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Comparison of physical, chemical and sensory analyzes of tarhana containing black carrot extract and classical tarhana

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A B S T R A C T

Tarhana, which is very rich in nutritional value, has been the crown of our tables for centuries and is one of our common values wherever we live. It is obtained with black carrot extract to give this special food an even richer form. Black carrot extract was used to increase the anthocyanin content of the tarhana. In this study, physical and chemical analyzes, total phenolic content and total flavonoid content, antioxidant activities, colour measurement, sensory analysis of tarhana prepared with black carrot extract were determined. At the same time, the total amount of monomeric anthocyanin was determined. All these values were compared with classical tarhana and it was determined that tarhana containing black carrot extract had high DPPH activity (4.21±1.78 mg/mL) and high anthocyanin content (19.14±2.02 mg cyn3-glu/kg sample). According to the sensory analysis, the acceptability of tarhana with black carrot extract was determined to be high.

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1. Introduction

In the realm of traditional foods, few can rival the unique and rich history of tarhana. This ancient staple, originating from the Middle East and Mediterranean regions, has been a beloved dish for centuries (Sormaz et al., 2019). Tarhana is a fermented grain and yogurt-based soup mix that not only carries a distinctive taste but also boasts remarkable health benefits. Tarhana offers a host of nutritional benefits. Being a fermented food, it contains beneficial probiotics that promote a healthy gut flora, aiding digestion and supporting the immune system (Gok and Vatandost, 2021). Additionally, it is rich in dietary fiber, vitamins, and minerals derived from its various ingredients. The combination of wheat and yogurt provides a good source of protein, essential amino acids, and calcium (Atasoy and Ertop, 2021). Tarhana is also relatively low in fat and can be a valuable addition to a balanced diet.

Black carrot (*Daucus carota* ssp. sativus var. atrorubens Alef) is a vegetable originating from Türkiye, Middle and Far East. It has a bluish-purple color due to its high anthocyanin level (Karatas et al., 2014). Black carrot is a product rich in phenolics and carotenoids with antioxidant activity. Anthocyanins found in black carrots are used as natural food colorants due to their high light, heat and pH stability. The effects of foods rich in anthocyanins on health (such as anti-inflammatory, anti-diabetic, anti-tumor, anti-ulcer, antioxidant, anti-carcinogenic) have been revealed in literature studies (Kammerer et al., 2004).

The majority of the red, blue and purple colors in flowers, fruits, vegetables and other plant tissues are due to anthocyanins (Mazza, 2007). In addition to the attractive red, orange and purple colors of anthocyanins, their solubility in water has provided the opportunity to use these compounds as natural colorants (Bakowska-Barczak, 2005). Food colorants are used to give foods an original appearance, to standardize the color or to indicate the quality of the color. For these purposes, the use of synthetic colorants in the food industry is common. However, the demand for anthocyanins, which is an alternative natural source, has increased because the use of artificial colorants has legal limits and creates consumer concerns (Giusti and Wrolstad, 2003).

An antioxidant can be defined as a substance that prevents reactions with oxygen or peroxides and resists oxidation. Many of the antioxidants are used as preservatives in various products. Antioxidants have a very wide area in the food industry. The most important factor determining the place of antioxidants on human health is their structure-activity relationships, their solubility, their chemical structures and their ability to be obtained from natural sources (Huang et al., 2005; Nacak, 2014). The antioxidant capacities of flavonoids differ depending on their structure (Bronze et al., 2012). Flavonoids; It is generally responsible for color, taste, inhibition of fat oxidation, protection of vitamins and enzymes in foods (Yao et al., 2004).

In this study, it is aimed to compare classic tarhana with a new tarhana product, modified by adding black carrot extract, regarding physical, chemical and sensory properties. It is thought that the nutritional value of tarhana will increase with the addition of black carrot extract. Physical and chemical analyses of classical tarhana and tarhana containing black carrots were performed and their protein contents were determined. Total phenolic compounds were extracted from classical tarhana and black carrot tarhana. ABTS and DPPH activities as antioxidant futures were investigated. In addition, total flavonoid and total anthocyanin amounts were also examined. The color parameters of the tarhana obtained were compared.

