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The Effect of Functional Component Grape Seed Powder on the Bioactive, Physicochemical, and Sensory Properties of Wild Cornelian Cherry (Cornus mas L.) and Blackthorn (Prunus spinosa) Fruit Leathers

Yabani Kızılcık (Cornus mas L.) ve Güvem Eriği (Prunus spinosa) Pestillerinin Biyoaktif, Fizikokimyasal ve Duyusal Özelliklerine Fonksiyonel Bileşen Üzüm Çekirdeği Tozunun Etkisi

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ABSTRACT

In this study, the aim was to produce functional fruit leathers using wild cornelian cherry and blackthorn enriched with grape seed powder added at different rates (0%, 1% and 10%). Some physicochemical, bioactive, color and sensory properties of the produced fruit leathers were investigated. According to the results for physicochemical features of fruit leathers, % ash amount was 1.68-2.00%, % dry matter was 82.75-91.03, protein amount was 3.52-5.71%, pH was 3.04-3.43. While dry matter values were statistically significant between samples, the fruit leather samples richest in terms of ash amount were cornelian cherry and blackthorn fruit leathers containing 10% grape seed powder. The highest protein values were determined for blackthorn fruit leather containing 10% grape seed powder. The total phenolic content of Cornelian cherry fruit leather samples was 90.7-1164.0 mg GAE/100 g, while blackthorn fruit leather samples contained 52.4-1545.6 mg GAE/100 g. Fruit leather samples were determined to have significant increases in antioxidant capacity. The highest antioxidant capacity was determined in blackthorn and cornelian cherry fruit leathers containing 10% grape seed powder with values of 1969.0 mg TE/100 g and 1463.3 mg TE/100 g according to the DPPH method and 7414.1 mg TE/100 g and 4982.4 mg TE/100 g according to the CUPRAC method, respectively. The phenolic content and antioxidant capacity of wild fruit leather significantly increased with the addition of grape seed powder. While grape seed powder added to the formulation thickened the samples, the redness of the cornelian cherry fruit leathers increased, while the blueness of blackthorn fruit leathers increased. In terms of sensory features, the general approval scores between fruit leathers were affected at a statistically significant level. The 10% grape seed proportion reduced sensory approval, while the 1% rate was liked more. The highest approval was obtained for cornelian cherry fruit leather containing 1% grape seed powder.

Key Words: Cornelian cherry, blackthorn, Fruit leather, Grape seed, Bioactive

ÖZ

Bu çalışmada, farklı oranlarda eklenen (%0, % 1 ve %10) üzüm çekirdeği tozu ile zenginleştirilmiş fonksiyonel yabani kızılcık ve güvem eriği pestilleri üretimi amaçlanmıştır. Üretilen pestillerin bazı fiziko-kimyasal, biyoaktif, renk ve duyusal özellikleri araştırılmıştır. Pestillerin fizikokimyasal özellikleri sonuçlarına göre % kül miktarları %1.68-2.00; % kurumadde değerleri82.75-91.03; protein miktarları %3.52-5.71; pH değerleri 3.04-3.43 arasında belirlenmiştir. % Kurumadde değerleri örnekler arasında istatistiki olarak önemli bulunurken, kül miktarları bakımından en zengin olan pestil örnekleri %10 üzüm çekirdeği içeren kızılcık ve güvem eriği pestillerinde olup, en yüksek protein değeri ise %10 üzüm çekirdeği tozu içeren güvem eriğinde belirlenmiştir. Kızılcık pestili örneklerinin toplam fenolik içeriği 90.7-1164.0 mg GAE/100 g aralığında, güvem eriği içeren pestil örneklerinde 52.4-1545.6 mg GAE/100g aralığında belirlenmiştir. Pestil örneklerinde en yüksek antioksidan kapasitesileri %10 üzüm çekirdeği tozu içeren güvem eriği ve kızılcık pestillerinde sırasıyla DPPH yöntemine göre 1969.0 mg TE/100 g ve 1463.3 mg TE/100 g, CUPRAC yöntemine göre ise 7414.1 mg TE/100 g ve 4982.4 mg TE/100 g olarak belirlenmiştir. Üzüm çekirdeği tozu ilavesi yabani meyveli pestillerin fenolik içeriğini ve antioksidan kapasitesini önemli derecede arttırdığı görülmüştür. Formülasyona ilave edilen üzüm çekirdeği tozu pestillerin rengini koyulaştırırken, kızılcık pestillerinde kırmızılığı arttırmış güvem eriklerinde ise maviliği arttırmıştır. Duyusal olarak pestiller arasında genel beğeni skorları istatistiki olarak önemli faklılıklar göstermiştir. %10 çekirdek oranı duyusal beğeniyi azaltmış olup %1 çekirdek içeren pestiller daha çok beğenilmiştir. En yüksek beğeni %1 çekirdek tozu içeren kızılcık pestillerinde skorlanmıştır.

