

PHYSICOCHEMICAL, PHYTOCHEMICAL, AND SENSORY EVALUATION OF COOKIES FORTIFIED WITH JUJUBE POWDER

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Abstract

The current study was conducted to fabricate cookies supplemented with various concentrations (0, 4, 8, 12, and 16%) of jujube powder. Cookies were analyzed for proximate composition, physical properties, phytochemical characterization, and sensory evaluation. Results showed that the addition of jujube powder significantly ($p < 0.05$) affected the proximate composition, especially fiber and ash contents. Incorporation of jujube powder increased the total phenolic contents (18.5 to 51.3 mg GAE/100g), total flavonoid contents (6.2 to 19.4 mg QE/100g), and antioxidant activity (22.4 to 58.6%). Similarly, physical properties and color (change in color, chroma, and whiteness index) were significantly changed with the supplementation of jujube powder in cookies. Moreover, the sensorial attributes results indicated that adding 8% jujube powder to cookies was acceptable. Conclusively, the results suggest that the incorporation of jujube powder can successfully enhance the functional value of cookies while maintaining acceptable sensory quality.

INTRODUCTION

Bakery products such as cookies are widely consumed around the world due to their pleasant taste, convenience, long shelf life, and affordability. Cookies are wheat flour-based products used as a snack in most parts of the world. These items are ready to eat, come in a variety of flavors, and have great nutritional

value. Cookies are appealing to people of all ages, particularly youngsters, because they are delightful to eat. They are differentiated from all other baked goods, such as breads and cakes, due to less water content, having a long shelf-life, and being free of microbial deterioration. Among baked goods, it seems to be the prime segment of snack food because they are prepared from easy,

inexpensive, and readily accessible raw materials (Abimbola and Olabisi, 2020). However, conventional cookies are generally prepared from refined wheat flour and are often low in dietary fiber, vitamins, and bioactive compounds (Xu et al., 2020). In recent years, there has been increasing interest in developing functional bakery products by incorporating fruit powders and other plant-based ingredients to enhance their nutritional and health-promoting properties (Guiné and Florença, 2024; Puspitasari and Kok, 2025).

Jujube (*Ziziphus jujuba* Mill.) is a nutrient-rich fruit known for its high content of natural sugars, dietary fiber, vitamins, minerals, and bioactive compounds such as phenolics and flavonoids (Pareek, 2013). The fruit has been widely used in traditional medicine and is recognized for its antioxidant, anti-inflammatory, and immune-enhancing properties (Gao et al., 2013). Due to these beneficial components, jujube has gained attention as a functional ingredient that can be incorporated into various food products to improve their nutritional quality (Hasan et al., 2022). Dietary fiber obtained from jujube fruit contains a high percentage of soluble fiber, which has a variety of functional attributes. The incorporation of these fibers into food may be the best option for developing a healthy product with great nutritional value (Masmoudi et al., 2021).

The incorporation of fruit powders into bakery products has been reported to improve dietary fiber content, antioxidant activity, and overall nutritional value. However, the addition of such ingredients can also influence the sensory and physical properties of baked goods, including color, texture, flavor, and overall acceptability (Ajila et al., 2008). Therefore, it is important to determine the appropriate level of fruit powder

incorporation that can enhance nutritional quality without negatively affecting product quality. The present study aimed to develop cookies fortified with different concentrations of jujube powder. Subsequently, assessing the effects of jujube powder incorporation on phytochemical characterization, sensorial attributes of cookies, and determining the most suitable formulation for producing nutritionally enriched and consumer-acceptable bakery products.

Material and Methods

Procurement of Raw Material

Raw material was procured from the supermarkets of Faisalabad. All the chemicals and reagents were used of analytical standards (Merck, Germany).

Preparation of raw material

Jujube fruit was washed with tap water to remove contaminants. The edible part was separated from the seed. Then, the fruit was sun-dried, followed by grinding to prepare powder. After that, the powder was passed through an 80-mesh sieve to obtain uniform powder particles. The powder was packed in airtight polythene bags and placed at room temperature for further study.

Development of cookies fortified with jujube powder

Cookies were prepared using varying concentrations (Table 1) of jujube powder according to the prescribed method (Zahid et al., 2025). After the cookies had developed, cooled at room temperature, they were packed in polythene bags and kept at room temperature for further analysis.

