The Pharma Innovation Journal 2023; 12(5): 4586-4593

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(5): 4586-4593

www.thepharmajournal.com
Received: 19-03-2023
Accepted: 22-04-2023

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Development of cookies from banana (*Musa* spp.) flour

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Abstract
Unripe bananas can be used as a source for making contemporary foods like cookies, snacks, and other baked goods. The experiment entitled "development of cookies from banana (*Musa* spp.) flour" was conducted factorial randomized completely randomized design (FCRD)for different parameters with 6 main treatments viz, T_1: 00:100 (Banana flour: Wheat flour), T_2: 10:90 (Banana flour: Wheat flour), T_3: 20:80 (Banana flour: Wheat flour), T_4: 30:70 (Banana flour: Wheat flour), T_5: 40:60 (Banana flour: Wheat flour) and T_6: 50:50 (Banana flour: Wheat flour) stored at ambient condition for 30 days were analyzed for changes in physical and sensory parameters i.e. moisture, starch, ash, crude fiber, protein. It was observed that samples of cookies with 30:70 (Banana flour: Wheat flour) were opted best treatment during ambient condition storage of 30 days.

Keywords: Cookies, contemporary food, ambient condition

Introduction
Bananas (*Musa* spp.) are one of worlds most important fruits consumed worldwide. Banana name comes from Arabic word "Banan" which means finger (Singh *et al*., 2018) [1]. Banana is believed to have been the world's first cultivated fruit and it is originated in southeast Asia and the South Pacific around 8000 to 5000 B.C. Banana plant is world's largest herb, a stenothermic plant and cultivated in hot and humid climates of the world. There are 1200 seedless, fleshy types of bananas, and dessert banana cultivars worldwide are classified as AA or AAA group, or cavendish type (Aurore *et al*., 2009) [2]. Plants of the genus Musa yield all palatable banana fruits (De Langhe *et al*., 2009) [3]. The term "plant of virtue" (*kalpatharu*) is another name for the banana. Geographically, Musa is widely dispersed in the tropics, from 30˚ N to 23 ˚ S latitude and 175˚ E to 150˚ W longitude (Nayar, 2010) [4]. This tropical crop is raised all year long in humid conditions. The ideal temperature for bananas is between 25˚ and 30˚ C. The pH range for the plant is 5.5 to 7.5. As long as they have a deep well-drained surface, almost all agricultural soils are acceptable. Upland black loam and sandy loam soils are ideal. Africa, Asia, and Latin America are the primary growing regions for bananas. India is the world's top producer of bananas, followed by China, the Philippines, Ecuador, and Brazil. The world produced 155.2 million tonnes of bananas overall (FAO Stat., 2018) [5]. In India, bananas are farmed on an area of 8.66 million hectares, yielding 30.46 million tonnes (FAO Stat., 2019) [6]. In 2021, India exported 341 thousand tonnes of bananas (FAO Stat., 2021) [7]. Andhra Pradesh, Assam, Bihar, Gujrat, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Tamil Nadu, and West Bengal are the largest states in India that produce the most bananas (Singh *et al*., 2018) [1].
"Grand Nain" is popular tissue culture variety of banana. It is one of the most extensively cultivated bananas and a member of the commercial cavendish banana cultivar group. The Grand Nain is classified as a monocot and belongs to the genus Musa, according to taxonomy. Bananas from the Cavendish variety distinguish themselves from other varieties by having the AAA genotype. This group represents a triploid variation of the species *Musa Accuminata*, as shown by the AAA genotype. Tropical areas of Central America, Africa, India, and Southeast Asia all have Grand Naine plantations. In many tropical communities, entire local economies are based upon banana production and exportation. Banana is rich source of potassium (K), which benefits muscles and keeps body fluids in balance. In certain areas, mashed banana is given to a new born infant as their first food. banana is the ideal food for toddlers, persons with disabilities, and those with HIV/AIDS (Aurore *et al*., 2009) [2]. Additionally, it is an excellent source of fibre and vitamin B6 (Singh *et al*., 2018) [1]. Because they serve as a substrate for colonic microbes that produce short-chain fatty acids (SCFA), including acetic, propionic, and butyric acid, fibre and resistant starch aid in the prevention of colon cancer (Elmstahl, 2002) [8].

