VANESSA BORDIN VIERA
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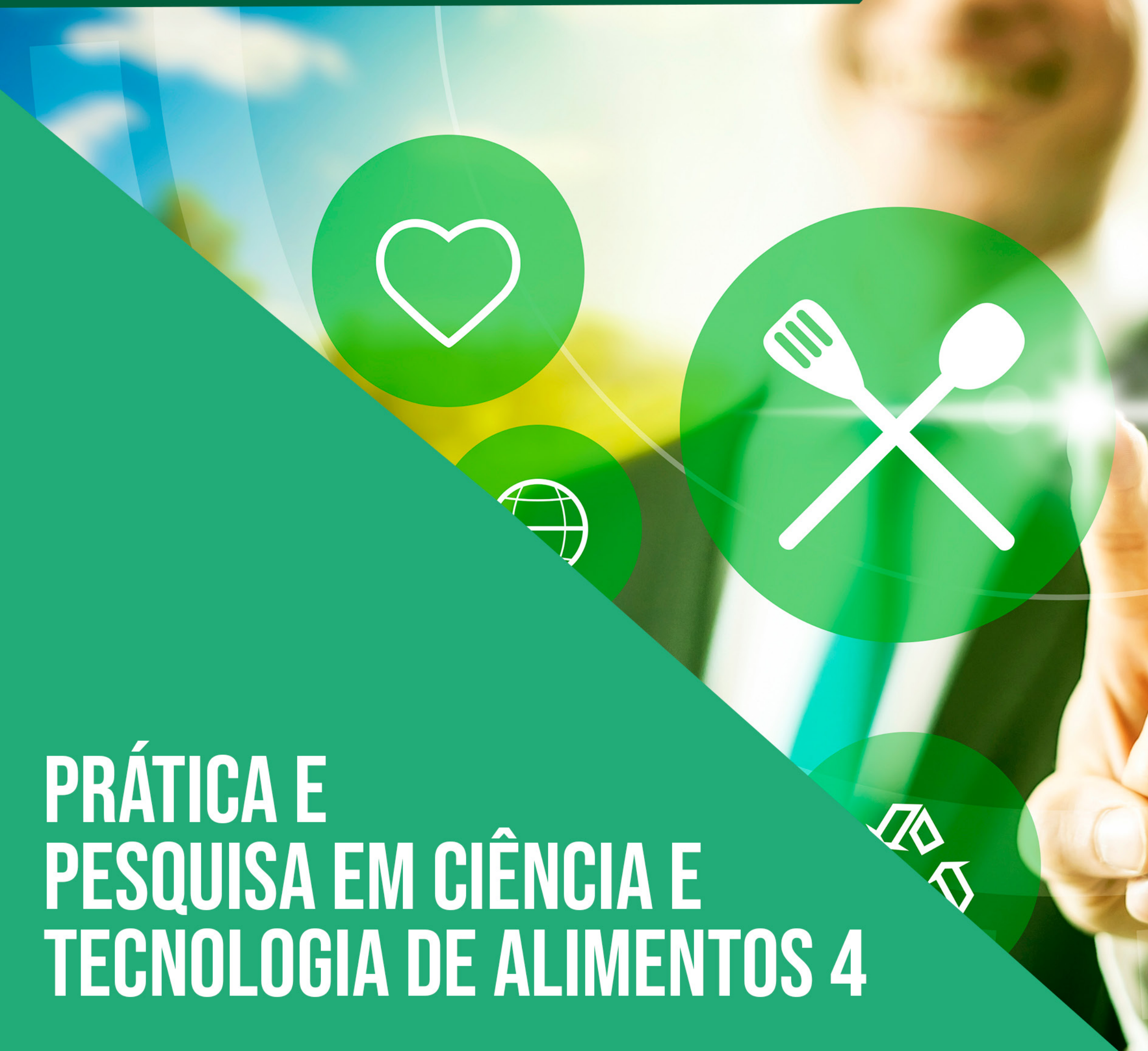