Table 1. Development of cookies using different concentrations of jujube powder

| Treatments | All purpose flour (%) | Jujube powder (%) |
|----------------|-----------------------|-------------------|
| T ₀ | 100 | 0 |
| T ₁ | 96 | 4 |
| T ₂ | 92 | 8 |
| T ₃ | 88 | 12 |
| T ₄ | 84 | 16 |

Proximate Composition

Proximate composition (moisture, fat, fiber, protein, ash, and nitrogen free extract) of cookies was measured according to the prescribed method (Asif *et al.*, 2025a).

Physical analysis of cookies

The thickness and diameter of various samples of cookies were measured using a vernier caliper (Mituyoto Co., Tokyo, Japan) (Kaur *et al.*, 2015). The spread ratio is determined by dividing the diameter by the thickness.

$$\text{Spread Ratio} = \frac{\text{Diameter}}{\text{Thickness}}$$

Phytochemicals Characterization**Preparation of Extracts**

Each sample of cookies (2g) was mixed in 20 ml of methanol (80%). After that, the solution was shaken at the shaker for 2 hrs at 200rpm, followed by centrifugation at 3500 rpm for 10 minutes. Then, the supernatant was separated and used in TPC, TFC, and DPPH radical scavenging activity (Asif *et al.*, 2024).

Total Phenolic Contents

Total phenolic contents in cookies were determined using Folin-Ciocalteu (FC) reagent according to the suggested protocol (Asif *et al.*, 2023). In this method, the sample extract and FC reagent (1:1) were added, followed by the addition of 2.5ml sodium carbonate (7.5% solution), and placed at room temperature for 30 minutes. Finally, the absorbance of the solution was measured at 765nm using a UV-Vis spectrophotometer. The total phenolic content was expressed in mg gallic acid equivalent (GAE)/ per 100gram.

Total Flavonoid Content (TFC)

Total flavonoid contents of cookies were determined using the suggested method (Asif *et al.*, 2025b). In this method, 0.25 mL of extracts, 0.75 mL of 5 % sodium nitrite, and 1.25 mL of distilled water were added to each test tube, and the samples were placed for 6 min at room temperature. After that, a 10 % solution of aluminum chloride (150 µL) was added to the mixture along with distilled water to bring the

volume up to 2.5 mL. At 510 nm, absorbance was measured by a spectrophotometer. TFC results were expressed as mg QE/100g.

Free Radical Scavenging Activity (DPPH)

The free radical scavenging activity of cookies was measured (Fatima *et al.*, 2025), with slight modifications. Briefly, two milliliters of DPPH solution (0.0125g dissolved in 500ml methanol) was mixed with twenty microliters of the sample extract, followed by incubation in a dark place for 30 minutes. After that, the absorbance of the solution was measured at 517nm using a spectrophotometer. The free radical scavenging activity was calculated using the given equation,

$$\text{DPPH} = 1 - \frac{\text{Absorbance (sample)}}{\text{Absorbance (blank)}} \times 100$$

Color Analysis

Color of cookies was measured using the CIE Lab SPACE system following the recommended protocol (Asif *et al.*, 2025a; Khan *et al.*, 2022). The parameters L*, a*, and b* were measured at various points on the cookies in triplicate. The change in color (ΔE), chroma (C*), and whiteness index (WI) were calculated using the following formulas:

$$\Delta E = \sqrt{(L^* - L^*_{\text{std}})^2 + (a^* - a^*_{\text{std}})^2 + (b^* - b^*_{\text{std}})^2}$$

$$C^* = \sqrt{(a^*)^2 + (b^*)^2}$$

$$\text{WI} = 100 - \sqrt{(100 - L^*)^2 + (a^*)^2 + (b^*)^2}$$

Here, std indicates the standard sample.

Sensory Evaluation

Organoleptic properties of cookies were carried out through panel of semi-trained judges. The 9-point hedonic scale used for organoleptic attributes, which comprised color, texture, taste, and overall acceptance, was evaluated. The actual composition of cookies was not shown to the panelists for exact judgment of the samples. The samples were provided to panelists in white polystyrene plates at room temperature. The samples were labelled with 3-digit codes. Cookies were presented to panelists in a separate booth for evaluation. Before each evaluation, water was

used to rinse the mouth and neutralize the taste buds (Murid *et al.*, 2023; Atique *et al.*, 2026).

