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STANDARDIZATION AND QUALITY EVALUATION OF SHREE ANNA (MILLET) BASED MURUKKU USING BROWN RICE FLOUR

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ABSTRACT

Murukku is a savory, crunchy snack that is most popular in India. Murukku is usually made with rice flour and black gram dal. This study aimed to develop and evaluate a millet-based snack called millet murukku, using finger millet flour, jowar flour, and brown 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 brown rice flour were added in the proportions of 50%MMF + 35%BRF + 15%OI (Sample A), 60%MMF + 25%BRF + 15%OI (Sample B), and 70%MMF + 15%BRF + 15%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 (50%MMF + 35%BRF + 15%OI) demonstrated desirable organoleptic properties based on taste panel studies. The selected sample A had an energy content of 599Kcal/100g, with 43.6g carbohydrates, 44.3g fat, 6.59g protein, 6.63g dietary fiber, negligible sugar content, sodium 540mg, calcium 148mg, and iron 2.34mg 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 flour, Jowar flour, Brown rice flour, Millet-based murukku.

1. INTRODUCTION

Millets, belonging to the Poaceae grass family, stand as ancient cultivated crops with a rich history. *(Z M Hassan et al., 2021).* According to *N. A. Nanje Gowda et al., (2022),* Among the small-seeded grains, several millet varieties hold significant importance in the realm of food. These include sorghum *(Sorghum bicolor L.)*, pearl millet *(Pennisetum glaucum)*, finger millet (*Eleusine carocana)*, teff *(Eragrostis tef)*, proso millet *(Panicum miliaceum)*, kodo millet *(Paspalum scrobiculatum)*, foxtail millet *(Setaria italica)*, little millet *(Panicum sumatrense)*, and fonio *(Digitaris exilis)*.

Finger millet, scientifically known as *Eleusine coracana* L., goes by various names across different regions. The nutritional value of finger millet surpasses any other cereal grains in terms of dietary fiber, essential amino acids, and minerals. Finger millet is also abundant in protein, iron, calcium, phosphorous, fiber, and a range of vitamins. It also has a high content of iodine and phosphorous among all food grains. Apart from these, finger millet is also rich in vitamins A and B complex vitamins *(Ishwar Patel et al., 2016).* Finger millet contains phytochemicals and exhibits antioxidant properties, which help in reducing excessive cellular oxidation and protecting against various types of cancer *(Anil Kumar et al., 2016).*

Jowar also known as great millet, 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).* In the current context, sorghum holds great importance as a gluten-free cereal, particularly due to the increasing prevalence of Celiac Disease (CD). The CD is an immune-mediated reaction to gluten intolerance, making sorghum a valuable dietary option for individuals affected by this condition *(Arun G. Kulamarva et al., 2009).*

The primary component found in fully ripe sorghum grains is starch, constituting approximately 65 to 80 grams per 100 grams of grains, depending on the variety. In addition to starch, sorghum seeds contain proteins (7-15 grams), other polysaccharides (up to 10 grams), and lipids (1.5-6 grams). Moreover, sorghum is recognized for its low glycemic index, making it a favorable choice for individuals managing diabetes *(Jakub Frankowski et al., 2022).*

Throughout centuries, rice *(Oryza sativa L.)*, a widely recognized cereal crop, has served as a fundamental staple for a significant portion of the global population, nourishing and sustaining millions of individuals worldwide *(Keneswary Ravichanthiran et al., 2018*). Brown rice offers notable advantages compared to milled rice, as it contains higher levels of beneficial nutrients *(Jae-Sung Lee et al., 2019).*

Therefore, the present study was designed to utilize finger millet, jowar, and brown rice flour to develop a savory, crunchy snack called murukku and to determine its quality parameters.

2. MATERIALS AND METHODS

2.1 RAW MATERIALS

The raw materials selected for this study were finger millet flour, jowar flour, brown rice, Bengal gram flour, chili powder, carrom seeds, asafetida, pink Himalayan salt, and cooking oil were purchased from the local market in Shapur Nagar, Hyderabad.