Bananas are not only consumed as fresh fruits but also cooked, like plantains. In different methods, they are processed to make chips, fries, fritters, purees, jams, ketchup, and alcohol. Drying is the best processing method for perishable food products. The baking and confectionery sectors have a huge demand for fruit powders. Around the world, banana flour is utilised in a rising range of bread products, baking, and supplementary weaning meals (Baiyeri *et al*., 2004; Adeniji and Empere, 2001) [9, 10]. There is a lot of promise for banana flour. Due to its high nutritional content, for commercial purposes, it may be used in place of fresh bananas to make cookies that are packed with fibre and minerals, as well as cakes and their premixes (Alam et.al., 2021) [11]. Banana fruits make up an alternate source of indigestible carbs due to a number of variables, including their high cellulose, lignin, and hemicellulose content as well as their inexpensive price. These elements make it possible to produce banana flour with beneficial characteristics (Jaurez-Garcia *et al*., 2006) [12]. Unripe banana flour has shown potential as a source of nutrients and health advantages (Da Mota *et al*. 2000; Perez and Schnell, 2004) [13, 14] and serves as a substitute source of both plantains and bananas contain antioxidants and indigestible carbohydrates. Cookies can be categorised as convenient and ready-to-eat foods. Making cookies is often a very easy procedure, and the fundamental components are flour, eggs, and sugar. Cookies are normally considered of being flat, firm, and crunchy foods. Because they are regarded as a practical snack with a crisp texture, sweet flavour, and reasonable price, cookies are widely consumed across the world. They are regarded as bakery items made with sugar, fat, and wheat flour that are lacking in several crucial components for human nutrition. As a result, adding ingredients is an alternate way to increase the nutritional content and functional appeal of foods (Park *et al*., 2015; Silva and Conti-Silva, 2018) [16, 15].

The present study was undertaken for the following objectives:

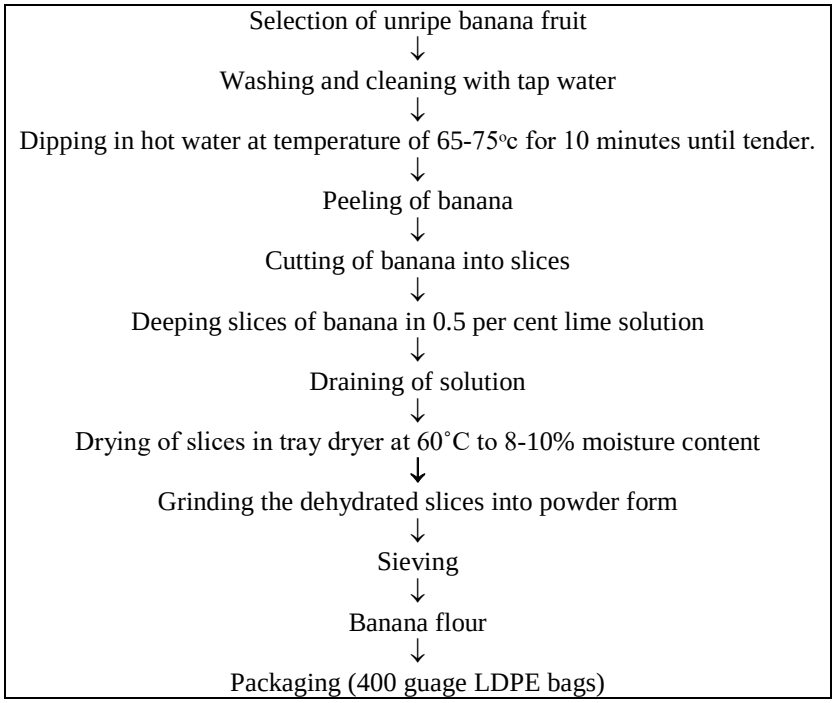
1. To standardize the relative proportion of banana flour in the cookies
2. To evaluate the physico-chemical and sensory qualities of banana flour cookies during storage.

