ACTA TECHNICA CORVINIENSIS – BULLETIN OF ENGINEERING
TOME XVI [2023] | FASCICULE 1 [JANUARY – MARCH]

[1.] Nicoleta Alexandra VANGHELE, [1.] Andreea MATACHE, [1.] Ancuţa–Alexandra PETRE

RECOVERY OF WASTE FROM THE WINE INDUSTRY – GRAPE SEED OIL

[1.] National Research – Development Institute for Machines and Installations designed to Agriculture and Food Industry – INMA Bucharest, ROMANIA

Abstract: Recently, the main objectives in the food industry have been to create easy–to–consume food products, to eliminate waste as much as possible by valorizing it in the context of the circular economy, and the efficient use of by–products as ingredients for the manufacture of new functional foods. As for the wine industry, it generates large amounts of grape pomace, a biological waste that is composed of seeds, skins, stems and remaining pulp. The main by–products that can be recovered from grape pomace are grape seed oil and grape seed meal.
Keywords: waste, industry, grapes, oil, circular economy

INTRODUCTION

In the food industry, the current trends are based on the development of sustainable strategies and the efficient recovery of waste and by–products. Even though waste from the agri–food industry is harmful to the environment, it has a high potential as a raw material for obtaining new products with high added value (*Milanović J. et al., 2021*).

In the world, one of the most used plant species in the agricultural industry is the vine, due to the products and by–products it offers and due to the socio–economic impact, it has (*Sargolzaei M. et al., 2021*).

By–products from the wine industry account for approximately 20%–25% of the processed grapes, and their value leads to an increase in economic efficiency by obtaining valuable products used in different industrial sectors (*Oprea, O.B. et al., 2022*).

The main wastes and by–products of the wine industry are grape stalks, marc/ marc and wine yeast, pulp, tartaric acid and tartrates, ethylic acid, oil and tannin. (*Wounds J. et al., 2020*).

Marc is a by–product that results from the pressing of grapes and sweet musts. Also, here we find bunches, skins, seeds and scraps of mash. Due to certain components (carbohydrates, seed oil, ethyl alcohol) the marc is used to obtain protein feed, tartaric acid, food oil, tannin, dyes (red wine) etc. (*Chicken B. 2018*).

One of the most affordable by–products in the wine industry is grape seeds that can reach about 2.4 million t/year. Due to its high content of proteins, fiber, minerals, polyphenols, antioxidants, phenolic compounds, nonphenolic antioxidants (tocopherols and beta–carotene), and tannins, grape seeds are used as a functional ingredient (*Oprea, O.B. et al., 2022; Spinei, M. et Oroian, M. 2021*). Also, the presence of this grape seed oil, among other benefits, has antioxidant, anti–inflammatory and antitumor activities, thus contributing to human health (*Rosa da Mata I. et al., 2022*).

MATERIALS AND METHODS

— Grape seed oil

The oil is described as a fatty, viscous liquid, having animal, vegetal or mineral origin, with multiple uses such as: in the food industry, technical industry, pharmaceutical, in obtaining and improving cosmetics, in painting, etc.

The recovery of the residues is mainly used in large wine–growing basins, which can provide a significant quantity of grape seeds (*Rusnac L.M.1995*).

Figure 1 – Grape seed oil

— Obtaining grape seed oil

The grapes arrived in the winemaking centres are subjected to a crushing operation, so the berries are broken and crushed, favoring the release of the juice.

The duration of the crushing operation must be reduced to avoid the diffusion of the component substances coming from the skin, pips, bunches into the mustache mass.

After the must drain, the marc remains exhausted, which favors the separation of the grape seeds. The grape seeds are cleaned, washed and conditioned reaching a humidity value below the critical value for temporary storage, following the operation of obtaining itself (Jordan, M., 2002).

Obtaining oil from grape seeds can be achieved by pressing (cold or hot), by extraction with solvent or even with ultrasound.

— Cold–pressing extraction

The cold pressing method is a method that retains several components beneficial to health because it does not involve heat or chemical treatment (Parry, J., et al. 2006). Unlike conventional solvent extraction, the yield is usually lower. As a result of the cold pressing process, there is no solvent residue from the oil, resulting in a safer and more desired product by consumers (Shinagawa, F.B. et al., 2015).

