Sustainability, Agri, Food and Environmental Research, (ISSN: 0719-3726), 12(X), 2024:
http://dx.doi.org/10.7770/safer-V12N1-art690

Exploring the impact of sprouting on the chemical and physical properties of green gram and gram flour-based biscuits

Exploración del impacto de la germinación en las propiedades químicas y físicas de las galletas a base de harina verde Gram y Gram

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ABSTRACT

Pulses, such as green gram and gram, are excellent sources of protein, fiber, vitamins, and minerals. The botanical names of green gram and gram are Vigna radiata and Cicer arietinum, respectively. This research paper explores the impact of incorporating sprouted green gram flour and sprouted gram flour into refined flour-based biscuits. The study analyses the chemical and physical properties of the biscuits by varying the blending ratios of the three flours. The results show that the addition of sprouted flour increases the protein content and decreases the carbohydrate and fat content of the biscuits. Moreover, the physical properties of the biscuits, such as weight, thickness, diameter, and spread ratio, were also affected by the addition of sprouted flour. The significant differences in the mean square, F value, and p-value indicate that the differences in nutritional content and physical content between the different flour blends are unlikely to be the result of chance. Overall, the study provides insights into the potential of using sprouted flour in biscuit production to enhance their nutritional quality and physical attributes.
Keywords: Sprouted green gram flour, sprouted gram flour, Refined flour, Biscuit, Physical properties, Chemical properties, Sensory evaluation

RESUMEN

Las legumbres, como el garbanzo verde y el garbanzo, son excelentes fuentes de proteínas, fibra, vitaminas y minerales. Los nombres botánicos de gramo verde y gramo son Vigna radiata y Cicer arietinum, respectivamente. Este trabajo de investigación explora el impacto de incorporar harina de gramo verde germinada y harina de gramo germinada en galletas a base de harina refinada. El estudio analiza las propiedades químicas y físicas de las galletas variando las proporciones de mezcla de las tres harinas. Los resultados muestran que la adición de harina germinada aumenta el contenido de proteínas y disminuye el contenido de carbohidratos y grasas de las galletas. Además, las propiedades físicas de las galletas, como el peso, el grosor, el diámetro y la proporción de esparcimiento, también se vieron afectadas por la adición de harina germinada. Las

diferencias significativas en el cuadrado medio, el valor F y el valor p indican que es poco probable que las diferencias en el contenido nutricional y el contenido físico entre las diferentes mezclas de harina sean el resultado de la casualidad. En general, el estudio proporciona información sobre el potencial del uso de harina germinada en la producción de galletas para mejorar su calidad nutricional y sus atributos físicos.
Palabras clave: Harina de gramo verde germinada, harina de gramo germinada, Harina refinada, Galleta, Propiedades físicas, Propiedades químicas, Evaluación sensorial

INTRODUCTION

Biscuits are a highly popular and commonly consumed snack food, and there have been efforts to enhance their nutritional value. (Hooda and Jood et al., 2005). Biscuits are a highly popular and consumed processed food product in India, particularly in urban areas, and are widely consumed by people of all age groups. (Agarwal et al., 1990). Numerous studies have investigated the effect of various ingredients on the quality of biscuits, with wheat flour, sugar, fat, water, and salt being the primary ingredients. Minor ingredients such as baking powder, skimmed milk, emulsifier, and sodium metabisulphite are also used to produce the dough (Chevallier et al., 2000a; Chevallier et al., 2000b; Maache-Rezzoug et al., 1998). Biscuits are popular due to their low cost, diverse flavors, availability, good quality, and long shelf-life compared to other processed foods (Ayo et al., 2003; Gandhi et al., 2001).