Material and Methods

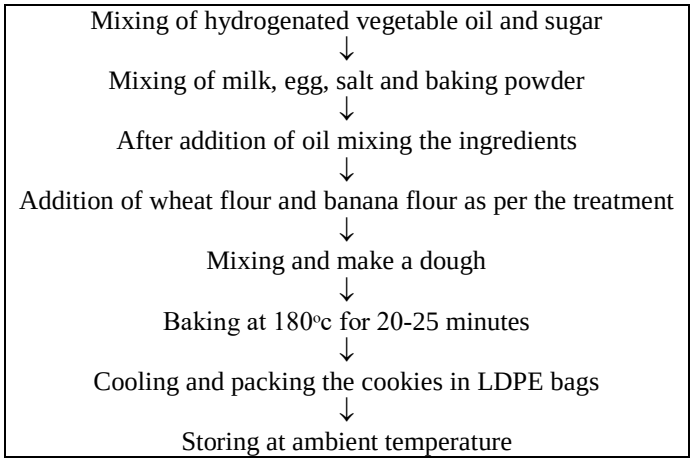
Unripe banana fruits were procured from the farm. Then the flour was prepared from the unripe banana with the series of different methods i.e. blanching, peeling, cutting into slice, tray drying, grinding and packaging. Wheat flour was procured from the local market. As per the concentration of banana and wheat flour the 6 treatments as T_1, T_2, T_3, T_4, T_5 and T_6. The treatments according to the different concentrations of banana and wheat are T_1 00:100 (BF:WF), T_2 10:90 (BF:WF), T_3: 20:80 (BF:WF), T_4: 30:70 (BF:WF), T_5: 40:60 (BF:WF), T_6: 50:50 (BF:WF). Cookies were packed in a 400 gauge LDPE (low density polyethylene) bag and stored at ambient temperature.

Procedure for preparation of banana flour

Preparation of banana flour



Procedure for preparation of banana flour cookies



Methods of analysis

The stored samples were analysed for different physical, chemical and sensory parametrs at 0 day and 30 day of storage

Physical and chemical parameters of banana flour and banana flour cookies

The banana flour were analysed for physical parameters such as recovery (%) and colour and chemical parameters such as Moisture. The moisture content was determined using a Contech moisture analyser (Model CA-123) at 100°C temperature. Reducing sugars and Total sugars was determined by method of Lane and Eynon (1923) [43] as reported by Ranganna (1986). Starch was estimated by using acid hydrolysis method with modification suggested by Rangana (1986) [42]. Fat was estimated by using crude ether extract of the dry material suggested by (ACIAC, 1975). Crude fiber was estimated by using crude ether extract of the dry material suggested by (Rangana 1986) [42]. Ash was determined according to method suggested by (Rangana 1986) [42]. Protein was estimated by Kel plus nitrogen distillation unit (A.O.A.C., 1975). The stored samples of banana flour cookies were analyzed for different physical parameters including diameter and thickness. diameter and thickness was measured using vernier calliper and expressed in centimeter and Chemical parameters suich as moisture, reducing sugar, total sugar, starch, crude fiber, ash, protein. And the similar methods used in the analysis of banana flour are used for the analysis of stored cookies.

Statistical evaluation

The data were analyzed to test significant differences by applying an analysis of variances (ANOVA) tool available in MS- Excel 2010. The significant differences were tested by 5% level of significance and are mentioned as $p<0.05$ for significant differences (Panse and Sukhatme, 1989) [44]. The experimental data was analyzed statistically using Factorial completely Randomized Design (FCRD).

Results and Discussion

Physico-chemical parameters of banana flour

The results of physico-chemical parameters of banana flour are presented Table 1.

Table 1: Physical and chemical composition of banana flour

Sr. no.	Physical and Chemical parameters	Mean*
1	Recovery (%)	14
2	Colour	
2.1	L*	79.85
2.2	a*	1.25
2.3	b*	20.51
3	Moisture (%)	9.5
4	Reducing sugars (%)	1.20
5	Total sugars (%)	1.83
6	Starch (%)	71.04
7	Fat (%)	0.44
8	Crude fiber (%)	3.8
9	Ash (%)	3.45
10	Protein (%)	3.41
11	Carbohydrate (%)	80.87

Table 2: Physical parameters of banana flour cookies

Treatments	Diameter	Thickness
T_1	6.110	1.580
T_2	5.950	1.421
T_3	5.850	1.401
T_4	5.820	1.311
T_5	5.810	1.222
T_6	5.800	1.270

