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Effects of grape pomace and grape seed flours on cookie quality

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RESEARCH ARTICLE

Abstract

The effects of grape pomace flours, whole grape pomace flour (WPF), pomace flour without seeds (PFWS) and seed flour (SF), on cookie quality were evaluated. Total dietary fibre (TDF) and total phenolics (TP) of WPF, SF and PFWS was determined as 88.7, 83.0 and 62.0% and 357.5, 542.8 and 62.0 g/kg GAE, respectively. TDF and TP of cookies had increased in proportion to rising pomace level. TP and antioxidant activity of cookies containing 10% SF was found to be higher (153.10 g/kg GAE and 5.61 mg/ml, respectively) than others. PFWS had no significant effect on total phenolic and antioxidant activity of cookies. Grape pomace did not significantly affect the width, thickness and spread ratio of cookies. The cookies containing 5% SF was most appreciated in terms of sensorial properties and purchasing intent. When the usage level of grape pomace flours exceeded 10% for all cookie samples, general acceptability and affordability significantly decreased.

Keywords: antioxidant activity, dietary fibre, total phenolic activity

1. Introduction

In recent years, functional and natural nutrition have become a major preference among consumers because of their positive effects on health. The risk of some diseases can be totally or partially eliminated by consuming the natural foods and/or foods with increased functionality. Besides the addition of dietary fibre, natural protective materials with antioxidant and antimicrobial features are exploited in order to increase functionality. Since the protective effects of fibrous foods against health problems caused by fibre deficiency are widely known, it is recommended that diets are chosen carefully and nutrition with high dietary fibre content should be included in daily diets (Gül, 2007). On the other hand, natural antioxidants have protective effects on human health against ageing, cancer, cardiovascular diseases and free radicals causing chronic diseases such as cataracts (Kinsella *et al.*, 1993; Lai *et al.*, 2001).

Grape is the most widely produced fruit and it has a centuries-old history. While 67 million of tons of the fruit are farmed globally on 7 million and 502 thousand hectares of land, the values for Turkey are 478 thousand hectares and 4.25 million tons. Of the farmed grape, 26 million tons/year are produced for export and 28 thousand tons/year wine for Turkey (FAO, 2010). When the grapes are pressed, the residual pomace is about 25%. 50% of that is peel and 25% is seed and stems (Kılıç, 1996). The rest is grape juice.

The grape pomace occurring due to the production of wine from grape is a very natural antioxidant source with rich dietary fibre and phenolic material content. During wine production, a huge amount of grape pomace is generated; it is a waste by-product that is difficult to dispose of and causes environmental pollution. The grape pomace is commonly used as feed and fertiliser. Many researchers (Baydar *et al.*, 2006; Bravo and Saura-Calixto, 1998; Vinson *et al.*, 2001), have reported that grape, grape pomace, grape sorbet and wine are very rich in terms of antioxidant and phenolic material.

Cookies are a widely consumed product around the world. Some of the reasons why they are popular is that they are ready-to-eat, have rich nutrition content, can be stored for a long time and are sweetened by adding different tastes (Ajila *et al.*, 2008). Many researchers have used the leaves of vegetables and fruits, in addition to bran of many different cereals, to improve the dietary fibre content of cookies and/or its antioxidant features. Some of the additives used for this purpose are: extruded orange pulp (Larrea *et al.*, 2005), rice and oat bran (Sudha, 2007), mango fruit (Vergara-Valencia *et al.*, 2007), wheat and lemon fibre (Uysal *et al.*, 2007), king palm (Vieira *et al.*, 2008), mango peel powder (Ajila, 2008), apricot kernel flour (Şeker *et al.*, 2010), rice and black bean extruded flours (Bassinello *et al.*, 2011), barley flour (Gupta *et al.*, 2011) and flaxseed meal (Rodrigues *et al.*, 2012).

The aim of the present research was to evaluate the effect of grape pomace flours, which are found to be rich in dietary fibre and other phytochemicals, on the physical, biochemical, sensory characteristics and affordability of cookies.

2. Materials and methods

Materials

Commercial wheat flour was supplied by Sosyete Milling factory (Karaman, Turkey). Its chemical composition was determined according to the American Association of Cereal Chemists methods (AACC, 1999a,e,f,i,j, 2000): 12.74% moisture (AACC method 44-01.01), 0.64% ash (AACC method 08-01.01), 8.5% protein (AACC method 46-12.01), 20.89% wet and 6.94% dry gluten (AACC method 38-12.02), 15.5 ml sedimentation (AACC method 56-60.01) and 355 s falling number (AACC method 56-81.03). Its alveo-consistograph values were determined by using AACC method 54-30.02 and method 54-50.01 and are given in Table 1 (AACC, 1999g,h).

