



International Journal of Advanced Research in Food Science and Agriculture Technology

Journal homepage:
<https://karyailham.com.my/index.php/fsat/index>
ISSN: 3030-556X



Development of High Caloric Grain-Based Banana Cream Biscuit

Weerasinghe Dilmi Nawodya Weerasinghe¹, Batagalle Lawaniye Gedara Hiruni Nawodya Weerasooriya¹, Indigahewala Gamage Gimanie Kasunmala^{2,*}

¹ Department of Chemistry, Faculty of Science, University of Ruhuna, Sri Lanka

² Division of Applied and Natural Sciences, University College Matara, University of Vocational Technology, Sri Lanka

ARTICLE INFO

Article history:

Received 15 October 2025

Received in revised form 30 October 2025

Accepted 20 November 2025

Available online 27 November 2025

Keywords:

Banana creamed biscuit; locally available grains; natural sweeteners; toddlers' breakfast

ABSTRACT

The rising concern about children's poor dietary habits and reliance on processed foods with high sugar has created a significant issue in noncommunicable diseases, even at a young age. Therefore, this study aims to develop a healthy and convenient alternative, a grain-based banana cream biscuit using locally available ingredients to promote balanced nutrition among children. Several biscuit formulations were prepared using composite flour mixtures of chickpea, mung bean, soybean, corn, and red rice, in order to balance the caloric requirement of toddlers (aged 1 to 3 years) and with date palm incorporated as a natural sweetener, while eliminating refined sugar. Dehydrated banana (*Musa paradisiaca*, ABB) was blended into a cream layer to enhance the flavor, texture, and nutritional value of the prepared biscuit. The addition of dates increased mineral and fiber content while providing natural sweetness, and the banana cream layer improved both the sensory appeal and micronutrient quality. Finally, three formulas were prepared, the best formula was selected by using sensory evaluation, and proximate analysis was done for the sensory-approved biscuit sample. The results revealed that the moisture, ash, crude fiber, fat, and protein contents of the developed biscuit as 7.73%, 1.70%, 1.55%, 18.04%, and 8.45%, respectively, and 75 g of the sandwich biscuit can deliver the caloric amount required of toddlers, which can demonstrate a balanced macronutrient profile suitable for children's breakfast consumption. Shelf-life evaluation exhibited that the biscuit remained stable at room temperature ($27 \pm 2^\circ \text{C}$, RH=74%) for up to three months in double-laminated (LLDPE: PET) packaging. This concludes that the developed banana cream biscuit offers a nutritious, child-friendly breakfast made from locally available grains, which will address the need for healthy, affordable, and appealing snacks while reducing dependence on imported and refined products.

* Corresponding author.

E-mail address: gimanikasunmala@gmail.com

<https://doi.org/10.37934/fsat.7.1.916>

1. Introduction

Malnutrition is a major concern among children, particularly in developing countries. Biscuits are a widely consumed snack among children due to their taste, convenience, and affordability. However, most commercially available biscuits are made from refined wheat flour and sugar, which provide energy but lack essential nutrients needed for proper growth and development. Therefore, there is a need to develop biscuits for breakfast that fulfil both the caloric and nutritional requirements using locally available ingredients, providing a healthy and appealing snack.

In this study, biscuits were formulated using chickpea flour, soybean flour, mung bean flour, corn flour, and red rice flour as substitutes for wheat flour. These grains are rich in proteins, dietary fiber, essential amino acids, vitamins, and minerals, making them suitable for enhancing the nutritional value of biscuits. Instead of refined sugar, date palm and jaggery were used as natural sweeteners to improve taste and nutritional quality. A banana-based cream filling was prepared to enhance sensory quality and provide additional natural flavor, moisture, and potassium content.

Despite the popularity of biscuits as a snack, most commercially available biscuits are high in sugar and fat but low in essential nutrients, which makes them inadequate for meeting children's daily nutritional and caloric needs. There is a lack of nutrient-rich biscuits made from local grains and natural sweeteners that are specifically designed for children's breakfast. The significance of this research lies in its potential to develop a healthy, nutritious, and palatable biscuit using locally available ingredients, which can contribute to improved child nutrition. Therefore, the main objectives of this study are to develop a nutrient-enriched biscuit using chickpea, soybean, mung bean, maize, and red rice flour as substitutes for wheat flour, and replace refined sugar with natural sweeteners such as date palm and jaggery, and prepare a banana-based cream filling suitable for children's taste preferences.

