Wine

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Dietary habits are a determining factor of the higher incidence and prevalence of chronic non-communicable diseases (NCDs). In the aim to find a possible preventive and intervention strategy, the Mediterranean diet (MedDiet) has been proposed as an effective approach. Within the MedDiet, moderate wine consumption with meals is a positive item in the MedDiet score; however, recent studies have reported a dose-response association between alcohol consumption and higher risk of a large number of NCDs. This review aimed to evaluate the association between NCDs and wine consumption in the framework of the MedDiet, with a simple review of 22 studies of the highest-level literature published over the last five years. We found that the information regarding the effects of wine in different health outcomes has not varied widely over the past five years, finding inconclusive results among the studies evaluated. Most of the literature agrees that light to moderate wine intake seems to have beneficial effects to some extent in NCDs, such as hypertension, cancer, dyslipidemia and dementia, but no definitive recommendations can be made on a specific dose intake that can benefit most diseases.

Keywords: Mediterranean diet ; wine intake ; cardiovascular disease ; cancer ; dementia

1. Introduction

Wine matrix composition is complex and mainly constituted by water (86%), ethanol (8–15%), glycerol and polysaccharides or other trace elements (1%), different types of acids (0.5%), and a volatile fraction (0.5%)[1]. The wine matrix contains several hundred compounds that are found in very low concentrations, and they have been found to play an important role in the evolution and quality of wine, as well as in the protection against NCDs[2].

2. Wine Polyphenols

Among the minority compounds, wine contains a large variety of phenolic compounds (range from 2000 to 6000 mg/L in red wines), also called polyphenols, which are responsible for special organoleptic features of wine (color, flavor, smell)[3][2]. Currently, there is a great interest in the volatile fraction of wine as these compounds are closely related to beverage flavor[4]. These volatile organic compounds (VOC) include alcohols, esters, aldehydes, ketones, acids, terpenes, phenols, and sulfur compounds in a great variety of concentrations that are secondary metabolites produced in grape plants as a defense mechanism[5]. The perception of aroma and flavor are a result of a complex interaction between the volatile (which includes flavor and aroma compounds) and nonvolatile (ethanol, polyphenolic compounds, proteins, and carbohydrates) fractions in wine[5][6]. It is estimated that wine contains more than a thousand volatile compounds, whose concentrations range between mg/L to ng/L[6]. Wine flavor is obtained by varietal aroma, grape variety, pre-fermentative (during alcoholic and malolactic fermentations) and post-fermentative aroma (during conservation and aging of wine)[1][7]. Wine aroma is quantitatively produced by higher alcohols, acids and esters, which are important for the sensory properties as quality of wine, intrinsic factors that influence consumer acceptance[1][8]. While the higher amount of alcohol is directly associated with wine quality (higher amounts, less wine quality), the amount of esters (generally ≤100 mg/L) is associated with wine odor (higher amounts, strong odor)[1][9]. Wine oligosaccharides (complex carbohydrate molecules) have been associated with significant physicochemical properties beneficial to consumers' health. So, some oligosaccharides such as arabinoxylan-, fructo-, gluco-, galacto-, isomalto-, mannan-, xylo-, soyo-oligosaccharides and others can be fermented, exerting benefits on the intestinal microbiota (prebiotic effect)[10][11]. In addition, it has been suggested pectin-derived acidic oligosaccharides and arabinoxylooligosaccharides may have anti-cancer[12] and antioxidant effects[13][14]. Similarly, it has been suggested that polysaccharides could also have a significant antioxidant effect in wine[11]. In addition, some of these VOCs are sesquiterpenes and monoterpenes, which have been shown to have potential health benefits, such as decreased risk of chronic diseases. These compounds have been associated with anti-inflammatory, antioxidant, anti-carcinogenic and anti-bacterial properties[15][16][17][18], contributing to wine's health effects.

During the red winemaking process the contact with grape skins and seeds is longer, and therefore, red wines tend to have a higher polyphenol content (six-fold greater) than white wines. It is estimated that the polyphenolic compound content in red wine varies from 1800 to 3000 mg/L[19]. Polyphenols, especially flavonoids such as flavonols (quercetin and myricetin), flavanols (catechin and epicatechin) and ANC, and non-flavonoids, which include phenolic acids (hydroxybenzoic acids and hydroxycinnamic acids) and stilbenes (trans-resveratrol), have been related to beneficial effects on human health due to their protective properties, antioxidant activity and capacity to delete reactive oxygen species (ROS) caused by exercise, food metabolism and environmental factors, such as exposure to air pollutants. These free radicals can lead to aging, cardiovascular and neurodegenerative diseases and even cancer by the reduction of cell proliferation, which can be used for potential cancer therapy[20][2][19].

