Journal of Food Science and Technology (Iran)

Homepage:www.fsct.modares.ir

Scientific Research

The effect of different levels of replacing wheat flour with jujube powder on the quality characteristics and sensory acceptance of biscuits

Yaghbnai[1*], M., Basiri[2], S.

1-Assistant Professor, Agricultural Engineering Research Department, Agricultural and Natural Resources Research and Education Center of Khorasan Razavi, AREEO, Mashhad, Iran

2-Associate Professor, Agricultural Engineering Research Department, Agricultural and Natural Resources Research and Education Center of Khorasan Razavi, AREEO, Mashhad, Iran

ARTICLE INFO

Article History:

Received: 2025/11/03

Review: 2025/12/06

Accepted: 2025/12/07

Keywords:

Sensory evaluation,
Biscuits,
Wheat flour replacement,
Jujube,
Functional product,
Physicochemical properties.

DOI: 10.48311/fsct.2026.117456.82919

*Corresponding Author E-

myaghbani@yahoo.com

ABSTRACT

Jujube is one of the strategic crops of South Khorasan and, due to its nutritional value and medicinal properties, has a high potential for use in the production of functional foods. In this study, jujube powder was used at different levels (0, 10, 20, and 30%) instead of wheat flour in biscuit formulations, and its effect on the chemical, physical, and sensory properties of the product was investigated in a completely randomized design. The results showed that with increasing jujube powder replacement level, moisture content decreased while protein, carbohydrate, and ash content increased ($p<0.05$). Also, with increasing jujube powder percentage, the thickness of the biscuit increased while the diameter and spread ratio decreased. Sensory evaluation indicated that among the samples containing jujube powder, biscuits containing 10 and 20 percent jujube powder received the highest scores in terms of color, flavor, texture, and overall acceptability, while 30% substitution decreased appearance and textural desirability. In general, using jujube powder up to 20% can improve the nutritional value of biscuits while maintaining desirable sensory properties, and this can be a suitable solution for developing functional cereal-based products.

1- Introduction

Jujube, with the scientific name *Ziziphus jujuba*, is a tree belonging to the *Rhamnaceae* family. Its fruit has been used in traditional medicine for treating various diseases. This plant, native to warm and semi-warm regions of Asia and America, is resistant to salinity, drought, temperature fluctuations, pests, and plant diseases. While the unripe jujube fruit is green in color, similar in shape to an olive, and possesses medicinal and antioxidant properties, its ripe fruit is wrinkled and brown, consumed both fresh and dried [1]. Currently, jujube is also considered a native plant of the Iranian plateau and is cultivated in the provinces of Khorasan, Golestan, Mazandaran, Fars, Isfahan, Yazd, Hamedan, Qazvin, and Qom. Jujube is rich in minerals (calcium, magnesium, sodium, potassium, and phosphorus), carbohydrates, fatty acids, and proteins, which are essential for some physicochemical processes crucial for human health. Furthermore, due to its richness in phenolic compounds, carbohydrates, proteins, and flavonoids, it is traditionally consumed as an infusion or powder, and its antioxidant compounds can be extracted and utilized through various methods [2,3,4,5]. The fruit pulp of this plant contains more vitamins A and C compared to other parts of the fruit, and it is the richest source of linoleic acid. Its leaves are the richest source of vitamin E and linolenic acid [6,7].

Jujube has a long history of consumption as both an edible fruit and a medicine. In recent years, consumers, in addition to considering its nutritional characteristics, have shown particular interest in the health-promoting properties of this product. Consequently, it has potential applications in various products, including baked goods. Among bakery products, biscuits hold a significant position due to attractive characteristics such as a long shelf life, variety in flavor and texture, and high per capita consumption. Since biscuits have diverse applications as a staple food, gift items, snacks, infant food, dietary products, etc., interest in such products is increasingly growing in nutritional programs and critical situations due to their nutritional properties and ease of consumption [8,9]. Today, to meet consumer demand for healthier and more nutritious compounds in biscuits, a broad perspective has emerged for improving the nutritional quality of this product. Typically, soft wheat flour with 8-11% protein is the preferred flour for biscuit production, where gluten forms only a minimal network for sheeting and shaping the biscuit dough. To produce biscuits fortified with nutritious compounds, wheat flour can be partially replaced or blended with other flours in specific ratios. In this regard, numerous research studies have been reported using various flours such as rice flour, blends of millet or chickpea flour, oat flour, soybean and cassava flour, and amaranth flour to enhance protein, mineral, and fiber content [10,11].

