Scientific Papers. Series B, Horticulture. Vol. LXI, 2017
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

ACHIEVEMENT OF SOME FUNCTIONAL INGREDIENTS FROM TOMATO WASTE AND WINEMAKING BY-PRODUCTS

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Abstract

A major problem facing the food industry is accumulation, handling and disposal of waste from the processing of raw materials. Therefore, valorisation of such waste by achievement of functional ingredients, leading to increasing of nutritional quality and antioxidant potential of foods is of real interest. Among waste and by-products from the processing industry of vegetables and fruits with valorisation potential are tomato waste, dark colour grape seed and skin (red, purple, and black). In this paper are presented results of the performed research for achievement of some functional ingredients (flours) from tomato waste and winemaking by-products (grape pomace and grape seed). Tomato waste and winemaking by-products were subjected to convective drying process at temperature of 50°C, in order to protect bioactive compounds (vitamins, phenolic compounds etc.), to a moisture which allows their milling and conversion into flours and, at the same time, their stability in terms of quality. The achieved functional ingredients were evaluated from sensory, physic-chemical and microbiological point of view. Flour obtained from tomato waste is characterized by content in carotenoids (lycopene – 225.92 mg/kg; ß-carotene - 16.22 mg/kg), protein (17.62%), minerals, total fibre (59.47%), total polyphenol (18.76 mg GAE/g). Flours achieved from winemaking by-products are characterized by content of protein (10.53-14.63%), minerals, total fibre (58.06-66.06%) and total polyphenol (200.15-322.75 mg GAE/g). Antioxidant capacity of flour achieved from tomato waste was 1.62 mg Trolox Equivalents/g, and of flour achieved from winemaking by-products varied in the range (40.75–51.25 mg Trolox Equivalents/g). Microbiological analysis showed that flours obtained from tomato waste and winemaking by-products (grape pomace and grape seed) are under the provisions of the legislation in force.

Key words*: tomato, waste, grape, pomace.*

INTRODUCTION

Numerous studies have shown the presence of bioactive compounds in various types of agro-industrial waste, with potential application in the industry.

Their reuse would reduce environmental risks caused by disposal, besides providing a source of profitability for populations living around industrial regions (Anastasiadi et al., 2008).

Tomatoes (*Lycopersicon esculentum* L.) are cultivated worldwide for their fruits, registering an annual production of 161.8 million tonnes (FAOSTAT, 2012). Regular consumption of tomatoes and processed tomato products was correlated with a reduction in susceptibility to various cancers and cardiovascular diseases (Borguini and Da Silva Torres, 2009). These positive effects are due to antioxidant compounds present in tomatoes, such as vitamins C and E, carotenoids, polyphenols, which play a key role in the mechanism of health protection by neutralizing free radicals (Ray et al., 2011). Also, tomatoes are an important source of trace elements, namely, selenium, copper, manganese and zinc, which are cofactors of antioxidant enzymes (Martinez-Valverde et al., 2002). Due to the complex biochemical composition, consumption of fresh or processed tomatoes (juice, piuree, paste, ketchup etc.) has beneficial effects on the human body: cardioprotective (Palomo et al., 2009), anti-platelet (platelet aggregation inhibition) (Fuentes et al., 2012), decreasing of triglycerides and cholesterol level in the blood (Hsu et al., 2008), reducing of oxidative stress induced by postprandial lypemia (increase of lipid level in the blood after lunch) (Burton-Freeman et al., 2012).

Studies concerning localization of antioxidant compounds in the different fractions of tomatoes (epicarp, seed and pulp) confirmed that, in all tomato cultivars under study, within the epicarp are the highest concentrations of phenolic compounds, flavonoids, lycopene and ascorbic acid. At the same time, tomato epicarp has an antioxidant activity higher than the pulp and seed fractions (George et al., 2004; Toor and Savage, 2005). Also, several studies showed that tomato seed are rich in nutrients including: carotenoids, proteins, polyphenols, minerals, fibres and oils (Liadakis et al., 1995; Persia et al., 2003; Toor and Savage, 2005; Demirbaş, 2010; Eller et al., 2010; Zuorro et al., 2013).