Table 3: Physical parameters of banana flour cookies

Treatments	Moisture	Starch	Fat	Crude fiber	Ash	Protein
T_1	3.13	0.70	22.56	0.914	0.356	3.161
T_2	3.20	17.19	23.27	1.777	0.932	7.743
T_3	3.57	21.02	24.20	2.122	1.069	7.806
T_4	4.11	23.53	25.11	2.514	1.106	7.870
T_5	4.62	26.61	25.87	2.807	1.143	8.217
T_6	5.57	29.85	26.93	3.206	1.179	8.294

The moisture content of cookies increased significantly with increase in the proportion of banana flour in the cookies. This might be due to hygroscopic nature of banana flour and wheat flour which retained higher moisture content in the products. There was significant increase in moisture during storage period of 30 days. The increase in moisture content of banana flour cookies during storage period might be due to hygroscopic nature of the banana flour and wheat flour. The starch content of the cookies increased with rise in the level of banana flour in the cookies. This might be due to reason that banana flour has been a rich source of starch. The starch content in cookie showed the decreasing trend during storage period of 30 days. This might be due to the increase in moisture content of the cookies during storage. The variation in fat content of the treatment depend upon the level of the banana flour in the cookies. It was also noticed that mean fat was changed during the storage period and it was decreased during the storage period of 30 days. Reduced fat level may be caused by increased lipase enzyme activity, which lowers the fat content during storage. As the banana flour increased the crude fiber content of the cookies increased. This might be due to presence of fiber in the banana flour. The decrease in crude fiber content observed during the storage period of 30 days. This decrease in crude fiber content in banana flour cookies might be due to the degradation of hemicellulose and other structural polysaccharide and increase in moisture content during storage. The ash content of banana flour cookies increased with the increase in substitution of the banana flour in the cookies. This might be due to higher amount of minerals present in the banana flour. The decrease in ash content was observed during storage period of 30 days. The decrease in ash content may be due to increase in moisture content of the cookies. The protein content of cookies showed variation due to the treatments. This might be due to the protein present in the banana flour. It was observed that with the passage of time during storage, protein content decreased significantly in all treatments during storage of 30 days. The hydrolysis of peptide bonds by the protease enzyme, which results in the splitting of protein molecules during storage, may be the reason of the decrease in protein content during storage.

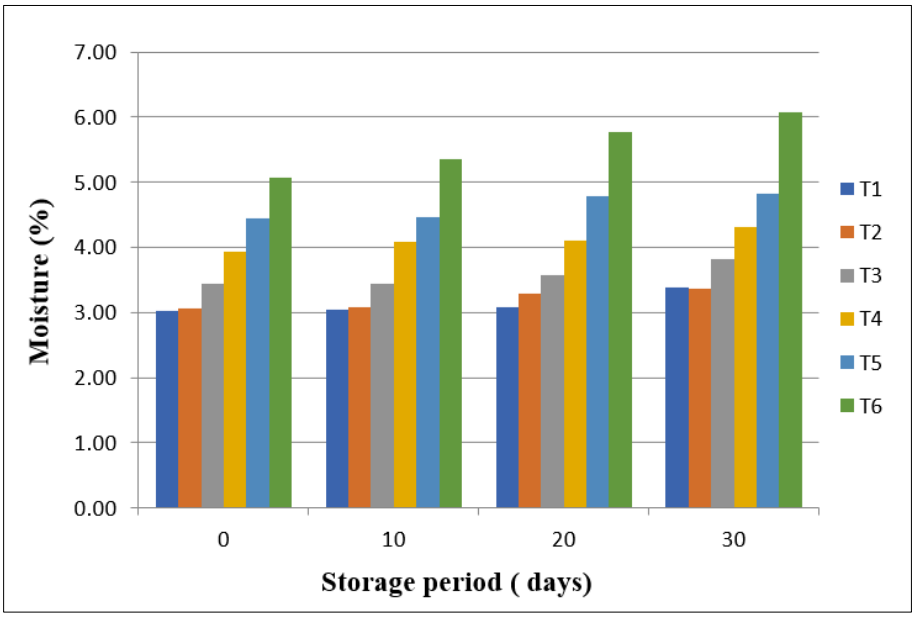


Fig 1: Changes in the moisture (%) content of banana flour cookies during storage at ambient condition