2. Materials and methods

2.1. Materials

All chemicals and solvents used in analysis were bought from Sigma Aldrich (Sternheim, Germany) and Merck (Darmstadt, Germany). Onions, garlic, capia pepper, green pepper, tomato paste, flour, yogurt, salt and black carrot were purchased from the local market. Yeast was provided from a local bakery.

2.2. Extraction of black carrot

10 g black carrot was treated with 100 mL distilled water for 1 h at room temperature. The mixture was filtered under vacuum on a Buchner funnel using Whatman No. 1 paper (Whatman Inc., Clifton, N.J.) to use making tarhana.

2.3. Tarhana production

Classical tarhana and black carrot tarhana productions are given in Figure 1. Black carrot tarhana productions: Onions (120 g), garlic (50 g), capia pepper (150 g), green pepper (120 g) and tomato paste (120 g) are cooked over medium heat for 10 min. The cooled mixture is passed through the blender and all other ingredients [wheat flour (1000 g), yogurt (400 g), black carrot extract (100 g), salt (80 g), fresh baker's yeast (20 g)] are added and kneaded until a homogeneous dough is obtained. The resulting dough is left to ferment for 5 days at 30 °C. The fermented product is placed on stainless steel trays with a thickness of 1–1.5 cm, dried in the oven at 50 °C for 48 h, ground and sieved.

Classic tarhana productions: Same method with black carrot tarhana was used for producing classical tarhana. Only in this production, instead of not used black carrot extract, the amount of yoghurt was increased to a total of 500 g.

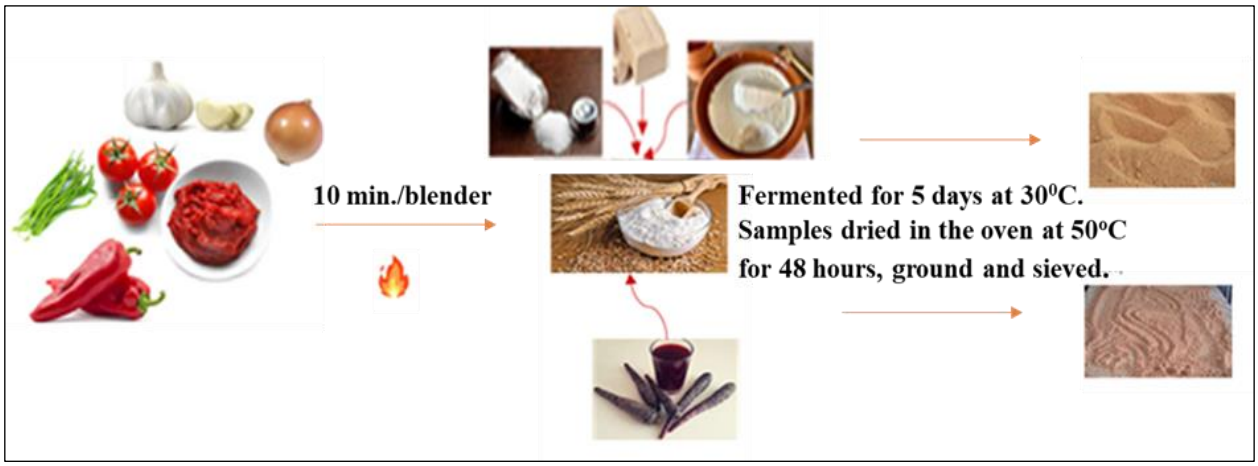

Figure 1. Tarhana Containing Black Carrot Extract and Classical Tarhana productions

2.4. Physical analyses

10 g of sample was mixed with 100 ml of distilled water at room conditions for 30 min and the mixture was filtered through filter paper. The pH of the solution was then measured using a digital pH meter. The percent humidity of tarhana samples was made according to the AACC 44-01.01 method (AACC, 2010).

2.5. Chemical analyses

The acidity of the fermentation products was determined by titration using 0.1 M NaOH. The results were calculated as lactic acid (Hendek and Atasoy, 2019). AACC 08-01.01 International methods were used for the determination of ash. The protein contents of the samples were determined by the Kjeldahl method and were determined from the crude nitrogen content of the samples (AOAC 2000, methods 992.23).