Anahtar Kelimeler: Kızılcık, Güvem eriği, Pestil,Üzüm Çekirdeği, Biyoaktif bileşikler

Introduction

Wild fruits are considered very valuable nutrient sources due to containing several vitamins and minerals and having antioxidant features, though they are not consumed widely in many countries due to their sour and bitter taste (Sik et al., 2022). Wild fruits were determined to have higher nutritional quality compared to some other fruits (Akinnifesi et al., 2005). Easily degraded fruit can be converted into both economic and long-life products (da Silva Simão et al., 2020) by making fruit leather in a variety of types and shapes (Kara & Küçüköner, 2019; Tontul & Topuz, 2019). Fruit leather is a traditional product commonly produced in Türkiye, Armenia, Lebanon, Syria, Saudi Arabia and Iran. Fruit leathers, produced by drying under the sun, are prepared in the summer for winter consumption in several regions of Türkiye and have high vitamin, mineral and carbohydrate content (Suna et al., 2014). Fruit leather is generally made from grapes, but can also be made with several sweet or sour fruits (Kara & Küçüköner, 2019). Fruit leathers differ according to the variety and formulation used (Kaya & Kahyaoglu, 2005; Özbek, 2010; Yıldız et al.). Fruit from the Cornelian cherry (Cornus mas L.) (wild cornelian cherry) and blackthorn (Prunus spinosa) (blackthorn) appear to be perfect nutrient sources, significantly contributing to human nutrition and health. These fruits were determined to contain low fat proportions, and high rates of carbohydrates, vitamins, minerals, flavonoids and phenolic acids, along with antioxidant content (Igwe & Charlton, 2016; Stacewicz-Sapuntzakis et al., 2001). A study determined that blackthorn contains high rates of calcium, magnesium, iron, zinc and manganese (Ozzengin et al., 2023). These fruits have a dominant sour taste. As a result, they are processed for products like jam, marmalade and fruit leather (Celik et al., 2006). Due to additives like walnuts and hazelnuts used in fruit leather production, apart from fruit, the nutritional quality increases (Kara & Küçüköner, 2019; Özbek, 2010; Şengül et al., 2020).

Grape seeds have been the topic of many scientific studies and are recognized as being a functional nutrient supplement rich in terms of bioactive compounds with high antioxidant value. Additionally, grape seeds are an important waste material and use in the food industry appears to be an important solution to economic and environmental problems (Beres et al., 2016; Bogoeva & Durakova, 2020; Schuster et al., 2017). Though fruit leathers are generally made from grapes, grape seeds are not used in fruit leather production. Grape seeds have a bitter taste, which makes consumption difficult. In this study, the aim was to produce fruit leather with advanced nutritional and functional features and high consumer approval by enriching fruit leather made from wild Cornelian cherry and blackthorn fruit with grape seed powder.

Materials and Methods

The wild Cornelian cherry and blackthorn fruits used for fruit leather samples were collected from the slopes of Mount Istaranca in Kırklareli. Fruits were stored at +4 oC until processing.

Fruit Leather Production

In the first stage of fruit leather preparation, fruits were washed and cleaned of dirt, leaves and other matter. For fruit leather production, 15% sugar, 5% starch and 10% flour, with 1% and 10% grape seed powder substituted for flour in samples apart from the control sample, were used. Firstly, wild Cornelian cherry and blackthorn fruits had the seeds removed and were boiled with water and sugar. The grape seed powder was obtained by grinding in a grinder for 1 min. The seed powder, flour and starch were slowly added to the boiling mixture and continuously stirred. In the second stage, the boiled product was spread on trays to 1 mm thickness and then left to dry in room conditions for 3 days. Later the fruit leather samples were analysed. Six types of fruit leather samples were prepared; CC –wild Cornelian cherry control fruit leather, CGS1 – wild cornelian cherry fruit leather with 1% grape seed powder, CGS2 - wild cornelian cherry fruit leather with 10% grape seed powder, SC – blackthorn control fruit leather, SGS1– blackthorn fruit leather with 1% grape seed powder and SGS2 – blackthorn fruit leather with 10% grape seed powder (Figure 1).