Statistical Analysis

All analyses were performed in triplicate, and data were presented as mean values along with standard deviations. The Tukey HSD test ($\alpha=0.05$) was used to check the significance difference among treatments using Statistix 8.1 software (Urooj *et al.*, 2026; Naqvi *et al.*, 2022).

Results and Discussion

Proximate Composition of Cookies

The proximate composition of cookies was determined, and the results are depicted in Table 2. Results showed that the addition of jujube powder significantly changed the proximate composition. Moisture content increased gradually from 4.00% in T₀ (control) to 4.70% in T₄. This increase may be due to the fiber and natural sugars present in jujube powder that possess hygroscopic properties and enhance water retention in the cookie matrix (Ajila *et al.*, 2008). These results are correlated with prior reported literature (Pathare *et al.*, 2013). Fat and protein

contents in cookies were significantly ($p<0.05$) decreased with increasing concentrations of jujube powder in cookies. Fiber was significantly increased from 0.82% in the control sample to 1.97% in T₄, which reflects the high fiber content of jujube fruit as compared to all-purpose flour. Incorporation of fruit powders in bakery products has been widely reported to increase fiber content and improve the functional properties of baked goods (Pathare *et al.*, 2013). Similarly, ash content increased from 0.96% in T₀ to 2.05% in T₄, indicating higher mineral content in the fortified cookies. Jujube fruit is known to contain essential minerals such as calcium, potassium, iron, and phosphorus, which contribute to the increased ash content (Gao *et al.*, 2013). The incorporation of jujube powder increases the nutritional quality of cookies by increasing dietary fiber and mineral content, while slightly reducing fat and protein levels. These results suggest that jujube powder can be effectively utilized as a functional ingredient in bakery products to enhance their nutritional profile.

Table 2. Proximate Composition of Cookies

| Treatments | Moisture (%) | Fat (%) | Protein (%) | Fiber (%) | Ash (%) | NFE (%) |
|----------------|-------------------------|--------------------------|-------------------------|------------------------|------------------------|--------------------------|
| T ₀ | 4.00±0.29 ^b | 22.00±0.02 ^a | 8.5±0.32 ^a | 0.82±0.56 ^c | 0.96±0.64 ^c | 63.72±0.87 ^a |
| T ₁ | 4.20±0.55 ^{ab} | 21.81±0.07 ^b | 8.20±0.44 ^b | 1.20±0.7 ^b | 1.25±0.78 ^b | 63.34±0.82 ^{ab} |
| T ₂ | 4.35±0.60 ^{ab} | 21.60±0.06 ^{bc} | 8.01±0.53 ^{bc} | 1.45±0.85 ^b | 1.40±0.58 ^b | 63.19±0.83 ^b |
| T ₃ | 4.50±0.65 ^{ab} | 21.34±0.08 ^c | 7.79±0.63 ^c | 1.69±0.9 ^a | 1.87±0.66 ^a | 62.81±0.74 ^c |
| T ₄ | 4.70±0.71 ^a | 21.06±0.09 ^d | 7.51±0.75 ^c | 1.97±0.95 ^a | 2.05±0.74 ^a | 62.71±0.61 ^c |

Physical properties

The physical properties (diameter, thickness, and spread ratio) of cookies were measured and the results are presented in Table 3. Results revealed that the incorporation of jujube powder in cookies significantly affects ($p<0.05$) the physical properties. The diameter of cookies slightly decreased with increasing levels of jujube powder.

The decrease in diameter may be due to higher fiber in jujube powder, which increases water absorption and dough viscosity, thereby restricting the spread of cookies during baking (Sahni and Shere, 2018). Similar observations have been reported in prior literature (Ajila *et al.*, 2008). Similarly, the thickness of cookies was significantly ($p<0.05$) increased with increasing

supplementation of jujube powder. It may be attributed to the fact that jujube powder contains fiber, resulting in a more compact dough structure and increasing thickness during baking (Toledo, 2018). The spread ratio was

significantly ($p < 0.05$) decreased with increasing jujube powder levels. Similar results have been reported in cookies enriched with fruit fibers and plant-based powders (Krajewska and Dziki, 2023).

