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Standardization and development of gluten free beetroot millet cracker

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Abstract

Cracker is a palatable, crunchy snack that is most popular in India. Cracker is usually made with refined flour and sugar. This study aimed to develop and evaluate a millet-based cracker , using beetroot extraction finger millet flour, jowar flour, jaggery, sesame seeds(brown and black) and rice flour. As millets are considered nutritionally rich foods so they can be used to develop healthy and functional foods. Different levels of finger millet flour, jowar flour, and other ingredients were added in the proportions of 50%JF + 30%beetroot extraction + 10%OI (Sample A), 50%RFF + 30% beetroot extraction + 20%OI (Sample B), and 25%JF + 25%RF + 30% beetroot extraction+20%OI (Sample C) for the development of murukku and its sensory attributes were analyzed. The one-way ANOVA revealed a significant difference between the mean scores of at least two samples ($F(2, 15) = 3.7855$, $p=0.046$, $p<0.05[\alpha]$). Sample A (50JF + 30% beetroot extraction+ 20%OI) demonstrated desirable organoleptic properties based on taste panel studies. The selected sample A had an energy content of 699Kcal/100g, with 80.37g carbohydrates, 0.17g fat, 9.56g protein, 2.8g dietary fiber, calcium 45mg, and iron 5.5mg per 100g. While the total viable count and coliform count increased during a month storage period from 1 to 2 and 1 to 1.7 respectively, harmful bacteria such as *E. coli*, *salmonella*, and *staphylococcus* were absent in initial and final assessments. The pH increased from 7.1 to 7.6 during storage. The color, odor, and taste of the sample scored 4.5 initially but decreased to 3.0 at the end, while the texture remained constant with a score of 3.0 throughout storage

Keywords: Finger millet Jowar; Rice flour; Millet- Based Cracker; Organoleptic Properties; Savory snack; Antioxidant Property

1. Introduction

Millets have emerged as a prominent gluten-free superfood, celebrated for their nutritional richness and versatility in culinary applications. Unlike traditional grains like wheat, barley, and rye, millets do not contain gluten, a protein composite that can trigger adverse reactions in individuals with celiac disease or gluten intolerance. This characteristic alone makes millets a preferred choice for those seeking gluten-free alternatives to grains that can be hard on their digestive systems. Millets stand out not only as a gluten-free superfood but also as a versatile and nutritious addition to any diet. Their diverse varieties and culinary applications make them suitable for a wide range of dishes, from breakfast porridge to baked goods and savory meals. By choosing millets and other gluten-free foods, individuals can enjoy the health benefits of improved digestion, nutrient absorption, and overall well-being. Whether you have celiac disease, gluten sensitivity, or simply wish to explore healthier dietary options, incorporating millets into your meals offers a delicious and nutritious alternative to traditional grains. Millets can also consume as savory snack.

Beetroot is a root vegetable also known as red beet, garden beet, or just beet. Beetroots are usually reddish-purple, although some varieties are yellow or white. They are often used raw in salads or cooked in dishes like soup and broscht. Beetroot can also be made into beet juice, a popular healthy beverage. Beetroots contain a wide variety of essential

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nutrients for a healthy life; they are rich in fibre, folate (vitamin B9), manganese, potassium, iron, and vitamin C. Beetroots also contain nitrates, which can help lower blood pressure and improve exercise performance.

Finger millet, scientifically known as *Eleusine coracana* L., goes by various names across different regions. In India, it is referred to as ragi and mandua, this versatile crop holds significant importance as a staple food in parts of eastern and central Africa, as well as in India. (Pragya Singh and Rita Singh Raghuvanshi., 2012). When it comes to nutritional value, finger millet surpasses many other cereal grains in terms of minerals, dietary fiber, and essential amino acids. This remarkable grain is abundant in protein, iron, calcium, phosphorus, fiber, and a range of vitamins. It stands out from other cereals with its exceptional fiber and calcium content, surpassing their levels. Additionally, finger millet boasts the highest iodine content among all food grains. Notably, ragi, a type of finger millet, shines in terms of its high-quality protein, essential amino acids, vitamin A, vitamin B complex, and phosphorus content (Ishwar Patel et al., 2016).

