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Effect of peeling, filling medium, and storage on the antioxidant activity and phenolic compounds of canned figs (*Ficus carica* L.)

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Abstract

The fig fruit, which has a short seasonal availability due to its perishable nature, was subjected to a canning process, and the effects of canning on phenolics and antioxidant properties were evaluated. For this purpose, the most popular fig varieties grown in Türkiye, namely Sarilop (yellow coloured) and Bursa Siyahi (dark purple coloured), were canned in different filling mediums such as syrup, water, and fig juice, as peeled or unpeeled. The canned figs were also stored at room temperature for 12 months, and the changes in phenolics and antioxidant properties during storage were determined. The canning process preserved a great part of the phenolics and antioxidant capacity. After canning, the Sarilop figs experienced a minor reduction in their total phenolic content, whereas no significant change was observed in the total phenolic content of the Bursa Siyahi figs. The total antioxidant activity of the figs increased by canning, which was observed more clearly for the unpeeled Bursa Siyahi figs. At the end of the storage, both Sarilop and Bursa Siyahi figs canned with fig juice had higher total phenolics, total antioxidant activity, and individual phenolics than the figs canned with other filling mediums. During the 12-month storage period, the most stable phenolic compounds found in the canned figs were rutin and gallic acid. However, the monomeric anthocyanins of the Bursa Siyahi figs were negatively affected by the storage and canning process.

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Introduction

Fig (*Ficus carica* L.) is an important fruit for fresh and dry consumption due to its high nutritional value (Barolo *et al*., 2014). It is a good source for vitamins (C, B_1, and B_2) and minerals (potassium, calcium, magnesium, and iron), and also contains at least 17 types of amino acids, low sodium, and no fat (Solomon *et al*., 2006; Arvaniti *et al*., 2019). Antioxidant compounds such as phenolics, carotenoids, organic acids, and vitamin E are also present in fig (Arvaniti *et al*., 2019). Therefore, it has a high antioxidant capacity, and macro- and micronutrient elements in its structure which enable fig to be considered as one of the natural functional foods.

Fig has short seasonal availability (between August and September) for fresh consumption. Therefore, it is consumed in different forms, such as jam, marmalade, juice, paste, and dried fruit in order to increase its consumption and availability (Barolo *et al*., 2014; Arvaniti *et al*., 2019). Fig is mostly dried to increase its shelf-life, and the sun-drying method is widely used for this purpose; however, due to the slowness of this process, some problems occur such as loss of quality, fungal growth, and mycotoxin production (Villalobos *et al*., 2016). The phenolic compounds of figs are also affected negatively by the drying process. Kamiloğlu and Capanoğlu (2015) reported that sun-dried figs (Sarilop and B. Siyahi) had lower levels of total phenolics and antioxidant capacity as compared to fresh ones.

Instead of drying, canning can be a good thermal process for fig to be both available all year and protected from quality losses and mycotoxin production. Today, canning is one of the most widely used food preservation methods in the world. Many studies showed that canned foods had similar amounts of some nutrients (such as vitamins and minerals) like fresh or frozen foods. Recently, freezing and canning processes were reported to increase the carotenoid and phenolic contents of

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apricots (*Prunus armeniaca* L.), while drying caused a decrease as compared to fresh ones (Wani *et al*., 2020). The impacts of the canning process and storage period on the antioxidants or phenolic compounds of canned fruits, such as apricots (Campbell and Padilla-Zakour, 2013; Le Bourvellec *et al*., 2018; Adkison *et al*., 2018; Wani *et al*., 2020), peaches (Campbell and Padilla-Zakour, 2013), strawberries (Shikov *et al*., 2012), and pineapples and mangos (Arampath and Dekker, 2020) have been examined. However, there is a limited study on the canning of figs (Caetano *et al*., 2017; Curi *et al*., 2019), and no data are available concerning the impact of canning on the antioxidant capacity, individual phenolic compounds, and total phenolic content of figs. Therefore, our aim was to investigate the effects of the canning process and subsequent storage period on the antioxidant properties of figs. For this purpose, the Sarilop (yellow skin) and B. Siyahi (dark purple skin) fig varieties were canned in different filling mediums such as sucrose syrup, water, and fig juice, and the effect of these filling mediums on the individual phenolic compounds and antioxidant capacities of the figs were investigated. Besides, the figs were canned as peeled or unpeeled to understand how these properties were affected by peeling. The prepared canned figs were stored at room temperature for a year, and the changes in their phenolic compounds, antioxidant capacity, and total phenolic contents were evaluated throughout storage.

Materials and methods

Canning

The Sarilop and B. Siyahi fresh fig varieties were obtained from the Fig Research Institute (Aydın, Türkiye). The figs were harvested in August 2019 before they fully ripened (firm with full colour development). The figs were washed with cold water, and divided into two groups. One group was peeled by hand, and used for the preparation of peeled canned figs, while the other group was canned unpeeled. For canning, the peeled and unpeeled figs were placed into glass jars (0.660 L) separately. The weight of the figs in jars ranged between 240 - 280 g for B. Siyahi, and 250 - 290 g for Sarilop. Syrup (27.5 °Brix, sucrose), water, and fig juice (27.9 °Brix) were used as filling mediums for canning. Citric acid was added (0.7%) to each filling medium. The pH values of the filling mediums were 2.5, 2.35, and 3.67 for water, syrup, and fig juice, respectively. In order to remove the air in the jars including figs, the filling mediums were added at 60°C. The jars were closed and pasteurised at 90°C for 15 min using a boiler. Finally, the jars were subsequently cooled in running water until they reached room temperature. Before the storage process, the sterility test was conducted according to Cemeroğlu (2018). For this purpose, the canned samples were incubated at 55 and 37°C for 7 and 14 d, respectively. The jars were checked for leaks and bombings. Moreover, the fruit weight, drained weight ratio (%), pH, and °Brix of both the figs and filling mediums were determined for each sample, before and after incubation, as well as at regular intervals every 3 d during the 16-day period following the canning process. When the physico-chemical properties reached stable values, a 12-month storage period at room temperature (25°C) started for the canned samples. Further analyses were conducted at 0, 6, and 12 months.

Extraction of phenolic compounds

Before conducting the total phenolic and phenolic profile analyses, phenolic compounds were extracted from both fresh and canned figs, as well as from the filling mediums. The extraction method was modified from Sengul *et al*. (2014). Briefly, 2 g of ground fresh/canned fig sample or 6 g of filling medium were weighted into test tubes, and 6 mL of methanol-water solution (75:25, v:v) containing 0.1% HCl was added into tubes. The mixture was vortexed (IKA, Germany) for 1 min, and then kept for 15 min in an ultrasonic bath at 4°C (Ultrasonic Cleaner, VWR, USA). Finally, it was centrifuged (Universal 32, Hettich, Germany) at 4°C and 10,000 rpm for 15 min. This procedure was performed once for filling mediums, while it was performed twice for the fig samples. At the end of the centrifugation, the supernatants were filtrated using a 0.45 µm membrane filter, and the extracts were stored at -20°C until further analyses.

Total phenolic content (TPC)

The TPC of the samples was determined by the Folin-Ciocalteau method as described by Singleton and Rossi (1965). The calibration curve of gallic acid was used for the calculation of the TPC, and the results were given as mg gallic acid equivalents (GAE)/100 g fresh weight (FW).

Total antioxidant activity (TAA)

The Trolox equivalent antioxidant capacity (TEAC) method described by Re *et al*. (1999) was used for the determination of the TAA of the samples. ABTS radical cation ($ABTS^{\cdot+}$) was prepared by mixing ABTS and potassium persulfate solutions. The capacity of the samples to inhibit the $ABTS^{\cdot+}$ was compared with Trolox standard, and the results were given as µmol TEAC/100 g FW.

Total monomeric anthocyanin content (TMA)

The TMA of the samples were determined by the pH differential assay as explained by Giusti and Wrolstad (2001). The pigment contents were calculated based on cyanidin-3-glucoside with molecular weight of 445.2 and extinction coefficient of 29,600, and the results were given as mg/kg FW.

