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Estrazione di polifenoli da sottoprodotti della vinificazione

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Abstract

ITA: L'industria alimentare è senza dubbio il più grande comparto manifatturiero nell'Unione Europea e la gestione dei sottoprodotti in tale settore è quindi una grande preoccupazione in ambito della tutela ambientale e della sostenibilità.
Il seguente lavoro di tesi si concentra sullo studio delle tecniche per l'estrazione dei polifenoli dai residui della vinificazione col fine di valorizzare gli scarti. Dopo aver analizzato i principali residui del processo e i composti fenolici contenuti sono state descritte le norme legislative italiane più recenti sulla gestione dei sottoprodotti; inoltre, nell'introduzione è presente un approfondimento sulla fattibilità tecnica della trasformazione degli scarti in un CDR (combustibile derivato da rifiuto). Particolare rilievo è stato dato alle tecniche più recenti di estrazione sia convenzionali che innovative; i processi di estrazione innovativi descritti non sono ancora pronti per espandersi nell'industria vinicola principalmente a causa degli elevati costi delle apparecchiature nonostante un impatto più sostenibile ed una resa estrattiva più elevata.

ENG: The food industry is undoubtedly the largest manufacturing sector in the European Union and the management of by-products in this sector is therefore a major concern in the field of environmental protection and sustainability.
The following thesis focuses on the study of techniques for the extraction of polyphenols from wine-making residues in order to enhance the value of waste. After analyzing the main residues of the process and the phenolic compounds contained in them, the most recent Italian legislative norms on the management of by-products have been described; moreover, in the introduction there is an in-depth study on the technical feasibility of transforming the waste into RDF (refuse derived fuel). Particular emphasis has been given to the most recent extraction techniques both conventional and innovative; the innovative extraction processes described are not yet ready to expand in the wine industry mainly because of the high costs of the equipment despite a more sustainable impact and a higher extraction yield.