Million tonnes of tomatoes are annualy processed to juice, sauces, piurees, paste and tomato canned, generating high amounts of tomato peel, pulp and seed, which are industrial waste (Papaioannou and Karabelas, 2012). When tomatoes are processed and converted into ketchup, sauces or juice, waste is generated representing 3-7% of the tomato mass introduced in the manufacture process (Savatović et al., 2010).

Tomato seed contains about 24.5% crude protein and have the highest content of glutamic acid and aspartic acid (Persia et al., 2003). Del Valle et al. (2006) evaluated the chemical composition of the waste resulted from the industrial processing of tomatoes to paste, in various stages of the process flow (after pulper, after finisher, before turbopress and after turbopress). Average composition (in dry weight basis) of tomato pomace was the following: 59.03% fibres, 25.73% total sugars, 19.27% protein, 7.55% pectins, 5.85% total fat and 3.92% minerals.

Aghajanzadeh et al. (2010) have shown that the dried tomato waste contains 22.6–24.7% protein, 14.5–15.7% fat and 20.8–23.5% fibres and, at the same time, represents a source of vitamins B_1, B_2 and A. In addition, tomato waste contains essential aminoacids, and tomato seed contains high concentrations of minerals (Fe, Mn, Zn and Cu). Tomato peel contains significantly higher concentrations of lycopene and β-carotene compared to the pulp and seed (Papaioannou and Karabelas, 2012). Majority of flavonoids is found in the peel of tomatoes.

Vitis vinifera L. production is widespread throughout the world, exceeding 68 million tonnes (FAOSTAT, 2010). As grape seeds comprise about 5% of the fruit weight (Choi and Lee, 2009), more than 3 million tonnes of grape seeds are discarded annually world-wide (Fernandes et al., 2012). Grape seeds represent a significant part in pomace, namely 38–52% of dry matter (Maier et al., 2009). Grape pomace represents a mixture of grape peel, seed and trace of pulp, resulted after wine obtaining. Grape seed and skin constituents have been shown to have health-functional activities as LDL cholesterol-lowering functional foods (Chen et al., 2011).

Composition of grape seeds is represented by 40% fibres, 16% essential oil, 11% protein, 7% complex phenolic compounds like tannins, and also sugars and minerals (Campos et al., 2008). Ca, K, Mg, Na and P are the most important minerals in grape seed (Ozcan, 2010). White grape seeds have a content of total polyphenols (on average 58.23±3.978 g/kg DM) higher compared to black grape seed (32.22±2.197 g/kg DM). Also, in grape seed, γ-tocotrienol is the most abundant (46.31±13.37 mg/kg DM), followed by α-tocotrienol (20.00±7.81 mg/kg DM) and α-tocopherol (12.45±4.85 mg/kgDM) (Lachman et al., 2013).

Grape pomace and its derivatives have use potential in diabetes management (Hogan et al., 2010). Three polyphenolic compounds in grape seed (gallic acid, catechin and epicatechin) inhibited pancreatic cholesterol esterase and may increase control on bioavailability of dietary cholesterol and cholesterol ester derivative, thus limiting the absorption of free cholesterol in blood (Ngamukote et al., 2011).

In this paper are presented results of the performed research for achievement of some functional ingredients (flours) from tomato waste and winemaking by-products (grape pomace and grape seed).

MATERIALS AND METHODS

Samples

Tomato waste resulted from tomato processing to juice within the Pilot Experiments Plant for Fruits and Vegetables Processing in IBA

Bucharest. Winemaking by-products (black grape seed and pomace) were collected after producing wine in the households in rural areas. Till processing, winemaking by-products were shipped and stored under refrigeration (3 °C). Tomato waste and winemaking by-products were subjected to dehydration process in a convection dryer at temperature 50 ºC to a moisture which allows their milling and conversion into flours and, at the same time, their stability in terms of quality. Milling of dried semi-finished products was performed by using Retsch mill. The achieved functional ingredients (flours) were packed in glass containers, hermetically sealed, protected by aluminum foil against light and stored in dry and cool areas (temperature of maximum 20 ºC), till to the sensory, physic-chemical and microbiological analysis). In Figure 1 are presented the flours mentioned above.