Phenolic profile

The major phenolics compounds of the fig samples were determined by HPLC (Shimadzu LC20A, Japan) consisting of a photo diode array (PDA) detector (Shimadzu, model SPD-M20A, Japan). The separation of the analytes was performed on a Macherey-Nagel C_{18} column (4.6 × 250 mm, 5 µm; Germany) with column temperature of 40°C. The flow rate was at 0.4 mL/min. The gradient elution (2% (v/v) acetic acid: methanol) was applied as follows: at 0 min, 95:5; at 10 min, 50:50; at 15 min, 30:70; and at 25 min, 95:5 (Nakilcioğlu and Hışıl, 2013). The quantification was carried out using calibration curves of external standards (chlorogenic acid, gallic acid, syringic acid, (-)-epicatechin, and rutin), and the results were given as mg/100 g FW.

Statistical analysis

The canning process was carried out in triplicates for each fig variety, and all analyses were performed in duplicates. The analysis results of the fresh figs and filling mediums were statistically evaluated using One-way analysis of variance (ANOVA). On the other hand, the results of the canned samples were statistically analysed using factorial variance analysis in order to observe the effects of the filling medium, storage time, and peeling. The statistical analyses were performed with Minitab statistical software (Version 19, Minitab Inc., USA), and significant differences were determined by the Tukey multiple comparison test ($p < 0.05$). The results were further processed with Principal Components Analysis (PCA) to detect the clustering formation, and establish the relationships for the phenolic compounds of canned samples. The PCA results were displayed as biplot graphics to highlight the interactions between the samples and variables.

Results and discussion

Antioxidant properties and phenolic compounds of fresh figs

Before the canning process, the total phenolic content (TPC), total antioxidant activity (TAA), total monomeric anthocyanin (TMA) contents, and concentrations of individual phenolic compounds of both peeled and unpeeled fresh Sarilop and B. Siyahi fig varieties were determined, and the results are shown in Table 1. The differences between the fig samples were evaluated statistically for each property ($p < 0.05$).

The TPC of the peeled and unpeeled Sarilop (yellow coloured) and B. Siyahi (dark purple coloured) fig varieties ranged between 59.71 and 88.73 mg GAE/100 g fresh fruits. Our results were in accordance with other studies (Sanchez *et al*., 2003; Slatnar *et al*., 2011; Ercisli *et al*., 2012). The presence of the peel for the same fig variety yielded a significant increase in TPC ($p > 0.05$). Higher contents of total phenolics were also reported in skin (19.1 - 140.2 mg/100 g) than in pulp (0 - 11.3 mg/100 g) of 18 fresh fig varieties grown in Spain (Vallejo *et al*., 2012). Although black coloured fig varieties were reported to have higher TPC previously (Solomon *et al*., 2006; Slatnar *et al*., 2011; Ercisli *et al*., 2012), there were no significant difference in the TPC of the yellow coloured Sarilop and dark purple coloured B. Siyahi varieties ($p > 0.05$).

The TEAC values of the peeled and unpeeled fig varieties ranged between 98.59 - 125.07 µmol Trolox/100 g FW. Our results were within the ranges reported by Ercisli *et al*. (2012) (36 - 623 µmol Trolox/100 g FW) and Solomon *et al*. (2006) (25 - 716 µmol Trolox/100 g FW). Unlike the TPC, there was no significant difference in the TEAC values of the peeled and unpeeled samples ($p > 0.05$). Also, no statistical difference was found between the TEAC values of the yellow coloured Sarilop and dark purple coloured B. Siyahi varieties ($p > 0.05$). Similarly, previous studies by Faleh *et al.* (2012) on dried figs and Harzallah *et al.* (2016) on various fruit parts of different fig varieties (green, black, and purple) in Tunisia reported no significant differences in antioxidant activity between the green and red

varieties of dried figs and different fruit parts, respectively.

The total anthocyanin content of fig is highly affected by genotype. As expected, anthocyanins could not be detected in the Sarilop samples which were yellow skin coloured. The TMA contents of the B. Siyahi variety were 10.44 (peeled) and 31.13 (unpeeled) mg/kg FW. Ercisli *et al*. (2012) reported similar TMA contents (0 - 42 mg/kg FW) for 24 local fig genotypes and varieties grown in north-western Turkey. The unpeeled samples had three times higher total anthocyanin level than the peeled ones. Also, Solomon *et al*. (2006), who investigated the TMA contents of some commercial fig varieties, found that anthocyanin contents of fruit skins were higher than those of fruit pulps, and that the amount of anthocyanins ranged from 3 - 110 mg/kg.

In the present work, epicatechin, chlorogenic acid, gallic acid, syringic acid, and rutin were determined using HPLC in the fresh Sarilop and B. Siyahi figs (Table 1). Similarly, rutin, epicatechin, gallic acid, chlorogenic acid, and quercetin were reported as the dominant fig phenolic compounds (Arvaniti *et al*., 2019; Palmeira *et al*., 2019). The concentrations of all phenolic compounds analysed were higher in the unpeeled samples than the peeled ones for B. Siyahi, while it was not valid for the Sarilop figs. Similarly, Del Caro and Piga (2008), who investigated phenolics in peel and pulp of two varieties of Italian fresh figs (one black and one green), found that phenolics were concentrated mainly in the peel, and that the black fig variety had the highest phenolic content. The major phenolic component was determined as rutin for the unpeeled Sarilop and B. Siyahi figs. For both varieties, the rutin concentrations of the unpeeled samples were statistically higher than those of the peeled samples ($p < 0.05$), and the lowest value was found for the peeled B. Siyahi as 2.17 ± 0.64 mg/100 g. Ammar *et al*. (2015) and Faleh *et al*. (2012) evaluated the distribution of phenolic components in the pulp and peel of Tunisian figs, and found that rutin was the major phenolic compound both in the pulp and peel. Similar to our results, Del Caro and Piga (2008) reported that the peel of the two varieties of Italian fresh figs was rich in rutin as compared to the pulp of the fruits. Palmeira *et al*. (2019) also reported that rutin was the major phenolic in Portuguese fig. The concentrations of epicatechin in the B. Siyahi samples were higher than Sarilop ($p < 0.05$), and the unpeeled B. Siyahi had the highest value (27.76 mg/100 g). Concerning gallic acid, the highest value was also observed in the unpeeled B. Siyahi (1.84 ± 0.44 mg/100 g), while there was no significant difference between the other samples (0.22 - 0.54 mg/100 g, $p > 0.05$). The Sarilop samples had higher syringic acid concentrations than the B. Siyahi samples; however, no difference was observed statistically between the B. Siyahi samples ($p > 0.05$). For chlorogenic acid, there were no statistical difference between the peeled samples ($p > 0.05$), and the unpeeled sample of the Sarilop variety had a higher value (6.27 mg/100 g) than B. Siyahi (4.39 mg/100 g). Similar to our results, Vallejo *et al*. (2012) found that in 18 fresh fig varieties cultivated in Spain, the skin of the figs exhibited higher chlorogenic acid contents, ranging from 2.5 - 5.8 mg per 100 g, as compared to the pulp, which contained chlorogenic acid levels ranging from 0.1 - 0.6 mg per 100 g.

