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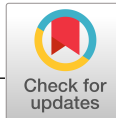


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Potential of grape byproducts as functional ingredients in baked goods and pasta

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Abstract

Wine making industry generates high quantities of valuable byproducts that can be used to enhance foods in order to diminish the environmental impact and to obtain more economic benefits. Grape byproducts are rich in phenolic compounds and dietary fiber, which make them suitable to improve the nutritional value of bakery, pastry, and pasta products. The viscoelastic behavior of dough and the textural and the sensory characteristics of baked goods and pasta containing grape byproducts depend on the addition level and particle size. Thus, an optimal dose of a finer grape byproducts flour must be found in order to minimize the negative effects such as low loaf volume and undesirable sensory and textural characteristics they may have on the final product quality. In the same time, an enrichment of the nutritional and functional value of the product by increasing the fiber and antioxidant compounds contents is desired. The aim of this review was to summarize the effects of the chemical components of grape byproducts on the nutritional, functional, rheological, textural, physical, and sensory characteristics of the baked goods and pasta. Further researches about the impact of foods enriched with grape byproducts on the human health, about molecular interactions between components, and about the effects of grape pomace compounds on the shelf life of baked goods and pasta are recommended.

KEYWORDS

antioxidant, fiber, grape byproducts, product quality, rheology

1 | INTRODUCTION

People's interest for functional foods increased last years, high-quality products development being an important research direction. The nutritional value of food products can be increased by adding vegetable, fruits, or non-grain plants flours (Galanakis, 2012; Kuchtová, Kohajdová, Karovičová, & Lauková, 2018; Liu, Ragone, & Murch, 2015). Nowadays, consumer awareness regarding functional foods and their relationship with health led to an increase of innovations in this field (Bornkessel, Bröring, Omta, & van Trijp, 2014; Šporin, Avbelj, Kovač, & Možina, 2018). Thus, in many countries some governmental pro-

grams are implemented, aiming to improve the nutritional aspects in people's diet. Most of these programs refer to the enrichment with functional ingredients in food products (Parker, Burns, & Sanchez, 2010; Samohvalova, Grevtseva, Brykova, & Grigorenko, 2016).

The increase of food demand at global level requires changes of foods manufacturing processes to make them sustainable by protecting the environment and reducing costs. Vegetables and fruit byproducts are valuable ingredients that can be used to enrich foods, wine industry being one of the fields that produce this kind of waste. Grape pomace is the solid waste that remains after pressing; it represents about 20% of the grape and is composed

of peels, seeds, and stalks (Bordiga, Travaglia, & Locatelli, 2019; Taşeri et al., 2018; Walker, Tseng, Cavender, Ross, & Zhao, 2014). About 30% to 40% of winery byproducts are valorized worldwide, being used for different purposes, mostly as animal feeds or fertilizers (Karnopp et al., 2015; Lavelli, Torri, Zeppa, Fiori, & Spigno, 2016; Maner, Sharma, & Banerjee, 2017). Grape production takes an important place on the worldwide crop growth, being considered the most abundant fruit (García-Lomillo & Gonzalez-SanJose, 2017; Gülcü et al., 2019; Zhu, Du, Zheng, & Li, 2015). Currently, the global annual production of grapes exceed 75 million of tones, the most important producing countries being China, Italy, the United States, France, Spain, and Turkey (OIV, 2019). About 50% of grapes go to the wine industry, which generates valuable byproducts after the fermentation processes (OIV, 2019; Tkacz, Wojdyło, Nowicka, Turkiewicz, & Golis, 2019) with several health and technological benefits (Lavelli et al., 2016; Preedy & Watson, 2019).

The impact of winery waste disposal on the environment can be evaluated by carbon footprint assessment by using Life Cycle Assessment methodology (Lucarini et al., 2018; Petti et al., 2015). For example, according to the results presented by Bevilacqua, Morassut, Serra, and Cecchini (2017), the CO₂ emission from pomace calculated for a wine production of 51 million hectoliters in Italia in 2016 was 834,300 tons. Thus, by analogy, at a global production of 292 million hectoliters of wine (OIV, 2019), an estimated emission from grape pomace will be more than 4,776,776 tons of CO₂. For this reason, the promotion of grape byproducts that present high biological value valorization in new food formulation development is urgently needed.

Whole grape pomace chemical composition consists of cell walls polysaccharides, such as hemicelluloses and cellulose and of pectin, lignin, protein, fat, and minerals (Beres et al., 2016; Deng, Penner, & Zhao, 2011). Thus, whole grape pomace is considered a source of dietary fiber (DF) composed of these non-amidic polysaccharides that are polymers with at list 10 monomeric units (Beres et al., 2019; Meini, Cabezudo, Boschetti, & Romanini, 2019). DF has an important role for the digestion processes, lipids absorption, glucose and cholesterol levels decrease, and weight control (Fuller, Beck, Salman, & Tapsell, 2016; Smith & Yu, 2015). Grape pomace DF represents a complex matrix because it contains also phenolic fractions, which make it have also antioxidant properties (Eskicioglu, Kamiloglu, & Nilufer, 2015; Zhu et al., 2015). Saura-Calixto introduced the concept of antioxidant dietary fiber (ADF), which means that 1 g of ADF may have the radical scavenging capacity of a 50 mg vitamin E and more than 50% of the dry matter of fibers (Saura-Calixto, 1998; Tseng & Zhao, 2013). An amount of the grape pheno-

lic compounds, approximately 70%, remains in pomace after wine making, the most important being tannins, phenolic acids, anthocyanins, and resveratrol, the quantities depending on the variety (Cerda-Carrasco, López-Solís, Nuñez-Kalasic, Peña-Neira, & Obreque-Slier, 2015; Sousa et al., 2014; Walker et al., 2014).

Grape seeds represent about 17% of fresh grape pomace weight and 38% to 52% on a dry matter basis of the pomace (Brenes, Viveros, Chamorro, & Arija, 2016; Fernandes, Casal, Cruz, Pereira, & Ramalhosa, 2013; Mateo & Maicas, 2015). Its constituents are DF, oils, proteins, phenolic compounds, and other substances such as minerals and vitamins, sugars, organic acids, and so forth. The chemical composition of grape seeds is similar to those of vegetables, so they are classified also in the pulse-protein category (Mironeasa, Codină, & Mironeasa, 2012). Grape seeds can be considered as ADF due to their high content of antioxidants and DFs (Iuga, Mironeasa, & Mironeasa, 2019; Sharma et al., 2016). The antioxidant constituents in grape seed are in highest concentration than in peels and stems and include several flavonoids with a phenolic nature such as monomeric flavanols, procyanidins, and phenolic acids (Jaisanthi & Banu, 2014; Tang et al., 2018). The most important polyphenols from grape seeds and peels are proanthocyanidins, flavonoids, phenolic acids, and stilbenes (Bordiga et al., 2019; Taşeri et al., 2018). Polyphenols digestion consists of absorption in the intestine along with the DFs and releasing from the matrix formed with fibers into the colon due to the favorable antioxidant environment created by the bacteria (Kawabata, Yoshioka, & Terao, 2019; Saura-Calixto, 2011). Antioxidants contribute to the prevention of various cancer types, cardiovascular diseases, neurodegenerative diseases, and several dermal disorders (Kawabata et al., 2019; Seifried, Harrison, & Seifried, 2017). Grape seeds are rich in monounsaturated and unsaturated fatty acids, one of them being the linoleic acid (Lachman et al., 2015; Pérez-Navarro, Da Ros, et al., 2019), whereas grape peels have high amounts of saturated acids mainly stearic, palmitic, and lignoceric (Pérez-Navarro, Da Ros, et al., 2019).

Grape peels represent approximately 50% of the grape pomace but the ratio between peels and seeds can vary depending on the grape variety and cultivation conditions (Hogervorst, Miljić, & Puškaš, 2017; Mironeasa, Iuga, Zaharia, & Mironeasa, 2019a). They have a high health potential, being a source of DF, mostly cellulose, hemicelluloses and pectin, sugars, proteins, phenolic compounds, vitamins, and minerals (Karovičová, Kohajdová, Minarovičová, & Kuchtová, 2015; Mironeasa et al., 2019a). Deng et al. (2011) found that the grape peels are particularly interesting for their content in fiber and phenolic compounds. Total DF content up to almost 60% of dry matter was reported, dominated up to 98.5% by

insoluble dietary fiber (IDF). Also, the content of proteins ranged from 5% to 12%, ash from 2% to 8%, and soluble sugars from 1% to more than 70%, depending on the winery process, if the pomace is fermented or not (Deng et al., 2011). The antioxidant properties of grape peels are promoted by the anthocyanins, hydroxycinnamic acids, catechins, and flavonols, which contribute to the inhibition of low-density lipoprotein oxidation (Deng et al., 2011; Meini et al., 2019). Dwyer, Hosseinian, and Rod (2014) found that red peels contain higher amounts of phenolic compounds and DF than white peels. In other studies, Mironeasa (2017) and Iuga, Mironeasa, Zaharia, Ropciuc, and Mironeasa (2017) reported that red grape byproducts present a high content of DF, but have lower total phenolic content compared to white grape pomace.

Many studies revealed that winery byproducts can be used to enhance food products such as bread, muffins, cookies, biscuits, or pasta (Aksoylu, Çağindi, & Köse, 2015; Bender et al., 2017; Gaita, Alexa, Moigradean, & Poiana, 2018; Iuga et al., 2019; Kuchtová et al., 2018; Mironeasa et al., 2019a; Smith & Yu, 2015). The addition of grape byproducts in bakery and pastry products influences dough rheology and final product texture, nutritional value, and sensory characteristics (Aghamirzaei, Peighambari, Azadmard-Damirchi, & Majzoobi, 2015; Boudová Pečivová et al., 2014; Gaita et al., 2018; Iuga, Mironeasa, et al., 2017; Kuchtová et al., 2018; Maner et al., 2017; Mironeasa et al., 2019b). The particle size, the amount of grape seeds or peels, and the grape variety play an important role on dough rheological and textural properties and final product quality (Mironeasa et al., 2019b; Mironeasa, Iuga, Zaharia, Dabija, & Mironeasa, 2017). Thus, the aim of this review is to underline the chemical composition of grape byproducts such as pomace, seeds, and peels and their addition effects on the rheological, textural, and nutritional characteristics of baked goods and pasta.

2 | GRAPE BYPRODUCTS CHEMICAL COMPOSITION

The main winery byproducts are pomace, seeds, and peels and represent a good source of bioactive compounds that make them suitable to be considered as functional ingredients. The chemical composition of grape byproducts depends on the maturity level, pedoclimatic conditions, environmental factors, and on the grape variety (Bordiga, 2018; Cerda-Carrasco et al., 2015; Sousa et al., 2014). Grape byproducts chemical composition of different varieties is presented in Table 1. The chemical characteristics of winery byproducts depend on the grape variety and processing methods. Zhao, Zhu, Zhang, and Tang (2015) showed that

the physicochemical properties and the antioxidant capacities of grape pomace are influenced also by the particle size, the superfine grinding having a great potential application for foods development.

The protein content of grape pomace was reported to be more than 8 g/100 g (Beres et al., 2019; Sousa et al., 2014; Teles et al., 2019; Tseng & Zhao, 2013), whereas some studies (Abdrabba & Hussein, 2015; Maman & Yu, 2019) revealed higher proteins content in grape seeds, depending on the variety. Some studies showed that the protein content of grape peels can vary from 5.3 to 12.7 g/100 g (Deng et al., 2011; Maurer et al., 2019; Mendes, Xavier, Evtuguin, & Lopes, 2013; Mironeasa et al., 2019c), as it is shown in Table 1. The amino acid profiles of grape byproducts depend on the variety (Iuga, Codină, Mironeasa, & Oroian, 2017; Tangolar, Turan, Tangolar, & Ateş, 2019); Iuga, Codină, et al. (2017) showed that grape seeds have high contents of glutamic acid, aspartic acid, glycine, and arginine, whereas grape peels are richer in lysine, glutamic acid, aspartic acid, and leucine—both grape seeds and peels proteins qualities being close to those of other cereals and oilseeds like sunflower, safflower, and flaxseeds (Mironeasa, 2017; Secen, 2017; Zhou, Li, Zhang, Bai, & Zhao, 2010). Dietary proteins are present in high amounts in grape seeds and after purification processes can be used in order to enhance food products nutritional and sensory characteristics (Yu & Ahmedna, 2013; Zhou, Zhang, Liu, & Zhao, 2011). Compared to soy protein isolates, grape seeds protein has better solubility and emulsifying capacity and forms more stable emulsions, whereas the foaming capacity is lower (Zhou et al., 2011). Grape seed protein was listed as being nondigestible or resistant protein (Saura-Calixto, Goñi, Mañas, & Abia, 1991; Yu & Ahmedna, 2013) due to the protein–tannin complexes formed, which affect grape seed protein digestibility due to the inhibitory effect of tannin on digestive enzymes (Alipour & Rouzbehan, 2010; Yu & Ahmedna, 2013).

The fat content depends also on the grape variety and processing conditions, most of the fat being located in grape seeds (Deng et al., 2011; Maurer et al., 2019; Mendes et al., 2013; Mironeasa et al., 2019c; Tseng & Zhao, 2013) and consisting of about 90% of monounsaturated fatty acids (Sousa et al., 2014). Baydar and Akkurt (2001) found that the oil contents for both red and white pomace seeds are similar with a total average of 16.3% (v/w), approximately 87% being unsaturated, which has more benefits for health as compared to saturated oils. In respect to antioxidants, tocopherol was found to be in higher concentration in red grape seeds compared to white seeds (Baydar & Akkurt, 2001), α -tocopherol being the dominant type of tocopherols in seeds and its content depending on climatic conditions, the growing zone, and grape variety (Burčová et al., 2019). Assessing the composition of unsaturated oil,

TABLE 1 Chemical components of grape byproducts, expressed in g/100 g

Byproduct	Protein	Fat	Sugars	Ash	Fibers				Moisture	Reference
					TDF	SDF	IDF	Others		
Grape pomace										
Red pomace	13.8	2.12	14.17	6.40	59.13	2.35	14.25	Lignin 42.53	4.31	Beres et al., 2019
Benitaka	8.4	8.16	29.2	4.65	46.17	9.76	36.40	Pectin 3.92	3.33	Sousa et al., 2014
Pinoit Noir	13.8	4.2	19.6	5.50	51.30	ND	ND	ND	ND	Beres et al., 2016
Grape seeds										
Sultana	18.89	7.39	ND	0.33	48.9	ND	ND	ND	6.93	Abdrabba & Hussein, 2015
Defatted grape seed	11.5	0.4	5.3	3.0	79.7	4.06	75.7	ND	ND	Costa et al., 2019
Muscadine Noble	13.2	13.6	62.3	4.4	45.5	ND	ND	ND	6.4	Maman & Yu, 2019
Muscadine Carlos	15.0	14.9	60.3	16.4	58.2	ND	ND	ND	4.5	
White grape seeds	9.7	18.3	ND	2.8	40.8	ND	ND	ND	7.7	Iuga et al., 2019
Red grape seeds	12.7	20.7	ND	2.6	45.2	ND	ND	ND	7.6	
Grape peels										
Muller Thurgau	6.5	2.64	55.77	2.53	28.01	0.72	27.29	Pectin 2.5	ND	Deng et al., 2011
Morio Muscat	5.3	1.14	77.53	3.31	17.28	0.84	16.44	Pectin 3.3	ND	
Cabernet sauvignon	12.3	6.33	Soluble 1.71	7.59	53.21	0.81	52.40	Pectin 7.5	ND	
Merlot	11.2	3.35	Soluble 1.34	7.19	51.09	1.51	49.59	Pectin 7.1	ND	
Pinot Noir	12.1	4.74	Soluble 1.38	6.17	56.31	1.72	54.59	Pectin 6.1	ND	
Isabel	6.1	3.6	58.2	6.1	25.8	8.4	17.4	ND	ND	Maurer et al., 2019a
Red peels	12.7	5.5	ND	5.6	45.9	ND	ND	ND	5.7	Mironeasa et al., 2019c
White peels	7.4	3.1	ND	3.7	28.5	ND	ND	ND	5.8	Mironeasa et al., 2019a

Abbreviations: TDF, total dietary fiber; SDF, soluble dietary fiber; IDF, insoluble dietary fiber; ND, not determined.

*Mean value of different particle sizes was presented.

Da Porto, Porretto, and Decorti (2013) found that linoleic acid represented approximately 72% of the grape seed oil analyzed. All grape byproducts were found to be abundant in linoleic, oleic, and palmitic fatty acids, according to the results obtained by Gülcü et al. (2019) and Lucarini et al. (2020). The same authors reported high contents of palmitic acid in pomace, which may be caused by the high amount of saturated compounds in their waxy structure (Gülcü et al., 2019). Unsaturated fatty acid (UFA) and saturated fatty acid (SFA) contents of grape seeds oil depend on the grape variety (Jokić, Bijuk, Aladić, Bilić, & Molnar, 2016; Yu & Ahmedna, 2013; Zdunić et al., 2019). According to the results obtained by Yu and Ahmedna (2013), grape seeds oil from Cabernet Sauvignon and Royal Rouge contained 61% and 64% UFA, respectively, whereas Jokić et al. (2016) reported a content of 75% of linoleic acid and 12% of oleic acid in grape seeds oil. Zdunić et al. (2019) revealed that grape seed oil from Prokupac clone 43/3 variety has the highest UFA content of 95% among the studied sam-

ples, whereas Prokupac clones 41/1 and 43/5 varieties presented the lowest UFA content of 87%. Grape pomace was reported to have a ratio of polyunsaturated fatty acid/SFA above 3 (Yi et al., 2009), whereas for grape seeds and oil the ratio ranged between 4 and 7, depending on the variety (Fernandes et al., 2013). Values higher than 0.45 are recommended for human consumption due to the fact that it may influence blood cholesterol levels (Barbi et al., 2019; Hamulka, Głabska, Guzek, Białkowska, & Sulich, 2018; Vehovský et al., 2019).

Compared with other vegetable oils, grape seed oil has low quantities of linolenic acid (Harbeoui et al., 2018; Ovcharova, Zlatanov, & Dimitrova, 2016), which increases oxidative stability and can represent an advantage in terms of human consumption and shelf life of the oil. The studies confirm that the fatty acids composition of grape byproducts differs depending on the processing method, the oil contents of grape juice byproducts being lower than of the wine byproducts (Gülcü et al., 2019). Taşeri

et al. (2018) showed that the drying method significantly affected ($p < .05$) the free fatty acid contents of seeds, which depend on the lipase activity, the open air method providing better results.

Grape byproducts are rich in sugars, the peels containing the highest quantities (Table 1). Peels from white grape pomace contain higher sugar content than red peels (Dwyer et al., 2014). Gülcü et al. (2019) reported that the principal sugars of grape juice and wine byproducts are fructose and glucose, whereas saccharose can be found only in seeds. According to the results reported by Taşeri et al. (2018), the drying method significantly affects ($p < .05$) the sugar content of grape peels, the open air solution being better than a solar collector. Mendes et al. (2013) analyzed white grape peels and showed that the main neutral sugars were rhamnose, fucose, arabinose, xylose, mannose, galactose, and glucose.

According to the data presented in Table 1, the ash content and the moisture depend on the grape variety. The moisture directly affects the chemical and microbiological stability of grape byproducts (Mironeasa, 2017; Sousa et al., 2014). The final moisture of grape byproducts that can be used as food ingredients depends on the processing methods and drying conditions (Mironeasa et al., 2017; Taşeri et al., 2018).

Grape byproducts are rich in DFs, usually ranging from 50 to 75 g/100 for dry matter (Saura-Calixto, 1998), the soluble dietary fiber (SDF) being composed mostly of pectins and the IDF of cellulose, hemicelluloses, and lignin (Beres et al., 2019; Deng et al., 2011; Sousa et al., 2014; Teles et al., 2019). The fiber composition of grape byproducts may be influenced by variety, field characteristics, and wine-processing procedures (Iora et al., 2015). Grape byproducts are considered a good source of DF because they have the appropriate ratio of SDF and IDF (Sousa et al., 2014) and exhibit a better nutritional quality than those from cereals because of the presence of significant amounts of associated bioactive compounds (flavonoids, carotenoids, etc.) (Saura-Calixto, 1998). Grape pomace, seeds, and peels contain higher IDF than SDF (Table 1). Deng et al. (2011) studied various grape peels chemical compositions and revealed that the white varieties contain higher quantities of pectins than the red ones. The same study showed that there are small quantities of water-soluble and hydroxide-soluble pectins in grape peels. Grape pomace contains high quantities of lignin (Table 1), which affects the enzymes production, making difficult the access of the microorganisms to cellulose and hemicelluloses (Teles et al., 2019). Grape byproducts DF can be considered ADF (Eskicioglu et al., 2015; Tseng & Zhao, 2013; Zhu et al., 2015) as they have a radical scavenging capacity similar to vitamin E and high amounts of fibers reported to the dry matter.

Functional properties of fibers such as water binding capacity, water holding capacity, and oil retention capacity must be considered when fiber-rich ingredients are used in food formulations. Water binding capacity of fibers is important for both physiological and technological points of view and is given by the hydroxyl groups (Maurya, Pandey, Rai, Porwal, & Rai, 2015; Oladiran, 2018). The hydration characteristics of fibers can be evaluated through the water retention, swelling, and absorption capacities, the affinity for water depending on the number for hydroxyl groups and by default on the fiber source (Oladiran, 2018; Saikia & Mahanta, 2016). Water holding capacity of fibers is related to their processing, particle size, and physicochemical structure (Maurya et al., 2015; Zhao et al., 2015; Zhu, Du, & Li, 2014). SDFs content such as pectin is another factor that influences water absorption due to its higher water binding capacity compared to cellulose (Maurya et al., 2015). The oil retention capacity of fibers is of technological importance and it is influenced by the insoluble fibers content, particle size, overall charge density, hydrophilic nature, and dehydration method (Maurya et al., 2015; Zhao et al., 2015). Saikia and Mahanta (2016) reported a water holding capacity of grape peels of 7.56 g/g, an oil holding capacity of 10.64 g/g, and a swelling of 9.40 mL/g, higher values being obtained for mandarin peels and lower for cellulose. High hydration properties of DFs are related to an improved fecal bulking process, whereas a good oil absorption capacity leads to a reduced fat absorption in intestine and an enhanced excretion, which may conduct to lower cholesterol values (Oladiran, 2018; Saikia & Mahanta, 2016). The grinding process affects the functional properties of fibers. Some studies showed an increase of about two times of the water retention, absorption, and swelling capacities and oil binding capacity after grape pomace IDF superfine grinding (Zhao et al., 2015; Zhu et al., 2014), regardless the pomace type, as a result of the surface area increase.

