



Sensory analysis and chemical characterization of cereal enriched with grape peel and seed flour

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ABSTRACT. Current study analyzes a breakfast cereal with partial replacement of corn grits by the flour of grape seeds and peels from the residues of the wine industry. Residues (peels and seeds) of grape varieties 'Isabel' and 'Bordô' were dried in an air circulation oven at 85°C for 6 hours to obtain the flour. Three formulations of breakfast extruded cereals were prepared with 10, 15 and 20% of grape flour to replace corn grits. The formulas were analyzed with regard to their phenolic compounds, fibers, instrumental texture and sensory evaluation so that the samples' general acceptance could be verified. Breakfast cereals with higher phenolic content were those made with 20% of seed and peel flour; fibers rates were similar and the most accepted were those containing 15 and 20% residue flour. The use of residues from the wine industry is an alternative to reduce the risk of pollution by inadequate disposal. The flour produced in this study is rich in fibers and bioactive compounds and represents an alternative source of human food.

Keywords: extrusion, total phenols, crude fiber, texture.

Análise sensorial e caracterização química de cereal matinal enriquecido com farinha da casca e semente de uva

RESUMO. O objetivo deste trabalho foi elaborar um cereal matinal com substituição parcial do grits de milho pela farinha da casca e semente de uva proveniente do resíduo da indústria vinícola. O resíduo (casca e semente) de uva composto pelas variedades Isabel e Bordô foi seco em estufa com circulação de ar a 85°C por 6h para obtenção da farinha. Foram elaboradas três formulações de cereais matinais extrusados utilizando 10, 15 e 20% da farinha de uva, em substituição ao grits de milho, e estas foram caracterizadas em relação aos compostos fenólicos, fibra bruta, textura instrumental e avaliação sensorial, para verificação da aceitação global das amostras. Os cereais matinais que apresentaram maior teor de fenólicos foram aqueles elaborados com 20% da farinha da casca e semente de uva; os valores das fibras foram semelhantes entre si e os de maior aceitação foram os cereais elaborados com 15 e 20%. O aproveitamento dos resíduos agroindustriais da indústria vinícola é uma alternativa para reduzir o risco de poluição com o seu descarte inadequado. O cereal elaborado nesse estudo, rico em fibras e em componentes bioativos, representa uma fonte alternativa de alimento para o organismo humano.

Palavras-chave: extrusado, fenólicos totais, fibra bruta, textura.

Introduction

Breakfast cereals, extruded products traditionally consumed with milk, are characterized by crispness and by texture directly associated to freshness and quality (TAKEUCHI et al., 2005).

Thermoplastic extrusion, a known efficient and versatile industrial technology, is used in the production of breakfast cereals (ROCKY, 1995) and has several advantages over conventional processes. It comprises lower costs and time in the process, less

physical space and greater flexibility for the manufacturing of various products, with changes only in the matrix, the process conditions, the initial formulation, the final product coverage and size of raw material (RIAZ, 2000).

A mixture of different cereals may be used in the formulations of extruded breakfast cereals, comprising flours, grits and integral flours, which may be mixed with other ingredients to vary their appearance, texture, flavor, aroma and other characteristics (RIAZ, 2000). In other words, these

nutritional attributions are specific to people's diet. Fresh or processed grapes are one of the most consumed fruits in the world. At present, grapes are being focused as an important source of biologically active compounds highly beneficial to human health (ORAK, 2007).

Due to its great agricultural activity, Brazil is one of the agents that most produce agribusiness wastes. Production data indicate that for each 100 liters of white wine produced, 31.7 kg of waste are generated, of which 20 kg are constituted by bagasse. Producers and wine industries face the problem of disposing their residual biomass which, albeit biodegradable, requires minimal time to be mineralized and in due time becomes a source of several environmental pollutants (CAMPOS, 2005 apud CATANEO et al., 2008).

The above-mentioned agribusiness wastes contain a variety of biologically active compounds that are lost, many of which are polyphenols (TORRES et al., 2002). The major grape phenols are flavonoids (anthocyanins), styrylbenzenes (resveratrol), phenolic acids (derived from hydroxybenzoic and hydroxycinnamic acids) and a wide variety of tannins (FRANCIS, 2000).

The benefits to health related to moderate wine consumption include different mechanisms in which ethanol and various types of phenolic compounds present in wine (BRAND-MILLER et al., 2007) are involved. However, the supply of these compounds from alcoholic beverages should be monitored with caution.

An accelerated search has been carried out in recent years for foods with high nutritional quality and phenolic compounds supply. Further, the search for alternative usage of organic matter generated by the wine industry is on the increase in several research centers. However, scanty research has been carried out on the addition of grape phenolic compounds in food, such as breakfast cereals. Current study focused on the preparation of a breakfast cereal with partial replacement of corn grits by the flour of grape residues (peels and seeds) derived from the wine industry. It also evaluated the product with regard to its sensory acceptance and physical and chemical features.

