

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2025; 9(1): 377-382
www.biochemjournal.com
Received: 01-11-2024
Accepted: 04-12-2024

Vinay GM
Department of Food
Processing Technology, College
of Food Processing Technology
& Bioenergy, Anand
Agricultural University,
Anand, Gujarat, India

P Srilatha
Department of Food
Processing Technology, College
of Food Processing Technology
& Bioenergy, Anand
Agricultural University,
Anand, Gujarat, India

Prakasha R
Department of Food
Processing Technology, College
of Food Processing Technology
& Bioenergy, Anand
Agricultural University,
Anand, Gujarat, India

Corresponding Author:
Vinay GM
Department of Food
Processing Technology, College
of Food Processing Technology
& Bioenergy, Anand
Agricultural University,
Anand, Gujarat, India

Effect of variation in baking powder level on the quality characteristics of ghee residue powder fortified pearl millet based biscuit

Vinay GM, P Srilatha and Prakasha R

DOI: <https://doi.org/10.33545/26174693.2025.v9.i1e.3521>

Abstract

This study evaluated the incorporation of pearl millet flour in biscuit formulation and investigated the effects of baking powder levels (0.25%, 0.5%, and 0.75%) and dough resting times (20, 30, and 40 minutes) on the proximate, physical, textural, and sensory properties of the biscuits. Biscuits were prepared using the creaming method, and parameters such as spread ratio, hardness, color attributes (L^* , a^* , b^* values), and sensory characteristics were assessed. The results indicated that higher levels of baking powder significantly ($p < 0.05$) increased the spread ratio while reducing biscuit hardness, owing to enhanced leavening and carbon dioxide production. Resting time showed no significant effect on spread ratio but influenced sensory attributes like toasted flavor and overall acceptability when combined with baking powder. Color analysis revealed a decrease in lightness (L^*) with increasing baking powder levels, while redness (a^*) and yellowness (b^*) values were significantly influenced by resting time. Sensory evaluation by trained panelists highlighted biscuits with 0.5% baking powder and a resting time of 30 minutes achieved the best balance of texture, taste, and overall quality. This study shows the potential of pearl millet flour in developing nutrient-rich biscuits and provides insights into optimizing formulation and processing conditions to improve product acceptability.

Keywords: Pearl millet, ghee residue, baking, biscuit, texture

Introduction

Millets are small-seeded grains that have been cultivated for centuries as a staple food in many parts of the world. Known for their resilience to harsh climatic conditions, millets are a valuable crop, especially in arid and semi-arid regions (Nagaraja *et al.*, 2024) [9]. They are rich in nutrients, including dietary fiber, protein, vitamins, and minerals, making them a vital component of sustainable diets and functional foods (G M *et al.*, 2025) [7]. With increasing awareness of the health benefits associated with millets, there has been a growing interest in their incorporation into various food products, including bakery items, snacks, and breakfast cereals.

Among the different millet varieties, pearl millet (*Pennisetum glaucum*) is one of the most widely cultivated and consumed. It is particularly valued for its high nutritional content, including complex carbohydrates, iron, zinc, magnesium, and antioxidants such as polyphenols (Etcheverry *et al.*, 2012) [5]. Pearl millet is also gluten-free, making it an excellent choice for individuals with gluten intolerance or celiac disease. Despite its health benefits, pearl millet has limited direct use in traditional baking due to its distinct flavor, dense texture, and lack of gluten, which affects dough elasticity. As a result, blending pearl millet flour with refined wheat flour and the strategic use of leavening agents like baking powder has emerged as an effective approach to enhance the functional and sensory properties of baked goods (GM and Singh, 2024) [6].

Ghee residue, is the by-product left after the clarification of ghee. It contains a mixture of milk proteins, lactose, fat and phospholipids. The composition of the residue can vary depending on the method of ghee production and the quality of the butter used. It is often discarded at industrial level after recovery of fat. The residue is sometimes used in the food industry as an ingredient in products such as bakery items, and snacks, or as an additive in traditional sweets (Wani *et al.*, 2022) [14].