The extraction method by cold pressing is carried out by means of a hydraulic press. Native (unwrapped) dry seeds (humidity from 8 to 10%) are processed under pressure of 600 bar at the cylinder temperature set at 50°C. The temperature of the extracted oil is 30 °C.

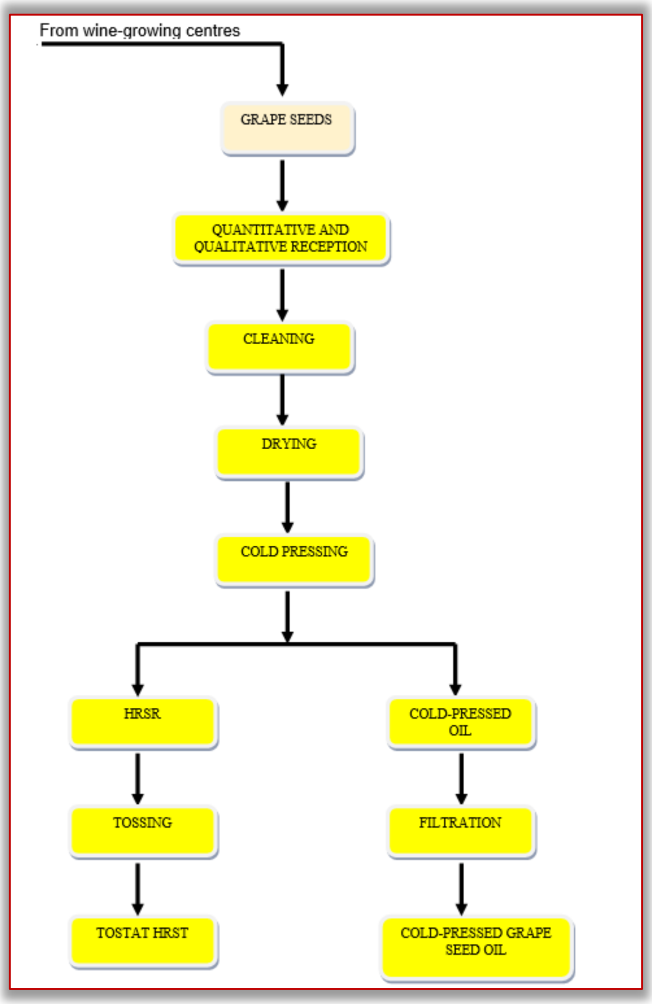

Figure 2 – Technological scheme of obtaining oil from cold–pressed grape pits, (*Adapted from Jordan M. 2002*)

— Ultrasonically Assisted Extraction

For this method the grape seeds are ground, a quantity of 50g is placed in an Erlenmeyer beaker over which 100 ml of n–hexane is added, covered with aluminum foil and are exposed for 90 minutes to ultrasound in an ultrasonic bath maintaining a temperature of 30 °C with the help of a pump water from the thermostatic bath is circulated. The solid is separated by decanting, it washes with n–hexane solution, and using a rotary evaporator the solvent is evaporated at a temperature of 37°C, and a pressure of 0,8 bar using 150 revolutions per minute (*Malićanin M. et al., 2014*).

The use of ultrasonics in oil extraction has multiple advantages such as: reducing extraction time, solvent consumption, and avoiding thermal damage to the extract or loss of bioactive components because the extraction is carried out at lower temperatures (*Mushtaq A. et al., 2020*).

— Composition of grape seed oil

Grape seed oil is a healthy rainy fat, especially due to the high levels of hydrophilic constituents such as phenolic compounds and lipophilic constituents such as vitamin E, unsaturated fatty acids and phytosterols (*Karaman S. et al., 2015,*). Grape seed oil has a nutritional profile similar to that obtained from sunflower seeds, which has led to its use as a culinary oil in countries such as Germany, France and Italy since 1930.

The composition of grape seed oil is influenced by certain environmental factors, the variety of vines or the degree of maturity of the seed because it retains both the quality and aroma of the grape variety (*Shinagawa F.B. et al., 2015*).

A proximal composition of grape seed oil is described in Table 1 (*Akkurt, M. 2001*)

Table 1. Fatty acids composition of grape seed oil:

Acid	Bloke	Proportion
Linoleic acid	ω 6 – unsaturated	46 ÷ 55,5 %
Oleic acid	ω 9 – unsaturated	35,5 ÷ 37 %
Palmitic acid	saturated	5,5 ÷ 8 %
Stearic acid	saturated	2,5 ÷ 3,5 %
Linolenic acid	ω– unsaturated	0,1÷2 %

RESULTS

The benefits of grape seed oil have long been studied and confirmed in the literature.