The mineral profile is an indicator of the origin and variety of grapes and is related to the soil composition and cultural practices (Beres et al., 2019; Chikwanha, Raffrenato, Muchenje, Musarurwa, & Mapiye, 2018). According to the results presented by Beres et al. (2019), grape pomace is rich in potassium, phosphorus, and calcium (Table 2). Other minerals present in grape pomace are magnesium, manganese, iron, zinc, copper, aluminum, strontium, and sulfur (Gomes et al., 2019; Gülcü et al., 2019). Many studies showed that grape peels are richer in potassium, magnesium, and calcium than grape seeds, whereas the seeds are richer in iron, manganese, and zinc (Gomes et al., 2019; Gülcü et al., 2019). Potassium is essential in plant growth and development (Rogiers, Coetzee, Walker, Deloire, & Tyerman, 2017) and this is why it is found in high amounts in grape byproducts (Gomes et al., 2019; Tangolar, Alkan

TABLE 2 Minerals contents of grape byproducts

Byproduct	K (mg/g)	Mg (mg/g)	Ca (mg/g)	P (mg/g)	Mn (µg/g)	Fe (µg/g)	Zn (µg/g)	Cu (µg/g)	Reference
Grape pomace									
Red wine pomace	26.5	0.9	3.2	3.6	60.0	94.3	18.8	386.5	Beres et al., 2019
Pinotage	24.1	1.1	2.6	2.3	14.2	147.0	11.5	7.93	Chikwanha et al., 2018
Shiraz	22.3	1.2	3.7	3.2	17.7	115.0	14.6	13.4	
Sauvignon Blanc	15.0	0.9	2.3	2.3	18.5	115.0	7.3	8.0	
Cabernet Sauvignon	27.3	1.0	3.8	2.7	ND	85.0	15.0	ND	Corbin et al., 2015
Sauvignon Blanc	20.2	0.7	2.1	2.3	ND	60.0	9.0	ND	
Grape seeds									
Syrah	9.3	0.4	1.2	1.1	4.2	18.3	3.5	7.3	Tangolar et al., 2018
Kalecik karasi	10.2	0.4	1.5	0.9	5.6	19.6	3.1	6.7	
Carignane	7.8	0.6	1.7	0.8	6.4	15.2	3.2	5.8	
Semillon	8.9	0.4	1.0	0.9	3.6	13.9	2.6	5.2	
Chardonnay	10.9	0.5	1.0	0.9	4.1	23.1	2.8	5.9	
Cabernet Sauvignon	21.0	0.5	1.1	1.2	10.9	18.9	4.7	18.4	
Mixture white seeds	2.6	ND	5.5	1.5	25.3	ND	12.3	6.9	Mironeasa et al., 2010
Aligoté	2.7	ND	5.3	1.6	31.4	ND	14.9	8.2	
Hybrid Nohan white	2.3	ND	5.5	1.9	ND	ND	7.0	5.4	
Hybrid Frăguță a	2.4	ND	5.2	2.1	23.6	ND	8.2	10.0	
Hybrid Frăguță b	2.3	ND	5.3	2.2	17.3	ND	9.7	6.8	
Juice pomace	8.9	1.2	4.2	21.0	16.2	106.0	12.5	69.6	Gülcü et al., 2019
Wine pomace	33.1	1.3	4.7	23.7	16.5	101.0	18.2	77.3	
Grape peels									
Juice pomace	10.4	1.0	3.1	18.9	14.9	102.0	9.5	71.2	Gülcü et al., 2019
Wine pomace	26.6	1.5	5.2	24.8	16.4	79.0	16.2	79.0	
Sultana	2.5	0.6	3.1	0.8	ND	16.5	ND	ND	Abdrabba & Hussein, 2015
Red grape peels	24.8	0.9	4.7	ND	ND	121.0	ND	125.0	Oprea et al., 2018

Abbreviations: ND, not determined.

Torun, Tangolar, & Torun, 2018). Thus, grape byproducts are rich also in minerals and can be considered as a functional ingredient that will improve the nutritional value of food products.

3 | POLYPHENOLIC PROFILE, ANTIOXIDANT, AND ANTIMICROBIAL PROPERTIES OF GRAPE BYPRODUCTS

3.1 | Polyphenolic profile of grape byproducts

Grape byproducts are recognized as a source of polyphenolic compounds, the amount depending on the grape

variety, the winemaking conditions, and the extraction method (Iuga, Ropciuc, Mironeasa, 2017; Luchian et al., 2019). The phenolic compounds found in grape byproducts can be classified into (a) phenolic acids including hydroxybenzoic and hydroxycinnamic acids; (b) flavonoids including flavonols, anthocyanins, and flavan-3-ols; (c) tannins and proanthocyanidins; and (d) stilbenes (Thomas, 2017). The processing conditions during pomace drying have a great influence on byproducts characteristics such as appearance and color, but also on the content of bioactive compounds (Horszwald, Julien, & Andlauer, 2013). The drying methods can affect the polyphenols content of grape byproducts. Polyphenols have the ability to diminish or inhibit free radicals effects by hydrogen atom transfer (Oroian & Escriche, 2015; Santos-Sánchez,

Salas-Coronado, Villanueva-Cañongo, & Hernández-Carlos, 2019). Goula, Thymiatis, and Kaderides (2016) reported losses of polyphenols when grape pomace was dried at temperatures higher than 60 °C. Taşeri et al. (2018) showed no differences regarding the phenolic content of grape seeds and peels dried in open air or in a solar collector. Higher processing temperatures (>90 °C) produce structure ruptures of phenolic compounds molecules, as for the fibers (Minatel et al., 2017). The type of wine processing significantly affects the polyphenolic profile of grape byproducts. In the case of red winemaking process, marc fermentation for several days leads to lower polyphenolic compounds retention in byproducts compared to white pomace, which is kept less in contact with the stem (Gómez-Brandón, Lores, Insam, & Domínguez, 2019).

Some bioactive compounds compositions of grape byproducts are presented in Table 3. Whole grape pomace is rich in polyphenols and non-anthocyanin phenolic compounds such as gallic acid, catechin, epicatechin, and β -type (epi) catechin dimer, the gallic acid being present in seeds, whereas anthocyanins such as malvidin-rutinoside, petunidin-rutinoside, malvidin hexoside, and delphinidin-rutinoside were found in peels (Sales et al., 2018). The phenolic compounds, anthocyanins, tannins, and flavonoids of grape byproducts depend on the variety (Guaita & Boso, 2019; Luchian et al., 2019; Silva et al., 2018). According to the results showed in Table 3, grape seeds have greater phenolic compounds content than grape peels. Silva et al. (2018) reported that the main polyphenols from two varieties of grape byproducts from Portugal were phenolic acids, flavan-3-ols, flavonols, stilbenes, and anthocyanins. Grape peels contain high amounts of malvidin-3-O-glucoside, followed by peonidin-3-O-glucoside, cyanidin-3-O-glucoside, and catechin, whereas grape seed's most abundant polyphenols are epicatechin, catechin, resveratrol, and gallic acid, depending on the variety (Biniari, Gerogiannis, Daskalakis, Bouza, & Stavrakaki, 2018; Silva et al., 2018).

Cerda-Carrasco et al. (2015) reported that white grape winery byproducts have greater total phenols and proanthocyanidins contents than the red ones, which confirms that the polyphenols extraction is better during the red winemaking process. White grape varieties do not contain anthocyanins, fact supported also by the color intensity. The phenolic profile of grape pomace strongly depends on the extractions that occur during the winemaking processes (Cerda-Carrasco et al., 2015; Jara-Palacios, Rodríguez-Pulido, Hernanz, Escudero-Gilete, & Heredia, 2016).

Tkacz et al. (2019) reported higher total phenols and flavan-3-ols values for grape seeds from different cultivars, whereas peels have higher phenolic acids, stilbenes, and anthocyanins contents. From the phenolic

acids, the caftaric acid was detected in all studied samples, for both seeds and peels, whereas the anthocyanins were found only in seeds of white grape varieties (Jara-Palacios et al., 2016; Sousa et al., 2014; Tkacz et al., 2019). Grape peels contain flavonols such as myricetin, quercetin, kaempferol, isorhamnetin, and derivatives of 3-O-galactoside, 3-O-rutinoside, 3-O-glucuronide, and 3-O-glucoside, all the studied samples containing quercetin-3-O-glucuronide. The flavan-3-ols are most abundant in grape seeds than in peels, catechin and epicatechin being reported for all samples (Jara-Palacios et al., 2016; Tkacz et al., 2019). According to the results obtained by Tkacz et al. (2019), the content of total phenols varied from 24.0 to 112.5 mg gallic acid equivalents (GAE)/g in grape seeds and from 13.8 to 104.4 mg GAE/g in grape peels, depending on the variety (Table 3). Gülcü et al. (2019) underlined the difference between the grape juice and winery byproducts. Grape juice pomace presented lower tannin, anthocyanin, and flavonoid than wine pomace, the total phenols values being close. Grape seed from winery had higher phenolic contents than those from juice pomace, whereas the peels from juice pomace are richer in tannins, but have lower values for anthocyanins and flavonoids, indicating that the processing methods affect the polyphenols profile of grape byproducts (Gülcü et al., 2019). The total phenolic, anthocyanin, tannin, and flavonoids contents of grape pomace were reported by Gülcü et al. (2019) to be 58.9 mg GAE/g, 1.3 mg/g, 107.2 mg tannic acid equivalents (TAE)/g, and 26.9 mg/g, respectively, whereas in juice pomace it was 59.6 mg GAE/g, 0.5 mg/g, 96.9 mg TAE/g, and 20.5 mg/g, respectively (Table 3). The most abundant phenolic compounds were reported to be epicatechin, catechin, gallic acid, syringic acid, caftaric acid, and quercetin. Both juice and wine pomaces, seeds, and peels major component was epicatechin (Gülcü et al., 2019).

Among different grape peels cultivars, Barbera and Albarossa presented higher anthocyanins and lower vanillin-reactive flavans and condensed tannins amounts compared to Nebbiolo and Uvalino varieties, whereas grape seeds from Barbera and Albarossa varieties had smaller quantities of vanillin-reactive flavans, proanthocyanidins, and condensed tannins compared to Nebbiolo and Uvalino, these differences disappearing after fermentative processes application (Guaita & Bosso, 2019).

Flavanols are bioactive secondary metabolites found in skins and seeds and can be found as monomers, polymers, or as glycosylated hexoside forms (Pérez-Navarro, Cazals, et al., 2019; Popov, Hejtmánková, Kotíková, Štráalková, & Lachman, 2017; Zerbib, Cazals, & Enjalbal, 2018). Pérez-Navarro, Cazals, et al. (2019) studied the flavanol glycoside profiles of three white (Airén, Albillo Dorado, and Montonera del Casar) and three red (Moribel, Tempranillo, and Tinto Fragoso) grape seeds and peels and revealed

TABLE 3 Antioxidant activity and bioactive compounds of grape byproducts

Byproduct	Total phenol (mg GAE/g)	Total anthocyanin (mg/g)	Total tannin (mg TAE/g)	Total flavonoid (mg/g)	Antioxidant activity			Reference
					TEAC ($\mu\text{mol TE/g}$)	ORAC ($\mu\text{mol TE/g}$)	IC ₅₀ (mg/mL)	
Grape pomace								
Juice pomace	59.6	0.5	96.9	20.5 ^b	46.7	ND	ND	Gülcü et al., 2019
Wine pomace	58.9	1.3	107.2	26.9 ^b	49.7	ND	ND	
Alicante bouschet	5.0	0.2	ND	ND	36.6	127.8	ND	Teles et al., 2019
Grape seeds								
Touriga Nacional	261.3 ^a	ND	33.9 ^a	ND	ND	ND	0.1	Silva et al., 2018
Preto Martinho	363.0 ^a	ND	56.3 ^a	ND	ND	ND	0.1	
Seyval Blanc	112.5	<LD	ND	<LD	ND	207.9	ND	Tkacz et al., 2019
Hibernal	131.9	<LD	ND	<LD	ND	293.1	ND	
Pinoit gris	114.4	<LD	ND	<LD	ND	457.0	ND	
Freiminer	240.4	<LD	ND	<LD	ND	215.8	ND	
Roter traminer	16.7	<LD	ND	<LD	ND	421.9	ND	
Regent	16.2	<LD	ND	<LD	ND	479.7	ND	
Rondo	24.0	<LD	ND	<LD	ND	476.6	ND	
Grape peels								
Seyval Blanc	19.0	<LD	ND	2.4	ND	67.6	ND	Tkacz et al., 2019
Hibernal	13.8	<LD	ND	3.3	ND	35.3	ND	
Pinoit gris	46.2	1.3	ND	3.4	ND	103.8	ND	
Freiminer	28.8	2.6	ND	1.5	ND	49.2	ND	
Roter traminer	61.8	30.4	ND	1.2	ND	17.6	ND	
Regent	95.5	30.6	ND	4.6	ND	339.2	ND	
Rondo	104.4	22.8	ND	2.7	ND	261.3	ND	
Juice pomace	36.8	1.0	104.9	13.4 ^b	31.9	ND	ND	Gülcü et al., 2019
Wine pomace	35.3	2.1	97.5	15.8 ^b	40.9	ND	ND	
Touriga Nacional	35.5	9.3	7.2 ^a	ND	ND	ND	0.7	Silva et al., 2018
Preto Martinho	360.2	65.8	86.7 ^a	ND	ND	ND	0.1	

^aExpressed as $\mu\text{g EE/mg}$ —epicatechin equivalents.

^bExpressed as $\mu\text{g CE/mg}$ —catching equivalents.

Abbreviations: GAE, gallic acid equivalents; TAE, tannic acid equivalents; TE, trolox equivalents; IC₅₀, DPPH inhibition percent; TEAC, trolox equivalent antioxidant capacity; ORAC, oxygen radical absorbance capacity; ND, not determined; LD, detection limit.

that grape seeds have higher total content of glycosylated monomers compared to peels, derivatives of (epi)catechin gallate being abundant. Higher monomeric flavanol diglycosides amounts were found in seeds, whereas monoglycosylated dimmers were identified only in peels. Greater quantities of glycosylated flavanols were found in red varieties compared to the white ones, suggesting the dependence of flavanol glycoside profiles on the variety, grape maturity, and environmental conditions (Pérez-Navarro, Cazals, et al., 2019; Zerbib et al., 2018).

The particle size of grape byproducts also influences the phenolic content as Beres et al. (2016) and Zhao et al. (2015) showed. Thus, smaller particle size of grape pomace had higher total phenolic compounds content due to the increase of the extraction yield grace to a better surface contact. The extraction performance depends also on the temperature and the solvent concentration (Beres et al., 2016; Zhao et al., 2015).

3.2 | Antioxidant properties

The nutritional value and sensory and textural characteristics of food products can be affected by oxidative degradation of lipids and proteins (Ahmed et al., 2016; Gürbüz, 2018; Hellwig, 2019), which may occur during production, storage, culinary preparation (Estévez, Li, Soladoye, & Van-Hecke, 2017), or even during digestion (Hellwig, 2019). Lipids and protein oxidation products were found to be harmful for the human body due to their direct contact with the intestine lamina, which may result in inflammatory and/or carcinogenic processes promotion and oxidative stress increase (Estévez et al., 2017; Gürbüz, 2018; Xiang, Yang, Beta, Liu, & Yang, 2019; Zhang et al., 2015).

Chemical, photochemical, and enzymatic reactions produce reactive oxygen species such as hydroxyl, peroxy, alkoxy, hydroperoxy radicals, singlet oxygen, hydrogen peroxide, and ozone, which are the most important catalyst for lipid oxidation reactions (Bartos, 2016; Gürbüz, 2018). The main pathways of lipid oxidation in foods are free radical-driven autoxidation, photooxidation, and enzymatic oxidation (Ahmed et al., 2016; Gürbüz, 2018). Lipid oxidation occurs in two stages. In the primary stage lipid peroxy radicals and hydroperoxides are generated, whereas in the secondary stage they are decomposed to aldehydes, ketones, alcohols, hydrocarbons, volatile organic acids, and epoxy compounds (Gorji, Smyth, Sharma, & Fitzgerald, 2016; Srivastava, 2013). Reactive oxygen, nitrogen, or sulfur species are also responsible for protein oxidation, which comprises radical start reactions, prolongation, and branching reactions, followed by termination reactions (Ahmed et al., 2016; Gürbüz, 2018).

The oxidative stress refers to the imbalance of the reactive oxygen species and antioxidant substances found in an organism or system that generates lipids, proteins, and DNA changes (Galano et al., 2016; Hellwig, 2019). Endogenous antioxidants of the biological systems are enzymes such as catalase and glutathione peroxidase or compounds such as bilirubin or albumin (Niedzwiedz, Aksymovych, Kubiak, & Jankowski, 2017; Santos-Sánchez et al., 2019; Shastri, Srivastava, Jyoti, & Gupta, 2016). When high quantities of reactive oxygen species are produced and the systems antioxidants are not sufficient, the deficit can be compensated by exogenous antioxidants from foods (Santos-Sánchez et al., 2019).

Antioxidants are able to reduce oxidative stress negative effects through enzymatic and/or chemical reactions. Free radical scavenging mechanism of antioxidants comprises transfer of hydrogen atom, proton-coupled electron, single electron, sequential electron proton, proton loss electron, proton loss hydrogen atom, and radical adduct formation, but also the chelating capacity of antioxidants plays an important role in oxidative stress reduction (Galano et al., 2016; Marković, 2016).

In vitro antioxidant activity of foods and byproducts can be evaluated through methods with various mechanisms of action, the most common being based on hydrogen atom transfer (HAT) or single electron transfer (SET). Therefore, it is necessary to determine the antioxidant capacity of grape byproducts by using many assays for a better characterization. The evaluation of the nonenzymatic chain-breaking antioxidant ability can be done by kinetic assays, by measuring the rate, or by establishing the thermodynamic reaction efficiency between an oxidant and an antioxidant (Apak, Özyürek, Güçlü, & Çapanoğlu, 2016). The assays based on HAT determine the ability of the antioxidant compound to inhibit free radicals such as peroxy activity through hydrogen atom donation (Apak et al., 2016; Lewoyehu & Amare, 2019). Among the HAT-based assays, oxygen radical absorbance capacity and total radical trapping antioxidant parameter can be mentioned. SET-based methods imply antioxidant action simulation by reacting with a fluorescent or colored probe as oxidizing agent instead of peroxy radicals (Lewoyehu & Amare, 2019). In spectrophotometric SET methods, the color changes when the antioxidant reduces the oxidizing agent, which is proportional with the antioxidants concentration of the sample (Lewoyehu & Amare, 2019). Some of the SET methods are based on discoloring and absorbance decrease, for example, the assays using 2,2'-azino-bis(3-ethylbenzothiazoline)-6-sulfonic acid (ABTS), 2,2-di(4-tert-octylphenyl)-1-picrylhydrazyl (DPPH), and trolox equivalent antioxidant capacity (TEAC). In others, the increase of the absorbance occurs during the reaction of the antioxidant with the chromogenic reagent, for

example, ferric reducing antioxidant power and cupric reducing antioxidant capacity (Shahidi & Zhong, 2015).

Guaita and Bosso (2019) reported higher antioxidant activity of grape seeds compared to peels, underlining a positive correlation with the tannins content. Tkacz et al. (2019) revealed that grape seeds have higher antioxidant activity ranging from 207.9 to 479.7 μmol trolox equivalents (TE)/g compared to peels for which it varied from 17.6 to 339.2 μmol TE/g in function of the variety, with higher values for the red ones (Table 3). The flavan-3-ols present in seeds give high antioxidant activity, whereas for peels the phenolic acids and the flavonols are more important. Monophenols antioxidant power increases in the presence of methoxy substituents, but still remains less effective than polyphenols. The antioxidant activity of grape byproducts depends also on the synergistic effects of these compounds and on their glycosylation level (Georgiev, Ananga, & Tsoleva, 2014; Tkacz et al., 2019). Silva et al. (2018) showed that Preto Martinho grape seeds and skins presented higher antioxidant activity measured by ABTS and DPPH methods compared to Touriga Nacional variety, the seeds exhibiting higher values (185.2 TE/g for Touriga Nacional and 206.3 for Preto Martinho) than peels (33.2 TE/g for Touriga Nacional and 80.6 for Preto Martinho). Xu, Burton, Kim, and Sismour (2016) showed that the antioxidant capacity of many grape pomace varieties measured by DPPH assay ranged from 3.54 to 28.2 μmol TE/g, whereas by ABTS assay it ranged from 334 to 1,013 μmol TE/g.

Among the factors influencing the antioxidant properties of grape byproducts, the conditioning and processing methods, extraction protocols, grape variety, and climatic conditions, which imply different chemical composition, can be mentioned. Grape byproducts drying method can influence the antioxidant activity. Carmona-Jiménez, García-Moreno, and García-Barroso (2018) revealed that red grape pomace of many varieties dried in a climatic chamber at 40 °C and 10% humidity presented 2.4 to 2.8 times higher antioxidant activity than untreated sample. On the other hand, heat pump drying of grape pomace induced a decrease of the DPPH scavenging activity proportional with temperature increase (Aktaş et al., 2019). Microwave pretreatment of grape pomace determined antioxidant activity against peroxy radical, according to the results obtained by Álvarez et al. (2017). The micromilling process of grape byproducts can be applied to produce a nanosized material and therefore enhanced extractability of phenolic compounds with higher antioxidant capacity, similar to the results reported by Mayer-Miebach, Adamiuk, and Behnlian (2012) for chokeberry pomace. The antioxidant activity was high for the superfine grinded grape pomace powder, indicating low values of the inhibition percent (IC_{50}), which represents

the amount of antioxidants required to decrease the initial DPPH concentration at 50% (Zhao et al., 2015). Samavardhana, Supawititpattana, Jittrepotch, Rojsuntornkitti, and Kongbangkerd (2015) showed that the highest antioxidant activity of grape seeds was obtained at larger particle size (>40 mesh) after applying a degreasing procedure and ultrasonic-assisted extraction, compared to undefatted, smaller particle size of grape seed extracted by shaking. According to the results obtained by Vergara-Salinas, Vergara, Altamirano, Gonzalez, and Pérez-Correa (2015), grape pomace hot water extract presented higher antioxidant activity as the temperature was higher probably due to the cell wall disintegration and Maillard reactions at >100 °C. Grape byproducts antioxidant capacity depends on the variety, for example, Tkacz et al. (2019) obtained higher values for red grape pomace (Regent, Rondo) than for white ones (Seyval Blanc, Hibernál), as it is shown in Table 3. Gülcü et al. (2019) reported difference between grape pomace from juice and from wine processing, the latter presenting higher antioxidant activity.