Sodium bicarbonate was provided by Şişecam Chemicals Group Soda Industry (Mersin, Turkey), corn syrup (42%) was provided by Sunar Corn Integrated Plant Inc. (Adana, Turkey), powdered sugar was provided by Saray Biscuits and Food Industry Inc. (Karaman, Turkey) and hydrogenated vegetable oil was supplied by local markets. All reagents used were of analytical grade.

Drying, flouring and packaging of grape pomace samples

Pomace of red grape (*Vitis vinifera* L., Uluğbey Karası) which is the by-product of the wine industry was taken from local wine makers at Uluğbey district of Isparta (Turkey). The grape pomace samples were conventionally dried at a specific temperature and duration (6-8 h at 55-60 °C until moisture level decreases to 7-8%). The completely dried pomace samples were divided into three groups: (1) whole pomace; (2) seedless pomace; and (3) seed. Then all samples were ground with a hummer mill (Tekpa Food and Technology Products Trade Inc., Ankara, Turkey) till the particle size reached less than 375 µm. The completely floured samples, whole pomace flour (WPF), pomace flour without seeds (PFWS) and seed flour (SF), were vacuumed in packages with a barrier property. Then they were protected in a freezer at -18 °C.

Preparation of cookies

Cookies were prepared using AACC method 10-50.05 (AACC, 1999b) with slight modifications. The amount of hydrogenated vegetable oil and powdered sugar were decreased by 50% and 23%, respectively, to produce more healthy cookies. The wire-cut cookie formula was:

- 64 g hydrogenated vegetable oil;
- 130 g powdered sugar;
- 2.1 g salt;
- 2.5 g sodium bicarbonate ($NaHCO_3$);
- 33 ml high-fructose corn syrup (42%);
- 16 ml distilled water; and
- 225 g flour.

The study was carried out by adding WPF and PFWS to cookie flour at four different rates (0, 5, 10 and 15%) and SF was added at 0, 5, 7.5 and 10%.

After mixing for 10 min the cookie dough was sheeted to 5 mm by rolling pin and cut into circular shapes with a circular scone cutter of 60 mm inner diameter. The cut-out pieces of dough were baked on greased pans at 205 °C for 10 min in a conventional oven. The cookies were cooled at room temperature and packed in high density polyethylene bags with hermetic cover until further analysis.

Chemical analysis

Three different grape pomace flours and cookies made from them were analysed for moisture (method 44-01.01; AACC, 1999e), ash (method 08-01.01; AACC, 1999a), total lipid (method 30-25.01; AACC, 1999c), protein-N × 6.25 (method 46-12.01; AACC, 1999f), total sugar (Praznik *et al.*, 1999), total dietary fibre (TDF) (method 32-05.01; AACC,

Table 1. Alveo-consistograph values of commercial wheat flour.

Water absorption (%)	Maximum pressure (mmH_2O)	Extensibility of dough (mm)	Area under the curve (J)	Ratio of curve height to length
52.05	44	71.5	77.5×10^{-4}	0.66

1999d), total phenolic (TP) (Singleton and Rossi, 1965) and antiradical activity by using α-diphenyl-β-picrylhydrazyl (DPPH) (Dorman *et al.*, 2003). Colours of dried and ground grape pomace samples and cookies were determined with Minolta CR 400 (Minolta Co Ltd., Tokyo, Japan).

Physical characteristics of cookies

Width (W) and thickness (T) of cookies from each batch were measured by calliper, and the spread ratio was calculated by the proportion of width to thickness (W/T). 6 cookie samples were taken in each experiment. Colours of grape pomace flours and cookies were determined with Minolta CR 400.

Sensory test and purchase intent of cookies

The sensory test was carried out 4 h after the cookies were made. 15 trained judges evaluated cookies for crust colour, crust appearance, crumb colour, hardness, fracture, chewiness, taste and flavour and affordability.

A five-point hedonic scale ranging from 'like extremely' to 'dislike extremely', corresponding to the highest and lowest scores of 5 and 1, respectively, was used. The purchase intent was also evaluated on a five-point scale, 'definitely would buy' to 'definitely would not buy' corresponding to the highest and the lowest scores of 5 and 1, respectively.

