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Development of Nutribars from Locally available Millets

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Abstract

The millets are mostly grown in semi-arid regions with drought and high-temperature conditions and are the staple food of the poor. They have short growing seasons with productivity, making them highly valuable. However, in recent years millets have gained attention due to their beneficial effects on human health. The consumption of millets is very limited to the poorer section of the population, this may be due to the non-availability of ready-to-eat and ready-to-use foods in urban areas. Therefore, an attempt was made in the present study to diversify the use of millets by subjecting three selected millets viz. Finger Millet (Eleusine coracana), Pearl Millet (Pennisetum), Little Millet (Panicum sumatrense) to thermal processing that is popping the millet and developing the nutribars using the mixture of these popped millets and different sweeteners like jaggery., palm, jaggery, brown sugar, and honey. Further, the products were analyzed for major nutrients (fat, protein, carbohydrate, and fiber) and minor nutrients (calcium, phosphorus, iron). Sensory evaluation was performed using a nine-point hedonic scale and a storage stability study was done at room temperature and at 5°C from 0th day to 30th day by analyzing. Free fatty acids, peroxide value, and microbial analysis. From the results, it is observed that there is no significant difference in the nutrients among the products, but brown sugar nutribars were mostly acceptable by the sensory panel among the other nutribars. The development of the product from popped millet and their quality analysis are discussed in the present paper.

Keywords: Millets; Popping, Nutribars; Nutrients; Sensory; Quality parameters

Introduction

Indian population is 1,410,881,069 according to the world meter out of which 25% are below the poverty line and 75% are above the poverty line (Niti Aayog data), and the rural population constitutes 64% (India-Rural population-2022 data forecast) wherein the consumption of millets is more apart from the consumption of paddy and wheat among the population.

Millets are small-seeded cereal grains that have been grown for ages in infertile, drought conditions. The major cultivators of millets like jowar, bajra, and ragi are seen to be predominantly harvested in geographical areas like Maharashtra, Rajasthan, and Karnataka and a portion of minor millets are cultivated in Madhya Pradesh and Uttarakhand state [1]. Millets have also been recognized as a crucial substitute for cereal crops like paddy and wheat which are predominantly consumed by the population to overcome the worldwide food shortage and increasing demands of the population in both developing and developed countries [2]. Nutritionally, millets are favorable in terms of proteins, fat, and mineral content, when compared with other cereal grains [3] and due to nutraceutical properties like management of weight, controlling blood sugar levels among the population [4], have gained a lot of attention in urban areas in recent times. The coarse texture, high fiber content, and typical flavor which can be unacceptable to the population, ready-to-eat products from millets have gained momentum. Fermented foods like dosa and idli, and bakery products like biscuits and savories are being made using finger millet as one of the ingredients [4].

In view of the urban population's craving for a ready-to-use highly nutritious products also simultaneously help in reducing obesity, millet products have gained importance and one such product will be the nutribars.

Nutribars are nutritious convenient foods that provide instant energy and other nutrients and is an option available in the market that is wholesome and nourishing food products. Based on the purpose, to be served nutribars may be rich in protein and maximize carbohydrates, an attempt can be made to provide nutrients for a complete mea+l with high calorific value. Generally, nutribars are flavored usually with sweetening agents, to make them more appetizing to the population, which is similar to that of baked goods or sweets. The nutribars are prepared using popped millets to give a crunchy texture.

Popping is a simple, inexpensive old practice where cereal grains are roasted using sand or salt as a heating medium. During popping, the grains are exposed to high temperatures for a short period of time. This process gives an acceptable taste and desirable aroma to the millets. Popped millets can be used as an alternative snack item to meet the changing consumer's taste and the elusive search for something unique that also appeals to a wide variety of people. The nutribars are also cost-effective and will be available within the reach of the common man. Literature regarding the effect of popping on the nutritional potential of a combination of three different millets with different sweeteners as a product is missing Therefore, the present study was conducted to compare the nutritional quality of the four types of nutribars prepared from the popped finger, pearl and little millet, along with sweetness, honey, jaggery, brown sugar, and palm jaggery.

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Materials and Method

Sample procurement

Little millet intact with husk was procured from a local farmer Chitradurga district, Karnataka, India. Pearl millet, finger millet, honey, palm jaggery, brown sugar, and dates were procured from the local market of Mysore, Karnataka, India. Popping was carried out by the sand roasting method in a traditional setup.