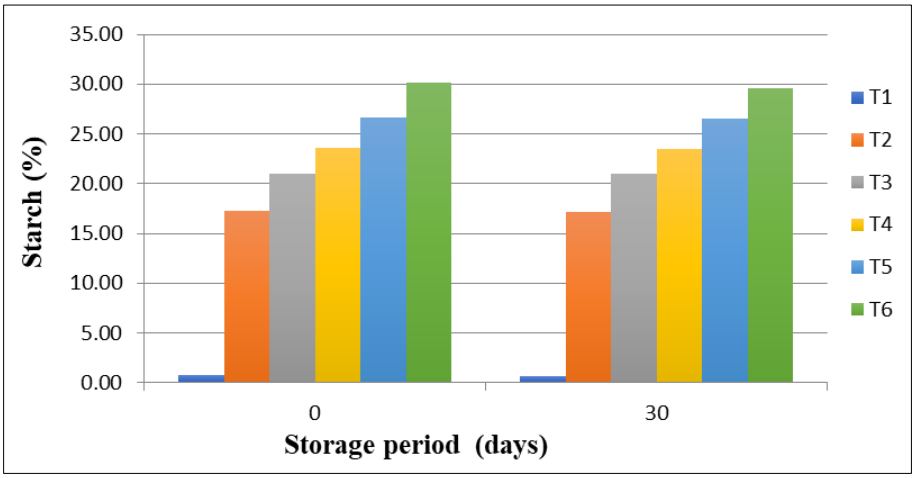


Fig 2: Changes in the starch (%) content of banana flour cookies during storage at ambient condition

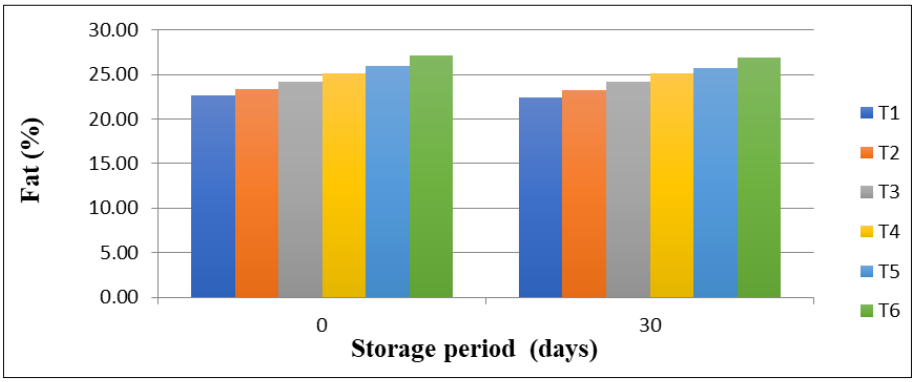


Fig 3: Changes in the fat (%) content of banana flour cookies during storage at ambient condition

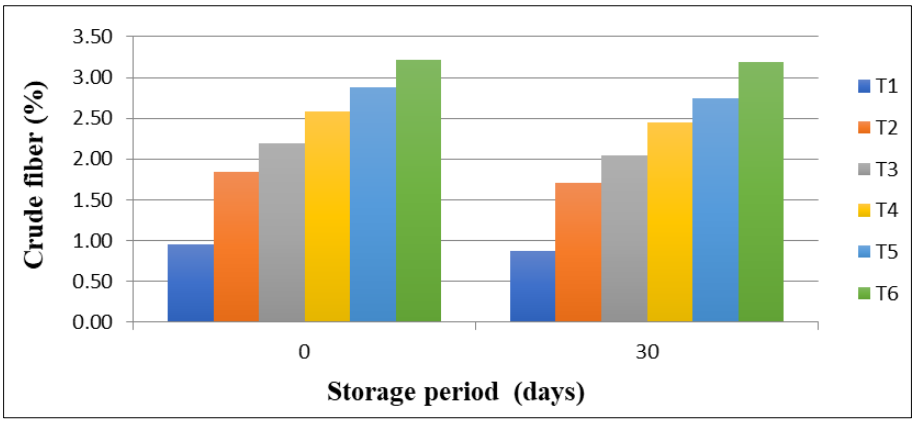


Fig 4: Changes in the crude fiber (%) content of banana flour cookies during storage at ambient condition

