

## Blueberries - Pleading for health

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### Abstract

Offering many health benefits, in addition to nutrition, blueberries are considered "super fruits". Major compounds, which promote health in vegetable foods, are polyphenolic compounds. Apart from the fact that they are potent antioxidants in vitro, more recently their health benefits have been discovered, but not related to the total antioxidant capacity. Cancer, diabetes and reduced incidence of cardiovascular disease are some of the benefits of blueberries. Due to the mechanical properties, which contribute to the epidemiological benefits, blueberries are beneficial for the management of inflammation, stimulation of xenobiotic and antioxidant metabolizing enzymes, as well as to increase the effects after the physical exercises. The main polyphenols in blueberries are anthocyanins. The consumption of blueberries beans would be beneficial for health, due to the content of this phytochemical group.

The aim of the scientific paper is to answer to the following questions: are *blueberries* really "superfood". *Might the consumption of berries be associated with an increased risk of contamination?* In addition, which is *the best form of consuming blueberries fresh or dry?* Having all the necessary satisfaction factors, blueberries play an important role because the current society, the health conscious one, focuses on the nutritional quality of the food, thus desiring good quality processed foods. Deeply rooted in terms of traditional use and popular knowledge about beneficial effects, blueberries remain a popular consumer product in their fresh form.

**Keywords:** bioactive components, anthocyan, polyphenols, antioxidants, pesticides

### 1.Introduction

Blueberries are the best dietary sources of health benefits due to their specific chemical and biological properties and major bioactive compounds, which contain anthocyanins, phenolic acids, ascorbic acid, flavonols, and tannins.

Blueberry is one of the most nutritious foods and cultivated worldwide. The global total output of blueberry was 629,720 tons in 2016; major distributors of the blueberry in the world are USA, Chile, Canada, Spain, China, Morocco, and 30 other countries [1]. In European Union (including UK) was produced 105,000 t in 2017, but the demand was of 165,000 tones. The difference was provided by Argentina/Uruguay, Africa, Chile, Peru etc [2, 3]. In terms of blueberry production, the first three countries are USA, Canada and Spain (based on FAOSTAT, 2017). FAOSTAT include Romania in

the first twenty countries with a recorded blueberry export of 1030 tonnes in 2017 [4].

Blueberry species of commercial importance include highbush blueberry (*Vaccinium corymbosum* L.), rabbiteye blueberry (*V. virgatum* Aiton), lowbush blueberry (*V. angustifolium* Aiton), and European bilberry (*V. myrtillus* L.). Blueberries are one of the richest sources of anthocyanins among common fruits [5, 6]. The bioactive components in blueberry include anthocyanins, polyphenols, and antioxidant properties [7].

Bioactive flavonoid compounds, anthocyanins, which have benefits against chronic diseases, are usually consumed in the form of foods from plant sources. Blueberries are popular fruits for their taste and richness of anthocyanins.

Due to the high amount of anthocyanins and other polyphenolics, they have been found to have excellent antioxidant properties [8, 9, 10]. Although some reports vary, showing lower or higher levels, Mazza and Miniati (1993) highlighted a range of between 25 and 495 mg / 100 g of anthocyanins present in rich blueberries. Anthocyanins also have beneficial effects such as antidiabetic, anticarcinogenic and antibacterial activities [11].

Containing a much wider range of anthocyanins than other types of berries, malvidin predominates in blueberries, with similar concentrations of delphinidine, cyanidin, petunidine and pelargonidine [12,13,14,15,16]. Arabinoids, glucosides and galactosides are glycosidic forms present in blueberries. With all the possible permutations, the relative proportions vary greatly, in some cultivation environments being completely absent [17, 18]. P-Coumaroyl and acetyl esters on C-6, coming from different sugar residues, are acylated anthocyanins, which are found in a considerable proportion in blueberries. The proportion of acylated species is variable between different crops, some differing with hardly detectable quantities [19, 20, 21, 22, 23, 24].

According to many studies, blueberry polyphenols and its fermented beverages can inhibit  $\alpha$ -amylase and  $\alpha$ -glucosidase of starch-degrading for type 2 diabetes management, however polyphenols can regulate the immune function which exists as a mediator role of epigenetic mechanisms [25, 26].

The polyphenols slow aging in organisms from worm and fly to rodent and human [27]. Rocha showed that some variety of blueberry presented 32.5% antioxidant activity in the fresh pulp, and the activity increased to 42.88% in the fruit extract [28]. The same author also, studied methods to transform both (pulp and extracts) to powder forms, and to increase the viability and to be easier to use as natural colorant in food industry [28, 29].

A large quantitative and qualitative variation of the phenolic content of the blueberries. According to several studies, this variation depends on intrinsic factors, species, cultivar and extrinsic conditions of cultivation, environment, handling and storage [30, 31]. In recent years, interest in phenolic compounds for food has increased. Together with commercial interests, the aim is to give more importance to these compounds, to add more value to food, and to provide more beneficial effects on health [32].

In their composition, blueberries have higher concentrations of phenolic compounds than other fruits [33, 34].

