

Gavrilă, Viorica

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Berries: Benefits for human health and the circular economy

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BERRIES - BENEFITS FOR HUMAN HEALTH AND THE CIRCULAR ECONOMY

Viorica GAVRILĂ

Institute of Agricultural Economics, Bucharest

Corresponding author e-mail: vio.gavrila@yahoo.com

Abstract: *The aim of this paper is to explore the evolution of the market for berries and their benefits, both fresh and processed. The market for fresh berries is reserved for high quality berries and is growing. For the other qualities there is a whole food industry producing valuable products. The recovery of valuable compounds from the by-products of the juice industry (tescovine) contains phytochemicals important for human health. This process leads to a chain closure of the food industry's secondary chains, specific to the circular bio-economy.*

Keywords: berries, market, valorisation

JEL classification: Q 11, Q 12.

INTRODUCTION

Bilberry (*Vaccinium myrtillus*) is a fruit-bearing shrub, mainly found in mountainous areas. Its fruits contain antibacterial, antiseptic substances and are a natural equivalent of insulin. The fruits contain many minerals and vitamins. and retain their qualities even frozen.

Raspberry (*Rubus idaeus*) is a shrub that grows wild in temperate countries. The fruits have a specific flavor, are rich in organic acids, vitamins, carotene, copper, iron, iron, potassium, magnesium and phosphorus.

The blueberry was first cultivated in North America in 1890, and in Europe since 1930. In Romania, the first cultivation was established in 1968 at the Bîlcești Argeș research base (Nicolae Tănăsescu, 2005). It makes good use of acid soils with a pH between 4.2 and 4.8.

The UN has declared blueberries one of the five healthiest foods for humans. For the industry, researchers are focusing on minimizing the negative consequences of processing conditions.

Thermally, raspberries have moderate requirements but are water-demanding. It needs humus-rich, permeable soil with a pH between 5.6 and 6.5.

MATERIAL AND METHOD

Relevant literature on the crop's agro-technical characteristics was consulted. A literature searches specific to processed products was carried out using PubMed, Google Scholar databases. Various relevant reports and journal websites were also consulted.

RESULTS AND DISCUSSIONS

Blueberries can still be productive 30 years after planting. One blueberry plant can produce up to 8 kg of fruit at maturity if well maintained. In the last 6 years, production is estimated to have increased by 172% in Europe (Table 1).

Table 1. Evolution of supply of blueberries grown in Europe, thousand tons

	2015	2016	2017	2018	2019	2020	2021	2021/2015
Europe*	61,1	66,92	86,48	106,32	133,98	154,58	166,25	172%
Spain	21,06	24,95	35,36	43,52	53,38	48,52	61,23	191%
Poland	14,10	14,72	16,34	25,30	34,77	54,10	55,40	293%
Portugal	4,44	6,57	9,84	11,06	15,16	15,42	17,14	286%
Germany	11,95	10,71	13,81	12,76	14,85	11,30	15,64	31%
Netherlands	7,37	7,70	8,30	9,30	11,06	9,20	8,50	15%

Source: Eurostat, (* including estimations)

In 2021 world cranberry production was 1,113,261 tons.

Table 2. World blueberry production, tons-2021

	Blueberry production - tons	% of total
SUA	351.130	32%
Peru	227.971	20%
Canada	146.551	13%
Chile	122.795	11%
Mexic	66.482	6%
Spania	61.230	6%
Total lume	1.113.261	100%

Source: FAOSTAT

In 2021 world raspberry production was 887 thousand tons. Worldwide there are four major producers, which account for more than 64% of production (Table 3)

Table 3. World raspberry production, thousand tons-2021

	Raspberry production - tons	% of total
Rusia	198	22%
Mexic	166	19%
Polonia	104	12%
SUA	101	11%
Total lume	887	100%

Source: FAOSTAT

The global blueberry market is expected to grow at a considerable pace during 2023-2030. Health-conscious customers prefer foods containing blueberries. Health food products, for example yogurt, are preferred as they are lower in fat and lower in calories and are also a rich source of protein and calcium. The upward market trend is also driven by growing demand for fruit-based drinks.