3.3 | Antimicrobial properties

Antimicrobial activity can be estimated by the minimum inhibitory concentration (MIC), which is the lower concentration of a compound that prevents visible bacteria development, lower values indicating higher antimicrobial activities (Ma, Xu, Lu, Ren, & Lu, 2018; Tseng & Zhao, 2012). The antimicrobial performances of grape byproducts extracts depend on the variety, processing, and extraction conditions (Sanhueza, Tello, Vivanco, Mendoza, & Wilkens, 2014; Silva et al., 2018; Tseng & Zhao, 2012). Tseng and Zhao (2012) suggested higher antimicrobial activities of Pinot Noir grape pomace or peels extracts compared to Merlot, better inhibition effects being obtained against *Listeria innocua* than against *Escherichia coli*, grape peels exhibiting higher antimicrobial activities than whole pomace. Total phenols content have an essential role in microbial growth, the number of hydroxyl groups influencing the antibacterial activity as they form hydrogen bonds with the bacteria's membrane protein, which leads to permeability changes and consequently cell disintegration (Boulekbache-Makhlouf, Slimani, & Madani, 2013; Tseng & Zhao, 2012). Grape seeds extract presented higher antimicrobial activity than peels due to their higher contents of catechin, epicatechin, and trans-resveratrol (Silva et al., 2018). Similar results were obtained by Peixoto et al. (2018), grape seeds extract MIC values being lower for Gram-positive bacteria *Enterococcus faecalis* and *Staphylococcus aureus*, whereas for Gram-negative bacteria the greatest antimicrobial activity

was against *Klebsiella pneumoniae*. Some studies revealed that extracts from Cabernet Sauvignon grape pomace exhibited higher antimicrobial activities compared to Syrah and Merlot pomaces, as a result of the total phenolics contents differences (Oliveira et al., 2013; Sanhueza et al., 2014). Antimicrobial activity against *S. aureus* and *Listeria monocytogenes* of different grape pomace varieties extracts was also reported by Xu et al. (2016), whereas for *Salmonella typhimurium* and *E. coli* growth no effects were obtained, probably due to the cell structure of Gram-negative bacteria, which have two-layer cell membrane and high outer membrane hydrophilicity, leading to great resistance on grape pomace extracts (Singh, Mallick, Banerjee, & Kumar, 2016; Xu et al., 2016). On contrary, other study reported growth inhibition of grape pomace on both Gram-negative and Gram-positive bacteria, depending on the extract concentration, better results being obtained at higher extract concentrations (Faisal, Mosammad, & Heri, 2015).

According to the results presented by Sousa et al. (2014), grape pomace microbiological characteristics are acceptable for human consumption probably due to the fact that it do not provide good conditions for bacteria growth, having low pH and moisture values. Also the toxicity absence was reported, which means that grape pomace is suitable to be used in food or pharmaceutical industry (Kalli, Lappa, Bouchagier, Tarantilis, & Skotti, 2018; Sousa et al., 2014). Bogoeva and Durakova (2020) obtained the numbers of pathogenic microorganism below the admissible limits in full fatted grape seeds stored for 3 months at a temperature of 18°C ÷ 25°C and at 45% ÷ 55% humidity, “packed in co-extruded barrier film with copolymer covering for heat sealing.” Similar results were reported by Durakova et al. (2018) for grape seeds flakes stored for 1 month at 25°C, 75% humidity, in the same package type and for grape seeds flour (Bogoeva et al., 2017) stored for 3 months in identical conditions.

4 | EFFECTS OF GRAPE BYPRODUCTS ADDITION ON THE NUTRITIONAL CHARACTERISTICS OF BAKED GOODS AND PASTA

Grape byproducts chemical composition confirms the possibility of using them to enhance the nutritional and functional values of food products. Regarding grape byproducts as a bioactive food ingredient may grow producers profit by considering them as value-adding products. Grape byproducts incorporation in bakery and pastry products may lead to many health benefits (García-Lomillo & González-SanJosé, 2017; Mildner-Szkudlarz, Siger, Szwengiel, &

Bajerska, 2015). Bakery products, mainly bread, cookies, biscuits, muffins, and pasta, have been enriched by partial replacement of flour with grape byproducts flour (Table 4) because it is as gluten-free ingredient and represents a rich source of DF and bioactive compounds (Gaita et al., 2018; Maner et al., 2017; Mildner-Szkudlarz, Zawirska-Wojtasiak, Szwengiel, & Pacyński, 2011; Sant’Anna, Cristiano, Marczak, Tessaro, & Thys, 2014; Rosales Soto, Brown, & Ross, 2012). Due to their potential, grape byproducts are considered a valuable functional ingredient that can be successfully used to develop novel formulations of products as healthy foods.

Grape pomace addition to wheat muffins formulations increased the phenolic content of the final product, which contributed to the advanced glycation end-products (AGEs) reduction (Ravichandran et al., 2019). AGEs are endogenously produced by the human body, but can result also from a nonenzymatic reaction between sugar and proteins (Maillard reaction) and are considered as a stressor for the human body cells (Nowotny, Schröter, Schreiner, & Grune, 2018; Ravichandran et al., 2019). Foods thermal processing is related to the formation of AGEs that are considered promoters of oxidative stress, aging, diabetes, cancer, degenerative diseases, and hormonal disruption (Ravichandran et al., 2019). The phenolic antioxidants have an inhibitory effect on AGEs, depending on their free-radical scavenging activity and concentration, heating temperature, and time (Mildner-Szkudlarz et al., 2015; Sharma, Kaur, Thind, Singh, & Raina, 2015). Carboxymethyllysine (CML) is one of the AGEs detected in muffins, its concentration being reduced by grape-pomace addition (Mildner-Szkudlarz et al., 2015). The inhibitory effects of grape pomace on CML may be due to its antioxidant phenolic contents, such as Gallic acid, catechin, epicatechin, and procyanidins. Lower effect was observed for the sample with protein-rich ingredients because of the protein–polyphenols binding mechanism. The antiglycation property of phenolic compounds is given by their inhibition of free radicals derived from the glycation processes capacity and the inhibition of protein modifications (Mildner-Szkudlarz et al., 2015). Bread prepared with 10% grape pomace powder had a significant increase in total phenolic content compared to bread with wheat flour (Hayta, Özüğür, Etgü, & Şeker, 2014). Also, the antiradical activity (DPPH scavenging activity) of bread samples significantly increased with the increase of grape pomace powder levels. Similar results were reported by Sharma, Dagadkhair, and Somkuwar (2018) for cookies enriched with grape pomace.

Grape seeds enhance the antioxidant capacity of wheat flour by increasing the phenolic compounds content in function of the amount added (Aghamirzaei et al., 2015; Meral & Köse, 2019). The total polyphenolic and flavonoid

TABLE 4 Effects of grape byproducts addition on the nutritional value of baked goods and pasta

Food matrix	Grape byproduct	Amount added (%)	Effects	Reference
Muffins	Pomace	10; 20	-Decreased protein content -Increased dietary fiber and fat contents	Ortega-Heras et al., 2019
Bread	Pomace	5; 10	-Increased the phenolic and flavonoid contents -Increased fat content at levels higher than 10% -Decreased protein contents of bread -Increased dietary fiber contents	Smith & Yu, 2015
Cookies	Pomace	5; 10; 15; 20	-Increased anthocyanin content	Maner et al., 2017
Cookies	Pomace	20; 25; 30	-No significant changes on lipids and protein contents -Increased fiber content	Karnopp et al., 2015
Fettuccini pasta	Pomace	2.5; 5.0; 7.5	-Increased phenolic, anthocyanin, and tannin contents	Sant'Anna et al., 2014
Bread Muffins Brownies	Pomace	5; 10; 15	-Increased total phenolic content and radical scavenging activities, except for brownies with white pomace -Increased dietary fiber contents	Walker et al., 2014
Cookies	Pomace, seeds, seedless pomace	5; 10; 15	-Increased ash and dietary fiber content -Increased protein contents at levels higher than 10% of grape seeds and seedless pomace -Increased fat contents when pomace was added -Decreased sugar contents	Acun & Gül, 2014
Bread	Seeds	2; 4; 6; 8; 10	-Increased ash, proteins, fat, and fiber contents	Boudová Pečivová et al., 2014
Biscuits	Defatted seeds	5	-Enhanced storage stability -Increased phenolic content and antioxidant activity -Increased ash, protein, fat, dietary fiber, magnesium, and calcium contents	Aksoylu et al., 2015
Pasta	Peels	3; 6; 9	-Increased total phenolic content and antioxidant activity	Gaita et al., 2018
Wheat flour	Peels	5; 10; 15	-Increased mineral contents of flour -Decreased short chain saturated fatty acids and increased total unsaturated fatty acid contents	Oprea et al., 2018

contents of white bread with grape pomace increased linearly with the addition level, the magnitude depending on the grape pomace variety (Smith & Yu, 2015). Depending on the grape variety, higher amounts of pomace lead to a better antioxidant activity of bread, which can slow down the oxidation reactions (Smith & Yu, 2015; Šporin et al., 2018). The amount of polyphenols from the final product depends on the processing conditions, especially

the temperature, the antioxidant capacity being given by the phenolic compounds of the ingredients, the intermediate phenolic compounds generated during the Maillard reactions, the thermal-induced degradation products, and the polyphenols–polysaccharides complexes (Šporin et al., 2018). Biscuits enriched with defatted grape seeds presented better storage stability by increasing the total phenolic content and the antioxidant activity (Aksoylu

et al., 2015; Arvik, 2012), similar results being obtained by Theagarajan, Malur Narayanaswamy, Dutta, Moses, and Chinnaswamy (2019) for grape pomace-enriched cookies. The addition of grape pomace to cookies formulations promoted an increase of total phenolic content, which leads to a higher antioxidant activity, the results indicating that a great amount of antioxidants remains in the final product after baking (Karnopp et al., 2015; Theagarajan et al., 2019). According to the results obtained by Maner et al. (2017), the anthocyanins content of cookies with grape pomace significantly increased, grape pomace being rich in malvidin 3-O-glucoside, peonidin-3-O glucoside, hydroxycinnamic acids, and flavonol glycosides. The same trend was observed for total phenols, flavonoids, tannins, and antioxidant activities due to the grape pomace content of gallic acid, ellagic acid, catechin, epicatechin, procyanidins, and anthocyanins (Maner et al., 2017). The total phenolic content and the radical scavenging activity of bread, muffins, and brownies enriched with white and red grape pomace increased with the addition level compared to the control, except the brownies with white grape pomace for which the phenolic content decreased and the antioxidant activity magnitude increase were not big probably due to the reactions that occur during baking (Walker et al., 2014). Products enriched with red grape pomace presented significantly higher phenols contents and antioxidant activities (Cobb, Yu, Zhu, Smith, & Chen, 2018; Walker et al., 2014). The antioxidant activity and total phenolic content can be influenced by the fermentation and baking process of bread enriched with grape seeds, as Meral and Köse (2019) showed. Thus, an increase of the antioxidant activity and gallic acid content with the fermentation time was recorded as a result of the fermentation, which can change antioxidants structure and polarity, whereas the alcohol formed can enhance phenolic extraction (Jayaram et al., 2014; Meral & Köse, 2019; Wang, Wu, Shyu, Al, & Ioeng, 2014). The same trend was obtained after bread baking, the temperature not having a significant influence on the antioxidant activity of bread with grape seeds, the phenolic compounds disintegration during baking being compensated by the formation of antioxidant compounds from the Maillard reactions and by the phenolic release acceleration (Ertürk & Meral, 2019; Meral & Köse, 2019). An increase of the total phenolic content was also reported by Acun and Gül (2014) when different levels of grape pomace, seedless grape pomace, and grape seeds flour were incorporated in cookies, grape seeds having the biggest influence, whereas significant antioxidant activities increases were obtained for grape seeds containing samples due to the high amounts of phenolic compounds present in seeds.

The phenolic contents of grape byproducts change during the digestion. Thus, Beres et al. (2019) showed that the amount of phenolic and the antioxidant activity of

grape pomace is higher in the intestine than in stomach, which suggests an increase of their bioaccessibility in the intestinal tract. In pomace flour, the phenolics are mostly bound to macromolecules, their absorption depending on their structure, interactions with other phenolic compounds, glycosylation, molecule size, and solubility (Beres et al., 2019). The phenolics that are bounded do not suffer any transformation until they arrive in the colon where the bacterial flora fractionates the molecules into smaller ones, releasing the bioactive compounds (Acosta-Estrada, Gutiérrez-Urbe, & Serna-Saldívar, 2014; Beres et al., 2019). The effects of phenolic compounds on the human health depend on the quantity consumed and on the presented form; the free phenolics are rapidly absorbed by the body, whereas the bounded ones act more as local antioxidants, preventing colon cancer and gastrointestinal diseases (Beres et al., 2019; Ficco et al., 2018). The changes of the phenolic profile of grape byproducts depend on the grape matrix, rather than on the variety (Gomes et al., 2019). The phenolic compounds from grape byproducts had high bioaccessibility and availability for the intestinal absorption, as Gomes et al. (2019) reported that the anthocyanins, flavonols, flavanols, hydroxybenzoic, and hydroxycinnamic acids contents and antioxidant activities were kept after the gastrointestinal passage. Higher bioaccessibility was reported for quercetin after digestion, whereas in the gastric phase the most bioaccessible were anthocyanins diglucosides (Gomes et al., 2019). Tkacz et al. (2019) showed that grape seeds and peels have high anticholinergic activity due to their phenolic compounds, which leads to a reduction of neurological disorders such as Alzheimer, Parkinson, Down syndrome, Wernicke-Korsakoff syndrome, dementia, delirium, or migraine. The same authors reported for grape peels and seeds higher α -glucosidase than α -amylase inhibitory effects as a measure of the antidiabetic activity (Tkacz et al., 2019).

The main phenolic acids found in pasta enriched with grape peels were gallic, caffeic, coumaric, ferulic, and rosmarinic acids, the amounts depending on the addition level and grape variety (Gaita et al., 2018). Furthermore, the bioavailability of phenolic compounds in pasta depends on the hydrogen, ionic, covalent, and hydrophobic interactions with proteins. Higher antioxidant activity and total phenolic content were obtained after grape peel incorporation in pasta, the amount increasing as the addition level was higher (Gaita et al., 2018). The same trend of total phenolic, anthocyanins, and tannin contents was reported by Sant'Anna et al. (2014) for raw and cooked fettuccini pasta enriched with grape pomace. The cooking process significantly affects anthocyanins quantity due to their high solubility and heat sensitivity, which may result in lower amounts due to the leaching process and thermal degradation during cooking (Sant'Anna et al., 2014). On

the other hand, the total phenolic and tannin contents were little affected by cooking, as they are resistant to the leaching phenomenon due to the fact that they are bounded and are stored into the organelles of vegetable cells (Sant'Anna et al., 2014; Sant'Anna, Brandelli, Damasceno, Marczak, & Cristina, 2012). Similar results were obtained by Marinelli, Padalino, Conte, Del Nobile, and Briviba (2018) for spaghetti with red grape pomace.

Some studies showed that the chemical composition and the digestibility of wheat flour and bread changed depending on the grape seeds flour addition level (Aghamirzaei et al., 2015; Boudová Pečivová et al., 2014). Thus, at higher grape seeds amounts, pH and moisture decrease, whereas ash, proteins, fats, and fiber contents increase, due to the composition of grape seeds (Aghamirzaei et al., 2015; Boudová Pečivová et al., 2014). Smith and Yu (2015) reported no significant changes of fat content of bread enriched with 5% grape pomace, increases being observed at 10% addition level. The moisture and ash content increased, whereas the protein content slightly decreased because of the dilution effect caused by the pomace, which has not high protein content (Table 1) (Smith & Yu, 2015). According to the results presented by Oprea et al. (2018), the nutritional value of bakery products may be augmented by incorporating grape peels. The protein, ash, and fat contents of grape peels–wheat flour blends increased compared to the control, whereas the carbohydrates level decreased. Higher minerals contents such as magnesium, potassium, iron, and copper were observed in flour blends, grape peels–wheat flour formulations being considered a source of copper (Oprea et al., 2018). The same authors also reported an increase of UFAs. Aksoylu, Çağindi, and Köse (2015) reported higher ash, protein, fat, magnesium, and calcium values for biscuits enriched with defatted grape seeds. The ash content of cookies with Bordeaux grape pomace varied with the amount added, whereas for the lipids and proteins did not registered significant differences ($p > .05$) (Karnopp et al., 2015). Higher ash values for cookies with grape pomace indicate the opportunity to obtain nutritionally improved products, rich in potassium, magnesium, iron, manganese, copper, and zinc (Maner et al., 2017). The muffins and brownies samples registered higher moisture value with the grape pomace addition level increase, whereas for the bread formulations there were not significant changes because of the optimal hydration use for each loaf (Walker et al., 2014). The muffins and brownies with white grape pomace had higher moisture values than the control and those with red pomace, due to the high concentration in sugar, which plays a humectants role (Walker et al., 2014). Lower protein content and higher fat and DF contents of muffins with grape pomace flour incorporation compared to the control were obtained by Ortega-Heras, Gómez, de Pablos-Alcalde,

and González-Sanjosé (2019). The ash and DF content of cookies increased with the addition level of grape seeds, seedless grape pomace, or whole grape pomace, whereas the protein contents increased at levels higher than 10% whole grape pomace and seedless grape pomace, the same trend being obtained for oil when whole grape pomace was added (Acun & Gül, 2014). Lower sugar contents reported for cookies with less than 10% grape byproducts can be due to the higher amount of DF (Acun & Gül, 2014). Theagarajan et al. (2019) reported higher protein, ash, and DF contents of cookies containing grape pomace compared to the control, whereas the carbohydrates, fat, and energy values were not significantly ($p > .05$) different.

Minerals are important for some body functions such as bones and teeth growth, enzymatic activity and structure, muscle contraction, kidney performance, heart activity, nerve signaling, hormone, and immune system functioning (Beres et al., 2019). Gomes et al. (2019) reported variable bioaccessibility of macro- and micronutrients in grape byproducts, from the macronutrients potassium being the most bioaccessible, whereas from micronutrients iron was predominant in peels and seeds from the studied varieties. Grape peels digestion resulted in higher bioaccessibility of minerals compared to the seeds (Gomes et al., 2019), which underlines their nutritional value and supports their use as functional ingredient.

Linear increase of the DF content with grape pomace concentration of enriched white bread was observed for many grape varieties (Smith & Yu, 2015). High amounts of DF, especially the soluble ones, are related to the increase of bread and cookies water retention capacity (Maner et al., 2017; Smith & Yu, 2015). DF has the ability to hold water, which plays an important role in the kinetics of water uptake. Due to the fact that water is present in capillary structure in DF as a consequence of surface tension, it can interact through hydrogen bonds or dipoles with other components, leading to better product porosity (Maner et al., 2017). Defatted grape seed addition to biscuits led to a threefold increase of crude fiber (Aksoylu et al., 2015). The DF contents of bread, muffins, and brownies with red and white grape pomace were significantly higher than of the control, increasing with the addition level, bigger changes being reported for those with red pomace (Walker et al., 2014).

Maurer et al. (2019) reported an amelioration of colitis in rats feed with grape peels, the DF being responsible for the intestinal barrier function reestablishment, whereas the phenolic compounds bounded to fiber fractions contributed to the cecal metabolism restoration, improving the production of beneficial compounds such as cecal short-chain fatty acids with anti-inflammatory and antiproliferative effects on the colonic cells and reducing the

activation of the unfolded protein response (Maurer et al., 2019; Yuan, Wang, Chen, Zhu, & Cao, 2016). DF presents many biological functions such as anticancer activity, gastrointestinal activity improvement, anti-apoptotic activity, cardiovascular disease prevention, anti-hypercholesterolemic activity, and anti-hyperglycemia effect (Kurek & Wyrwicz, 2015; Özkaya, Baumgartner, & Özkaya, 2018; Zhu et al., 2014).

5 | DOUGH RHEOLOGY AND WHEAT FLOUR PROPERTIES AS INFLUENCED BY GRAPE BYPRODUCTS ADDITION

The complex dough matrix is formed mainly of gluten, starch, and water and it is considered a viscoelastic biopolymer (Collar & Angioloni, 2014). The technological processes and the quality of the final product are directly influenced by dough's rheological behavior, which can be evaluated through empirical (consistency, viscosity, and extension properties measurements) or dynamic (viscosity functions, elastic modulus, creep, and recovery compliances measurements) methods (Belton, 2012; Faridi & Faubion, 2012). The viscoelastic behavior of dough suggests that when a mechanical force is applied, dimensional changes occur, but they will be partially reversed when the force is removed, which means that dough stores mechanical energy dissipated as elastic potential energy, fact that may give information about the maximum dough resistance during mixing (Belton, 2012).