Figure 1. Cornelian cherry and Blackthorn Fruit Leathers

Physicochemical Analyses

pH, % Moisture, % Ash and % Protein Analyses

Analyses of some physicochemical features (moisture, acidity, protein, ash) of fruit leather samples were performed according to the method reported in AOAC (2000). The moisture content of the samples was determined by drying them in a vacuum oven at 70°C for 3.5 hours. Ash values in samples were determined in an ash oven (Protherm, Türkiye) at approximately 550 °C. Protein content for fruit leathers used the Kjeldahl nitrogen detection method. Samples were prepared with distilled water at 10% w/v and measured with a pH meter (İnolab, WTWC pH 720).

Total Phenolic Matter, DPPH and CUPRAC Analyses

Extraction was completed according to the method of Jeandet et. al. (1992). A sample was homogenized with 80% methanol (6%, w/v) and later placed in an ultrasonic water bath for 10 minutes. The sample was then mixed continuously at 250 rpm for 1 hour in an orbital mixer, then incubated and finally strained through filter paper. TPC was calculated by the Folin-Ciocalteu method using a calibration curve of gallic acid. (Singleton et al., 1999). Absorbance was spectrophotometrically determined at 760 nm using a laboratory spectrophotometer (Shimadzu UV-1800, Kyoto 604–8511, Japan). Results are stated as gallic acid equivalent (GAE) on a dry matter basis (mg GAE/100 g). Antioxidant activity was determined using 2,2-diphenyl 1picrylhydrazyl radical scavenging activity (DPPH). Absorbance was read at 517 nm. DPPH Results were expressed in Trolox equivalent (TE) units (mg TE/100 g) (Nizamlioglu et al., 2022). Antioxidant capacity detection with CUPRAC was determined according to the method described by Apak et al. (2004). The absorbance of the mixture was measured spectrophotometrically at 450 nm (Shimadzu UV-1800, Japan). Results are stated using Trolox standard (mg TE/ 100 mg).

Color Analyses

Fruit leather samples had L* (white or sheen/darkness), a* (red/green) and b* (yellow/blue) values measured with a Hunter color measurement device (Chroma Meter CR-400, Konica-Minolta Sensing Inc., Osaka, Japan) (Maskan et al., 2002). The fruit leather samples were measured with the Hunter colorimeter for L*(whiteness or brightness/darkness), a* (redness/greenness) and b* (yellowness/blueness) values (Maskan et al., 2002).

Sensory Analysis

A sensory assessment was completed with 36 students from İstanbul Aydın University (semi-trained). A rating system from 1.0 to 7.0 was used for color/appearance, taste, hardness, stickiness and general acceptability (1= very bad, 7= perfect). Samples were coded with random 4-figure numbers and offered to panelists (Yavuz, 2019).

Statistical Analyses

Analyses were completed with 3 repeated samples. Mean ± standard deviation was calculated from three repeats. One-way analysis of variance and the Duncan multiple comparison test to differentiate between mean values were applied using the JMP 9 program. Significant differences between groups are reported at α=0.05 level.

Results and Discussions

Physicochemical Features of Fruit Leather Samples

The physicochemical features of fruit leather samples are given in Table 1. As the amount of grape seed powder in the formulation increased, significant increases in ash, protein and dry matter values were observed in the samples. When examined in statistical terms, grape seed powder added to the formulation and fruit variety caused statistically significant changes in the ash content of samples (P<0.05). For wild cornelian cherry fruit leathers, ash was 1.68-1.98%, protein 4.29-5.71% and for blackthorn fruit leathers, ash was 1.74-2.00%, protein 3.52-4.82%.