Preparation of nutribars

In a pan, the popped millets were roasted for two minutes. The mixture of honey and dates were added to bind ingredients in the case of the standard nutribars while in the experimental nutribars the different sweeteners were made to a syrup consistency and added in the place of honey. Then the mixture was transferred to a mold pressed and kept in the freezer to set for thirty minutes. The mass was cut into bars and baked in a preheated at 150°C for thirty minutes and cooled at room temperature.

Nutrient analysis

Principle nutrients

The sample was homogenized into a fine powder using a mixer grinder and were used for the analysis of nutrient and antinutrient parameters. Nutrient analysis was carried out using AOAC method [5]. Moisture content was determined gravimetrically after uniformly drying the test portion in a preheated oven (AOAC 934.01.). Ash content was determined after reducing the test portion into the inorganic matter in muffle furnace (AOAC 942.05). Total fat content was determined in the petroleum ether extract of the raw and popped millet flour samples using the classic SoxPlus apparatus (AOAC 963.15) after moisture removal. Total nitrogen content was determined by titrimetry method using Kjeldahl instrument and multiplied with a conversion factor of 6.25 to obtain the protein content (Jones,2018). Insoluble dietary fiber (IDF) and soluble dietary fiber (SDF) were quantified after enzymatic digestion of test the portion by Hellendoorns method [6]. The carbohydrate content was calculated by the difference method.

Minerals

Raw and popped millet flour was weighed 1g in duplicate in silica crucibles for ashing.The ash of the samples were digested by adding 5ml of Hcl and 1 ml of distilled water were added and the sample is digested in a hot plate at 200°C for 10 minutes. The clear residue thus obtained was diluted with double distilled water and minerals were analyzed using UV colorimeter at suitable detection wavelengths: iron (540 nm), calcium was analyzed using titrimetry method [7].

Sensory evaluation

The sensory qualities were evaluated by the sensory panelist for ensuring the acceptability of the products. For assessing the palatability and acceptability of nutribars, using a nine-point hedonic scale. Quality attributes considered were appearance, color, taste,texture, flavor, and overall acceptability from 0th day to 30th day.

Storage stability

The developed products were packed in aluminum pouches and stored at room temperature and refrigerated temperature for 15th and 30th day.

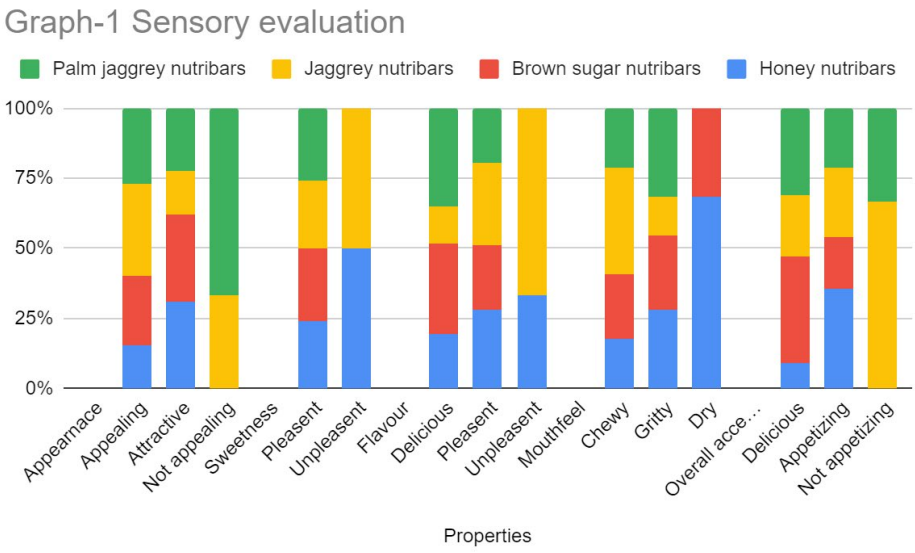

Figure 1: Sensory attributes of the nutribars were tested in terms of preferences of the panellists.

Table 1: Nutrient analysis of Nutribars.