Even though the alcoholic fraction of wine (ethanol) has been associated with pro-oxidant effects, the phenolic content (polyphenols) seems to counteract the potential pro-oxidant effect of ethanol[21]. The antioxidant capacity of wines is only associated to its phenolic content or the action of a single phenolic compound but within the total polyphenol content (synergistic antioxidant effect)[2].

To date, the main biological effects attributed to phenolic acids (gallic acid or caffeic acid) are their antioxidant, anti-mutagenic, anti-proliferative and antimicrobial properties[20]. In addition, in vitro studies have reported vasodilator activity of phenolic acids[20][19]. However, Mudnic et al.[22] found a negative correlation between antioxidant activity and vasodilatory capacity after testing nine different phenolic acids. Moreover, caffeic acid has been associated with neuroprotective activity[23] and inhibition of peroxynitrite-induced neuronal injury, and ferulic acid is considered to have antidiabetic properties[24] because of its capacity to reduce blood glucose levels through increasing plasma insulin concentrations.

Flavonols (quercetin, mainly) found in red wine have an approximate concentration of 50 mg/L[25]. The beneficial effects of dietary flavonol on human health have been related to the inhibition of low-density lipoprotein cholesterol (LDL-C) oxidation and a reduction of oxidative stress through decreases in BP, which are primary risk factors for the development of atheroma plaque[19][26]. This flavonol is able to reduce oxidative stress through an upregulation of nitric oxide synthase (NOS) expression, as well as an activation and modulation of antioxidant mechanisms. In addition, quercetin has been associated with decreased inflammation, reduction of the expression of Toll-like receptors (TLR2 and TLR4) by the inhibition of nuclear factor kappa-B's (NF-κB) translocation to the nucleus. Quercetins can inhibit cell proliferation, which leads to an attenuation of the progression of cancer[2]. Besides their anti-hypertensive and anti-atherogenic effects, flavonols have been inversely related to aging, obesity and the occurrence of neurodegenerative diseases, CVD and several specific types of cancer such as breast, pancreatic, uterine, prostate or urinary tract cancer, among others[2][20][27][28][29][30][31].

It has also been demonstrated that ANC are beneficial to human health. Their concentration in red wine is approximately 500 mg/L[32]. ANC are strong antioxidants and have the capacity of inhibiting cancer cell growth, inflammation, neuro-inflammation and oxidative stress, as well as preventing obesity[33][34][35][36][37]. Finally, stilbenes are bioactive compounds with concentrations in red wine of approximately 20 mg/L [38]. The main function of stilbenes in plants is to protect them against pathogens and fungi, and therefore, they present a strong antifungal and antimicrobial capacity[39]. The most important stilbene is trans-resveratrol, as it presents multiple relevant pharmacological effects on health. These compounds (resveratrol, mainly) present anti-inflammatory, anti-oxidative and anti-aggregatory effects, as well as a high capacity for modulating lipoproteins and inhibit the initiation, promotion and progression of tumors. Therefore, their biological activity has frequently been related to atherosclerosis, cancer, CVD or neurodegenerative diseases (e.g., Alzheimer's disease)[19][40][41][42][43]. In addition, resveratrol is associated with a lower risk of coronary heart disease (CHD) and myocardial infarction[44], and several clinical studies and meta-analyses have found a significant reduction of systolic BP (SBP) with resveratrol intake. Therefore stilbenes might have an protective role against hypertension, as well as diabetes and diabetes-related complications[45][46][47][48][49].

There is noteworthy information suggesting that the potential benefits of wine intake on NCDs such as dyslipidemia, hypertension, MetS, CVD and T2DM, are dependent on the bioavailability of polyphenols[2]. Phenolic compounds' bioavailability can be affected by different factors such as environmental, dietary factors (fibers and fats that help or reduce absorption), possible interactions with others compounds of similar mechanisms of absorption. Moreover, thermal treatments, storage, cooking techniques, food matrix, chemical structure, amount of polyphenols in food could contribute to their bioavility. Therefore, others intrinsic factors such as age, gender and genetic differences, enzyme activity, transporters, intestinal microflora, health status, among others may influence[20][50][51]. So not all polyphenols are absorbed with equal efficacy, only between 5 to 10% of the total polyphenol intake may be directly absorbed in the small intestine[52][53].

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