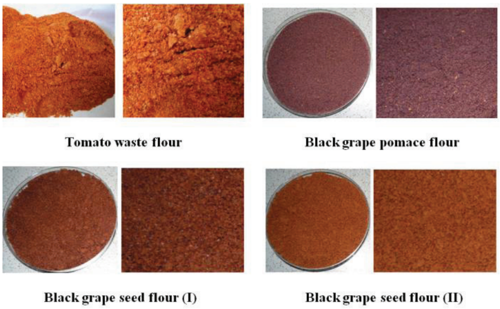

Figure 1. Flours achieved from tomato waste and winemaking by-products

Methods

Sensory analysis

Sensory analysis (appearance, taste and smell) was performed by descriptive method.

Physic-chemical analysis

Measurement of the color parameters of samples was performed at room temperature, using a HunterLab colorimeter, equipped with Universal Software V4.01 Miniscan XE Plus programme, to register CIELab parameters (the Commission Internationale de l'Eclairage - CIE), L^*, a^* and b^*: L^* - color luminance (0 = black, 100 = white); a^* - red-green coordinate (-a = green, +a = red); b^* - yellow-blue coordinate (-b = blue, +b = yellow).

Moisture determination was performed with Ohaus Moisture Analyzer MB45 at temperature 105 °C.

Protein content was determined by the Kjeldahl method with a conversion factor of nitrogen to protein of 6.25 (AOAC Method 979.09, 2005). Fat content was determined according to AOAC Method 963.15, and ash content according to AOAC Method 923.03 (AOAC, 2005).

In order to determine minerals samples were mineralized by calcination, with the addition of hydrochloric acid and hydrogen peroxide. The minerals sodium (Na), potassium (K), calcium (Ca), magnesium (Mg) and zinc (Zn) were determined by atomic absorption spectrophotometer (type *AAnalyst* 400, Perkin–Elmer). The minerals iron (Fe) and selenium (Se) were determined by Graphite Furnace Atomic Absorption Spectrophotometer (type *AAnalyst* 600, Perkin–Elmer).

Total dietary fibre (TDF) was determined by enzymatic method using the assay kits: K-TDFR ''Total dietary fibre'' (AOAC Method 991.43).

Lycopene and beta carotene content were performed by using spectrophotometric method developed by Nagata and Yamashita (1992).

Total polyphenol content

Total polyphenol content was conducted according to Horszwald and Andlauer (2011) with some modifications (concerning extract volumes of the used sample and reagents, using UV-VIS Jasco V 550 spectrophotometer), based on calibration curve of gallic acid achieved in the concentration range 0 to 0.20 mg/mL. The extraction of phenolic compounds was performed in methanol:water 50:50, and the absorbance of the extracts was determined at a wavelenght λ = 755 nm. Results were expressed as mg of gallic acid equivalents (GAE) per g flour (black grape seed flour, black grape pomace flour, tomato waste flour).

Antioxidant capacity

The DPPH scavenging radical assay was conducted according to Horszwald and Andlauer (2011) with some modifications (concerning extract volumes of the used sample and reagents, using UV-VIS Jasco V 550 spectrophotometer). The reaction was performed in dark for 30 min (at ambient temperature) and after this time the absorbance was read at 517 nm. It was achieved the calibration curve Absorbance = f (Trolox concentration), in the concentration range 0-0.4375 mmol/L and the results were expressed as mg Trolox Equivalents per g flour (black grape seed flour, black grape pomace flour, tomato waste flour).

Microbiological analysis

The water activity (*A*w) was determined by an instrument Aquaspector AQS-2-TC, Nagy. The measurements were performed at 25ºC. Yeast and mold were determined by the method SR ISO 21527-1:2009. *Enterobacteriaceae* was determined according to the SR ISO 21528-2:2008 method and *Escherichia coli* by SR ISO 16649-2:2007 method. *Salmonella* was determined by the method SR EN ISO 6579:2003/AC:2006.

RESULTS AND DISCUSSIONS

Sensory analysis

After sensory analysis it was found that the obtained flours have specific characteristics. Tomato waste flour is in the form of orange powder with pleasant taste and smell, characteristic. Black grape seed flour and black grape pomace flour are in the form of a dark brown powder, purple tinge, respectively, with specific, pleasant taste and smell.