Table 3. Physical properties of cookies supplemented with different concentrations of jujube powder

| Treatments | Diameter (mm) | Thickness (mm) | Spread Ratio (-) |
|----------------|-------------------------|------------------------|-------------------------|
| T ₀ | 58.2±0.75 ^a | 8.0±0.45 ^c | 7.28±0.32 ^a |
| T ₁ | 57.1±0.68 ^{ab} | 8.2±0.40 ^{bc} | 6.96±0.28 ^{ab} |
| T ₂ | 56.0±0.70 ^b | 8.5±0.42 ^b | 6.59±0.30 ^b |
| T ₃ | 55.0±0.65 ^{bc} | 8.8±0.38 ^{ab} | 6.25±0.25 ^{bc} |
| T ₄ | 54.0±0.60 ^c | 9.0±0.35 ^a | 6.00±0.22 ^c |

Phytochemical Characterization

The phytochemical characterization of cookies was determined, and the results are shown in Table 4. Results indicated that the incorporation of jujube powder in cookies was significantly ($p < 0.05$) increased the total phenolic content (TPC), total flavonoid content (TFC), and antioxidant activity (DPPH%) with increasing supplementation of jujube powder. TPC increased from 18.5 to 51.3 mg GAE/100g, while TFC increased from 6.2 to 19.4 mg QE/100g, and DPPH radical scavenging activity improved from 22.4% to 58.6%. The increment in phenolic and flavonoid contents is attributed to the high concentration of polyphenols,

flavonoids, and other bioactive compounds naturally present in jujube fruit (Wojdyło *et al.*, 2016). The upsurge in antioxidant activity associated with the increased TPC and TFC indicates a strong correlation between phenolic content and radical scavenging activity. These outcomes are consistent with previous studies on fruit-fortified bakery products (Kim *et al.*, 2014). The progressive increase in antioxidant activity with higher jujube levels confirms that incorporation of jujube powder can enhance the functional properties of cookies, making them potential sources of natural antioxidants for health-promoting baked products.

Table 4. Phytochemical characterization of cookies supplemented with jujube powder

| Treatments | TPC (mg GAE/100 g) | TFC (mg QE/100 g) | DPPH (%) |
|----------------|------------------------|------------------------|------------------------|
| T ₀ | 18.5±0.45 ^c | 6.2±0.30 ^c | 22.4±0.52 ^c |
| T ₁ | 26.8±0.50 ^d | 9.4±0.4 ^d | 31.7±0.60 ^d |
| T ₂ | 34.6±0.63 ^c | 12.1±0.55 ^c | 40.5±0.73 ^c |
| T ₃ | 42.9±0.71 ^b | 15.7±0.64 ^b | 49.8±0.82 ^b |
| T ₄ | 51.3±0.86 ^a | 19.4±0.70 ^a | 58.6±0.91 ^a |

Color Analysis

The color attributes of cookies were significantly ($p < 0.05$) affected by the incorporation of jujube powder as shown in Figure 1. The color change (ΔE) was increased progressively, which showed that cookies became darker and more visually different from the control. It may be attributed to

the high natural pigments and phenolic compounds in jujube powder, which contribute to browning during baking (Asif *et al.*, 2023). The Chroma (C*) values slightly decreased from T₀ to T₃, indicating a reduction in color saturation, due to the higher redness (a*) of jujube-enriched cookies. The decrease in Chroma

at moderate levels of jujube powder may be due to the dilution of yellow pigments (b^*) and increased fiber content affecting light reflection (Hernández *et al.*, 2016).

The Whiteness Index (WI) showed a consistent decline with increasing jujube powder, from 60.65 in T_0 to 44.47 in T_a , reflecting the darker appearance of the cookies. Similar trends have

been reported in cookies enriched with fruit powders or fiber-rich plant materials, where increased pigment content and Maillard reaction during baking reduce surface whiteness (Pan *et al.*, 2024).

