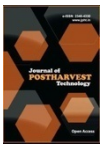

Journal of Postharvest Technology
2023, **11**(2): 71-78
www.jpht.in

RESEARCH ARTICLE

Development of sprouted green gram and gram flour biscuits and evaluation of sensory attributes

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Received: 29.02.2023 Accepted: 14.04.2023

ABSTRACT

This study investigated the impact of incorporating sprouted gram and mung flour on the sensory attributes of biscuits. The sprouted flours were prepared by sprouting raw gram and mung beans, drying them in a cabinet dryer, and grinding them into flour. The biscuit dough was then prepared by mixing the flours with sugar, butter, baking powder, baking soda, and water. The dough was rolled, cut into shapes, and baked at a specific temperature for a set time. Sensory evaluations were conducted by a panel using a 9-point hedonic scale to assess taste, shape, texture, color, crunchiness, and overall acceptability. The results showed that biscuits containing sprouted gram and mung flour received higher scores for color, crunchiness, and overall acceptability compared to the control. Therefore, the addition of sprouted gram and mung flour can be a promising ingredient for producing biscuits with improved sensory quality.

Keywords: Sprouted gram flour, sprouted mung flour, biscuits, sensory quality

Citation: Gupta, S. and Bhatt, D. K. 2023. Development of sprouted green gram and gram flour biscuits and evaluation of sensory attributes. *Journal of Postharvest Technology*, **11** (2): 71-78.

INTRODUCTION

Sprouted seeds have been consumed in Eastern countries for a long time, and their popularity has also risen in Western countries since the 1980s. They have unique characteristics that can enhance the sensory properties of food, such as their rich flavor, unique color, and high content of bioactive substances (Treadwell et al., 2010) Sprouting is a low-cost and straightforward method that does not require sophisticated equipment, has a short production cycle (usually two to three weeks), and takes up minimal space in greenhouse production (Delian et al., 2015; Kyriacou et al., 2016).

Germination is a cost-effective method that can significantly modify the nutritional composition of beans, lentils, and peas (Vidal-Valverde et al., 2002). The germination process leads to an increase in crucial dietary fiber components like cellulose and lignin, while also reducing flatulence caused by lentils and improving the digestibility of starch (Vidal-Valverde et al., 1992). Moreover, germination has been found to have a significant impact on the nutritional and sensory properties of soybean seeds (Ahmad et al., 2000).

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ISSN: 2348-4330

Biscuits are a popular ready-to-eat snack due to their wide consumption base, availability, longer shelf-life, affordability, diverse flavors, and good quality. To improve the nutritional value of biscuits, several research studies have been conducted using legumes like chickpea, pigeon pea, moong bean, cowpea, and green lentils, which have been added to wheat flour to create high protein and high fiber biscuits (Thongram et al., 2016; Tiwari et al., 2011; Zucco et al., 2011). However, most commercial biscuits are made using refined flour, which is low in nutritional value and may contribute to health problems such as obesity and diabetes (Gaesser et al., 2019). The Ministry of Agriculture in Egypt has introduced mung bean as a new crop due to its high nutritional value. Mung bean contains 27% protein and has an essential amino acid composition comparable to soybean, kidney bean, and the reference protein established by the FAO and WHO (El-Adawy et al., 1996).

Chickpeas have been widely consumed for centuries, with the Kabuli variety known for its large size, salmon-white color, and high levels of carbohydrate and protein (Sing et al., 1991; Rincón et al., 1998). However, there is limited research on the use of sprouted green gram and sprouted gram flour in biscuits. Therefore, this study aims to develop and evaluate the sensory characteristics of sprouted green gram and sprouted gram flour biscuits and compare them to traditional biscuits made with refined flour. This study builds upon previous research and extends the knowledge on the potential use of sprouted green gram and sprouted gram flour in baked goods.

MATERIALS AND METHODS

At the Department of Food Technology, Bundelkhand University in Jhansi, Uttar Pradesh, India, a study was conducted using high-quality Green Gram (Mung Bean or Moong) with the botanical name Vigna radiata L. Wildzek, and Gram (Chickpea or Chick Pea or Bengal Gram) with the botanical name Cicer arietinum, both of which were purchased from the local market. The refined flour, sugar, butter, baking powder, and baking soda used in the study were also purchased from the local market in Jhansi, UP.