Statistical analysis

All experiments were carried out in triplicate. Analysis of variance (ANOVA) was conducted by using the SPSS 16.0 (SPSS Inc., Armonk, NY, USA) procedures. The calculated mean values were compared using Duncan's multiple range tests with significance defined at $P<0.01$.

3. Results and discussion

Chemical characteristics and colour values of grape pomace flours

The proximate composition of WPF, PFWS and SF are given in Table 2. The ash and protein content of SF was less than those of other pomace forms, but total lipid and TP content were found to be more. While the dietary fibre content of WPF was found to be the highest (88.7%), SF followed it with a value of 83.0%. PFWS's TDF content and antioxidant activity value were found to be less than other forms of pomace.

In studies conducted by different researchers, it is reported that TDF content of grape peel is 54.1-64.6 g/100 g dry sample (Bravo and Saura-Calixto, 1998), the protein content of orange pomace is 9.79 g/100 g, dietary fibre content is 74.87 g/100 g, oil content is 2.43 g/100 g and ash content is 2.66 g/100 g (Larrea *et al.*, 2005). According to those values, it was found that WPF is richer than orange pomace in terms of mineral content, total oil and TDF. The dietary fibre content of grape pomace flour is reported as more than that of different leaf sources determined by different researchers (Ajila *et al.*, 2008; Uchoa *et al.*, 2009). In a study where Monte Negro red grape pomace and stems were examined, the reported values are 12.2% for protein content of pomace, oil content is 13.5%, sugar content is 3.27%, TDF content is 74.5%, total soluble polyphenol content is 2.63 g

Table 2. Composition of whole grape pomace flour (WPF), pomace flour without seeds (PFWS) and seed flour (SF).[1]

Properties	Grape pomace flours		
	WPF	PFWS	SF
Moisture (%)	6.9^{b}	6.7^{a}	9.2^{c}
Ash (%)	9.1^{a}	10.1^{a}	3.4^{b}
Total lipid (%)	7.2^{b}	7.7^{b}	16.3^{a}
Protein (%)	11.0^{b}	13.2^{a}	8.3^{c}
Total sugar (g/100 g)	10.3^{a}	8.0^{b}	11.3^{a}
Total dietary fibre (%)	88.7^{a}	68.7^{c}	83.0^{b}
Total phenolic (g/kg GAE)	357.5^{b}	62.0^{c}	542.8^{a}
Antiradical activity (DPPH, IC_{50}, mg/ml)	0.05^{c}	11.12^{a}	0.121^{b}
L value (lightness)	50.4^{ab}	52.7^{a}	47.8^{b}
a value (redness)	8.2^{b}	8.0^{b}	10.7^{a}
b value (yellowness)	8.9^{b}	8.4^{c}	12.3^{a}

[1] Mean values in the table in the same line followed by different superscript letters are significantly different ($P<0.01$).
DPPH = α-diphenyl-β-picrylhydrazyl; GAE = gallic acid equivalent.

GAE/100 g dry sample, IC_{50} value of grape pomace is 1.41 mg dry material /mg DPPH, the IC_{50} value of stems is 0.46 mg dry material /mg DPPH (Llobera and Canellas, 2007).

The total polyphenol content in the mango peel powder was reported to be 96.2 mg GAE/g peel powder (Ajila *et al.*, 2008), in grape pomace extract in the range of 68.4 to 98.3 mg GAE/g (Özkan *et al.*, 2004), in apple pomace 33.4 g GAE/g (Wolfe *et al.*, 2003), whereas in dried powder of mango fruit pulp with skin (peel) it was reported to be 16.1 mg/g (Vergara-Valencia *et al.*, 2007). These values are very low compared to total polyphenol content of SF and WPF.

While no statistically significant difference was seen between SF and WPF in terms of L value (a measure for lightness), PWSF drew attention with its lighter colour. The redness (a value) and yellowness (b value) were determined as higher in seed flours.