However, substitution of wheat flour with plant powders, including jujube powder, besides improving nutritional value, may also affect the physical, textural, and sensory acceptance properties of the product. The reduction in gluten and increase in fiber resulting from substitution can alter the dough's rheological behavior, ultimately changing the textural and appearance characteristics of the biscuits. Additionally, at high substitution levels, the flavor, color, and overall acceptance of the product may decline [12,13]. Therefore, given the lack of sufficient research on the use of jujube powder in biscuit formulation, this study aimed to evaluate the effect of different levels of replacing wheat flour with jujube powder on the chemical, physical, and sensory acceptance characteristics of biscuits to determine the optimal substitution level.

2- Materials and Methods

2.1. Materials

Wheat flour (Setareh flour) was procured from Ghods Razavi Flour Factory (Mashhad, Iran). Dried jujube fruits were purchased from the market and ground into powder. The milled powder was then passed through a 170-mesh sieve to obtain uniform particles, and the

portion passing through the sieve was used in the biscuit formulation. The composition per 100 grams of wheat flour and jujube powder is presented in Table 1. Other formulation ingredients, including sugar, salt, sodium bicarbonate, and shortening oil, were obtained from reliable commercial sources. All chemicals used in the chemical tests were purchased from Merck Company (Merck, Germany).

2.2. Methods

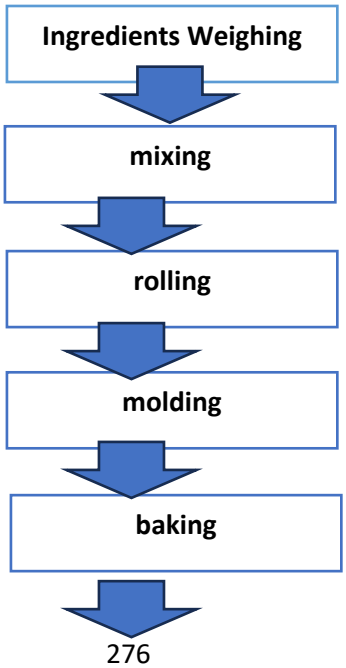
In this study, jujube powder was used at four replacement levels (0, 10, 20, and 30% by weight) in place of wheat flour in the biscuit dough formulation. The base formulation consisted of flour (100 g), sugar (40 g), shortening oil (15 g), salt (1 g), sodium bicarbonate (1 g), and vanilla powder (1 g). The approximate composition of wheat flour and jujube powder can be seen in Table 1.

Table 1. Approximate analysis of wheat flour and jujuba powder (per100 gr).

Sample	carbohydrate(g)	protein(gr)	fat (gr)	Ash(gr)
Wheat flour	71.4 ± 0.05	9.1 ± 0.04	1.95 ± 0.06	1.68 ± 0.6
Jujuba powder	**74.6 ± 0.08**	**9.7 ± 0.02**	**1.1 ± 0.12**	**3.18 ± 0.4**

The biscuit preparation steps included mixing the dry ingredients, adding the liquid ingredients, preparing the dough, kneading for 10 minutes, molding, and baking. The resulting dough, after kneading until achieving uniform thickness, was cut with a round mold and then the samples were baked in an oven at 200 ±5 °C for 20 minutes [13].

After cooling to room temperature, the samples were stored in sealed containers until the time of testing. The biscuit production process diagram is shown in Figure 1. The tests, conducted on the final product samples, included chemical analyses (moisture, ash, fat, protein, and carbohydrate) and physical analyses (diameter, thickness, and spread ratio) performed according to standard methods [14, 15].



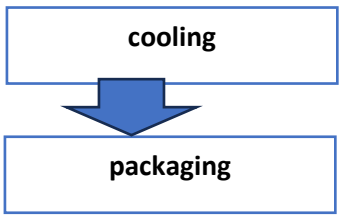


Fig. 1. Flow chart for biscuit production.