After the instrumental analysis of color (Figure 2) it was found that black grape seed flour (I) has the darkest color, registering the minimum value of luminance (L* = 24.38), while the tomato waste flour has the lightest color (L* = 59.13).

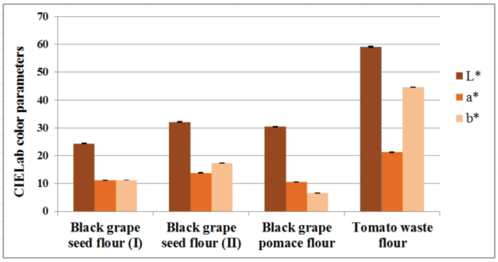

Figure 2. Color parameters of the flours achieved from tomato waste and winemaking by-products

Also, the maximum positive values of parameter a* (red coordinate) and of parameter b* (yellow coordinate) were registered for tomato waste flour.

Physic-chemical analysis

Composition of the flours achieved from tomato waste and winemaking by-products is presented in Table 1.

Water content of grape pomace flour is higher than that reported by Sousa et al., 2014 (3.33±0.04% dry basis), and of grape seed flour is lower than that reported by Aghamirzaei et al., 2015 (7.48±0.73% dry basis).

Table 1. Physic-chemical composition of flours achieved from tomato waste and winemaking by-products

Flour type	Water (%)	Ash (%)	Protein (%)	Fat (%)	Total fibre (%)
Black grape seed flour (I)	4.90±0.12	2.80±0.04	10.53±0.09	15.36±0.17	64.67±1.20
Black grape seed flour (II)	3.91±0.08	2.90±0.04	10.85±0.09	13.17±0.15	66.06±1.22
Black grape pomace flour	4.59±0.10	6.61±0.09	10.63±0.09	8.49±0.10	58.86±1.09
Tomato waste flour	7.64±0.17	4.05±0.05	17.62±0.16	10.38±0.12	59.47±1.10

Water content of tomato waste flour is higher than that reported by Majzoobi et al. (2011) (4.71% dry basis). After physic-chemical analysis it was found that the achieved flours are distinguished by content of total ash, protein and total fibre. Their ash content varied in the range 2.80-6.61% (minimum value was registered for the black grape seed flour (I), and the maximum one for the black grape pomace flour). Ash content of grape seed flour is comparable with that reported by Aghamirzaei et al. (2015) (2.45±0.18% dry basis), and ash content of grape pomace flour is higher compared to that obtained by Sousa et al. (2014) (4.65±0.05% dry basis). Ash content of tomato waste flour is comparable to that reported by Majzoobi et al. (2011) (4.53%).

Flours obtained from winemaking by-products registered close values for protein content (10.53-10.85%), lower than those obtained by Valiente et al. (1995), Llobera & Cañellas (2007) and Bravo & Saura-Calixto (1998) in grape residues (11g/100g, 12g/100g, and 14g/100g). Protein content (17.62%) of tomato waste flour obtained in this study is with 10.65% lower than that reported by Majzoobi et al., 2011 (19.72%). Grape seed flour obtained within the experiments has fat content higher than grape pomace flour. It is noted that grape pomace flour achieved in this experimental study has a fat content significantly higher than that reported by Bampi et al. (2010) in flour grape residues (2.56 g/100g). Grape fats are concentrated, mainly, in seeds and consist in approximately 90% mono-unsaturated fatty acids, known for their beneficial properties, notably for cardiovascular system (Rockenbach et al., 2010). Tomato waste flour had a fat content 2.09 times higher than that found by Majzoobi et al. (2011) in case of powder obtained from tomato waste (4.96%).

Flours obtained from tomato waste and winemaking by-products presented a high total fibre content (58.86-66.06%), the maximum value being registered for grape seed flour (II). Values of this chemical parameter for flours obtained from winemaking by-products are higher than those reported by Aghamirzaei et al. (2015) for grape seed powder (42.74±0.6% dry basis) and Sousa et al. (2014) for grape pomace flour (46.17±0.80% dry basis). Sousa et al. (2014) mentioned that grape pomace flour is a good source of dietary fibre providing 79% insoluble fibre and 21% soluble fibre. Pérez-Jiménez et al. (2008) mentioned that dietary fibre of grapes significantly reduced lipid profile and blood pressure, and these effects were significantly higher than those produced by other dietary fibre, such as oat or psyllium fibre, probably, due to the combined effect of dietary fibre and antioxidants.