Nutribars	Moisture (%)	Fat (g/100g)	Protein (g/100g)	Carbohydrate (g/100)	Dietary Fibre (g/100g)	Energy (kcal)	Calcium (mg/100g)	Iron (mg/100g)
Honey	6.6±0.12	2.43±0.07	1.72±0.06	87.43±0.13	1.41±0.04	430±0.09	68.11±0.07	5.57±0.07
Brown suagar	5.60±0.00	1.50±0.07	1.53±0.06	90.97±0.15	1.84±0.03	486±0.06	78.77±0.10	7.07±0.07
Jaggery	9.87±0.09	1.13±0.07	1.97±0.09	85.47±0.19	1.97±0.03	487±0.09	82.46±0.04	6.12±0.01
Palm Jaggery	5.93±0.03	2.23±0.09	1.90±0.06	87.83±0.09	2.37±0.03	475±0.06	114.00±2.08	4.90±0.06
Mean	7.00±0.51	1.83±0.16	1.78±0.06	87.93±0.06	1.90±0.10	469.5±019	85.84±5.17	5.92±0.24
F-Value	68.88**	74.72**	7.94**	255.54**	145.46**	88**	358.22**	265.15**

Table 2: Free fatty acids and peroxide value in stored nutribars.

Sample	Sample stored at room temperature (27°C)			Sample stored in refrigeration (5°C)		
	Free fatty acids (%)					
	0th day	15th day	30th day	0th day	15th day	30th day
Honey nutribars	Nil	0.32	0.74	Nil	Nil	Nil
Brown sugar nutribars	Nil	0.56	1	Nil	Nil	Nil
Jaggrey nutribars	Nil	0.48	0.96	Nil	Nil	Nil
Palm jaggrey nutribars	Nil	0.24	0.8	Nil	Nil	Nil
	Preoxide Value					
	0th day	15th day	30th day	0th day	15th day	30th day
Honey nutribars	Nil	1.29	1.95	Nil	Nil	Nil
Brown suagr nutribars	Nil	1.46	1.66	Nil	Nil	Nil
Jaggrey nutribars	Nil	1.34	2.14	Nil	Nil	Nil
Palm jaggrey nutribars	Nil	1.65	2.11	Nil	Nil	Nil

Table 3: Microbial Analysis.

Sample stored at room temperature (27°C)												
Dilution	Honey nutribars			Brown sugar nutribars			Jaggrey nutribars			Palm jaggrey nutribars		
	Duration (days)			Duration (days)			Duration (days)			Duration (days)		
	0th	15th	30th	0th	15th	30th	0th	15th	30th	0th	15th	30th
104	-	-	-	-	-	-	-	-	++	-	-	-
103	-	-	-	-	-	-	-	-	-	-	-	-
102	-	-	-	-	-	-	-	-	-	-	-	-
101	-	-	-	-	-	-	-	-	-	-	-	-
Sample stored in refrigeration (5°C)												
104	-	-	-	-	-	-	-	-	-	-	-	-
103	-	-	-	-	-	-	-	-	-	-	-	-
102	-	-	-	-	-	-	-	-	-	-	-	-
101	-	-	-	-	-	-	-	-	-	-	-	-

- Indicates absence of microbial colonies, and ++ indicates the presence of microbial colonies

Free fatty acids estimation

Free fatty acids of stored products on 0,15, and 30th day was determined by the standard method of [8]

Peroxide value

Peroxide value of stored products on 0, 15 and 30th day was determined by the method of [8]

Microbial analysis

The microbial load of the developed products was enumerated in terms of total viable count on 15th and 30th day of storage as per the method described by American Public Health Association (APHA,1984).

Statistical analysis

The results were subjected to two-way variance (ANOVA) using the Statistical Package for Social Science (SPSS) version 20

Results and Discussion

Nutrient analysis

A significant variation in moisture, fat, protein, carbohydrate, dietary fiber, calcium, and iron were observed among the different varieties of nutribars ($p \geq 0.05$) (Table-1). The moisture content in the case of jaggery nutribars was highest (9.87%) and lowest in brown sugar nutribars (5.6%). The fat was highest in the case of nutribars prepared out of honey with 2.43g/100g as the quantity of dates used was more when compared with other nutribars. Protein content was found to be highest in case of jaggery with 1.97g/100g. The carbohydrates content was highest in case of palm jaggery nutribars with 2.37g/100g. the ash content was highest in the case of palm jaggery nutribars with 2.01g/100g. this significant difference in the nutrients might be due to the difference in the nutrient composition of the different sweeteners. Such a variation in the nutritional status in accordance with nutrient were observed by [9] wherein they reported an increase in nutrient content when the sugar was replaced with jaggery in the preparation of muffins. Calcium content was highest in case of palm jaggery nutribars with 114.00 mg/100g as the palm jaggery is rich in calcium content. The iron content was highest in case of brown sugar nutribar with 7.07 mg/100g. Similar results were reported by [10] where there was significant difference between the two types of ladoos prepared using popped millet. The calcium, phosphorous, and iron content was higher in type-1 ladoos i.e., 65.51,168.26, 4.89 and 0.49 mg/100g, respectively when compared with type-2 ladoos. [11] reported similar nutrient content in the crunchy bars developed using popped pearl millet wherein it consisted of 82.3g/100g carbohydrate,10.8g/100g protein and 4.3g/100g fat content. The total ash content of the nutri bar was 1.39g/100g. The calcium, phosphorus, iron and zinc content were found to be 58.7,215.6, 5.13 and 3.17 mg/100g, respectively.