PRÁTICA E PESQUISA EM CIÊNCIA E TECNOLOGIA DE ALIMENTOS 4

Atena Editora

Ano 2020

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APRESENTAÇÃO

A obra intitulada “Prática e Pesquisa em Ciência e Tecnologia 3 está dividida em 2 volumes totalizando 34 artigos científicos que abordam temáticas como elaboração de novos produtos, embalagens, análise sensorial, boas práticas de fabricação, microbiologia de alimentos, avaliação físico-química de alimentos, entre outros.

Os artigos apresentados nessa obra são de extrema importância e trazem assuntos atuais na Ciência e Tecnologia de Alimentos. Fica claro que o alimento *in natura* ou transformado em um produto precisa ser conhecido quanto aos seus nutrientes, vitaminas, minerais, quanto a sua microbiologia e sua aceitabilidade sensorial para que possa ser comercializado e consumido. Para isso, se fazem necessárias pesquisas científicas, que comprovem a composição, benefícios e atestem a qualidade desse alimento para que o consumo se faça de maneira segura.

Diante disso, convidamos os leitores para conhecer e se atualizar com pesquisas na área de Ciência e Tecnologia de Alimentos através da leitura desse e-book. Por fim, desejamos a todos uma excelente leitura!

Vanessa Bordin Viera
Natiéli Piovesan
Juliana Késsia Barbosa Soares
Ana Carolina dos Santos Costa

SUMÁRIO

CAPÍTULO 14

PROXIMATE COMPOSITION AND FUNCTIONAL PROPERTIES OF DIETARY FIBER CONCENTRATES FROM GRAPE POMACE SKINS

Data de aceite: 01/07/2020

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ABSTRACT: Red grape pomace skins, Cabernet Sauvignon, Marselan, Merlot, Pinotage, Pinot Noir, Shiraz and Tannat, and white grape pomace skins, Chardonnay and Riesling, were used to produce dietary fiber concentrates. The samples were evaluated for proximate composition (dry matter (DM), ash, protein, lipids, dietary fiber and carbohydrates) and functional properties (water holding (WHC), oil binding (OBC) and cation binding capacities (CBC)). The highest ash content was observed in the dietary fiber concentrates, ranging from 7.76 to 18.60 g 100 g^{-1} DM. The concentration caused a reduction in the lipid content for all varieties and Shiraz presented the lowest value, 1.81 g 100 g^{-1} DM. Overall, the red grape varieties showed higher ash, protein and lipid content than white grape varieties. Dietary fiber was the major constituent in all varieties of grape pomace skins. Tannat (67.95 g 100 g^{-1} DM) and Riesling (52.21 g 100 g^{-1} DM) showed the highest content between red and white varieties, respectively. The carbohydrates content was lower in the dietary fiber concentrates. WHC and OBC results were similar for both, grape pomace skins and dietary fiber concentrates. The values ranged from 1.95 to 2.48 g water g^{-1} DM and from 1.25 to 2.24 g oil g^{-1} DM, respectively. CBC was higher in dietary fiber concentrates and Cabernet Sauvignon

showed the highest value, 33.37 mg Cu g-1 DM. This study demonstrated that as grape pomace skins as its dietary fiber concentrates are important sources of dietary fiber with functional properties and these ingredients could be added in food products.
KEYWORDS: insoluble dietary fiber, physicochemical properties, vinification by-product.