Relatori: Gaetano Lamberti e Diego Caccavo

Bibliografia

1. Watson, R.R., *Polyphenols in Plants*. Isolation, Purification and Extract Preparation, ed. 2. 2019: Elsevier Pages 3-24.
2. Eleni Naziri, N.N., Fani Th. Mantzouridou, Maria Z. Tsimidou, *Valorization of the major agrifood industrial by-products and waste from Central Macedonia (Greece) for the recovery of compounds for food applications.* Food Research International pages:350-358, 2014.
3. Tataridis, E.T.N.a.P., *Integrated Enology-Utilization of winery by-products into high added value products.* e-Journal of Science & Technology (e-JST), 2006.
4. Campos, J.F., et al., *Leaf and root extracts from Campomanesia adamantium (Myrtaceae) promote apoptotic death of leukemic cells via activation of intracellular calcium and caspase-3.* Frontiers in Pharmacology, 2017. **8**: p. 466.
5. Ferreira, L.C., et al., *Anti-inflammatory and antinociceptive activities of Campomanesia adamantium.* Journal of Ethnopharmacology, 2013. **145**(1): p. 100-108.
6. Zuntini Viscardi, D., et al., *Seed and peel essential oils obtained from Campomanesia adamantium fruit inhibit inflammatory and pain parameters in rodents.* PloS one, 2017. **12**(2): p. e0157107.
7. Bonilla, A., et al., *Champanones, yellow pigments from the seeds of champa (Campomanesia lineatifolia).* Phytochemistry, 2005. **66**(14): p. 1736-1740.
8. Madalosso, R., et al., *Campomanesia lineatifolia Ruiz & Pav. as a gastroprotective agent.* Journal of ethnopharmacology, 2012. **139**(3): p. 772-779.
9. Tanumoy Bera, K.S.I., and Ann C. Wilkie, *Biofuel: Concepts and Considerations.* **EDIS** , **2020**, 2020.
10. Lanfranchi, M., E. Schimmenti, and C. Giannetto, *Economic analysis and energy valorisation of by-products of the wine supply chain: the case of the 'Mamertino wine PDO'.* International Journal of Environmental Studies, 2018. **75**(5): p. 800-811.
11. Raboni, M., P. Viotti, and A.G. Capodaglio, *A comprehensive analysis of the current and future role of biofuels for transport in the European Union (EU).* Revista ambiente & agua, 2015. **10**: p. 9-21.
12. Teixeira, A., et al., *Natural bioactive compounds from winery by-products as health promoters: A review.* International journal of molecular sciences, 2014. **15**(9): p. 15638-15678.
13. Mattos, G.N., et al., *Grape by-product extracts against microbial proliferation and lipid oxidation: a review.* Journal of the Science of Food and Agriculture, 2017. **97**(4): p. 1055-1064.
14. Kammerer, D., et al., *Polyphenol screening of pomace from red and white grape varieties (Vitis vinifera L.) by HPLC-DAD-MS/MS.* Journal of agricultural and food chemistry, 2004. **52**(14): p. 4360-4367.
15. Amico, V., et al., *Constituents of grape pomace from the Sicilian cultivarNerello Mascalese'.* Food chemistry, 2004. **88**(4): p. 599-607.
16. Ping, L., et al., *Evaluation of grape stalks as a bioresource.* Industrial crops and products, 2011. **33**(1): p. 200-204.
17. SóniaO.ProzilDmitryV.EvtuguinLuísaP.CruzLopes, *Chemical composition of grape stalks of Vitis vinifera L. from red grape pomaces.* Industrial Crops and Products Pages:178-184, 2011.
18. Spigno, G., L. Marinoni, and G.D. Garrido, *State of the art in grape processing by-products*, in *Handbook of Grape Processing By-Products*. 2017, Elsevier. p. 1-27.
19. Deng, Q., M.H. Penner, and Y. Zhao, *Chemical composition of dietary fiber and polyphenols of five different varieties of wine grape pomace skins.* Food Research International, 2011. **44**(9): p. 2712-2720.
20. De Castro, M.L. and L. Garcıa-Ayuso, *Soxhlet extraction of solid materials: an outdated technique with a promising innovative future.* Analytica chimica acta, 1998. **369**(1-2): p. 1-10.
21. Dimou, C., et al., *Wine lees valorization: Biorefinery development including production of a generic fermentation feedstock employed for poly (3-hydroxybutyrate) synthesis.* Food Research International, 2015. **73**: p. 81-87.
22. V. Lavelli, L.T., G. Zeppa, L. Fiori, G. Spigno, *Recupero dei sottoprodotti di vinificazione per lo sviluppo di applicazioni alimentari innovative : stato dell'arte.* INDUSTRIE DELLE BEVANDE, 2018. **Chiriotti Pages:5-14**.
23. Bordiga, M., *Valorization of wine making by-product*. 2016: CRC Press Pages:83-89.
24. Andersen, O.M.a.K.R.M., *Flavonoids: chemistry, biochemistry and applications.* CRC press Pages: 1050, 2005.
25. Makris, D.P., S. Kallithraka, and P. Kefalas, *Flavonols in grapes, grape products and wines: Burden, profile and influential parameters.* Journal of Food Composition and Analysis, 2006. **19**(5): p. 396-404.
26. Spigno, G. and D.M. De Faveri, *Antioxidants from grape stalks and marc: Influence of extraction procedure on yield, purity and antioxidant power of the extracts.* Journal of Food Engineering, 2007. **78**(3): p. 793-801.
27. Xia, E.-Q., et al., *Biological activities of polyphenols from grapes.* International journal of molecular sciences, 2010. **11**(2): p. 622-646.
28. Spigno, G., L. Tramelli, and D.M. De Faveri, *Effects of extraction time, temperature and solvent on concentration and antioxidant activity of grape marc phenolics.* Journal of food engineering, 2007. **81**(1): p. 200-208.

