EFFECT OF ADDITION OF GRAPE SEED FLOUR ON CHEMICAL, TEXTURAL AND SENSORY PROPERTIES OF BREAD DOUGH

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The effect of adding varying amounts of grape seed flour (GSF) to pure wheat flour and to a commercially available bread baking mixture (Backmischung) on the chemical, textural and sensory properties of bread dough was evaluated. The pH (from 6.25 to 5.72) and moisture (from 52.3 to 50.2 %) in the dough decreased with increasing amounts (0 to 100 g/kg) of grape seed flour. The samples of dough from the baking mixture were the firmest, the lowest in moisture (50.0 %), and their doughs were the stickiest. The best textural and sensory properties were found in bread with 60 to 70 g of grape seed flour per kilogram.
Keywords: grape seed flour, wheat flour, bread, dough, mixture, quality, sensory analysis, texture

Auswirkungen der Zugabe von Traubenkernmehl auf chemische und sensorische Eigenschaften sowie die Konsistenz von Brotteig. Die Auswirkung der Zugabe unterschiedlicher Mengen von Traubenkernmehl zu Weizenmehl und einer handelsüblichen Backmischung auf die chemischen und sensorischen Eigenschaften sowie die Konsistenz von Brotteig wurde untersucht. Der pH-Wert (6,25 bis 5,72) und die Feuchtigkeit (52,3 bis 50,2 %) im Teig nahmen mit steigenden Mengen (0 bis 100 g/kg) von Traubenkernmehl ab. Die Teig- und Brotproben der Backmischung waren die festesten und am wenigsten feucht (50,0 %), ihre Teige waren die klebrigsten. Die besten Eigenschaften hinsichtlich Konsistenz und Sensorik wurden im Brot mit 60 bis 70 g Traubenkernmehl pro Kilogramm gefunden.
Schlagwörter: Traubenkernmehl, Weizenmehl, Brot, Teig, Backmischung, Qualität, Sensorik, Konsistenz

Different ingredients are included in bread formulations to improve nutritional and health benefits, organoleptic properties and shelf life. Grape seeds, a major component of grape pomace, are a waste product of the wine industry. Grape seed products (flour, oil, o/w emulsion etc.) belong to a group of additives with health benefits. A variety of nutraceutical and bioactive compounds, including procyanidins, phenolic compounds, tannins, dietary fibre, and resveratrol, a cancer chemopreventive agent, can be extracted from grape seeds (Hoye and Ross, 2011). Antioxidants have also been found in cereals (Stratil et al., 2006), plant and seed oils, vegetables (Stratil et al., 2007) and fruits (Stratil et al., 2007; Wang et al., 2007). Natural antioxidants including tocopherols and phenolic compounds may act to confer an effective defense system against free radical attack (Peng et al., 2010; Meral and Doğan, 2013). Grape seed flour is used in various food products as a raw material due to its high fibre content. Although the fibre amount of grape seed varies depending on grape variety, grape seed contains up to 40 % of fibre (Kim et al., 2006; Özvural and Vural, 2011). Phenolic antioxidants have been viewed as an important class of food ingredients either as food additives or as novel ingredients to introduce extra health benefits to various food products. Colour uniformity, flavour attributes, texture and overall acceptance of cereal bars containing 'Merlot' GSF (grape seed flour) had the best performance in consumers tests. Conditions of the test were: n = 100 for each product; 38 men and 62 women, between 18 and 60 years who had been recruited from Washington State University. Hedonic evaluations were made by using a 7-point scale anchored with 'dislike very much' (1) and 'like very much' (7) of each attribute. Filtered deionised water and unsalted crackers were provided for rinsing the palate (Soto et al., 2012). Grape seeds are also an important oil source since they contain 10 to 20 % fat. The oil is especially rich in unsaturated fatty acids (Baydar and Akkurt, 2001) which are very important for the stability of oils because of the chemical reactions in the double bonds. Özvural and Vural (2011) found increases in protein contents, in total dietary fibre and in water holding capacity of frankfurters after grape seed flour addition. Mironeasa et al. (2012) studied the influence of GSF as a wheat flour replacement in the baking industry. Rheological properties of the dough using the Mixolab apparatus were measured. Their results showed the increase of the substitution level of GSF in the blend as a decreasing factor of the FN (Falling Number) index value. They also indicated an increased α-amylase activity in wheat-grape seed composite flours. The objective of this study was to examine the influence of grape seed flour on firmness and tenacity of dough or bread. The present work examines the effect of grape seed flour on sensory and textural properties of bread. Limitations of additions of grape seed flour with regards to acceptance for assessors and consumers were evaluated.