COMPOSIÇÃO CENTESIMAL E PROPRIEDADES FUNCIONAIS DE CONCENTRADOS DE FIBRA ALIMENTAR DE CASCAS DE BAGAÇO DE UVA

RESUMO: Cascas de bagaço de uva tinta, Cabernet Sauvignon, Marselan, Merlot, Pinotage, Pinot Noir, Shiraz e Tannat e cascas de bagaço de uva branca, Chardonnay e Riesling, foram utilizadas para produzir concentrados de fibra alimentar. As amostras foram avaliadas quanto à composição centesimal (matéria seca (MS), cinzas, proteína, lipídeos, fibra alimentar e carboidratos) e propriedades funcionais (capacidade de retenção de água (CRA), capacidade de ligação ao óleo (CLO) e capacidade de ligação a cátions (CLC). O maior conteúdo de cinzas foi encontrado nos concentrados de fibra alimentar, variando de 7,76 a 18,60 g 100 g^{-1} MS. A concentração ocasionou uma redução no conteúdo lipídico em todas as variedades avaliadas e Shiraz apresentou o menor valor, 1,81 g 100 g-1 MS. De maneira geral, as variedades de uvas tintas apresentaram maiores teores de cinzas, proteína e lipídeos do que as variedades brancas. Fibra alimentar foi o principal constituinte das cascas de uva, em todas as variedades. Tannat (67,95 g 100 g^{-1} MS) e Riesling (52,21 g 100 g^{-1} MS) apresentaram os maiores teores entre as variedades tintas e brancas, respectivamente. O teor de carboidratos foi menor nos concentrados de fibra alimentar Os resultados encontrados para CRA e CLO foram semelhantes para ambas as amostras, cascas de bagaço de uva e concentrados de fibra alimentar. Os valores variaram entre 1,95 e 2,48 g água g^{-1} MS e 1,25 e 2,24 g óleo g^{-1} MS, respectivamente. CLC foi maior nos concentrados de fibra alimentar e Cabernet Sauvignon apresentou o maior valor, 33,37 mg Cu g^{-1} MS. O presente estudo demonstrou que as cascas do bagaço de uva e seus concentrados de fibra alimentar são uma importante fonte de fibra alimentar com propriedades funcionais e podem ser adicionados como ingredientes em produtos alimentícios.
PALAVRAS-CHAVE: fibra alimentar insolúvel, propriedades físico-químicas, subproduto da vinificação.

1 | INTRODUCTION

Brazil is the 5th producer of wine in the Southern Hemisphere (IBRAVIN, 2017) and Southern Brazil is the main winemaking region in the country. In 2017, Rio Grande do Sul state produced almost 50 million liters of wine (IBRAVIN, 2017). It was estimated that for each 100 liters of wine, 18 kg of pomace was produced (CAMPOS et al., 2008).

Grape pomace is composed of biodegradable organic matter and its inappropriate disposal creates serious environmental problems (MAKRIS et al., 2007). There is an increasing interest from both industrial and scientific research standpoints to characterize the bioactive compounds presents in the grape pomace, which could be used as functional ingredients in the food processing industry (GONZALÉZ-CENTENO et al., 2010).

As an important source of oil (FERNANDES et al., 2013) and phenolic compounds (ROCKENBACH et al., 2011), the winemaking by-product also contain high dietary fiber (DF) content (BRAVO; SAURA-CALIXTO,1998; LLOBERA; CANELLAS, 2008), mainly insoluble dietary fiber (IDF), such as cellulose and hemicellulose, and low soluble dietary fiber (SDF) levels, such as pectin (KAMMERER et al., 2005). The intake of these substances has been related to important nutritional and health benefits (KENDALL et al., 2010).

Grape pomace contains 60-85% of total dietary fiber (TDF) and the skins are the most important fraction of this component (about 60%) (BRAVO; SAURA-CALIXTO, 1998; LLOBERA; CAÑELLAS, 2007; DENG et al., 2011).

Dietary fiber (DF), defined as "edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine" (AACC, 2001) is abundant in plant products such as fruits, vegetables, and grains (DENG et al., 2011). Generally, fruit DF has better nutritional value than DF derived from cereals, because they also contain significant amounts of bioactive compounds such as polyphenols and carotenoids (MILDNER-SZKUDLARZ et al., 2011).