2.3. Sensory Evaluation

This test describes the level of consumer acceptance and satisfaction regarding the biscuit characteristics. The biscuit samples were analyzed for sensory attributes. Sensory quality characteristics were evaluated by a trained panel of 20 individuals using a 5-point hedonic scale (1, very bad and 5, very good) for flavor, color, appearance, crispness, and overall acceptance [15].

2.4. Statistical Analysis

In this study, all tests were performed with four treatments and three replications. Statistical analysis of the data was conducted using one-way analysis of variance (ANOVA) with SPSS software version 26. Mean comparisons were performed using Duncan's multiple range test at a 95% probability level ($p < 0.05$).

3- Results and Discussion

3.1. Physical Characteristics of Biscuits

The physical characteristics, including thickness, diameter, weight, and spread ratio of the biscuit samples, are presented in Table 2. The results showed a significant difference among the various treatments ($p<0.05$). The weight of the biscuits ranged from 9.39 to 10.35 grams, with the highest value belonging to the sample containing 30% jujube powder. The increase in weight is likely related to the ability of jujube powder to retain oil during the baking process [15, 16]. According to the table results, with an increase in the substitution level of jujube powder, the biscuit diameter values decreased from 4.61 mm (0% substitution sample) to 4.43 mm (sample containing 30% jujube). These changes may be due to the gluten content in the flour. The biscuit thickness varied from 0.59 to 0.82 cm. With the addition of jujube flour, this value increased, and the changes were significant ($p<0.05$). The increase in thickness may be due to the decrease in diameter, as these two have an inverse relationship [13, 17]. The spread ratio of the biscuits also varied from 7.68 for the sample containing 100% wheat to 6.43 for the 30% substitution sample. It is evident that changes in diameter and thickness are reflected in the biscuit spread ratio. These changes are likely due to the reduction in gluten and increase in fiber, which prevents the dough from spreading during baking. The decrease in the spread ratio of enriched biscuits is attributed to the formation of more hydrophilic sites in the biscuit dough. The spread factor or spread ratio is an index of biscuit characteristics [18, 19].

Table 2. Physical properties of Biscuits.

Sample	Weight (g)	Thickness (cm)	Diameter (mm)	spread Ratio
0% substitute	9.39 ± 0.08^{c}	0.59 ± 0.04^{c}	46.1 ± 0.22^{a}	7.68 ± 0.65^{a}
10% substitute	9.64 ± 0.08^{b}	0.64 ± 0.02^{c}	45.1 ± 0.12^{ab}	7.18 ± 0.46^{b}
20% substitute	9.89 ± 0.07^{ab}	0.75 ± 0.03^{b}	45.0 ± 0.26^{ab}	6.66 ± 0.56^{bc}

30% substitute	10.35 ± 0.11[ab]	0.82 ± 0.04[a]	43.3± 0.18[b]	6.43 ± 0.44[c]

(Means with different letters in each column differ significantly in p<0.05)

3.2. Chemical Composition of Biscuits

As observed in Table 3, all chemical compositions of the samples were significantly different from each other (p<0.05). The moisture content of the jujube/wheat biscuits varied from 4.69% to 3.22%. With an increase in jujube powder substitution, the moisture content of the biscuits generally decreased. It has been reported that the moisture content of different biscuits varies depending on the type of biscuit produced; for example, cream crackers have about 4.3% moisture, while digestive crackers have about 4.5% moisture [20].

The protein content of all biscuit samples was significantly different from each other, with the lowest amount for the 0% substitution sample (11.68%) and the highest for the sample containing 30% jujube (12.43%). These differences were observed because the protein content of the mixtures continuously increased with the higher content of jujube flour. The reason for the increase in protein content in samples containing jujube flour is likely due to the higher protein levels in jujube flour. It has been reported that jujube contains a sufficient amount of protein with high levels of amino acids such as cysteine, glycine, arginine, serine, alanine, histidine, and leucine (an essential amino acid) [21, 22].