In our country there is no statistical data on blueberry production, the information being taken from various sources on the internet. It is estimated that over 2000 hectares are cultivated in Romania. Romanian blueberry growers do not manage to sell through the big stores, only through agri-food markets or to various intermediaries. To be exported, the blueberries must

meet certain conditions: 14-22 mm, they are harvested in suspended crates and stored in cold rooms.

According to ZF Romania exported in 2020 almost 7000 tons of berries worth €25 million, the amount of blueberries being 2000 tons. We have chosen, as an example, two producers of cultivated blueberries in Braşov county.

AGROINTENS S.A. - BRAŞOV COUNTY

- owns two farms, 60 ha, 22 employees;
- is GAP (GLOBALGAP) certified, an internationally accepted and retailer recognized standard for primary production covering the entire production process up to the departure of the product from the plantation and from there to the processing facilities and from there to the final consumer;
- packaging capacities (125g to 2,5 kg);
- has fresh fruit storage capacity;
- cooperates with major companies that ensure optimal transportation of fresh blueberries.

Table 3. Economic data of AGROINTENS S.A. company

Year	Turnover	Net profit	Debts
2022	11.143.742	0	12.700.980
2021	8.078.048	0	8.314.937
2020	8.215.102	0	9.344.903

Source: termene.ro

AFIN LUCRI SRL – BRAŞOV COUNTY

- works under the VALEA CU AFINE brand, currently distributed through METRO
- is GAP certified
- production, packaging and marketing
- processing and packaging
- logistics services related to the affine trade
- advice and support in setting up and developing a plantation, marketing fresh fruit

Table 4. Economic data of AFIN LUCRI SRL company

Year	Turnover	Net profit	Debts
2022	544.114	196.821	897.555
2021	401.225	13.268	990.639
2020	412.443	124.461	723.335

Source: termene.ro

Table 5. The price paid by the consumer when buying online from the manufacturer and the trader

Product	Price/UM online trade directly from the manufacturer including transportation (29,99 lei)	Price/UM at retailer including transportation (10 lei)	Conclusion
Organic dried blueberries - 100 g	52,49	32,5	Disadvantage buying from the producer
Organic cranberry juice - 350 ml	23,33	29,00	Disadvantage buying from the producer

Source: www.merryberry.ro; www.comenzi.farmaciatei.ro

There are other companies that capitalize on the fruits of wild flora. Biodac is a company from Timisoara specialized in the production and marketing of jams and jams, etc. It offers pasteurized products without preservatives, for example blueberry jam 340g at a price of 25 lei/jar (Table 6).

Table 6. Economic data of AFIN LUCRI SRL company

Year	Turnover	Net Profit	Debts
2022	23.791	0	83.799
2021	51.798	3.230	90.493
2020	26.378	0	97.875

Source: termene.ro

The content of antioxidants, vitamins and other elements is particularly important.

A study carried out in Poland using samples from wild flora and samples from cultivated blueberries determined the concentration of 13 elements. Higher levels of Ca, Na and Mg were observed in fruit picked from the forest. Similar levels of Cu, Cr, Fe and Ni were detected in both wild and cultivated plants. The significantly higher Fe and Cd content in cultivated blueberries was related to the metal content of soil samples collected from the same sites.