Dietary fiber can also add functional properties to foods, e.g., increase water and oil holding capacities, emulsification and/or gel formation (ELLEUCH et al., 2011). Due to the large amount generated worldwide every year from the wine and grape juice industry, grape pomace has the potential to serve as an important source of insoluble fiber for functional food development (YU; AHMEDNA, 2013). The production of dietary fiber concentrates from wastes is one way to recovering this important fraction of vegetables (Nieto-Calvache et al., 2019).

The aim of the present study was to produce dietary fiber concentrates from grape pomace skins and to evaluate the proximate composition and functional properties of samples.

2 I MATERIAL AND METHODS

Samples

Red and white winemaking by-products were collected from different wineries in Rio Grande do Sul state (Brazil): Cabernet Sauvignon, Marselan, Merlot, Pinotage, Pinot Noir, Shiraz and Tannat (red varieties), Chardonnay and Riesling (white varieties). The white varieties were collected the day of the harvest, after pressing the grapes. The red varieties were collected after maceration of the grapes for 2-3 weeks and pressing. Grape pomace (skins and seeds) was dehydrated in a forced-air-drying onven at 55°C for 24 h. Skins and seeds were separated with sieves. First, the dried pomace was sieved through a mesh (3 mm), to reduce the particle size. Thus, the particulate material was sieved through a mesh with 0.2 mm, for separating the skins from seeds – seeds were retained on the sieve). The procedures were carried out manually. Finally, skins were milled and stored at -18°C for further analysis.

Dietary fiber concentration

Dietary fiber concentrates from grape pomace skins were obtained after ethanol extraction, according Bender et al. (2017). The sample was immersed in boiling ethanol (final concentration 85%, v/v), at a ratio 2:1 (solvent: solute), under agitation, for 30 min. After precipitation (30 minutes), supernatant was discarded and precipitate was re-immersed in ethanol (final concentration 80%, v/v), twice. In each step, the supernatants were discarded and the remainder fibrous precipitate was dried in a forced-air-drying oven at 40°C for 24 h.

Proximate composition

Moisture (105°C/12 h), ash (550°C/5 h), crude protein (Kjeldahl method – N x 6.25) and total dietary fiber, including soluble and insoluble dietary fiber were determined according to AOAC (1995) methods. Lipid content was determined according to Bligh and Dyer method (1959). Carbohydrate was calculated by difference (100 – (total dietary fiber + lipid + crude protein + ash content) (CHAU; HUANG, 2003). The results were expressed in g 100 g^{-1} of dry matter (DM).

Functional properties

Water holding capacity (WHC) and oil binding capacity (OBC) were determined according to Femenia et al. (1997). Sample was hydrated in distilled water (for WHC) or soy oil (for OBC). After equilibrium (24 h) and centrifugation (3000 rpm, 15 min), the supernatant was discarded. The results were expressed as the amount of water/oil retained by 1 g of sample (g water/oil g^{-1} DM), respectively.

Cation binding capacity was estimated as copper-binding as described by McBurney et al. (1983). The results were expressed as the amount of copper held by 1 g sample (mg Cu g^{-1} DM).

Statistical analysis

Results were expressed as mean (n = 3). The effect of samples on the proximate composition and functional properties was compared using F test ($P < 0.05$). The effect of samples on the proximate composition and functional properties from each grape variety was compared by Tukey test ($P < 0.05$).

3 | RESULTS AND DISCUSSION

The dietary fiber concentration proved to be effective for modified all components from proximate composition. There was significant interaction between grape varieties and samples ($P < 0.05$) (Table 1). For all grape varieties, dietary fiber concentrates showed lower lipid, total and insoluble dietary fiber content than its grape pomace skins.