The fat content followed a similar trend to protein. The highest amount (26.53%) was for the sample containing 30% jujube, while the lowest amount (25.85%) was obtained for the sample with 0% jujube. With an increase in the percentage of jujube flour, the carbohydrate content of the samples varied from 51.69% to 57.82%, showing that as the substitution level of jujube powder with wheat flour increased, their carbohydrate content also increased. This was predictable because jujube has a higher carbohydrate content than wheat flour and is consistent with the results of reported research [23, 24, 25].

The ash percentage of the samples varied between 2.35% and 4.35%. As observed, with an increase in the substitution level of jujube powder with wheat flour, the ash percentage of the biscuits also increased. The reason for this is the higher ash content of jujube compared to wheat flour, and similar results have been reported by other researchers [26, 27]. Therefore, adding jujube flour to biscuit production can increase mineral intake in consumers.

Table 3. Chemical composition of biscuits.

Sample	Moisture (%)	Carbohydrate (%)	Fat (%)	Protein(%)	Ash(%)
0% substitute	4.69 ± 0.08[a]	51.69 ± 0.34[d]	25.85 ± 0.22[b]	11.68 ± 0.32[c]	2.35±0.12[c]
10% substitute	3.64 ± 0.08[ab]	53.24 ± 0.12[c]	26.11 ± 0.12[ab]	12.18 ± 0.46[b]	2.98±0.12[bc]
20% substitute	3.35± 0.07[b]	55.75 ± 0.23[b]	26.41 ± 0.26[ab]	12.39±0.56[ab]	3.65± 0.12[b]
30% substitute	3.22 ± 0.11[c]	57.82 ± 0.36[a]	26.53± 0.18[a]	12.43 ± 0.44[a]	4.35± 0.22[a]

(Means with different letters in each column differ significantly in p<0.05)

3.3. Sensory Evaluation

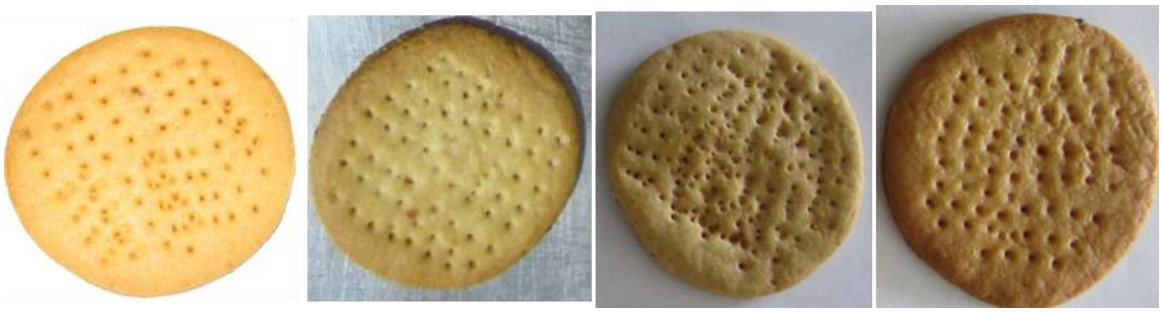
The sensory properties of the biscuits are presented in Table 4. Photographs of the biscuit products are also presented in Figure 2. The color score ranged from 4.82 to 3.22. The sample containing 0% jujube (100% wheat) received the highest score, while the sample containing 30% jujube had the lowest score. Darkness in the samples increased with higher jujube content in the biscuits. Among the samples containing jujube powder, a significant increase in the mean flavor scores was observed up to a 20% substitution level of jujube powder. The sample with 20% substitution obtained a sensory score of 4.21 for flavor. Adding 30% jujube flour caused a decrease in this score, which may be due to the bitter aftertaste of jujube powder. Also, a high substitution level creates a coarser texture and unpleasant flavor. The crispness scores indicated that after the control sample, the samples containing 10% and 20% jujube powder, with scores of 4.16 and 3.85 respectively, did not have a significant difference from each other, but they were significantly different from the sample containing 30% jujube.

In terms of appearance, the sample containing 100% wheat flour and the sample containing 30% jujube powder had the highest (4.6) and lowest (3.52) scores, respectively. The overall acceptance scores of the samples also indicated that the samples containing 10% and 20% jujube powder did not have a significant difference from the sample containing 100% wheat flour, and only the 30% substitution sample showed a significant difference from the control sample. Based on these results, up to a 20% substitution of wheat flour with jujube powder in the biscuit formulation does not create a significant difference in overall acceptance compared to the control sample.