The addition of fiber-rich ingredients affects dough rheological properties (Table 5), depending on the addition level (Arufe et al., 2017; Bender et al., 2017; Elawad et al., 2016; Kurek, Wyrwicz, Karp, Brzeska, & Wierzbicka, 2017; Mironeasa et al., 2019a; Shiau, Wu, & Liu, 2015) and particle size (Iuga et al., 2019; Kurek, Wyrwicz, Piwińska, & Wierzbicka, 2016; Mironeasa et al., 2019c; Wang, Hou, & Dubat, 2017), the changes leading especially to the dilution effect of the main endogenous biopolymers such as starch and gluten, which give dough viscoelastic properties (Elawad et al., 2016; Shiau et al., 2015). The addition of high amounts of fibers in wheat dough can cause negative effects on final product volume, porosity, and crumb color darkening, but the addition of an appropriate proportion of soluble and insoluble fibers and/or enzymes such as hemicelluloses and pentosans can minimize these effects (Koletta, Irakli, Papageorgiou, & Skendi, 2014; Kurek et al., 2016). Also the decrease of fiber-rich ingredients particle size can reduce the negative effects on the final product quality (Iuga et al., 2019; Mironeasa et al., 2019c; Wang et al., 2017). Grape byproducts are rich in fibers (Beres et al., 2019; Deng et al., 2011; Sousa et al., 2014; Teles et al., 2019)

with a good proportion between SDF and ADF (Sousa et al., 2014), which upholds the possibility of using them to enrich bakery and pastry products without damaging their final quality.

According to the results reported by some studies, the water absorption measured by means of the farinographic method was reduced after grape pomace addition to wheat flour due to the fiber content increase, depending on the grape variety (Mildner-Szkudlarz, Bajerska, Zawirska-Wojtasiak, & Górecka, 2013; Šporin et al., 2018). Mildner-Szkudlarz et al. (2013) obtained a decrease of dough stability compared to the control sample and an increased mixing tolerance index with grape pomace addition, whereas Šporin et al. (2018) reported an increase of dough stability and softening degree when Merlot pomace was incorporated and a decrease for Zeleny variety of pomace containing samples.

The solvent retention capacity is a measure of dough polymer networks swelling and was studied by Walker et al. (2014) for flour, bread, muffins, and brownies enriched with white and red grape pomaces. The water holding capacities of flours mixed with grape pomace were lower than of the control and may cause texture changes. Wheat dough textural characteristics are influenced by grape peels addition by increasing hardness and decreasing adhesiveness compared to the control, as a result of gluten matrix dilution (Aghamirzaei et al., 2015; Mironeasa et al., 2019c). Depending on the amount and on the particle size, dough springiness and cohesiveness have a decreasing tendency compared to the control, changes related to the components of grape peels and to the intermolecular interactions that occur (Iuga, Mironeasa, 2017; Mironeasa et al., 2019c). Higher hardness and cohesiveness of dough with small particle sizes can be attributed to the higher water absorption capacity of finer grape peels flour (Mironeasa et al., 2019c). Boudová Pečivová et al. (2014) reported higher firmness and stickiness values for bread doughs with grape seeds compared to the control, but the freshness was maintained for a longer time.

The result obtained by Mironeasa, Zaharia, Codină, Ropciuc, and Iuga (2018, 2019a) showed that the addition of red grape peels with different particle sizes affected dough rheological properties measured by both empirical and dynamic methods. Thus, the stability and the softening degree of white wheat dough decreased when grape peels flour was added probably due to the lower water availability and the gluten dilution effect caused by the fiber presence, especially the insoluble one (Collar & Angioloni, 2014; Mironeasa et al., 2019b, 2019c). The gelatinization temperature, the temperature at peak viscosity, and the gas retention coefficient was reported to be higher in dough formulations with greater amount of grape peels; the fiber and minerals contents

TABLE 5 Effects of grape byproducts on dough rheology

Food matrix	Grape byproduct	Amount added (%)	Effects	Reference
Biscuits dough	Pomace	10; 20; 30	-Reduced flour water absorption -Reduced dough stability -Increased mixing tolerance index	Mildner-Szkudlarz et al., 2013
Wheat bread dough	Pomace	6; 10; 15	-Decreased water absorption when Merlot pomace was added -Increased stability time -Decrease dough strength, except for Merlot pomace addition -Decreased dough softening degree for Merlot pomace addition and increased for Zelen variety	Šporin et al., 2018
Wheat bread dough	Peels	3; 5; 7; 9	-Decreased dough stability and softening degree -Increased the gelatinization temperature, temperature at peak viscosity, and gas retention -Increased the viscous modulus and decreased the loss tangent	Mironeasa et al., 2019
Wheat bread dough	Peels	5; 10; 15	-Not significant effects on dough stability -Increased dough elasticity -Increased mixing resistance and dough consistency	Oprea et al., 2018
Wheat bread dough	Peels	5; 7.5; 10	-Decreased flour extensibility -Decreased falling number and wet gluten content	Bender et al., 2017
Cookie dough	Peels	5; 10; 15	-Decreased dough consistency and stability -Increased water absorption	Kuchtová et al., 2018
	Seeds		-Increased dough consistency and stability -Decreased water absorption	
Butter biscuits	Peels	15	-Increased butter biscuits dough viscosity -Decreased the modulus of instantaneous springiness and the elasticity modulus -Increased dough plastic viscosity	Brykova et al., 2018
	Seeds			
Biscuits dough	Seeds	5; 10; 15; 20	-Decreased butter biscuits dough extensibility -Decreased water absorption capacity -Strengthening effect on gluten matrix	Samohvalova et al., 2016
Wheat bread dough	Seeds	3; 5; 7; 9	-Decreased loss tangent values -Delayed starch gelatinization	Mironeasa et al., 2017
Wheat bread dough	Seeds	5; 10; 15; 20; 25	-Decreased Zeleny sedimentation value -No significant changes on wet gluten were observed -Increased dough softening degree -Improved dough stability at addition levels lower than 10%	Aghamirzaei et al., 2015

of grape peels may be responsible for the gelatinization process changes because of the different gelatinization temperature of fiber fractions and because of the calcium, which improves the alpha-amylase activity (Mironeasa et al., 2019b, 2019c; Oprea et al., 2018). At high addition levels and particle sizes of red grape peels, dough becomes stronger as the increase of the viscous modulus and the decrease of the loss tangent showed (Mironeasa et al., 2019b). Similar results were found for the wheat–white grape peels dough formulations (Mironeasa et al., 2019a). As the creep recovery test indicated, the elasticity and the recoverable proportion were higher for the wheat–red grape peels dough formulations with small particle size and 5% addition level (Mironeasa et al., 2019c). Therefore, small particle sized and lower replacement levels were found to be recommendable to obtain bread with good quality (Mironeasa et al., 2019a, 2019b, 2019c). An increase of the water absorption capacity of wheat flour mixed with grape peels as the addition level increased was indicated by several studies (Kuchtová et al., 2018; Oprea et al., 2018). It may be caused by the presence of hydroxyl groups in the structure of fibers, which leads to higher water interactions through hydrogen bonds (Kohajdová, Karovičová, Jurasová, & Kukurová, 2011). The enrichment has not significant effect on dough stability, but a better elasticity was observed especially for high replacement levels (Oprea et al., 2018). The decrease of the gluten amount by grape peels incorporation caused a decrease of dough stability, its properties depending on the gluten quantity and quality (Helgerud et al., 2016; Kuchtová et al., 2018). Higher mixing resistance and dough consistency were recorded due to the negative protein dilution effect, whereas the starch gel formation, stability, and retrogradation were influenced in a minor way by the addition of grape peels (Oprea et al., 2018). In opposition, Kuchtová et al. (2018) obtained lower consistency and higher resistance to degradation for cookies dough made of white wheat flour and grape peels in various concentrations, probably due to the interactions with the other ingredients from the formulations.

The extensibility of wheat flour enriched with grape peels decreased with the added amount increase due to the high content of fibers (Bender et al., 2017). The gluten development was negatively influenced by the fiber from fruit processing byproducts, resulting in less extensible dough because they reduce the hydration rate of the wheat proteins, leading to gluten network weakening (Abebe, Ronda, Villanueva, & Collar, 2015). The protein films are damaged by the presence of DFs such as cellulose and lignin, which may create a physical barrier and can affect the water absorption capacity of gluten (Abebe et al., 2015). A better dough resistance to deformation was reported and can be attributed to the high soluble fiber content, which

leads to a higher water retention capacity (Bender et al., 2017; Fu, Wang, & Dupuis, 2017). The falling number (FN) index and the wet gluten of wheat–grape peels formulations decreased with the addition level (Bender et al., 2017; Mironeasa et al., 2019a). A decrease of FN index was also found when grape seed flour was incorporated in wheat flour (Mironeasa et al., 2012, 2016, 2017), indicating an increase of alpha-amylase activity in the composite flour. Bender et al. (2017) reported a decrease of FN and wet gluten values with the addition level of Riesling and Tannat grape peels increase, which can be explained by the wheat flour amount lowering and thus the enzymes were able to act in the grape peels flour (Bender et al., 2017). The same trend of the wet gluten content was obtained by Aghamirzaei et al. (2015) for wheat flour containing different levels of grape seeds powder. According to the results presented by Brykova, Samohvalova, Grevtseva, Kasabova, and Grygorenko (2018), butter biscuits dough viscosity and plastic viscosity increased when grape peels or seeds powders were added, the modulus of instantaneous springiness and the elasticity modulus decreasing compared to the control.

The Zeleny sedimentation value of wheat flour, a measure of the baking quality, decreased with grape seed addition increase due to the diluting effect of fibers on the gluten matrix. Also, the grape seed proteins can decrease the swelling power of glutenin macropolymers, leading to low Zeleny test values (Aghamirzaei et al., 2015). The arabinoxylan found in flour has a negative impact on gluten properties because it interacts with proteins and can be evaluated through hydration and swelling of accessible arabinoxylans with sucrose (Katyal et al., 2018; Walker et al., 2014). The results obtained by Walker et al. (2014) showed that the formulations with grape pomaces had higher sucrose retention, which means that the fibers may contribute to the smaller loaf and extensibility. No significant changes of wet gluten content were observed for the wheat flour enriched with grape seeds (Aghamirzaei et al., 2015).

The addition of grape seeds flour to wheat flour augments the hydrophobic compounds contents due to their high amount of fats and lignin, which leads to a decrease of mixes water absorption capacity (Aghamirzaei et al., 2015; Deng et al., 2011; Kuchtová et al., 2018; Mironeasa et al., 2017; Samohvalova et al., 2016; Sousa et al., 2014). The improvement of dough stability at concentrations up to 10% grape seeds can be attributed to the fatty acids presence, which interacts with the polymeric fraction of gluten and forms lipoprotein complexes, higher grape seeds concentrations having negative effects due to the high amount of fibers (Aghamirzaei et al., 2015; Kuchtová et al., 2018; Mironeasa et al., 2012; Mironeasa et al., 2017). The increase of the softening degree with grape seeds addition level

indicates a reduction of dough tolerance caused by the dilution of glutenins and the weakening of crosslinks between the proteins, which influences gluten formation (Aghamirzaei et al., 2015; Mironeasa et al., 2017). Dough consistency reduction after grape seeds addition can be attributed to the increase of flour amylase activity, fact revealed also by the decrease of FN index (Kuchtová et al., 2018; Mironeasa et al., 2012; Mironeasa et al., 2017).

The rheological behavior of wheat–grape byproducts flour dough depends on the amount added, the particle size, and the grape variety (Bender et al., 2017; Iuga, Mironeasa, et al., 2017; Iuga et al., 2019). According to the results presented by Iuga et al. (2019), the elastic modulus of wheat–red grape seed dough was lower than of the white seed mix, whereas the particle size and the addition level had a synergistic effect on the elastic and viscous moduli, which means that some interactions between grape seeds chemical constituents and wheat flour occur (Iuga, Mironeasa, et al., 2017). Similar results were obtained by Parra, Sahagún, Ribotta, Ferrero, and Gómez (2019) for dough with different levels and particle sizes of dried apple pomace addition. The gelatinization temperatures of the white grape seeds–wheat flour mixes were higher than for the red ones, the addition causing a delay of starch gelatinization (Mironeasa et al., 2017), similar to the data reported by Kiumarsi et al. (2019) for gluten-free bread enriched with DFs. The resistance to deformation of dough with red grape seeds was also higher at small particle sizes probably due to the strengthening effect of the phenolic compounds that interact with proteins (Iuga, Ropciuc, et al., 2017; Iuga et al., 2019). Some studies reported lower CO₂ production during fermentation at large grape seeds particle sizes additions because they may act as weakness points due to their high fiber content, which break down the starch–gluten network (Iuga, Mironeasa, et al., 2017; Mironeasa et al., 2017). The high gas production for small particle size can be related, probably, to the interactions between fats and the polymeric fraction of gluten, which leads to a better gas holding (Mironeasa et al., 2017). The dynamic moduli changes of grape seeds–wheat flour dough depend on the particle size and addition level, the loss tangent of all studied samples being lower than of the control as a result of the lower water availability (Iuga, Mironeasa, et al., 2017; Mironeasa et al., 2017; Tietze, Jekle, & Becker, 2016). Low gluten quality of dough incorporated with grape seeds was reported by Samohvalova et al. (2016), the extensibility of butter biscuits dough being also affected. The strengthening effect of grape seeds flour on the gluten matrix can be attributed to the nonstarch polysaccharides, tannins, and polyphenols, which form complexes with proteins and to the oxidation of sulfhydryl groups to disulfides caused by the high amount of oxi-

dizing substances (Samohvalova et al., 2016; Tkacz et al., 2019).

6 | INFLUENCE OF GRAPE BYPRODUCTS ON FINAL PRODUCT QUALITY

Consumer's acceptance depends on the physical and sensorial characteristics of the final product. Grape byproducts addition in bakery and pastry goods has some advantages as the increase of the polyphenols content and antioxidant activity, a higher intake of SDFs and IDFs, but some negative effects such as reduced loaf volume or harder texture and low consumer acceptability can be obtained (Table 6) (Maner et al., 2017; Smith & Yu, 2015; Walker et al., 2014). To minimize these effects, the optimal amount and particle size of such a fiber-rich ingredient must be found such that good technological, physical, textural, and sensorial characteristic can be achieved (Iuga & Mironeasa, 2019; Karnopp et al., 2015; Mironeasa & Mironeasa, 2019; Mironeasa et al., 2019a; Walker et al., 2014).

6.1 | Effects of grape byproducts addition on the physical characteristics and shelf-life

DF-rich ingredients can alternate the aerated structure of bakery and pastry products through gluten dilution, gluten network physical ruptures, and/or competition for water, fruit fibers having lower effect compared to cereal bran due to their high SDF content (Alba, Campbell, & Kontogiorgos, 2019). The influence of fibers on gas cells stability can be better understood through the dual mechanism described by MacRitchie (2016): gas retention is provided by means of gluten network, but there is also a thin layer of liquid around the gas cells, which contributes to the volume stabilization. During dough proofing and baking, coalescence of gas cells can occur promoted by the ruptures in the starch–gluten network, but the liquid film present around can fill the discontinuities, promoting better stability, higher loaf volume, and finer pores (Alba et al., 2019, MacRitchie, 2016). As grape byproducts IDF can act as inert fillers and can create ruptures in dough matrix, the diminishing of the negative effects magnitude on gas retention and loaf volume of the final product can be explained through this mechanism.

Physical characteristics of baked goods and pasta can be affected by grape byproducts incorporation, depending on the amount added, grape variety, and particle size. No significant influence of grape pomace addition up to

TABLE 6 Effects of grape byproducts addition on baked goods and pasta quality

Food matrix	Grape byproduct	Amount added (%)	Effects	Reference
Bread Muffins Brownies	Pomace	5; 10; 15	-Decreased loaf volume -Increased firmness and chewiness -Determined darker color -Grainy texture	Walker et al., 2014
Bread	Pomace	2; 5; 10	-Hardness increase -Darker crumb color -Low acceptability for bread with more than 10% grape pomace	Hayta et al., 2014
Muffins	Pomace	10; 20	-Decreased loaf volume -Increased hardness -Decreased resilience and cohesiveness -Negatively affected the sensory characteristics at levels higher than 10% -Decreased lightness	Ortega-Heras et al., 2019
Pasta	Pomace	2.5; 5.0; 7.5	-Decreased sensory characteristics scores -Decreased lightness and redness tone	Sant'Anna et al., 2014
Cookies	Peels	5; 10; 15	-Decreased volume and thickness -Decreased fracturability and hardness -Decreased lightness -No significant changes of the sensory characteristics at less than 5% addition	Kuchtová et al., 2018
Muffins	Peels	5.0; 7.5; 10.0	-Increased hardness -Decreased cohesiveness and resilience -Decreased lightness -Improved sensory scored at levels up to 10%	Bender et al., 2017
Pasta	Peels	3; 6; 9	-Improved sensory characteristics scores at levels up to 6%	Gaita et al., 2018
Biscuits	Seeds	5	-Decreased hardness -Determined darker color -The maximum storage time is 5 months, after lower texture, flavor and, acceptability scores being obtained due to the rigid, grainy, and rough structure	Aksoylu et al., 2015
Bread	Seeds	2; 4; 6; 8; 10	-Higher dough stickiness and firmness -Determined darker color -Addition levels higher than 8% determined low sensory scores	Boudová Pečivová et al., 2014
Cookies	Pomace, seeds, seedless pomace	5; 10; 15	-No changes on spread ratio -Lower brightness -Lower sensory characteristics scores at addition levels higher than 10%	Acun & Gül, 2014

6% in cookies regarding the weight, diameter, thickness, spread ratio, spread factor, and water activity was reported by Theagarajan et al. (2019). According to Acun and Gül (2014), there were no changes in cookies width and spread ratio when whole grape pomace, seedless grape pomace, and grape seeds flours were incorporated, the thickness decreasing only when pomace flour without seeds was added as a result of the gluten dilution effect. The decrease of cookies volume and thickness with grape peels addition is related to the high fiber content, which reduces the gas retention capacity (Deng et al., 2011; Kuchtová et al., 2018; Walker et al., 2014). Grape peels or seeds were added to butter biscuits to slightly increase the specific volume and to increase the stability and wetting ability as compared to the control, as Brykova et al. (2018) showed. On contrary, a decrease of butter biscuits volume with the grape seed flour addition level increase was reported by Samohvalova et al. (2016), acceptable results being obtained for replacements up to 15%.

The loaf volume of muffins, brownies, and bread with grape pomace decreased with the addition level increase as a result of higher fiber content, which harms dough structure and determines a lower CO₂ retention, and due to the fibers water absorption, which makes difficult starch–gluten matrix development on water restriction (Cruz Requena et al., 2016; Mildner-Szkudlarz et al., 2011; Mironeasa et al., 2017; Smith & Yu, 2015; Walker et al., 2014). Similar results were obtained also by Ortega-Heras et al. (2019) for muffins with white and red grape pomace. Šporin (2019) reported lower bread loaf volume supplemented with Merlot and Zeleny grape pomace compared to the control, the decrease being proportional with the addition level increase, probably due to dough tensile strength reduction by the complexes with high molecular mass formed between the ferulic acid and gluten and/or to the inhibitory effect of phenolic compounds on yeast activity.

The results obtained by Koca, Tekguler, Arif Yilmaz, Hasbay, and Koca (2018) showed that the incorporation of grape seeds in Turkish noodle led to cooking loss, water absorption, and volume increase as the addition level was greater, probably as a result of gluten content and strength decrease, which was related to lower water retention and more intense solids leaching.

Backed goods and pasta shelf life can be affected by pathogen microorganism development. The phenolic compounds found in grape byproducts can represent natural ingredients, which can be used to extend the shelf life of foods as they have showed significant antimicrobial activity. Furthermore, SDF with low molecular mass present in grape pomace powders and smaller available water amount enhance the microbial shelf life of the product, whereas texture shelf life is rather influenced by the fraction of IDF (Mehta, 2014).

The main action mechanism of the polyphenols against microorganisms supposes the penetration of cell membrane and reactions with the cytoplasm or cellular proteins (Yadav, Kumar, Kumar, & Mishra, 2015). Šporin (2019) studied the effects of red (Merlot) and white (Zeleny) grape pomaces addition at 6%, 10%, and 15% levels in bread and revealed that both exhibited an inhibitory activity against microbial growth proportional with the addition level increase. After 5 days of incubation without exogenous inoculation, the enriched breads presented lower number of mold colonies compared to the control, higher effectiveness being observed for Merlot pomace. However, no statistically significant effect ($p > .05$) of bread supplementation on the inhibitory activity against *Aspergillus flavus*, *Aspergillus ochraceus*, *Penicillium nordicum*, and *Penicillium verrucosum* inoculated was obtained, except at some concentrations on certain day of incubation (Šporin, 2019). According to the results obtained by Savla and Yardi (2016), the addition of white grape pomace in rice gluten-free pasta determined better antimicrobial activity, the total number of microorganism of the enriched pasta being significantly lower in the first and fifth day of storage compared to the control. Final products microbial growth can be reduced by water activity lowering, which can be achieved through grape byproducts incorporation as they contain sugars and polyphenols, which are known to decrease the water activity of the food system (Cauvain, 2016).

Bakery products shelf life extension should include also staling retardation. Staling is a complex phenomenon that starts immediately after baking and involves physicochemical changes during storage that alternate consumer acceptance. Structural changes that led to firmness increase, available water loss, starch retrogradation, and oxidation reactions that affect products flavor and taste occur (Preedy & Watson, 2019; Rosell, Bajerska, & El Sheikha, 2015). The main mechanisms of bakery products staling include water redistribution, amylopectin molecules recrystallization, and gluten protein network rigidity decrease (Šporin, 2019). The increase of crumb firmness during storage can be attributed to the rearrangement of branched amylopectin starch fraction within the swollen grain, the chains spread into the available water associating through intramolecular bonds, leading to structure rigidity increase (Rosell et al., 2015). Water migration through direct diffusion, vapor phase transfer, or syneresis from the polymeric structure influences bakery products staling. The gradient of moisture between crust and crumb will determine movements of water until equilibrium, leading to loss of bread consumer acceptance, whereas in pan bread this migration is beneficial because soft crust is expected (Cauvain, 2016). The rate of moisture migration depends on the product volume, such as a more porous structure facilitates

water diffusion, which implies crumb dehydration and crust softening (Cauvain, 2016). Fruit byproducts used in baking goods have been found to limit the staling process, which can be associated with the fiber content that may reduce the retrogradation of amylopectin and enhance the water retention capacity (Gómez & Martínez, 2018). Moisture loss during bread staling can be lowered by grape byproducts addition because the high insoluble fiber content plays the role of bulking agent and they retain more water (O'Shea, 2014). Grape byproducts proteins may probably contribute to bakery product staling process slowing, loaf volume increase, and crumb firmness decrease due to their ability of water retention, similar to gluten proteins. Luo et al. (2018) obtained lower hardness increase rate during storage of Chinese steamed bread enhanced with grape seeds extract, more pronounced effect being observed at higher concentrations. Lower magnitude of cohesiveness values increase and chewiness and resilience decrease during storage was also reported, which indicate staling inhibition determined probably by the ability of phenolic compounds to form complexes with starch and protein (Luo et al., 2018). The decrease of retrogradation enthalpy indicated that grape seed extract can reduce wheat starch retrogradation by retarding the recrystallization as the high number of available hydroxyl groups of phenols is forming hydrogen bonds with amylose/amylopectin, influencing amylopectin retrogradation (Luo et al., 2018; Lv et al., 2020). Šporin (2019) reported lower increase rate of wheat bread firmness during storage, proportional with the addition level of grape pomace increase, as a result of fiber interactions with starch and their water absorption capacity, which slow down the retrogradation phenomenon. The addition of 2.5% and 5.0% grape seeds determined a decrease of bread firmness during storage compared to the control, whereas at 7.5 % bread firmness increased faster probably as a result of gluten dilution effect (Meral & Dogan, 2013).