— Antioxidative activity

The main capacity of grape seed oil is antioxidative, this ability plays the role of eliminating ROS (oxygen–reactive species) and inhibiting lipid oxidation (*Freedman J.E. et al., 2001*), removes free radicals that influence the functioning of the immune system (*Soobrattee M.A., 2005*) and decreases the level of low–density lipoproteins (LDL) (*Valls–Belles V. et al., 2006*) thus reduces the process of occurrence of diseases.

Grape seed oil has also been used in cosmetics, it has been shown that its addition to sunscreens has increases the effectiveness of sunscreen creams in the order of protecting the skin against UV rays (*Souza Sanches P. et al., 2022*). Grape seed oil has benefited the sunscreen formula due to its synergistic effect with antioxidants, anti–aging properties, anti–inflammatory effects (*Chee Chin Chu et Kar Lin Nyam, 2021*).

Introduced in the diet of birds, grape seed oil has improved their health and weight gain (*Dumitra Panaite T. et all., 2020*). The use of grape seed extracts also benefited chicken eggs, the yolks showed less oxidized lipids even though the weight of the eggs was reduced (*Romero C. et al., 2022*).

Another study showed that grape seed oil increases productivity in rabbits and can be successfully used as a dietary supplement in their diet (*Ahmed M. et al., 2022*).

— Anti–inflammatory effect of grape seed oil

Generally, chronic diseases are associated with inflammatory processes, and the consumption of nutrients with an anti–inflammatory role have a beneficial role in treating of chronic diseases. Grape seed oil dried platelet adhesion in vitro (*Olas B. et al., 2012*) and plays a reducing role in oxidized LDL, thus showing the cardioprotective potential of grape seed oil (*Sano A. et al., 2007*).

— Cell cycle control

The phenolic compounds present in grape seed oil have anticancer activities and act in cell cycle modulation (*Engelbrecht A.M. et al., 2007; Huang S. et al., 2012*), are cytotoxic to tumor and cancer cells without attacking healthy cells (*Husein A.I. et al., 2014*).

— Antimicrobial activity of grape seed oil

The oil extracted from the grape seeds has been shown to have an inhibitory effect on the growth of *Staphylococcus aureus* and *Escherichia coli* (*Rotava R. et al., 2009*). Phenolic compounds such as resveratrol, responsible for antimicrobial activity involve inducing oxidative damage to the bacterial membrane, especially *E. coli*, without harming host cells. In conclusion it is suggested that the use of resveratrol can replace traditional therapies in which antibiotics are ineffective (*Subramanian M. et al., 2014*).

In other words, the phenolic compounds present in the grape seed oil have not only antioxidant activity, but also antimicrobial, anticancer, cardioprotective and anti–aging effects, whether it is introduced directly into the food of humans or animals or in different extracts.

CONCLUSIONS

The magic word that characterizes the peculiarity of waste in the food industry is "recovery". The waste of the food industry should be regarded as raw materials for the production of high–value–added products, rather than as waste within the meaning of the dictionary definition.

There is practically no 'waste' of the food industry that cannot be used as a raw material for the production of products with market value. Even after exhausting all the possibilities of recovery as raw materials, there is the alternative of using this waste as fuels, to ensure at least part of the energy needed to support the production. The food industry is under increased pressure to improve its environmental performance, both from consumers and a from legislative for that are also responding to consumer pressure.

A series of 'clean and friendly' technologies for the processing of food products have been precisely developed with the aim of enabling producers to better understand the effects that their activities have on the environment and to be able to adopt practical measures to achieve sustainable production.

The complex use of waste, residues and by–products from the wine complex (marcs seeds, berry skin, green shoots and unripe grapes, yeast sediments, etc.) allows us to capitalize on their high economic potential on the basis of modern and efficient biotechnologies.

Biotechnologies for the processing of waste and wine–sector by–products have as a major objective the protection of the environment (soil, water and air) from dangerous pollution, caused by their uncontrolled decomposition.

The complex capitalization of the wine by–products is determined by the high share of them and of the substances, active principles they contain, useful to different industries.