Egypt and India have the highest consumption of pulses, which serve as a vital source of important nutrients, especially proteins, for their populations. Conversely, developed countries derive their protein intake mainly from animal-derived proteins (Rochfort et al., 2007). Nonetheless, pulses are traditionally consumed whole or split after soaking and cooking, although recently they have become increasingly popular and are widely used in food products such as pasta, bread, and other bakery products (Sozer et al.,2017) Legumes, such as pulses, provide a sustainable and cost-effective source of protein and key nutrients to address global food security challenges. The 2016 International Year of Pulses helped increase awareness of their nutritional benefits. However, the presence of antinutrients limits consumption. Pulse grains are high in protein, carbohydrates, and dietary fiber and offer various nutritional benefits (Tharanathan et al., 2003).

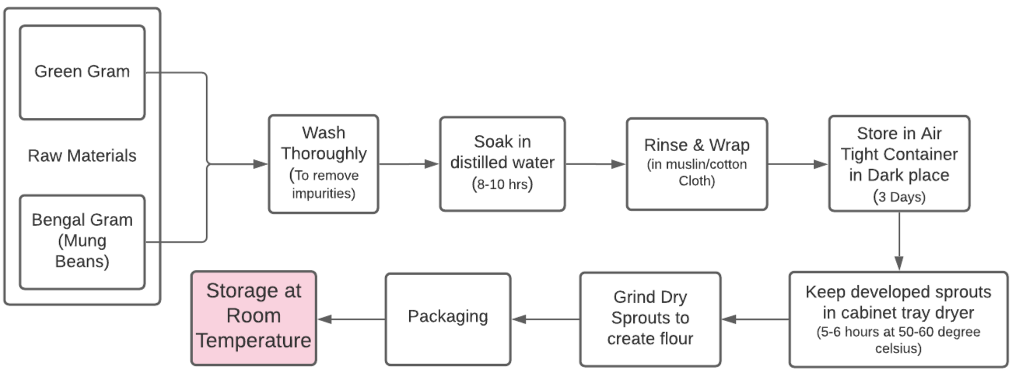
Vidal-Valverde et al. (2002) suggested that germination is a cost-effective method that can significantly modify the nutritional composition of beans, lentils, and peas. The nutritive value of the germinated product depends on the germination conditions. Germination is an effective approach to reduce flatulence caused by lentils, while also improving the digestibility of starch despite lower starch content. Moreover, germination leads to an increase in crucial dietary fiber components like cellulose and lignin, which hold significant physiological importance (Vidal-Valverde et al., 1992). The germination process has been found to have a significant impact on the nutritional and sensory properties of soybean seeds. (Ahmad et al. 2000) reported a significant increase in ascorbic acid and riboflavin content and a notable change in thiamine content after germination. Enzymatic activities, such as diastatic and proteolytic activities, were also found to improve, resulting in enhanced digestibility. Additionally, germination was observed to decrease the beany flavor and improve the overall sensory qualities of the soybean seeds. Germination of cowpeas (Vigna sinensis var. carilla) has been shown to improve the vitamin C content and increase antioxidant activity, as measured by TEAC, making it a beneficial process (Rosa Doblado et al., 2006). Germination reduced iron and increased phosphorus and sodium contents in both soybeans and mung beans, but potassium content was not changed significantly. Germination increased amounts of thiamine, riboflavin, niacin, and ascorbic acid in both soybeans and mung beans. (ABDULLAH A et al., 1984). Soaking green gram for 6 or 9 hours followed by sprouting can yield high-quality malt with improved nutritional and pasting properties, including increased protein and fiber content and decreased fat content, according to Tilekar Rasika Dattatray et al.'s 2019 study (Tilekar Rasika Dattatray et al.'s 2019).

This study explores the use of sprouted green gram flour and sprouted gram flour in biscuit production. The aim is to investigate the impact of these alternative flours on the physical and chemical properties of the final product and to determine whether they can be used to develop biscuits with improved nutritional value.