Chemical characteristics of cookies

The effects of WPF, PFWS and SF addition on the chemical composition of cookies are given in Table 3. In terms of moisture, no statistically significant difference was found between cookies. Vierira *et al.* (2008) have reported that the moisture value of cookies produced by adding king palm residues varies between 5.13% (control) and 5.50% (25% addition level). Uysal (2005) also stated that apple, lemon, wheat fibre and wheat bran have effects on cookie moisture at different levels: 5.41, 7.17, 5.71 and 3.89%, respectively. But Ajila *et al.* (2008) have established that the moisture content of cookies that contain a 10% level of mango peel powder increased from 3.75 (control) to 5.2%, and that the moisture level increased to 6% when the mango peel powder addition level was increased to 20%.

The ash content of cookies increased in parallel with an increase in pomace. It was especially striking that, compared with other pomace forms, the ash content of the cookies containing PFWS in different addition levelswas higher and reached the highest level (2.31%) with the addition of 15% PFWS. While the protein content of cookies produced by replacing wheat flour with different levels of WPF and PFWS increases when the addition rate exceeds 10%, no increase was observed in cookies containing only SF. While no significant difference was observed between the oil content of cookies containing PFWS and SF, oil content increased in cookies containing WPF in parallel with increasing addition level. This result may be caused by the proportional rise in seed rate in whole pomace, since the oil content of seed flours was found to be much higher than the oil content of other forms of pomace flours. If the usage rate in cookies containing seed were to exceed 10%, a rise in oil content, as in whole pomace, could result. However, because the seed flour affects the sensorial properties negatively, it could not be used at content rates exceeding 10%. While the sugar content of samples containing 15% WPF was found to be the same as the control group, the sugar content of cookies containing 5 and 10% WPF were found to be lower than of the control group. This result was caused by a proportional decrease in powdered sugar content due to the addition of dietary fibre to the cookies.

TDF content of cookies increased with rising pomace levels. Especially with cookies containing 15% seedless pomace, the TDF content value (10.94%) increased to approximately 2.3

Table 3. Chemical properties of cookies.[1]

Grape pomace form	Level (%)	Moisture (%)	Ash (%)	Protein (%)	Total lipid (%)	Total sugar (g/100 g)	Total dietary fibre (%)	Total phenolic (g/kg GAE)	DPPH (mg/ml)
WPF	0	8.31^{a}	1.34^{c}	5.86^{b}	16.82^{c}	14.47^{b}	4.78^{d}	0.00^{d}	0.00^{c}
	5	6.86^{a}	1.48^{bc}	5.89^{ab}	19.47^{b}	12.93^{c}	7.58^{c}	63.87^{c}	0.00^{c}
	10	6.85^{a}	1.63^{b}	6.09^{a}	18.24^{bc}	13.01^{c}	10.45^{a}	75.11^{b}	9.56^{a}
	15	7.89^{a}	1.98^{a}	6.18^{a}	23.20^{a}	15.07^{a}	9.26^{b}	85.88^{a}	9.12^{b}
PFWS	0	7.22^{a}	1.31^{d}	5.78^{b}	18.95^{a}	14.30^{a}	4.73^{d}	0.00^{d}	0.00^{a}
	5	6.73^{a}	1.73^{c}	5.93^{b}	18.65^{a}	12.82^{c}	6.49^{c}	10.19^{c}	0.00^{a}
	10	5.62^{a}	2.04^{b}	5.79^{b}	18.56^{a}	12.76^{c}	9.56^{b}	11.52^{b}	0.00^{a}
	15	5.99^{a}	2.31^{a}	6.14^{a}	18.75^{a}	13.04^{b}	10.94^{a}	12.62^{a}	0.00^{a}
SF	0	6.44^{a}	1.31^{b}	5.72^{a}	18.86^{a}	14.18^{a}	4.69^{c}	0.00^{d}	0.00^{d}
	5	5.90^{a}	1.43^{b}	5.75^{a}	19.21^{a}	12.42^{c}	6.27^{b}	81.38^{c}	8.98^{a}
	7.5	5.84^{a}	1.43^{b}	5.58^{a}	19.08^{a}	12.96^{b}	6.68^{b}	107.25^{b}	7.97^{b}
	10	5.51^{a}	1.70^{a}	5.59^{a}	18.79^{a}	12.00$_{d}$	9.50^{a}	153.10^{a}	5.61^{c}

[1] For each grape pomace group, mean values in the same column followed by different superscript letters are significantly different ($P<0.01$).
DPPH = α-diphenyl-β-picrylhydrazyl; PFWS = pomace flour without seeds; SF = seed flour; WPF = whole grape pomace flour.