2.6. Tarhana extraction

After the tarhana samples were thoroughly mixed with methanol at a ratio of 1:5, the methanolic extracts were filtered under vacuum on a Buchner funnel using Whatman No. 1 paper (Whatman Inc., Clifton, N.J.). The filtrates were evaporated under vacuum at 400C on a rotary (HEI-VAP Value G1, Schwabach, Germany). This evaporated extract, prepared as stock, was stored at 40 °C to be used for all analyses. Samples were prepared fresh at the desired concentration and used.

2.7. Total phenolic content (TPC)

Total phenolic content was determined according to Sonmez and Sahin (2022). Folin-Ciocalteu was diluted 1:10 with water. 0.1 ml of methanolic tarhana extracts and 0.2 ml of diluted Folin-Ciocalteu reagent were mixed and incubated for 3 min. Aqueous sodium carbonate solution (20% w/v) was added followed by incubation in the dark for 60 min. Gallic acid (GAE) was used as a standard for the calibration curve.

All measurements were determined using UV-vis spectrophotometer at 765 nm. The results of total phenolic content (TPC) was given as mg GAE equivalent/g sample.

2.8. DPPH radical scavenging activity assay

DPPH radical scavenging activities of tarhana extracts were measured according to Cadi et al. (2020). Tarhana samples prepared at different concentrations of 0.2 mL were mixed with 0.05 mM DPPH. After the mixture was incubated at room temperature for 30 min, the absorbance was measured at 517 nm. A graph was drawn with % inhibition-absorbance values. The extract concentration providing 50% inhibition (IC50) was calculated from the graph of scavenging effect percentage against the extract concentration.

$$\%\, I = \frac{(A_{control} - A_{\,sample})}{A_{control}} * 100$$

2.9. ABTS radical cation decolorization assay

ABTS scavenging activities of the extracts were measured according method of Sonmez et al. (2019). ABTS and $K_2S_2O_3$ were dissolved in distilled water to prepare ABTS radical solution. This mixture was kept in the dark for 18-24 h at room temperature and the absorbance of the solution was adjusted at 734 nm. Tarhana samples were prepared at different concentrations. Initial absorbance of ABTS radical and absorbance values after 6 min were measured at 734 nm. The results were expressed as IC50.

$$\%\, I = \frac{(A_{initial} - A_{\,expiration})}{A_{initial}} * 100$$

2.10. Total monomeric anthocyanin

Total monomeric anthocyanin contents were applied with reference to Giusti and Wrolstad, (2001). The absorbance of tarhana samples in buffers at pH 1.0 and 4.5 were measured at 520 nm (λmax) and 700 nm using an UV-Vis spectrophotometer. Results were calculated as mg cyn3-glu/kg sample.

2.11. Total flavonoid content (TFC)

Total flavonoid content was determined by a colorimetric method (Chlopicka et al., 2012). Tarhana extracts were diluted with distilled water. Then $NaNO_2$ solution was added to the mixture, and after 5 min $AlCl_3.6H_2O$ solution was added. After the mixture was left for incubation, 1 M NaOH was added and made up to a total of 10 mL with distilled water. The absorbance values of these mixtures were measured with a UV-vis spectrophotometer at a wavelength of 510 nm. The results were stated as mg catechin eq./g sample.

2.12. Colour measurement

Colour values of redness/ greenness (a*), yellowness/ blueness (b*) and lightness (L*) of samples were measured using a colourimeter (CR-10; Konica Minolta, Japan). Measurements were made in 5 repetitions. The results were given as an average value and statistical analysis was performed.

2.13. Sensory analysis

Sensory evaluation, color, taste, smell, consistency and general acceptability of tarhana soup were evaluated. Evaluations for this purpose were determined by 10 untrained panelists consisting of students and staff of Pamukova Vocational School. Within the scope of the study, 100 g of tarhana sample, 1.5 L of distilled water, 40 g of oil, 10 g of salt are mixed over medium heat and cooked for 10 min. The prepared tarhana samples were presented to the panelists in porcelain bowls at 60°C (Tarakci and Ogurlu, 2023). Scoring was made by the panelists between 1 and 5 (1; very bad, 5; excellent).

2.14. Statistical analysis

Statistical evaluations were analysed by Minitab Statistical Software using ANOVA with a 95% confidence interval. Differences among samples were determined by Tukey's test ($p < 0.05$). Also, the results of statistical analysis were checked and corrected by Fisher's test ($p < 0.05$).