MATERIALS AND METHODS

Source of raw materials: The present study was conducted in the Department of Food Technology Bundelkhand University Jhansi (Uttar Pradesh) India. Good Quality Green Gram (Mung Bean or Moong) Botanical name: Vigna radiata L. Wildzek, and Gram (Chickpea or Chick Pea or Bengal Gram) Botanical name: *Cicer arietinum* was purchased from the local market. The food items viz. refined flour, sugar, butter, baking powder, and baking soda was also purchased from the local market, Jhansi, UP.

Preparation of sprouted flour: Firstly, Green gram and gram seeds were cleaned, graded, sorted, and washed three times using potable water. Then, the seeds were soaked in distilled water for 8 to 10 hrs at room temperature. The unimpeded water was discarded and the soaked seeds were rinsed twice with potable water to avoidpost-contaminationn during germination. The soaked seeds were germinated in a cotton cloth or muslin cloth for 72 h (3 days) at room temp with frequent watering (figure A). The germinated green gram and gram seeds were dried in a cabinet tray dryer at 50-60°C for 5 to 6 hours (figure B). The dried sprouted green gram and gram were then ground into a fine powder and passed through a sieve to obtain a smooth texture (figure C). (Atlaw Tamiru Kasaye et al 2015). preparation of sprouted flour in figure 1.



Preparation of blends from sprouted green gram, gram, and refined flour

For this study on biscuit preparation, we developed five different flour blends with varying ratios of refined flour, sprouted gram flour, and sprouted green gram flour.

- The control group (T0) consisted of 100 g of refined flour.
- For T1, we used 90 g of refined flour, 5 g of sprouted gram flour, and 5 g of sprouted green gram flour.
- For T2, we used 80 g of refined flour and 10 g of each sprouted gram flour and sprouted green gram flour.
- For T3, we used 70 g of refined flour and 15 g of each sprouted gram flour and sprouted green gram flour.
- For T4, we used 60 g of refined flour and 20 g of each sprouted gram flour and sprouted green gram flour.
- For T5, we used 50 g of refined flour and 25 g of each sprouted gram flour and sprouted green gram flour listed in Table 1.

All ingredients were thoroughly mixed together before being used in biscuit preparation.

Table 1: Blending ratio of refined flour, sprouted green gram flour, and sprouted gram flour. The experimental baking formula for different sample biscuits.

S. No.	Items	T0 (Control)	T1	T2	T3	T4	T5
1	Refined Flour	100	90	80	70	60	50
2	Sprouted Gram Flour	00	5	10	15	20	25
3	Sprouted Mung Flour	00	5	10	15	20	25
4	Baking Powder	01	01	01	01	01	01
5	Baking soda	01	01	01	01	01	01
6	Water	making soft dough	making soft dough	making soft dough	making soft dough	making soft dough	making soft dough
7	Sugar	60	60	60	60	60	60
8	Butter	50	50	50	50	50	50

Preparation of biscuits: The biscuits were formulated according to the recipe given by Whitley (1970) with slight modifications. The ingredients used for biscuit making have been listed in Table 1. Biscuits were prepared using the traditional creaming method. Fat and sugar were mixed until light and fluffy. Then, composite 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 color developed), cooled, and stored in a high-density polyethylene jar at room temperature for further analysis (figure D). Detailed procedures for each step can be found in Figure 2.