2. Methodology

2.1 Raw Materials

Dried seeds of the chickpea (*Cicer arietinum*), mung bean (*Vigna radiata*), soya bean (*Glycine max*), Maize (*Zea mays*), red rice (*Oryza sativa*), banana (*Musa paradisiaca*, ABB), vegetable fat, egg, salt, and baking powder (INS 500(ii)) were purchased from local stores, Matara, Sri Lanka. Dried date palm (*Phoenix dactylifera*) and Jaggery were used as the natural sweeteners.

2.2 Preparation of Raw Materials

All the dried seeds were directly converted into flour except for the soya bean seeds. Therein, seeds were cleaned, washed with potable water, and dried in a dehydrator at 60 °C until the moisture content reached 10%. Then, the seeds were ground using an industrial-scale grinder and sieved through a 0.05 mm sieve. For the preparation of soya bean seed flour, cleaned soya bean seeds were soaked in water for 6 hours. Then the seeds were drained off and roasted in a pan for 30 min. on a low flame until the seeds were partially cooked. Then the seeds were removed from the pan and sent through the flaking machine. The distance between the two rollers was adjusted according to the seed size. Then the flakes were dried in a dehydrator at 60 °C until the moisture content reached 10% and ground into 0.05 mm powder.

Fully ripe bananas (*Musa paradisiaca*, ABB) were peeled and cut into small slices (approximately 2-3 mm). The slices were immersed in a 1% citric acid solution for 5 min. to prevent enzymatic browning. Banana slices, then steam-blanching for 3 min., transferred to an ice bath and air-dried (25

°C, RH 65-75%). Finally, dried banana powder was obtained by drying banana pieces at 60 °C until the moisture content reached up to 10%, and ground into 0.05 mm powder. Thereafter, all the flours were separately packed in double-laminated (LLDPE: PET) pouches and stored at ambient conditions (27 ± 2 °C, RH: 74%) for the subsequent use of the study.

2.3 Preparation of Grain Biscuit

The exact values of each ingredient of the biscuit were measured according to the calculated formula. Then the weighted vegetable fat, date palm, and jaggery were beaten by using an electric beater until the mixture achieved a light and fluffy texture. A dry mixture was prepared by merging the flour mixture, baking powder, and salt. Subsequently, both the dry and the wet ingredient mixtures were gradually combined with the egg to form a smooth, uniform dough. The dough was then flattened evenly (approximately 5 mm thick) and cut into a uniform shape by using a biscuit cutter. Biscuits were arranged on baking trays and rested for 10 min. while covering with a wet cloth to ensure even hydration, along with improved texture. Finally, the biscuits were baked at 130 °C for 30 min. in a preheated oven. The baked biscuits were separately packed in double laminate (LLDPE: PET) pouches and stored at ambient conditions (27 ± 2 °C, RH: 74%) for the subsequent use of the study.

2.4 Preparation of Banana Cream

Exactly weighted vegetable fat, banana powder, and jaggery were mixed (ratio of 1:1:3) by using an electric beater until a smooth, creamy consistency was achieved. The prepared banana cream was placed in a clean, airtight container and refrigerated (4 °C) for 30 min. to allow the cream to set properly and develop flavor.



(a)



(b)

Fig. 1. (a) Appearance of dehydrated banana slices (b) Appearance of grain-based banana crem biscuit

2.5 Sensory Evaluation

Sensory evaluation of prepared banana cream biscuits was carried out by recruiting 30 numbers of semi-trained panelists, and they were properly instructed beforehand. Three types of banana cream biscuits were developed by varying different flour combinations, and samples were served separately on the white porcelain plates, which were randomly labeled with three digits, cup of water and a ballet paper were served to the panelists before the evaluation. Respondents were asked to evaluate five sensory stimuli, such as colour, flavour, texture, aroma, and overall acceptability, against a five-point hedonic scale. The lower the score given for a sensory stimulus attributed to the lower the satisfaction of the respondent.