Jowar (or) Sorghum plays a vital role in the economies of developing countries and serves as a staple food for more than half a billion people. It holds particular significance in arid and semi- arid regions, where the prevalence of drought stress poses a significant constraint (Kibrom B. Abreha et al., 2021). sorghum is recognized for its low glycemic index, making it a favorable choice for individuals managing diabetes (Jakub Frankowski et al., 2022). By seeing nutritional importance of the above ingredients, the research study framed to Development of Gluten Free Beetroot Millet Cracker Using Jaggery Sesame Seeds and Rice Flour.

2. Material and methods

2.1. Raw Materials

The necessary ingredients are obtained from local market located at Shastripuram, Shivrampally Jagir and Attapur Hyderabad. The three samples of crackers i.e jowar, ragi, and jowar ragi mixed cracker, were made by standardizing the ingredients (jowar, ragi, beetroot) The other ingredients i.e jaggery, sesame seeds {brown, black} were kept constant.

2.2. Assessment of Organoleptic Properties

The organoleptic properties of the samples were estimated by the score card method using the Hedonic rating scale. The sensory evaluation of the samples was done by the score card method, which mainly consist of six parameters i.e aroma, appearance, taste, texture, mouthfeel, and over all acceptability. A 5- point hedonic scale is used to assess the above -mentioned parameters of the three samples. Based on the organoleptic scores the best sample is selected out of three samples.

2.3. Formulation of millet based crackers

Samples	Combinations
Sample-A	50%JF+30%Beetroot Extraction+20%OI
Sample-B	50%RF+30%Beetroot Extraction+20%OI
Sample-C	25%JF+25%RF+30%Beetroot Extraction+20%OI

JF (jowar flour); RF (ragi flour); OI (The other ingredients comprised species are (sesame seeds, black sesame seeds, and jaggery rice flour) (shown in Fig.2, Fig.3 and Fig.4))