**Table 7. Element content of different cranberry samples mg/kg (mean+ SD, n=3)
(W-wild, C-grown)**

	Al		Ca		Cd		Cr		Cu	
W1	14,8	± 0,55a	185	± 9,7a	0,004	± 0,0003a	0,039	± 0,002a	0,31	± 0,017a
W2	12,4	± 0,60b	164	± 7,9b	0,002	± 0,0001b	0,174	± 0,008b	0,26	± 0,012b
W3	15,1	± 0,67a	203	± 8,9ac	0,001	± 0,0005c	0,023	± 0,001c	0,24	± 0,013b
W4	16,3	± 0,73a	192	± 8,7ac	0,003	± 0,0001d	0,084	± 0,004d	0,41	± 0,016d
C1	13,3	± 0,91	112	± 5,1d	0,013	± 0,0006e	0,033	± 0,006e	0,28	± 0,011abce
C2	17,9	± 0,8	162	± 6,1b	0,04	± 0,0015f	0,014	± 0,001e	0,32	± 0,014ac
	Fe		K		Mg		Mn			
W1	8,38	± 0,33a	880	± 27a	84,2	± 6,92a	17,1	± 1,03a	W- sãlbatic C- cultivat	
W2	7,82	± 0,39a	1036	± 51b	75,1	± 3,09a	5,82	± 0,16b		
W3	5,31	± 0,25b	1090	± 52b	96,9	± 2,11b	29	± 1,35c		
W4	12,7	± 0,64c	1105	± 53b	90,1	± 3,42b	18,5	± 0,88a		
C1	5,44	± 0,27d	825	± 15a	51,4	± 2,60c	4,47	± 0,03d		
C2	10,7	± 0,52d	1031	± 28b	48,1	± 2,07c	2,94	± 0,015e		
	Na		Ni		Pb		Zn			
W1	52,7	± 1,93a	0,26	± 0,019e	0,556	± 0,063a	6,07	± 0,75a		
W2	54,0	± 1,78a	0,25	± 0,012e	0,373	± 0,018b	5,26	± 0,26ab		
W3	54,9	± 2,03a	0,25	± 0,011e	0,266	± 0,013b	4,22	± 0,17bcd		
W4	61,6	± 2,97b	0,31	± 0,015t	0,396	± 0,018ab	3,83	± 0,15c		
C1	48,1	± 2,12c	0,17	± 0,008e	0,276	± 0,014b	2,95	± 0,15ce		
C2	49,2	± 2,63c	0,3	± 0,015e	0,315	± 0,015b	3,79	± 0,15ce		

Source: Paulina Drozd et al, 2018

Colour is one of the major attributes affecting consumer perception. A study on the influence of light as a function of anthocyanin concentration in blueberry fruit shows the properties of natural nontoxic colorant extracted from fresh blueberry (*Vaccinium Myrtillus*) fruit under the influence of different types of light (Table 8). The colours were measured in CIELAB system using a standard white. The samples differed in dye concentration (M. Pop et al, 2010)

Table 8. Anthocyanin content in the analysed samples of blueberries

	A1	A2	A3	A4	A5
Anthocyanin content (mg/mL)10 ⁻³	0,86	1,23	1,65	2,36	4,78

Source; M. Pop et al, 2010

The authors concluded that the brightness is quite independent of the nature of the standard light source (D65 daylight simulator, colour temperature approx. 6500 K). The standard light F2 (cold white fluorescent simulator) and A (incandescent bulb simulator, colour temperature approx. 2856 K) cause small colour shifts that shift slightly towards yellow and red respectively (M. Pop et al, 2010).

The scientific community is exploring new ways to capitalize on blueberries. For example, the potential health benefits of fermented blueberry are being explored. A review of the current scientific evidence presents a thorough understanding of cranberry polyphenols and the role of fermentation in increasing their bioavailability, with further studies expected to provide a much clearer perspective on fermentation as a value-add (Nilushni Sivapragasam, 2023).

Another study evaluated the bioavailability of phenolic substances and plasma antioxidant capacity in vivo after consumption of blueberries with and without whole milk. The results show that the ingestion of blueberries in combination with milk affects the in vivo antioxidant properties of blueberries and reduces the absorption of caffeic acid, (Mauro Serafini et al., 2008).

The role of fibres in digestion is well known. It is important to note that insoluble fibres are usually better for preventing constipation because they do not ferment in the intestines. Soluble fibres ferment in the stomach producing bloating and gas (Anna-Marja Aura et al., 2015). Tescovin from the cranberry and raspberry juice industry is a valuable by-product, rich in polyphenols, dietary fibres, vitamins, minerals and unsaturated fatty acids. In a study on healthy women, 30% of gluten-free flour used in cakes was replaced with dried and ground blueberry and raspberry tescovin. It was observed significant changes in the composition of serum phospholipids of fatty acids, decrease of LDL cholesterol level (20,16%,) increase of adiponectin level (25,52%) and decrease of ALT and AST - liver enzymes (Popovic T et al. 2022). In a randomized study, 59 overweight or abdominal obese subjects with mild hyperinsulinemia or hypertriglyceridemia consumed daily 280g/day of frozen raspberries with maintenance of usual diet for 8 weeks. Several functional pathways were enriched following dietary supplementation with raspberries, a major part of which were involved in the regulation of cytotoxicity, cell trafficking, protein signal transduction and interleukin production; 10 serum metabolites were significantly altered. The study demonstrated that a raspberry-rich diet positively impacts immunity and phospholipid metabolism (Maxillien Franck et al, 2020).