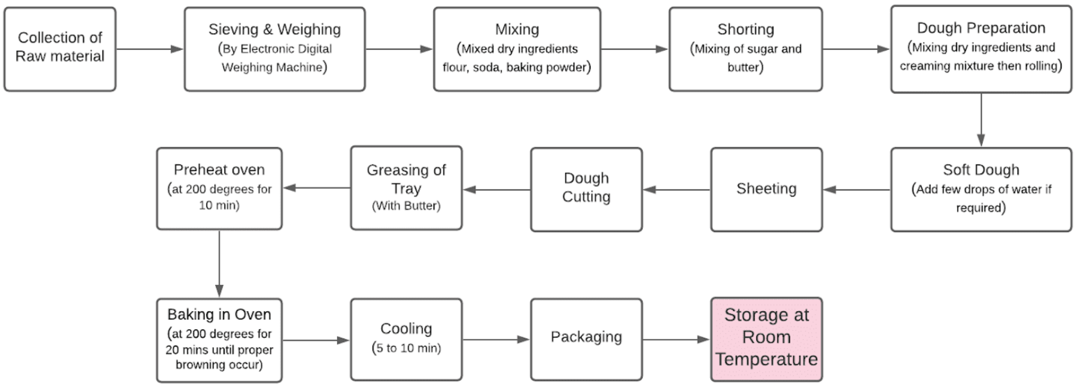


Figure 2 for Biscuit Preparation.

Evaluation of various quality characteristics of Biscuit

Determination of the Physical Characteristics of Biscuits: Biscuits meet certain quality standards, so it is important to evaluate their physical characteristics such as weight, thickness, diameter, and spread ratio. The method described by AACC (1967) provides a standardized approach for measuring these parameters. Biscuits are weighed and their diameter is measured by stacking six biscuits and measuring with a calliper. The Spread ratio is calculated by dividing the width by thickness, which is measured three times for each biscuit. Thickness is measured with a caliper, both when stacked and after rearranging the biscuits.

Determination of the Chemical analysis of the Biscuit: Chemical analysis of biscuits including moisture, protein, ash, and fat was determined by the standard AOAC 2000 method. The carbohydrate content of biscuit samples was calculated by differential method (100- moisture, protein, fat, ash, and crude fibre). Food energy was calculated by multiplying the value of crude proteins, fat, and carbohydrates by 4, 9, and 4 Cal respectively and results were expressed in Cal (FDA, 2004). Analyses were carried out for three replicates per sample.

Statistical analysis: The data obtained from various experiments in triplicate for each parameter was statistically analysed as per the methods suggested by Panse and Sukhatme (1967). Results were expressed as means with standard deviations. (ANOVA, Bonferroni post hoc test, $p \leq 0.05$) (Myers, Montgomery, & Anderson-Cook, 2016).