Table 1. Physicochemical properties of fruit leathers

Fruit leather sample	Ash %	Dry matter %	Protein %	pH	TA %
CC	1.68±0.05^{c}	82.75±0,77^{c}	4.29±0.04^{c}	3.04±0.0^{f}	1,52±0,03^{c}
CGS1	1.89±0.00^{b}	86.94±1,40^{b}	5.09±0.09^{b}	3.09±0.1^{e}	1.52±0.01^{c}
CGS2	1.98±0.00^{ab}	90.50±0,19^{a}	5.71±.0.01^{a}	3.20±0.0^{d}	1.53±0.12^{c}
SC	1.74±0.01^{c}	84.49±1,34^{c}	3.52±0.29^{d}	3.32±0.1^{c}	1,58±0,01^{b}
SGS1	1.90±0.01^{b}	88.04±0,49^{b}	4.28±0.05^{c}	3.35±0.0^{b}	1.59±0.01^{ab}
SGS2	2.00±0.03^{a}	91.03±0,45^{a}	4.82±0.11^{b}	3.43±0.0^{a}	1,61±0,02^{a}

*Değerler ortalama ± standart sapma (n = 3) olarak verilmiştir. İstatistiki analizler her sütun için kendi içinde yapılmıştır ve aynı sütundaki farklı harfler p <0.05 düzeyinde anlamlı olarak farklıdır.*Values are given as mean ± standard deviation (n = 3). Statistical analysis for each column was made within itself and the different letters in the same column are significantly different at p <0.05 level.

Dry matter were 82.75-90.50 % for wild cornelian cherry fruit leathers and from 84.49-91.03% for blackthorn fruit leathers. Among dry matter values, fruit leathers containing 10% grape seed powder were determined to have the highest values compared to other samples. A study reported that refined flour mixed with grape seed powder had significantly higher total dietary fiber (TDF), lipids, ash, protein and carbohydrate content than refined flour (Difonzo et al., 2023). The pH values of fruit leathers were significantly different (P<0.05). The highest pH was observed in the SGS2 sample containing 10% grape seed powder.

Total Phenolic Matter and Antioxidant Features

The total phenolic matter and antioxidant features of fruit leather samples are given in Table 2. The addition of grape seed powder was determined to provide a statistically significant increase in the total phenolic matter content of samples (P<0.05). The minimum total phenolic matter amounts in samples were 90.7 mg GAE/100 g to 52.4 mg GAE/100 g for samples only containing wild fruit. Maximum values were observed in CGS2 and SGS2 samples containing 10% grape seed powder with values of 1164.0 mg GAE/100 g and 1545.6 mg GAE/100 g, respectively. A study by Kamiloglu and Capanoglu (2014) reported the total phenolic matter amounts in grape, white mulberry, apricot and plum fruit leathers were 72 mg GEA/100 g, 28 GEA/100 g, 481 GEA/100 g and 1015 GEA/100 g, respectively.

Table 2. Total phenolic contence (TFC), antioxidant activity (DPPH, CUPRAC) of the fruit leathers

Analyses	CC	CGS1	CGS2	SC	SGS1	SGS2
TFC (mg GAE/100 g)	90.7±1.42^{d}	1076.5±3.51^{c}	1164.0±5.25^{b}	52.4±0.73^{e}	1059.0±7.00^{c}	1545.6±3.30^{a}
DPPH (mg TE/100 g)	106.8±2.62^{d}	1029.5±8.20^{c}	1463.3±5.50^{b}	113.5±0.03^{d}	1204.6±1.44^{c}	1969.0±5.20^{a}
CUPRAC (mg TE/100 g)	2365.4±26.7^{d}	4812.6±19.4^{ab}	4982.4±17.0^{b}	1531.4±0.7^{e}	4479.2±0.3^{c}	7414.1±21.5^{a}

*Values are given as mean ± standard deviation (n = 3). Statistical analysis for each row was made within itself and the different letters in the same row are significantly different at p <0.05 level. *Değerler ortalama ± standart sapma (n = 3) olarak verilmiştir. İstatistiksel analiz her sütun için kendi içinde yapılmıştır ve aynı sütundaki farklı harfler p <0.05 düzeyinde anlamlı olarak farklıdır.