The present study was carried out in Capital Degree and PG College, Hyderabad, Telangana, India.

2.1.1 PREPARATION OF BROWN RICE FLOUR

Brown rice was thoroughly washed to remove the dust and other foreign substances. The clean rice was dried for 3-4 hours and then the rice was ground to make fine flour and sieved through mesh sieves.

2.2 FORMULATION OF MILLET-BASED MURUKKU

Three combinations of millet-based murukku were formulated by incorporating the flour mixed at various proportions of finger millet, jowar, and brown rice as follows

Table-1 Formulation for the preparation of millet murukku

Samples	Combinations
S-A	50%MMF + 35%BRF + 15%OI
S-B	60%MMF + 25%BRF + 15%OI
S-C	70%MMF + 15%BRF + 15%OI

MMF-Multi-millet flour (finger millet and jowar), **BRF**-Brown rice flour, **OI**-Other ingredients.

2.3 PREPARATION OF MILLET-BASED MURUKKU

The millet-based murukku was prepared by mixing the dry ingredients, kneading with water, and a little hot oil into the dough. The dough was covered for 30 minutes and covered with a wet cotton cloth. Meanwhile, oil was kept on the stove for frying the murukkus. After resting the dough was passed through an extruder (murukku maker) into the hot oil and the murukku was fried till it turned out crispy. Then the murukku was cooled down and stored in an airtight container for further analysis.

2.4 ORGANOLEPTIC EVALUATION

The sensory evaluation was carried out for the prepared murukku samples using a 5-point hedonic scale with a panel of 20 judges considering the 6 parameters as Aroma, Appearance, Texture, Taste, Mouthfeel, and Overall acceptability.

2.5 NUTRITIONAL EVALUATION

The nutritional evaluation of the best-selected sample was analyzed as follows

Table-2 Nutritional qualities and methods of the millet murukku

Nutritional qualities	Methods
Energy	FAO method
Carbohydrate	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	FSSAI Manual 2015-Beverages, Sugars, and Confectioneries
Sodium	AOAC 20th Edn.2016, 969.23
Calcium	IS 5949:1990 (RA.2003)
Iron	AOAC 20th Edn.2016, 999.11

2.6 SHELF-LIFE ANALYSIS OF THE SELECTED MURUKKU SAMPLE

The selected murukku sample was kept for one month of storage to know the shelf life by performing total viable bacteria, coliforms, E. coli, Salmonella, or Staphylococcus aureus, Yeast and Mold.

2.7 STATISTICAL ANALYSIS

Data obtained from sensory analysis were subjected to mean and standard deviation and it was statistically analyzed by one-way analysis of variance (ANOVA) by using a significance of 0.05.

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.

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* nutribars using millets and there was no significant change in the organoleptic properties from the 0^{th} day to the 30^{th} 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.

3.2 NUTRITIONAL ANALYSIS OF THE SELECTED MURUKKU SAMPLE

The Selected Murukku of Nutritional Analysis shown in the table-4. Selected murukku sample had an energy content of 599Kcal/100g, 43.6g of carbohydrates, 44.3g of total fat, 6.59g of protein, 6.63g of dietary fiber, and negligible sugar content. The mineral analysis revealed the presence of sodium (540mg/100g), calcium (148mg/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.

3.3.1 ORGANOLEPTIC ANALYSIS OF THE SELECTED MURUKKU SAMPLE DURING STORAGE

The organoleptic evaluation was done over a month at the initial and at the end of the storage duration. As shown in chart-2 the texture remained constant at initial and final evaluation whereas, there was a decrease in color, odor, and taste scores by the end of the storage. Meherunnahar *et al (2023)* foxtail millet noodles were stored for 6 months and acquired desirable organoleptic scores and the scores indicated that the noodles were improved in flavor and taste.