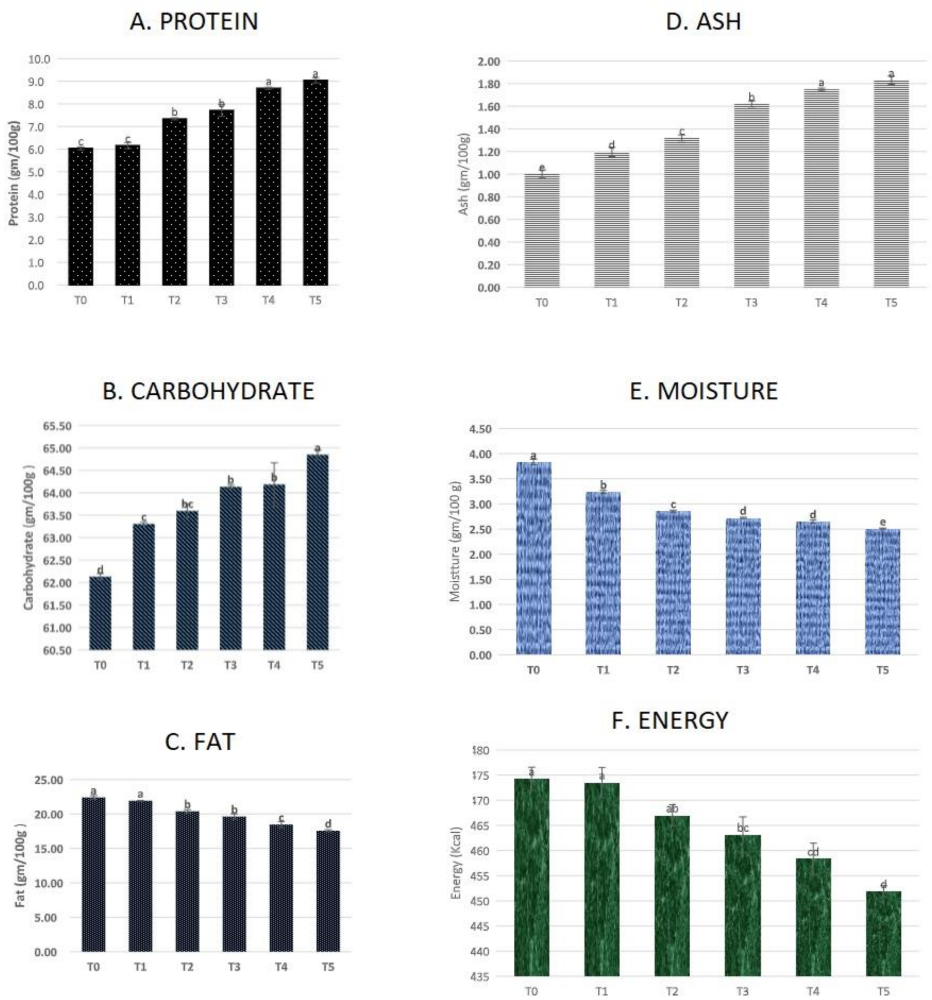
RESULT AND DISCUSSION

Based on the table 2, we can make some observations and draw some conclusions. The p -values of all parameters indicate that all samples and control are differ highly significant on the basis of protein, carbohydrates, fat, ash, moisture and energy. we move from T0 to T5, we see a gradual increase in the protein content of the samples, from 6.04% in T0 to 9.04% in T5. This suggests that the addition of sprouted pulses to the biscuit formulations has led to an increase in the protein content of the biscuits. Secondly, we see a decrease in the fat content of the samples, from 22.4% in T0 to 17.56% in T5. This suggests that the substitution of some of the flour with sprouted pulses has led to a reduction in the fat content of the biscuits. Thirdly, we see a slight increase in the carbohydrate content of the samples, from 62.13% in T0 to 64.85% in T5. This suggests that the substitution of some of the flour with sprouted pulses has led to a slight increase in the carbohydrate content of the biscuits. Fourthly, we see a gradual decrease in the moisture content of the samples, from 3.83% in T0 to 2.51% in T5. This suggests that the addition of sprouted pulses to the biscuit formulations has led to a reduction in the moisture content of the biscuits. Fifthly, we see a slight increase in the ash content of the samples, from 1% in T0 to 1.83% in T5. This suggests that the substitution of some of the flour with sprouted pulses has led to a slight increase in the mineral content of the biscuits. Finally, we see a gradual decrease in the energy content of the samples, from 474.27 kcal/100g in T0 to 451.90 kcal/100g in T5. This suggests that the addition of sprouted pulses to the biscuit formulations has led to a reduction in the calorie content of the biscuits.

Table 2. Chemical properties of biscuits

Sample	Protein	Carbohydrate	Fat	Ash	Moisture	Energy
T0 (Control)	6.04±0.07	62.13±0.07	22.40±0.27	1.00±0.0.36	3.83±0.05	474±2.30
T1	6.16±0.14	63.31±0.03	21.92±0.06	1.20±0.04	3.24±0.03	474±2.98
T2	7.34±0.05	63.60±0.15	20.38±0.24	1.32±0.02	2.86±0.02	467±2.14
T3	7.71±0.27	64.13±0.04	19.62±0.38	1.62±0.02	2.72±0.01	463±3.54
T4	8.69±0.05	64.19±0.48	18.46±0.44	1.75±0.01	2.65±0.03	458±3.11
T5	9.04±0.12	64.85±0.10	17.56±0.15	1.83±0.03	2.51±0.01	452±1.14
Mean Square	4.68	2.62	10.80	0.32	0.72	228.82
F-Value	251.99	57.31	133.39	337.47	766.33	32.48
P value	1.02e-11***	5.86e-08***	4.36e-10***	1.80e-12***	1.35e-14***	1.42e-06***
C.D.	0.406	0.638	0.848	0.093	0.091	7.907

Values are means±standard deviation of the triplicate sample. *** - Highly significant



Based on Table 3, we can make some observations and draw some conclusions.