3. Results and discussion

The physical and chemical analyzes, total phenolic content, total flavonoid content, DPPH, ABTS antioxidant activity and total monomeric anthocyanin values of tarhana containing black carrot extract and classical tarhana are given in Table 1.

While pH values of tarhana extracts were determined as 5.05±0.005 in classical tarhana and 4.15±0.01 in tarhana containing black carrot extract, titration acidity in terms of lactic acid was calculated as 0.15±0.01 and 0.24±0.01, respectively ($p<0.05$). While the pH of tarhana containing black carrot extract is lower than that of classical tarhana, its titratable acidity is higher. Since black carrot extract is acidic, it decreased the pH value of tarhana and increased its acidity (Table 1). As a result, it was discovered that adding black carrot extract to Tarhana increased its acidity value. When the tarhana were compared, a statistically significant difference was found between the samples in terms of titratable acidity ($p<0.05$). In the research conducted by Cankurtaran et al. (2020) on tarhana obtained with taro and yam flours, pH values (4.23-5.21) were determined to be higher than tarhana containing black carrot extract. Titratable acidity values of tarhana samples containing 0%, 5%, 10%, 15%, 20%, 25% and 30% hazelnut pulp were examined by Ogurlu and Tarakcı (2023). Calculated between 0.58-0.74 values in terms of lactic acid per 100g sample. The titratable acidity value of tarhana containing black carrot extract is lower than that of tarhana containing hazelnut pulp. %dry matter, ash and protein content of classical tarhana is 13.66±0.15, 1.46±0.45 and 12.52±0.24 respectively. At the same time, the %dry matter, ash and protein values of tarhana containing black carrot extract were determined as 12.66±0.05, 1.61±0.41 and 12.72±0.61, respectively. In the study conducted by Aktaş and Akın (2020), tarhana with rice bran and corn bran was examined. While the % moisture and %ash values of tarhana containing black carrot extract were determined to be higher than the tarhana containing rice bran and corn bran, the % protein was determined to be lower. Tarhana containing different amounts of almond pulp was examined by Sensoy and Tarakcı (2023). It was reported that the % ash content of these samples were between 1.41 and 1.65, and the % protein content between 13.02 and 16.11. While the % ash content of tarhana containing black carrot extract had a similar effect, it was observed that the % protein content was lower.

In the data obtained, the total phenolic content of classical tarhana is 1.04±0.008 mg GAE/g sample, while tarhana with black carrot extract is 1.08±0.08 mg GAE/g sample ($p<0.05$). DPPH and ABTS activated IC50 values of classical tarhana as antioxidant activity were determined as 6.01±1.25 mg/mL and 0.83±0.03 mg/mL, respectively. For tarhana containing black carrot extract, antioxidant activity values were determined as 4.21±1.78 mg/mL and 0.93±0.01 mg/mL, respectively. While the DPPH activity of tarhana containing black carrot extract was higher than that of classical tarhana, ABTS activity had a lower effect ($p<0.05$). When the total flavonoid content is considered, it is seen that there is 1.17±0.06 mg catechin/g sample for classical tarhana and 0.75±0.05 mg catechin/g sample for tarhana containing black carrot extract ($p<0.05$). While both tarhana have similar phenolic content, classical tarhana contains more flavonoids. When the total monomeric anthocyanin content of tarhana are examined, it is seen that it is 9.96±1.27 mg cyn3-glu/kg sample for classical tarhana and 19.14±2.02 mg cyn3-glu/kg sample for tarhana containing black carrot extract ($p<0.05$). Tarhana, which contains black carrot extract, contains a significant amount of anthocyanins. Tarhana containing shalgam residuals was examined by Tanguler and Tatlısoy (2022) and the anthocyanin content of the obtained products was determined as 4.13 to 13.72 mg/L. It appears that tarhana containing black carrot extract has a higher anthocyanin content. Ghafoor et al. (2021) examined the total phenolic and total flavonoid values of tarhana samples containing different concentrations of pickling herb (PHET; E. tenuifolia subspp. sibthorpiana L.) (2-18%). Total phenolic content changed from 78.26 to 336.88 mg GAE/L in tarhana containing 18% PHET (in free form). In the same study, the highest total flavonoid content (1371.33 mg/L and 364.67 mg/L) was detected in tarhana, which contains 18% PHET.