Acknowledgement

This work was supported by the Ministry of Research, Innovation and Digitalization through Program 1 – Development of the national research–development system, Subprogram 1.2 – Institutional performance – Projects for financing excellence in RDI, Contract no. 1PFE/30.12.2021; and by a grant offered by the Romanian Minister of Research as Intermediate Body for the Competitiveness Operational Program 2014–2020, called POC/78/1/2/, project number SMIS2014 + 136213, acronym METROFOOD–RO.

References

[1] Ahmed M. et all. 2022, A comparative study among dietary supplementations of antibiotic, grape seed and chamomile oils on growth performance and carcass properties of growing rabbits, Saudi Journal of Biological Sciences Volume 29, Issue 4, 2483–2488;

[2] Akkurt, M., 2001, Oil Content and Oil Quality Properties of Some Grape Seeds. Ankara University Faculty of Agriculture Department of Horticulture –Ankara – TURKEY. Turk J Agric For 25, 163–168;

[3] Chee Chin Chu, Kar Lin Nyam, 2021, Application of seed oils and its bioactive compounds in sunscreen formulations, Journal of the American Oil Chemists' Society (JAOCS), Volume98, 713–726;

[4] Dumitra T. Panaite, et all. 2020, Effect of The Inclusion of Grape Seed Oil in Broiler Diet on The Intestinal Microflora Balance, Journal of Hygienic Engineering and Design, Vol.33 .225–232

[5] Engelbrecht, A.M., Mattheyse, M., Ellis, B., 2007; Proanthocyanidin from grape seeds inactivates the PI3–kinase/PKB pathway and induces apoptosis in a colon cancer cell line. Cancer Lett. 258(1): 144–153;

[6] Freedman, J.E., Parker, C., Li, L., 2001, Select flavonoids and whole juice from purple grapes inhibit platelet function and enhance nitric oxide release. Circulation.; 103(23): 2792–2798;

[7] Hen B., 2018, By–Products of Wine Origin and Their Use (Informative Study);