In biscuit making, baking powder plays a crucial role as a chemical leavening agent that promotes the release of carbon dioxide during baking. This leavening effect improves the spread, texture, and lightness of biscuits, contributing to their overall quality and consumer acceptability (Canali *et al.*, 2020) [3]. When combined with pearl millet flour, baking powder helps overcome the dense and coarse texture of millet, creating biscuits with desirable sensory and structural attributes (Dias-Martins *et al.*, 2018) [4]. However, the interaction between baking powder levels and dough resting time can significantly influence the final product, affecting parameters such as spread ratio, hardness, and sensory properties like crispness and flavor.

This study explores the utilization of pearl millet flour in biscuit making, focusing on the role of baking powder and dough resting time in optimizing the physical, textural, and sensory characteristics of the biscuits. By integrating pearl millet and ghee residue powder into baked products, this research aims to develop healthier, nutrient-rich biscuits that align with modern dietary trends and consumer preferences.

Materials and Methods

Materials

Pearl millet flour and refined wheat flour were sourced from a local market in Anand, Gujarat. All chemicals used in the analysis were of analytical grade and procured from Loba Chemie and Molychem.

Biscuit Preparation

The biscuits were formulated using the creaming method, as described by Vinay (2023) [13]. Based on preliminary trials a dairy byproduct called ghee residue powder used in biscuit making to improve the quality attributes. Ghee residue powder was fixed to 25% of flour basis. To begin, 40% bakery fat and 25% ghee residue powder were whipped at high speed until a smooth consistency was achieved. Gradually, 40% icing sugar was added and blended thoroughly. Baking powder was incorporated at varying levels of 0.25%, 0.5%, and 0.75%. The dry ingredients were sifted and mixed into the fat-sugar blend, and water was added to form a pliable dough. The dough was allowed to rest for 20, 30, and 40 minutes to facilitate better consistency. After resting, the dough was rolled out to a uniform thickness and cut into round shapes using a mould. The biscuits were then baked at 175°C for 14 minutes to achieve the desired texture and golden-brown appearance.

Proximate Composition

The biscuits were analyzed for moisture, fat, fat acidity, ash, acid-insoluble ash, and protein content, following the standard procedures outlined by AOAC (2016) [1]. All the analysis were made in triplicates.

Colour Measurement

The color attributes of the biscuits were evaluated using a Lovibond Color Lab (RT850i). The equipment was calibrated with black and white reference tiles to ensure precise measurements. The L* (lightness), a* (redness/greenness), and b* (yellowness/blueness) values were recorded in triplicate to provide a detailed assessment of the biscuits' visual properties.

Spread Ratio

The spread ratio of the biscuits was calculated by measuring

the diameter and thickness of six biscuits. The average thickness was recorded, and the ratio of diameter to thickness was computed to determine the spread ratio, which reflects the extent of dough expansion during baking.

Hardness

The hardness of the biscuits was assessed using a texture analyzer (Model: TA-HD Plus, Make: Stable Micro Systems, Surrey, UK) equipped with a cutting blade and a 5 kg load cell. The maximum force required to break the biscuits was derived from the force-distance curve generated during the test, as per the method described by Tyagi *et al.* (2007) [12].

Sensory Analysis

Ten trained and semi-trained panelists were recruited to evaluate the sensory properties of the biscuits. The panelists used a linear intensity scale ranging from 0 to 10 for quantitative descriptive analysis, as per Nandagopal (2017) [10]. Various sensory attributes, including taste, texture, color, and overall acceptability, were assessed to provide a comprehensive understanding of the biscuits' quality and consumer appeal.

Statistical Analysis

All experimental data were collected in triplicate, and the results were expressed as mean values with standard deviations. To evaluate the interaction effects of baking powder levels and resting time on sensory and textural attributes, a two-way analysis of variance (ANOVA) was performed using SPSS software. A p-value of less than 0.05 was considered statistically significant.

Results and Discussion

Proximate composition

A detailed proximate composition of the biscuits is given in Table 1. The moisture content of biscuit varied from the 1.02% to 2.71%. The moisture of biscuit increased with increase in the baking powder level and with the resting period except at 0.75% baking powder no proper trend was observed. The variation in the moisture significantly ($p < 0.05$) affected by baking powder level, resting time and the interaction effect of both (Table 2). The variation is due to leavening action, with increasing baking powder level it decreased due to rapid reaction of baking powder with dough lead to early gas formation and lost during before baking, hence higher moisture found with increase in baking powder. Fat content of biscuit varied from the 17.21% to 23.31% and acidity of extracted fat varied from 0.28% to 0.36% oleic acid. Baking powder levels has no significant effect ($p < 0.05$) on the acidity of the extracted fat (Table 2). The resting period had significant effect on the fat acidity, as all baking powder gets enough time to react with sodium bicarbonate.