Blending ratio

The blending ratio of the three flours was varied in each sample of biscuits. For the control sample (T0), 100% refined flour was used.

T1, 90% refined flour, 5% sprouted gram flour, and 5% sprouted mung flour were used.

T2, 80% refined flour, 10% sprouted gram flour, and 10% sprouted mung flour were used.

T3, 70% refined flour, 15% sprouted gram flour, and 15% sprouted mung flour were used.

T4, 60% refined flour, 20% sprouted gram flour, and 20% sprouted mung flour were used.

T5, 50% refined flour, 25% sprouted gram flour, and 25% sprouted mung flour were used.

These variations in the blending ratio of the flours allowed for the evaluation of the impact of sprouted gram flour and sprouted mung flour on the sensory attributes of the biscuits.

For each sample of biscuits, 1 gram of baking powder and 1 gram of baking soda were used. The water was added in sufficient quantity to make a soft dough, and 60 grams of sugar and 50 grams of butter were used for each sample.

Preparation of sprouted flour

Cleaned seeds of both gram were soaked in water for 8 to 10 hours at room temperature. The unabsorbed water was discarded and soaked seeds were rinsed twice with potable water to avoid post-contamination during germination. The soaked seeds were allowed to germinate for 72 hours at room temperature, with frequent watering. The germinated green gram and gram seeds were dried in a cabinet tray dryer at 50-60°C for 5 to 6 hours and the ground into fine powder. The flour was passed through a sieve to obtain a smooth texture by Yasmin et al. (2008) with some modification. For each sample of biscuits, 1 gram of baking powder and 1 gram of baking soda were used. The water was added in sufficient quantity to make a soft dough, and 60 grams of sugar and 50 grams of butter were used for each sample.

Preparation of biscuits

The biscuits were formulated according to the recipe given by AACC (2000) with slight modifications. Fat and sugar were mixed until light and fluffy. Then, composite flour sprouted green gram flour, sprouted gram flour and refined flour and other ingredients such as baking powder and baking soda were added and mixed thoroughly. Water was added to form a soft dough, which was rolled out into sheets and cut into circles. The biscuits were baked at 200°C for 20 minutes (until proper colour developed), cooled, and stored in a high-density polyethylene jar at room temperature for further analysis. Overall, this study aimed to evaluate the impact of sprouted gram flour and sprouted mung flour on sensory attributes of biscuits. The use of varying ratios of flours allowed for a more comprehensive analysis of the effects of the sprouted flours on the final product by (Prathusha and Cynthia, 2022) with some modifications.

Sensory evaluation

Participants

In this study, 24 non-trained panellists consisting of staff, students, and teachers from the Institute of Food Technology Bundelkhand University were recruited to perform the sensory analysis. Each panellist evaluated the biscuit samples individually in a separate room or space, at the temperature that matched the temperature of the sample they were evaluating. This approach was taken to ensure that the evaluations were unbiased and to reduce any potential distractions or influences from other panellists. Each panellist was given a sachet of water to rinse their mouth after each stage of sensory evaluation. The sensory evaluation data were collected individually from each panellist.

Samples

Six different biscuit samples were evaluated in this study. The samples were prepared using the same recipe with varying levels of sprouted gram and mung flour. The samples were packaged in a well-sealed material and coded with random alphabets to ensure that the panellists were unaware of the actual sample represented by each code (Barroso et al., 2015).

Evaluation

The panellists were educated on sensory testing terminologies and were asked to evaluate the samples for color, crispiness, taste, flavour, and general acceptability using a 9-point Hedonic scale where 9 was equivalent to like extremely and 1 meant

dislike extremely, as described by Nwakalor et al. (2014). Each point on the scale represented a different level of liking or disliking as follows:

9 - Dislike extremely
8 - Dislike very much
7 - Dislike moderately
6 - Dislike slightly
5 - Neither like nor dislike
4 - Like slightly
3 - Like moderately
2 - Like very much
1 - Like extremely

Data analysis

The sensory evaluation data were subjected to statistical analysis using analysis of variance (ANOVA) to determine if there were significant differences among the samples based on the sensory attributes evaluated. The level of significance was set at $p<0.05$. The statistical analysis was conducted using the R programming language with the Tukey's test, which considered a 5% level of significant.