[8] Huang, S., Yang, N., Liu, Y., 2012; Grape seed proanthocyanidins inhibit colon cancer–induced angiogenesis through suppressing the expression of VEGF and Ang1. Int J Mol Med. 30(6): 1410–1416;
[9] Husein, A.I., Ali–Shtayeh, M.S., Jondi, W.J., Zatar, N.A., Abu–Reidah, I.M., Jamous, R.M., 2014, In vitro antioxidant and antitumor activities of six selected plants used in the Traditional Arabic Palestinian herbal medicine. Pharm Biol.; 52(10): 1249–1255;
[10] Iordan, M., 2002, Mineral food industries, Macarie Publishing House, Târgoviște;
[11] Karaman, S., Karasu, S., Tornuk, F. 2015, Recovery potential of cold press byproducts obtained from the edible oil industry: physicochemical, bioactive, and antimicrobial properties. J Agric Food Chem.; 63(8): 2305–2313;
[12] Malićanin, M.; Cancer, V.; Antić, V.; Ancient, M.; Palade, L.M.; Kefalas, P.; Rakic, V., 2014, Content of Antioxidants, Antioxidant Capacity and Oxidative Stability of Grape Seed Oil Obtained by Ultra Sound Assisted Extraction. J. Am. Oil Chem. Elderberry., 91, 989–999;
[13] Milanović, J.; Malićanin, M.; Rakić, V.; Jevremović, N.; Karabegović, I.; Danilović, B., 2021, Valorization of Winery Waste: Prokupac Grape Seed as a Source of Nutritionally Valuable Oil. Agronomy, 11, 1864;
[14] Mushtaq, A.; Roobab, U.; Denoya, G.I.; Inam–your–Raheem, M.; Gullón, B.; Loorenco, J.M.; Francisco, B.J.; Zeng, X.A.; Wali, A.; Aadil, R.M. 2020Advances in green processing of seed oils using ultrasound–assisted extraction: A review. J. Food Process Preserv., 44, e14740;
[15] Olas, B., Wachowicz, B., Stochmal, A., Oleszek, W. 2012, The polyphenol–rich extract from grape seeds inhibits platelet signal signaling pathways triggered by both proteolytic and non–proteolytic agonists. Platelets. 23(4): 282–289;
[16] Oprea, O.B.; King, M.E.; Apostle, L.; Gaceu, L. 2022, Research on the Potential Use of Grape Seed Flour in the Bakery Industry. Foods, 11, 1589
[17] Parry, J., Hao, Z., Luther, M. 2006, Characterization of cold–pressed onion, parsley, cardamom, mullein, roasted pumpkin, and milk thistle seed oils. J Am Oil Chem Soc.; 83: 847–854;
[18] Rani, J., Indrajeet, Rautela, A., & Kumar, S. (2020). Bio valorization of winery industry waste to produce value–added products. Bio valorization of Wastes to Renewable Chemicals and Biofuels, 63–85;
[19] Romero, C.; Arija, I.; Viveros, A.; Chamorro, S. Productive Performance, Egg Quality and Yolk Lipid Oxidation in Laying Hens Fed Diets including Grape Pomace or Grape Extract. Animals 2022, 12, 1076;
[20] Rosa da Mata I., Morelo Dal Bosco, S., Garavaglia, J., 2022, Chapter 17 – Different biological activities (antimicrobial, antitumor, and antioxidant activities) of grape seed oil, Multiple Biological Activities of Unconventional Seed Oils, Academic Press, 215–227;
[21] Rotava R., Zanella, I., da Silva, L.P., 2009; Antibacterial, antioxidant and tanning activity of grape by product. Cienc Rural. 39(3): 941–944;
[22] Rusnac, L.M., 1995, Technology of vegetal and volatile oils, "Politehnica" University of Timisoara, Timisoara,
[23] Sano, A., Uchida, R., Saito, M., 2007, Beneficial effects of grape seed extract on malondialdehyde–modified LDL. J Nur Sci Vitamin (Tokyo). 53(2): 174–182;
[24] Sargolzaei, M.; Rustioni, L.; Cola, G.; Ricciardi, V.; Bianco, P.A.; Maghradze, D.; Failla, O.; Quaglino, F.; Toffolatti, S.L.; By Lorenzis, G. 2021, Georgian grapevine cultivars: ancient biodiversity for future viticulture. Front. Plant Sci., 12, 630122;
[25] Shinagawa, F.B., Santana, F.C., Torres, L.R.O., 2015, Grape seed oil: a potential functional food? Food Sci Technol (Campinas). 35(3): 399–406;
[26] Soobrattee, M.A., Neergheen, V.S., Luximon–Ramma, A., Aruoma, O.I., 2005; Bahorun, T. Phenolics as potential antioxidant therapeutic agents: mechanism and actions. Moved Res. 579 (1–2): 200–213;
[27] Souza Sanches, P., et all. 2022. Influence of grape seed oil on sun protection factor in sunscreen formulations: a study using Central Composite Design approach. Drug Analytical Research, 6(1), 40–45;
[28] Spinei, M.; Oroian, M. 2021 The Potential of Grape Pomace Varieties as a Dietary Source of Pectic Substances. Foods, 10, 867;
[29] Subramanian, M., Goswami, M., Chakraborty, S., Jawali, N. 2014; Resveratrol induced inhibition of Escherichia coli proceeds via membrane oxidation and independent of diffusible reactive oxygen species generation. Redox Biol. 2: 865–872.
[30] Valls–Belles, V., Torres, M.C., Muñiz, P., Beltran, S., Martinez–Alvarez, J.R., Codoñer–Franch, P., 2006; Defatted milled grape seed protects adriamycin–treated hepatocytes against oxidative damage. Eur J Nutr. 45(5): 251–258;
[31] https://encrypted–tbn0.gstatic.com/images?q=tbn:ANd9GcRKhDX5D9LrGtkeshhCui–CePYB8PbZHR0VQg&usqp=CAU

Note: This paper was presented at ISB–INMA TEH' 2022 – International Symposium on Technologies and Technical Systems in Agriculture, Food Industry and Environment, organized by University "POLITEHNICA" of Bucuresti, Faculty of Biotechnical Systems Engineering, National Institute for Research–Development of Machines and Installations designed for Agriculture and Food Industry (INMA Bucuresti), National Research & Development Institute for Food Bioresources (IBA Bucuresti), University of Agronomic Sciences and Veterinary Medicine of Bucuresti (UASVMB), Research–Development Institute for Plant Protection – (ICDPP Bucuresti), Research and Development Institute for Processing and Marketing of the Horticultural Products (HORTING), Hydraulics and Pneumatics Research Institute (INOE 2000 IHP) and Romanian Agricultural Mechanical Engineers Society (SIMAR), in Bucuresti, ROMANIA, in 6–7 October, 2022.

ISSN: 2067-3809