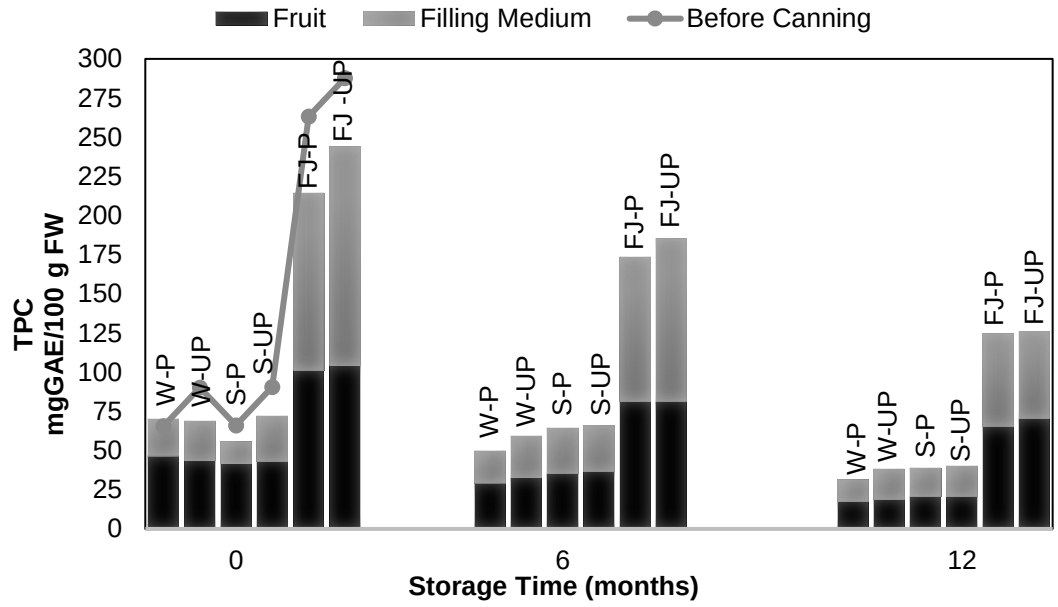
Table 1. Antioxidant properties of peeled and unpeeled fresh fig cultivars.

	Sarilop		**Bursa Siyahi**	
	Peeled	**Unpeeled**	**Peeled**	**Unpeeled**
Antioxidant property				
TPC (mg GAE/100 g FW)	59.71 ± 6.95^{b}	88.73 ± 9.98^{a}	62.88 ± 8.90^{b}	80.26 ± 1.34^{a}
TAA (µmol TEAC/100 g FW)	98.59 ± 1.02^{a}	125.07 ± 15.79^{a}	106.72 ± 18.74^{a}	119.45 ± 17.54^{a}
TMA (mg/kg FW)	-	-	10.44 ± 3.99	31.13 ± 1.05
Phenolic compound (mg/100 g FW)				
Epicatechin	11.99 ± 0.22^{c}	6.00 ± 0.87^{d}	18.83 ± 3.16^{b}	27.76 ± 1.94^{a}
Chlorogenic acid	1.77 ± 0.39^{c}	6.27 ± 1.39^{a}	2.96 ± 0.62^{bc}	4.39 ± 0.35^{b}
Syringic acid	17.42 ± 0.83^{a}	14.66 ± 1.48^{b}	1.92 ± 0.27^{c}	2.37 ± 0.34^{c}
Gallic acid	0.54 ± 0.01^{b}	0.22 ± 0.02^{b}	0.53 ± 0.06^{b}	1.84 ± 0.44^{a}
Rutin	13.93 ± 0.54^{b}	29.78 ± 4.63^{a}	2.17 ± 0.64^{c}	35.96 ± 6.35^{a}

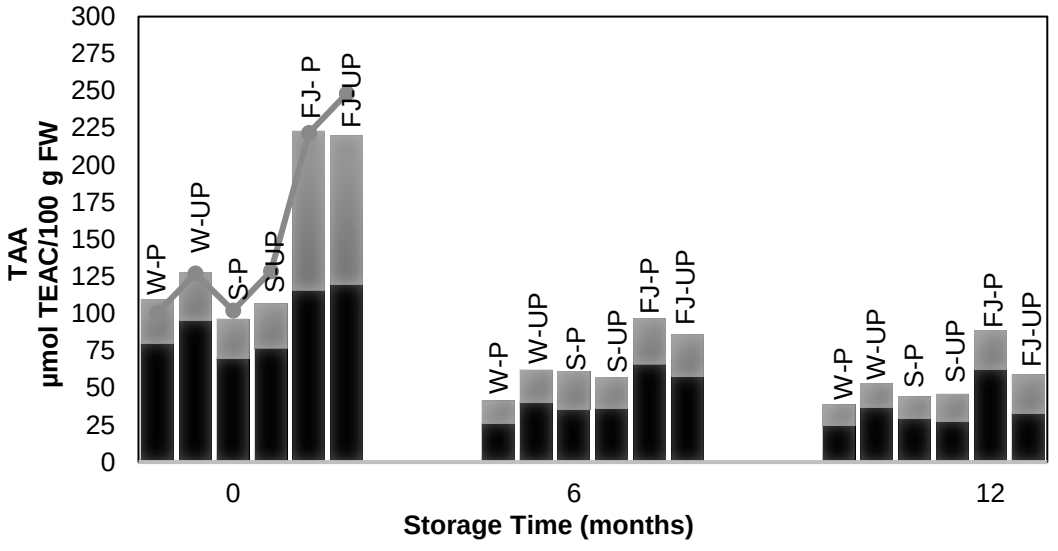
Values are mean ± standard deviation ($n = 6$). Different lowercase letters in the same row indicate significant differences (ANOVA, $p < 0.05$).

Effects of canning and storage on antioxidant properties of figs

The TPC, TEAC, and TMA of the canned Sarilop and B. Siyahi figs, both before and after canning, as well as during the 12-month storage period, are shown in Figures 1 and 2, respectively. The analyses were performed in the fruits and filling mediums separately, and the results were given as the sum of the content or value of the filling medium and the fruit. The TPC and TEAC values of the filling mediums before canning were also determined. The TPC values were 1.09 ± 1.00, 1.41 ± 0.87, and 202.32 ± 15.72 mg GAE/100 g, while the TEAC values were 1.87 ± 0.49, 3.59 ± 1.16, and 121.25 ± 7.06 µmol Trolox/100 g for water, syrup, and fig juice, respectively. The sum of the TPC or TEAC values of the fresh fig samples and initial filling medium were expressed as "Before Canning" (Figures 1 and 2).



(a)



(b)

Figure 1. (a) TPC and **(b)** TAA of canned Sarilop figs during storage. W-P: water-peeled; W-UP: water-unpeeled; S-P: syrup-peeled; S-UP: syrup-unpeeled; FJ: fruit juice peeled; and FJ-UP: fruit juice unpeeled.