Material and methods

Cereal processing

After fermentation for wine production, the residues (peel and seed) of the 'Isabel' and 'Bordô' grape varieties were collected in the Agribusiness Cooperative of Wine Producers of Marialva

(Coavitti), Marialva, Paraná State, Brazil. Residues were then pressed by a small mechanical press to remove the excess of wine. The samples were packed in coolers with ice and taken to the Laboratory of Food Biochemistry at the State University of Maringá, Maringá, Paraná State, Brazil, and preserved at -18°C for subsequent drying, chemical processing and evaluation.

The material was dried in a forced-air circulation oven (Quimis) at 85°C , for 6 hours, and then ground in a mill (MA 048) to obtain uniform grain flour.

Cereal processing was performed in the Laboratory of Cereal Technology, State University of Maringá, Maringá, Paraná State, Brazil, with three formulations: 10, 15 and 20% of grape peel and seed flour (CS) replacing an equal amount of corn grits. Breakfast cereals were produced by an extruder (Imbramaq BI-50) which mixed corn grits, seed and peel flour and 7% of water on a weight basis. After cereal extrusion, a 700 g sample was coated with 50% sucrose, 33% water, 10% cocoa, 5% invert sugar and 2% caramel colorant up to 1,000 g. The sample was then packed in a polypropylene bag for subsequent sensory analysis and instrumental texture. Another 700 g were left uncoated but were also packed in polypropylene bags for chemical analysis.

Chemical and physical characterization

The following characteristics of the cereal were analyzed: crude fiber, according to AOAC (1997) method; phenolic compounds, according to the method by Singleton and Rossi Jr. (1965), using Folin-Ciocalteu reagent; absorbance reading in a spectrophotometer (Genova) at 765 nm. Results were quantified by the construction of standard curve with gallic acid ($\text{mg gallic acid } 100 \text{ g}^{-1}$).

Cereal instrumental texture was analyzed one day after extrusion. Fifteen replicate samples for each recipe were used. Texture meter (Stable Micro Systems Texture Analyzer TAXT2, Texture Technologies Corp., England) was employed with a Warner Bratzler probe 12 x 7 cm (HDP/BS).

Sensory analysis

Sensory test was performed to assess the sample's overall acceptance by 40 untrained testers. A hedonic scale was used to check the testers' like or dislike of the cereal prepared with 10, 15 and 20% residue flour. The scale ranged from 1 (I dislike it very much) to 9 (I like it very much) scores. The acceptability index (AI) was performed according to the overall acceptance attribute (STONE; SIDEL, 1985). The product's acceptability index (AI) was calculated by the following expression:

$$IA = \frac{A \times 100}{B} \quad (1)$$

which:

A = average score for the product;

B = maximum score given to the product.

Scores for an acceptable index must be equal to or higher than 70% (DUTCOSKY, 2007).

Statistical analysis

Data were statistically evaluated by analysis of variance (ANOVA) and average analysis by Tukey's test at 5% probability by SAS program.

From the results of cereal analysis, it was possible to calculate the correlation coefficient between the concentration of grape residue flour, phenolic compounds, fibers and texture.

Results and discussion

Characterization of the flour of grape peels and seeds

Grape peel and seed flour is an excellent source of phenolic compounds, as Table 1 shows. High levels are justified owing to the fact that grapes are excellent sources of natural antioxidants, especially phenolic compounds, such as luteolin, quercetin, procyanidins, tannins and resveratrol (BRAGA; BARLETA, 2007).

Soares et al. (2008) report that food rich in phenolic compounds, especially flavonoids, which are antioxidant agents, decreases cancer development, cardiovascular diseases and neurological disorders. Consequently, flour from grape peels and seeds is a nutritional alternative to enrich new food products.

Table 1 shows that the levels of phenols and crude fiber in wet and dry flour samples differ significantly at 5% from corn grits. The above demonstrates the importance of the cereal that must be enriched with such ingredients as flour of grape peels and seeds to improve its nutritional value.

Table 1. Chemical analysis of raw material.

Samples*	Total phenols (mg 100 g ⁻¹)	± δ	Crude fibers (g 100 g ⁻¹)	± δ
PS wet	111.39 b**	26.10	-	-
PS dry	283.74 a	17.23	16.65 a	1.11
Corn grits	29.24 c	1.23	1.55 b	0.08

*PS: grape peel and seed flour; PS wet: samples before drying; ±δ: standard deviation.
**Same small letters in the column do not differ by Tukey's test (p < 0.05).