The ash content of biscuit ranged from 0.79% to 1.23% and acid insoluble ash varied from 0.04% to 0.09%. Ash of the biscuits differed significantly ($p < 0.05$) with the baking powder level and resting period. The variation was due to amount of baking powder and varied moisture level in the biscuit. The protein content of the biscuit 10.54% 11.61% and it varied significantly with baking powder and resting time and interaction had no effect on the protein content of the biscuits. The increase in the protein content of the biscuit raised from the ammonium bicarbonate used in the

baking powder. The results are in agreement with the results reported by the Vinay (2023) [13].

Colour

The instrumental color of the biscuits, represented by L^* (lightness), a^* (redness/greenness), and b^* (yellowness/blueness), was significantly influenced by both baking powder levels and dough resting time, as shown in Table 3. The colour value of the biscuits are presented in Figure 1. The results revealed that baking powder and resting time individually, as well as their interaction, had a significant effect ($p < 0.05$) on all color parameters except for a^* , which was not significantly affected by baking powder

levels ($p = 0.082$).

The lightness (L^*) of the biscuits decreased with higher levels of baking powder and longer resting times. This reduction in lightness could be attributed to the formation of a denser structure and darker surface due to extended Maillard reactions and caramelization during baking. Conversely, the redness (a^*) and yellowness (b^*) values decreased significantly with increased resting time and baking powder levels, which may be due to the formation of gas pockets and blisters on the surface of the biscuits, which disrupts uniform browning and reduces the intensity of these color parameters. Kulthe *et al.* (2017) [8] observed a decrease in the lightness of pearl millet based cookies