2.4. Method of preparing beetroot millet based crackers

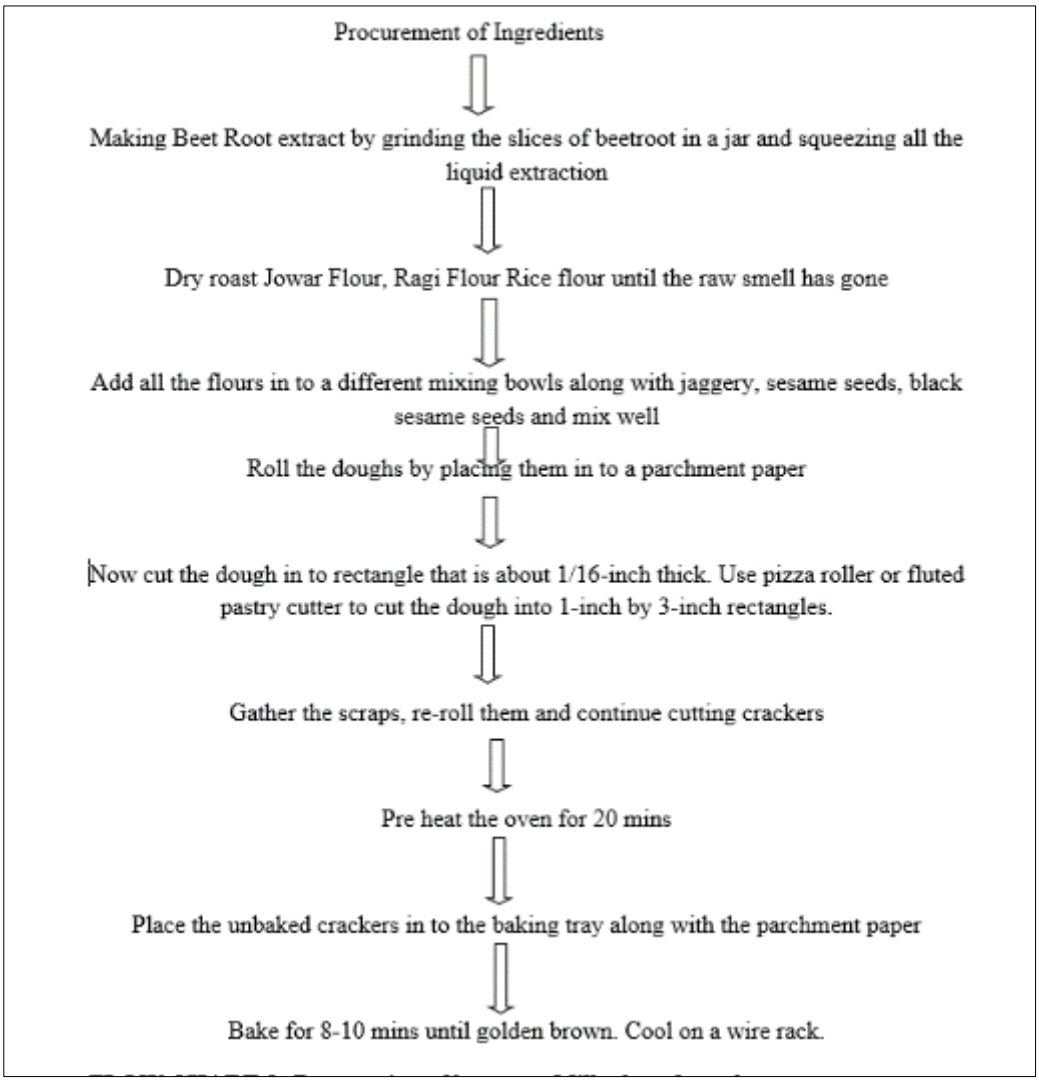

Figure 1 Preparation of beet root Millet based crackers

Figure 2 Jawar Crackers

Figure 3 Ragi Crackers

Figure 4 Jawar and Ragi Crackers

2.5. Nutrient Analysis of The Selected Samples

Nutrient analysis of the selected sample is performed to know the values of energy, carbohydrates, total fat, total sugars, protein, Ca, Na, Fe, and dietary fiber.

The nutrient analysis of the best-selected sample was analyzed as follows.

Table 1 Nutritional qualities and method of the beetroot millet crackers

Nutritional qualities	**methods**
Energy	FAO method
Carbohydrates	CTL/SOP/FOOD/262-2014
Total Fat	AOAC 20th Edn.2016, 920,39
Protein	AOAC 20th Edn.2016, 986.25
Dietary Fiber	AOAC 20th Edn.2016, 985.29
Total Sugars	FFASI Manual 2015-Beverages, Sugars, and Confectioneries
Sodium	AOAC20th Edn.2016, 996.23
Calcium	IS 5949: 1990 (RA2003)
Iron	AOAC 20th Edn.2016, 999.11

2.6. Shelf-life analysis of the selected samples

The shelf analysis of the selected samples of the selected sample was packed in an air tight container and was analyzed for one month. The chosen sample was analyzed initially and after the storage, period to investigate the following aspects.

2.7. Microbial and chemical analysis of the selected samples

The microbial and chemical analysis was done for the selected sample. Both the analysis was done at the initial stage and the end of the storage.

2.8. Statistical analysis

Statistical analysis was done with Mean, Standard deviation, and ANOVA by using their formulas.