29. 2016, G.U.n.d.d., *Disciplina organica della coltivazione della vite e della produzione e del commercio del vino(Testo unico del vino)*.
30. Atanacković, M., et al., *Influence of winemaking techniques on the resveratrol content, total phenolic content and antioxidant potential of red wines.* Food Chemistry, 2012. **131**(2): p. 513-518.
31. Azmir, J., et al., *Techniques for extraction of bioactive compounds from plant materials: A review.* Journal of food engineering, 2013. **117**(4): p. 426-436.
32. De Castro, M.L. and F. Priego-Capote, *Soxhlet extraction: Past and present panacea.* Journal of chromatography A, 2010. **1217**(16): p. 2383-2389.
33. Manikandan, A.P., S. Akila, and K. Prabu, *Production of Polyphenol from Phyllanthus Emblica using Soxhlet Extraction Process.* International Journal of Recent Technology and Engineering (IJRTE), 2019. **8**(4): p. 5010-5012.
34. Aguilar, T., et al., *Effect of thermomaceration and enzymatic maceration on phenolic compounds of grape must enriched by grape pomace, vine leaves and canes.* European food research and technology, 2016. **242**(7): p. 1149-1158.
35. Vankar, P.S., *Essential oils and fragrances from natural sources.* Resonance, 2004. **9**(4): p. 30-41.
36. Silva, L., et al., *Comparison of hydrodistillation methods for the deodorization of turmeric.* Food Research International, 2005. **38**(8-9): p. 1087-1096.
37. Roselló-Soto, E., et al., *Clean recovery of antioxidant compounds from plant foods, by-products and algae assisted by ultrasounds processing. Modeling approaches to optimize processing conditions.* Trends in Food Science & Technology, 2015. **42**(2): p. 134-149.
38. Barba, F.J., et al., *Green alternative methods for the extraction of antioxidant bioactive compounds from winery wastes and by-products: A review.* Trends in Food Science & Technology, 2016. **49**: p. 96-109.
39. 阳静, I., *A kind of extraction process of grape skin polyphenol*, in *Shenzhen City Heng Shan Tang Biotechnology Co. Ltd*. 2015.
40. Barbosa-Canovas, G.V., et al., *Pulsed electric fields.* Journal of Food Science, 2000. **65**: p. 65-79.
41. Balasa, A., S. Toepfl, and D. Knorr, *Impact of pulsed electric field treatment on polyphenolic content of grapes.* Control Applications in Post-Harvest and Processing Technology (CAPPT 2006), 2006: p. 169.
42. Boussetta, N. and E. Vorobiev, *Extraction of valuable biocompounds assisted by high voltage electrical discharges: A review.* Comptes Rendus Chimie, 2014. **17**(3): p. 197-203.
43. Boussetta, N., et al., *Application of electrical treatments in alcoholic solvent for polyphenols extraction from grape seeds.* LWT-Food Science and Technology, 2012. **46**(1): p. 127-134.
44. Boussetta, N., et al., *Effect of high voltage electrical discharges, heating and ethanol concentration on the extraction of total polyphenols and lignans from flaxseed cake.* Industrial Crops and Products, 2013. **49**: p. 690-696.
45. Ani ALUPULUI , I.C., Vasile Lavric, *MICROWAVE EXTRACTION OF ACTIVE PRINCIPLES FROM MEDICINAL PLANTS.* U.P.B. Sci. Bull., Series B, Vol. 74, Iss. 2, 2012.
46. Liazid, A., et al., *Microwave assisted extraction of anthocyanins from grape skins.* Food chemistry, 2011. **124**(3): p. 1238-1243.
47. Chemat, S.A.B.P.-I.D., *An innovative grape juice enriched in polyphenols bymicrowave-assisted extraction.* Food Chemistry, 2013. **Pages:3268-3272**.
48. Barba, F.J., et al., *Effect of alternative physical treatments (ultrasounds, pulsed electric fields, and high-voltage electrical discharges) on selective recovery of bio-compounds from fermented grape pomace.* Food and Bioprocess Technology, 2015. **8**(5): p. 1139-1148.
49. Casazza, A.A., et al., *High-pressure high-temperature extraction of phenolic compounds from grape skins.* International Journal of Food Science & Technology, 2012. **47**(2): p. 399-405.
50. Li, J., et al., *Novel approach for extraction of grape skin antioxidants by accelerated solvent extraction: Box–Behnken design optimization.* Journal of Food Science and Technology, 2019. **56**(11): p. 4879-4890.
51. Rajha, H.N., et al., *β-Cyclodextrin-Assisted Extraction of Polyphenols from Vine Shoot Cultivars.* Journal of Agricultural and Food Chemistry, 2015. **63**(13): p. 3387-3393.
52. Cho, Y.-J., et al., *Ultrasonication-assisted extraction of resveratrol from grapes.* Journal of Food Engineering, 2006. **77**(3): p. 725-730.