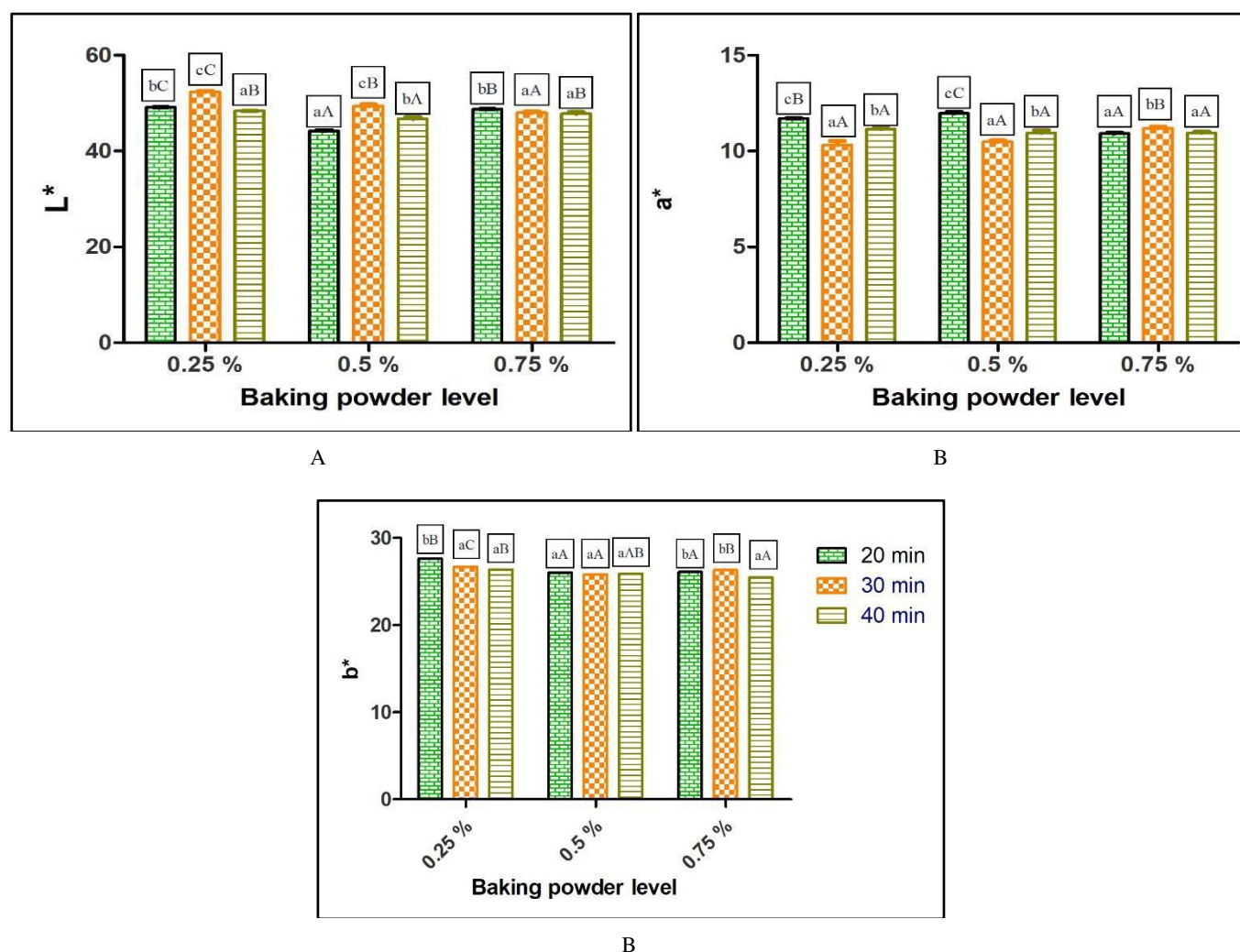


Fig 1: Effect of dough resting time and different levels of baking powder on the biscuit colour A) Lightness B) Redness C) Yellowness

Sensory attributes

The sensory evaluation of the biscuits included parameters such as powdery surface, browning, raw flavor, toasted flavor, sweetness, crispness, hardness, coarseness, chewiness, adhesiveness, and overall acceptability. The effects of baking powder levels, resting time, and their interaction on these sensory attributes are summarized in the Table 4. The results indicated that baking powder levels had a significant effect ($p < 0.05$) on specific parameters, including powdery surface, toasted flavor, coarseness, chewiness, adhesiveness, and overall acceptability. For instance, higher baking powder levels increased the powdery surface and adhesiveness, likely due to excess leavening agents forming fine surface residues and altering

the texture. Baking powder also influenced toasted flavor, coarseness, and chewiness, with notable changes attributed to the leavening effect that alters the internal structure and flavor profile of the biscuits. Reported similar findings for the pearl millet biscuit.

Resting time alone had no significant effect ($p > 0.05$) on any of the sensory attributes. However, the interaction between baking powder and resting time showed significant effects on toasted flavor, sweetness, hardness, and chewiness ($p < 0.05$). For example, prolonged resting time combined with higher baking powder levels enhanced the toasted flavor but decreased chewiness, likely due to changes in dough aeration and protein interactions during resting and baking. These findings underscore the importance of

optimizing baking powder levels and resting time to achieve a balance of sensory attributes and ensure high overall acceptability. The 0.5% baking powder level and 30 minutes showed maximum score for the pearl millet biscuit.

Spread ratio and hardness

The spread ratio and cutting strength of biscuits were significantly influenced by the baking powder levels ($p<0.001$) as shown in Table 5 and Figure 2. However, resting time did not significantly affect the spread ratio ($p=0.975$ NS), whereas it had a significant effect on cutting strength ($p<0.02$). The spread ratio increased with the level of baking powder. At 0.25% baking powder, the spread ratio remained relatively consistent across different resting times (20, 30, and 40 minutes), showing no significant changes. However, at higher baking powder levels (0.5% and 0.75%), the spread ratio increased, with the highest values observed at 0.75% baking powder and longer resting times (5.46 ± 0.41 at 40 minutes). This increase can be attributed to the enhanced leavening effect of baking powder, which produces carbon dioxide, expanding the dough and

increasing its spread. Arepally *et al.* (2023) [2] reported similar results.

Cutting strength, a measure of biscuit hardness, was also affected by both baking powder levels and resting time. At lower baking powder levels (0.25% and 0.5%), cutting strength increased with resting time, indicating that prolonged resting allowed for better dough structure development. However, at 0.75% baking powder, cutting strength remained relatively stable across different resting times, likely due to the excessive leavening weakening the biscuit structure. An increase in the level of baking powder decreased the hardness of a biscuit, while with the dough resting time, cutting strength increased up to 30 minutes thereafter it started to decrease. Similar results were reported for the noodles with the dough resting time by Pronyk *et al.* (2007) [11].