3.3.2 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. Meherunnahar *et al (2023)* foxtail millet noodles were stored for 6 months and the microbial load was within limits. Dr. 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.

3.3.3 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 Joseph O Owheruo *et al (2018).*

Table-3 Mean and Standard deviation of the different samples for 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

Chart-1 Calculated ANOVA values for the means of the samples

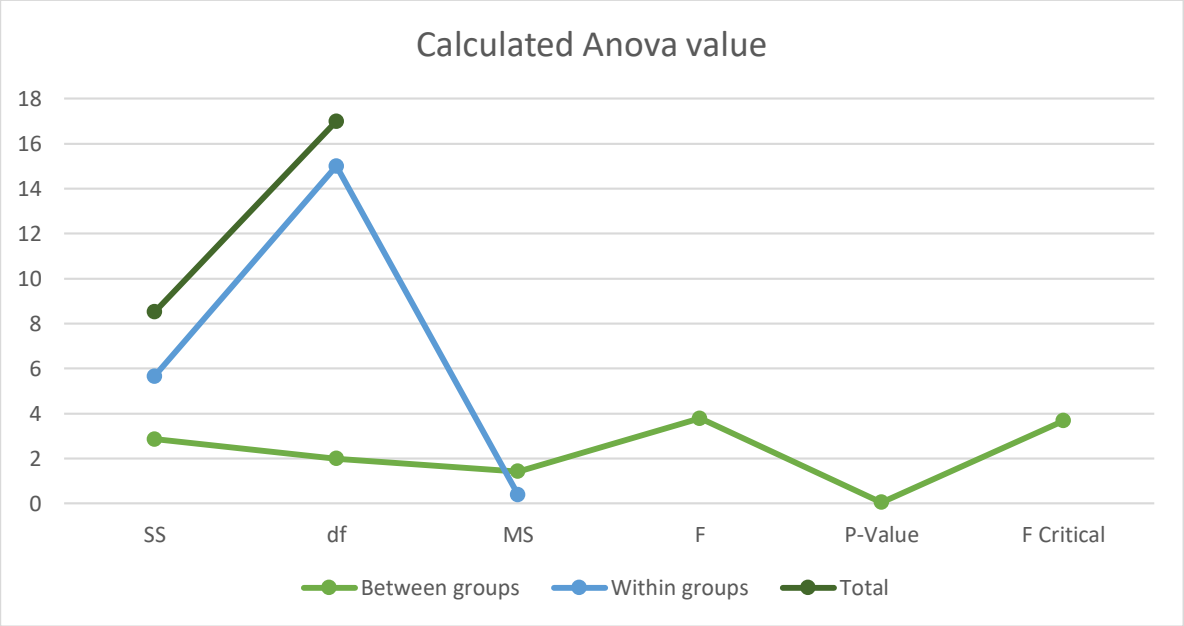


Table-4 Nutritive value of the millet murukku

S. NO	PARAMETERS	UNITS	RESULTS
1	Energy (by calculation)	Kcal/100g	599
2	Carbohydrates (by difference)	g/100g	43.6
3	Total fat	g/100g	44.3
4	Protein	g/100g	6.59
5	Dietary fiber	g/100g	6.63
6	Total sugars	g/100g	BDL (DL:2.0)
7	Sodium (Na)	mg/100g	540
8	Calcium (Ca)	mg/100g	148
9	Iron (Fe)	mg/100g	2.34

Chart-2 Organoleptic evaluation of the selected murukku sample during storage from the 0^{th} day to the 30^{th} day