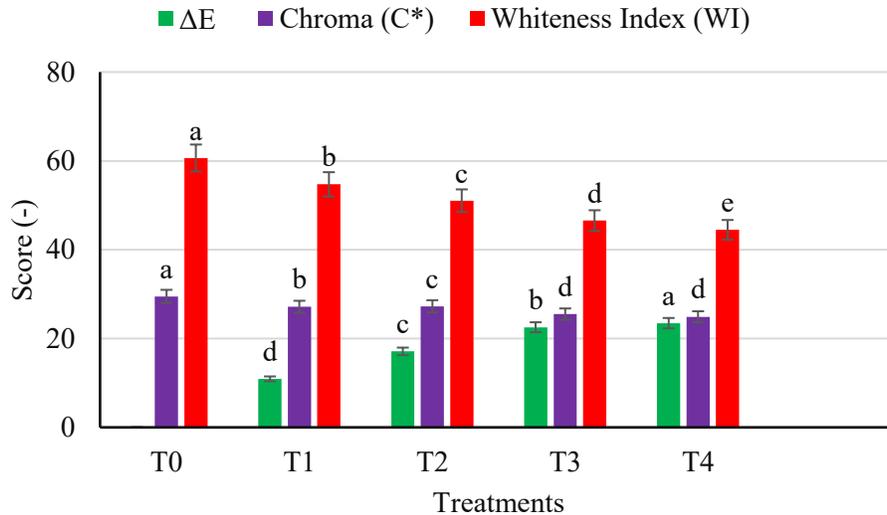


Figure 1. Graphical representation of the change in color, chroma, and whiteness index of cookies

Sensory Analysis

The sensory evaluation of cookies was carried out using a 9-point hedonic scale. Results demonstrated that the incorporation of jujube powder significantly influenced the color, texture, taste, and overall acceptability of the cookies. Color scores gradually decreased as the concentration of jujube powder increased from T_1 to T_4 . The reduction in color scores may be attributed to the darker brown pigments naturally present in jujube fruit, as well as intensified Maillard browning reactions during baking due to the presence of natural sugars and amino acids (Asif *et al.*, 2024). Similar findings were reported in prior literature (Gao *et al.*, 2013). Texture scores also declined slightly with increasing levels of jujube powder. This may be related to the higher fiber content of jujube powder, which can interfere with gluten network formation in wheat-based bakery products. The weakening of gluten structure often results in slightly softer or more

crumbly cookies. These results are correlated with previous findings (Sudha *et al.*, 2007). Taste scores declined slightly, possibly due to the stronger fruit flavor and increased fiber content affecting mouthfeel. These findings are consistent with Ajila *et al.* (2008), who reported that the incorporation of fruit powders in bakery products can enhance flavor at moderate levels but may negatively affect sensory attributes when used in excessive amounts. Overall acceptability followed a similar trend, where treatments T_1 and T_2 received relatively high scores and were not significantly different from the control in some cases. Among all treatments, cookies containing 8% jujube powder showed a desirable balance between sensory quality and functional enhancement. At higher concentrations the decline in acceptability suggests that excessive substitution of wheat flour with fruit powder may negatively affect the overall sensory perception of the product. These results indicate that the

incorporation of jujube powder can successfully enhance the nutritional and functional value of cookies while maintaining consumer acceptability when used at moderate levels. Therefore, the use

of 8% jujube powder appears to be the most suitable level for the development of nutritionally enriched cookies without significantly compromising sensory quality.

Table 5. Sensory evaluation of cookies

| Treatments | Color | Texture | Taste | Overall Acceptability |
|----------------|-------------------------|-------------------------|-------------------------|-------------------------|
| T ₀ | 8.60±0.15 ^a | 8.45±0.20 ^a | 8.30±0.18 ^a | 8.40±0.17 ^a |
| T ₁ | 8.30±0.18 ^{ab} | 8.20±0.16 ^{ab} | 8.15±0.14 ^{ab} | 8.22±0.15 ^{ab} |
| T ₂ | 7.95±0.20 ^b | 8.05±0.19 ^b | 8.00±0.17 ^b | 8.03±0.18 ^b |
| T ₃ | 7.60±0.21 ^c | 7.80±0.22 ^{bc} | 7.70±0.20 ^c | 7.75±0.21 ^c |
| T ₄ | 7.20±0.23 ^d | 7.50±0.25 ^c | 7.35±0.22 ^d | 7.40±0.23 ^d |

Conclusion

The aim of the present study to develop functional cookies supplemented with varying concentrations of jujube powder. Results exhibited that the incorporation of jujube powder enhanced fiber and ash contents. Similarly, the addition of jujube powder enhanced the functional properties by increasing nutritional and phytochemical characterization without severely compromising sensory quality. Moreover, sensory results indicated that up to 8% addition of jujube powder was acceptable with respect to sensory attributes because increasing concentration significantly reduced the sensory score. Overall results concluded that jujube powder can be employed as a functional ingredient in cookie formulations to improve nutritional value while keeping consumer acceptability at an acceptable level.