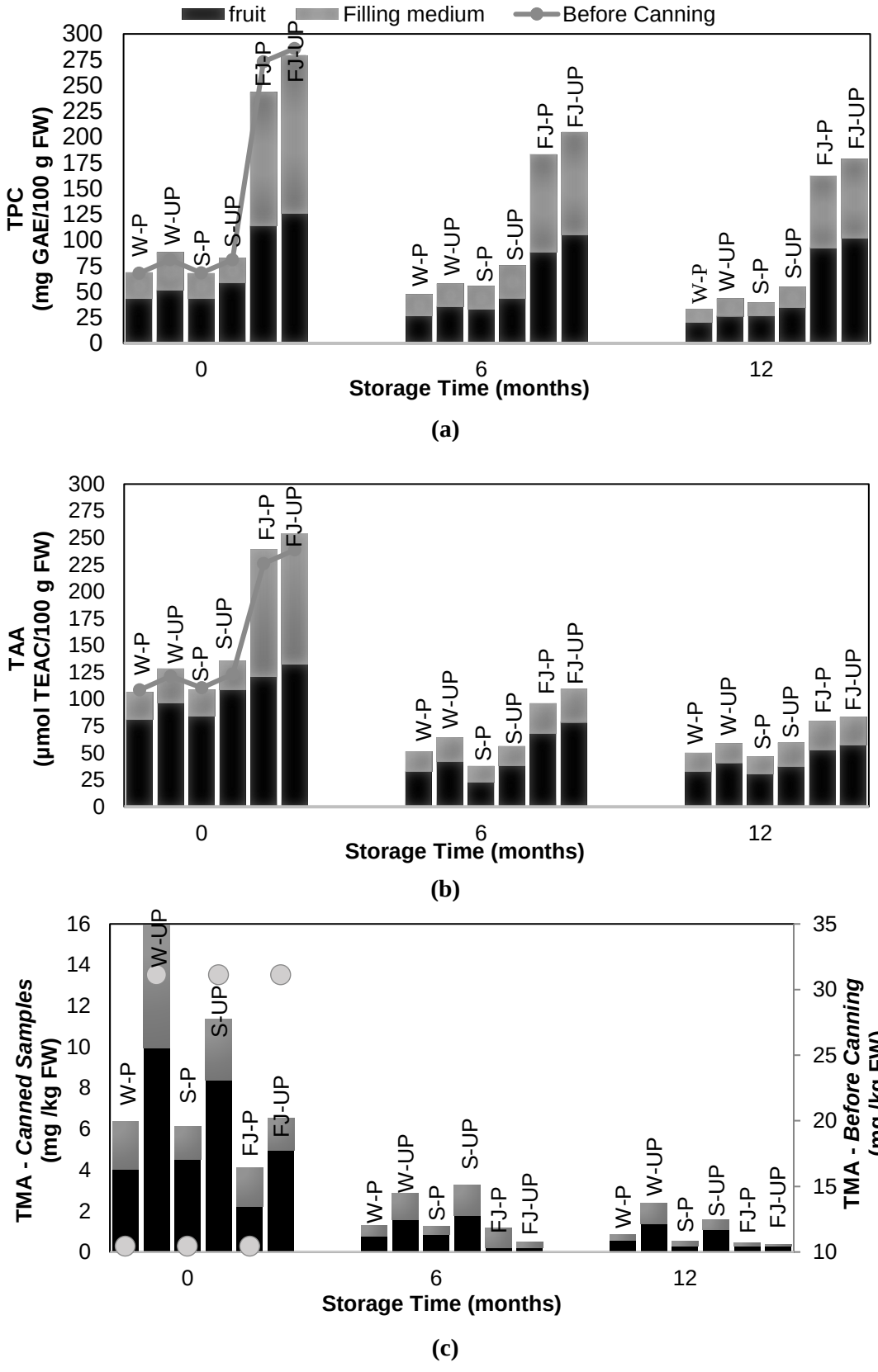


Figure 2. (a) TPC, **(b)** TAA, and **(c)** TMA of canned Bursa Siyahi figs during storage. cyn-3-gly: cyanidin-3-glycoside; W-P: water-peeled; W-UP: water-unpeeled; S-P: syrup-peeled; S-UP: syrup-unpeeled; FJ-P: fruit juice peeled; and FJ-UP: fruit juice unpeeled.

Total phenolic content (TPC)

The TPC of both canned Sarilop and B. Siyahi figs were significantly affected by the factor's 'peel' and the interaction 'filling medium × storage time' ($p < 0.05$). The TPC of the unpeeled canned figs were significantly higher than those of the peeled canned figs for both varieties ($p < 0.05$). Similar to our results, Campbell and Padilla-Zakour (2013) found that peeling and variety had a significant effect on total concentration of phenolics in canned peach and apricots. As expected, among the canned figs, the B. Siyahi figs in unpeeled form, canned with fig juice, exhibited the highest TPC, significantly surpassing the TPC observed in the other filling mediums (water and syrup). Furthermore, a decrease (15 - 18%) in the TPC was observed after the canning process of the Sarilop fig, while there was no significant change in the TPC of the B. Siyahi fig. Similarly, the canning process of apricots caused significant losses of total phenolics from 13% ('Hargrand' apricot) to 47% ('Iranien' apricot) (Le Bourvellec *et al*., 2018). On the other hand, Chaovanalikit and Wrolstad (2004) found that there was an increase in the TPC after the canning of cherries which was explained by the increased extraction efficiency of phenolics. We also monitored the levels of total phenolics in the filling mediums after canning and during storage. As seen in Figure 2, the TPC of the canning water and syrup increased, while the TPC of canning fig juice decreased (about 50%) after canning. Similar trends were reported for various canned fruits. For example, Chaovanalikit and Wrolstad (2004) found that half of the polyphenolics leached into the syrup with the canning of cherries. Also, Campbell and Padilla-Zakour (2013) observed a substantial diffusion of phenolic compounds into the syrup, accounting for more than 30% of the total phenolics, during the canning process of peaches and apricots. These results indicated that if the filling medium of canned fruits was discarded, significant losses of phenolic compounds would occur. Therefore, our findings strongly support the consumption of both the canned figs and the filling medium to maximise the intake of phenolic compounds.

As expected, the TPC of all canned figs decreased as the storage time increased. After 6- and 12-month storage, the TPC of the canned Sarilop figs decreased by 25 - 35 and 50 - 60%, and the TPC of the canned B. Siyahi figs decreased by 20 - 30 and 40 - 50%, respectively. Consistent with our findings, 30 - 43% losses in the TPC of canned peach were observed after 3-month storage (Hong *et al*., 2004). When the figs canned with water and syrup were evaluated separately for 6- and 12-month storage, no statistically significant difference was found between them ($p > 0.05$). Also, there was a significant effect of the peel on the TPC during storage (Figure 2a). Similar to our study, Campbell and Padilla-Zakour (2013) observed that the TPC of canned peach and apricot decreased during storage, and that losses in TPC were greater in peeled canned peaches (38%) and apricots (24%) as compared to unpeeled canned peach (30%) and apricots (20%) after 6-month storage. Both Sarilop and B. Siyahi figs canned with fig juice had higher TPC than the figs canned with other filling mediums at the end of 12-month storage.

Total antioxidant activity (TAA)

The canning process increased the TAA of the figs, which was observed more clearly for the unpeeled B. Siyahi figs than the Sarilop figs. The increase in the TPC of the unpeeled canned B. Siyahi figs with water, syrup, and fig juice were 5.8, 10, and 6.3%, respectively. The effect of peel on the TAA of the canned Sarilop figs was different for each filling medium. After the canning process, the TAA of the Sarilop figs canned with water slightly increased (0.4 - 9.1%), while a decrease (5.8 - 16.9%) occurred in the TAA of the figs canned with syrup. There was also a decrease (11%) in the TAA of the unpeeled Sarilop figs canned with fig juice; however, no change in the TAA values was observed for the peeled canned samples. Antioxidant compounds can be oxidised and degraded by thermal treatment, and characteristics such as cultivar, heating temperature, and time can influence the stability of compounds (Rickman *et al*., 2007). There are also some studies reporting an increase or no change in TAA after canning (Choi *et al*., 2006; Chen *et al*., 2015). The extractability of antioxidant compounds might be changed by heat treatment due to the disruption of the plant cell wall. Also, non-enzymatic reaction products having antioxidant capacity, such as melanoidins, can be formed during heat treatment (Rufián-Henares and Morales, 2007; Chen *et al*., 2015), and their formation might contribute to the antioxidant capacity of figs during the canning process.

Based on the factorial variance analysis of the TAA values of the canned Sarilop figs, the interactions between storage time and filling medium, as well as between peel and filling medium, were

found to be significant ($p < 0.05$). Across all filling mediums, the TAA values showed a significant decrease during the first 6-month storage ($p < 0.05$). However, for water, no significant difference was observed between the samples stored for six and 12 months ($p > 0.05$). The TAA of the canned Sarilop figs decreased in the range of 51 - 65 and 60 - 76% after 6- and 12-month storage, respectively. The effect of the peeling, and the interaction between storage time and filling medium on the TAA of the B. Siyahi figs were found to be statistically significant ($p < 0.05$). The decrease in the TAA values during first 6-month storage was also significant for all filling mediums ($p < 0.05$). In the second 6-month storage, no significant losses were observed in the samples canned with water and syrup; however, the TAA of the samples canned with fig juice continued to decrease. After 6- and 12-month storage, the TAA of the B. Siyahi figs decreased in the range of 47 - 65 and 55 - 65%, respectively. No statistical difference was detected between the samples canned with syrup and water during the storage period in terms of TAA ($p > 0.05$). Similar to the TPC results, despite the significant decrease in TAA after storage for six months, both Sarilop and B. Siyahi figs canned with fig juice had the highest TAA values (Figure 1b). Differently from the results of our study, Shikov *et al*. (2012) observed an increase in the TAA values of canned strawberry after storage for 12 months, which was explained by Maillard reaction products. Additionally, no significant change was found in the antioxidant capacity of blackberries canned in syrup and water during storage at 25°C for six months (Hager *et al*., 2008).