MATERIALS

A common commercial wheat flour, ground (T 512) (moisture content (MC) = 13.50 %, ash = 0.55 %, gluten (GC) = 34.10 %, Falling number (FN) = 296 s) provided by Kojetín spol. s.r.o., (Kojetín, Czech Republic) was used for the evaluation. A bread baking mixture (Vitis AG, Trittenheim, Germany) consisting of wheat flour, soy starch, grape seed flour (70 g/kg), sunflower seeds, gluten, rye flour, flaxseed, malt, salt, dehydrated yeast was used for comparison. Grape seed flour (B-J Vitis s.r.o., Březí u Mikulova, Czech Republic) was prepared from grape seeds separated from pomace. Grape seeds were dried up to 2 to 4 % moisture and defatted by cold pressing to produce virgin grape seed oil as a main product. The defatted seeds were ground to a grape seed flour of particle size 100 to 150 μm required for dough preparation. The following dough mixture was prepared: F1 (control sample) 1000 g/kg wheat flour + 0 g/kg grape seed flour, F2 980 g/kg wheat flour + 20 g/kg grape seed flour, F3 960 g/kg wheat flour + 40 g/kg grape seed flour, F4 940 g/kg wheat flour + 60 g/kg grape seed flour, F5 920 g/kg wheat flour + 80 g/kg grape seed flour, F6 900 g/kg wheat flour + 100 g/kg grape seed flour, F7 (bread mixture Backmischung) 930 g/kg wheat flour + 70 g/kg grape seed flour. Then, sodium chloride (35 g/kg, LomaSalt RS 50 Extra, Faravelli s.r.o., Prague), yeast (30 g/kg, *Saccharomyces cerevisiae*; Paniferm, Uniferm, Werne GmbH & Co, Germany), caraway (3 g/kg, ROLS Lešany; spol. s.r.o., Lešany, Czech Republic), sourdough (200 g/kg) and water (660 ml) were added to 1000 g of the flour mixture to prepare six independent dough samples.