2.6 Nutritional Properties of Formulated Rice Flakes

Moisture, ash, fat, fiber, and protein content were determined according to AOAC official method 920.151, 942.05, 923.03, 991.42, 923.04, respectively (AOAC, 2000).

2.7 Shelf-Life Analysis of Formulated Rice Flakes

Shelf-life analysis was conducted using the best banana cream biscuits formulation (B), which was packed in double-laminated (LLDPE: PET) pouches and was stored in a storage box at room temperature (27 ± 2 °C, RH: 74%). The sample was analysed with respect to the test parameters such as moisture content, total plate count (TPC, SLS: 516: Part 1: 1991), and viable yeasts and mold count (Y & M, SLS 516: Part 2: 1991) for a period of 3 months while drawing samples for the analysis monthly. All the tests were triplicated for each parameter.

2.8 Statistical Analysis

The results were expressed as mean $\pm$ standard error (SE) by comparing the means using one-way ANOVA using the IBM SPSS Statistics 22.0 package. Sensory scores were analysed using the Friedman test, followed by the Nemenyi post hoc test for mean separation when results were significant ($p < 0.05$).

3. Result and Discussion

Sri Lanka is a developing country that is severely affected by child malnutrition (approximately 17%, 2024). The major reasons for this malnutrition may be poverty, which affects the purchasing power of the household level, as well as the consumption pattern of the children. Toddlers (aged 1-3 years) who are just after weaning are prone to malnutrition because they are very picky eaters. Therefore, this study was proposed to develop a nutritious, grain-based banana cream biscuit that could fulfil the breakfast energy and nutrient requirements of toddlers. The formulations were calculated by using a composite flour mixture of chickpea, mung bean, soya bean, and red rice, which demonstrated a balanced combination of macronutrients while improving sensory characteristics. The inclusion of legumes and cereals increased the protein and energy density of the product, whereas red rice contributed additional dietary fiber and minerals.

3.1 Sensory Evaluation of Grain-Based Banana Cream Biscuits

Sensory analysis was conducted to identify the preference of the prepared three biscuit formulas. Sensory scores from 30 panellists for three biscuit samples (A–C) across five attributes were analysed using the Friedman test, followed by the Nemenyi post hoc test, and the sensory profile of each product is illustrated in Figure 2.

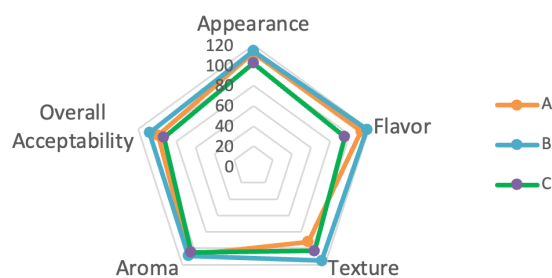


Fig. 2. Sensory attributes of the different formulations of grain-based banana cream biscuits, A, B, C indicate the three different formulas

According to Figure 2, all the sensory attributes except aroma were significantly ($p < 0.05$) different among each biscuit formula. The highest sensory ratings for all sensory stimuli were secured by the B biscuit formulation, and the lowest ratings were recorded by the C formula. When considering all the sensory stimuli texture of the biscuits was considerably varied with the different flour combinations, and that has affected the final flavour, colour, and the overall acceptability of the panellists.

Sensory evaluation results of Adebayo *et al.*, [17] also showed that texture had a direct influence on acceptance and flavour, when the biscuits were made with composite grain flour mixtures. Banana cream was added not only for the sensory improvement, but also it was a natural source of potassium and vitamin E [18].

The Friedman test showed a significant overall difference among the samples ($\chi^2 = 8.4$, $p < 0.05$), indicating variation in sensory acceptability. Although the Nemenyi test did not find significant differences between specific pairs (critical difference = 1.48), the average ranks revealed a clear preference order among the samples.