Total dietary fiber (TDF) was the predominant component in all varieties of grape pomace skins. Grape variety Pinotage showed the highest content before dietary dietary concentration, 58.66 g 100 g^{-1} DM. As expected, dietary fiber concentrates presented an increase in TDF, highlighting Tannat (67.95 g 100 g^{-1} DM) in red grape varieties and Riesling (52.21 g100 g^{-1} DM) in white grape varieties. These contents are in agreement with Llobera and Cañellas (2008) (about 50-75 g 100 g^{-1} DM). According Femenia et al. (1997) and Larrauri (1999) these ingredients could be considered as a rich source of dietary fiber.

The main constituent of dietary fiber was the insoluble fraction, ranging from 31.09 to 54.67 g 100 g^{-1} DM in grape pomace skins and from 41.08 to 62.34 g 100 g^{-1} DM in dietary fiber concentrates, for Chardonnay and Tannat, respectively. Deng et al. (2011) reported that the main constituents of insoluble dietary fiber are cellulose and hemicellulose. The main constituents of soluble dietary fiber (SDF) in the pomace sample are pectins, accounting for more than 60% of SDF (DENG et al., 2011). The SDF content in the present study was lower than reported by Llobera and Cañellas (2007), 10.08 g 100 g^{-1} DM, for Manto Negro variety. The differences could be attributed to the different cultivars studied.

Soluble fibers are characterized by the ability to increase viscosity and reduce glycemic response and plasma cholesterol. Insoluble fibers are characterized by porosity, low density and ability to increase fecal bolus and decrease intestinal transit (REF).

In dietary fiber concentrates it was observed lower carbohydrates content than grape pomace skins. This result is related to increase in complex carbohydrates provided by the dietary fiber.

Overall, red grape varieties presented higher ash, protein and lipid contents than white ones. The result was consistent with Deng et al. (2011). Dietary fiber concentrates showed higher protein content, ranging from 15.50 to 20.21 g 100 g^{-1} DM. This result was higher than reported by González-Centeno et al. (2010) and Llobera and Cañellas (2007), 3.1 to3.8 g 100 g^{-1} DM and similar to Deng et al. (2011), 11.26 to 12.34 g 100 g^{-1} DM.

The lipid content was low in all samples. The successive washes with ethanol retained the lipids in the supernatant. Because of this, the content in dietary fiber concentrates was compared to grape pomace skins, mainly for Shiraz variety that presented 1.81 g 100 g^{-1} DM.

Ash content ranged from 6.34 to 13.72 g 100 g^{-1} DM in Chardonnay and Cabernet Sauvignon grape pomace skins, respectively, and 7.63 and 18.60 g 100 g^{-1} DM in Tannat and Merlot dietary fiber concentrates, respectively.

Regarding the chemical composition of grape pomace skins and its dietary fiber concentrates, these ingredients could be used to improve the protein content and to reduce calories in food products and as a source of dietary fiber.

The functional properties of dietary fiber are related to its physiological effects and technological properties (Benítez et al., 2017). In the present study, we investigated the water holding, oil binding and cation binding capacities in grape pomace skins and its dietary fiber concentrates (Table 2).

The water holding capacity (WHC) ranged from 1.95 to 2.96 g water g^{-1} DM. For Chardonnay dietary fiber concentrate that exhibited the highest value for SDF, WHC was not statistically different for its grape pomace skin. The results in the present study were lower than reported by González-Centeno et al. (2010). Borchani et al. (2011) mentioned that the particle size, source, temperature, pH and ionic strength influence the WHC of fiber. Fibers from fruit by-products have greater affinity for water entrapping than cereal wastes. These differences are related to the physicochemical properties of fibers, mainly the higher soluble fiber content in vegetables than cereals (Elleuch et al., 2011).