The control sample had a mean weight of 10.08 ± 0.66 grams, which was significantly higher than all the treated samples (T1-T5) with mean weights ranging from 8.75 ± 0.15 grams to 9.94 ± 0.51 grams. The thickness of the control sample was 8.22 ± 0.01 mm, which was significantly higher than the thickness of all treated samples except T3. The mean thickness of the treated samples ranged from 6.73 ± 0.07 mm to 8.64 ± 0.05 mm. The diameter of the control sample was 7.8 ± 0.07 cm, which was significantly larger than the diameter of all treated samples except T2. The mean diameter of the treated samples ranged from 8.2 ± 0.2 cm to 8.72 ± 0.1 cm. The spread ratio, which is a measure of the extent to which the sample spreads out when cooked, was highest in the control sample (5.69 ± 0.05) and lowest in T5 (5.96 ± 0.1).

The results of the analysis of variance (ANOVA) showed that the differences in the weight, thickness, diameter, and spread ratio between the control and treated samples were significant (F values ranging from 6.894 to 196.2, all $p < 0.05$). The post-hoc analysis using the Tukey's HSD test revealed that all the treated samples were significantly different from the control sample in terms of weight, thickness, diameter, and spread ratio (CD values ranging from 0.196 to 0.879).

Table 3. Physical properties of biscuit

Sample	Weight	Thickness	Diameter	Spread Ratio
T0(Control)	10.08 ± 0.66	8.22 ± 0.01	7.8 ± 0.07	5.69 ± 0.05
T1	8.75 ± 0.15	6.73 ± 0.07	8.2 ± 0.2	7.3 ± 0.2
T2	9.59 ± 0.35	7.59 ± 0.14	8.72 ± 0.1	6.94 ± 0.09
T3	9.94 ± 0.51	8.39 ± 0.78	8.63 ± 0.08	6.42 ± 0.06
T4	10.12 ± 0.58	8.24 ± 0.03	8.48 ± 0.08	6.17 ± 0.04
T5	9.87 ± 0.44	8.64 ± 0.05	8.59 ± 0.1	5.96 ± 0.1
Mean Square	1.5704	2.9349	25.6681	2.2159
F value	6.894	27.735	52.674	196.2
P value	0.0002169***	2.112e-10***	5.341e-14***	2.2e-16***
C.D.	0.879	0.599	0.214	0.196