Table 4. Sensory characteristic of biscuits

Sample	Color	Taste	Crispness	Apperance	Overal accpt.
0% substitute	4.82 ± 0.28[a]	4.65± 0.18[a]	4.54 ± 0.22[a]	4.6 ± 0.32[a]	4.6 ± 0.26[a]
10% substitute	4.12± 0.36[ab]	4.00 ± 0.19[b]	4.18 ± 0.30[ab]	4.16 ± 0.21[ab]	4.35 ± 0.31[ab]
20% substitute	3.85 ± 0.27[b]	4.21 ± 0.27[b]	3.77± 0.27[b]	3.85 ± 0.27[b]	4.28 ± 0.25[ab]
30% substitute	3.22 ± 0.11[c]	3.11 ± 0.15[c]	3.35 ± 0.11[b]	2.82 ± 0.11[c]	3.52 ± 0.18[b]

(Means with different letters in each column differ significantly in $p<0.05$)



0 % substitution 10 % substitution 20% substitution 30% substitution

Fig 2. Biscuits with different level of jujube powder

4-Conclusion

The present study showed that substituting wheat flour with jujube powder significantly changes the chemical and physical characteristics of biscuits. With an increase in jujube powder level, moisture, fat, and ash increased, while protein and carbohydrate decreased. The physical characteristics of the biscuits also indicated a decrease in diameter and an increase in thickness. Sensorily, the results indicated that substitution at the 10% to 20% level had better overall acceptance among the samples containing jujube, while 30% substitution caused a decline in sensory quality. Therefore, to achieve maximum substitution of jujube powder in the biscuit formulation while maintaining maximum overall acceptance, a substitution level of about 20% jujube powder in biscuits is recommended. These results, while enhancing nutritional value and utilizing native materials, can provide a basis for developing health-oriented products in the food industry.

Data Availability

The data used to support the finding of this study are available from the corresponding author upon request.

Conflict Of Interest

The authors have no conflicts interest to report.

Funding Statemant

The researchers did not receive any specific grant from funding agencies the public, commercial or not-for-profit sectors.

5. References

[1] Ebrahimi, M., Ghouth, K., Pooyan, M., Hosseyni, S. and Shahi, T. 1398. Book: Jujube from planting to processing, Published by: Fekre Bekr, 568 paper. (In Persion)

[2] Dhif, H., Salah-Abbes, J., Samir Abb`es, Calleja-G´omez, M., Pallar´es, N., Berrada. H. 2025. Comparative study of phenolic profile and antioxidant activities of different parts of Ziziphus lotus using aqueous, hydroalcoholic and pulsed electric field extractions. *Microchemical Journal*, 217, 1-10. doi.org/10.1016/j.microc.2025.114815.

[3] Abdeddaim, M., Lombarkia, O., Bacha, A., Fahloul, Dj., Abdeddaim, Dj., Farhat, R., Saadoudi, M., Noui, Y. and Lekbir, A. (2014). Biochemical characterization and nutritional properties of Zizyphus lotus L. fruits in Aures region, Northeastern of Algeria. Annals. *Food Science and Technology,* 15: 75-81.

[4] Zhang, H., Jiang, L., Ye, S., Ye, Y., & Ren, F. (2021). Nutritional compositions and health functions of jujube (Ziziphus jujuba Mill.) fruit. *Journal of Food Science*, 86(2), 387–396.

[5] Chen, H., Yu, X., & Li, L. (2009). Chemical constituents and health effects of Ziziphus jujuba. Food Chemistry, 113(3), 603-608.

[6] Ji X, Peng Q, Yuan Y, Shen J, Xie X, Wang M. (2017). Isolation, structures and bioactivities of the polysaccharides from jujube fruit (Ziziphus jujuba Mill.): A review. *Food Chemistry,* 227:349-357. doi: 10.1016/j.foodchem.2017.01.074.

[7] Singh, J., & Raj, P. (2013). Effect of fruit powders on quality characteristics of bakery products: A review. *International Journal of Food Science and Nutrition*, 64(6), 691-713.