According to Soares et al. (2008), the grape peels and seeds contain flavonoids (catechin, epicatechin, procyanidins and anthocyanins), phenolic acids and resveratrol, which proved to be a functional food. These authors analyzed the levels of phenolic compounds from grape peels after fruit pulping and found rates for the dry weight of grape cultivar

'Isabella' (1,026.69 mg 100 g⁻¹) higher than those in current study. However, the peels used by these researchers did not undergo an extraction process of phenolic compounds as that in peels and seeds used in this work, i.e., they underwent an extraction process of phenolic components during winemaking.

Cataneo et al. (2008) found a variation for total phenolic compounds in grape ('Couderc 13') dry bagasse ranging between 109.64 and 207.80 mg 100 g⁻¹, and between 370.17 and 420.61 mg 100 g⁻¹ in grape ('Pinot Gris') dry bagasse. Rates in the above-mentioned research lie within the range observed for grape 'Couderc 13' by these authors. However, the phenolic characteristics of grapes and bagasse may vary according to grape variety, maturation degree and processing method.

Table 2 shows rates of phenolic compounds of extruded cereal with partial replacement of corn grits by flour of grape peels and seeds (PS). The correlation coefficient (r = 0.99) between PS flour concentration and total phenols corresponds to a strong interaction of total phenols and the addition of PS flour. Increase in the levels of phenolic compounds is desirable since they help in the good functioning of the organism, such as antioxidant activity.

Table 2. Chemical determinations of cereal enriched with flour of grape peels and seeds from the wine industry.

Samples*	Total phenols (mg 100 g ⁻¹)	± δ	Crude fibers (g 100 g ⁻¹)	± δ
10% PS	47.51 c**	1.85	2.77 a	0.80
15% PS	60.95 b	4.23	3.32 a	0.87
20% PS	76.00 a	6.56	6.28 a	1.20

*PS: grape peel and seed flour. **Same small letters in the column do not differ by Tukey's test (p < 0.05).

The study on fibers in fruit flours for the manufacture of foodstuffs for human consumption is of utmost importance. Fibers may be divided into soluble fibers which are associated with reduced blood cholesterol and glucose control, and insoluble fibers which cause a beneficial effect on bowel movement, that is, they contribute towards a good evacuation (ORDOÑEZ-PEREDA et al., 2005). This is the reason why recently the search for food with high fiber contents is on the increase.

The percentage of crude fiber in flour of grape peels and seeds (Table 1) was similar to rates in white grapes (19.9 g 100 g⁻¹) obtained by Baumgartel et al. (2007) and lower than those in purple grapes (31.2 g 100 g⁻¹). The flour actually has 10 times more fiber contents than that of corn grits. Table 2 also shows that the partial substitution of corn grits in breakfast cereal increased the percentage of crude

fibers, with a strong positive interaction ($r = 0.93$) with regard to the ingredient.

Sensory analysis

Breakfast cereals used in current study showed no statistical difference with regard to the overall average score by 40 untrained testers (Table 3). When the criterion of acceptance rate was taken into account, the cereals formulated with 15 and 20% of PS flour reached the limiting point and may be considered well accepted. On the other hand, cereals with 10% PS flour remained below 70%. Low acceptability index was due to the hardness analysis (instrumental texture). In fact, the formulation of the above had the highest hardness rate.

Table 3. Averages of sensory analysis and instrumental texture.

Samples*	Overall average	$\pm \delta$	Acceptance index (%)	Instrumental texture (kgf)	$\pm \delta$
10%/PS	6.19 a**	1.89	68.78	3.48 a	0.82
15% PS	6.73 a	1.44	74.86	2.47 b	0.54
20% PS	6.45 a	1.59	71.69	2.10 b	0.49

*PS: grape peel and seed flour. **Similar small letters in the column do not differ by Tukey's test ($p < 0.05$).

It has been observed that the instrumental texture is reversely ($r = -0.92$) linked to PS flour concentration, or rather, increasing concentration of PS flour means less cereal hardness.

Since the cereal with 15% PS flour had the highest acceptance rate, it might be perceived that the most acceptable texture ranged between 2.10 and 2.47 kgf.

The formulations for a higher nutritional food coupled to satisfactory sensory acceptance were thus prepared with 15 and 20% PS flour.

The extruded cereal preserved the functional components of the flour of grape peels and seeds. This is an advantage from the extrusion process, since the change in the nutritional rate depends on the processing rigor with higher digestibility and the inactivation of anti-nutritional factors. This process also increased the product useful life due to its low water activity (ORDOÑEZ-PEREDA et al., 2005).

Conclusion

The best breakfast cereals made with the partial substitution of corn grits by grape peel and seed flour with higher phenolic compounds were those featuring 20% PS flour; moreover, cereals with 15 and 20% PS flour had the highest acceptance rate.

The preparation of breakfast cereal produced with residues from wine industry is an alternative to reduce the risk of pollution derived from their

inadequate disposal; in fact, they represent an alternative food source rich in fiber and bioactive compounds for the preservation of human health.

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