Total monomeric anthocyanin (TMA) content

After the canning process, the TMA content of the B. Siyahi figs decreased for the peeled and unpeeled samples by 39.0 and 48.7%, 41.1 and 62.3%, and 70.3 and 78.0% for water, syrup, and fig juice, respectively. As seen, higher losses in TMA content were observed in the unpeeled canned figs as compared to the peeled canned ones, and the highest loss occurred in the fruits canned with fig juice. These results demonstrated that water as a filling medium preserved the monomeric anthocyanins in the canned figs better as compared to the syrup and fig juice. The thermal degradation products of sucrose in syrup and other components in the fig juice might have caused the decrease in the monomeric anthocyanins. On the other hand, there are some studies on various fruits demonstrating opposite trends. For example, Hager *et al*. (2008) reported higher losses in the TMA content of blackberries canned with water (17.8%) as compared to those canned with syrup (10.5%); while Chaovanalikit and Wrolstad (2004) observed a slight increase in the TMA content of cherries after canning with syrup (19 °Brix). The stability of anthocyanin pigments is known to be dependent on various factors including pH, temperature, light, metal ions, enzymes, oxygen, ascorbic acid, and sugars (Mazza and Minitiati, 1993). The analysis of the filling mediums after canning revealed that migration of anthocyanins from the figs to the filling mediums took place, with approximately 26 - 38% of anthocyanins transferring from the fruit into the filling mediums. This phenomenon could be attributed to the increased extraction efficiency of anthocyanins in the softened figs, a phenomenon also observed by Chaovanalikit and Wrolstad (2004) during the canning of cherries, where around half of the anthocyanins leached into the syrup. Similarly, Hager *et al*. (2008) reported a significant transfer of monomeric anthocyanins (21 - 33%) into the filling mediums (water and syrup) after the canning of blackberries.

The change in the TMA content of the B. Siyahi figs during storage is shown in Figure 2c. The storage time, the interaction between peel and storage time, and the interaction between filling medium and peel were found to be significant ($p < 0.05$). The TMA content of all samples decreased significantly during the first 6-month storage ($p < 0.05$), but there was no significant change in the second 6-month storage ($p > 0.05$). The TMA content in the fresh figs decreased for the peeled and unpeeled samples by 87.60 and 90.84%, 88.16 and 89.57%, and 88.61 and 98.41% for water, syrup, and fig juice, respectively, after 6-month storage (Figure 2c). The decrease in the TMA content during storage was also higher for the unpeeled samples as compared to the peeled ones. As expected, it was observed that the unpeeled canned samples had higher TMA content than the peeled canned samples during storage ($p < 0.05$). The statistical evaluation demonstrated that the figs canned with water and syrup had higher TMA values. Differently from the TPC and TAA values, the figs canned with water (at 0 and after 12 months) and syrup (after 6 months) had the highest TMA content. The difference between the fig juice and the other filling mediums were found to be significant, except for 12 months. This difference was probably due to

the higher losses that occurred in the TMA content after the canning process for the samples filled with fig juice as compared to the other filling mediums. Even though higher TPC and TAA values were obtained in the figs canned with fig juice, the anthocyanin stability could not be protected. At the end of the storage period, higher than approximately 90% of anthocyanins were lost. Previous studies on various fruits demonstrated similar trends. For example, Yoshimura *et al*. (1997) reported 46% losses for canned plums stored at 30°C for 47 days. Similarly, dramatic losses in monomeric anthocyanins were found during the storage of canned blackberry at 25°C (Hager *et al*., 2008). Higher losses in TMA content were reported for blackberries canned in syrup (65.8% loss) than those canned in water (60.6% loss). Also, 42% loss was observed in TMA content of canned cherries after 5-month storage at 22°C (Chaovanalikit and Wrolstad, 2004).

Effects of canning and storage on phenolic compounds of figs

The concentrations of epicatechin, gallic acid, syringic acid, rutin, and chlorogenic acid of the canned samples (of fruits and filling mediums, separately) during 12-month storage at 25°C were determined, and the results are presented in Table 2. Before the canning process, the concentrations of epicatechin, chlorogenic acid, syringic acid, rutin, and gallic acid of the fig juice used as a filling medium in canning were also determined, and their concentrations were 122.64, 22.82, 27.28, 43.32, and 9.96 mg/100 g FW, respectively. As expected, canning fig with fig juice caused a great increase in phenolic compounds; thus, the figs canned with fig juice had the highest epicatechin, chlorogenic acid, syringic acid, gallic acid, and rutin concentrations (as the sum of the fruit and filling medium), both after canning and storage.

Canning differently affected the individual phenolic compounds of the Sarilop and B. Siyahi figs. In general, after the canning of Sarilop figs, there was a significant increase in epicatechin, chlorogenic acid, and gallic acid concentrations, whereas the concentration of syringic acid did not change, and the rutin concentration decreased as compared to the initial values. However, after the canning of the B. Siyahi figs, the concentrations of chlorogenic acid, gallic acid, and syringic acid increased, while the concentrations of epicatechin and rutin decreased. The reason of the increase can be explained by the fact that phenolic compounds are more easily released and extracted with heat treatment, as mentioned earlier. On the other hand, according to Oliveira *et al*. (2012), there were no significant changes observed in individual phenolic compounds of peaches that underwent heat treatment at 90°C. All phenolic compounds of the canned figs were statistically evaluated by factorial variance analysis. For the canned Sarilop figs, the interaction between peel, filling medium, and storage period was found to be significant for epicatechin, chlorogenic acid, syringic acid, and rutin concentrations ($p < 0.05$). Concerning epicatechin, after the canning process, there was a slight increase (23 - 31%) in the peeled Sarilop samples canned using water and syrup, while a much higher increase (about 2.8 times of initial value) was observed in the unpeeled samples. Heat treatment applied in canning might have enhanced the release and extractability of epicatechin, especially from the peels. During the storage of the canned samples, there was a dramatic decrease in the epicatechin concentrations of the unpeeled Sarilop samples canned with water and syrup. At the end of 6-month storage, epicatechin decreased by 82 - 91 and 92 - 95% in the peeled and unpeeled samples canned with water and syrup, respectively. However, a lower decrease (about 65%) was observed in both peeled and unpeeled samples canned with fig juice. Therefore, we can state that epicatechin was more stable in the Sarilop samples canned with fig juice during storage. Similar to our results, epicatechin exhibited a significant decrease (83%) in heat-treated peaches during the first 18-day storage at 22°C (Oliveira *et al*., 2012).

The presence of the peel did not affect the chlorogenic acid concentration of the Sarilop samples canned with water and syrup (6.7 - 8.9 mg/100 g FW, sum of fruit and filling medium) significantly; however, the unpeeled figs canned with fig juice had higher values (31.4 mg/100 g) than the peeled ones (28.4 mg/100 g). As seen in Table 2, the chlorogenic acid concentration increased by canning in all Sarilop samples, but the increase in the peeled samples canned with water and syrup was much higher than the other samples. During storage, the chlorogenic acid concentration of all canned samples decreased as the storage time increased. There were 52.1 - 73.7 and 84.7 - 92% losses in the chlorogenic acid concentration of the canned Sarilop samples at the end of 6- and 12-month storage, respectively. However, Oliveira *et al*. (2012) reported that the level

Table 2. Concentrations of phenolic compounds in unpeeled and peeled canned Sarilop and Bursa Siyahi figs during storage (mg/100 g FW).