In vitro and in vivo studies have revealed different mechanisms by which anthocyanins and elegitannins from red raspberries and red raspberry extract might reduce the risk of developing or reverse metabolically associated pathophysiological pathophysologies (Burton-Freeman et al, 2016).

Treatment with cranberry phenolic extract has also been shown to ameliorate genetic and diet-induced metabolic syndromes (Guo J. Han et al, 2019), and in vitro studies have shown the ability of cranberry extract to inhibit the growth and decrease of cell adhesion and migration of various cancer cell lines in vitro (Lamdan H, et al 2020). Biological properties of cranberry include neuroprotective effects through antioxidant and anti-inflammatory actions; cranberry extract has antidepressant-like effects (Luiza Spohr et al, 2022)

Table 9. Changes in blueberry fruit quality in terms of selected bioactive compounds and quality properties depending on a pretreatment and processing method

Pre-Treatment Method		Influence on the Product Quality	Reference
Storage	Modified atmosphere	Total phenolics (↑)	[74]
		Antioxidant capacity (–)	[8]
		Vitamin C (–)	[76]
Thermal	Freezing	Total phenolics (↑)	[71]
		Total anthocyanins (–)	[69]
		Delphinidin glucoside (↑)	[77]
	Blanching	Total anthocyanins (↑)	[83–85]
		Total anthocyanins (–)	[36,69]
		Antioxidant capacity by ORAC (↓)	[36,69]
Mechanical	Cutting (halves/quarters)		
	Scarification		
	Abrasive skin removal	Total phenolics (↓)	[86]
Vitamin C (↓)		[46]	
Chemical	Chemical substances	Organoleptic properties (↓)	[87]
	Natural substances	Total phenolics (–)	[88,89]
		Total anthocyanins (–)	[88,89]
		Antioxidant capacity (–)	[88,89]
Processing Methods		Influence on the Product Quality	Reference
Juicing		Total monomeric anthocyanins (↓)	[69,70]
Dehydration	Osmotic dehydration	Total phenolics (↓)	[8,90]
		Total anthocyanins (↓)	[90]
		Vitamins A, C and niacin (↑) ***	[11]
	Freeze-drying	Polyphenols (ellagic acids, quercetin, naringin, kaempferol) (↑) ***	[11]
		Antioxidant capacity (↑) ***	[11]
		Total phenolics (↓) ***	[11]
	Hot air drying	Total anthocyanins (↓) ***	[11]
		Antioxidant capacity (↓) ***	[11]
		Total phenolics (↓)	[91]
	Fluidized bed drying	Total anthocyanins (↓)	[91]
		Total monomeric anthocyanins (↑)	[92]
	Vacuum drying	Volatile compounds (↑) **	[93]
		Total phenolics (↑) **	[93]
		Total anthocyanins (↑) **	[93]
	Radiant zone drying	Total phenolics (–) ***	[94]
Total anthocyanins (–) ***		[94]	
13 Identified anthocyanins (–) ***		[94]	

Source: Anna Michalska - Ciechanowska, Grzegorz P. Lysiak, 2015

Researchers' attention has been extended to improving the nutritional aspects and, at the same time, to mitigating the negative consequences of processing conditions. Some results are contradictory, with the authors concluding that a thorough analysis at the molecular level of the blueberry components is needed.

CONCLUSIONS

Researchers' attention on blueberries and raspberries has been directed towards improving the nutritional aspects and at the same time, minimizing the negative consequences of processing conditions. Regarding the changes undergone by processing some results are contradictory, the authors conclude that a thorough analysis at the molecular level of the blueberry components is needed.

Tescovin from the cranberry and raspberry juice industry is a valuable by-product, rich in polyphenols, dietary fiber, vitamins, minerals and unsaturated fatty acids. Being a product rich in insoluble fibers, they close the production cycle through their use in food.

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