The mean scores and standard deviation for each sensory attribute evaluated for each sample. The statistical test for testing significant difference between different samples on the basis of sensory attributes was conducted under ANOVA included the mean square, F-value, p-value, and critical difference (C.D.). The mean square represents the variance between the groups and the F-value is the ratio of the variance between the groups and the variance within the groups. The p-value represents the probability of obtaining the observed results by chance alone, and the critical difference (C.D.) is the minimum difference between means that is necessary to be considered statistically significant at a 95% confidence level. The ANOVA results for each sensory attribute are presented in the table 1 provided. The F-value indicates whether there are significant differences among the samples for each sensory attribute, and the p-value indicates the level of significance of the F-value. The C.D. indicates the minimum difference between means that is considered statistically significant. Overall, the data were analysed using ANOVA with Tukey's test, and results were considered statistically significant if the p-value was less than 0.05. The ANOVA results are presented in the table 1, including the F-value and p-value for each sensory attribute evaluated

RESULTS AND DISCUSSION

The sensory data obtained from the evaluation of biscuits made with different blends of refined flour, sprouted gram flour, and sprouted mung flour are presented in Table 1. The mean scores for each sensory attribute were analyzed using ANOVA. The color of the biscuits improved significantly with the addition of sprouted gram and mung flour, as evidenced by the increase in mean scores from T0 to T5. The highest mean score of 8.83 ± 0.381 was obtained in sample T4, which contained 60% refined flour and 20% each of sprouted gram and mung flour.

This result indicates that the addition of sprouted gram and mung flour can improve the color of biscuits. Similarly, the taste of the biscuits also improved with the addition of sprouted gram and mung flour, as evidenced by the increase in mean scores from

T0 to T5. The highest mean score of 8.83 ± 0.381 was obtained in sample T4, which contained 60% refined flour and 20% each of sprouted gram and mung flour. This result indicates that the addition of sprouted gram and mung flour can improve the taste of biscuits.

Table 1: Sensory analyses of prepared biscuits

SAMPLE	COLOUR mean ± SD	TASTE mean ± SD	TEXTURE mean ± SD	SHAPE mean ± SD	CRUNCHINESS mean ± SD	OVERALL mean ± SD
T0	6.83 ± 0.702 c	6.50 ± 0.511 d	6.83 ± 0.702 d	7.00 ± 0.834 c	6.83 ± 0.917 c	6.83 ± 0.702 c
T1	7.83 ± 0.702 b	7.50 ± 0.780 c	7.50 ± 0.780 c	7.67 ± 0.963 b	8.00 ± 0.834 b	8.00 ± 0.834 b
T2	7.92 ± 0.282 b	8.33 ± 0.482 b	8.33 ± 0.482 b	8.33 ± 0.482 a	8.33 ± 0.482 ab	8.33 ± 0.482 ab
T3	8.50 ± 0.511 a	8.5 ± 0.511 ab	8.50 ± 0.511 ab	8.50 ± 0.511 a	8.67 ± 0.482 a	8.50 ± 0.511 ab
T4	8.83 ± 0.381 a	8.83 ± 0.381 a	8.83 ± 0.381 a	8.83 ± 0.381 a	8.83 ± 0.381 a	8.83 ± 0.381 a
T5	8.67 ± 0.482 a	8.83 ± 0.381 a	8.50 ± 0.511 ab	8.67 ± 0.482 a	8.67 ± 0.482 a	8.67 ± 0.482 a
Mean Square	13.0944	20.2	13.8	11.7333	13.2444	12.644
F value	46.137	73.358	41.4	28.242	33.434	36.865
p-value	2.2e-16 ***	2.2e-16 ***	2.2e-16 ***	2.2e-16 ***	2.2e-16 ***	2.2e-16 ***
C.D.	0.4593954	0.4525017	0.4978601	0.5558172	0.5427373	0.5050239