Total fibre content of tomato waste flour is lower by 18.19% than that reported by Majzoobi et al. (2011) for tomato pomace powder (72.68%).

Flours obtained from winemaking by-products and tomato waste are an important source of minerals (K, Ca, Mg, Fe, Zn și Se). Their content in minerals is presented in Figures 3 and 4. Flours achieved from winemaking by-products have a high potassium content in the range 1102.35-3406.67 mg/100g, the maxium value being recorded by black grape pomace flour. Their potassium content is higher than that reported by Gül et al. (2013) (2343.10 mg/100 g for whole flour of Öküzgözü pomace, 1587.10 mg/100g for whole flour of Narince pomace, 312.89 mg/100 g for seed flour of Öküzgözü pomace and 458.24 mg/100 g, respectively, for seed flour of Narince pomace).

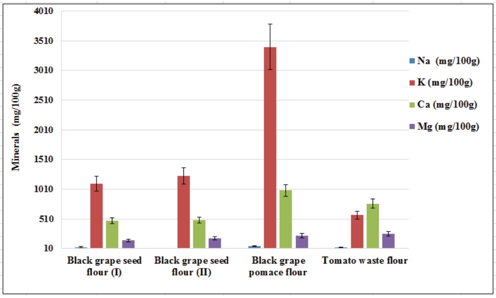

Figure 3. Mineral content (Na, K, Ca, Mg) of the flours achieved from tomato waste and winemaking by-products

Potassium content of tomato waste flour (573.09±64.76 mg/100g) is higher than that reported by Nour et al. (2015) for tomato waste (moisture content = 69.98±0.18%, K = 303.02 mg/100 g). These flours have potassium content higher than that in sodium. The results are in conformity with those obtained by Sousa et al. (2014) which states that this may lead to a balance of minerals, which favours hypertension control.

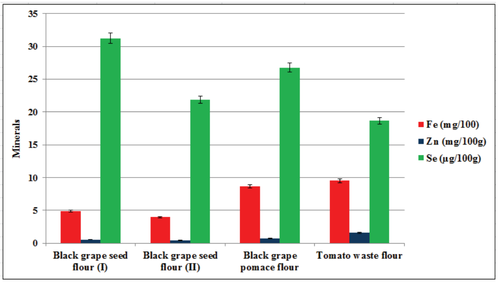

Figure 4. Mineral content (Fe, Zn, and Se) of the flours achieved from tomato waste and winemaking by-products

Calcium and magnesium content of tomato waste flour, black grape seed flour and black grape pomace flour, respectively, are higher than those reported by the other authors (Gül et al., 2013; Sousa et al., 2014).

Iron content of vegetable flours achieved in this study varied in the range 3.97-9.54 mg/100 g. Minimum value was registered for black grape seed flour (II), and the maximum one was registered for tomato waste flour. Grape pomace flour has an iron content of about 2.00 times higher than black grape seed flour. Grape pomace flour achieved in this study has an iron content of about 1.91 times higher than that reported by Lachman et al. (2013) (4.54 mg/100 g), but of about 2.6 times lower than that reported by Gül et al. (2013) (22.52 mg/100 g for whole flour of Öküzgözü pomace and 13.92 mg/100 g, respectively, for whole flour of Narince pomace). At the same time, flours achieved from blake grape seed within this study presented an iron content comparable to that reported by Gül et al. (2013) (2.86 mg/100 g for seed flour of Öküzgözü pomace and 5.13 mg/100 g, respectively, for seed flour of Narince pomace). Iron is an essential element for almost all living organisms as it participates in a wide variety of metabolic processes, including oxygen transport, deoxyribonucleic acid (DNA) synthesis, and electron transport (Abbaspour et al., 2014). Flours achieved from winemaking by-products registered a low Zn content (0.42 mg/100 g-0.75 mg/100 g), compared to those presented by other authors (Sousa et al., 2014, 0.98±0.702 mg/100 g in case of grape pomace flour and, respectively Lachman et al., 2013, 1.1 mg/100 g in case of grape seed). Tomato waste flour recorded the highest Zn content (1.56 mg/100 g). Zn is an important element of the immune system. Also, Bashandy et al. (2016) showed that the protective effect of zinc can be attributed to its antioxidant and antiinflammatory properties.