The DPPH values of fruit leather samples are given in Table 2. The CC, CGS1 and CGS2 samples had values ranging from 106.8-1463.3 mg TE/100g, while SC, SGS1 and SGS2 samples had values from 113.5-1969.0 mg TE/100 g. The DPPH values of fruit leather samples enriched with grape seed powder were statistically significantly different compared to fruit leathers in the control group (P<0.05). The CUPRAC values for fruit leather samples were 2365.4-4982.4 mg TE/100 g for CC, CGS1 and CGS2 samples and 1531.4-7414.1 mg TE/100 g for SC, SGS1 and SGS2 samples. Just as with the DPPH values, an increase was observed in CUPRAC values with the addition of grape seed powder to the formulation and the difference was determined to be significant in statistical terms (P<0.05). A study reported that the DPPH values for grape, white mulberry, apricot and plum fruit leathers were 75 mg TE/100 g, 28 TE/100 g, 169 TE/100 g and 1147 TE/100 g, respectively (Kamiloglu & Capanoglu, 2014).The blackthorn fruit leathers were determined to have higher total phenolic matter and antioxidant values compared to wild cornelian cherry fruit leathers. The total phenolic matter and antioxidant features of fruit leather samples are given in Table 2. The addition of grape seed powder was determined to provide a statistically significant increase in the total phenolic matter content of samples (P<0.05). The minimum total phenolic matter amounts in samples were 90.7 mg GAE/100 g to 52.4 mg GAE/100 g for samples only containing wild fruit. Maximum values were determined in CGS2 and SGS2 samples containing 10% grape seed powder with values of 1164.0 mg GAE/100 g and 1545.6 mg GAE/100 g, respectively. A study by Kamiloglu and Capanoglu (2014) reported the total phenolic matter amounts in grape, white mulberry, apricot and plum fruit leathers were 72 mg GEA/100 g, 28 GEA/100 g, 481 GEA/100 g and 1015 GEA/100 g, respectively.

Color Features of Fruit Leathers

The color analysis results for fruit leather samples are shown in Figure 2. The CC, CGS1 and CGS2 fruit leather samples had L* (sheen) values from 28.80 to 39.71, while SC, SGS1 and SGS2 samples varied from 28.65-36.66. leather. The increase in grape seeds in wild cornelian cherry fruit leather increased L* and a* values and increased the brightness and redness of the fruit leather (P<0.05). The l value of blackthorn leather containing 10% grape seed decreased and the a value increased. High grape seed usage resulted in leather with high redness and low brightness.

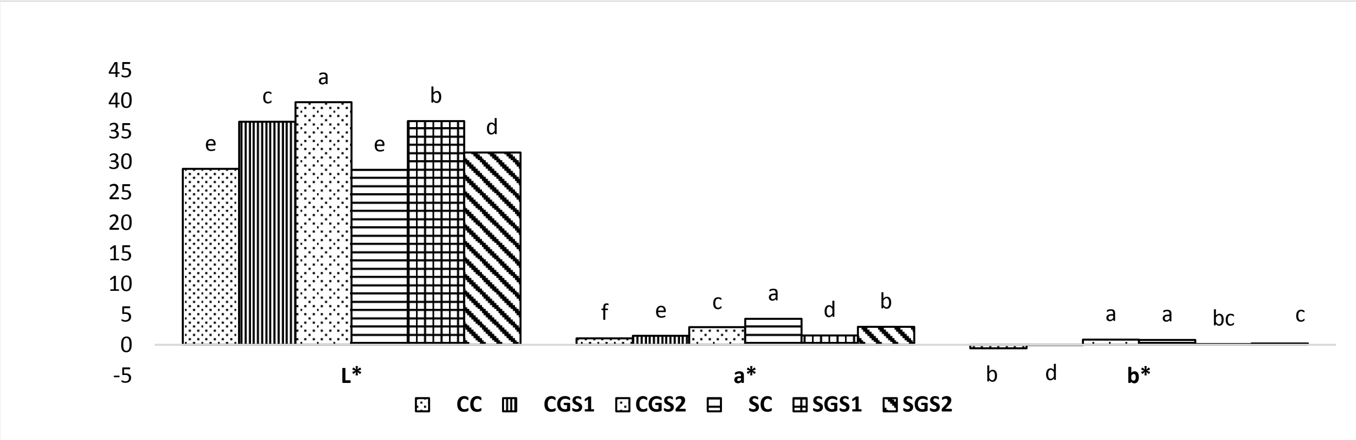

Figure 2. Color values (L*, a* and b*) of the fruit leathers

The addition of grape seed powder to the formulation caused a significant increase in the a* values of the wild cornelian cherry fruit leather and increased the redness (P<0.05). For the blackthorn fruit leather, the addition of grape seed powder caused samples to have lower redness than the control samples. For the b* (yellow-blue) parameter, the values were -0.56 to 0.86 for CC, CGS1 and CGS2 and 0.80-0.23 for SC, SGS1 and SGS2 fruit leathers. Blue was dominant for the wild cornelian cherry control sample, while the addition of grape seed powder caused a significant increase in the yellowness. The addition of grape seed powder to the blackthorn samples increased the b* values. A study found the L*, a* and b* values were 31.26, 0.98 and 14.59, respectively, for fresh blackthorn samples and reported the addition of grape seed powder to fruit leathers lowered the a* and b* values (Ozzengin et al., 2023). Another study obtained similar results for color values of fruit leathers with added grape seeds and pulp (Özaltın & Çağındı, 2023).