These findings suggest that higher baking powder levels enhance the spread ratio but may negatively affect the structural integrity (cutting strength) of the biscuits. The interaction between baking powder and resting time must be optimized to achieve a desirable balance between biscuit spread and texture.

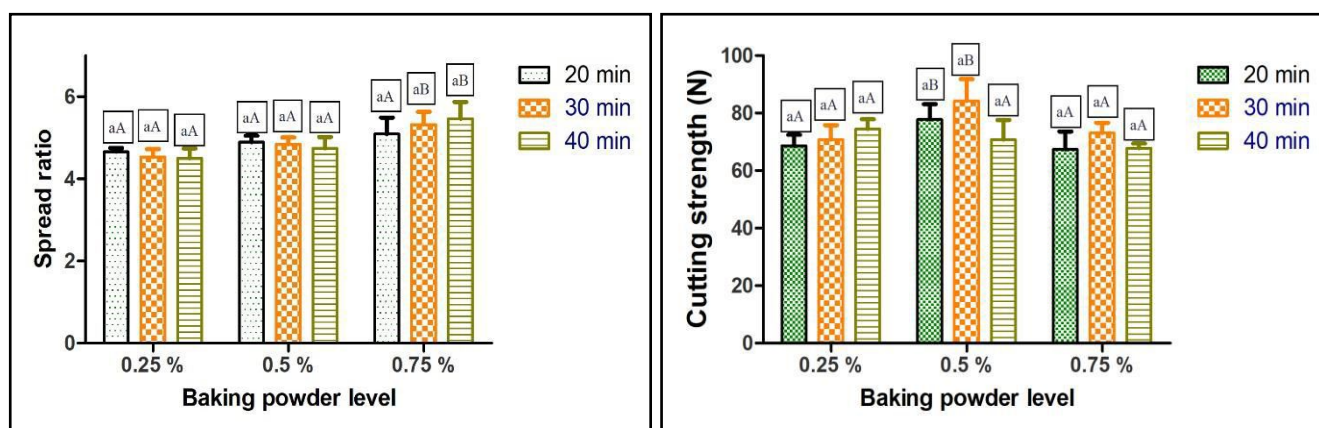


Fig 2: Effect of dough resting time and different levels of baking powder on the spread ratio and hardness of biscuit

Table 1: Effect of dough resting time and different levels of baking powder on the proximate value of 25% GRP biscuit

Parameters	Baking powder (%) *Resting time (min)	20	30	40
Moisture (%)	0.25	1.12±0.15 ^{abA}	1.02±0.03 ^{aA}	1.34±0.07 ^{cA}
	0.5	1.28±0.08 ^{aA}	1.44±0.05 ^{aB}	1.82±0.09 ^{bB}
	0.75	2.71±0.08 ^{cB}	2.02±0.12 ^{aC}	2.40±0.08 ^{bC}
Fat (%)	0.25	19.61±0.40 ^{bA}	18.67±0.24 ^{aB}	20.22±0.91 ^{bA}
	0.5	22.08±0.29 ^{bB}	23.31±0.06 ^{aC}	23.15±0.07 ^{aC}
	0.75	19.55±0.34 ^{bA}	17.21±0.42 ^{aA}	21.95±0.31 ^{cB}
Acidity of extracted fat (% oleic acid)	0.25	0.35±0.01 ^{abB}	0.35±0.01 ^{bB}	0.33±0.02 ^{aB}
	0.5	0.30±0.01 ^{bA}	0.28±0.01 ^{abA}	0.28±0.01 ^{aA}
	0.75	0.34±0.01 ^{bB}	0.36±0.01 ^{cB}	0.31±0.01 ^{aB}
Ash (%)	0.25	1.03±0.12 ^{aAB}	1.03±0.08 ^{aA}	0.79±0.17 ^{aA}
	0.5	0.84±0.03 ^{aA}	1.23±0.01 ^{bB}	1.29±0.01 ^{bB}
	0.75	1.16±0.07 ^{aB}	1.14±0.06 ^{aAB}	1.23±0.04 ^{aB}
Acid insoluble ash (%)	0.25	0.09±0.01 ^{bB}	0.06±0.01 ^{abAB}	0.04±0.02 ^{aA}
	0.5	0.06±0.01 ^{bA}	0.05±0.01 ^{aA}	0.06±0.00 ^{bA}
	0.75	0.07±0.01 ^{aA}	0.06±0.00 ^{aC}	0.06±0.01 ^{aA}
Protein (%)	0.25	10.54±0.29 ^{aA}	10.62±0.19 ^{aA}	10.88±0.81 ^{aA}
	0.5	11.59±0.16 ^{aB}	11.31±0.05 ^{aB}	11.61±0.17 ^{aB}
	0.75	11.20±0.17 ^{aB}	11.31±0.27 ^{aB}	11.49±0.07 ^{aB}