6.2 | Effects of grape byproducts addition on texture

Food products' texture is important as it may influence consumers' purchase decision and can be influenced by the addition of fiber-rich ingredients. The phenolic compounds and DF present in grape pomace may induce negative effects in the final product texture as a result of the interactions with other components of the formulation. In dough matrix, interactions between polyphenols and proteins occur; the hydrogen linkages formation and/or hydrophobic interactions result in soluble and insoluble polyphenol-protein complexes formation (Lavelli, Kerr, García-Lomillo, & González-SanJosé, 2017).

The degree of polymerization and the number of galloyl ester groups of the polyphenolic compound are responsible for the interaction pathway. Therefore, the formation of protein-phenolic aggregates through linkages of peptides rich in proline with galloylated monomers is more important, mainly with flavanol oligomers with the degree of polymerization higher than 4, than with nongalloylated monomers such as catching and epicatechin (Lavelli et al., 2017). Proanthocyanidins found in grape byproducts are more susceptible to form cross-linkages with proteins because they present higher number of potential interaction sites than monomers, but this process can be affected by pectin presence because it can form ternary aggregates from proteins, polyphenols, and polysaccharides (Lavelli, Sri Harsha, & Fiori, 2015). It was demonstrated that proanthocyanidins with higher molecular mass are forming stronger interactions in foods than other phenolic compounds (Lavelli, Harsha, Ferranti, Scarafoni, & Iametti, 2016). The lignin and hemicelluloses ratio of fiber-rich ingredients significantly influences baked goods texture, for example, lower lignin content leads to softer and finer mouthfeel, whereas high amounts determine crunchy texture (Mehta, 2014). Final product softness, spread, and shape can be influenced by the molecular mass and linkages types of low-viscosity SDF such as inulin and fructooligosaccharides (Mehta, 2014).

Grape pomace addition was responsible for hardness increase in cookies due to the gluten dilution effect and to the increase of fiber content (Karnopp et al., 2015). On the other hand, Mildner-Szkudlarz et al. (2013) reported that when white grape pomace powder was used in wheat biscuits, the hardness and color deterioration were reduced. Lower fracturability and hardness values were observed for cookies with grape peels and grape seeds, the decrease of hardness with the replacement level being attributed to the gluten content reduction, which leads to a retardation of gluten matrices formations (Chauhan, Saxena, & Singh, 2016; Kuchtová et al., 2018). Aksoylu et al. (2015) reported a decrease of biscuits with grape seeds hardness compared to the control, the values increasing gradually during storage due to the starch retrogradation phenomenon (Chung, Cho, & Lim, 2014; Mironescu & Mironescu, 2014).

An increase of bread, muffins, and brownies firmness and chewiness was reported for wheat bread with grape pomace as a consequence of their lower loaf volume, the polyphenols present in grape pomace also having an important role because they affect yeast performance by increasing the amylase activity resulting in maltose availability decrease (Mildner-Szkudlarz et al., 2011; Walker et al., 2014). Muffins springiness decreased with grape pomace addition level increase, but an opposite trend was observed for the brownies samples (Walker et al., 2014). Another study underlines that grape pomace addition in

muffins decreased resilience and cohesiveness with the amount increase as a result of the fiber desegregation effect, which leads to lower requirement of energy for the second compression (Ortega-Heras et al., 2019). Muffins containing different grape peels varieties flours presented higher hardness as the amount increased, suggesting an increase of dough density and a reduced air incorporation during mixing and an insufficient gel formation caused by the protein and starch dilution effect (Aghamirzaei et al., 2015; Bender et al., 2017; Ortega-Heras et al., 2019). No significant influence was reported for muffins springiness, whereas the cohesiveness and resilience were lower as the grape peels amounts augmented (Bender et al., 2017).

Hayta et al. (2014) reported that hardness of bread increased with level of grape pomace (seeds and peels) powder increases from 0% to 10%. Fresh breads exhibited the lowest values of hardness compared with breads in the first and second day, hardness gradually increasing with staling. Probably, the binding water by pomace fiber can result in an increase of hardness value. In addition, all the loaves with grape pomace were less cohesive than the control bread after 48 hr of storage. Textural characteristics changes of bakery products are negatively influenced by pomace probably due to the gluten dilution effect (Hayta et al., 2014). Grape seed extract incorporation in Chinese steamed bread determined higher firmness compared to the control, which might be associated with the lower volume caused probably by the interactions of polyphenols with the gluten network (Luo et al., 2018).

Elasticity, adhesiveness, and bulkiness were negatively affected by the incorporation of grape pomace in spaghetti, the addition of transglutaminase diminishing these effects (Marinelli et al., 2018). Hardness value of Turkish noodle enriched with grape seeds flour increased compared to the control and decreased proportionally with the added amount increase, probably due to the higher water uptake during boiling caused by the fiber content of grape seeds (Koca et al., 2018). Grape pomace addition in durum wheat pasta led to an increase of firmness and adhesiveness due to the breaking of the continuous structure of pasta caused by fibers (Tolve, Pasini, Vignale, Favati, & Simonato, 2020).

6.3 | Effects of grape byproducts addition on the sensory profile and color

One of the most important aspects in novel food development is the sensory profile that can be changed by grape byproducts incorporation. Cookies from wheat flour replaced with grape pomace were found to have good sensory characteristics depending on the addition level. Thus, at 5% of grape pomace good scores for appearance, texture, mouth sensation, taste, aroma, and acceptability were

obtained, higher than the control, but at more than 10% amounts of grape pomace these values decreased (Maner et al., 2017; Smith & Yu, 2015). Better sensory characteristics in terms of color, taste, odor, texture, and appearance of cookies with grape pomace incorporation up to 6% compared to the control sample were obtained by Theagarajan et al. (2019). Acun and Gül (2014) reported lower scores for color, taste, chewiness, hardness, and affordability of cookies with more than 10% grape pomace byproducts. On the other hand, improved sensory characteristics in terms of external appearance, taste, and smell of butter biscuits with grape seeds or peels addition of 15% were obtained by Brykova et al. (2018). Sharma et al. (2018) underlined that grape pomace variety influences the sensory characteristics of cookies, Sauvignon Blanc pomace-containing samples obtaining the best sensory scores. An addition of about 15% organic grape peels flour to cookies was found to be optimal in order to obtain the best scores for appearance, flavor, texture, and overall acceptability (Abreu et al., 2019). Karnopp et al. (2015) obtained no significant differences of sensory characteristics of cookies from whole wheat flour and grape pomace, underlining that there are no negative effects of the addition on the consumer's preferences. Natural pigments of grape seeds and the promotion of nonenzymatic browning reactions are responsible for the darker color of biscuits enhanced with grape seeds (Aksoylu et al., 2015). The luminosity increased during storage probably due to the pigments degradation in time, which has a strong relation with the product's pH values (Aksoylu et al., 2015). The sensory evaluation of biscuits with grape seeds revealed that they cannot be consumed after 5 months, lower texture, flavor, and acceptability scores being registered after storage as a result of the rigid, grainy, and rough structure of grape seeds fractions (Aksoylu et al., 2015). The presence of catching, epicatechin, and proanthocyanidins in grape seeds led to a decrease of cookies pleasant sensation in the mouth caused by the astringent sensation (Kuchtová et al., 2018; Silva et al., 2018). The fat content of grape seeds positively influences the flavor intensity and perception (Kuchtová et al., 2018). Adding up to 15% grape seeds flour to butter biscuits did not modify significantly their sensory characteristics, except the color, which was darker, but at higher levels the product became firm and too compact (Samo-hvalova et al., 2016). Cookies containing grape pomace byproducts presented lower brightness, whereas when grape seeds flour was added higher redness and greenness of cookies were obtained compared to the samples with whole and seedless grape pomace (Acun & Gül, 2014).

Mildner-Szkudlarz et al. (2015) also reported a decrease of scores for color, appearance, taste, flavor, and overall acceptability with the grape pomace level increase in muffins, at 30% a fruity-acidic and pungent taste was noted

due to the phenolic and mostly catching presence (Kuchtová et al., 2018; Mildner-Szkudlarczyk et al., 2015). Similar trend was reported by Ortega-Heras et al. (2019) for muffins with grape pomace, an incorporation of maximum 10% being recommended. A decrease of lightness of wheat muffins and cookies incorporated with grape peels was observed, the color being influenced by the grape variety as they contain different pigments (Bender et al., 2017; Kuchtová et al., 2018; Ortega-Heras et al., 2019). Good color, taste, flavor, texture, and acceptability score were reported by Bender et al. (2017) for muffins with different grape peels at levels up to 10%, the authors showing also that the consumers have a positive purchase intention for this kind of products, females being more receptive. No significant differences compared to the control on cookies with 5% grape peels sensory characteristics were obtained, so at this level the overall acceptability will not be affected (Kuchtová et al., 2018).

Muffins, bread, and cookies from wheat flour containing grape pomace presented darker color as the amount increased due to the higher sugars content, which promotes the Maillard reactions and to the polyphenols presence (Giuberti, Marti, Fortunati, & Gallo, 2017; Maner et al., 2017; Smith & Yu, 2015; Walker et al., 2014). Good acceptability of wheat-grape pomace bread was reported for levels up to 10%, whereas for muffins 5% addition level was acceptable and for brownies levels up to 15% can be accepted by consumers (Walker et al., 2014). The panelists also notified a grainy texture of the products, which suggests that smaller particle sizes are recommended (Kuchtová et al., 2018; Walker et al., 2014). Bread with 10% grape pomace was evaluated with the lowest overall acceptability scores, whereas breads with 2% and 5% addition level had similar acceptability values (Hayta et al., 2014). Grape seeds incorporation in bread formulation led to darker color, depending on the amount added, due to the enzymatic reactions and to the oxidation of monophenols to diphenols (Boudová Pečivová et al., 2014). According to the results presented by Boudová Pečivová et al. (2014), an incorporation of grape seeds in bread at levels higher than 8% is not recommended from sensorial point of view. Grape pomace-containing bread samples had darker crumb color values depending on the chemical composition of the added ingredient and the anthocyanins content (Hayta et al., 2014).

Wheat flour substitution by grape pomace powder led to the decrease of fettuccini pasta sensory scores, the flavor, aftertaste, and texture being not dependent on the addition level (Sant'Anna et al., 2014). The sensory scores did not significantly differ ($p > .05$) among the samples with different substitution levels, but were lower compared to the control (Sant'Anna et al., 2014). Similar results were reported by Savla and Yardi (2016) for gluten-free pasta and

by Marinelli et al. (2018) for spaghetti with grape pomace addition. According to the results presented by Marinelli et al. (2018), smaller red grape pomace flour particle size ($<125 \mu\text{m}$) determined improved sensory attributes of spaghetti compared to smaller ones. Sant'Anna et al. (2014) reported a decrease of lightness and reddish tone values of fettuccini pasta with grape pomace flour addition increase, which can be related to the anthocyanins content increase. Furthermore, the cooking process led to the decrease of lightness and reddish tone of pasta probably as a result of the leaching phenomenon of anthocyanins from the grape pomace added and pigments degradation (Sant'Anna et al., 2014). Gaita et al. (2018) obtained better scores for the sensory characteristics of pasta with 3% and 6% grape peels compared to the control, probably due to the fact that no water was added to the recipe and pasta did not broke. Consumers can associate the darker color with a healthier product, being considered more attractive (Bender et al., 2017; Kuchtová et al., 2018; Walker et al., 2014). The color changes depend not only on the added amount, but also on the grape variety (Bender et al., 2017; Smith & Yu, 2015).

7 | CONCLUSIONS AND FURTHER RESEARCH

Grape byproducts are an important source of DF and compounds with antioxidant properties, their chemical composition depending on the grape variety. The bakery, pastry, and pasta products nutritional and functional characteristics can be improved by adding grape pomace, seeds, or peels, augmenting the amount of fibers, phenolic compounds, and minerals. The impact of these fiber-rich ingredients on the rheological properties of dough depends on the basic matrix, on the addition level and particle size. The incorporation of fiber-rich ingredients results in higher nutritional value of the baked goods or pasta, but at the same time can alter the rheological characteristics of dough and consequently the physical and sensory properties of the final product. The texture, volume, color, and sensory characteristics are strongly affected at high amounts of grape byproducts, thus an optimization being required in order to obtain desirable technological and sensorial quality and in the same time a nutritionally enhanced product. The researches made until now underline the possibility of using grape byproducts as functional ingredients in bakery, pastry, and pasta industries without damaging products quality if appropriate amounts are added. However, more investigations on the effects of grape byproducts on baked goods and pasta quality at molecular level are required, because some contradictory results were reported until now. There are limited studies

regarding the effects of grape byproducts on the microbiological shelf life and staling of baked goods and pasta. Thus, further researches should be focused on the effects of foods containing grape byproducts on the human health, on the molecular interactions of grape byproducts with the food matrix components, and on the possibility to extend the shelf life of bakery, pastry, and pasta products by using such natural ingredients.

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AUTHOR CONTRIBUTIONS

Mădălina Iuga and Silvia Mironeasa contributed equally in the preparation and the writing of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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REFERENCES

- Abdrabba, S., & Hussein, S. (2015). Chemical Composition of pulp, seed and peel of red grape from Lybia. *Global Journal of Scientific Researches*, 3(2), 6–11.
- Abebe, W., Ronda, F., Villanueva, M., & Collar, C. (2015). Effect of tef [*Eragrostis tef* (Zucc.) Trotter] grain flour addition on viscoelastic properties and stickiness of wheat dough matrices and bread loaf volume. *European Food Research and Technology*, 241(4), 469–478. <https://doi.org/10.1007/s00217-015-2476-0>
- Abreu, J., Quintino, I., Pascoal, G., Postinger, B., Cadena, R., & Teodoro, A. (2019). Antioxidant capacity, phenolic compound content and sensory properties of cookies produced from organic grape peel (*Vitis labrusca*) flour. *International Journal of Food Science and Technology*, 54(4), 1215–1224. <https://doi.org/10.1111/ijfs.14100>
- Acosta-Estrada, B. A., Gutiérrez-Urbe, J. A., & Serna-Saldívar, S. O. (2014). Bound phenolic in foods, a review. *Food Chemistry*, 152, 46–55. <https://doi.org/10.1016/j.foodchem.2013.11.093>
- Acun, S., & Gül, H. (2014). Effects of grape pomace and grape seed flours on cookie quality. *Quality Assurance and Safety of Crops & Foods*, 6(1), 81–88. <https://doi.org/10.3920/QAS2013.0264>
- Aghamirzaei, M., Peighambaroust, S. H., Azadmard-Damirchi, S., & Majzoobi, M. (2015). Effects of grape seed powder as a functional ingredient on flour physicochemical characteristics and dough rheological properties. *Journal of Agricultural Science and Technology*, 17(2), 365–373.
- Ahmed, M., Pickova, J., Ahmad, T., Liaquat, M., Farid, A., & Jahangir, M. (2016). Oxidation of lipids in foods. *Sarhad Journal of Agriculture*, 32(3), 230–238. <https://doi.org/10.17582/journal.sja/2016.32.3.230.238>
- Akin, A., & Altindişli, A. (2011). Determination of fatty acid composition and lipid content of some grape cultivar seeds in Turkey. *Biyoloji Bilimleri Araştırma Dergisi*, 4(2), 13–15.
- Aksoyly, Z., Çağındı, Ö., & Köse, E. (2015). Effects of blueberry, grape seed powder and poppy seed incorporation on physicochemical and sensory properties of biscuit. *Journal of Food Quality*, 38(3), 164–174. <https://doi.org/10.1111/jfq.12133>
- Aktaş, M., Taşeri, L., Şevik, S., Gülcü, M., Uysal Seçkin, G., & Dolgun, E. C. (2019). Heat pump drying of grape pomace: Performance and product quality analysis. *Drying Technology*, 37(14), 1766–1779. <https://doi.org/10.1080/07373937.2018.1536983>
- Alba, K., Campbell, M., & Kontogiorgos, V. (2019). Dietary fibre from berry-processing waste and its impact on bread structure: A review. *Journal of the Science of Food and Agriculture*, 99(9), 4189–4199. <https://doi.org/10.1002/jsfa.9633>
- Alipour, D., & Rouzbehan, Y. (2010). Effects of several levels of extracted tannin from grape pomace on intestinal digestibility of soybean meal. *Livestock Science*, 128(1-3), 87–91. <https://doi.org/10.1016/j.livsci.2009.11.003>
- Allen, L., de Benoist, B., Dary, O., & Hurrell, R. (2006). *Guidelines on food fortification with micronutrients*. Geneva, Switzerland: World Health Organization; Rome, Italy: Food and Agriculture Organization of the United Nations.
- Álvarez, A., Poejo, J., Matias, A. A., Duarte, C. M. M., Cocero, M. J., & Mato, R. B. (2017). Microwave pretreatment to improve extraction efficiency and polyphenol extract richness from grape pomace. Effect on antioxidant bioactivity. *Food and Bioprocess Processing*, 106, 162–170. <https://doi.org/10.1016/j.fbp.2017.09.007>
- Angioloni, A., & Collar, C. (2008). Functional response of diluted dough matrixes in high-fibre systems: A viscometric and rheological approach. *Food Research International*, 41(8), 803–812. <https://doi.org/10.1016/j.foodres.2008.07.003>
- Arufe, S., Chiron, H., Doré, J., Savary-Auzeloux, I., Saulnier, L., & Della Valle, G. (2017). Processing & rheological properties of wheat flour dough and bread containing high levels of soluble dietary fibres blends. *Food Research International*, 97, 123–132. <https://doi.org/10.1016/j.foodres.2017.03.040>
- Arvik, T. (2012). Grape (*Vitis vinifera*) seed and skin flours contribute flavor and functionality to baked goods. *Cereal Foods World*, 57(6), 262–264. <https://doi.org/10.1094/CFW-57-6-0262>
- Apak, R., Özyürek, M., Güçlü, K., & Çapanoğlu, E. (2016). Antioxidant activity/capacity measurement. 1. Classification, physicochemical principles, mechanisms, and electron transfer (ET)-based assays. *Journal of Agricultural and Food Chemistry*, 64(5), 997–1027. <https://doi.org/10.1021/acs.jafc.5b04739>
- Baixaui, R., Sanz, T., Salvador, A., & Fiszman, S. M. Á. (2008). Muffins with resistant starch: Baking performance in relation to the rheological properties of the batter. *Journal of Cereal Science*, 47, 502–509. <https://doi.org/10.1016/j.jcs.2007.06.015>