[8] Lu, Y., Bao, T., Mo, J., Ni, J., & Chen, W. (2021). Research advances in bioactive components and health benefits of jujube (Ziziphus jujuba Mill.) fruit. *Journal of Zhejiang University. Scienc,* 22(6), 431–449. doi.org/10.1631/jzus.B2000594.

[9] Gao Q.H., Wu C.S., Wang, M. (2013) The jujube (Ziziphus Jujuba Mill.) fruit: a review of current knowledge of fruit composition and health benefits. *Journal of Agricultural and Food Chemistry,* 61:3351–3363.

[10] Benammar, C., Hichami, A., Yessoufou, A., Simonin, A.M., Belarbi, M., Allali, H. & Khan N. A. (2010). *Zizyphus lotus* L. (Desf.) modulates antioxidant activity and human T-cell proliferation. *BMC Complementary and Alternative Medicine*, **10** (54):1-9.

[11] Rahimi, N., Asnaashari, M., & Hosseini, H. (2017). Physical and chemical properties of cookies enriched with dietary fiber from fruit powders. *Iranian Journal of Agricultural Sciences*, 48(2), 235-245.

[12] Ghalem, M., Merghache, S. and Belarbi, M. (2014). Study on the antioxidant activities of root extracts of Zizyphus lotus from the western region of Algeria. *Pharmacognosy Journal*, 6: 32-42.

[13] Manley, D. (2011). Manley's Technology of Biscuits, Crackers and Cookies (Fourth Edition),

Woodhead Publishing, Pages 223-234, ISBN 9781845697709.
[14] AOAC International (1998). Official methods of analysis (16th edition). Gaithersburg, MD, method 920.151.
[15] Saadoudi, M., Hambaba, L., Abdeddaim, M., Lekbir, A., Bacha, A., Boudraa, S. and Zidani, S. (2017). Nutritional composition, physical properties and sensory evaluation of biscuit produced from jujubes. *Annals Food Science and Technology,* 18(3):395-401.
[16] Duta, D.E., Culetu, A. (2015). Evaluation of rheological, physicochemical, thermal, mechanical and sensory properties of oat-based gluten free cookies. *Journal of Food Engineering*, 162, 1-8, doi.org/10.1016/j.jfoodeng.2015.04.002.
[17] Mancebo, C.M., Rodriguez, P. and Gómez, M. (2016). Assessing rice flour-starch-protein mixtures to produce gluten free sugar-snap cookies*, LWT - Food Science and Technology*, 67, 127-132, doi.org/10.1016/j.lwt.2015.11.045.
[18] Ajila, C.M., Leelavathi K, and Prasada Rao, U.J. (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.
[19] Rufeng, N., Enqi, L., Chuangji, C. and Jiangping, Z. (1995). A study of the production of healthy biscuit made with tartary buckwheat grown in North China. *Current Advances in Buckwheat Research*, 861-865.
[20] Kim, S., Park, J., & Choi, Y. (2018). Nutritional and sensory evaluation of biscuits containing jujube powder. *Food Science and Biotechnology*, 27(5), 1327-1334.
[21] Davidson, I., (2025). Chapter 18 - Ingredients for biscuits: an introduction, in book: Biscuit, Cookie and Cracker Production (Second Edition), Academic Press, Pages 213-221, ISBN 9780443241024.
[22] Gebreselassie, E., and Clifford, H. (2016). Oxidative Stability and Shelf Life of Crackers, Cookies, and Biscuits, AOCS Press, Pages 461-478, ISBN 9781630670566.
[23] Mepba, H.D., Eboh, L. and Nwaojigwa, S.U. (2007). Chemical composition, Functional and Baking Properties of Wheat-Plantain Composite Flours. *African Journal of Food, Agriculture, Nutrition and Development*, **7**(1): 1-22.
[24] Ghani, A., Amini, S., Mohtashami, S. and Neamati, S.H. (2022). Physicochemical and biochemical variations of jujube (Ziziphus jujuba Mill.) populations: A comparison of Iranian and imported types. *Industrial Crops and Products*, 183, p.114898.
[25] Hussein, A. Yasser, Hussein, F. Hasan, A. Ali, Z., Abbas, S. Fadhal (2025). 'The Effect of Jujube Fruit Flour on Physical, Chemical, Sensory and Microbial Properties of Biscuits. *International Journal of Nutrition Sciences*, 10(3), 435-440. doi: org/ 10.30476/ijns.2025.105232.1388.
[26] Jinpeng, Z., Yunhao, L., Qiang, H. (2024). Recent advances on bioactive compounds, health benefits, and potential applications of jujube (Ziziphus Jujuba Mill.): A perspective of by-products valorization. *Trends in Food Science & Technology*,145, 1-13.doi.org/10.1016/j.tifs.2024.104368.
[27] Reche, J., Hernández, F., Almansa, M.S., Carbonell-Barrachina, Á.A., Legua, P. and Amorós. A. (2018). Physicochemical and nutritional composition, volatile profile and antioxidant activity differences in Spanish jujube fruits. *LWT - Food Science and Technology*, https://doi.org/10.1016/j.lwt.2018.08.023