Data are represented as mean±S.D (n=3)

^{abc} indicates within baking powder levels means with different superscripts are significantly different ($p<0.05$) from each other

^{ABC} indicates within dough resting time with different superscripts are significantly different ($p<0.05$) from each other

Table 2: p-values of main effects and interaction effects for proximate analysis of 25% GRP biscuit

Parameter	Moisture	Fat	Acidity of extracted fat	Ash	Acid insoluble ash	Protein
Baking powder	<0.001*	<0.001*	<0.220 ^{NS}	<0.001*	0.588 ^{NS}	<0.001*
Resting time	<0.001*	<0.001*	<0.001*	0.016*	0.04*	0.017*
Baking powder* Resting time	<0.001*	0.001*	0.007*	0.001*	0.005*	0.346 ^{NS}

p-value with superscript * and ^{NS} indicates that independent variables or its interaction variables or its interaction have a significant ($p < 0.05$) & non-significant ($p > 0.05$) effect on dependent variables respectively

Table 3: p-values of main effects and interaction effects for colour and water activity

Parameter	L*	a*	B*	a _w
Baking powder	<0.001*	0.082 ^{NS}	<0.001*	<0.001*
Resting time	<0.001*	<0.001*	<0.001*	<0.001*
Baking powder* Resting time	<0.001*	<0.001*	<0.001*	<0.001*

p-value with superscript * and ^{NS} indicates that independent variables or its interaction variables or its interaction have a significant ($p < 0.05$) & non-significant ($p > 0.05$) effect on dependent variables respectively

Table 4: p-values of main effects and interaction effects for sensory attributes of GRP biscuit

Parameter	Powdery surface	Browning	Raw	Toasted	sweet	crispness	Hardness	Coarseness	chewiness	Adhesiveness	Overall acceptability
Baking powder	0.009*	0.178 ^{NS}	0.103 ^{NS}	0.023 ^{NS}	0.463 ^{NS}	0.247 ^{NS}	0.004 ^{NS}	0.056*	0.006*	<0.001*	0.048*
Resting time	0.552 ^{NS}	3.056 ^{NS}	0.492 ^{NS}	0.078 ^{NS}	0.748 ^{NS}	0.074 ^{NS}	0.062 ^{NS}	0.249 ^{NS}	0.100 ^{NS}	0.283 ^{NS}	0.087 ^{NS}
Baking powder* Resting time	0.653 ^{NS}	0.568 ^{NS}	0.098 ^{NS}	0.012*	0.011*	0.222 ^{NS}	0.031*	0.979 ^{NS}	0.037*	0.202 ^{NS}	0.270 ^{NS}

p-value with superscript * and ^{NS} indicates that independent variables or its interaction variables or its interaction have a significant ($p < 0.05$) & non-significant ($p > 0.05$) effect on dependent variables respectively

Table 5: p-values of main effects and interaction effects for spread ratio and hardness GRP biscuits

Parameter	Spread ratio	cutting strength
Baking powder	<0.001*	<0.001*
Resting time	<0.975 ^{NS}	<0.02*
Baking powder* Resting time	<0.17 ^{NS}	<0.018*

p-value with superscript * and ^{NS} indicates that independent variables or its interaction variables or its interaction have a significant ($p < 0.05$) & non-significant ($p > 0.05$) effect on dependent variables respectively

Conclusion

The study demonstrated that baking powder levels and dough resting time significantly influence the nutritional, physical, textural, and sensory properties of biscuits. Higher levels of baking powder increased the spread ratio due to enhanced leavening but caused a reduction in hardness and structural integrity at prolonged resting times. Resting time alone showed limited effects on most parameters but, in combination with baking powder, impacted sensory attributes such as toasted flavor, chewiness, and overall acceptability. Optimal baking powder levels of up to 0.5% and resting times of 30 minutes are recommended to achieve a desirable balance of spread, texture, and sensory quality in pearl millet biscuits. These findings provide valuable insights for optimizing biscuit formulation and processing conditions to enhance product quality and consumer satisfaction.