Conflict of interest

The authors declare that they have no known conflict of interest.

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REFERENCES

- Ajila, C., K. Leelavathi and U.P. Rao. 2008. Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. *Journal of Cereal Science*. 48:319-326.
- Asif, M., M. Abbas, K. Fatima, N. Ahmad, S. Ahmed, P. Meghwar, E. Hosseini, A. Nasir and S.A. Hassan. 2025a. Innovative corn extrudates incorporating barley-oat flour blends: Nutritional, functional, and sensory evaluation. *Applied Food Research*. 100812.
- Asif, M., M.K.I. Khan, M.I. Khan and A.A. Maan. 2024. Effect of citrus pomace and chickpea on physicochemical, biofunctional and organoleptic properties of corn extrudates. *Journal of Tianjin University Science and Technology*. 57:49-65.
- Asif, M., M.K.I. Khan, M.I. Khan, A.A. Maan, H. Helmick and J.L. Kokini. 2023. Effects of citrus pomace on mechanical, sensory, phenolic, antioxidant, and gastrointestinal index properties of corn extrudates. *Food Bioscience*. 55:103012.

5. Asif, M., A.A. Maan, A. Nazir, M.I.M. Khan and M.K.I. Khan. 2025b. Effect of chickpea on the physicochemical, nutritional, antioxidant, and organoleptic characterization of corn extrudates. *Journal of the Science of Food and Agriculture*. 105:2059-2067.
6. Atique, Z., M. Aftab, A. Usman, S. Ahmed, A. Faryad, M. Sultan, B. Almas, K. Fatima and M. Asif. 2026. FABRICATION AND CHARACTERIZATION OF GRANOLA BAR SUPPLEMENTED WITH FLAXSEED AND BANANA PEEL POWDER FOR COMPOSITIONAL, BIOFUNCTIONAL, AND SENSORIAL ATTRIBUTES. *Policy Research Journal*. 4:233-242.
7. Fatima, K., M. Asif, S.A. Hassan, M. Naveed, T. Alvi and M. Abbas. 2025. Fabrication and Characterization of Protein Fortified Corn Extrudates for Nutritional, Bio-functional, Structural and Organoleptic Properties. *Food Biophysics*. 20:1-12.
8. Gao, Q.-H., C.-S. Wu and M. Wang. 2013. The jujube (*Ziziphus jujuba* Mill.) fruit: a review of current knowledge of fruit composition and health benefits. *Journal of Agricultural Food Chemistry*. 61:3351-3363.
9. Guiné, R.P. and S.G. Florença. 2024. Development and characterisation of functional bakery products. *Physchem*. 4:234-257.
10. Hasan, S.K., M.R. Kabir, M.R. Kabir, M.R. Islam, M.J. Akhter and J.Y. Moury. 2022. Proximate composition, minerals, phytochemicals, and functional activities of jujube fruits grown in Bangladesh. *Journal of Agriculture and Food Research*. 8:100302.
11. Hernández, F., L. Noguera-Artiaga, F. Burló, A. Wojdyło, Á.A. Carbonell-Barrachina and P. Legua. 2016. Physico-chemical, nutritional, and volatile composition and sensory profile of Spanish jujube (*Ziziphus jujuba* Mill.) fruits. *Journal of the Science of Food Agriculture*. 96:2682-2691.
12. Kaur, M., K.S. Sandhu, A. Arora, A.J.L.-F.S. Sharma and Technology. 2015. Gluten free biscuits prepared from buckwheat flour by incorporation of various gums: Physicochemical and sensory properties. 62:628-632.
13. Khan, M.K.I., M. Asif, Z.U. Razzaq, A. Nazir and A.A. Maan. 2022. Sustainable food industrial waste management through single cell protein production and characterization of protein enriched bread. *Food Bioscience*. 46:406-416.
14. Kim, M.J., J.E. Choi and J.H. Lee. 2014. Quality characteristics of cookies added with jujube powder. *Food Science and Preservation*. 21:146-150.
15. Krajewska, A. and D. Dziki. 2023. Physical properties of shortbread biscuits enriched with dried and powdered fruit and their by-products: a review. *International Agrophysics*. 37.
16. Masmoudi, M., H. Yaich, M. Borchani, R. Mbarki and H. Attia. 2021. Chemical, physical and sensory characteristics of biscuits enriched with jujube (*Ziziphus lotus* L.) flour and fiber concentrate. *Journal of Food Science and Technology*. 58:1411-1419.
17. Murid, M., M.K.I. Khan, A.A. Maan, M. Asif and S.S. Sablani. 2023. Preferential binding effect of cocoa powder on fried donuts through the electrostatic coating method. *International Journal of Food Science and Technology*. 58:720-729.