- Barbi, R. C., de Souza, A. R. C., Hamerski, F., Lopes Teixeira, G., Corazza, M. L., & Hoffmann Ribani, R. (2019). Subcritical propane extraction of high-quality inajá (*Maximiliana maripa*) pulp oil. *Journal of Supercritical Fluids*, *153*, 104576. <https://doi.org/10.1016/j.supflu.2019.104576>
- Bartosz, G. (2016). *Food oxidants and antioxidants: Chemical, biological, and functional properties*. Boca Raton, FL: CRC Press.
- Baydar, N. G., & Akkurt, M. (2001). Oil content and oil quality properties of some grape seeds. *Turkish Journal of Agriculture and Forestry*, *25*(3), 163–168. <https://doi.org/10.3906/tar-9909-25>
- Belton, P. S. (2012). The molecular basis of dough rheology. In S. P. Cauvain (Ed.), *Breadmaking: Improving quality* (2nd ed., pp. 337–351). Cambridge, UK: Woodhead Publishing.
- Bender, A. B. B., Speroni, C. S., Salvador, P. R., Loureiro, B. B., Lovatto, N. M., Goulart, F. R., ... Penna, N. G. (2017). Grape pomace skins and the effects of its inclusion in the technological properties of muffins. *Journal of Culinary Science and Technology*, *15*(2), 143–157. <https://doi.org/10.1080/15428052.2016.1225535>
- Beres, C., Freitas, S. P., Godoy, R. L., de, O., de Oliveira, D. C. R., Deliza, R., ... Cabral, L. M. C. (2019). Antioxidant dietary fibre from grape pomace flour or extract: Does it make any difference on the nutritional and functional value? *Journal of Functional Foods*, *56*, 276–285. <https://doi.org/10.1016/j.jff.2019.03.014>
- Beres, C., Simas-Tosin, F. F., Cabezudo, I., Freitas, S. P., Iacomini, M., Mellinger-Silva, C., & Cabral, L. M. C. (2016). Antioxidant dietary fibre recovery from Brazilian Pinot noir grape pomace. *Food Chemistry*, *201*, 145–152. <https://doi.org/10.1016/j.foodchem.2016.01.039>
- Bevilacqua, N., Morassut, M., Serra, M. C., & Cecchini, F. (2017). Determinazione dell'impronta carbonica dei sottoprodotti della vinificazione e loro valenza biologica. *Ingegneria Dell'Ambiente*, *4*(3), 277–286. <https://doi.org/10.14672/ida.v4i3.1142>
- Biniari, K., Gerogiannis, O., Daskalakis, I., Bouza, D., & Stavrakaki, M. (2018). Study of some qualitative and quantitative characters of the grapes of indigenous Greek grapevine varieties (*Vitis vinifera* L.) using HPLC and spectrophotometric analyses. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, *46*(1), 97–106. <https://doi.org/10.15835/nbha46611008>
- Bogoeva, A. L., Durakova, A. G., Pavlov, A. I., Yanakieva, V. B., Vrancheva, R. Z., Bozadzhiev, B. V., & Choroleeva, K. B. (2017). Antioxidant activity and storage regime of defatted grape seeds flour. *Wine Studies*, *6*(1), 1–4. <https://doi.org/10.4081/ws.2017.6695>
- Bogoeva, A. L., & Durakova, A. G. (2020). Sorption characteristics of full-fatted grape seeds flour of Bulgarian origin. *Journal of Agriculture and Food Research*, *2*, 100026. <https://doi.org/10.1016/j.jafr.2020.100026>
- Bordiga, M., Travaglia, F., & Locatelli, M. (2019). Valorisation of grape pomace: An approach that is increasingly reaching its maturity—A review. *International Journal of Food Science and Technology*, *54*(4), 933–942. <https://doi.org/10.1111/ijfs.14118>
- Bordiga, M. (2018). *Post-fermentation and -distillation technology: Stabilization, aging, and spoilage*. Boca Raton, FL: CRC Press.
- Bornkessel, S., Bröring, S., Omta, S. W. F., & van Trijp, H. (2014). What determines ingredient awareness of consumers? A study on ten functional food ingredients. *Food Quality and Preference*, *32*, 330–339. <https://doi.org/10.1016/j.foodqual.2013.09.007>
- Boudová Pečivová, P., Kráčmar, S., Kubáň, V., Mlček, J., Juríková, T., & Sochor, J. (2014). Effect of addition of grape seed flour on chemical, textural and sensory properties of bread dough. *Mitt Eilungen Klosterneuburg*, *64*(3), 114–119.
- Boulekbache-Makhlouf, L., Slimani, S., & Madani, K. (2013). Total phenolic content, antioxidant and antibacterial activities of fruits of *Eucalyptus globulus* cultivated in Algeria. *Industrial Crops and Products*, *41*(1), 85–89. <https://doi.org/10.1016/j.indcrop.2012.04.019>
- Brenes, A., Viveros, A., Chamorro, S., & Arija, I. (2016). Use of polyphenol-rich grape byproducts in monogastric nutrition. A review. *Animal Feed Science and Technology*, *211*, 1–17. <https://doi.org/10.1016/j.anifeedsci.2015.09.016>
- Brownlee, I. A. (2011). The physiological roles of dietary fibre. *Food Hydrocolloids*, *25*, 238–250. <https://doi.org/10.1016/j.foodhyd.2009.11.013>
- Brykova, T., Samohvalova, O., Grevtseva, N., Kasabova, K., & Grygorenko, A. (2018). The influence of grape powders on the rheological properties of dough and characteristics of the quality of butter biscuits. *Chemistry of Food Products and Materials*, *11*(4), 33–38. <https://doi.org/10.15673/fst.v12i2.945>
- Burčová, Z., Kreps, F., Schmidt, Š., Stržincová, P., Jablonský, M., Kyseľka, J., ... Šurina, I. (2019). Antioxidant activity and the tocopherol and phenol contents of grape residues. *BioResources*, *14*(2), 4146–4156. <https://doi.org/10.15376/biores.14.2.4146-4156>
- Carmona-Jiménez, Y., García-Moreno, M. V., & García-Barroso, C. (2018). Effect of drying on the phenolic content and antioxidant activity of red grape pomace. *Plant Foods for Human Nutrition*, *73*(1), 74–81. <https://doi.org/10.1007/s11130-018-0658-1>
- Cauvain, S. P. (2016). Bread and other bakery products. In D. Kilcast & P. Subramaniam (Eds.), *The stability and shelf life of food* (2nd ed., pp. 431–459). Boca Raton, FL: CRC Press. <https://doi.org/10.1016/B978-0-08-100435-7.00015-0>
- Chauhan, A., Saxena, D. C., & Singh, S. (2016). Physical, textural, and sensory characteristics of wheat and amaranth flour blend cookies. *Cogent Food & Agriculture*, *2*(1), 1125773. <https://doi.org/10.1080/23311932.2015.1125773>
- Cerda-Carrasco, A., López-Solis, R., Nuñez-Kalasic, H., Peña-Neira, Á., & Obreque-Slier, E. (2015). Phenolic composition and antioxidant capacity of pomaces from four grape varieties (*Vitis vinifera* L.). *Journal of the Science of Food and Agriculture*, *95*(7), 1521–1527. <https://doi.org/10.1002/jsfa.6856>
- Chikwanha, O. C., Raffrenato, E., Muchenje, V., Musarurwa, H. T., & Mapiye, C. (2018). Varietal differences in nutrient, amino acid and mineral composition and in vitro rumen digestibility of grape (*Vitis vinifera*) pomace from the Cape Winelands vineyards in South Africa and impact of preservation techniques. *Industrial Crops and Products*, *118*, 30–37. <https://doi.org/10.1016/j.indcrop.2018.03.026>
- Chung, H. J., Cho, A., & Lim, S. T. (2014). Utilization of germinated and heat-moisture treated brown rices in sugar-snap cookies. *LWT - Food Science and Technology*, *57*(1), 260–266. <https://doi.org/10.1016/j.lwt.2014.01.018>
- Cobb, V., Yu, J., Zhu, S., Smith, I., & Chen, G. (2018). Impacts of grape pomace on the in vitro starch digestion and overall digestibility of extruded food products. *EC Nutrition*, *13*(3), 65–70.
- Collar, C., & Angioloni, A. (2014). Nutritional and functional performance of high β -glucan barley flours in breadmaking: Mixed breads versus wheat breads. *European Food Research and Technology*, *238*(3), 459–469. <https://doi.org/10.1007/s00217-013-2128-1>

- Collar, C., Santos, E., & Rosell, C. M. (2007). Assessment of the rheological profile of fibre-enriched bread doughs by response surface methodology. *Journal of Food Engineering*, 78(3), 820–826. <https://doi.org/10.1016/j.jfoodeng.2005.11.026>
- Corbin, K. R., Hsieh, Y. S. Y., Betts, N. S., Byrt, C. S., Henderson, M., Stork, J., ... Burton, R. A. (2015). Grape marc as a source of carbohydrates for bioethanol: Chemical composition, pre-treatment and saccharification. *Bioresource Technology*, 193, 76–83. <https://doi.org/10.1016/j.biortech.2015.06.030>
- Costa, G. N. S., Tonon, R. V., Mellinger-Silva, C., Galdeano, M. C., Iacomini, M., Santiago, M. C. P. A., ... Freitas, S. P. (2019). Grape seed pomace as a valuable source of antioxidant fibers. *Journal of the Science of Food and Agriculture*, 99(10), 4593–4601. <https://doi.org/10.1002/jsfa.9698>
- Correa, M. J., Añón, M. C., Pérez, G. T., & Ferrero, C. (2010). Effect of modified celluloses on dough rheology and microstructure. *Food Research International*, 43(3), 780–787. <https://doi.org/10.1016/j.foodres.2009.11.016>
- Cruz Requena, M., Aguilar González, C. N., Prado Barragán, L. A., Correia, T., Contreras Esquivel, J. C., & Rodríguez Herrera, R. (2016). Functional and physico-chemical properties of six desert-sources of dietary fiber. *Food Bioscience*, 16, 26–31. <https://doi.org/10.1016/j.fbio.2016.08.001>
- Da Porto, C., Porretto, E., & Decorti, D. (2013). Comparison of ultrasound-assisted extraction with conventional extraction methods of oil and polyphenols from grape (*Vitis vinifera* L.) seeds. *Ultrasonics Sonochemistry*, 20(4), 1076–1080. <https://doi.org/10.1016/j.ultsonch.2012.12.002>
- Deng, Q., Penner, M. H., & Zhao, Y. (2011). Chemical composition of dietary fiber and polyphenols of five different varieties of wine grape pomace skins. *Food Research International*, 44(9), 2712–2720. <https://doi.org/10.1016/j.foodres.2011.05.026>
- Durakova, A. G., Bogoeva, A. L., Pavlov, A. I., Dinkov, K. T., Vrancheva, R. Z., & Yanakieva, V. B. (2018). Antioxidant activity and storage regime of grape seeds flakes – a waste product in wine elaboration. *Bulgarian Journal of Agricultural Science*, 24(3), 503–508.
- Dwyer, K., Hosseinian, F., & Rod, M. (2014). The market potential of grape waste alternatives kyle. *Journal of Food Research*, 3(2), 91–106. <https://doi.org/10.5539/jfr.v3n2p91>
- Elawad, M. R. O., Yang, T. A., Ahmed, R. H. A., Ishag, A. E. K., Mudawi, H. A., & Abdelrahim, K. M. S. (2016). Chemical composition and functional properties of wheat bread containing wheat and legumes bran. *International Journal of Food Science and Nutrition*, 1(5), 2455–4898.
- Ertürk, B., & Meral, R. (2019). The impact of stabilization on functional, molecular and thermal properties of rice bran. *Journal of Cereal Science*, 88, 71–78. <https://doi.org/10.1016/j.jcs.2019.05.011>
- Eskicioglu, V., Kamiloglu, S., & Nilufer, D. (2015). Antioxidant dietary fibres: Potential functional food ingredients from plant processing by-products. *Czech Journal of Food Sciences*, 33(6), 487–499. <https://doi.org/10.17221/42/2015-CJFS>
- Estévez, M., Li, Z., Soladoye, O. P., & Van-Hecke, T. (2017). Health risks of food oxidation. *Advances in Food and Nutrition Research*, 82, 45–81. <https://doi.org/10.1016/bs.afnr.2016.12.005>
- Fadda, C., Angioloni, A., Piga, A., & Collar, C. (2010). Impact of sourdough, yeast and gluten on small and large deformation rheological profiles of durum wheat bread doughs. *European Food Research and Technology*, 231(3), 431–440. <https://doi.org/10.1007/s00217-010-1300-0>
- Faisal, K., Mosammad, S. S., & Heri, K. (2015). Antimicrobial activities of grape (*Vitis vinifera* L.) pomace polyphenols as a source of naturally occurring bioactive components. *African Journal of Biotechnology*, 14(26), 2157–2161. <https://doi.org/10.5897/ajb2015.14617>
- Falowo, A. B., Fayemi, P. O., & Muchenje, V. (2014). Natural antioxidants against lipid-protein oxidative deterioration in meat and meat products: A review. *Food Research International*, 64, 171–181. <https://doi.org/10.1016/j.foodres.2014.06.022>
- Faridi, H., & Faubion, J. M. (2012). *Dough rheology and baked product texture*. New York, NY: Van Nostrand Reinhold.
- Fernandes, L., Casal, S., Cruz, R., Pereira, J. A., & Ramalhosa, E. (2013). Seed oils of ten traditional Portuguese grape varieties with interesting chemical and antioxidant properties. *Food Research International Journal*, 50(1), 161–166. <https://doi.org/10.1016/j.foodres.2012.09.039>
- Ficco, D. B. M., Muccilli, S., Padalino, L., Giannone, V., Lecce, L., Giovanniello, V., ... Spina, A. (2018). Durum wheat breads ‘high in fibre’ and with reduced in vitro glycaemic response obtained by partial semolina replacement with minor cereals and pulses. *Journal of Food Science and Technology*, 55(11), 4458–4467. <https://doi.org/10.1007/s13197-018-3374-9>
- Fu, B. X., Wang, K., & Dupuis, B. (2017). Predicting water absorption of wheat flour using high shear-based GlutoPeak test. *Journal of Cereal Science*, 76, 116–121. <https://doi.org/10.1016/j.jcs.2017.05.017>
- Fuller, S., Beck, E., Salman, H., & Tapsell, L. (2016). New horizons for the study of dietary fiber and health: A review. *Plant Foods for Human Nutrition*, 71(1), 1–12. <https://doi.org/10.1007/s11130-016-0529-6>
- Gaita, C., Alexa, E., Moigradean, D., & Poiana, M. A. (2018). *Designing of high value - added pasta formulas by incorporation of grape pomace skins*. Romanian Biotechnological Letters. Retrieved from https://www.rombio.eu/docs/Gaita_etnonbreakingspaceal.pdf
- Galanakis, C. M. (2012). Recovery of high added-value components from food wastes: Conventional, emerging technologies and commercialized applications. *Trends in Food Science & Technology*, 26(2), 68–87. <https://doi.org/10.1016/j.tifs.2012.03.003>
- Galano, A., Mazzone, G., Alvarez-Diduk, R., Marino, T., Alvarez-Idaboy, J. R., & Russo, N. (2016). Food antioxidants: Chemical insights at the molecular level. *Annual Review of Food Science and Technology*, 7(1), 335–352. <https://doi.org/10.1146/annurev-food-041715-033206>
- García-Lomillo, J., & González-SanJosé, M. L. (2017). Applications of wine pomace in the food industry: Approaches and functions. *Comprehensive Reviews in Food Science and Food Safety*, 16(1), 3–22. <https://doi.org/10.1111/1541-4337.12238>
- Georgiev, V., Ananga, A., & Tsolova, V. (2014). Recent advances and uses of grape flavonoids as nutraceuticals. *Nutrients*, 6(1), 391–415. <https://doi.org/10.3390/nu6010391>
- Giuberti, G., Marti, A., Fortunati, P., & Gallo, A. (2017). Gluten free rice cookies with resistant starch ingredients from modified waxy rice starches: Nutritional aspects and textural characteristics. *Journal of Cereal Science*, 76, 157–164. <https://doi.org/10.1016/j.jcs.2017.06.008>
- Gomes, T. M., Toaldo, I. M., da Silva Haas, I. C., Burin, V. M., Caliari, V., Luna, A. S., ... Bordignon-Luiz, M. T. (2019). Differential contribution of grape peel, pulp, and seed to bioaccessibility

- of micronutrients and major polyphenolic compounds of red and white grapes through simulated human digestion. *Journal of Functional Foods*, 52, 699–708. <https://doi.org/10.1016/j.jff.2018.11.051>
- Gorji, S., Smyth, H. E., Sharma, M., & Fitzgerald, M. (2016). Lipid oxidation in mayonnaise and the role of natural antioxidants: A review. *Trends in Food Science & Technology*, 56, 88–102. <https://doi.org/10.1016/j.tifs.2016.08.002>
- Goula, A. M., Thymiatou, K., & Kaderides, K. (2016). Valorization of grape pomace: Drying behavior and ultrasound extraction of phenolic. *Food and Bioprocess Technology*, 100, 132–144. <https://doi.org/10.1016/j.fbp.2016.06.016>
- Gómez-Brandón, M., Lores, M., Insam, H., & Domínguez, J. (2019). Strategies for recycling and valorization of grape marc. *Critical Reviews in Biotechnology*, 39(4), 1–14. <https://doi.org/10.1080/07388551.2018.1555514>
- Gomez, M., & Martinez, M. M. (2018). Fruit and vegetable by-products as novel ingredients to improve the nutritional quality of baked goods. *Critical Reviews in Food Science and Nutrition*, 58(13), 2119–2135. <https://doi.org/10.1080/10408398.2017.1305946>
- Gómez, M., Jiménez, S., Ruiz, E., & Oliete, B. (2011). Effect of extruded wheat bran on dough rheology and bread quality. *LWT - Food Science and Technology*, 44, 2231–2237. <https://doi.org/10.1016/j.lwt.2011.06.006>
- Guaita, M., & Bosso, A. (2019). Polyphenolic characterization of grape skins and seeds of flour Italian red cultivars at harvest and after fermentative maceration. *Foods*, 8(9), 395–418. <https://doi.org/10.3390/foods8090395>
- Guendez, R., Kallithraka, S., Makris, D. P., & Kefalas, P. (2005). An analytical survey of the polyphenols of seeds of varieties of grape (*Vitis vinifera*) cultivated in Greece: Implications for exploitation as a source of value-added phytochemicals. *Phytochemical Analysis*, 16(1), 17–23. <https://doi.org/10.1002/pca.804>
- Gülcü, M., Uslu, N., Özcan, M. M., Gökmen, F., Özcan, M. M., Banjanin, T., ... Lemiasheuski, V. (2019). The investigation of bioactive compounds of wine, grape juice and boiled grape juice wastes. *Journal of Food Processing and Preservation*, 43(1), 1–14. <https://doi.org/10.1111/jfpp.13850>
- Gürbüz, G. (2018). *Investigations on protein-lipid interactions under oxidative conditions*. Retrieved from <https://helda.helsinki.fi/bitstream/handle/10138/233098/Investig.pdf?sequence=1>
- Hamulka, J., Głabka, D., Guzek, D., Białkowska, A., & Sulich, A. (2018). Intake of saturated fatty acids affects atherogenic blood properties in young, Caucasian, overweight women even without influencing blood cholesterol. *International Journal of Environmental Research and Public Health*, 15(11), 2530. <https://doi.org/10.3390/ijerph15112530>
- Harbeoui, H., Bettaieb Rebey, I., Ouerghemmi, I., Aidi Wannes, W., Zemni, H., Zoghalmi, N., ... Tounsi, M. S. (2018). Biochemical characterization and antioxidant activity of grape (*Vitis vinifera* L.) seed oils from nine Tunisian varieties. *Journal of Food Biochemistry*, 42(5), 1–12. <https://doi.org/10.1111/jfbc.12595>
- Hayta, M., Özüğür, G., Eتgü, H., & Şeker, I. T. (2014). Effect of grape (*Vitis vinifera* L.) pomace on the quality, total phenolic content and anti-radical activity of bread. *Journal of Food Processing and Preservation*, 38(3), 980–986. <https://doi.org/10.1111/jfpp.12054>
- Helgerud, T., Schüller, R. B., Dessev, T., Rukke, E. O., Knutsen, S. H., Afseth, N. K., & Ballance, S. (2016). Mixing properties and rheological characteristics of dough used to make potato-cereal soft wraps. *International Journal of Food Science and Technology*, 51(1), 142–149. <https://doi.org/10.1111/ijfs.12983>
- Hellwig, M. (2019). The chemistry of protein oxidation in food. *Angewandte Chemie International Edition*, 58(47), 16742–16763. <https://doi.org/10.1002/anie.201814144>
- Hogervorst, J. C., Miljić, U., & Puškaš, V. (2017). 5 - extraction of bioactive compounds from grape processing by-products. In C. M. Galanakis (Ed.), *Handbook of grape processing by-products* (pp. 105–135). London, UK: Academic Press. <https://doi.org/10.1016/B978-0-12-809870-7.00005-3>
- Holtung, L., Grimmer, S., & Aaby, K. (2011). Effect of processing of black currant press-residue on polyphenol composition and cell proliferation. *Journal of Agricultural and Food Chemistry*, 59(8), 3632–3640. <https://doi.org/10.1021/jf104427r>
- Horszwald, A., Julien, H., & Andlauer, W. (2013). Characterisation of Aronia powders obtained by different drying processes. *Food Chemistry*, 141(3), 2858–2863. <https://doi.org/10.1016/j.foodchem.2013.05.103>
- Hrušková, M., & Faměra, O. (2003). Prediction of wheat and flour Zeleny sedimentation value using NIR technique. *Czech Journal of Food Sciences*, 21(3), 91–96. <https://doi.org/10.17221/3482-cjfs>
- Iora, S. R., Maciel, G. M., Zielinski, A. A., da Silva, M. V., Pontes, P. V. D. A., Haminiuk, C. W., & Granato, D. (2015). Evaluation of the bioactive compounds and the antioxidant capacity of grape pomace. *International Journal of Food Science & Technology*, 50(1), 62–69. <https://doi.org/10.1111/ijfs.12583>
- Iuga, M., Mironeasa, S., Zaharia, D., Ropciuc, S., & Mironeasa, C. (2017). Effects of grape seeds flour addition on wheat flour dough rheological properties. *International Multidisciplinary Scientific GeoConference: SGEM: Surveying Geology & mining Ecology Management*, 17(63), 209–217. <https://doi.org/10.5593/sgem2017H/63/S25.027>
- Iuga, M., Codină, G. G., Mironeasa, S., & Oroian, M. (2017). *Amino acid composition of grape seeds and peels from grape pomace*. International Symposium Prospects for the 3th Millennium Agriculture, Cluj-Napoca, 4, 381.
- Iuga, M., Ropciuc, S., & Mironeasa, S. (2017). Antioxidant activity and total phenolic content of grape seeds and peels from Romanian varieties. *Food and Environment Safety Journal*, 16(4), 276–282. Retrieved from <http://www.fia.usv.ro/fiajournal/index.php/FENS/article/view/541>
- Iuga, M., & Mironeasa, S. (2019). Grape seeds effect on refined wheat flour dough rheology: Optimal amount and particle size. *Ukrainian Food Journal*, 8(4), 799–814. <https://doi.org/10.24263/2304-974X-2019-8-4-11>
- Iuga, M., Mironeasa, C., & Mironeasa, S. (2019). Oscillatory rheology and creep-recovery behaviour of grape seed-wheat flour dough: Effect of grape seed particle size, variety and addition level. *Bulletin UASVM Food Science and Technology*, 76(1), 40–51.
- Jaisanthi, J., & Banu, A. T. (2014). Phytonutrient composition, antioxidant activity and acceptability of baked product incorporated with grape seed extract. *Journal of Human Nutrition and Food Science*, 2(6), 1049–1054.
- Jara-Palacios, M. J., Rodríguez-Pulido, F. J., Hernanz, D., Escudero-Gilete, M. L., & Heredia, F. J. (2016). Determination of phenolic substances of seeds, skins and stems from white grape marc by near-infrared hyperspectral imaging. *Australian Journal of Grape and Wine Research*, 22(1), 11–15. <https://doi.org/10.1111/ajgw.12165>

