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Valorization of Winery By-Products with Enhanced Properties As Source of Crude Fiber

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***Abstract*—Wineries by product, grape pomace (GP) can be competitive with other agro industrial wastes taking into consideration their large quantity generated from worldwide annual wine production. GP was used as a substrate inoculated with commercial strains of the mushroom Pleurotus ostreatus under solid state fermentation. Enriched grape pomace proved to be a promising alternative source of crude fiber with potential use in human food and animal feed industry.**

Keywords—Winery byproducts, grape pomace, Pleurotus ostreatus sustainability in the winery, crude fiber

INTRODUCTION

Grapes are one of the most important fruit crop with global annual production during the year 2016 almost 75, 8 million of tons [23] with 47% of the global grape production used as wine grapes. Grape production in Greece is estimated in 807570 tones [9]. A serious problem in viticulture is the large amounts of by-products produced every year that raises serious environmental issue. A large volume (200.000 tones) of winery wastes are produced with most of them remaining unexploited every year on an international level [9].

During the wine production, several by-products are produced that are rich in biodegradable organic matter that can cause, if not treated correctly, potential environmental hazards. More precisely, inappropriate grape pomace disposal can attract flies and pests and can easily create unwanted hazards [6].

Furthermore, utilization of wine by-products in combination with the production of sustainable wine can provide enough advantages in order for a winery to differentiate in the market.

Vineyard and winemaking by-products contain valuable chemical compounds that are not extracted during wine making process. The nutritional concentration can vary on the different type of each by-product (marc, pomace, grape seeds) and also on the different wine making process (white or red vinification). Grape pomace (GP) is a major by-product of wine making, as it is equivalent to about 20% of the grapes used. It consists of pressed skins and pulp (10-12% of grapes), grape seeds (3-6%) and stems (2,5-7,5%) [29] and contributes to approximately 62% of the organic waste [24]. GP is a rich source of high value products including 15% sugars [30] ethanol, tartates, malates, citric acid, grape seed oil, hydrocolloids and fiber [29, 5, 13, 30]. The overall properties of GP has widened their utilization and supported the sustainable agricultural production [15] as long as the existence of phenolic phytochemicals that are found in abundance in grapes, wines and wine by-products [4]. GP provides phenolic compounds as they share characteristics with anthocyanins in terms of solubility in waster and stability to temperature and oxygen [4]. According to Sousa the microbiological quality of GP can be consumed by humans due to its unfavorable conditions of low moisture and pH lower than 4. It is also a good source of soluble fiber, with high antioxidant activity due to the natural presence of polyphenols and significant amounts of bioactive compounds, flavonoids, carotenoids, etc [27, 18, 8] and exhibit a better nutritional quality than those from cereals [26].The fiber composition of grape byproducts may be influenced by various factors such us variety, field characteristics, and wine processing procedures [14]. The main component of grape pomace is dietary fiber, ranging between 43% and 75% d.w [17]. According to reference [5, 26], grape fiber was called "antioxidant dietary fiber" (ADF) as it possesses an interesting characteristic associated with a large number of insoluble phenolics belonging to the proanthocyanidin class.The consumption of dietary fibers promote physiological actions like reducing cholesterol and attenuating blood glucose and maintaining gastrointestinal health [7] and are recommended for the treatment and prevention cardiovascular diseases, certain types of cancers, diabetes and gastrointestinal disorders [10].

Apart from the above various beneficial effects, fibers also possess various biotechnological potentials and technological attributes like water binding, gelling, structure building, potential fat replacers and that is the reason why they can been used as fortification ingredients in food [22,2].
Reference [2] focuses on the possible use of grape pomace as food ingredient in a wide range of products like plant food products, meat products, fish, and dairy products and salad dressing [28] with obvious improvement in the nutritional profile of the final product and increase in its value.

I. MATERIAL AND METHODS

A. *Collection and preparation of the grape pomace substrate*

The marcs were collected from wineries in Attica, Greece during the harvest (August, September) 2017. Two white varieties (Savvatiano, Roditis) and two red varieties (Cabernet Sauvignon, Syrah) were received. The marcs were natural dried and all the impurities were removed. The dried marcs were then placed in zip lock polyethylene bags and stored in a dark and cool place.

B. *Microorganisms used*

In this study, the use of the mushroom Pleurotus ostreatus was made in order to check the changes of physico-chemical qualities of the final products with the enrichment.

The specific fungus has been chosen due to its non-toxicity, ease of cultivation [1] and finally because of its widespread use and readability. Also, the process of preparation of the substrate is simpler but with appropriate regulation of the environmental conditions (temperature, ventilation, lighting, relative humidity, etc.) throughout the production process.

The grape pomace substrates were inoculated with commercial strains of the mushroom Pleurotus ostreatus in different rates of 10% (A), 15% (B) and 20% (C).

II. ANALYSIS

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A. *Moisture and ash analysis*

Each sample was homogenized and analyzed for moisture (oven drying method) and ash content according to the standard AOAC procedures [3].

B. *Crude fiber analysis*

Crude fiber was determined in Selecta Digester Dosi-Fiber. Crude fiber is lost on ignition of dried residue remaining after the digestion of the sample with 1.25% (w/v) sulfuric acid ($H2SO4$) and 1.25% (w/v) NaOH solutions under specific conditions [3].