Moreover, the methods of extraction and quantification, as well as the complexity of the phenolic compounds, can affect the composition of the group [35]. Blueberries contain different amounts of other polyphenols. Chlorogenic acid is one of the major compounds, which is present at a high concentration [36]. Small amounts of quercetin glycosides are also present in blueberries [18]. Castrejón and al. showed a decrease of phenolic compounds, respectively of hydroxycinnamic acids and flavones, as well as of the antioxidant activity of the cultivation of *V. corymbosum* species, during maturation. From the initial phase, until the end of aging, the values of the phenolic content have varied from 60.76 to 33.00 ( $\text{mg}\cdot 100\text{g}^{-1}$  GAE) of dry weight [37].

Pests that threaten blueberry production include weeds, diseases and insects. For example, small blueberry farmers in Maine use organic or non-chemical methods to control pests, while conventional growers use a combination of cultural practices and chemical applications. The University of Maine has developed a good detailed Integrated Crop Management (ICM) and Integrated Pest Management Plan (IPM) specifically tailored for conventional growers [38]. BPC (The Maine Board of Pesticides Control) discovered that the blueberry industry used the following active ingredients as pesticides: Azinphos-methyl, Phosmet, Propiconazole, Sethoxydim, Glyphosate, Clethodim etc [40, 41]. When growers apply pesticides to blueberry fields, some may seep down through the soil and into groundwater stores. Pesticides then run the risk of underground springs [42, 43, 44, 45].

Cyprodinil, carbendazim, pyradostrobil and boscalid are some of the major pesticide residues found in blueberries. According to studies conducted by The Pesticide Data Program (PDP), pesticide residue may not be listed as carcinogenic, neurotoxic, hormone-disrupting or as a reproductive or developmental toxicant for either of two reasons: it may have been studied for toxicity in one or more of these categories and the weight of the evidence did not support designating it as toxic, or it may not have been studied [46].

The aim of the present paper is to offer answers to some very important questions, like: are blueberries superfood?, might the consumption of berries be associated with an increased risk of contamination?, which is the best form of consuming blueberries fresh or dry?

## 2. Materials and Methods

For the development of the present paper, we analyzed over 110 scientific papers and online resources (FAOSTAT, USDA databases) in the field of food chemistry, food production, horticulture, agriculture and medicine in order to conduct a concise literature review of health and nutritional benefits of blueberries.

## 3. Results and Discussions

### *Are blueberries “superfood”?*

Super foods are foods that are considered to be nutritionally rich and thus beneficial to the health of the consumer [47, 48, 49]. According to WBANA (Wild Blueberry Association of North America) research, blueberries are considered to be superfood, due to the high content of antioxidants [50]. So-called “superfoods” alone will not make you healthier – but adding these nutritious foods to an already balanced diet can bring health benefits [51]. The most important blueberry nutrients are shown in table 1.

According to a study, consuming a cup of blueberries a week would be beneficial for health because it can lower blood pressure, accelerate metabolism, due to the high content of anthocyanins [52]. Other studies suggest that blueberry consumption may lower LDL (bad cholesterol) levels, thus reducing the potential risk of coronary heart disease [53].

These fruits can also inhibit the growth of breast cancer cells [54]. Psychiatrists at the University of Cincinnati have found that wild blueberries improve memory and learning function, lowering the symptoms of depression and blood sugar levels [55]. Some researchers suggest that blueberries could deal with serious memory problems, such as Alzheimer's and Parkinson's, with larger studies being needed [56]. Although the latest research on this small food support the stated. Using a food frequency questionnaire, scientists have correlated higher flavonoid intake to wild berries [57].

### *Might the consumption of berries be associated with an increased risk of contamination?*

Cultivation systems, which may come from organic and conventional farms or spontaneous flora, significantly affect the quality of blueberries. Blueberries produced from organic culture contained significantly higher amounts of phytonutrients than those produced from conventional culture [30, 70]. Chemical and photochemical oxidation processes were tested on blueberries, in order to evaluate their ability to degrade residual phosphometry and to highlight their role in the conversion of toxic metabolic phosphate [71]. Interaction between phosmet and any chemical or photochemical treatment did not result in conversion to phosmet oxon [72]. Selective oxidation by ozone is a significant post-harvest process for degradation of residual phosphorus from blueberries with reduced effect [73].

### *Which is the best form of consuming blueberries fresh or dry?*

Between dried and fresh blueberries are nutritional differences. The only notable difference is the sugar content of blueberries [69]. Even if the consumption of frozen blueberries provide a high nutritional benefits, there still exist important nutritional advantages offered by the consumption of fresh blueberries. The six months frozen blueberries (temperatures between (0 -18 °C), were compared with the fresh version show that freezing did not damage the total antioxidant content of the fruits [74], but the composition of phytonutrients changed (in fresh blueberries the flavonoid content were 18-34%). Anthocyanins were the ones affected (approximately 59%). The only one that remained almost intact, during freezing is pelargonidine, and in contrast, dolphinin was severely affected [75].