Note: SD stands for standard deviation and *** denotes statistical significance at p<0.001. C.D. stands for critical difference at p

The texture of the biscuits also improved with the addition of sprouted gram and mung flour, as evidenced by the increase in mean scores from T0 to T5. The highest mean score of 8.83 ± 0.381 was obtained in sample T4, which contained 60% refined flour and 20% each of sprouted gram and mung flour. This result indicates that the addition of sprouted gram and mung flour can improve the texture of biscuits. The shape of the biscuits did not show significant differences among the different blends, as evidenced by the mean scores which were mostly above 7.0 for all samples.

The crunchiness of the biscuits improved significantly with the addition of sprouted gram and mung flour, as evidenced by the increase in mean scores from T0 to T5. The highest mean score of 8.67 ± 0.482 was obtained in sample T5, which contained 50% refined flour and 25% each of sprouted gram and mung flour. This result indicates that the addition of sprouted gram and mung flour can improve the crunchiness of biscuits.

Overall, the sensory data suggests that the addition of sprouted gram and mung flour can improve the sensory quality of biscuits. The optimal blend for improving sensory attributes of biscuits was found to be T4, containing 60% refined flour and 20% each of sprouted gram and mung flour.

Sensory evaluation of biscuits with malted green gram flour (MGF) replacing refined wheat flour (RWF) at different levels and using flavors like cocoa, coconut powder, and ajwain was conducted. Biscuits with 40% MGF replacement were found to be

highly acceptable in terms of appearance, color, taste, aftertaste, and overall acceptability, comparable to the control group (Sharma and Chopra, 2015).

Sudha et al. (2007) reported that the color of the biscuits became darker and the surface smoothness decreased with increasing levels of bran incorporation. Biscuits with higher levels of rice bran had a dark crumb color and very hard texture. Taste and mouthfeel were affected at a 20% level, resulting in a dry mouthfeel. Wheat and oat bran had similar sensory characteristics, while barley bran reduced surface smoothness and darkened the crumb color at higher levels. There were some negative changes observed in all parameters over the course of one year, but the best sensory evaluation was observed between 3 and 6 months of storage. The descriptors "amaranthy," "sweet," and "flour" were found to be superior in terms of tastiness, while the descriptor indicating "strange" did not occur throughout the storage period. Overall, the assessors considered the amaranth biscuits to be very tasty and comparable to other similar shelf-stable baked products (Hozová et al., 2000). Bajaj (2006) evaluated the sensory parameters of biscuits with variations in mint incorporation and assessed their acceptance and quality during storage, showing that biscuits with menthol and extract had comparable sensory attributes to those with synthetic antioxidants and received higher overall acceptability scores.

CONCLUSION

Based on the sensory data, it can be concluded that the inclusion of sprouted gram and mung flour in biscuit formulations had a significant effect on the sensory quality of the biscuits. As the percentage of sprouted gram and mung flour increased, there was a significant improvement in color, taste, texture, shape, crunchiness, and overall acceptability of the biscuits. The highest mean score for color, taste, texture, shape, crunchiness, and overall acceptability was observed in T4 (60% refined flour, 20% sprouted gram flour, and 20% sprouted mung flour) followed by T5 (50% refined flour, 25% sprouted gram flour, and 25% sprouted mung flour) and T3 (70% refined flour, 15% sprouted gram flour, and 15% sprouted mung flour). This indicates that the blend of 60% refined flour, 20% sprouted gram flour, and 20% sprouted mung flour can be considered as the most suitable blend for making biscuits with good sensory qualities. The sensory attributes of the biscuits were significantly affected by the blending ratio of different flours. The findings suggest that the inclusion of sprouted gram and mung flour in biscuit formulations can lead to the development of products with improved sensory qualities, which could be beneficial for the food industry in developing healthy and nutritious bakery products.

ACKNOWLEDGMENTS

The author expresses gratitude towards the Institute of Food Technology at Bundelkhand University for facilitating the necessary resources and infrastructure to conduct the research.

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