times of the control sample. Larrea *et al.* (2005) reported the TDF content in cookies which was produced by adding 25% extruded orange pulp, the maximum additive percentage for cookies, as 14.71%. Also Vieira *et al.* (2008) indicated that the TDF content in cookies made using residue from king palm was 7.10% for cookies which were prepared by adding 25% rate of 60 mesh palm residuals and 6.71% for cookies prepared by adding 25% rate of 42 mesh palm residuals. Filipčev *et al.* (2011) determined the TDF content of cookies which contained 50% buckwheat and rye flour as 5.37 g/100 g and 8.87 g/100 g, respectively. When comparing the results of other researchers with ours, it was revealed that even 15% grape pomace additive can significantly increase the dietary fibre content of cookies and fibre-rich cookies can be prepared if that rate were to exceed 20%.

When the grape pomace level in the cookie sample was increased, the TP also increased. As expected, while TP of cookies containing seed flour was higher than the others, seedless pomace with less TP had no significant effect on TP content of cookies. TP content in cookies which were prepared by adding 10% seed flour increased from 0 to 153.10 g/kg GAE. Ajila *et al.* (2008) revealed that polyphenols in cookies which were produced by adding mango peel powder, increased from 0.54 to 4.50 mg/g at the 20% addition level. Filipčev *et al.* (2011) reported that the polyphenols in cookies containing 50% buckwheat increased from 157.06 mg to 238.92 mg GAE/100 g and the same value for cookies containing 50% rye increased to 191.45 mg GAE/100 g. In another study, it was revealed that using cumin and ginger significantly increased the total polyphenol content of cookies from 78.5 mg GAE /100 g in the control to 93.0 and 109.8 mg GAE /100 g, respectively (Abdel-Samie *et al.*, 2010).

No antioxidant activity was observed in cookies to which PFWS had been added. For cookies which were prepared with WPF, while no antioxidant activity was observed at the 5% addition level, very small antioxidant activities were observed at the 10 and 15% levels (9.56 and 9.12 mg/ml, respectively). The highest antioxidant activity (IC_{50} value = 5.61 mg/ml) was detected in cookies which were prepared by adding 10% SF. The use of SF, which has high antioxidant activity, increased the antioxidant activity of cookies too. The heat treatment which was applied during cooking led to the decomposition of antioxidant rich compounds. This is why no antioxidant activity was observed in the cookie group with the addition of seedless pomace, which has low antioxidant activity even in its raw form. In a study conducted with the aim of determining the heat stability of the pomace flour of wine production residue from Merlot (Ross *et al.*, 2011), significant decreases in the TP content and antioxidant activity, measured using FRAP, DPPH, and TEAC, were observed when Merlot GSF was heated to ≥180 °C. Longer heating times also caused a reduction in antioxidant capability. Overall, while a decrease in antioxidant content was observed during heating, this occurred at higher baking temperatures. Thus GSF may be suitable for use as an ingredient in baked goods to bolster antioxidant content.

Ajila *et al.* (2008) revealed that DPPH value, which was IC_{50} 250 mg/ml for control cookies, decreased to 4.3 mg/ml at the 20% mango peel powder additive level. Filipčev *et al.* (2011) reported that the DPPH values of cookies to which they added 50% buckwheat and rye decreased from 23.06 mg/ml to 5.25 mg/ml and 8.10 mg/ml, respectively. The values which were reported by researchers for 20 and 50%

Table 4. Physical characteristics and colour values (L, a, b) of cookies supplemented with different proportions of whole grape pomace flour (WPF), pomace flour without seeds (PFWS) and seed flour (SF).[1]

Grape pomace form	Level (%)	Width (mm)	Thickness (mm)	Spread ratio	L	a	b
WPF	0	59.57^{a}	11.98^{a}	4.98^{a}	62.43^{d}	6.71^{a}	17.63^{a}
	5	60.26^{a}	11.86^{a}	5.09^{a}	52.42^{c}	6.42^{ab}	12.03^{b}
	10	58.97^{a}	11.47^{a}	5.15^{a}	49.24^{b}	5.99^{ab}	9.98^{c}
	15	59.89^{a}	11.11^{a}	5.39^{a}	45.82^{a}	5.66^{b}	8.77^{d}
PFWS	0	59.08^{a}	12.12^{a}	4.88^{b}	62.47^{a}	6.40^{a}	16.73^{a}
	5	58.06^{a}	11.12^{b}	5.23^{ab}	54.29^{b}	5.20^{b}	12.09^{b}
	10	58.56^{a}	10.74^{bc}	5.45^{a}	49.09^{c}	4.99^{b}	9.55^{c}
	15	58.06^{a}	10.29^{c}	5.64^{a}	44.95^{d}	5.11^{b}	7.64^{d}
SF	0	59.53^{a}	11.45^{a}	5.22^{a}	63.66^{a}	6.29^{b}	16.86^{a}
	5	59.70^{a}	11.72^{a}	5.10^{a}	57.97^{b}	7.39^{ab}	15.23^{b}
	7.5	60.55^{a}	11.69^{a}	5.18^{a}	56.99^{b}	7.09^{ab}	14.84^{b}
	10	59.80^{a}	11.58^{a}	5.17^{a}	53.89^{b}	7.51^{b}	12.94^{c}