METHODS

Wheat flour dough was measured by the Alveograph (Chopin, Tripette & Renauld, Villeneuve-la-Garenne, France) according to the ISO 5530-4 (2002). Information about flour which was found by alveograph analysis where P (tenacity) = 71 mm H_2O, L (extensibility) = 105 mm, P/L (configuration ratio) = 0.68, W (deformation energy) = 218 10E-4 J, Ie (elasticity index) = 49.50 %. Sample F7 Backmischung with addition of 500 ml of water per bag (750 g) was used for preparing dough for baking bread. Sample mixtures F1 to F6 were prepared as described above. The dough samples were mixed for 10 minutes in a spiral stirring machine (ALBA, spol. s.r.o., Hořovice, Czech Republic) and left to rest for 30 minutes, cut into six separate pieces (750g each) and left to stand for further 10 minutes. Then, the pieces of dough were put on a baking tray and left to rise for 55 minutes at a temperature of 35 °C and at a humidity of 70 to 80 % in the proofer (KA-E1V, Kornfeil, s.r.o. Čejč, Czech Republic). Then they were baked for 34 minutes at a temperature of 180 to 220 °C in a Rotomax rotary gas furnace (Kornfeil). Each sample of dough was characterized by moisture and pH. Moisture was determined as the weight loss during the drying period at a temperature of 130 ± 3 °C for one hour (according to ISO 712 (1998); pH of the model dough was measured by a pH meter (pH Tester with Spear Electrode, ENVCO-Environmental Equipment, Brisbane, Australia) with a durable glass spear tip electrode, enclosed in a resilient engineered plastic body. Doughs were cut into 6 pieces and each piece was measured three times. The textures of the samples of dough before baking and bread after baking and 2 days after baking were evaluated by using a TA-XT Plus Texture Analyzer (O.K. SERVIS BioPro, s.r.o., Prague, Czech Republic), and conducting a "measure force in compression" test with an AACC 36 mm cylinder probe with radius (P/36R); P = probe, R = radius. The analyzer was set at a 'return to start' cycle, a pre-test speed of 1 mm/s, a test speed of 1.7 mm/s, a post-test speed of 10.0 mm/s and a distance of 6.25 mm. Six portions (100 g each) of a sample of dough were put into the six plastic bowls and left to rest for 60 minutes in the cooling chamber at the temperature of 18 ± 2 °C to ensure equal conditions for the rest of dough. Doughs were cut into 6 pieces and each piece was measured three times. The same test was used for measuring samples of bread which were sliced to 25 mm thickness. Six of them were measured in triplicate immediately after baking and after two days of storage (samples of bread were put into plastic bags and stored at a room temperature of 25 ± 2 °C). In order to achieve a complete description of the dough quality needed for baking technology and bread quality, a deformation measurement was used, by means of which the influence of grape seed flour on the textural properties of dough and bread was specified. Firmness F – power which is necessary for achievement of deformation or penetration of the product, Firmness A – total force which is necessary for deformation, and Stickiness F (measured only in the dough) – maximum stickiness of dough, were measured as characteristic parameters. The content of crude fibre (CF) in bread samples was determined by using an Ankom 220 Fibre Analyzer (Ankom Technology, New York, USA) by methods according to Mišurcová et al. (2010). Each sample was measured six times and measurements were repeated three times. Digestibility of bread samples was determined by the decrease in organic matter after pancreatin digestion (protease activity 350 U/g, lipase activity 6000 U/g, amylase activity 7500 U/g, all from Merck KGaA, Germany) in a Daisy incubator (Ankom) by a modified method according to Forejtova et al. (2005) in Mišurcová et al. (2010). Each sample was measured six times and measurements were repeated three times. The ash content was determined by methods according to Mišurcová et al. (2010). Each sample of bread was measured six times and measurements were repeated three times. Methodology according to Kjeldal was used for the determination of total nitrogen in the bread (in Mišurcová et al. (2010)). Each sample was measured six times and measurements were repeated three times. Sensory evaluation of bread (taste, sourness, saltines, sensation when swallowing, impalpability, gumminess, sogginess, color and quality of the product) was performed by 15 panelists at the level of "a selected assessor" according to ISO 8586-1 (1993) within the sensory laboratory equipped in accordance with ISO 8589 (1988) in Topek, s.r.o., Topolná, Czech Republic. Samples were coded F1 to F7 and presented anonymously at room temperature (22 ± 1 °C) in each run. Sensory analyses were replicated three times. A non-parametric analysis of variance (Kruskal-Wallis test) and a Friedman test (Agresti, 1984) was applied for the evaluation of the individual sensory properties. The results of texture analyses were statistically evaluated by Statistica CZ (Statsoft, Inc., Tulsa, USA), version 9.1. Differences among the comparisons had to achieve $P < 0.05$ to show significance in all cases. The results of basic chemical analyses were statistically evaluated according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

The results of chemical analyses showed significant differences in pH. Increasing amounts of grape seed flour decreased pH. The control variant showed the highest pH. On the other hand, dough prepared from Backmischung had the lowest pH (Table 1) probably due to amounts and properties of the ingredients. Moisture was probably decreased with increased amounts of grape seed flour because the dry matter was increased. The samples of dough with the addition of 100 g/kg