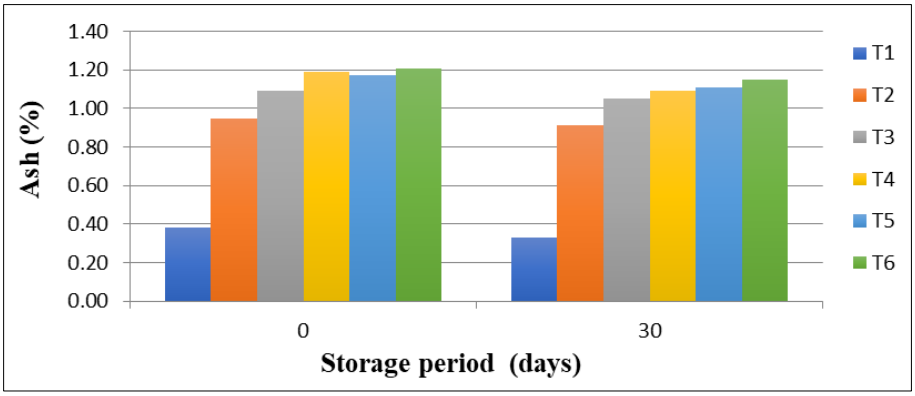


Fig 5: Changes in the ash (%) content of banana flour cookies during storage at ambient condition

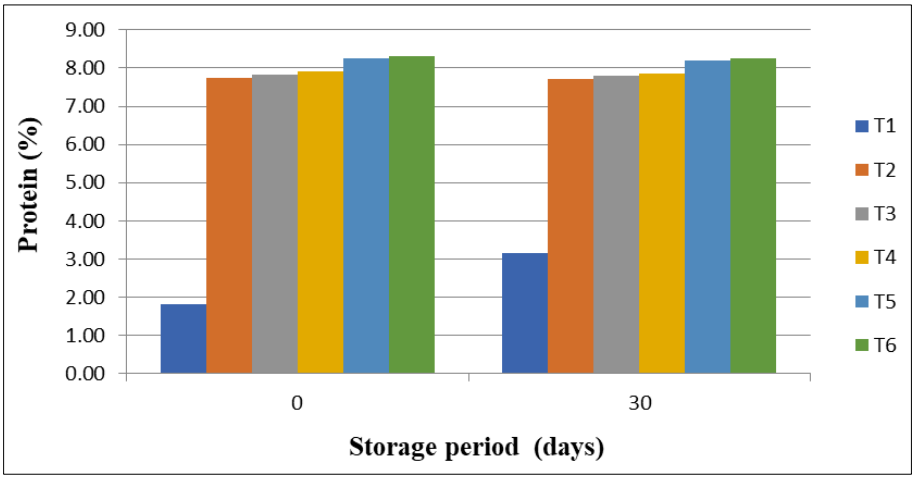


Fig 6: Changes in the protein (%) content of banana flour cookies during storage at ambient condition

Sensory analysis

The banana flour cookies samples store at ambient condition for 30 days showed different performance in sensory score. The cookies sample of T4 obtained the highest sensory score for colour (8.23), flavour (7.82), overall acceptability (7.76).

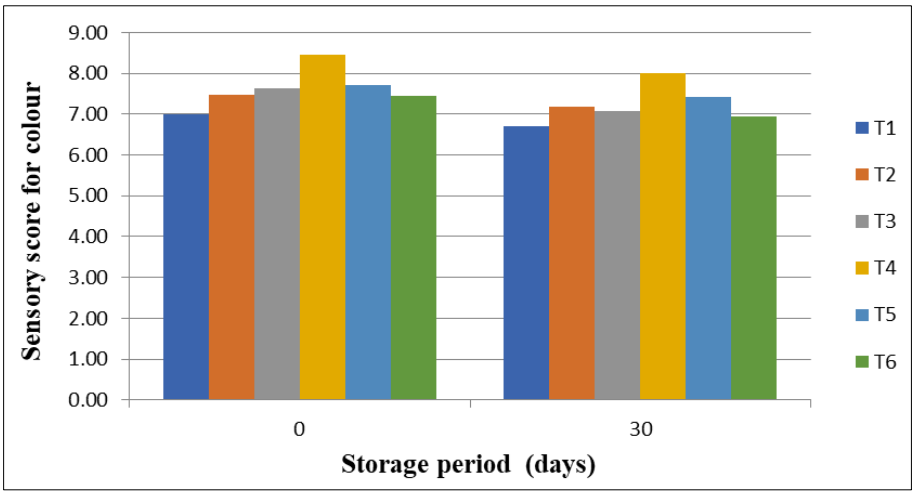


Fig 7: Changes in the sensory score for colour of banana flour cookiesduring storage at ambient condition