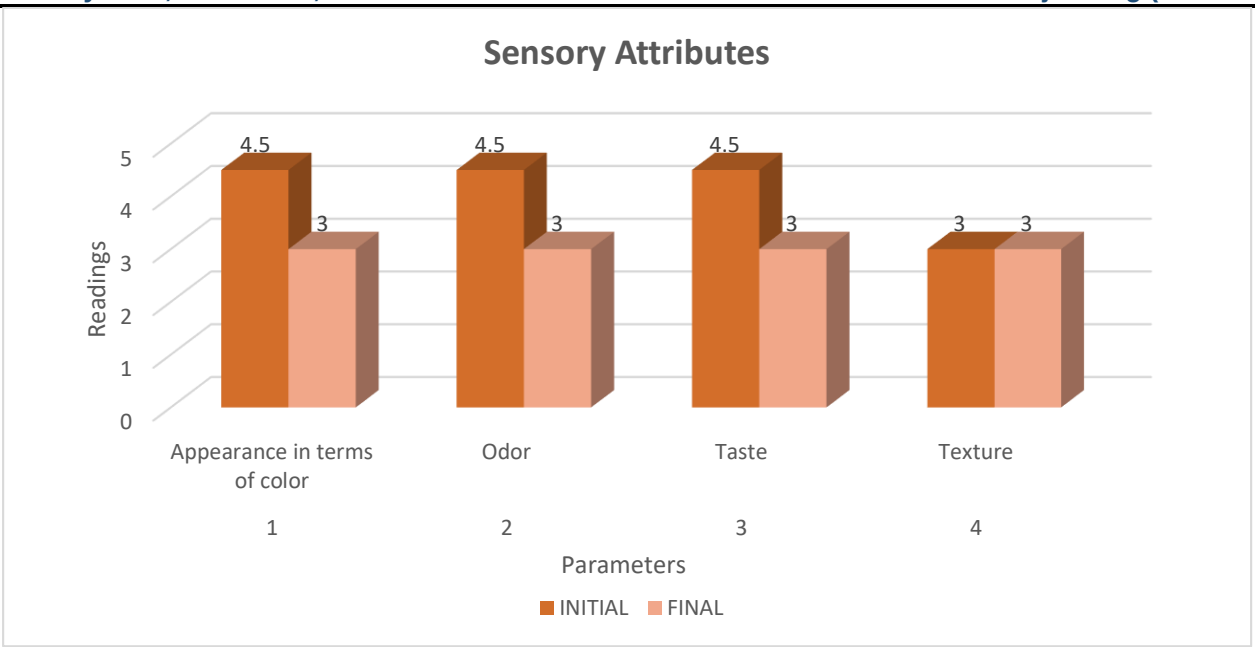


Chart-3 Microbiological parameters of the selected murukku sample during storage

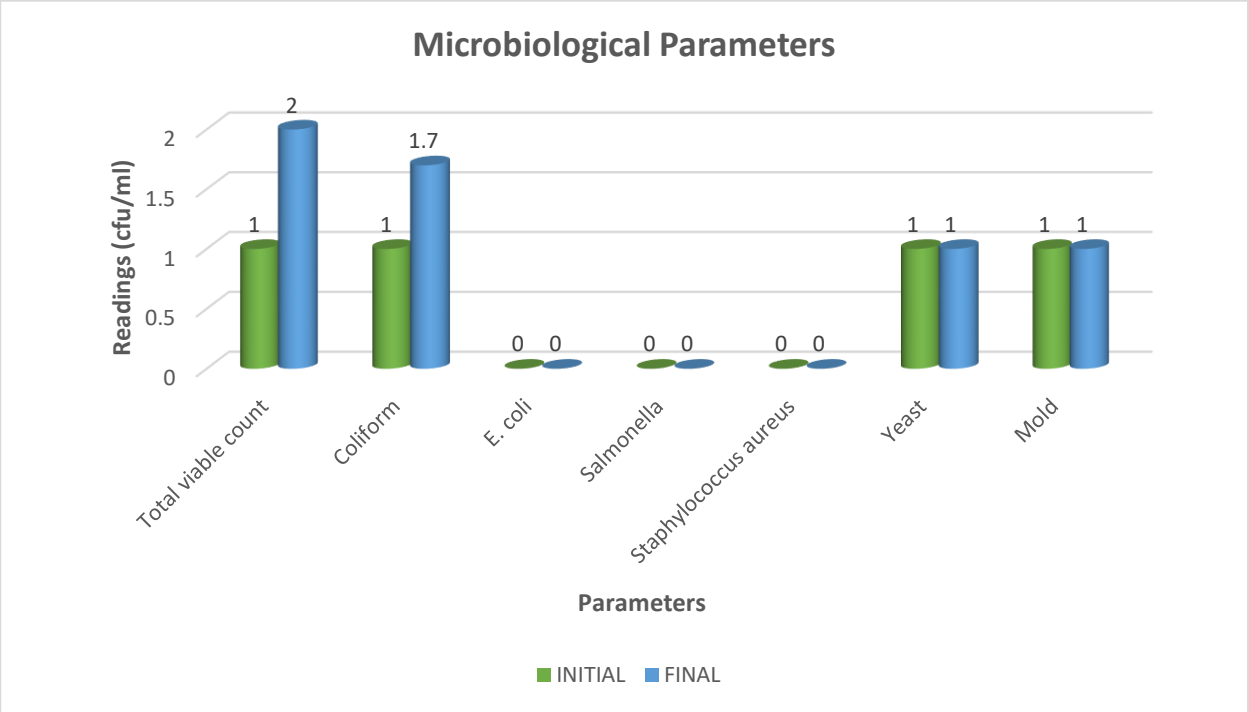
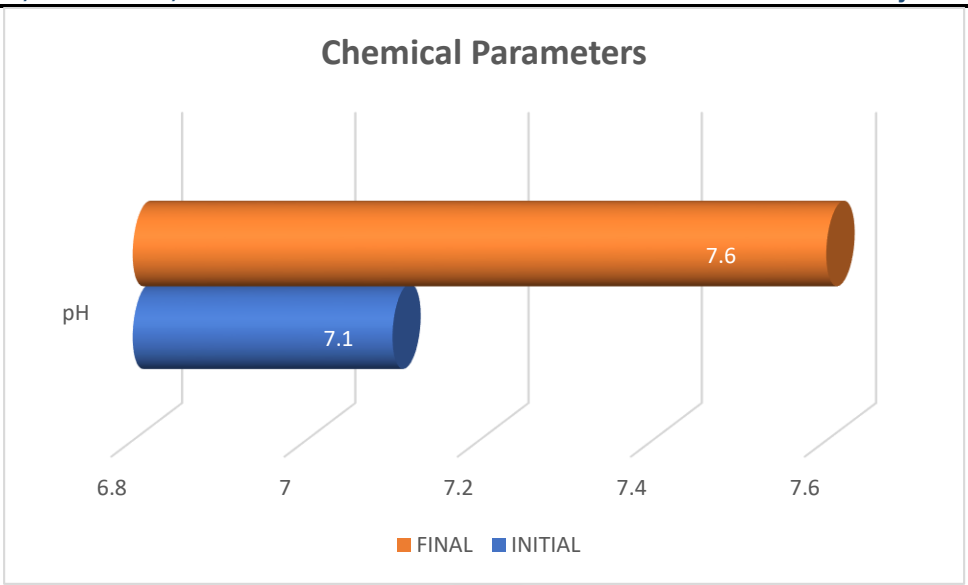


Chart-4 Chemical parameters of the selected murukku sample during storage



4. CONCLUSION

The study concluded that millet murukku formulated with 50% of multi-millet flour (finger millet and jowar), 35% of brown rice flour, and 15% of other ingredients was highly acceptable in terms of organoleptic properties such as aroma, appearance, texture, taste, mouthfeel, and overall acceptability. The formulated murukku was also found to be highly nutritious and the formulated murukku was good and within limits for a month. Hence, there is a scope for the development of murukku using finger millet and jowar by replacing white rice flour with brown rice flour.

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