Table 1: Chemical and textural quality characteristics of individual dough ($\bar{x} \pm \sigma^2$)

ormulations*	pH-value	Moisture (%)	Firmness F (g)	Firmness A (g)	Stickiness F (g)
F1	6.25 ± 0.01^{g}	52.3 ± 0.46^{c}	2.90 ± 0.50^{a}	0.82 ± 0.16^{a}	(-) $3.15 \pm 0.58^{a,b,c,d,e}$
F2	6.11 ± 0.03^{f}	51.4 ± 0.09^{a}	2.73 ± 0.36^{a}	0.81 ± 0.12^{a}	(-) 2.88 ± 0.36^{a}
F3	6.02 ± 0.02^{e}	51.3 ± 0.23^{a}	3.04 ± 0.51^{a}	0.87 ± 0.17^{a}	(-) $3.10 \pm 0.44^{a,b}$
F4	5.92 ± 0.01^{d}	51.0 ± 0.54^{a}	2.86 ± 0.50^{a}	0.81 ± 0.14^{a}	(-) $3.02 \pm 0.45^{a,b,c}$
F5	5.82 ± 0.01^{c}	50.5 ± 2.64^{b}	2.92 ± 0.63^{a}	0.84 ± 0.17^{a}	(-) $3.02 \pm 0.51^{a,b,c,d}$
F6	5.72 ± 0.01^{b}	$50.2 \pm 0.78^{a,b}$	3.10 ± 0.48^{a}	0.87 ± 0.13^{a}	(-) $3.16 \pm 0.38^{a,b,c,d,e}$
F7	5.36 ± 0.01^{a}	50.0 ± 1.32^{b}	5.40 ± 0.79^{b}	1.39 ± 0.22^{b}	(-) 3.78 ± 0.60^{e}

**F1: 1000 g/kg wheat flour + 0 g/kg grape-seed flour, F2: 980 g/kg wheat flour + 20 g/kg grape-seed flour, F3: 960 g/kg wheat flour + 40 g/kg grape-seed flour, F4: 940 g/kg wheat flour + 60 g/kg grape-seed flour, F5: 920 g/kg wheat flour + 80 g/kg grape-seed flour, F6: 900 g/kg wheat flour + 100 g/kg grape-seed flour, F7: (bread mixture Backmischung) contained 930 g/kg wheat flour + 70 g/kg grape-seed flour.*
Superscripts indicate where the differences between the samples in selected characters are; (n = 18; mean ± S.D.)

grape seed flour (sample F6) and bread baking mixture (sample F7) had the lowest moisture (Table 1). The dough produced from the bread baking mixture had the highest firmness F, firmness A and also stickiness F of all dough samples (Table 1). Our results are in agreement with those presented by Meral and Doğan (2013) who found that GS (grape seed) increases the dough development time and the dough stability value with the increase of GS content. On the other hand the dough with addition of 20 g/kg grape seed flour (F2) had the lowest stickiness F (Table 1). The results obtained by sensory analysis of bread showed that sourness, salinity, sensation when swallowing, impalpability, gumminess, sogginess of all the breads did not change significantly with the increasing amounts of grape seed flour (Table 2). Table 2 also illustrates that in the bread with the grape seed flour addition of 100 g/kg (F6), taste was worse in comparison with the control sample (F1). Our results are not in agreement with those presented by Soto et al. (2012) who said that the cereal bar containing ‚Merlot‘ GSF had the highest acceptance of all because of its sensory properties. Training assessors noticed darker color of the bread with the addition of 40 to 100 g/kg grape seed flour (F3-F6) and bread produced from the bread baking mixture (F7) in comparison with the control variant (F1; Table 2). Our results are in agreement with those presented by Hoye and Ross (2011) who found that replacement above 5 g grape seed flour per 100 g hard red spring wheat flour decreased the loaf brightness (loaf was darker). Color intensity was higher (the bread was darker) in the bread produced from the bread baking mixture in comparison with the bread with addition of 20 g/kg (F2) and 40 g/kg (F3) grape seed flour (Table 2). Our results are in agreement with those presented by Peng et al.,2010 who suggested that grape seed extract (GSE) could affect bread color. Measurments confirmed that the addition of grape seed flour intensified color of bread due to oxidation of monophenols to diphenols and of enzymatic reactions. Bread produced from the bread baking mixture had the darkest color due to the amount of grape seed flour and malt. The worse overall quality (whole quality of bread, the values of sourness, saltines, sensation when swallowing, impalpability, gumminess, sogginess taste and color) was observed in the bread with 80.0 g/kg (F5) and 100 g/kg (F6) grape seed flour in comparison with the control sample (F1; Table 2). Soto et al. (2012) stated that cereal bars with ‚Merlot‘ GSF incorporated had the highest score. On the other hand, Hoye and Ross (2011) found that higher amounts of grape seed flour caused a lower overall acceptance. According to results (Table 3) obtained by the chemical analysis of bread we can say that the control bread (without grape seed flour) had the lowest amount of

