydrate component lignin. According to the DMRT, there is no significant difference in fibre content between T2 and T4. There is a significant difference in fibre content between T3 and other treatments.

3.7.4 Fat Content

In bakery product fat and oil responsible for tenderization, through inhibition of gluten development and starch gelatinization. There was a significant reduction in the fat content of every biscuits sample throughout the storage period.

3.7.5 Total Sugar Content

During biscuits making some considerable amount of sugar was added to it. It is very important for creaming and taste of the products. According to DMRT, the total sugar content was changed throughout the storage period.

3.7.6 Protein Content

The protein content of all samples was decreased slightly during the storage period. This may due to interaction between reducing sugars and amino acids (Maillard reaction). Also, it is a course of quality and degradation of many nutrients in food. Maillard reaction course to loss of protein stability (Fennema, 1996).

3.8 Organoleptic Qualities of Biscuits during Storage

Organoleptic characters of biscuits stored at ambient temperature were changed slightly than freshly made biscuits. Maillard reaction, lipid oxidation, total sugar content reduction, moisture uptake and other chemical reactions may change the sensory qualities of the biscuits during the storage period. Maillard reaction has an impact on sensory qualities (Fennema, 1996). Singh *et al*(2007) reported the moisture uptake and gas exchange were caused by off odour development in biscuits. The results of organoleptic analysis after one month period are shown in Table 6.

Table 6: organoleptic characteristics of chocolate biscuits after one month of storage at ambient temperature

Trt	Taste	Colour	Texture	Flavour	Overall Acceptability
T2	5.27 \pm 1.01 ^b	5.73 \pm 0.78 ^a	5.83 \pm 0.59 ^a	5.67 \pm 0.62 ^a	5.80 \pm 0.66 ^{ab}
T3	5.53 \pm 0.86 ^b	5.27 \pm 0.86 ^a	5.33 \pm 0.71 ^b	5.57 \pm 0.81 ^a	5.67 \pm 0.54 ^b
T4	6.17 \pm 0.65 ^a	5.37 \pm 0.66 ^a	5.37 \pm 0.66 ^b	5.90 \pm 0.71 ^a	6.06 \pm 0.63 ^a

The value is means of 30 replicates \pm Standard Error. The means with the same letters are not significantly different from each other at 5% level based on Tukey's test.

According to DMRT, T4 chocolate biscuits which made from finger millet with green apple puree was had the highest mean values for taste and overall acceptability. There was no significant difference between the mean values of different treatments for colour and flavour. Also, T2 was had highest mean value of texture.

As per the table 6, T4 chocolate biscuits which made from Finger millet with green apple puree was shown highest organoleptic qualities after one month of storage period compared to the other two treatments. From overall acceptance rating, chocolate biscuits prepared from Finger millet with green apple puree had shown highest mean value and no remarkable change of organoleptic characters was observed up to one month of storage period at 30°C of ambient temperature and 70%-80% relative humidity. Therefore, the chocolate biscuits prepared from Finger millet with green apple puree can be stored at ambient condition without any change in quality.

3.9 Microbial Qualities of Biscuits during Storage

Microorganisms play a significant role in the determination of shelf-life. They are the main cause of food spoilage. A high aerobic plate count indicates the presence mixed population of micro-organisms which may consist of spoilage types. The microbiological examination after one month storage period, in terms of total plate count, revealed that there was no evidence for any microbes observed in the stored biscuit samples.

The process such as roasting of flour and baking biscuits at high temperature destroyed a large number of micro-organisms. Therefore, these biscuits were suitable for consumption. Total plate count (TPC) of cookies was examined on 1, 2 and 3 months' period (Chandru et al, 2010). Limits of microbial counts have been recommended in most foods to keep them safe for consumption. The product should however be well kept after processing in suitable packaging materials capable of preventing contamination and proliferation of spoilage microorganisms.

4. Conclusion

Based on the nutritional, organoleptic and microbial qualities, the biscuit sample prepared from Finger millet with cocoa powder and green apple puree was the best treatment compared to other combinations at the end of one month storage period.

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