مجله علوم و صنایع غذایی ایران

سایت مجله: www.fsct.modares.ac.ir

مقاله علمی_پژوهشی

تاثیر سطوح مختلف جایگزینی آرد گندم با پودر عناب بر خصوصیات کیفی و پذیرش حسی بیسکوئیت

مسعود یقبانی[1*]، شادی بصیری[2]

۱- استادیار، بخش تحقیقات فنی و مهندسی کشاورزی مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی خراسان رضوی، سازمان تحقیقات، آموزش و ترویج کشاورزی، مشهد ، ایران

۲- دانشیار، بخش تحقیقات فنی و مهندسی کشاورزی مرکز تحقیقات و آموزش کشاورزی و منابع طبیعی خراسان رضوی، سازمان تحقیقات، آموزش و ترویج کشاورزی، مشهد ، ایران

اطلاعات مقاله

تاریخ های مقاله :

تاریخ دریافت: ۱۴۰۴/۰۸/۱۲

تاریخ داوری: ۱۴۰۴/۰۹/۱۵

تاریخ پذیرش: ۱۴۰۴/۰۹/۱۶

کلمات کلیدی:

ارزیابی حسی،

بیسکوئیت،

سطح جایگزینی آرد گندم،

عناب،

محصول فراسودمند،

ویژگی‌های فیزیکوشیمیایی.

DOI: 10.48311/fsct.2026.117121.82900

* مسئول مکاتبات:

myaghbani@yahoo.com

چکیده

عناب از محصولات استراتژیک خراسان جنوبی بوده و به دلیل ارزش تغذیه‌ای و خواص دارویی خود، ظرفیت بالایی برای استفاده در تولید فرآورده‌های فراسودمند دارد. در این پژوهش، پودر عناب در سطوح مختلف (۰، ۱۰، ۲۰ و ۳۰ درصد) جایگزین آرد گندم در فرمولاسیون خمیر بیسکوئیت شد و اثر آن بر ویژگی‌های شیمیایی، فیزیکی و حسی محصول نهایی در قالب طرح کاملا تصادفی مورد بررسی قرار گرفت. نتایج نشان داد با افزایش سطح جایگزینی پودر عناب، میزان رطوبت کاهش یافت درحالی‌که مقدار پروتئین و کربوهیدرات و خاکستر افزایش پیدا کرد ($p<0.05$). همچنین با افزایش درصد پودر عناب، ضخامت بیسکوئیت افزایش یافته درحالی‌که قطر و نسبت گسترش کاهش یافت. ارزیابی حسی بیانگر آن بود که در بین نمونه های حاوی عناب، بیسکوئیت‌های حاوی ۱۰ و ۲۰ درصد پودر عناب از نظر رنگ، طعم، بافت و پذیرش کلی بالاترین امتیاز را دریافت کردند، در حالی‌که جایگزینی ۳۰ درصدی باعث کاهش مطلوبیت ظاهری و بافتی شد. به طور کلی، استفاده از پودر عناب تا سطح ۲۰ درصد می‌تواند باعث بهبود ارزش تغذیه‌ای بیسکوئیت همراه با حفظ ویژگی‌های حسی مطلوب آن شود و این امر می‌تواند راهکاری مناسب برای توسعه محصولات فراسودمند حاوی عناب بر پایه غلات باشد.