Table 2. Sensory quality (expressed as median values) of bread with grape-seed flour (F1 to F7 see Table 1)

Formulations*	F1	F2	F3	F4	F5	F6	F7
Taste (1 = very good to 5 = very bad)	3^{a}	$3^{a,b}$	$4^{a,b}$	$4^{a,b}$	3^{b}	4^{b}	$2^{a,b}$
Sourness (1 = none to 5 = very high	1^{a}	1^{a}	1^{a}	1^{a}	1^{a}	1^{a}	1^{a}
Saltiness (1 = none to 5 = very high	1^{a}	1^{a}	1^{a}	1^{a}	1^{a}	2^{a}	2^{a}
Swallowing sensation (1 = pleasant to 5 = bad)	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}
Impalpability (1 = very high to 5 = very low)	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}
Gumminess (1 = very high to 5 = hardly noticeable)	4^{a}	4^{a}	4^{a}	5^{a}	5^{a}	4^{a}	4^{a}
Sogginess (1 = very good to 5 = very bad)	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	3^{a}	2^{a}
Colour (1 = light to 5 = very dark)	1^{a}	$2^{a,b}$	$3^{b,c,d}$	$3^{b,c,d,e}$	$4^{c,d,e}$	$4^{d,e}$	5^{e}
Overall quality (1 = excellent to 5 = very bad, unacceptable)	2^{a}	$3^{a,b}$	$3^{a,b}$	$3^{a,b}$	3^{b}	3^{b}	$2^{a,b}$

** Five-point quality ordinal scale hedonic type with characteristics of each step used. Median values with the same superscript letter in each row are not significantly different ($P \geq 0.05$); each formulation was evaluated separately (n = 15, mean ±S.D.)*

Table 3: Indicators of wheat-bread nutritional value and digestibility after application of grape seed flour (n = 18; mean ± S.D.)

Formulations*	Moisture (g/kg)	N-subst. (g/kg)	Fat (g/kg)	Fibre (g/kg)	Ash (g/kg)	W_{DM}** (%)	D** (%)	Firmness F*** (%)	Firmness A*** (%)
F1	358 ± 5.46	118 ± 1.52	1.76 ± 0.24	5.07 ± 0.49	343 ± 16.3	84.4 ± 2.15	87.8 ± 1.56	292 ± 36	401 ± 80
F2	362 ± 5.18	119 ± 1.68	2.16 ± 0.33	4.93 ± 0.72	346 ± 18.4	81.2 ± 1.68	83.7 ± 1.81	267 ± 49	339 ± 67
F3	362 ± 4.92	118 ± 1.77	3.49 ± 0.41	5.14 ± 0.46	349 ± 21.0	74.5 ± 1.79	78.5 ± 1.73	266 ± 51	324 ± 80
F4	366 ± 4.99	118 ± 1.42	3.22 ± 0.39	5.19 ± 0.62	356 ± 25.3	70.2 ± 2.14	73.9 ± 1.69	216 ± 21	260 ± 34
F5	362 ± 5.12	120 ± 1.55	3.18 ± 0.27	5.13 ± 0.81	364 ± 32.3	63.2 ± 2.01	67.8 ± 1.55	236 ± 29	288 ± 45
F6	367 ± 5.18	121 ± 1.49	3.12 ± 0.34	5.30 ± 0.69	362 ± 29.2	52.3 ± 1.77	57.0 ± 1.81	227 ± 36	279 ± 59
F7	380 ± 4.92	168 ± 2.01	4.59 ± 0.15	5.39 ± 0.73	356 ± 25.0	96.0 ± 1.92	97.6 ± 2.01	183 ± 4	220 ± 19