	Storage time (month)		Sarilop						Bursa Siyahi					
			Peeled			Unpeeled			Peeled			Unpeeled		
			Water	Syrup	Fig Juice	Water	Syrup	Fig Juice	Water	Syrup	Fig Juice	Water	Syrup	Fig Juice
Epicatechin	B.C.	Fruit	11.99 ± 0.2	11.99 ± 0.2	11.99 ± 0.2	6.00 ± 0.8	6.00 ± 0.8	6.00 ± 0.8	18.83 ± 3.1	18.83 ± 3.1	18.83 ± 3.1	27.76 ± 1.9	27.76 ± 1.9	27.76 ± 1.9
		F.m.	-	-	122.64 ± 15.8	-	-	122.64 ± 15.8	-	-	122.64 ± 15.8	-	-	122.64 ± 15.8
	0	Fruit	6.58 ± 1.7	11.11 ± 2.2	132.75 ± 2.2	7.31 ± 1.1	9.53 ± 0.4	125.96 ± 2.0	7.87 ± 1.2	6.91 ± 2.4	137.35 ± 5.4	6.06 ± 0.4	7.40 ± 1.0	161.60 ± 7.3
		F.m.	8.19 ± 0.8	4.61 ± 1.6	105.46 ± 6.9	9.66 ± 1.3	7.64 ± 1.6	109.76 ± 9.7	7.12 ± 1.3	3.81 ± 0.9	164.44 ± 4.6	7.46 ± 1.8	6.04 ± 1.0	167.92 ± 6.5
	6	Fruit	0.76 ± 0.2	1.75 ± 0.3	43.30 ± 3.4	0.49 ± 0.0	0.96 ± 0.3	43.02 ± 2.3	0.47 ± 0.1	0.25 ± 0.0	52.95 ± 5.4	0.31 ± 0.0	0.15 ± 0.0	54.48 ± 0.2
		F.m.	0.55 ± 0.2	1.12 ± 0.2	40.57 ± 6.5	0.33 ± 0.0	0.41 ± 0.1	40.72 ± 1.0	0.37 ± 0.0	0.41 ± 0.1	60.99 ± 8.1	0.43 ± 0.1	0.47 ± 0.2	45.54 ± 5.6
	12	Fruit	0.31 ± 0.2	0.41 ± 0.1	22.88 ± 6.9	0.24 ± 0.0	0.74 ± 0.1	35.24 ± 0.3	0.67 ± 0.3	0.73 ± 0.4	32.85 ± 11.6	0.22 ± 0.0	0.31 ± 0.1	33.15 ± 9.6
		F.m.	1.07 ± 0.3	0.64 ± 0.0	18.34 ± 5.5	1.38 ± 0.3	2.00 ± 0.8	41.47 ± 1.1	0.82 ± 0.5	0.50 ± 0.4	12.57 ± 0.5	1.30 ± 0.4	0.14 ± 0.0	14.51 ± 0.5
Chlorogenic acid	B.C.	Fruit	1.77 ± 0.4	1.77 ± 0.4	1.77 ± 0.4	6.27 ± 1.4	6.27 ± 1.4	6.27 ± 1.4	2.96 ± 0.6	2.96 ± 0.6	2.96 ± 0.6	4.39 ± 0.3	4.39 ± 0.3	4.39 ± 0.35
		F.m.	-	-	22.82 ± 1.7	-	-	22.82 ± 1.7			22.82 ± 1.7			22.82 ± 1.7
	0	Fruit	4.71 ± 0.7	4.54 ± 1.0	13.80 ± 0.9	4.22 ± 0.5	5.49 ± 0.3	21.24 ± 0.5	5.46 ± 0.6	3.00 ± 0.8	14.66 ± 1.2	3.65 ± 0.9	3.83 ± 1.5	16.38 ± 0.2
		F.m.	4.16 ± 0.4	2.15 ± 0.8	14.65 ± 0.1	2.76 ± 0.4	2.38 ± 0.6	10.15 ± 0.4	2.20 ± 0.5	1.36 ± 0.4	16.26 ± 1.1	2.15 ± 0.3	1.39 ± 0.3	18.86 ± 0.6
	6	Fruit	1.34 ± 0.1	1.29 ± 0.2	3.98 ± 0.2	1.71 ± 0.2	1.30 ± 0.0	4.60 ± 0.0	0.62 ± 0.1	0.40 ± 0.0	3.55 ± 0.3	0.65 ± 0.1	0.42 ± 0.0	4.03 ± 0.1
		F.m.	1.27 ± 0.1	1.20 ± 0.1	3.50 ± 0.5	1.63 ± 0.0	1.55 ± 0.1	5.24 ± 0.7	0.72 ± 0.0	0.59 ± 0.0	3.78 ± 0.4	0.91 ± 0.1	0.61 ± 0.1	3.14 ± 0.3
	12	Fruit	0.30 ± 0.0	0.24 ± 0.1	1.70 ± 0.3	0.43 ± 0.0	0.42 ± 0.0	2.29 ± 0.0	0.59 ± 0.1	0.37 ± 0.0	2.53 ± 0.7	0.73 ± 0.0	0.43 ± 0.0	2.71 ± 0.4
		F.m.	0.41 ± 0.01	0.34 ± 0.0	1.39 ± 0.2	0.59 ± 0.0	0.59 ± 0.1	2.51 ± 0.1	0.71 ± 0.0	0.43 ± 0.1	1.45 ± 0.0	0.76 ± 0.0	0.55 ± 0.1	1.73 ± 0.0