[1] Mean values in the table in the same column followed by different superscript letters are significantly different for each grape pomace group (P<0.01). a = redness; b = yellowness; L = lightness.

usage rates are almost the same as the antioxidant activity of cookies which were prepared by adding 10% SF. If the grape seed addition rate exceeds 10%, cookies with much higher antioxidant activity can be produced.

Physical characteristics and colour values of cookies

Data on the physical characteristics and colour values (L, a, b) of cookies are presented in Table 4. As a result of the addition of pomace groups with different rates, no statistically significant difference was observed between width and spread ratio of cookies. While different pomace groups did not affect the thickness of cookies, except where PFWS was added, the spread ratio increased while thickness decreased against a rising pomace level. The decrease in the thickness of cookies with the addition of PFWS may be due to dilution of gluten. Ajila *et al.* (2008) reported a decrease in the diameter and thickness values of cookies with 15 and 20% mango peel powder addition. There are many different studies which reveal that the diameter of cookies decreases with increasing addition levels of wheat, rice and barley (Sudha *et al.*, 2007), that different fibre sources (apple, lemon, wheat fibre and wheat bran) affect the spread ratio in different rates (7.49, 6.58, 5.56, 8.74, respectively) (Uysal, 2005) and that rye addition with 30, 40 and 50% rates has no significant effect on the spread ratio of cookies, while a 40 and 50% addition of buckwheat has a minor effect on the spread ratio (Filipčev *et al.*, 2011).

As WPF, PFWS and SF addition rates in cookies were increased, the colour of the cookies became darker. Also, as grape pomace powder has a reddish brown colour, its incorporation in the wheat flour decreased the brightness of the cookies. The crust colour of the control group was brighter than the crust colour of the cookies which were enriched with grape pomace. At increasing pomace levels, the values of cookies produced by adding WPF and PFWS decreased significantly. On the other hand, the redness-greenness values of cookies with grape seed additive were found to be higher than other pomace groups. That might be caused by increasing rates of materials containing grape seed and providing the colour. The decrease in the b value which is determined as yellowness against rising pomace rate is very striking. Especially at the 15% level, the b value of cookies which were prepared by adding WPF and PFWS decreased by almost fifty percent.

Sensory evaluation and purchase intent of cookies

As can be seen in Figure 1, as with the L value, the crust colour of cookies which were produced by adding WPF and PFWS achieved fewer points than the control group. As addition rates in cookies containing WPF increase, the crust colour becomes less attractive for customers. On the other hand, no significant difference was observed between cookies which contain different levels of PFWS. While there is no difference between samples containing WPF and PFWS in terms of crust appearance, the cookies containing 5% SF were appreciated more than control samples in terms of both crust appearance and crust colour. In terms of crumb colour, samples were evaluated to a similar degree.

As the amount of grape pomace increases, the hardness values of cookies which is felt in the mouth increases, while crispness and chewiness values decreases at a limited rate. All of the groups with 5% usage level scored point values