III. RESULTS AND DISCUSSION

The proximate composition results of the samples produced are presented in Table 1.

Table 2. Proximate composition results of the samples

Samples	Moisture %	Ash	Crude Fiber %
3A	5,28	3,36	28,81
3B	4,93	2,5	28,9
3C	3,06	4,08	29,7
4A	5,44	3,15	28,76
4B	4,59	3,35	30,05
4C	3,06	4,28	30,47
5A	4,89	3,83	28,95
5B	4,37	3,16	31,27
5C	3,15	4,09	30,14
6A	4,56	3,69	30,52
6B	4,21	3,79	30,32
6C	3,19	4,53	29,38
7A	4,21	4,62	30,52
7B	4,08	3,14	30,16
7C	3,36	4,55	28,37
FB	3, 5	2,39	30,47

The results showed that sample 5A recorded the highest moisture content (5,44%) and was significantly different from the minimum samples 3C and 4C (3,06%) .

The values of moisture content obtained fell within the range of (3,06–5,44%) which is safe for storage of dried products [12]. Reference [16] states that moisture content of the commercialized fibre products was below 9.0%. Wheat flour (whole grain) moisture content is 10, 3 % [21], higher than our samples probably due to the drying process that has occurred.

As shown at figures 1, 2 moisture content decreases from day 3 to day 7 whereas at figure 3 there is an increase with the higher moisture content the blank sample.

According to reference [21] ash refers to the inorganic residue remaining after either ignition or complete oxidation of organic matter in a foodstuff and its content represents the total mineral content in foods which is essential for nutritional evaluation. The relatively high ash content of the samples is a positive parameter since it may possibly diminish the growth of certain microorganisms

Table 1. Descriptive statistics of moisture, ash and crude fiber

	Moisture	Ash	Crude Fiber %
Valid	16	16	16
Missing	0	0	0
Mean	4.109	3.657	29.799
Median	4.215	3.740	30.095
Mode [a]	3.060	2.390	30.470
Std. Deviation	0.815	0.692	0.837
Variance	0.664	0.479	0.700
Minimum	3.060	2.390	28.370
Maximum	5.440	4.620	31.270

[a] More than one mode exists, only the first is reported

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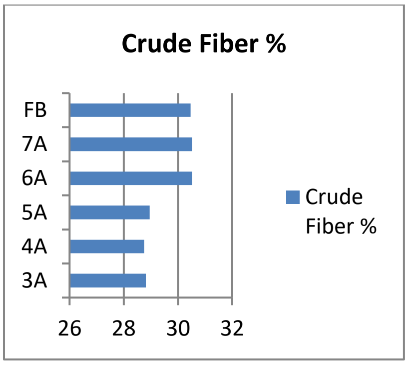
Crude fiber consists largely of cellulose (60-80%) and lignin (4-6%) plus some mineral matter and is beneficial in treating or preventing different types of diseases like constipation, hemorrhoids, coronary heart diseases, and some type of cancer [19].

Crude fiber content was determined and shown in figures 7,8 and 9. Crude fiber in the samples was found between 28,37% - 31, 27%, much higher than 7,53% that was found in the wheat bran soft sample [11]. High crude fiber was recorded for sample 5B (10%, fifth day of fermentation) with variance 0,700 (Table 2). As shown at figures 7,8 samples tend to present higher prices at days 5,6,7 but with no significant difference from the blank sample whereas at figure 9 the highest price was found at day 4.



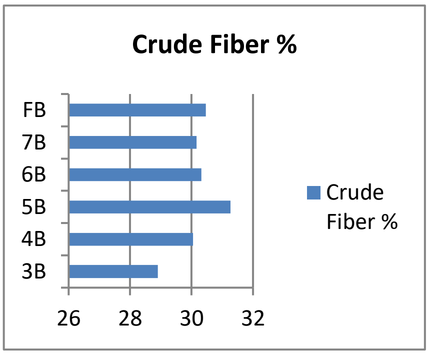


Fig. 3,4. Crude fiber from day 3 to day 7 for samples 10%, 15%

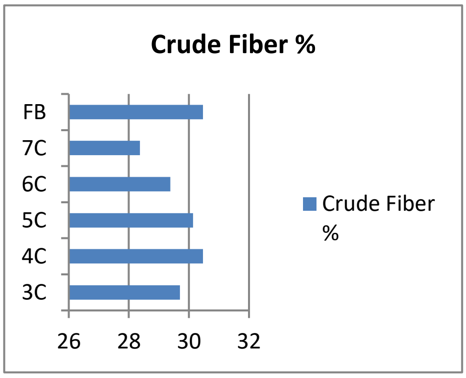


Fig. 5. Crude fiber from day 3 to day 7 for samples 20%

VI. CONCLUSION

Based on our results on crude fiber, enriched grape pomace fiber can be used as ingredient in food industry, particularly for its nutritional and functional characteristics.

Grape pomace have compounds with beneficial health effects that can be used as a substrate and bioactive food ingredient allowing the valorization of winery by- products and produce value-added products that can be used as human or animal food taking into account the importance of fiber in human diet.

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