The values for oil binding capacity (OBC) were higher in Cabernet Sauvignon, Chardonnay, Shiraz and Tannat dietary fiber concentrates. For other grape varieties, the higher values were presented in grape pomace skins. These results also were lower than those reported by González-Centeno et al. (2010), above 4 g oil g^{-1} DM and higher than the values described by Martínez et al. (2012) for mango, passion fruit, pineapple and guava dietary fiber concentrates, that ranged from 0.7 to 1.6 g oil g^{-1} DM. The OBC is dependent on fiber composition, surface properties and hydrophobic nature of the fiber particles (Femenia et al., 1997). Besides the techonological property related to prevention of phase separation during food preservation, storage and distribution, the OBC is associated to an important physiological effect. During human metabolism, ingredients with high OBC could entrap the lipids in the intestinal lumen, helping to reduce serum cholesterol levels (Nieto-Calvache et al., 2019).

Overall, the cation binding capacity (CBC) was higher in dietary fiber concentrates, mainly for Cabernet Sauvignon, 33.37 mg Cu g^{-1} DM. Regarding the physiological effects, materials with high CBC could entrap, destabilize, and disintegrate a lipid emulsion, decreasing the diffusion and absorption of lipids (Benítez et al., 2017). Due to the functional properties, the dietary fiber concentrates from grape pomace skins could be used as a stabilizer in products with high lipid content and as a functional ingredient to prevent syneresis and modify viscosity and texture in bakery products.

4 I CONCLUSIONS

The results suggested that the dietary fiber concentration could be carried out to increase this important constituent of grape pomace skins and to reduce lipid content. Overall, dietary fiber concentrates from grape pomace skins showed higher total dietary fiber content and significant amounts of water holding, oil and cation binding capacities and could be used as additive for improving the dietary fiber content in food products.

Due to its proximate composition and functional properties, dietary fiber concentrates from Tannat and Riesling were highlighted in red and white grape varieties, respectively.

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Component (g 100 g^{-1} DM)	Samples	Grape varieties									CV	*P* (SXV)*
		Cabernet Sauvignon	Chardonnay	Marselan	Merlot	Pinotage	Pinot Noir	Riesling	Shiraz	Tannat		
TDF	Grape pomace skins	57.14^{b}	37.18^{b}	58.00^{b}	47.19^{b}	58.66^{b}	56.72^{b}	35.95^{b}	52.02^{b}	55.40^{b}	1.49	< 0.001
	Dietary fiber concentrate	61.11^{a}	49.10^{a}	65.28^{a}	53.17^{a}	64.14^{a}	62.37^{a}	52.21^{a}	63.00^{a}	67.95^{a}		
IDF	Grape pomace skins	52.55^{b}	31.09^{b}	54.51^{b}	42.60^{b}	53.33^{b}	54.37^{b}	32.37^{b}	47.88^{b}	54.67^{b}	2.04	< 0.001
	Dietary fiber concentrate	56.04^{a}	41.08^{a}	59.11^{a}	43.77^{a}	57.25^{a}	57.06^{a}	44.44^{a}	59.50^{a}	62.34^{a}		
SDF	Grape pomace skins	4.59^{ns}	6.09^{ns}	3.50^{b}	4.59^{b}	5.33^{ns}	2.34^{ns}	3.58^{b}	4.13^{ns}	0.73^{b}	18.86	< 0.001
	Dietary fiber concentrate	5.07^{ns}	8.01^{ns}	6.17^{a}	9.40^{a}	6.89^{ns}	5.31^{ns}	7.77^{a}	3.50^{ns}	5.91^{a}		
CARB	Grape pomace skins	8.80^{a}	42.87^{a}	17.63^{a}	19.29^{a}	11.05^{a}	11.49^{a}	42.53^{a}	12.34^{a}	13.44^{a}	6.03	< 0.001
	Dietary fiber concentrate	6.33^{b}	28.83^{b}	8.70^{b}	13.78^{b}	7.79^{b}	9.10^{b}	23.05^{b}	7.72^{b}	1.40^{b}		
Protein	Grape pomace skins	14.79^{b}	9.20^{b}	6.78^{b}	11.96^{b}	13.76^{ns}	16.22^{ns}	8.69^{b}	12.56^{ns}	15.50^{b}	2.62	< 0.001
	Dietary fiber concentrate	16.82^{a}	10.81^{a}	7.40^{a}	12.59^{a}	14.04^{ns}	16.13^{ns}	11.49^{a}	12.70^{ns}	20.21^{a}		
Lipid	Grape pomace skins	5.55^{a}	4.41^{a}	5.13^{a}	5.30^{a}	4.92^{a}	5.30^{a}	4.45^{a}	6.87^{a}	7.26^{a}	3.93	< 0.001
	Dietary fiber concentrate	2.37^{b}	3.50^{b}	2.15^{b}	1.86^{b}	2.13^{b}	1.95^{b}	2.72^{b}	1.81^{b}	2.81^{b}		
Ash	Grape pomace skins	13.72^{ns}	6.34^{b}	12.46^{b}	16.27^{b}	11.89^{ns}	10.27^{ns}	8.38^{b}	16.21^{a}	8.39^{a}	2.87	< 0.001
	Dietary fiber concentrate	13.37^{ns}	7.76^{a}	16.48^{a}	18.60^{a}	11.61^{ns}	10.45^{ns}	10.53^{a}	14.76^{b}	7.63^{b}		