Sensory Assessment

The sensory analysis results for the fruit leather are given in Figure 3. There were statistically significant differences in the hardness, taste and general sensory points according to the grape seed powder proportion and fruit variety (P<0.05). There were reductions in scores linked to the increase in grape seed powder for both fruit varieties for the color, flavour, hardness, stickiness and general approval tests. The highest color scores were for the CC and SC samples. According to fruit variety, the color, taste, stickiness and general acceptability were similar to control samples for fruit leather samples containing 1% grape seed powder. Blackthorn fruit leathers received higher scores compared to wild cornelian cherry fruit leathers. Though the fruit leathers containing 10% grape seed powder received low scores, these were not below 3.5

and not at levels that could not be consumed.

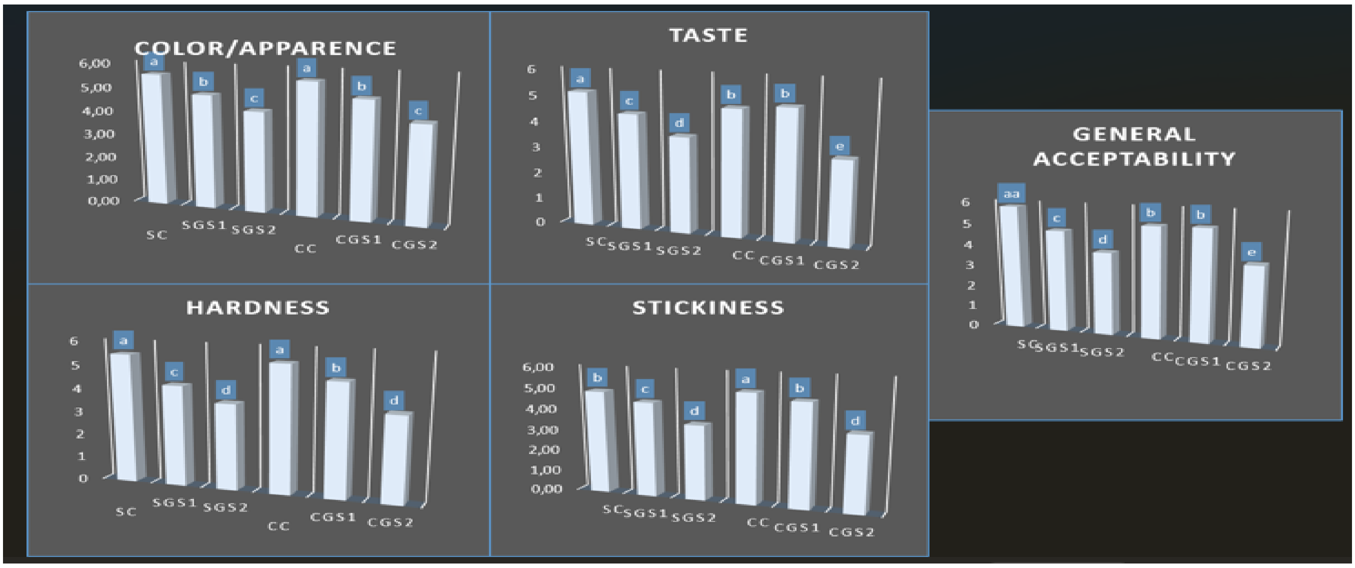

Figure 3. Sensory analysis results of cornelian cherry and blackthorn fruit leathers

Conclusions

The results show that these wild fruits had significant differences in physical, chemical and antioxidant features. The grape seeds appear to provide good bioactivity to the protein, phenolic matter and antioxidant features of wild fruit leather. Additionally, the wild fruit leather and low grape seed content received high consumer approval in sensory terms. The sweet snack of fruit leather gained stronger nutritional and health aspects. In conclusion, enrichment of wild cornelian cherry and blackthorn fruit leathers with grape seed powder elevated their nutritional and functional quality and these products gained the potential to have high added value.

Conflict of interest:

The authors declare that they have no conflict of interest.

Author contributions:

The authors declare that they contributed to the article at equal rates.

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