As mentioned above, various tarhana productions modified by adding different natural products or extracts have been reported in the literature. The physical and chemical properties of the modified tarhana products can increase or decrease depending on the structural characteristics of the used additives.

The products of tarhana with black carrot extract and classic tarhana are given Figure 2. Graphical representation of colour measurement of tarhana with black carrot extract and classical tarhana extracts are given in Figure 3.

Table 1. Physical and chemical analyzes, total phenolic content (TPC), total flavonoid content (TFC), DPPH activity, ABTS activity and total monomeric anthocyanin values of tarhana with black carrot extract and classical tarhana.

Component	Classic tarhana	Tarhana with black carrot
pH	5.05±0.005^{a}	4.15±0.01^{b}
Titration acidity (lactic acid g/100g)	0.15±0.01^{b}	0.24±0.01^{a}
% Moisture	13.66±0.15^{a}	12.72±0.05^{b}
% Ash	1.46±0.45^{a}	1.61±0.41^{a}
% Crude protein	12.52±0.24^{a}	12.72±0.61^{a}
TPC (mg GAE/g sample)	1.04±0.008^{b}	1.08±0.08^{a}
DPPH assay (IC_{50}, mg/mL)	6.01±1.25^{a}	4.21±1.78^{b}
ABTS assay (IC_{50}, mg/mL)	0.83±0.03^{b}	0.93±0.01^{a}
TFC (mg catechin/g sample)	1.17±0.06^{a}	0.75±0.05^{b}
Total monomeric anthocyanin (mg cyn3-glu/kg sample)	9.96±1.27^{b}	19.14±2.02^{a}

Results are expressed as means ± SD (standard deviation) (n=3). 'a-b' refers the significant differences between the values in the same row ($p < 0.05$).

Lightness (L*), redness (a*) and yellowness (b*) values of tarhana containing black carrot extract were measured and the corresponding values were found to be in the range of 82.90±0.54, 7.63±0.13 and 21.97±0.17. The L*, a* and b* values of classic tarhana were found to be in the range of 84.66±0.24, 7.76±0.12 and 17.49±0.15, respectively. It was observed that the L* value decreased with the addition of black carrots and it was determined to be statistically significant ($p<0.05$). When the results are examined, it is understood that the effect of black carrot extract on the a* value of tarhana is statistically significant ($p>0.05$). Additionally, the effect of black carrot extract on the b* value of tarhana was found to be statistically significant ($p<0.05$). L* values of tarhana found in the studies of Tarakçı et al. (2013) and Kose and Cagindi (2002) are lower compared to our values. a* and b values of tarhana found in the studies of Tarakçı (2013) are higher compared to our values. Additionally a* and b values of tarhana found in the studies of Kose and Cagindi (2002) are higher compared to our values.

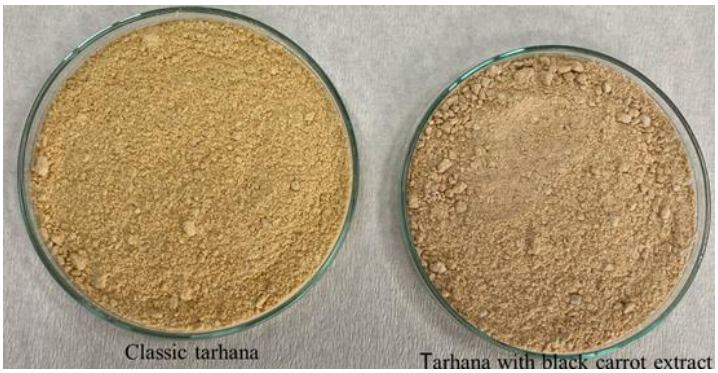

Figure 2. Tarhana with black carrot extract and classic tarhana

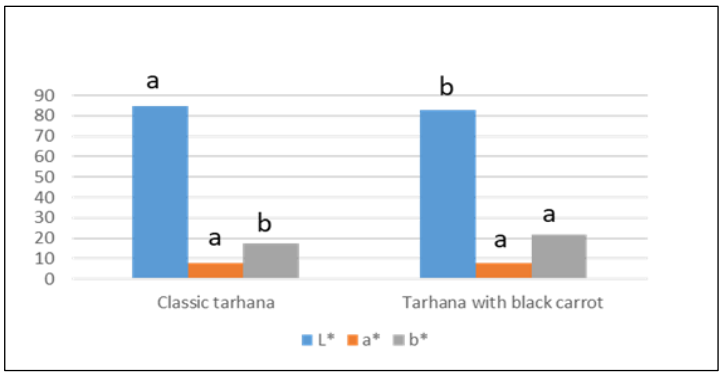

Figure 3. Colour measurement of tarhana with black carrot extract and classical tarhana