3. Results and discussion

3.1. Organoleptic evaluation

The organoleptic evaluation of the three samples was performed in Jeedimetla-IDA, Hyderabad. The data in the table-3 shows the average and the standard deviation of the sensory scores for different parameters. In the evaluation of appearance, Sample-A stood out with a visually appealing rating of 3.2 and a low standard deviation of 0.615, implying consistent agreement among evaluators. On the other hand, Sample B received a lower score of 2.325 and a larger standard deviation of 0.765, suggesting less uniformity in its appearance. Sample-C obtained a score of 2.5 with a standard deviation of 0.688, positioning it between the other two samples. In terms of texture, Sample-A received the highest rating of 3.975 with a small standard deviation of 0.572, indicating a pleasant and consistent texture. Sample B scored 2.9 with a comparable standard deviation of 0.575, suggesting moderate variability. Sample-C obtained a score of 3.075 with a standard deviation of 0.591, similar to Sample-B but slightly less consistent. Regarding taste, Sample-A once again took the lead with a high score of 4.25 and a small standard deviation of 0.472, indicating a consistently favorable taste. Sample B scored 3.375 with a slightly larger standard deviation of 0.582. Sample-C received a score of 3.5 with a standard deviation of 0.606, falling between the other two samples. In the mouthfeel category, Sample-A obtained a high score of 4.375 with a standard deviation of 0.509, providing a pleasant sensation to evaluators with good consistency. Sample B received a lower score of 3.075 with a smaller standard deviation of 0.466, indicating moderate variability. Sample-C scored 3.15 with a larger standard deviation of 0.67, suggesting a less consistent mouthfeel compared to the other two samples. JETIR2307392 Journal of Emerging Technologies and Inn Finally, in overall acceptability, both Sample-A and Sample-B obtained high scores of 4.25 and 3.375, respectively, with small standard deviations of 0.5 and 0.509, showing high consistency in terms of acceptability. Sample C received a score of 3.3 with a standard deviation of 0.636, placing it between the other two samples in terms of overall acceptability. Based on the above results sample A acquired desirable organoleptic scores. Similar studies were conducted by Indu Bhargavi et al (2023) on the development of Nutri-bars using millets and there was no significant change in the organoleptic properties from the 0th day to the 30th day of storage conditions. Chart-1 indicates the calculation of the ANOVA value, where the calculated P-value (0.046) was lesser than the significance value[α] (0.05) and the F-value (3.7855) is greater than the F-critical value (3.6823), therefore it is concluded that there was a significant difference between the samples. The result of the ANOVA indicates that the sensory attributes had a notable impact on the samples. According to the study conducted by Laghima Arora et al (2023), there was a notable difference ($p<0.05$) observed in the resistant starch levels between the product derived from foxtail millet and conventional cereal, except for kheer.

Table 2 Mean and Standard deviation of the different samples for sensory parameters

Sensory Parameters	Sample-A	Sample-B	Sample-C
Aroma	2.45+0.841	2.125+0.559	2.2+0.656
Appearance	3.2+0.615	2.325+0.765	2.5+0.688
Texture	3.975+0.572	2.9+0.575	3.075+0.591
Taste	4.25+0.472	3.375+0.582	3.5+0.606
Mouthfeel	4.375+0.509	3.075+0.466	3.15+0.670
Overall Acceptability	4.25+0.5	3.375+0.509	3.3+0.636

Table 3 Calculated ANOVA values for the means samples

Source of variation	SS	Df	MS	F	P-Value	F Critical
Between groups	2.85881944	2	1.42940972	3.78554088	0.046670412	3.682320344
Within groups	5.66395833	15	0.37759722			
Total	8.52277777	17				

3.2. Nutritional Analysis of The Selected Cracker Sample

The Selected Cracker of Nutritional Analysis shown in the table-4. Selected Cracker sample had an energy content of 699Kcal/100g, 80.37g of carbohydrates, 0.17g of total fat, 9.56g of protein, 2.8g of dietary fiber, and negligible sugar content. The mineral analysis revealed the presence of calcium (mg/100g), and iron (2.34mg/100g). The millet upma and millet khichdi were prepared by Iksha Chhabra and Avneet Kaur (2022) and were rich in protein and dietary fiber due to the usage of millets and a mix of legumes.

Table 4 Nutritive value of the millet cracker

Parameters	Results	Units
Energy	699	kcal
Carbohydrates	80.37	g/100g
Total fat	0.17	g/100g
Protein	8.7	g/100g
Dietary fiber	2.8	g/100g
Calcium	45.0	mg/100g
Iron	5.5	mg/100g
Moisture	8.7	g/100g
Ash	1.2	g/100g
Gluten	Not detected	ppm

3.3 Microbiological parameters of the selected murukku sample during storage

Chart-3 illustrates the microbiological analysis which shows the low counts of total viable bacteria and coliforms, with no detection of *E. coli*, *Salmonella*, or *Staphylococcus* aureus. Yeast and Mold remained constant during storage.. Sarojini JK et al (2021) The ready-to-cook kodo millet pasta was stored for 3 months and there were significant changes in the pasta, The pasta became rancid after 3 months of storage.