3.2 Proximate Analysis of Grain-Based Banana Cream Biscuits

Proximate analysis of the sensory approved sample B grain-based banana cream biscuit formula was evaluated in terms of nutritional values, and the results are tabulated in Table 1. According to the results given in Table 1, the protein and fat content of grain-based banana cream biscuit were 8.45% and 18.04% respectively, which aligns with findings of Karuna *et al.*, [19], who observed that legume incorporation significantly boosts protein in composite flour-based snacks. Similarly, Ezeocha and Ojimelukwe [20] reported improved energy density in weaning foods formulated with soy and cereals, supporting the suitability of this formulation for toddler nutrition.

The crude fiber content (1.55%) was comparable to the biscuit formulations studied by Okoye *et al.*, [21], indicating beneficial dietary fiber levels for promoting digestive health in children. Moreover, replacing refined sugar with date palm enhanced the nutritional profile and reduced added sugar, a strategy supported by Toma *et al.*, [22], who highlighted dates as a natural sweetener rich in iron and antioxidants.

Table 1

Proximate analysis of grain-based banana cream biscuits

Parameters (%)	Sample
Moisture	7.72 ± 0.35%
Ash	1.69 ± 0.02%
Fat	18.04 ± 0.64%
Fiber	1.55± 0.11%
Protein	8.45± 0.32%

Data represented as mean ± standard deviation (n = 3).

The relatively high fat content (18.04%) in the current formulation contributed significantly to the total caloric value, as fat provides 9 kcal/g. This is consistent with Okoye *et al.*, [21], who emphasized that increased lipid content in biscuits enhances energy density, which is particularly valuable for young children with smaller stomach capacity. In addition, the use of date palms instead of refined sugar has added natural energy, fiber, and micronutrients, while reducing added sugar intake, which is a recommendation of the WHO guidelines (2015) to minimize sugar consumption in early childhood.

The banana cream biscuit is formulated to fulfill toddlers' breakfast energy requirement, which is typically estimated at 300–350 kcal (FAO/WHO, 2004, approximately 350 Kcal). In this study, the total energy content of 100 g of prepared banana cream biscuit was approximately 450 kcal, which yielded 5 five cream-filled sandwich biscuits. Accordingly, each biscuit provided around 90 kcal. Consuming 3 to 4 cream-filled sandwich biscuits would meet the average breakfast energy requirement for children aged 1–3 years.

This aligns with the findings of Akinola *et al.*, [23], who reported that energy-dense weaning snacks made from legumes and cereals can deliver 30–45 kcal per unit (biscuit/pellet), suitable for portion-controlled feeding in toddlers. Similarly, Adebayo *et al.*, [24] formulated soy-maize biscuits that provided approximately 36 kcal per piece, confirming the suitability of such products in complementary feeding.

3.3 Shelf-Life Analysis of Grain-Based Banana Cream Biscuits

The shelf life of the best-performed biscuit formula at sensory evaluation (sample B) was measured in LLDPE: PET double laminated packaging for a period of three months at ambient conditions (27 ± 2 °C, RH: 74%). Moisture content of the biscuits was slightly changed during the period of three months of storage (7.72 - 8.15%), but the increment was not significant (p>0.05). According to the microbial analysis, total plate content and viable yeast and mold count were much lower values than the standard values (TPC; <1*10⁴: Y&M; <1*10²); therefore, grain-based banana cream biscuits were microbiologically safe during the period of three months storage. Shelf-life evaluation showed 3 months of stability in LLDPE: PET laminated packaging, compatible with Singh and Kumar (2014), who found similar packaging effective for moisture control and product freshness. These findings suggest that the developed biscuit can serve as a practical breakfast or snack item that meets a considerable proportion of toddlers' daily energy needs in a small, acceptable portion size. Furthermore, the product's local grain and fruit base promotes affordability and accessibility, addressing both nutritional and economic aspects of child malnutrition in developing countries.