Selenium content of vegetable flours achieved within this study (18.65-31.23 µg/100 g) is comparable to that reported by Lyons et al. (2005) in case of grain (0.5-72 µg/100 g). These authors stated that the variation of selenium content is determined by the selenium content of the soil. Selenium is an essential micronutrient with an important role into human body (thyroid hormone metabolism, cardiovascular health, prevention of neurodegeneration and cancer, and optimal immune responses) (Huang et. al., 2012).

Total polyphenol content

Flours achieved from winemaking by-products and tomato waste flour are potential sources of natural antioxidants. Thus, these are characterized by the total polyphenol content and tomato waste flour contains in addition carotenoids (lycopene and β-carotene). Total polyphenol content of the achieved flours is presented in Figure 5. Total polyphenol content of the achieved flours from winemaking by-products varied in the range 200.15-322.75 mg GAE/g, the maximum value being recorded in case of grape pomace flour. Values of polyphenol content obtained within this study are higher compared to that reported by Tseng and Zhao (2013) for flour obtained from black grape seed and peel, *Pinot Noir* cultivar (67.74 mg GAE/g, flour moisture being 5.63%; flour was obtained by lyophilisation of residues resulted after winemaking, at temperature -55 °C and vacuum of 17.33 Pa).

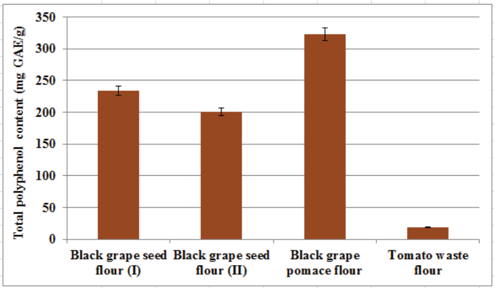

Figure 5. Total polyphenol content of flours achieved from winemaking by-products and tomato waste

At the same time, polyphenol content of the achieved grape seed flour is lower than that reported by Gül et al. (2013), for seed flour of Öküzgözü pomace (552.10 mg GAE/g) and seed flour of Narince pomace (563.27 mg GAE/g). Total polyphenol content of black grape pomace flour (322.75 mg GAE/g) achieved in this study is higher than that reported by Gül et al. (2013), for whole flour of Öküzgözü pomace (236.6 mg GAE/g) and, respectively, for whole flour of Narince pomace (65.93 mg GAE/g). Total polyphenol content of winemaking by-products is influenced by many factors: grape cultivar, climate conditions and culture area, ripening time, processing and storage conditions, as well as the used extraction methods and analytical methods (Lafka et al., 2007).

Phenolic compounds in extracts of grape pomace present antioxidant, anticancerigene and antidiabetes properties (Ruberto et al., 2007; Hogan et al., 2010; Parry et al., 2011; Zhou and Raffoul 2012; González-Centeno et al., 2013), as well as antibacterial activity against *E. coli, L. monocytogenes*, and *S. aureus* (Ozkan et al., 2004; Darra et al., 2012).

Polyphenol content of tomato waste flour (18.76±0.19 mg GAE/g; moisture = 7.64±0.17%) was significantly lower compared to that of the flours achieved from winemaking by-products. Nour et al. (2015) obtained for tomato waste (moisture content = 69.98±0.18%) a total polyphenol content of 0.866 ±0.012 mg GAE/g.

Antioxidant capacity

Antioxidant capacity of the achieved flours is presented in Figure 6.

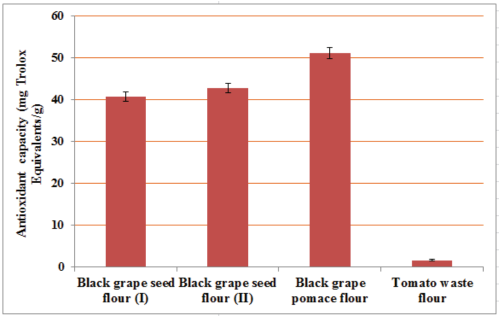

Figure 6. Antioxidant capacity of the flours achieved from winemaking by-products and tomato waste

Antioxidant capacity of flour achieved from winemaking by-products varied in the range 40.75–51.25 mg Trolox Equivalents/g, maximum value being recorded for black grape pomace flour.