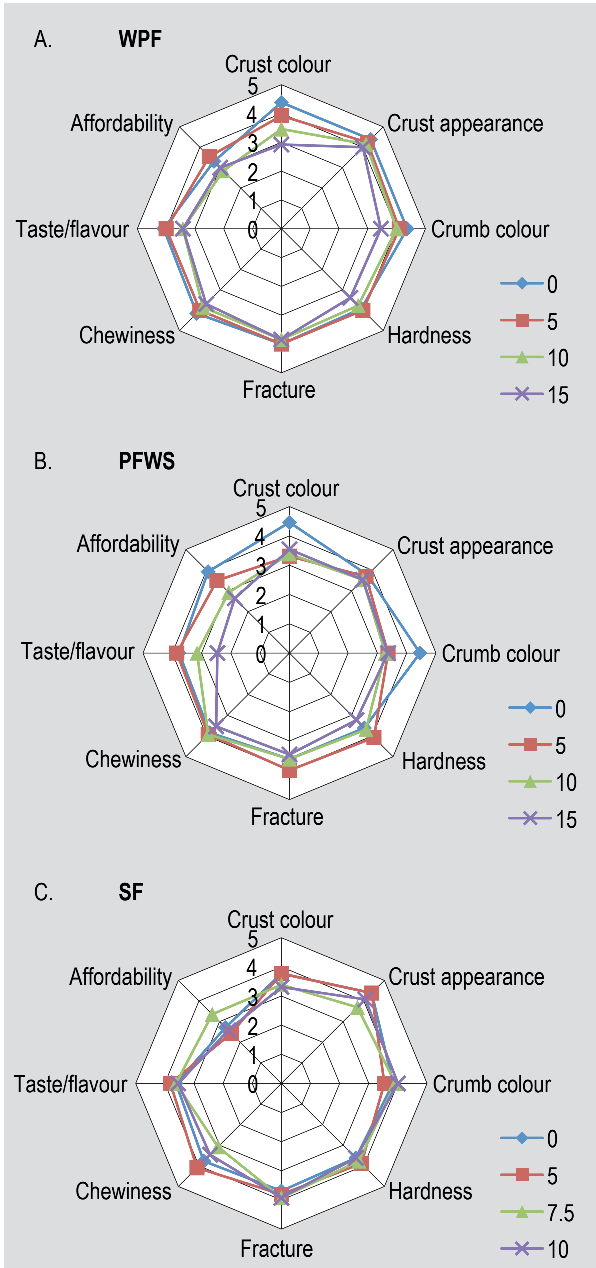

Figure 1. Sensory evaluation of cookies supplemented with different amounts (0, 5, 7.5, 10 or 15%) of (A) whole grape pomace flour (WPF), (B) pomace flour without seeds (PFWS) and (C) seed flour (SF).

similar to the control group in terms of taste, whereas the cookies with 5% SF additive were preferred more than the control group and cookies with 7.5% SF additive were ranked in the same group with the control group. But when the grape pomace addition level exceeded 5%, the taste points for the cookies significantly decreased. When the cookies were compared in terms of affordability, the cookies with 5% WPF and PFWS gained more acceptance from consumers and scored almost the same points as the control sample. When the usage level reached 10 and 15%, the affordability points of related cookies decreased. For SF cookies, the usage level of 7.5% scored highest for affordability.

4. Conclusions

After separating the grape pomace into three different forms and comparing the flours, which were made by grinding them into a certain particle size, in terms of TDF content, it was determined that WPF scored highest, SF followed with near scores and PFWS has less dietary fibre content than the others. On the other hand, SF and WPF were determined as rich in terms of TP material and antioxidant activity.

When WPF, SF and PFWS were added to the cookie recipe at different levels, the dietary fibre content of the cookies also increased. It was determined that the highest TDF content belonged to the cookies which were prepared by adding 15% seedless grape pomace. But a point worth considering is that the TDF content value of cookies with 10% SF is close to that of cookies with 15% PFWS. If the bitterness due to the use of more seed flour can be masked by using other additives, the nutritional value of cookies can be improved by increasing seed flour usage. SF addition also increased and improved the TP content and antioxidant activity of cookies. TP content of cookies prepared by adding seedless pomace was found to be less than the other groups and no antioxidant activity was observed. While no antioxidant activity was observed in 5% pomace for cookies which were prepared by adding whole pomace, the antioxidant activity was at least observed at the 10 and 15% addition levels.

Grape pomace did not significantly affect the physical features of cookies such as width, thickness and spread ratio, and the colours of cookies became darker as the pomace level increased. The cookies containing 5% SF received the highest approval in terms of sensorial properties. When the usage level exceeded 10% for all cookie samples, general acceptability values significantly decreased.

In the light of these findings, it would appear that grape pomace can be used in cookie production after drying and flouring according to the appropriate specifications, and that when grape pomace flours are used at maximum 10% level, cookies with high TP, antioxidant and dietary fibre content, which consumers can be pleased with, can be produced without effecting overall quality.

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