4. Conclusion

The developed grain-based banana cream biscuit provides a balanced nutritional composition suitable for fulfilling toddlers' breakfast energy requirements with an appropriate level of protein, fat, and fiber. Consumption of 75 g of prepared cream-filled sandwich biscuits would meet the average breakfast energy requirement (300 kcal) for children aged 1–3 years. The use of locally available grains, date palm, and banana cream improved both nutritional value and sensory quality, making it an appealing and healthy alternative to sugar-rich commercial snacks. Therefore, this product can serve as a nutritious, child-friendly breakfast option that promotes better nutrition and supports sustainable food production.

Acknowledgement

This research was not funded by any grant.

References

- [1] Omoba, O. S., O. O. Awolu, A. I. Olagunju, and A. O. Akomolafe. "Optimisation of plantain-brewers' spent grain biscuit using response surface methodology." *Journal of Scientific Research and Reports* 2, no. 2 (2013): 665-681. <https://doi.org/10.9734/jsrr/2013/4944>.
- [2] Omoba, Olufunmilayo S., John RN Taylor, and Henriëtte L. de Kock. "Sensory and nutritive profiles of biscuits from whole grain sorghum and pearl millet plus soya flour with and without sourdough fermentation." *International journal of food science & technology* 50, no. 12 (2015): 2554-2561. <https://doi.org/10.1111/ijfs.12923>.
- [3] Marquart, Len, Hing Wan Chan, Mary Orsted, and Kristen A. Schmitz. "Gradual incorporation of whole-grain flour into grain-based products." *Cereal foods world* 51, no. 3 (2006): 114. <https://doi.org/10.1094/cfw-51-0114>.
- [4] Kusnandar, Feri, Dede R. Adawiyah, and Mona Fitria. "Pendugaan umur simpan produk biskuit dengan metode akselerasi berdasarkan pendekatan kadar air kritis [accelerated shelf-life testing of biscuits using a critical moisture content approach]." *Jurnal Teknologi dan Industri Pangan* 21, no. 2 (2010): 117-117.
- [5] Poms 1, R. E., M. E. Agazzi, A. Bau, M. Brohee, C. Capelletti, J. V. Nørgaard, and E. Anklam. "Inter-laboratory validation study of five commercial ELISA test kits for the determination of peanut proteins in biscuits and dark chocolate." *Food Additives and Contaminants* 22, no. 2 (2005): 104-112.. <https://doi.org/10.1080/02652030400027953>.
- [6] Jain, Roomani, and Ila Joshi. "Nutrient analysis of germinated sesame seeds and development of value added biscuits." *Studies on Home and Community Science* 9, no. 2-3 (2015): 61-64.. <https://doi.org/10.1080/09737189.2015.11885436>.
- [7] Jones, Julie. 2013. "Fiber and Nutrient Profiles of Ancient Grains and Their Effect on Health." CFW Plexus, no. AACCI 2013 Annual Meeting (December). <https://doi.org/10.1094/cplex-2013-1226-82w>.
- [8] Fernandes, Fabiano AN, and Sueli Rodrigues. "Ultrasound as pre-treatment for drying of fruits: Dehydration of banana." *Journal of Food Engineering* 82, no. 2 (2007): 261-267. <https://doi.org/10.1016/j.jfoodeng.2007.02.032>.
- [9] Forsberg, Tina, Per Åman, and Rikard Landberg. "Effects of whole grain rye crisp bread for breakfast on appetite and energy intake in a subsequent meal: two randomised controlled trails with different amounts of test foods and breakfast energy content." *Nutrition Journal* 13, no. 1 (2014): 26.). <https://doi.org/10.1186/1475-2891-13-26>.
- [10] Schusdziarra, Volker, Margit Hausmann, Claudia Wittke, Johanna Mittermeier, Marietta Kellner, Aline Naumann, Stefan Wagenpfeil, and Johannes Erdmann. "Impact of breakfast on daily energy intake-an analysis of absolute versus relative breakfast calories." *Nutrition journal* 10, no. 1 (2011): 5. <https://doi.org/10.1186/1475-2891-10-5>.
- [11] Liubych, V., and V. Zheliezna. "Effect of water-heat treatment on spelt grain flour quality." *Grain Products and Mixed Fodder's* 20, no. 2 (2020): 19-25.. <https://doi.org/10.15673/gpmf.v20i2.1761>.
- [12] Guo, Mengmeng, Jinhua Du, Zhao'An Zhang, Kaili Zhang, and Yuhong Jin. "Optimization of brewer's spent grain-enriched biscuits processing formula." *Journal of Food Process Engineering* 37, no. 2 (2014): 122-130. <https://doi.org/10.1111/jfpe.12067>.
- [13] Biesiekierski, Jessica Rose, Ourania Rosella, Rosemary Rose, Kelly Liels, J. S. Barrett, Susan Joy Shepherd, Peter Raymond Gibson, and Jane G. Muir. "Quantification of fructans, galacto-oligosaccharides and other short-chain carbohydrates in processed grains and cereals." *Journal of Human Nutrition and Dietetics* 24, no. 2 (2011): 154-176.. <https://doi.org/10.1111/j.1365-277x.2010.01139.x>.
- [14] Mohsen, Sobhy M., Amal Ashraf, Sayeda S. Ahmed, and Tarek G. Abdelmaksoud. "Biscuits enriched with the edible powder of Angoumois grain moth (Sitotroga cerealella): Optimization, characterization and consumer