Syringic acid	B.C.	Fruit	17.42 ± 0.8	17.42 ± 0.8	17.42 ± 0.8	14.66 ± 1.5	14.66 ± 1.5	14.66 ± 1.5	1.92 ± 0.3	1.92 ± 0.3	1.92 ± 0.3	2.37 ± 0.3	2.37 ± 0.3	2.37 ± 0.3
		F.m.	-	-	27.28 ± 1.5	-	-	27.28 ± 1.5	-	-	27.28 ± 1.5	-	-	27.28 ± 1.5
	0	Fruit	7.78 ± 0.2	3.83 ± 1.1	23.48 ± 0.4	9.62 ± 0.9	5.23 ± 0.1	27.03 ± 0.5	8.50 ± 0.6	6.33 ± 0.3	26.15 ± 2.4	9.41 ± 0.4	5.41 ± 0.4	39.76 ± 0.4
		F.m.	5.33 ± 1.1	4.41 ± 0.5	19.37 ± 2.2	7.71 ± 0.3	5.53 ± 0.5	44.87 ± 11.2	6.65 ± 0.6	4.09 ± 0.4	33.21 ± 2.2	8.19 ± 0.3	6.18 ± 0.4	31.81 ± 2.9
	6	Fruit	3.23 ± 0.3	4.81 ± 0.3	19.61 ± 0.9	2.44 ± 0.4	3.65 ± 0.5	22.37 ± 0.4	8.38 ± 0.8	5.21 ± 0.4	37.65 ± 5.5	9.67 ± 0.2	5.88 ± 0.2	42.36 ± 1.2
		F.m.	3.94 ± 0.2	3.50 ± 0.2	19.62 ± 1.5	6.23 ± 0.7	6.08 ± 0.5	24.32 ± 0.9	7.13 ± 0.2	4.66 ± 0.7	22.10 ± 4.4	7.80 ± 0.4	5.74 ± 1.1	25.94 ± 4.4
	12	Fruit	2.60 ± 1.3	3.67 ± 0.8	16.25 ± 0.5	1.05 ± 0.1	2.61 ± 1.1	19.89 ± 0.3	2.68 ± 0.3	1.70 ± 0.2	11.53 ± 1.0	1.01 ± 0.1	1.22 ± 0.1	14.64 ± 2.2
		F.m.	1.71 ± 0.6	1.88 ± 0.7	16.47 ± 0.3	3.95 ± 0.3	3.09 ± 0.3	17.73 ± 0.8	2.92 ± 1.0	1.19 ± 0.2	18.22 ± 1.1	3.75 ± 1.3	1.16 ± 0.2	22.17 ± 0.9
Gallic acid	B.C.	Fruit	0.54 ± 0.0	0.54 ± 0.0	0.54 ± 0.0	0.22 ± 0.0	0.22 ± 0.0	0.22 ± 0.02	0.53 ± 0.1	0.53 ± 0.1	0.53 ± 0.1	1.84 ± 0.4	1.84 ± 0.4	1.84 ± 0.4
		F.m.	-	-	9.96 ± 0.7	-	-	9.96 ± 0.7		-	9.96 ± 0.7	-	-	9.96 ± 0.7
	0	Fruit	0.36 ± 0.0	0.54 ± 0.1	15.93 ± 4.8	0.53 ± 0.1	0.72 ± 0.0	16.63 ± 4.4	2.47 ± 1.0	0.76 ± 0.1	36.66 ± 3.3	2.78 ± 0.6	1.11 ± 0.1	24.82 ± 1.0
		F.m.	2.02 ± 0.4	2.40 ± 0.2	16.91 ± 1.4	2.66 ± 0.1	3.06 ± 0.3	19.20 ± 0.2	3.25 ± 0.3	2.45 ± 0.4	22.33 ± 0.4	4.63 ± 0.4	3.99 ± 0.1	24.75 ± 0.6
	6	Fruit	1.84 ± 0.2	1.39 ± 0.2	10.07 ± 0.4	2.35 ± 0.2	1.92 ± 0.1	10.51 ± 0.2	1.73 ± 0.3	1.28 ± 0.1	24.77 ± 1.4	2.71 ± 0.4	1.81 ± 0.6	13.65 ± 0.1
		F.m.	2.59 ± 0.7	2.81 ± 0.0	12.53 ± 1.6	2.96 ± 0.1	2.79 ± 0.2	14.37 ± 0.8	2.95 ± 0.4	2.37 ± 0.2	16.98 ± 1.3	4.14 ± 0.1	3.40 ± 0.2	15.45 ± 1.9
	12	Fruit	1.39 ± 0.3	1.95 ± 0.7	5.33 ± 0.4	1.18 ± 0.1	1.50 ± 0.5	5.98 ± 0.2	1.14 ± 0.5	0.73 ± 0.2	0.97 ± 0.4	0.45 ± 0.1	0.80 ± 0.4	0.96 ± 0.8
		F.m.	1.39 ± 0.3	1.05 ± 0.3	6.91 ± 0.3	1.51 ± 0.2	1.28 ± 0.2	7.16 ± 0.2	1.92 ± 0.2	4.19 ± 0.1	5.40 ± 0.9	2.77 ± 0.9	4.91 ± 0.1	4.83 ± 0.2
Rutin	B.C.	Fruit	13.93 ± 0.5	13.93 ± 0.5	13.93 ± 0.5	29.78 ± 4.6	29.78 ± 4.6	29.78 ± 4.6	2.17 ± 0.6	2.17 ± 0.6	2.17 ± 0.6	35.96 ± 6.3	35.96 ± 6.3	35.96 ± 6.3
		F.m.	-	-	43.32 ± 10.3	-	-	43.32 ± 10.3	-	-	43.32 ± 10.3	-	-	43.32 ± 10.3
	0	Fruit	3.86 ± 0.2	1.71 ± 0.5	21.59 ± 0.3	17.28 ± 0.6	21.35 ± 2.1	46.49 ± 1.6	1.25 ± 0.3	1.10 ± 0.2	22.05 ± 2.3	9.98 ± 1.3	14.42 ± 1.7	35.19 ± 3.3
		F.m.	2.43 ± 0.5	0.88 ± 0.6	20.40 ± 3.4	11.35 ± 1.2	12.82 ± 3.9	38.53 ± 4.4	0.77 ± 0.2	0.54 ± 0.1	21.86 ± 5.9	6.33 ± 1.2	6.16 ± 1.6	32.71 ± 1.0
	6	Fruit	6.18 ± 1.5	7.49 ± 1.4	19.05 ± 1.6	26.69 ± 2.5	21.99 ± 2.0	39.98 ± 3.3	3.14 ± 0.3	3.28 ± 0.4	17.39 ± 2.6	20.95 ± 5.6	7.16 ± 1.0	29.44 ± 1.3
		F.m.	5.62 ± 0.8	4.62 ± 0.0	14.90 ± 1.8	17.73 ± 1.7	17.86 ± 1.9	51.74 ± 11.6	2.76 ± 0.3	1.21 ± 0.5	18.39 ± 1.6	15.82 ± 2.3	7.74 ± 3.1	17.48 ± 1.5
	12	Fruit	4.90 ± 1.7	1.11 ± 0.1	13.99 ± 0.	19.48 ± 5.0	19.59 ± 3.7	27.74 ± 3.4	2.19 ± 0.5	3.64 ± 0.4	21.86 ± 3.4	18.31 ± 1.1	13.90 ± 1.7	23.33 ± 1.5
		F.m.	4.63 ± 0.9	1.52 ± 0.2	16.13 ± 1.0	18.22 ± 4.3	20.52 ± 2.2	27.74 ± 3.8	1.85 ± 0.2	1.45 ± 0.1	16.75 ± 1.1	13.95 ± 0.8	10.83 ± 1.9	24.26 ± 1.0

Values are mean ± standard deviation (n = 6). F.m.: filling medium.

of chlorogenic acid in heat-treated peaches increased by 35% during the first 36-day storage at 22°C, and remained stable thereafter. Concerning syringic acid, the peel was significantly effective on the concentration of the canned Sarilop figs ($p < 0.05$), and higher values were obtained for the unpeeled canned samples. Canning differently affected the syringic acid content of the canned Sarilop samples. A decrease in syringic acid content (4.1 - 52.7%) was observed in the peeled canned samples, while there was an increase (18.2 and 71.4%) in the unpeeled ones, except the sample canned with syrup. During the storage of the canned Sarilop samples, there were some losses in syringic acid concentration, but no decrease was observed in the peeled figs canned with syrup. For gallic acid, the effect of the peel was not significant, but the interaction between storage time and filling medium was found to be significant ($p < 0.05$). Canning greatly increased the gallic acid content of all Sarilop samples. During storage, no change was detected for the samples canned with water and syrup ($p > 0.05$), while the concentration of the samples canned with fig juice decreased significantly. When the effect of the filling mediums on the rutin concentration of the canned Sarilop figs was examined, we could conclude that the samples canned with fig juice had the highest amount, and that there was no significant difference between the samples canned with water and syrup. During the storage period of the canned Sarilop figs, the concentration of rutin did not change significantly, but the effect of the peel on its concentration was found to be significant ($p < 0.05$).

The factorial variance analysis of the phenolic compounds in the canned B. Siyahi figs showed that the interaction between filling medium and storage period was significant, and that the peel did not show a significant effect for epicatechin and syringic acid in the canned figs ($p < 0.05$). On the other hand, the interaction between peel, filling medium, and storage time was found to be significant for chlorogenic acid, gallic acid, and rutin ($p < 0.05$). Unlike the canned Sarilop figs, a decrease was observed in the epicatechin contents (20.4 - 51.6%) of both peeled and unpeeled B. Siyahi samples canned with water and syrup after the canning process. During the first 6-month storage of these samples, there was also a dramatic decrease in epicatechin concentrations (93.8 - 95.4%) similar to the canned Sarilop figs, while a lower decrease was also observed in both peeled and unpeeled samples canned with fig juice (62.2 - 69.6%). Therefore, similar to Sarilop, epicatechin was also more stable in the B. Siyahi samples canned with fig juice during storage. The chlorogenic acid concentration also increased by canning in all B. Siyahi samples as observed in the Sarilop samples. Similarly, the chlorogenic acid concentration of all canned B. Siyahi samples decreased as the storage time increased. There were 73.1 - 82.5 and 74.3 - 87.4% losses in chlorogenic acid concentration of these samples at the end of 6- and 12-month storage, respectively. The canning process greatly increased the syringic acid and gallic acid contents of all B. Siyahi samples. During the storage of the canned B. Siyahi samples, a slight change in syringic acid content was observed during the first 6-month storage; however, there were losses (50 - 79.5%) in the samples stored for 12 months. The amount of gallic acid and rutin did not change during storage in the samples with water and syrup significantly ($p > 0.05$), but decreased in the samples canned with fig juice ($p < 0.05$). Therefore, rutin and gallic acid were found to be the most stable phenolic compounds in both Sarilop and Siyahi figs canned with water and syrup during 12-month storage.

