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Green Processing and Biotechnological Potential of Grapes Pomace

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Grape pomace is a high quality biodegradable residue of the winery industry. It is comprised of grape seed, skin and stalks, and is blessed with substantial quantities of phenols, flavonoids and anthocyanins with high antioxidant potential. Currently, there is huge emphasis on the isolation of bioactive molecules of grape pomace using green technologies such as microwave, ultrasound, supercritical fluids, high voltage discharge, enzymatic methods and other hybrid techniques. The major applications of these bioactives are contemplatedas nutraceuticals and extension in shelf-life of perishable foodstuffs. Alternatively, the crude form of grape pomace residues can be used for the production of energy, biofertilizers, biochar, biopolymers, composites, feed for ruminants and also, mushroom cultivation through microbial processing. This review discusses value-addition to grape pomace through biotechnological interventions and green processing, providing state-of-art knowledge on current scenario and opportunities for sustainability.

Introduction

Increase in food processing has massively contributed to increasing agro-industrial waste. Agro industrial waste is produced in all phases of cycle starting from agricultural production, industrial manufacturing, processing and distribution. Waste produced by household activities is approximately 42%, industrial waste produced is nearly 39%, and around 20% of waste is produced during distribution (Kumar et al., 2017). The production of waste is expected to increase up to 130 Mt by the end of 2020, if no prevention policy is deployed (Mirabella et al., 2014).Fortunately, these wastes constitute a rich source of essential bioactive compounds, and therefore, many developed countries are putting their intensive efforts to extract valuable components from them. This has led to a research drive which has turned wastes into useful resources. Wine industries are one of the food industries which producea substantial quantity of these residues around the world. Every year, millions of tons of residues are generated during wine making process by the wineries. Majority of the worldwide wineries are mostly small or medium sized and are insufficient to dispose waste and become a real burden on wine producers.

Grapes (*Vitis spp*) are one of the largest, most significant fruit crops, which have been cultivated for thousands of years and have been blessed by several ancient civilizations for their use in winemaking. Grapes have gained high economic production in grape juices, seed oil, raisins, vinegar, jams and jellies. With this, the total grape production worldwide in the year 2018–19 was 22.15 million metric tons (Shahbandeh, 2019).Out of 50 million tons production of grapes globally, the production from European countries corresponds to 27 million tons (Scoma et al., 2016) with leading wine producing countries being Italy, France and Spain. Taking this into consideration, around 75% of grapes are utilized in producing 27 billion litres of wine per year (Amienyo et al., 2014).From increasing consumption of wine in

recent years, the concomitant increase of grape pomace production has recently drawn attention. Grape pomace is a biodegradable solid byproduct of the wine making process, obtained after mechanical press or fermentation, encompassing peels (skin), seeds and some parts of the stem. Grape pomace is therefore, considered as an agro-industrial waste, representing about 25% (w/w) of the weight of grapes processed, and thus amounts to more than 9 million tons annually. There is an urge for waste reduction policy in order to achieve sustainable wine making process. Grape pomace consists of bioactive compounds such as phenols which have potential beneficial effects towards human health. These phenolics are secondary plant metabolites and possessantioxidant, antiviral, antimicrobial and anti-inflammatory properties which vary with the variety of grapes. Hence, grape pomace is also considered as a inexpensive source of phytochemicals that are further applied in animal feed, cosmetics, pharmaceuticals and food industries.

Extraction procedure of components from grape pomace is an essential step in order to achieve maximum yield of phenolic compounds. Many studies have reported green novel extraction techniques, their designing and optimization, and identification of the phenolics released from grape pomace. In general, for the extraction of bioactive compounds, the use of subcritical water (Zhang et al. 2020), high voltage electrical discharge, pulsed electric field, microwave and ultrasound assisted techniques are gaining popularity (Banožić et al. 2020).Some of the promising techniques for extraction of grape pomace bioactives include the use of ultrasound (Nayak et al. 2018), enzyme assisted techniques (Tomaz et al., 2018, Štambuk et al., 2016), cold plasma (Bao, 2020) and high pressure processes (Periera et al., 2019; Teles et al. 2020), among others. The domain of such investigations helps in limiting the waste generation from wineries and solving, to some extent, the waste management problems. This review summarizes the recent developments and availability of extraction technologies for characterization and extraction of polyphenols from different sources of grape pomace, its composition and diversified applications in different biotechnological fields so as to minimize the waste and enhance the valorization potential of this massive resource.

Production of grape pomace

Grapes are edible berries, cultivated worldwide for its fresh consumption or for pressed beverage, popularly known as “wine”. The journey of grape pomace starts right after harvesting when the grape juices are processed into wine. Stem of the grapes is removed as they contain anti-nutritional components such as tannins but sometimes, intentionally added during fermentation process depending on the required wine composition and sensorial attributes.

Composition of grape pomace

Grape pomace constitutes two different types of residues, namely seedless pomace (containing pulp, skin and stems) and pomace containing seeds. Seedless pomace recently gained much attention for being a rich source of phenolics, which are not extracted during the vinification process. They are well known for their antioxidant properties.

Green processing of grape pomace for bioactives

Wineries are responsible for environmental pollution as they dispose large amount of by-products directly in nature. The target for valorisation of these residues is not only limited to remediating the environmental problems but also to utlilize it as a source for functional ingredients. Valorisation of waste from wineries provides commercialization of phenolic extracts, dietary fibres and oil derived from grape pomace.

Biofuels

Rapidly grown demand for heat, electricity and cold created a burden on mother nature. This has created a need for a sustainable substitute which was supplemented by biodegradable waste fuels from agro-food sector. Contending climate changes seeks an alternative to low carbon sources of energy and fuel. One of the main sources of greenhouse gases is automobile traffic, therefore, there is an urge for substituting these fossils fuel with the renewable alternative biofuel.

Future research directions and perspectives

Grape pomace offers huge potential for its utilization employing green extraction processes for isolating value-added biomolecules and their further processing for food and other applications (Table 3), and through biotechnological innovation and exploitation for the production of microbial based products. The use of grape biomass is gaining popularity as a source of dietary fibre in food formulations and as an inexpensive bio-material for biodegradable food packaging.

Conclusion

Substantial quantity of grape pomace is produced globally but it does not find any suitable application. Its disposal in environment rather causes serious pollution concerns. In view of its rich organic nature, grape pomace could bepotentially utilized for the production of value-added commodities through green processing and biotechnological innovations. From the details given in this review, it could be concluded that supercritical extraction of grape pomace and also extraction using.