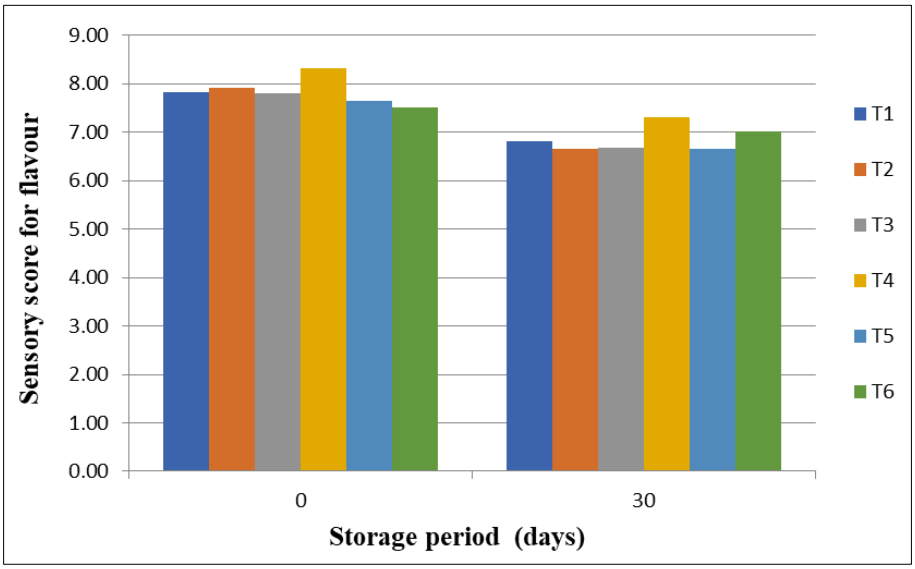


Fig 8: Changes in the sensory score for flavour of banana flour cookies during storage at ambient condition

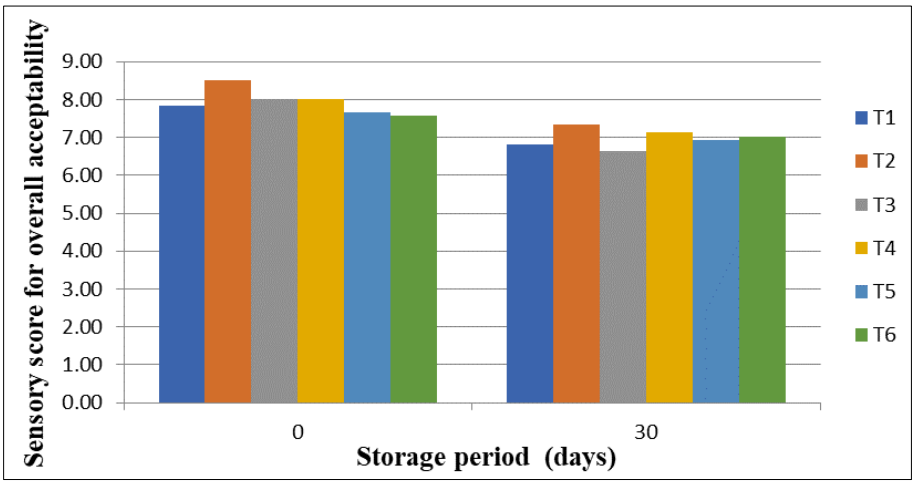


Fig 9: Changes in the sensory score for overall acceptability of banana flour cookies during storage at ambient condition

Conclusion

Present investigation concluded that the banana flour cookies irrespective of ratios were acceptable during 30 days of storage at ambient conditions. Substitution of banana flour improved physical, chemical and sensory quality characteristics of the cookies.

The sensory evaluation of cookies revealed that the colour, flavour and overall acceptability of the cookies retained up to 30 days of storage period at ambient conditions. Based on the organoleptic evaluation of the cookies, it is concluded that the banana flour cookies could be prepared by mixing banana flour and wheat flour in the ratio of T_4 [Banana flour (30%): Wheat flour (70%)].

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