Sensory evaluation

The sensory attributes of the nutribars were tested in terms of preferences of the panelists (Graph-1). The quality standards were tested against the properties like appearance, sweetness, flavor, mouth-feel, and overall acceptability in nutribars developed using various sweeteners, the maximum panelist found jaggery (74%) and palm jaggery (61%) nutribars appealing due to bright glossy colour. The

brown sugar and palm jaggery nutribars were ranked high (100%) for the pleasant sweetness while nutribars developed using honey and jaggery were unpleasant to (6%) of the panelist. The mouthfeel of jaggery nutribars was found to be chewy (74%) due to the incomplete crystalization of the sugars present while plam jaggery, brown sugar and honey nutribars had gritty desirable texture (58%, 48%, and 52% respectively). The overall acceptability was rated delicious for both brown sugar and palm jaggery nutribars (55% and 45% respectively) due their pleasant sweetness, flavour and gritty texture which are the characteristic features, inspite of having appealing appearance, pleasant sweetness, and flavour jaggery nutribars were only apitizing (61%) to the panelist due to the soggy texture of the nutribars. On conducting the sensory evaluation, the brown sugar nutribars were rated the highest followed by palm jaggery nutribars which can be selected as the best and can be further popularize amongst the population. There was no significant change in the sensory attributes when evaluated from 0th to 30 days storage conditions. Similar studies were conducted by [12] on the sensory evaluation of chapati, biscuit, sattu and noodles prepared by using mixed flours in different proportions, and the best was selected on the basis of the sensory scores of products prepared and findings used for further study.

Storage stability

The free fatty acid content increased gradually from 0th day to 30th day at normal room temperatures which ranged from 0-0.74,0.8, 0.96, and 1.0 % oleic acid in honey, brown sugar, jaggery, and palm jaggery nutribars respectively by 30 days (Table- 2). From these results obtained it can be implied that the product has not reached rancidity and can be consumed even after storing it for 30 days at room temperature as the results are in agreement with reports of [13] who have observed that the range between 0.46-1.00% were safe as the fat has not reached the stage of producing fatty acid during oxidation. The peroxide value (PV) increased slightly at room temperatures which ranged from 0.00- 1.95, 2.11, 2.14, and 1.66 in honey, brown sugar, jaggery, and palm jaggery nutribars respectively by 30 days (Table-2) and was no significant increase on either 15th day or on and 30th day of storage at room temperature [14] observed similar results in the PV values of pearl millet upma mix wherein it did not show any significant ($p<0.05$) increase during the first 2 months and increased slightly, thereafter. While the nutribars stored in refrigeration conditions did not show any change in either of the tests performed in the period of 30 days (Table-2).

Microbial analysis

The results obtained for the microbiological examination of the nutribars (Table-3) when compared with fresh i.e., 0th day samples showed that the total plate count (TPC) slightly increased by the storage duration of 30 days in nutribars made out of jaggery, while the other three nutribars showed no microbial growth at the room as well as refrigerated temperature. Hence it can be concluded that the nutribars were stable at room temperature and refrigeration for the duration of 30 days with aluminum packaging material.

Conclusion

From the present study it is very clearly understood that the nutritional status of the products varied with the sweeteners used and the best nutritionally standard is the one prepared with palm jaggery. The sensory studies revealed brown sugar and palm jaggery nutribars were the most accepted which can be attributed to the crunchy texture of the product and the storage studies indicate no microbial growth and adverse effects on the product up to the 30th day at both room temperature and refrigeration. Hence the nutribar prepared palm jaggery which is acceptable for the majority can be promoted as a source of energy bar at an economically cheaper rate.

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