Principal component analysis (PCA) was applied as an analytical method for the elaboration of the bioactive phenolic compounds of the canned fig samples. Figure 3 shows the biplots of the principal components 1 and 2 (PC1 and PC2, respectively) for the canned Sarilop figs (Figure 3a) and B. Siyahi figs (Figure 3b). As seen in Figure 3, the distribution of the groups showed that there were significant statistical differences among the canned samples. PC1 and PC2 explained 95.43% of the variance of the experiment, where PC1 explained 83.91%, and PC2 explained 11.52% for the canned Sarilop figs (Figure 3a). For the canned B. Siyahi figs, PC1 and PC2 explained 94.66% of the variance, while PC1 explained 85.36%, and PC2 explained 9.30% (Figure 3b). By PC1, all canned samples prepared with fig juice (both peeled and unpeeled) were separated from the samples prepared with water and syrup during storage. This was due to the higher concentration of epicatechin, chlorogenic acid, syringic acid, rutin, and gallic acid presented by these samples (prepared with fig juice) as compared to the other samples (prepared with water and syrup). PC2 separated the peeled and unpeeled samples by their association with the phenolic compounds of rutin and syringic acid.

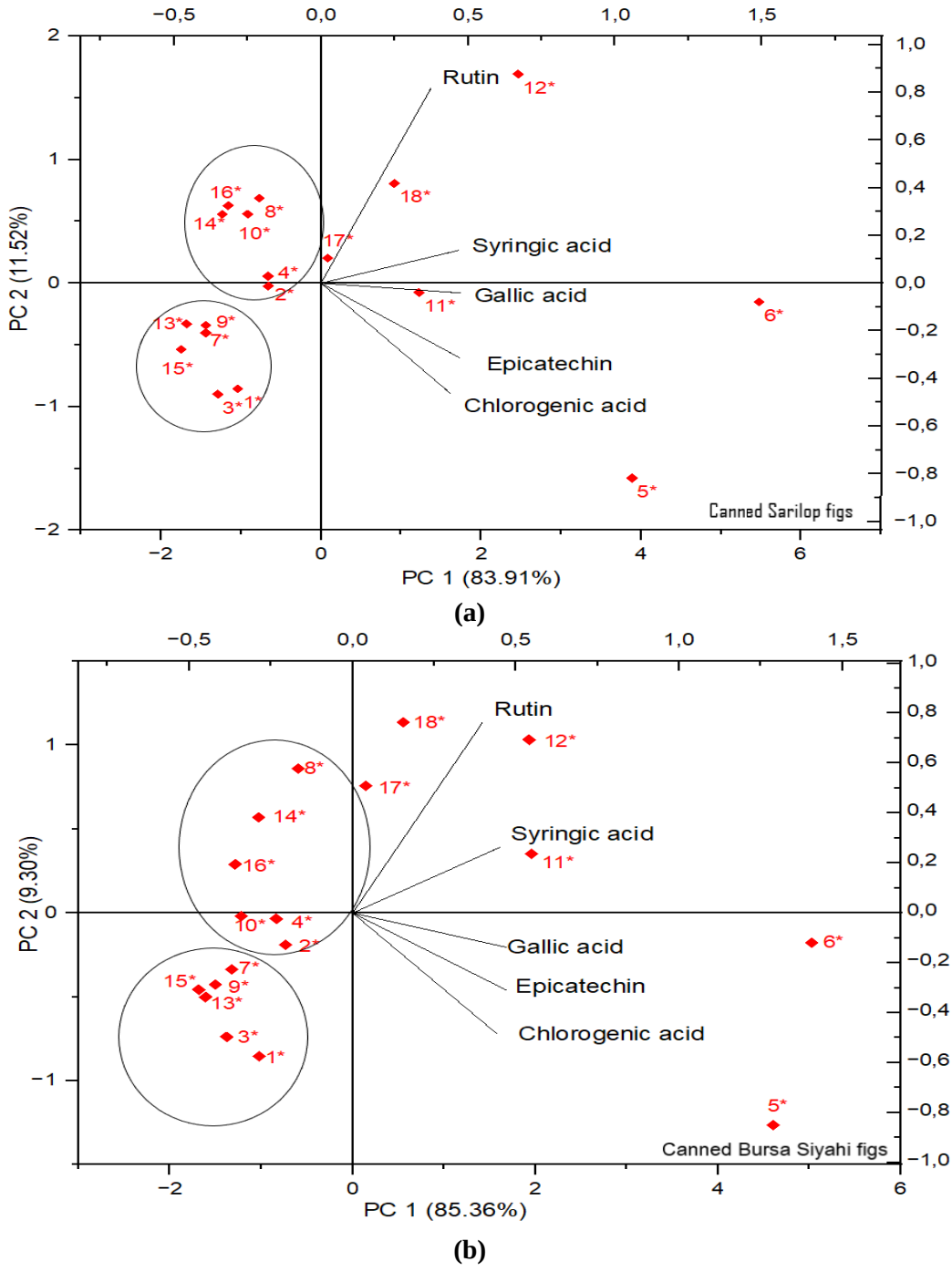


Figure 3. Biplot for PCA carried out on phenolic compounds of the canned **(a)** Sarilop figs and **(b)** Bursa Siyahi figs. 1*: W-P, 0 mo storage; 2*: W-UP, 0 mo storage; 3*: S-P, 0 mo storage; 4*: S-UP, 0 mo storage; 5*: FJ-P, 0 mo storage; 6*: FJ-UP, 0 mo storage; 7*: W-P, 6 mos storage; 8*: W-UP, 6 mos storage; 9*: S-P, 6 mos storage; 10*: S-UP, 6 mos storage; 11*: FJ-P, 6 mos; 12*: FJ-UP, 6 mos; 13*: W-P, 12 mos storage; 14*: W-UP, 12 mos storage; 15*: S-P, 12 mos storage; 16*: S-UP, 12 mos storage; 17*: FJ-P, 12 mos; and 18*: FJ-UP, 12 mos. W-P: water-peeled; W-UP: water-unpeeled; S-P: syrup-peeled; S-UP: syrup-unpeeled; FJ-P: fruit juice peeled; FJ-UP: fruit juice unpeeled; mo: month; and mos: months

Conclusion

In general, the canning process preserved an important part of the phenolic content and antioxidant potential of the figs. After canning, a slight decrease was observed in the TPC values of the Sarilop figs, while there was no significant change in the TPC values of the B. Siyahi figs. The TPC values of the unpeeled canned figs were significantly higher than those of the canned peeled figs for both varieties. As expected, the highest TPC was found in the unpeeled dark purple coloured B. Siyahi figs canned with fig juice which had much higher TPC as compared to the other filling mediums (water and syrup). The canning differently affected the individual phenolic compounds of the Sarilop and B. Siyahi figs. In general, after canning, there was an increase in chlorogenic acid and gallic acid concentrations, while the concentration of rutin decreased as compared to the initial values. The canning process increased the TAA values of the figs, which was observed more clearly in the unpeeled B. Siyahi figs. However, the monomeric anthocyanins in the B. Siyahi figs were affected negatively by the canning process. Regarding the filling mediums, the TPC values of canning water and syrup increased, while the TPC values of the canning fig juice decreased (about 50%) after canning. The canning process also led to a transfer of approximately 26 - 38% of monomeric anthocyanins from the fruit into the filling mediums. Therefore, the consumption or secondary use of these filling mediums could be important in increasing the intake of total phenolics and monomeric anthocyanins from canned figs. Based on the findings of the present work, it is suggested to consume the canned fig as a whole, including both the peels and the filling mediums. By the end of the storage study, both Sarilop and B. Siyahi figs canned with fig juice exhibited higher TPC, TAA, and individual phenolics as compared to the figs canned with other filling mediums. However, it is recommended to consume them within six months to prevent losses.

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