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Wild raspberries from Republic of North Macedonia as a valuable source for healing vinegars

Sanja Kostadinović Veličkovska^{1,*}, Daniela Todevska¹, Fidanka Ilieva¹, Maja Čočevska², Elizabeta Jančovska Seničeva³, Biljana Bauer⁴

¹University “Goce Delčev”, Faculty of Agriculture, Krste Misirkov bb, 2000 Štip, Republic of North Macedonia

²University “Goce Delčev”, Faculty of Medical Sciences, Krste Misirkov bb, 2000 Štip, Republic of North Macedonia

³Food and Veterinary Agency, III Makedonska brigada No 20, 1000 Skopje, Republic of North Macedonia

⁴Institute of Pharmacognosy, Faculty of Pharmacy, SS. Cyril and Methodius University, Majka Tereza 47, 1000 Skopje, , Republic of North Macedonia

*Corresponding author: Sanja Kostadinović Veličkovska

Introduction

Fruit vinegars in our country and around the world occupy a special place in the trend of healthy eating. They have pleasant flavors, attractive colors and aromas, and contain a number of nutrients that have passed into them during the processing of fruit into vinegar, which is why today they are one of the most commonly consumed products in everyday and dietary nutrition. Their characteristic properties are responsible for the range of health benefits they possess and are considered to contribute to the prevention of various diseases. The production of vinegar at home is carried out according to traditional procedures in small quantities. However, it is considered that the resulting vinegar is of better quality compared to white industrial vinegar obtained synthetically and commercial fruit vinegars, because in its production, which is a spontaneous process, no additional ingredients are used except for the basic raw material, fruit pulp or concentrated natural fruit juice. Another advantage of fruit vinegars obtained by traditional procedures is that they can be produced from organically grown fruit, which ensures a special quality and healthy product. Worldwide research has shown that vinegars derived from natural fruit juice or other fermentable raw materials are abundant in quality nutritional ingredients [1]. The main object of this study was production of high-quality raspberry vinegars with spontaneous fermentation and without addition of any starter cultures. The quality of the produced vinegar was examined by determining physicochemical parameters (pH, dry matter, total acids and alcohol) as well as determining total polyphenols, anthocyanins and antioxidant activity determined by DPPH radical (expressed as ascorbic acid equivalent).

Materials and methods

Harvesting and selection of plant material

Home-made raspberry vinegar (*Rubus idaeus*), produced by spontaneous fermentation was investigated. The raspberries were collected from the region of Berovo, the east region of North Macedonia, during the harvesting season (August, September and October, 2024). All samples were kept in closed sterile bottles at –18 °C. Before the analysis, the samples were kept at room temperature, centrifuged and filtered.

Production of vinegar from wild raspberries by spontaneous fermentation

The vinegar from wild raspberry was produced by spontaneous fermentation in glass barrels with a total volume of 5 to 6 liters. The fermentation process was conducted at room temperature at 21 - 26 °C for a time period of 41 days, excluding the starter cultures and yeasts for fast fermentation. Spontaneous fermentation includes alcoholic fermentation for 24 days and spontaneous acetic fermentation, where acetic acid bacteria produce acetic acid, at dark, from 24th till 41st day. Once the acetic fermentation was completed, the vinegars were filtered, pasteurized for the period of 20 min. at 72 °C, and transferred to airtight containers to reduce the risk of spoilage.



Results and discussion

The aroma of wild raspberries is more pronounced than some cultivated raspberry species. This is due to the presence of the acid 3-methyl-3-butanoic acid, which is present only in wild raspberry varieties. Minerals are important cofactors for enzyme activity, for the regulation of alkalinity in cells and outside the cells, stimulate the formation of blood cells, regulate blood pressure and prevent atherosclerosis and manifest a number of other important physiological functions. The berry fruit accordingly has a red, pink-violet, purple, and violet-blue color, which is due to the presence of anthocyanins. The main anthocyanins in blueberries are: delphinidin 3-glucoside, delphinidin-3-galactoside, cyanidin-3-glucoside, cyanidin-3-galactoside, petunidin-3-glucoside, pelargonidin-3-rutinoside, malvidin-3-glucoside, malvidin-3-galactoside, in blackberries they are cyanidin-3-glucoside and cyanidin-3-xyloside, in raspberries they are cyanidin-3-glucoside and cyanidin-3-rutinoside. Different types of anthocyanins are present in fruit, in different quantities: in apples from 0-60 mg/100g fresh fruit, in blueberries from 300-698 mg/100g fresh mass, in blackberries from 82.5-325.9 mg/100g fresh fruit, in raspberries from 20-687 mg/100g.

Table 1. Nutritional composition of raspberries

Composition		Vitamins (mg/100g)	Minerals (mg/100g)		
Dry matters (%)	7-11	Vitamin C	20	Ca	40
Carbohydrates (%)	8,8	Thiamin B1	0,02	Mg	22
Sugars (%)	3,5-5,5	Riboflavin B2	0,04	P	15
Sucrose (%)	0,7-3,0	Niacin B3	0,5	K	224
Total acids (%)	0,9-1,8	Vitamin A(IE)	90	Na	10
pH	3,0-3,7				
Proteins (g/100g)	0,7				
Lipids(g)	0,1				

Table 2. Chemical composition of raspberry pulp

Fruit pulp	Soluble dry matter (g/100 mL)	Total acids (g/100 mL)	pH	Total sugars (g/100 mL)	Total phenolic compounds (mg/mL)
Raspberries	9,2±0,1	1,17±0,04	3,01	7,82±0,1	1,721 ±0,49

Raspberry vinegar produced from spontaneous fermentation (without starter cultures)	
Dry matter (%)	3.0 ± 0.7
pH	2.9 ± 0.1
Total acids (g/L)	9.0 ± 0.8
Ethanol (% v/v)	4.24 ± 0.08
Total polyphenols	459.28 ± 15.28
Total anthocyanins	399.21±21.31
Antioxidant activity determined by DPPH radical (as equivalent of ascorbic acid mg/L)	0.49 ± 0.09

Table 3. Chemical composition of vinegar of wild raspberry produced from spontaneous fermentation (without starter cultures)

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