Values are means±standard deviation of the triplicate sample

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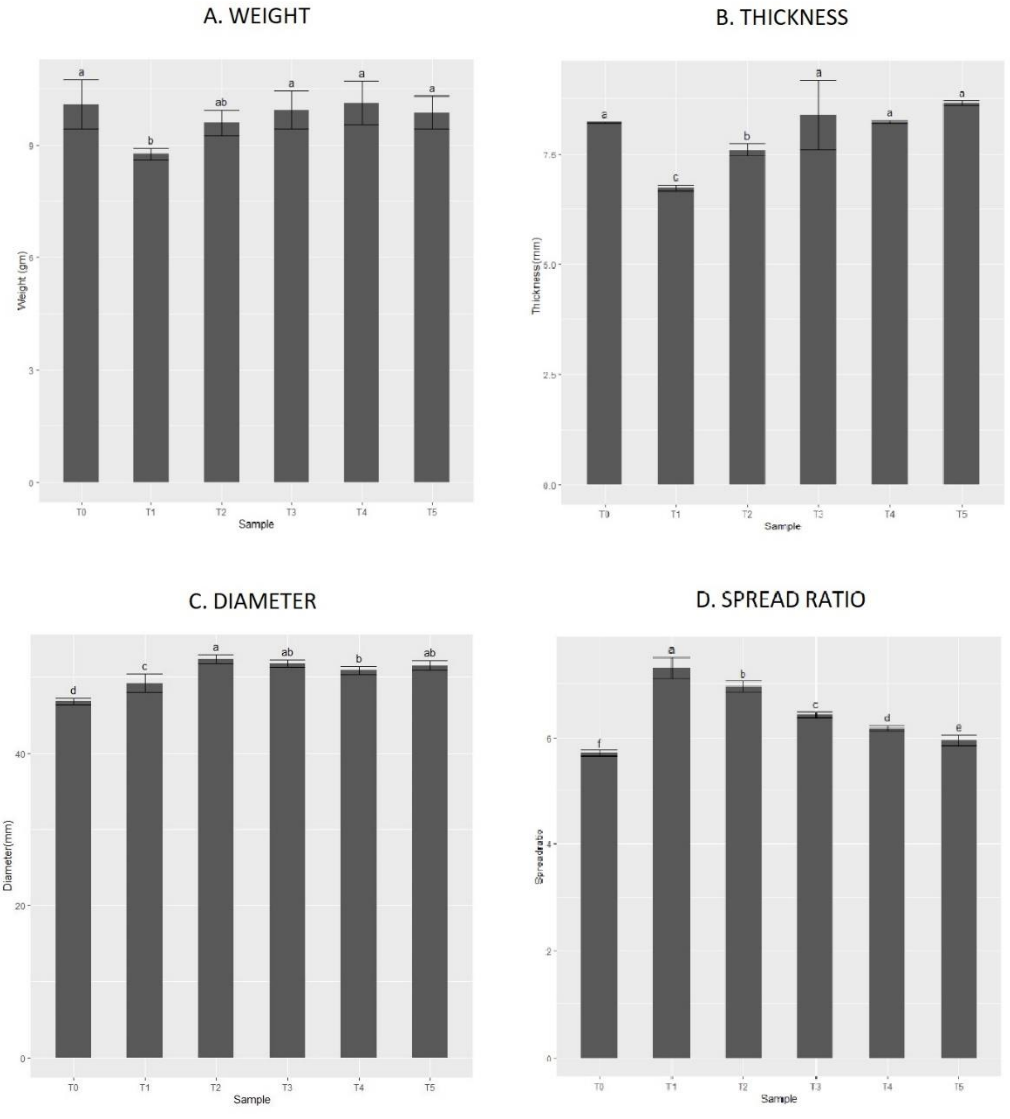

CONCLUSION

Based on the results of the study, it can be concluded that the use of sprouted gram flour and sprouted green gram flour in different ratios can lead to changes in the nutritional content of biscuits. Specifically, increasing the amount of sprouted gram flour and sprouted green gram flour resulted in an increase in protein content and a decrease in carbohydrate and fat content. The results from the physical analysis table showed that the weight, thickness, diameter, and spread ratio of the control samples were significantly different from the treated samples, indicating that the treatment methods had an impact on the physical properties of the samples. These findings support the hypothesis that using sprouted gram flour and sprouted green gram flour in biscuit preparation can lead to improved nutritional content and change the physical properties of biscuits. The significant differences in the mean square, F value, and p-value indicate that the differences in nutritional content and physical content between the different flour blends are unlikely to be the result of chance. The study provides valuable insights into the potential benefits of using sprouted flour in the food industry and offers a more natural and healthier alternative to traditional biscuit ingredients. The findings can serve as a foundation for further research on the use of sprouted flour in other food products to improve their nutritional content.

ACKNOWLEDGMENTS

The author would like to thank the Institute of Food Technology, Bundelkhand University for providing the infrastructure and resources to carry out the research work.

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Received: 19th April 2023; Accepted: 30th April 2023; First distribution: 19th September 2023