Antioxidant capacity of flour achieved from tomato waste was 1.62 mg Trolox Equivalents/g.

For flours achieved from winemaking by-products and tomato waste, between the total polyphenol content and antioxidant capacity it is a linear correlation, regression coefficient R^2 being 0.9559 (Figure 7).

Results are in conformity with those of Ky and Teissedre (2015) which obtained positive correlations between the total polyphenol content and antioxidant capacity (DPPH method) for seed extract and for skin extract, respectively (R^2 = 0.87 for seed extract, R^2 = 0.79 for skin extract).

Lycopene content of the tomato waste flour was 225.92 mg/kg, and ß-carotene content, respectively 16.22 mg/kg. Lycopene content of tomato waste flour was higher than that reported by Nour et al. (2015) for tomato waste (moisture content = 69.98±0.18%): 174.12 mg/kg. ß-carotene content of tomato waste flour achieved in this study was lower than that reported by Nour et al. (2015) 32.66 mg/kg.

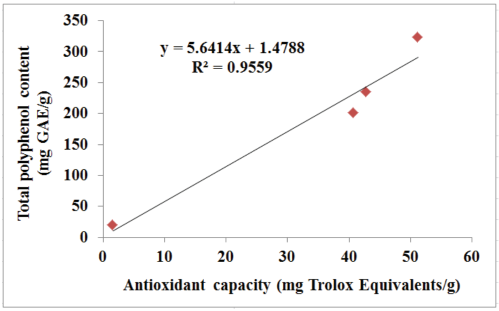

Figure 7. Correlation between the total polyphenol content and antioxidant capacity in case of flours achieved from winemaking by-products and tomato waste

Microbiological analysis

Results of the microbiological analysis of flours achived from tomato waste and winemaking by-products (grape seed, grape pomace) are presented in the Table 2.

Table 2. Microbiological analysis of flours achieved from tomato waste and winemaking by-products

Flour type	Yeast and mold (CFU/g)	*Enterobacteriaceae* (CFU/g)	*Escherichia coli* (CFU/g)	*Salmonella* (in 25g)	Water activity (Aw)
Black grape seed flour (I)	< 10	< 10	< 10	absent	0.338
Black grape seed flour (II)	< 10	< 10	< 10	absent	0.289
Black grape pomace flour	< 10	< 10	< 10	absent	0.274
Tomato waste flour	< 10	< 10	< 10	absent	0.344

Microbiological analysis shown that the achieved flours are in the frame of the provisions of the legislation into force. These flours show low values of water activity (0.274-0.344), which give them microbiological stability.

CONCLUSIONS

Flours achieved from tomato waste and winemaking by-products are important sources of protein, minerals (K, Ca, Mg, Fe, Zn and Se), dietary fibres and bioactive compounds. Thus, black grape pomace flour and black grape seed flour are characterized by total polyphenol content (200.15 mg GAE/g...322.75 mg GAE/g) and tomato waste flour by content of carotenoids (lycopene - 225.92 mg/kg; ß-carotene - 16.22 mg/kg). Also these flours have antioxidant potential being beneficial in a healthy diet for prevention of diseases caused by free radicals. On the other hand, flours achieved in this study are characterized by high dietary fibre content (58.86-66.06%), being important sources to increase the fibre content of foods (bakery products, pastry products, etc.). Increase of the fibre content in case of the sweet flour products is very important because it reduces their glycemic impact on the human body, thus preventing the development of diabetes mellitus and obesity. Also, dietary fibre have an important role in promoting feeling of satiety and detoxification of the human body.

Flours achieved from winemaking by-products and tomato waste can be regarded as functional ingredients and can be used to fortify food products (bakery and pastry products, especially) in order to increase the nutritional and their antioxidant potential.

ACKNOWLEDGEMENTS

This study was supported by the Ministry of Research and Innovation, by Nucleu Programme PN 16 46, contract 29 N/2016.

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