Conflict of interest

All the authors declare that they have no conflicts of interest

Funding: No fund/grant received.

Data availability: All data included in the manuscript.

Author contributions: VGM: Methodology, Formal analysis; PR: Writing Original draft, Investigation; PS:

Conceptualization, Supervision.

Disclaimer (Artificial Intelligence): Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have not been used during the writing or editing of manuscripts.

References

1. AOAC Official Methods Analysis. Association of Official Analytical Chemists. Ed.: Latimer, G. W. 20th Edition, AOAC International: Arlington, VA; 2016
2. Arepally D, Reddy RS, Coorey R, Goswami TK. Evaluation of functional, physicochemical, textural and sensorial properties of multi-millet-based biscuit. International Journal of Food Science & Technology. 2023 May;58(5):2437-2447.
3. Canali G, Balestra F, Glicerina V, Pasini F, Caboni MF, Romani S. Influence of different baking powders on physico-chemical, sensory and volatile compounds in biscuits and their impact on textural modifications during soaking. Journal of food science and technology. 2020 Oct;57:3864-3873.
4. Dias-Martins AM, Pessanha KL, Pacheco S, Rodrigues JA, Carvalho CW. Potential use of pearl millet (*Pennisetum glaucum* (L.) R. Br.) in Brazil: Food security, processing, health benefits and nutritional products. Food research international. 2018 Jul 1;109:175-186.
5. Etcheverry P, Grusak MA, Fleige LE. Application of in vitro bioaccessibility and bioavailability methods for calcium, carotenoids, folate, iron, magnesium, polyphenols, zinc, and vitamins B6, B12, D, and E. Frontiers in physiology. 2012 Aug 6;3:317.
6. GM V, Singh AK. Effect of Ghee Residue Powder and Pearl Millet Flour Substitution on Rheological, Textural, and Sensorial Characteristics of Eggless Muffin. Journal of Food Processing and Preservation. 2024;2024(1):5519265.

7. G M, Vinay, Akbari SH, Modi RB, Srilatha P, Prakasha R. Arresting rancidity in pearl millet flour through halogen air fryer treatment. *Journal of Advance in Biology and Biotechnology*. 2025;28(1):31–38. doi:10.9734/jabb/2025/v28i11858.
8. Kulthe AA, Thorat SS, Lande SB. Evaluation of physical and textural properties of cookies prepared from pearl millet flour. *International Journal of Current Microbiology and Applied Sciences*. 2017;6(4):692-701.
9. Nagaraja TE, Parveen SG, Aruna C, Hariprasanna K, Singh SP, Singh AK, Joshi DC, Joshi P, Tomar SM, Talukdar A, Kumar S. Millets and pseudocereals: A treasure for climate resilient agriculture ensuring food and nutrition security. *Indian journal of genetics and plant breeding*. 2024 Apr 10;84(01):1-37.
10. Nandagopal, P. Shelf-life studies on high fiber reduced calorie biscuits made from dairy-multigrain composite applying selected packaging materials. (Master thesis, National Dairy Research Institute, Karnal); 2017
11. Pronyk C, Cenkowski S, Muir WE, Lukow OM, Wyatt J, Nicholson D. Effects of dough resting time and saturated steam pre-treatment on the textural properties of superheated steam processed instant Asian noodles. In 2007 ASAE Annual Meeting 2007 (p. 1). American Society of Agricultural and Biological Engineers.
12. Tyagi SK, Manikantan MR, Oberoi HS, Kaur G. Effect of mustard flour incorporation on nutritional, textural and organoleptic characteristics of biscuits. *Journal of Food Engineering*. 2007 Jun 1;80(4):1043-1050.
13. Vinay GM. A comparison study on nutritional, textural and sensory evaluation of biscuits made from millet. *International Journal of Science and Research*. 2023;12(11):1278-1282.
14. Wani AD, Prasad W, Khamrui K, Jamb S. A review on quality attributes and utilization of ghee residue, an under-utilized dairy by-product. *Future Foods*. 2022 Jun 1;5:100131.