18. Naqvi, S.N.U.A., J. Farah, A. Baila, W. Nitasha, A. Muhammad, Z. Muhammad, Y. Tahira and B. Muhammad Abu. 2022. Characterizing The Vegetables Enriched Pasta for Nutritional and Sensorial Attributes. RADS Journal of Food Biosciences. 2:28-33.
19. Pan, S., X. Liu, X. Zheng, J. Wu, M. Tan, N. Cao, X. Zhao, M. Wu, Y. Han and X. Yan. 2024. Impact of long-term cold storage on the physicochemical properties, volatile composition, and sensory attributes of dried jujube (*Zizyphus jujuba* Mill.). Foods. 14:50.
20. Pareek, S. 2013. Nutritional composition of jujube fruit. Emirates Journal of Food Agriculture. 25.
21. Pathare, P.B., U.L. Opara and F.a.-J. Al-Said. 2013. Colour measurement and analysis in fresh and processed foods: A review. Food and Bioprocess Technology. 6:36-60.
22. Puspitasari, E.D. and T. Kok. 2025. Nutritional and Sensory Profile of Conventional, Gluten-Free, and Plant-Based Cookies. Keluwih: Jurnal Kesehatan dan Kedokteran. 7.
23. Sahni, P. and D. Shere. 2018. Utilization of fruit and vegetable pomace as functional ingredient in bakery products: A review. Asian Journal of Dairy Food Research. 37:202-211.
24. Sudha, M., R. Vetrimani and K. Leelavathi. 2007. Influence of fibre from different cereals on the rheological characteristics of wheat flour dough and on biscuit quality. Food Chemistry. 100:1365-1370.
25. Toledo, N.M.V.D. 2018. Use of fruit processing by-products for the development of cookies: physicochemical, nutritional, technological and sensory aspects. Universidade de São Paulo.
26. Urooj, A., F. Mumtaz, A. Shabbir, M. Sultan, S.M.B. Tirmazi, M.S. Sarwar, S. Iqbal and M. Asif. 2026. EXPLORING THE AMELIORATIVE EFFECTS OF ANETHUM GRAVEOLENS AND FOENICULUM VULGARE SEEDS ON DYSLIPIDEMIA: A COMPARATIVE EFFICACY IN HIGH FAT DIET-INDUCED MODEL. Policy Research Journal. 4:506-527.
27. Wojdyło, A., Á.A. Carbonell-Barrachina, P. Legua and F. Hernández. 2016. Phenolic composition, ascorbic acid content, and antioxidant capacity of Spanish jujube (*Ziziphus jujube* Mill.) fruits. Food Chemistry. 201:307-314.
28. Xu, J., Y. Zhang, W. Wang and Y. Li. 2020. Advanced properties of gluten-free cookies, cakes, and crackers: A review. Trends in Food Science & Technology. 103:200-213.
29. Zahid, T., S. Nooreen, M. Asif, S. Maqsood, A. Saddiqa, M. Nazar, T. Alvi and M. Rafiq. 2025. Development and characterization of protein-rich cookies fortified with red kidney beans: A nutritional approach to combat malnutrition. Journal of Pure Applied and Agriculture. 10:21-29.