- perception assessment." *Food systems* 7, no. 1 (2024): 165-178.. <https://doi.org/10.21323/2618-9771-2024-7-1-165-178>.
- [15] Yang, Ni, Joanne Hort, Robert Linforth, Keith Brown, Stuart Walsh, and Ian D. Fisk. "Impact of flavour solvent (propylene glycol or triacetin) on vanillin, 5-(hydroxymethyl) furfural, 2, 4-decadienal, 2, 4-heptadienal, structural parameters and sensory perception of shortcake biscuits over accelerated shelf life testing." *Food chemistry* 141, no. 2 (2013): 1354-1360. <https://doi.org/10.1016/j.foodchem.2013.03.084>.
- [16] Alifiya, Jyoti Prabha Bishnoi, Anee Shree, and Simmy Gupta. "Utilization of Terminalia arjuna for development of herbal multi-grain biscuits."
- [17] Adebayo, S. F., Aderibigbe, O. R., and Adeyeye, E. I. "Sensory evaluation and nutritional quality of biscuits produced from composite flours of wheat and banana". *International Journal of Food Science and Nutrition*, 3, no. 2, (2018): 12–18.
- [18] Fasogbon, B. M., Adeoye, B. K., and Oluwajoba, O. "Effect of banana flour on nutritional quality of biscuits". *Journal of Food Quality*, (2021): Article ID 6612743.
- [19] Karuna, D. S., Noel, G., and Sundaresan, A. "Influence of legume flour incorporation on protein content in composite flours and its effect on bakery products". *African Journal of Food Science*, 10, no 3, (2016): 35–42.
- [20] Ezeocha, V. C., and Ojimelukwe, P. C. "Nutrient composition and acceptability of soy-maize complementary food enriched with carrot powder". *Nigerian Food Journal*, 30, no 1, (2012): 73–77.
- [21] Okoye, J. I., Nkwocha, A. C., and Agbo, O. A. "Nutritional evaluation of biscuits produced from wheat–banana flour blends fortified with soy flour". *International Journal of Nutrition and Food Sciences*, 9, no 2, (2020): 56–63.
- [22] Toma, R. B., Ismail, M., and Hussain, M. "Dates as natural sweeteners: Nutritional and antioxidant benefits in food products". *Journal of Food Processing & Technology*, 10, no 5, (2019): 799.
- [23] Akinola, F., O. A. Adeyemi, G. O. Olabanji, and O. O. Adeyoju. "Proximate, Functional and Pasting Properties of Composite Flours Made from Wheat, Breadfruit and Cassava Starch." *Applied Journal of Scientific and Engineering Research (AJSER)*, 2, no 3, (2017): 1–12.
- [24] Adebayo, A. F., Olayemi, F. F., and Adeola, A. A. 2020. "Development and Evaluation of Nutrient-Dense Biscuits from Composite Flours of Sorghum, Soybean and Groundnut." *African Journal of Food Science*, 14, no 5: 127–134.