- Jayaram, V. B., Rezaei, M. N., Cuyvers, S., Verstrepen, K. J., Delcour, J. A., & Courtin, C. M. (2014). Ethanol at levels produced by *saccharomyces cerevisiae* during wheat dough fermentation has a strong impact on dough properties. *Journal of Agricultural and Food Chemistry*, 62, 9326–9335. <https://doi.org/10.1021/jf502547a>
- Jokić, S., Bijuk, M., Aladić, K., Bilić, M., & Molnar, M. (2016). Optimisation of supercritical CO₂ extraction of grape seed oil using response surface methodology. *International Journal of Food Science and Technology*, 51(2), 403–410. <https://doi.org/10.1111/ijfs.12986>
- Kalli, E., Lappa, I., Bouchagier, P., Tarantilis, P. A., & Skotti, E. (2018). Novel application and industrial exploitation of winery by-products. *Bioresources and Bioprocessing*, 5, 46. <https://doi.org/10.1186/s40643-018-0232-6>
- Karnopp, A. R., Figueroa, A. M., Los, P. R., Teles, J. C., Simões, D. R. S., Barana, A. C., ... Granato, D. (2015). Effects of whole-wheat flour and bordeaux grape pomace (*Vitis labrusca* L.) on the sensory, physicochemical and functional properties of cookies. *Food Science and Technology*, 35(4), 750–756. <https://doi.org/10.1590/1678-457X.0010>
- Karovičová, J., Kohajdová, Z., Minarovičová, L., & Kuchtová, V. (2015). The chemical composition of grape fibre. *Potravinarstvo*, 9(1), 53–57. <https://doi.org/10.5219/428>
- Katyal, M., Viridi, A. S., Singh, N., Chopra, N., Kaur, A., Ahlawat, A. K., & Singh, A. M. (2018). Fractionation and grain hardness effect on protein profiling, pasting and rheological properties of flours from medium-hard and extraordinarily soft wheat varieties. *Journal of Food Science and Technology*, 55(11), 4661–4674. <https://doi.org/10.1007/s13197-018-3433-2>
- Kawabata, K., Yoshioka, Y., & Terao, J. (2019). Role of intestinal microbiota in the bioavailability and physiological functions of dietary polyphenols. *Molecules*, 24(2), 370. <https://doi.org/10.3390/molecules24020370>
- Kiumarsi, M., Shahbazi, M., Yeganehzad, S., Majchrzak, D., Lieleg, O., & Winkeljann, B. (2019). Relation between structural, mechanical and sensory properties of gluten-free bread as affected by modified dietary fibers. *Food Chemistry*, 277, 664–673. <https://doi.org/10.1016/j.foodchem.2018.11.015>
- Koca, I., Tekguler, B., Arif Yilmaz, V., Hasbay, I., & Koca, A. F. (2018). The use of grape, pomegranate and rosehip seed flours in Turkish noodle (erişte) production. *Journal of Food Processing and Preservation*, 42(1), e13343. <https://doi.org/10.1111/jfpp.13343>
- Kohajdová, Z., Karovičová, J., Jurasová, M., & Kukurová, K. (2011). Effect of the addition of commercial apple fibre powder on the baking and sensory properties of cookies. *Acta Chimica Slovaca*, 4(2), 88–97. <https://doi.org/10.2478/s11696-014-0567-1>
- Kolettta, P., Irakli, M., Papageorgiou, M., & Skendi, A. (2014). Physicochemical and technological properties of highly enriched wheat breads with wholegrain non wheat flours. *Journal of Cereal Science*, 60(3), 561–568. <https://doi.org/10.1016/j.jcs.2014.08.003>
- Kuchtová, V., Kohajdová, Z., Karovičová, J., & Lauková, M. (2018). Physical, textural and sensory properties of cookies incorporated with grape skin and seed preparations. *Polish Journal of Food and Nutrition Sciences*, 68(4), 309–317. <https://doi.org/10.2478/pjfn-2018-0004>
- Kurek, M., & Wyrwicz, J. (2015). The application of dietary fiber in bread products. *Journal of Food Processing & Technology*, 6(5), 1–8. <https://doi.org/10.4172/2157-7110.1000447>
- Kurek, M. A., Wyrwicz, J., Karp, S., Brzeska, M., & Wierzbicka, A. (2017). Comparative analysis of dough rheology and quality of bread baked from fortified and high-in-fiber flours. *Journal of Cereal Science*, 74, 210–217. <https://doi.org/10.1016/j.jcs.2017.02.011>
- Kurek, M., Wyrwicz, J., Piwińska, M., & Wierzbicka, A. (2016). The effect of oat fibre powder particle size on the physical properties of wheat bread rolls. *Food Technology and Biotechnology*, 54(1), 45–51. <https://doi.org/10.17113/ftb.54.01.16.4177>
- Lachman, J., Hejtmánková, A., Táborský, J., Kotíková, Z., Pivec, V., Střalková, R., ... Dědina, M. (2015). Evaluation of oil content and fatty acid composition in the seed of grapevine varieties. *LWT - Food Science and Technology*, 63(1), 620–625. <https://doi.org/10.1016/j.lwt.2015.03.044>
- Lavelli, V., Torri, L., Zeppa, G., Fiori, L., & Spigno, G. (2016). Recovery of winemaking by-products. *Italian Journal of Food Science*, 28(4), 542–564.
- Lavelli, V., Kerr, W. L., García-Lomillo, J., & González-SanJosé, M. L. (2017). Applications of recovered bioactive compounds in food products. In C. M. Galanakis (Ed.), *Handbook of grape processing by-products* (pp. 233–266). London, UK: Academic Press.
- Lavelli, V., Sri Harsha, P. S., & Fiori, L. (2015). Screening grape seeds recovered from winemaking by-products as sources of reducing agents and mammalian α -glucosidase and α -amylase inhibitors. *International Journal of Food Science & Technology*, 50(5), 1182–1189. <https://doi.org/10.1111/ijfs.12763>
- Lavelli, V., Harsha, P. S., Ferranti, P., Scarafoni, A., & Iametti, S. (2016). Grape skin phenolic as inhibitors of mammalian α -glucosidase and α -amylase—effect of food matrix and processing on efficacy. *Food & Function*, 7(3), 1655–1663. <https://doi.org/10.1039/c6fo00073h>
- Lewoyehu, M., & Amare, M. (2019). Comparative evaluation of analytical methods for determining the antioxidant activities of honey: A review. *Cogent Food & Agriculture*, 5(1), 1685059. <https://doi.org/10.1080/23311932.2019.1685059>
- Liu, Y., Ragone, D., & Murch, S. J. (2015). Breadfruit (*Artocarpus altilis*): A source of high-quality protein for food security and novel food products. *Amino Acids*, 47(4), 847–856. <https://doi.org/10.1007/s00726-015-1914-4>
- Lucarini, M., Durazzo, A., Romani, A., Campo, M., Lombardi-Boccia, G., & Cecchini, F. (2018). Bio-based compounds from grape seeds: A biorefinery approach. *Molecules*, 23(8), 1888. <https://doi.org/10.3390/molecules23081888>
- Lucarini, M., Durazzo, A., Kiefer, J., Santini, A., Lombardi-boccia, G., Souto, E. B., ... Cecchini, F. (2020). Grape seeds: Chromatographic profile of fatty acids and phenolic compounds and qualitative analysis by FTIR-ATR spectroscopy. *Foods*, 9(1), 10–24. <https://doi.org/10.3390/foods9010010>
- Luchian, C. E., Cotea, V. V., Vlase, L., Toiu, A. M., Colibaba, L. C., Răschip, I. E., ... Rotaru, L. (2019). Antioxidant and antimicrobial effects of grape pomace extracts. *BIO Web of Conferences*, 15, 0–5. <https://doi.org/10.1051/bioconf/20191504006>
- Luo, S., Shen, X., Zheng, L. P. Z., Zhao, Y., Zhong, X., & Jiang, S. (2018). Effect of grape seed extract on sensory, textural, and anti-staling properties of Chinese steamed bread. *Journal of Food Processing and Preservation*, 42, 1–7. <https://doi.org/10.1111/jfpp.13497>
- Lv, Y., Li, M., Pan, J., Zhang, S., Jiang, Y., Liu, J., ... Zhang, H. (2020). Interactions between tea products and wheat starch during retrogradation. *Food Bioscience*, 34, 100523. <https://doi.org/10.1016/j.fbio.2019.100523>

- Ma, J., Xu, R. R., Lu, Y., Ren, D. F., & Lu, J. (2018). Composition, Antimicrobial and antioxidant activity of supercritical fluid extract of *Elsholtzia ciliata*. *Journal of Essential Oil-Bearing Plants*, 21(2), 556–562. <https://doi.org/10.1080/0972060X.2017.1409657>
- MacRitchie, F. (2016). Seventy years of research into breadmaking quality. *Journal of Cereal Science*, 70, 123–131. <https://doi.org/10.1016/j.jcs.2016.05.020>
- Maier, T., Schieber, A., Kammerer, D. R., & Carle, R. (2009). Residues of grape (*Vitis vinifera* L.) seed oil production as a valuable source of phenolic antioxidants. *Food Chemistry*, 112(3), 551–559. <https://doi.org/10.1016/j.foodchem.2008.06.005>
- Maman, R., & Yu, J. (2019). Chemical composition and particle size of grape seed flour and their effects on the characteristics of cookies. *Journal of Food Research*, 8(4), 111. <https://doi.org/10.5539/jfr.v8n4p111>
- Maner, S., Sharma, A. K., & Banerjee, K. (2017). Wheat flour replacement by wine grape pomace powder positively affects physical, functional and sensory properties of cookies. *Proceedings of the National Academy of Sciences India Section B - Biological Sciences*, 87(1), 109–113. <https://doi.org/10.1007/s40011-015-0570-5>
- Marinelli, V., Padalino, L., Conte, A., Del Nobile, M. A., & Briviba, K. (2018). Red grape marc flour as food ingredient in durum wheat spaghetti: Nutritional evaluation and bioaccessibility of bioactive compounds. *Food Science and Technology Research*, 24(6), 1093–1100. <https://doi.org/10.3136/fstr.24.1093>
- Marković, Z. (2016). Study of the mechanisms of antioxidative action of different antioxidants. *Journal of the Serbian Society for Computational Mechanics*, 10(1), 135–150. <https://doi.org/10.5937/jsscm1601135M>
- Mateo, J. J., & Maicas, S. (2015). Valorization of winery and oil mill wastes by microbial technologies. *Food Research International*, 73, 13–25. <https://doi.org/10.1016/j.foodres.2015.03.007>
- Maurer, L. H., Cazarin, C. B. B., Quatrin, A., Minuzzi, N. M., Costa, E. L., Morari, J., ... Emanuelli, T. (2019). Grape peel powder promotes intestinal barrier homeostasis in acute TNBS-colitis: A major role for dietary fiber and fiber-bound polyphenols. *Food Research International*, 123, 425–439. <https://doi.org/10.1016/j.foodres.2019.04.068>
- Maurya, A. K., Pandey, R. K., Rai, D., Porwal, P., & Rai, D. C. (2015). Waste product of fruits and vegetables processing as a source of dietary fibre: A review. *Trends in Biosciences*, 8(19), 5129–5140.
- Mayer-Miebach, E., Adamiuk, M., & Behnsilian, D. (2012). Stability of chokeberry bioactive polyphenols during juice processing and stabilization of a polyphenol-rich material from the by-product. *Agriculture*, 2(3), 244–258. <https://doi.org/10.3390/agriculture2030244>
- Mehta, R. S. (2014). Addressing texture challenges in baked goods with fiber. In Y. L. Dar & J. M. Light (Eds.), *Food texture design and optimization* (pp. 245–280). Chicago, IL: John Wiley & Sons.
- Meini, M. R., Cabezudo, I., Boschetti, C. E., & Romanini, D. (2019). Recovery of phenolic antioxidants from Syrah grape pomace through the optimization of an enzymatic extraction process. *Food Chemistry*, 283, 257–264. <https://doi.org/10.1016/j.foodchem.2019.01.037>
- Mendes, J. A. S., Xavier, A. M. R. B., Evtuguin, D. V., & Lopes, L. P. C. (2013). Integrated utilization of grape skins from white grape pomaces. *Industrial Crops and Products*, 49, 286–291. <https://doi.org/10.1016/j.indcrop.2013.05.003>
- Meral, R., & Köse, Y. E. (2019). The effect of bread-making process on the antioxidant activity and phenolic profile of enriched breads. *Quality Assurance and Safety of Crops & Foods*, 11(2), 171–181. <https://doi.org/10.3920/QAS2018.1350>
- Meral, R., & Dogan, I. S. (2013). Grape seed as a functional food ingredient in bread-making. *International Journal of Food Sciences and Nutrition*, 64(3), 372–379. <https://doi.org/10.3109/09637486.2012.738650>
- Mildner-Szkudlarz, S., Siger, A., Szwengiel, A., & Bajerska, J. (2015). Natural compounds from grape by-products enhance nutritive value and reduce formation of CML in model muffins. *Food Chemistry*, 172, 78–85. <https://doi.org/10.1016/j.foodchem.2014.09.036>
- Mildner-Szkudlarz, S., Bajerska, J., Zawirska-Wojtasiak, R., & Górecka, D. (2013). White grape pomace as a source of dietary fibre and polyphenols and its effect on physical and nutraceutical characteristics of wheat biscuits. *Journal of the Science of Food and Agriculture*, 93(2), 389–395. <https://doi.org/10.1002/jsfa.5774>
- Mildner-Szkudlarz, S., Zawirska-Wojtasiak, R., Szwengiel, A., & Pacyński, M. (2011). Use of grape by-product as a source of dietary fibre and phenolic compounds in sourdough mixed rye bread. *International Journal of Food Science and Technology*, 46(7), 1485–1493. <https://doi.org/10.1111/j.1365-2621.2011.02643.x>
- Minatel, I. O., Borges, C. V., Ferreira, M. I., Gomez, H. A. G., Chen, C.-Y. O., & Lima, G. P. P. (2017). Phenolic compounds: Functional properties, impact of processing and bioavailability. In M. Soto-Hernández, M. P. Tenango, & R. García-Mateos (Eds.), *Phenolic compounds - Biological activity* (pp. 1–24). London, UK: IntechOpen. <https://doi.org/10.5772/66368>
- Mironeasa, S., Leahu, A., Codină, G.-G., Stroe, S.-G., & Mironeasa, C. (2010). Grape Seed: physico-chemical, structural characteristics and oil content. *Journal of Agroalimentary Processes and Technologies*, 16(1), 1–6.
- Mironeasa, S., Codină, G. G., & Mironeasa, C. (2016). Optimization of wheat-grape seed composite flour to improve alpha-amylase activity and dough rheological behavior. *International Journal of Food Properties*, 19(4), 859–872. <https://doi.org/10.1080/10942912.2015.1045516>
- Mironeasa, S., Zaharia, D., Codină, G. G., Ropciuc, S., & Iuga, M. (2018). Effects of grape peels addition on mixing, pasting and fermentation characteristics of dough from 480 wheat flour type. *Bulletin UASVM Food Science and Technology*, 75(1), 27–35.
- Mironeasa, S., Iuga, M., Zaharia, D., Dabija, A., & Mironeasa, C. (2017). Influence of particle sizes and addition level of grape seeds on wheat flour dough rheological properties. *International Multidisciplinary Scientific GeoConference: SGEM: Surveying Geology & Mining Ecology Management*, 17(63), 265–272. <https://doi.org/10.5593/sgem2017H/63/S25.034>
- Mironeasa, S. (2017). *Valorization of secondary products from wine making*. Iași, Romania: Performantica Publishing House.
- Mironeasa, S., Iuga, M., Zaharia, D., & Mironeasa, C. (2019a). Optimization of grape peels particle size and flour substitution in white wheat flour dough. *Scientific Study and Research: Chemistry and Chemical Engineering, Biotechnology, Food Industry*, 20(1), 29–42.
- Mironeasa, S., Iuga, M., Zaharia, D., & Mironeasa, C. (2019b). Optimization of white wheat flour dough rheological properties with different levels of grape peels flour addition. *Bulletin UASVM Food Science and Technology*, 76(1), 27–39.
- Mironeasa, S., & Mironeasa, C. (2019). Dough bread from refined wheat flour partially replaced by grape peels: Optimizing the

- rheological properties. *Journal of Food Process Engineering*, 42(6), 1–14. <https://doi.org/10.1111/jfpe.13207>
- Mironeasa, S., Codină, G. G., & Mironeasa, C. (2012). The effects of wheat flour substitution with grape seed flour on the rheological parameters of the dough assessed by Mixolab. *Journal of Texture Studies*, 43(1), 40–48. <https://doi.org/10.1111/j.1745-4603.2011.00315.x>
- Mironeasa, S., Iuga, M., Zaharia, D., & Mironeasa, C. (2019c). Rheological analysis of wheat flour dough as influenced by grape peels of different particle sizes and addition levels. *Food and Bioprocess Technology*, 12(2), 228–245. <https://doi.org/10.1007/s11947-018-2202-6>
- Mironescu, M., & Mironescu, D. (2014). *Starch bioengineering*, Sibiu, Romania: Lucian Blaga University from Sibiu Publishing House.
- Mohammed, I., Ahmed, A. R., & Senge, B. (2014). Effects of chickpea flour on wheat pasting properties and bread making quality. *Journal of Food Science and Technology*, 51(9), 1902–1910. <https://doi.org/10.1007/s13197-012-0733-9>
- Niedzwiedz, A., Aksymovych, I., Kubiak, K., & Jankowski, M. (2017). Role of free radicals in oxidative stress – Basic knowledge for clinician. *Науковий Вісник Ветеринарної Медицини*, 1, 77–81.
- Nowotny, K., Schröter, D., Schreiner, M., & Grune, T. (2018). Dietary advanced glycation end products and their relevance for human health. *Ageing Research Reviews*, 47, 55–66. <https://doi.org/10.1016/j.arr.2018.06.005>
- OIV (International Organisation of Vine and Wine). (2019). Statistical report on world vitiviniculture. Retrieved from <http://www.oiv.int/public/medias/6782/oiv-2019-statistical-report-on-world-vitiviniculture.pdf>
- Oladiran, D. A. (2018). *Nutritional and functional properties of porridges from extrusion cooked cassava-soy composite with wheat bran or grape pomace*. Retrieved from <http://hdl.handle.net/2263/65934>
- Oliveira, D. A., Salvador, A. A., Smânia, A., Smânia, E. F. A., Maraschin, M., & Ferreira, S. R. S. (2013). Antimicrobial activity and composition profile of grape (*Vitis vinifera*) pomace extracts obtained by supercritical fluids. *Journal of Biotechnology*, 164(3), 423–432. <https://doi.org/10.1016/j.jbiotec.2012.09.014>
- Oprea, O. B., Apostol, L., Bungau, S., Cioca, G., Samuel, A. D., Badea, M., & Gaceu, L. (2018). Researches on the chemical composition and the rheological properties of wheat and grape epicarp flour mixes. *Revista de Chimie*, 69(1), 70–75.
- Oroian, M., & Esriche, I. (2015). Antioxidants Characterization, natural sources, extraction and analysis. *Food Research International*, 74, 10–36. <https://doi.org/10.1016/j.foodres.2015.04.018>
- Ortega-Heras, M., Gómez, I., de Pablos-Alcalde, S., & González-Sanjosé, M. L. (2019). Application of the just-about-right scales in the development of new healthy whole-wheat muffins by the addition of a product obtained from white and red grape pomace. *Foods*, 8(9), 419–434. <https://doi.org/10.3390/foods8090419>
- O'Shea, N. L. (2014). *Characterisation and application of fruit by-products as novel ingredients in gluten-free products* (PhD thesis). Cork, Ireland: University College Cork.
- Ovcharova, T., Zlatanov, M., & Dimitrova, R. (2016). Chemical composition of seeds of four Bulgarian grape varieties. *Ciencia e Técnica Vitivinícola*, 31(1), 31–40. <https://doi.org/10.1051/ctv/20163101031>
- Özkaya, B., Baumgartner, B., & Özkaya, H. (2018). Effects of concentrated and dephytinized wheat bran and rice bran addition on bread properties. *Journal of Texture Studies*, 49, 84–93. <https://doi.org/10.1111/jtxs.12286>
- Palafox-Carlos, H., Ayala-Zavala, J. F., & González-Aguilar, G. A. (2011). The role of dietary fiber in the bioaccessibility and bioavailability of fruit and vegetable antioxidants. *Journal of Food Science*, 76(1), 6–15. <https://doi.org/10.1111/j.1750-3841.2010.01957.x>
- Parker, L., Burns, A. C., & Sanchez, E. (2010). *Local government actions to prevent childhood obesity*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/12674>
- Parra, A. F. R., Sahagún, M., Ribotta, P. D., Ferrero, C., & Gómez, M. (2019). Particle size and hydration properties of dried apple pomace: Effect on dough viscoelasticity and quality of sugar-snap cookies. *Food and Bioprocess Technology*, 12(7), 1083–1092. <https://doi.org/10.1007/s11947-019-02273-3>
- Peixoto, C. M., Dias, M. I., Alves, M. J., Calheta, R. C., Barros, L., Pinho, S. P., & Ferreira, I. C. F. R. (2018). Grape pomace as a source of phenolic compounds and diverse bioactive properties. *Food Chemistry*, 253, 132–138. <https://doi.org/10.1016/j.foodchem.2018.01.163>
- Pérez-Navarro, J., Da Ros, A., Masuero, D., Izquierdo-Cañas, P. M., Hermosín-Gutiérrez, I., Gómez-Alonso, S., ... & Vrhovsek, U. (2019). LC-MS/MS analysis of free fatty acid composition and other lipids in skins and seeds of *Vitis vinifera* grape cultivars. *Food Research International*, 125, 1–9. <https://doi.org/10.1016/j.foodres.2019.108556>
- Pérez-Navarro, J., Cazals, G., Enjalbal, C., Izquierdo-Cañas, P. M., Gómez-Alonso, S., & Saucier, C. (2019). Flavanol glycoside content of grape seeds and skins of *vitis vinifera* varieties grown in castilla-La Mancha, Spain. *Molecules*, 24, 4001–4017. <https://doi.org/10.3390/molecules24214001>
- Petti, L., Arzoumanidis, I., Benedetto, G., Bosco, S., Cellura, M., Camillo De Camillis, V. F., ... Vale, G. T. M. (2015). Life cycle assessment in the wine sector. In B. Notarnicola, G. Tassielli, P. A. Renzulli, R. Salomone, G. M. Cappelletti, O. Malandrino, ... G. Saija (Eds.), *Life cycle assessment in the agri-food sector* (pp. 123–184). Cham, Switzerland: Springer International Publishing.
- Poljsak, B., & Milisav, I. (2012). The neglected significance of “antioxidative stress.” *Oxidative Medicine and Cellular Longevity*, 2012, 1–12. <https://doi.org/10.1155/2012/480895>
- Popov, M., Hejtmánková, A., Kotíková, Z., Štřalková, R., & Lachman, J. (2017). Content of flavan-3-ol monomers and Gallic acid in grape seeds by variety and year. *Vitis*, 56, 45–48. <https://doi.org/10.5073/vitis.2017.56.45-48>
- Preedy, V. R., & Watson, R. R. (Eds.). (2019). *Flour and breads and their fortification in health and disease prevention*. Cambridge, MA: Academic Press.
- Ratnasooriya, C. C., & Rupasinghe, H. P. V. (2012). Extraction of phenolic compounds from grapes and their pomace using β -cyclodextrin. *Food Chemistry*, 134(2), 625–631. <https://doi.org/10.1016/j.foodchem.2012.02.014>
- Ravichandran, G., Lakshmanan, D. K., Raju, K., Elangovan, A., Nambirajan, G., Devanesan, A. A., & Thilagar, S. (2019). Food advanced glycation end products as potential endocrine disruptors: An emerging threat to contemporary and future generation. *Environment International*, 123, 486–500. <https://doi.org/10.1016/j.envint.2018.12.032>
- Rogiers, S. Y., Coetzee, Z. A., Walker, R. R., Deloire, A., & Tyerman, S. D. (2017). Potassium in the grape (*Vitis vinifera* L.) berry: Transport