The graphical representation of the sensory analysis results of tarhana with black carrot extract and classic tarhana is given in Figure 4. Tarhana produced in the same way were presented to the panelists and evaluated in terms of color, taste, smell, consistency and general acceptability. Sensory analysis results of classic tarhana and tarhana with black carrot extract were determined as color (3.8±0.63 and 4.2±0.78, respectively), taste (3.6±0.69 and 4.3±0.67, respectively), smell (3.7±0.82 and 4.3±0.82, respectively), consistency (3.4±0.96 and 4.2±0.76, respectively) and general acceptability (4±0.66 and 4.4±0.69, respectively).

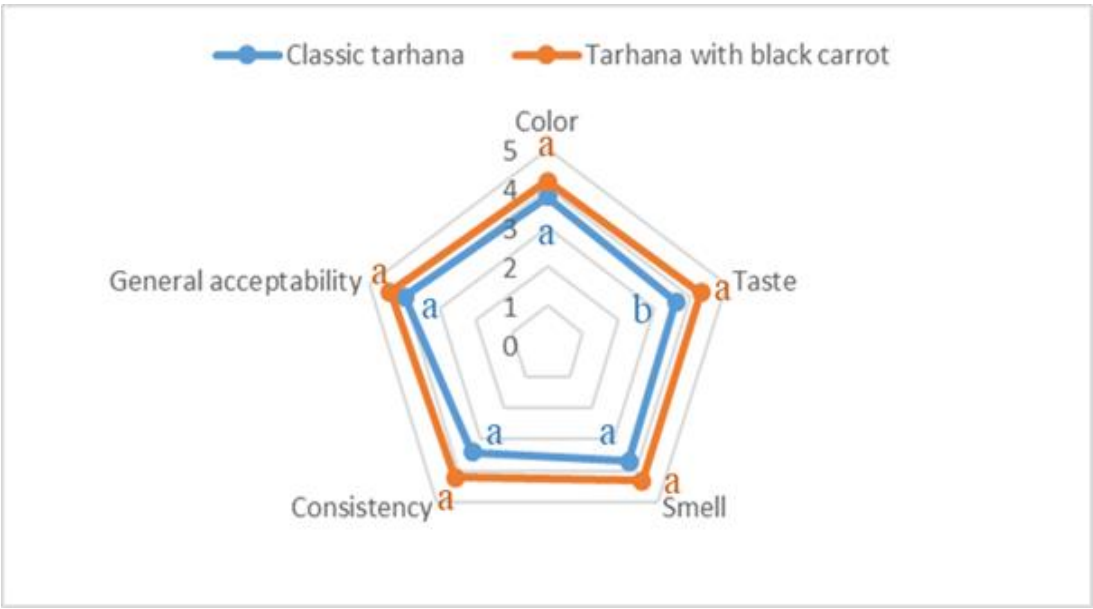

Figure 4. Sensory evaluation of tarhana with black carrot extract and classic tarhana.

4. Conclusions

This study shows that tarhana prepared with black carrot extract has a lower pH value and higher acidity in terms of lactic acid. Tarhana containing black carrot extract, which has a higher phenolic content than classical tarhana, shows a very high DPPH activity (4.21±1.78 mg/mL). At the same time black carrot extract contains a significant amount of anthocyanins (19.14±2.02 mg cyn3-glu/kg sample). According to color measurement and sensory analysis evaluations, the acceptability of tarhana containing black carrot extract was determined to be very high. These results lead to further studies on the importance of tarhana consumption containing black.

Compliance with Ethical Standards

Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' Contributions

Zuhal SAHIN: Validation, Writing - original draft., Methodology, Investigation, Conceptualization, Review and editing, Visualization, Formal analysis, Data curation. **Fatih SONMEZ**: Validation, Review and editing, Formal analysis, Data curation. Validation, Review and editing, Formal analysis, Data curation.

Ethical approval

Not applicable.

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Data availability

Not applicable.

Consent for publication

Not applicable.

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