Table 1 - Proximate composition of grape pomace skins and dietary fiber concentrates, regarding samples (S) and grape varieties (V) combination.

* Statistically different ($P < 0.05$) by F test.

Means with different letters, for the same component, in the same column, indicate statistical differences ($P < 0.05$).

TDF: Total dietary fiber; IDF: Insoluble dietary fiber; SDF: Soluble dietary fiber; CARB: Carbohydrates; CV: Coefficient variation; ns: not significant.

Parameter	Samples	Grape varieties									CV	*P* (SXV)
		Cabernet Sauvignon	Chardonnay	Marselan	Merlot	Pinotage	Pinot Noir	Riesling	Shiraz	Tannat		
WHC (g water g^{-1} DM)	Grape pomace skins	2.30^{ns}	2.03^{ns}	2.35^{a}	2.35^{a}	2.96^{a}	2.48^{ns}	1.95^{b}	2.10^{ns}	2.48^{ns}	5.21	< 0.001
	Dietary fiber concentrate	2.45^{ns}	2.03^{ns}	2.22^{b}	2.18^{b}	2.22^{b}	2.41^{ns}	2.25^{a}	2.16^{ns}	2.42^{ns}		
OBC (g oil g^{-1} DM)	Grape pomace skins	1.55^{b}	1.25^{b}	1.92^{a}	2.09^{ns}	1.95^{ns}	2.24^{a}	1.64^{ns}	1.55^{b}	1.63^{b}	4.19	< 0.001
	Dietary fiber concentrate	1.74^{a}	1.56^{a}	1.54^{b}	1.83^{ns}	1.77^{ns}	1.79^{b}	1.49^{ns}	1.91^{a}	1.80^{a}		
CBC (mg Cu g^{-1} DM)	Grape pomace skins	23.96^{b}	14.86^{b}	23.08^{b}	25.92^{ns}	23.53^{b}	26.12^{ns}	15.79^{b}	37.52^{ns}	20.75^{b}	5.52	< 0.001
	Dietary fiber concentrate	33.37^{a}	20.04^{a}	27.35^{a}	27.20^{ns}	29.27^{a}	25.24^{ns}	19.48^{a}	31.70^{ns}	27.00^{a}		

Table 2 - Functional properties of grape pomace skins and dietary fiber concentrates, regarding samples (S) and grape varieties (V) combination.

* Statistically different ($P < 0.05$) by F test.

Means with different letters, for the same parameter, in the same column, indicate statistical differences ($P < 0.05$).

WHC: Water holding capacity; OBC: Oil binding capacity; CBC: Cation binding capacity; CV: Coefficient variation; ns: not significant.

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