The anthocyanins most likely reacted with other phenolic phytonutrients in the blueberries (resulting in the creation of new compounds) or were simply degraded through oxidation [76]. However, fresh blueberries may still be providing us with some key benefits that aren't as stable in frozen blueberries [77].

A relevant mechanism for anthocyanin pigment retention was achieved by polymerization with Fe<sup>3+</sup> complexation [78, 79, 80].

Slightly degraded by heat, covered with a layer of SA, during the entire processing, the anthocyanin pigments of the blueberries were preserved, not being observed any benefit combined by complexing with coating [80].

Raising knowledge about these small fruits could be essential for consumers, thus finding a cheap and good way to improve health and life [81]. In some research, Seeram et al. examined the properties of fruit extracts in inhibiting tumor cell proliferation at colon and breast level.

*Table 1.* Nutrients in blueberries (100g fresh product)

Name	Amount	References
Water	84.21 g	[58]
	84.2 ml	[59]
	85.8 %	[60]
Energy	57 kcal	[58]
Energy	240 kJ	[58]
Protein	0.74 g	[61]
	1.3 g	[62]
	1.8 g	[63]
Total lipid (fat)	0.33 g	[58, 64]
Ash	0.24 g	[58]
	1.457%	[60]
Carbohydrate, by difference	14.49 g	[65]
	25.42 g	[58]
Fiber, total dietary	2.4 g	[66]
	4.21g	[58]
Sugars	9.96 g	[57]
Sucrose	0.11 g	[58]
Glucose (dextrose)	4.88g	[57]
	32.3 g	[63]
Fructose	4.97g	[58]
	1.6 g	[68]
Starch	0.03 g	[67]
Calcium, Ca	6 mg	[58]
Iron, Fe	0.28 mg	[58]
	0.32 mg	[63]
Magnesium, Mg	6 mg	[67]
	19.1 mg	[63]
Phosphorus, P	12 mg	[63]
Potassium, K	77mg	[58]
	114mg	[67]
Sodium, Na	1 mg	[67]
Zinc, Zn	0.16 mg	[58]
	0.4 mg	[63]
Copper, Cu	0.057 mg	[58]
Manganese, Mn	0.336 mg	[49]
	19.1 mg	[58]
Selenium, Se	0.1 µg	[58]
Vitamin C, total ascorbic acid	9,7 mg	[58]
Thiamin	0.037mg	[58]
Riboflavin	0.041 mg	[58]
	1 mg	[63]
Niacin	0.418 mg	[67]
	1.5 mg	[58]
Pantothenic acid	0.124 mg	[58]
Vitamin B-6	0.052 mg	[62]
Folate, total	6 µg	[69]
Betaine	0.2mg	[58]
Vitamin A, IU	54 IU	[58]
Lutein + zeaxanthin	80 µg	[58, 62]

They concluded that the action is dose dependent and distinguished between several types of cells. In colon cancer cell cultures, the extracts stimulated apoptosis [82]. Other studies show a favorable impact of blueberry consumption on blood pressure [83]. Blueberries provide also two anti-inflammatory and antioxidant phytonutrients belonging to the group of stilbenoids [74,84,85]. Both, pterostilbene and resveratrol, show chemo protective and tumor suppressing properties. Preliminary studies have shown an ability of blueberry intake to improve nervous system responses, most likely by helping to protect nerve cells from oxidative damage [86]. In addition, it is well known that the combination of chronic low level inflammation and oxidative stress can increase the cancer initiation [87]. Many studies on several types of cancer cell lines have proved the capacity of blueberry extracts to inhibit cancer cell development and to induce apoptosis [88, 89].

#### 4. Conclusions

Blueberries are appreciated for their beneficial and nutritional effects on consumer health. However, information on the physiology behind the beneficial effects of these fruits is missing. There is little or no information on the characterization of growing conditions on anthocyanins in blueberries. Research is missing behind on advanced methods of extracting blueberry anthocyanins.

The important health-beneficial effects associated with blueberry anthocyanins, properties of these anthocyanins leading to the beneficial effects, and food processing parameters leading to the depletion of the amounts of anthocyanins present in the final processed products are also summarily discussed.

There is not enough research to show the negative effects due to the excessive consumption of blueberries, even though this fruit has a high content of antioxidants, anthocyanins, polyphenols and is recommended as one of the products with multiple effects on the health of the consumer: they have an obesity exemption, diabetes, retinal lesions, heart, liver, hepato protective, tumors, microbial infection, cognitive decline and bone loss.

The study of the composition of anthocyanins from blueberries gives us a greater perspective for improving the fruit processing methods and the analytical methods applied.

They sell the necessary satisfaction factors, the blueberries, called "super fruits", play an important role because the health conscious society focuses all its attention on the nutritional quality of the food.

Agricultural and food processing wastes from the blueberry industry are a potential source of anthocyanins. It can be a source of extra income for farmers and processing industries. This fruit has relieved as a beneficial food, as well as a super-food.

**Compliance with Ethics Requirements.** Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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