**F1 to F7: see Table 1; **W_{DM} : digestibility of dry matter and ash, D: digestibility of organic matter; ***Increase of Firmness F, 2nd. day after baking – power which is necessary for achievement of deformation or penetration of the product, increase of Firmness A, 2nd day after baking – total force which is necessary for deformation* nitrogen substances, fat and fibre and the lowest moisture and content of ash. Samples of bread with 20 to 100 g/kg grape seed flour had lower moisture, amount of nitrogen substances and amount of fat in comparison with bread produced from the bread baking mixture. It is due to ingredients present in the bread baking mixture, especially due to wheat flour, soy starch, grape seed flour 70 g/kg, sunflower seeds, gluten, rye flour, flaxseed and malt. Sample of bread with 100 g/kg grape seed flour and bread produced from the bread baking mixture had the highest amount of fibre in comparison with the other samples of bread (Table 3). Samples of bread with 80 to 100 g/kg grape seed flour had the highest amount of ash. This is due to a higher amount of milled bran. On the other hand, W_{DM} (digestibility of dry matter and ash) and D (digestibility of organic matter) decreased with increasing amount of grape seed flour. The highest W_{DM} and D had bread produced from the Backmischung because of the presence of soy starch, sunflower seeds, gluten, flaxseed, dehydrated yeast in comparison with other samples of bread (Table 3). Measurements of bread textural properties 2 days after baking according to fresh bread (after baking) are shown in Table 3. Firmness F and firmness A decreased in the bread with additions of 20 to 60 g/kg grape seed flour and bread from the bread baking mixture (70 g/kg). In comparison firmness F and A increased with additions of 80 to 100 g/kg grape seed flour to breads in general (Table 3). Our results are in agreement with Hoye and Ross (2011) who stated that the firmness of bread increases with increased GSF addition. Wang et al. (2007) found that hardness, namely firmness, is one of the commonly used indices to describe bread quality as the change of hardness normally reflects the loss of resilience. It can be said that bread with additions of 40 to 60 g/kg grape seed flour was losing freshness more slowly than bread with the lowest and two highest additions (80 to 100 g/kg) of grape seed flour. Bread from the bread baking mixture (70 g/kg) was the freshest (the bread had the longest shelf life). The control sample of bread (without grape seed flour) was the driest.

CONCLUSION

Grape seeds are very valuable materials with a lot of valuable important properties for our health. This work shows results which can be used in the bakery technology or can help to produce final bakery products of better nutritional quality. In conclusion, assessors value lower additions of grape seed flour (up to 70 g/kg (F3, F4, F7), especially 40 to 70 g/kg) as acceptable and compromise between sensory and texture characteristics and health benefits represented by the presence of bioactive substances in grape seed flour (simple phenolic compounds, polyphenols etc.). Higher additions of grape seed flour (80 to 100 g/kg) were unacceptable on the part of assessors and final quality of bread, too. From this point of view the highest moisture, amount of fibre and digestibility bread produced from the bread baking mixture in comparison with other samples of bread was evaluated the best. With respect to moisture, amount of fibre and digestibility the bread produced from the bread baking mixture was evaluated the best compared to other samples. And bread produced from the bread baking mixture had the darkest color which is positive, too (according to preference of consumers today).

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