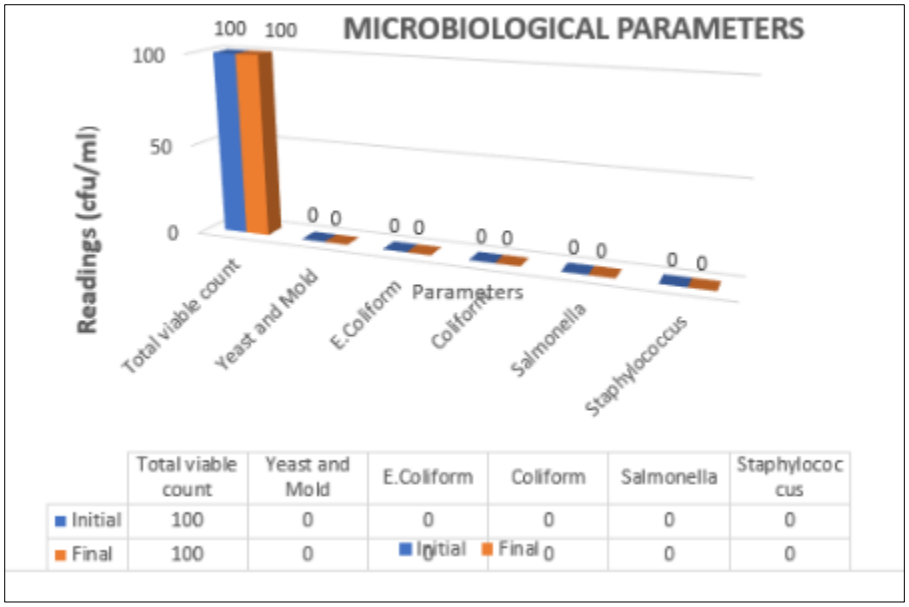

Figure 5 Microbiological parameters of the selected cracker sample during storage

3.4 Chemical parameters

Moving on to the chemical parameters, the pH level of the sample increased from 7.1 to 7.6 during storage. (Chart-4). The pH values of the pearl millet and finger millet decreased from 8.50 to 7.60 and 7.90 respectively, which was reported by Owheruo et al (2018).

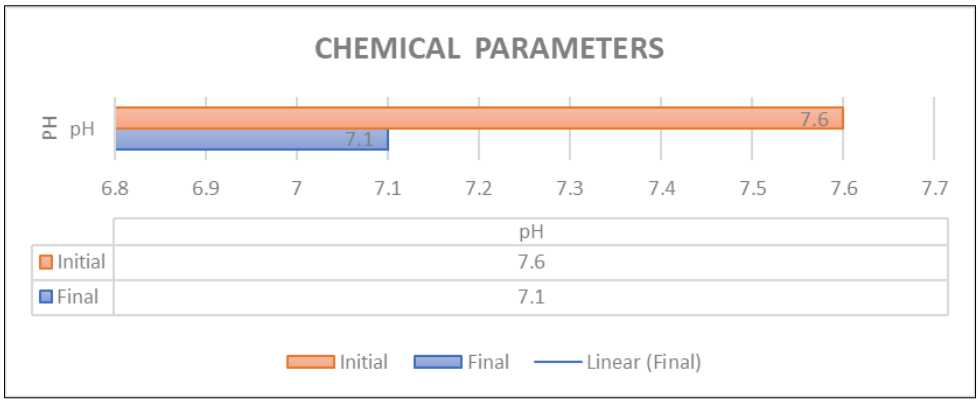

Figure 6 Chemical analysis of millet crackers

4. Conclusion

The study conclude that millet cracker formulated with multi millet 50% of jowar (finger millet) 30% of beetroot extraction and 20% of other ingredients was highly acceptable in terms of organoleptic properties such as aroma, appearance, texture, taste, mouthfeel, and overall acceptability. The formulated cracker was good and within limits for a month. Hence there is a scope of developing cracker using finger millet and jowar by replacing with refined flour and sugar.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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