- and function. *Frontiers in Plant Science*, 8, 1–19. <https://doi.org/10.3389/fpls.2017.01629>
- Rosales Soto, M. U., Brown, K., & Ross, C. F. (2012). Antioxidant activity and consumer acceptance of grape seed flour-containing food products. *International Journal of Food Science and Technology*, 47(3), 592–602. <https://doi.org/10.1111/j.1365-2621.2011.02882.x>
- Sabir, A., Unver, A., & Kara, Z. (2012). The fatty acid and tocopherol constituents of the seed oil extracted from 21 grape varieties (*Vitis* spp.). *Journal of the Science of Food and Agriculture*, 92(9), 1982–1987. <https://doi.org/10.1002/jsfa.5571>
- Rosell, C. M., Bajerska, J., & El Sheikha, A. F. (2015). *Bread and its fortification: Nutrition and health benefits*. Boca Raton, FL: CRC Press.
- Saikia, S., & Mahanta, C. L. (2016). In vitro physicochemical, phytochemical and functional properties of fiber rich fractions derived from by-products of six fruits. *Journal of Food Science and Technology*, 53(3), 1496–1504. <https://doi.org/10.1007/s13197-015-2120-9>
- Sales, N. F. F., de Costa, L. S., Carneiro, T. I. A., Minuzzo, D. A., Oliveira, F. L., Cabral, L. M. C., ... El-Bacha, T. (2018). Anthocyanin-rich grape pomace extract (*Vitis vinifera* L.) from wine industry affects mitochondrial bioenergetics and glucose metabolism in human hepatocarcinoma HepG2 Cells. *Molecules*, 23, 611–628. <https://doi.org/10.3390/molecules23030611>
- Samavardhana, K., Supawitpattana, P., Jittrepotch, N., Rojsuntornkitti, K., & Kongbangkerd, T. (2015). Effects of extracting conditions on phenolic compounds and antioxidant activity from different grape processing byproducts. *International Food Research Journal*, 22(3), 1169–1179.
- Samohvalova, O., Grevtseva, N., Brykova, T., & Grigorenko, A. (2016). The effect of grape seed powder on the quality of butter biscuits. *Eastern-European Journal of Enterprise Technologies*, 3(11–81), 61–66. <https://doi.org/10.15587/1729-4061.2016.69838>
- Sanhueza, L., Tello, M., Vivanco, M., Mendoza, L., & Wilkens, M. (2014). Relation between antibacterial activity against food transmitted pathogens and total phenolic compounds in grape pomace extracts from Cabernet Sauvignon and Syrah varieties. *Advances in Microbiology*, 4(5), 225–232. <https://doi.org/10.4236/aim.2014.45029>
- Sant'Anna, V., Christiano, F. D. P., Marczak, L. D. F., Tessaro, I. C., & Thys, R. C. S. (2014). The effect of the incorporation of grape marc powder in fettuccini pasta properties. *LWT - Food Science and Technology*, 58(2), 497–501. <https://doi.org/10.1016/j.lwt.2014.04.008>
- Sant'Anna, V., Brandelli, A., Damasceno, L., Marczak, F., & Cristina, I. (2012). Kinetic modeling of total polyphenol extraction from grape marc and characterization of the extracts. *Separation and Purification Technology*, 100(24), 82–87. <https://doi.org/10.1016/j.seppur.2012.09.004>
- Santos-Sánchez, N. F., Salas-Coronado, R., Villanueva-Cañongo, C., & Hernández-Carlos, B. (2019). Antioxidant compounds and their antioxidant mechanism. In Emad Shalabi (Ed.), *Antioxidants*. London, UK: IntechOpen. <https://doi.org/10.5772/intechopen.85270>
- Santos, L. P., Morais, D. R., Souza, N. E., Cottica, S. M., Boroski, M., & Visentainer, J. V. (2011). Phenolic compounds and fatty acids in different parts of *Vitis labrusca* and *V. vinifera* grapes. *Food Research International*, 44(5), 1414–1418. <https://doi.org/10.1016/j.foodres.2011.02.022>
- Saura-Calixto, F., Goñi, I., Mañas, E., & Abia, R. (1991). Klason lignin, condensed tannins and resistant protein as dietary fibre constituents: Determination in grape pomaces. *Food Chemistry*, 39(3), 299–309. [https://doi.org/10.1016/0308-8146\(91\)90147-G](https://doi.org/10.1016/0308-8146(91)90147-G)
- Saura-Calixto, F. (2011). Dietary fiber as a carrier of dietary antioxidants: An essential physiological function. *Journal of Agricultural and Food Chemistry*, 59(1), 43–49. <https://doi.org/10.1021/jf1036596>
- Saura-Calixto, F. (1998). Antioxidant dietary fiber product: A new concept and a potential food ingredient. *Journal of Agricultural and Food Chemistry*, 46(10), 4303–4306. <https://doi.org/10.1021/jf9803841>
- Savla, H., & Yardi, V. (2016). Development of gluten-free pasta (Sevaiya) using grape pomace and assessing its quality and acceptability. *International Proceedings of Chemical, Biological and Environmental Engineering*, 95, 44–49. <https://doi.org/10.7763/ipcbee.2016.v95.8>
- Scalbert, A., Johnson, I. T., & Saltmarsh, M. (2005). Polyphenols: Antioxidants and beyond. *The American Journal of Clinical Nutrition*, 81, 215–217. <https://doi.org/10.1093/ajcn/81.1.215s>
- Secen, S. (2017). Determination of fatty acid composition and phenolic content of seed oils of Cappadocia region grape varieties. *Aksaray University Journal of Science and Engineering*, 1(1), 1–8. <https://doi.org/10.29002/asujse.296708>
- Seifried, R. M., Harrison, E., & Seifried, H. E. (2017). Antioxidants in health and disease. In A. M. Coulston, C. J. Boushey, & M. G. Ferruzzi (Eds.), *Nutrition in the prevention and treatment of disease* (4th ed., pp. 321–346). Cambridge, MA: Academic Press. <https://doi.org/10.1016/B978-0-12-802928-2.00016-3>
- Shahidi, F., & Zhong, Y. (2015). Measurement of antioxidant activity. *Journal of Functional Foods*, 18, 757–781. <https://doi.org/10.1016/j.jff.2015.01.047>
- Sharma, C., Kaur, A., Thind, S. S., Singh, B., & Raina, S. (2015). Advanced glycation end-products (AGEs): An emerging concern for processed food industries. *Journal of Food Science and Technology*, 52(12), 7561–7576. <https://doi.org/10.1007/s13197-015-1851-y>
- Sharma, S. K., Bansal, S., Mangal, M., Dixit, A. K., Gupta, R. K., & Mangal, A. K. (2016). Utilization of food processing by-products as dietary, functional, and novel fiber: A review. *Critical Reviews in Food Science and Nutrition*, 56(10), 1647–1661. <https://doi.org/10.1080/10408398.2013.794327>
- Sharma, A. K., Dagadkhair, R. A., & Somkuwar, R. G. (2018). Evaluation of grape pomace and quality of enriched cookies after standardizing baking conditions. *Journal of AgriSearch*, 5(1), 50–55. <https://doi.org/10.21921/jas.v5i01.11134>
- Shastri, A., Srivastava, R., Jyoti, B., & Gupta, M. (2016). The antioxidants-scavengers of free radicals for immunity boosting and human health/overall well being. *International Journal of Contemporary Medical Research*, 3(10), 2454–7379.
- Shiau, S. Y., Wu, M. Y., & Liu, Y. L. (2015). The effect of pineapple core fiber on dough rheology and the quality of mantou. *Journal of Food and Drug Analysis*, 23(3), 493–500. <https://doi.org/10.1016/j.jfda.2014.10.010>
- Silva, V., Igrejas, G., Falco, V., Santos, T. P., Torres, C., Oliveira, A. M. P., ... Poeta, P. (2018). Chemical composition, antioxidant and antimicrobial activity of phenolic compounds extracted from wine industry by-products. *Food Control*, 92, 516–522. <https://doi.org/10.1016/j.foodcont.2018.05.031>

- Singh, M., Mallick, A. K., Banerjee, M., & Kumar, R. (2016). Loss of outer membrane integrity in Gram-negative bacteria by silver nanoparticles loaded with *Camellia sinensis* leaf phytochemicals: Plausible mechanism of bacterial cell disintegration. *Bulletin of Materials Science*, 39(7), 1871–1878. <https://doi.org/10.1007/s12034-016-1317-5>
- Smith, I. N., & Yu, J. (2015). Nutritional and sensory quality of bread containing different quantities of grape pomace from different grape cultivars. *EC Nutrition*, 2, 291–301.
- Sousa, E. C., Uchôa-Thomaz, A. M. A., Carioca, J. O. B., de Moraes, S. M., de Lima, A., Martins, C. G., ... Rodrigues, L. L. (2014). Chemical composition and bioactive compounds of grape pomace (*Vitis vinifera* L.), Benitaka variety, grown in the semiarid region of Northeast Brazil. *Food Science and Technology*, 34(1), 135–142. <https://doi.org/10.1590/S0101-20612014000100020>
- Spanghero, M., Salem, A. Z. M., & Robinson, P. H. (2009). Chemical composition, including secondary metabolites, and rumen fermentability of seeds and pulp of Californian (USA) and Italian grape pomaces. *Animal Feed Science and Technology*, 152(3–4), 243–255. <https://doi.org/10.1016/j.anifeeds.2009.04.015>
- Šporin, M., Avbelj, M., Kovač, B., & Možina, S. S. (2018). Quality characteristics of wheat flour dough and bread containing grape pomace flour. *Food Science and Technology International*, 24(3), 251–263. <https://doi.org/10.1177/1082013217745398>
- Šporin, M. (2019). *Improving the nutritional value and a shelf life of bread with the addition of grape pomace and olive cake* (PhD thesis). Ljubljana, Slovenia: University Of Ljubljana.
- Srivastava, Y. (2013). *advances in food science and nutrition*. Akure, Nigeria: Science and Education Development Institute.
- Tang, G. Y., Zhao, C. N., Liu, Q., Feng, X. L., Xu, X. Y., Cao, S. Y., ... Li, H. Bin (2018). Potential of grape wastes as a natural source of bioactive compounds. *Molecules*, 23(10), 1–20. <https://doi.org/10.3390/molecules23102598>
- Tangolar, S., Turan, M., Tangolar, S., & Ateş, F. (2019). Evaluation of amino acid contents and enzyme activities of seeds from Semillon and Carignane wine grape cultivars grown under different irrigation conditions. *Scientia Horticulturae*, 251, 181–188. <https://doi.org/10.1016/j.scienta.2019.02.079>
- Tangolar, S., Alkan Torun, A., Tangolar, S., & Torun, M. B. (2018). Evaluation of the mineral element profile of wastes of some wine grape (*Vitis vinifera* L.) varieties. *International Journal of Agriculture, Environment and Food Sciences*, 2(1), 1–6. <https://doi.org/10.31015/jaefs.18001>
- Tangolar, S. G., Özoğul, Y., Tangolar, S., & Torun, A. (2009). Evaluation of fatty acid profiles and mineral content of grape seed oil of some grape genotypes. *International Journal of Food Sciences and Nutrition*, 60(1), 32–39. <https://doi.org/10.1080/09637480701581551>
- Taşeri, L., Gülcü, M., Palabiyik, I., Seçkin, G. U., Aktas, T., & Gecgel, U. (2018). Effects of open air and solar drying on the nutritional quality of seed oil, seeds and skins from Muscat Hamburg grapes. *Grasas y Aceites*, 69(4), 1–8. <https://doi.org/10.3989/gya.0341181>
- Teles, A. S. C., Chávez, D. W. H., Oliveira, R. A., Bon, E. P. S., Terzi, S. C., Souza, E. F., ... Tonon, R. V. (2019). Use of grape pomace for the production of hydrolytic enzymes by solid-state fermentation and recovery of its bioactive compounds. *Food Research International*, 120, 441–448. <https://doi.org/10.1016/j.foodres.2018.10.083>
- Theagarajan, R., Malur Narayanaswamy, L., Dutta, S., Moses, J. A., & Chinnaswamy, A. (2019). Valorisation of grape pomace (cv. Muscat) for development of functional cookies. *International Journal of Food Science and Technology*, 54(4), 1299–1305. <https://doi.org/10.1111/ijfs.14119>
- Thomas, S. (2017). *Grapes polyphenolic composition, antioxidant characteristics and health benefits*. New York, NY: Nova Science Publishers.
- Tietze, S., Jekle, M., & Becker, T. (2016). Possibilities to derive empirical dough characteristics from fundamental rheology. *Trends in Food Science and Technology*, 57, 1–10. <https://doi.org/10.1016/j.tifs.2016.08.016>
- Tkacz, K., Wojdyło, A., Nowicka, P., Turkiewicz, I., & Golis, T. (2019). Characterization in vitro potency of biological active fractions of seeds, skins and flesh from selected *Vitis vinifera* L. cultivars and interspecific hybrids. *Journal of Functional Foods*, 56, 353–363. <https://doi.org/10.1016/j.jff.2019.03.029>
- Tolve, R., Pasini, G., Vignale, F., Favati, F., & Simonato, B. (2020). Effect of grape pomace addition on the technological, sensory, and nutritional properties of durum wheat pasta. *Foods*, 9, 354. <https://doi.org/10.3390/foods9030354>
- Torres, C. De, Diaz-maroto, M. C., Hermosin-gutiérrez, I., & Pérez-coello, M. S. (2010). Effect of freeze-drying and oven-drying on volatiles and phenolic composition of grape skin. *Analytica Chimica Acta*, 660, 177–182. <https://doi.org/10.1016/j.aca.2009.10.005>
- Tseng, A., & Zhao, Y. (2013). Wine grape pomace as antioxidant dietary fibre for enhancing nutritional value and improving storability of yogurt and salad dressing. *Food Chemistry*, 138(1), 356–365. <https://doi.org/10.1016/j.foodchem.2012.09.148>
- Tseng, A., & Zhao, Y. (2012). Effect of different drying methods and storage time on the retention of bioactive compounds and antibacterial activity of wine grape pomace (Pinot Noir and Merlot). *Journal of Food Science*, 77(9), 1–10. <https://doi.org/10.1111/j.1750-3841.2012.02840.x>
- Vehovský, K., Stupka, R., Zadinová, K., Šprysl, M., Okrouhlá, M., Lebedová, N., ... Čítek, J. (2019). Effect of dietary rapeseed and soybean oil on growth performance, carcass traits, and fatty acid composition of pigs. *Revista Brasileira de Zootecnia*, 48, e20180131. <https://doi.org/10.1590/rbz4820180131>
- Vergara-Salinas, J. R., Vergara, M., Altamirano, C., Gonzalez, Á., & Pérez-Correa, J. R. (2015). Characterization of pressurized hot water extracts of grape pomace: Chemical and biological antioxidant activity. *Food Chemistry*, 171, 62–69. <https://doi.org/10.1016/j.foodchem.2014.08.094>
- Walker, R., Tseng, A., Cavender, G., Ross, A., & Zhao, Y. (2014). Physicochemical, nutritional, and sensory qualities of wine grape pomace fortified baked goods. *Journal of Food Science*, 79(9), S1811–S1822. <https://doi.org/10.1111/1750-3841.12554>
- Wang, N., Hou, G. G., & Dubat, A. (2017). Effects of flour particle size on the quality attributes of reconstituted whole-wheat flour and Chinese southern-type steamed bread. *LWT - Food Science and Technology*, 82, 147–153. <https://doi.org/10.1016/j.lwt.2017.04.025>
- Wang, C., Wu, S., Shyu, Y., Al, W. E. T., & Ioeng, J. B. I. B. (2014). Antioxidant properties of certain cereals as affected by food-grade bacteria fermentation. *Journal of Bioscience and Bioengineering*, 117(4), 449–456. <https://doi.org/10.1016/j.jbiosc.2013.10.002>
- Xia, E. Q., Deng, G. F., Guo, Y. J., & Li, H. B. (2010). Biological activities of polyphenols from grapes. *International Journal of Molecular Sciences*, 11(2), 622–646. <https://doi.org/10.3390/ijms11020622>
- Xiang, J., Yang, C., Beta, T., Liu, S., & Yang, R. (2019). Phenolic profile and antioxidant activity of the edible tree peony flower and underlying mechanisms of preventive effect on H₂O₂-induced oxidative

- damage in Caco-2 cells. *Foods*, 8(10), 471. <https://doi.org/10.3390/foods8100471>
- Xu, Y., Burton, S., Kim, C., & Sismour, E. (2016). Phenolic compounds, antioxidant, and antibacterial properties of pomace extracts from four Virginia-grown grape varieties. *Food Science and Nutrition*, 4(1), 125–133. <https://doi.org/10.1002/fsn3.264>
- Yadav, D., Kumar, A., Kumar, P., & Mishra, D. (2015). Antimicrobial properties of black grape (*Vitis vinifera* L.) peel extracts against antibiotic-resistant pathogenic bacteria and toxin producing molds. *Indian Journal of Pharmacology*, 47(6), 663–667. <https://doi.org/10.4103/0253-7613.169591>
- Yi, C., Shi, J., Kramer, J., Xue, S., Jiang, Y., Zhang, M., ... Pohorly, J. (2009). Fatty acid composition and phenolic antioxidants of wine-making pomace powder. *Food Chemistry*, 114(2), 570–576. <https://doi.org/10.1016/j.foodchem.2008.09.103>
- Yu, J., & Ahmedna, M. (2013). Functional components of grape pomace: Their composition, biological properties and potential applications. *International Journal of Food Science and Technology*, 48(2), 221–237. <https://doi.org/10.1111/j.1365-2621.2012.03197.x>
- Yilmaz, Y., & Toledo, R. T. (2004). Health aspects of functional grape seed constituents. *Trends in Food Science and Technology*, 15(9), 422–433. <https://doi.org/10.1016/j.tifs.2004.04.006>
- Yuan, H., Wang, W., Chen, D., Zhu, X., & Cao, S. (2016). Characterization of resistant starch from Se-rich rice flour and its anti-diabetic effect in diabetic ICR mice. *Starch/Starke*, 68(1), 106–111. <https://doi.org/10.1002/star.201500168>
- Zdunić, G., Gođevac, D., Šavikin, K., Krivokuća, D., Mihailović, M., Pržić, Z., & Marković, N. (2019). Grape seed polyphenols and fatty acids of autochthonous prokupac vine variety from Serbia. *Chemistry and Biodiversity*, 16(7), e1900053. <https://doi.org/10.1002/cbdv.201900053>
- Zerbib, M., Cazals, G., & Enjalbal, C. (2018). Identification and quantification of flavanol glycosides in *Vitis vinifera* grape seeds and skins during ripening. *Molecules*, 23, 2745–2758. <https://doi.org/10.3390/molecules23112745>
- Zhang, Y., Gan, R., Li, S., Zhou, Y., Li, A., & Xu, D. (2015). Antioxidant phytochemicals for the prevention and treatment of chronic diseases. *Molecules*, 20(12), 21138–21156. <https://doi.org/10.3390/molecules201219753>
- Zhao, X., Zhu, H., Zhang, G., & Tang, W. (2015). Effect of superfine grinding on the physicochemical properties and antioxidant activity of red grape pomace powders. *Powder Technology*, 286, 838–844. <https://doi.org/10.1016/j.powtec.2015.09.025>
- Zhou, T., Li, Q., Zhang, J., Bai, Y., & Zhao, G. (2010). Purification and characterization of a new IIS globulin-like protein from grape (*Vitis vinifera* L.) seeds. *European Food Research and Technology*, 230(5), 693–699. <https://doi.org/10.1007/s00217-009-1211-0>
- Zhou, T., Zhang, T., Liu, W., & Zhao, G. (2011). Physicochemical characteristics and functional properties of grape (*Vitis vinifera* L.) seeds protein. *International Journal of Food Science and Technology*, 46(3), 635–641. <https://doi.org/10.1111/j.1365-2621.2010.02532.x>
- Zhu, F. M., Du, B., & Li, J. (2014). Effect of ultrafine grinding on physicochemical and antioxidant properties of dietary fiber from wine grape pomace. *Food Science and Technology International*, 20(1), 55–62. <https://doi.org/10.1177/1082013212469619>
- Zhu, F., Du, B., Zheng, L., & Li, J. (2015). Advance on the bioactivity and potential applications of dietary fibre from grape pomace. *Food Chemistry*, 186, 207–212. <https://doi.org/10.1016/j.foodchem.2014.07.057>

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