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EVALUATION OF JAM AND SYRUP PROCESSING POTENTIAL OF THREE SUMMER-BEARING RASPBERRY CULTIVARS

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ABSTRACT

The development of value-added products represents a strategic approach to increasing the profitability and sustainability of small fruit production. This study aimed to evaluate the jam and syrup processing potential of three summer-bearing raspberry (Rubus idaeus L.) cultivars. Fruits from each cultivar were subjected to standardized processing protocols, and the resulting products were analyzed for physicochemical properties (soluble solids, titratable acidity, and vitamin C). Significant differences among cultivars and processing methods were observed, particularly in titratable acidity, soluble solids and total sugars, suggesting that cultivar selection plays a decisive role in determining product quality and market suitability. Overall, the findings highlight the importance of cultivar choice in optimizing raspberry-derived jam and syrup production, exhibiting variable total sugar contents between cultivars (syrup: 'Canby'-84,4 g/L; jam: 'Willamette' 55.67 %).

INTRODUCTION

Berries play an important role in human nutrition and food industries due to their distinctive color, characteristic flavor and aroma, high vitamin and mineral content, as well as their extensive applications in food processing. Moreover, they are able to grow under extreme environmental conditions where most other fruit species cannot thrive (This et al., 2007). Among their sensory attributes, color is particularly significant, as it strongly influences consumer perception and acceptability. Indeed, color is considered the most important intrinsic sensory cue, shaping consumer expectations of the foods they are about to consume (Spence, 2015).

Red raspberry (*Rubus idaeus* L.), a perennial shrub belonging to the Rosaceae family and classified as a nanophanerophyte, is highly valued by consumers due to its intense flavor, appealing appearance, and well-documented health benefits (Titirica et al., 2023; Wróblewska et al., 2020). Its sensory profile is characterized by a distinctive sweet–tart taste, largely determined by ripening stage, cultivar, and the balance of simple sugars, organic acids, and volatile compounds. For optimal consumer acceptance, raspberries should be fresh, juicy, and of high quality (Quintanilla et al., 2022). Nutritionally, raspberries are rich in bioactive compounds and essential micronutrients. Their chemical composition typically

includes 4.5–10.6 g% sugars, 1.1–2.3 g% organic acids, 0.5–2.8 g% pectins, 1.2 g% proteins, and 0.6 g% ash. Mineral contents include 127 mg% potassium, 45 mg% phosphorus, 27.3 mg% calcium, 24 mg% magnesium, 15 mg% manganese, 3.9 mg% sodium, 3 mg% zinc, 1 mg% copper, and 0.6 mg% iron. Vitamin content is also notable, comprising approximately 25 mg% ascorbic acid, trace amounts of vitamin B1 (0.002 mg%), vitamin B2 (0.03 mg%), provitamin A, and vitamins D and P. Additionally, raspberries contain tannins, natural pigments, and other bioactive compounds (Mladin & Mladin, 1992).

Traditionally, raspberry harvests have been primarily consumed fresh or processed into frozen fruit, jams, preserves, juices, and flavoring agents for products such as ice cream and yogurt. In recent years, however, the fresh fruit sector has expanded significantly, becoming a critical component of the raspberry industry. This shift reflects both growing consumer demand and the highly perishable nature of raspberries, which necessitates rapid consumption or processing.

MATERIAL AND METHODS

To carry out this research, three summer-bearing raspberry cultivars were selected and used, namely, 'Canby', 'Willamette' and 'Tulameen' as presented in Table 1. The fruits used in this experiment were harvested from a private plantation located in Aghireșu-Fabrici (46°52′00″N 23°16′12″E), Cluj County.

Table 1

Main characteristics of the three raspberry cultivars selected for this study

'Canby'	Origin: USA
	Plant characteristics: Nearly thornless, with large, flavorful, red berries. Its vigorous canes are capable of sustaining a heavy summer yield. The fruits are suitable for fresh consumption as well as for processing.
'Willamette'	Origin: USA
	Plant characteristics: A traditional, self-fertile floricane cultivar that consistently produces firm, medium-sized, dark red berries maturing in midsummer. The fruit has a slightly tart, juicy flavor, suitable for jams, jellies, sauces, and baking.
'Tulameen'	Origin: Canada
	Plant characteristics: An outstanding mid-season raspberry cultivar, grown for its overall performance. It produces consistently high yields of large, flavorful berries in abundance on resilient canes, which adapt well to a wide range of soil types and climatic conditions.

All the analyses and conservation methods (jam and syrup) were carried out in the laboratories of Fruit growing and Horticultural Products' Technology within the

Faculty of Horticulture and Business in Rural development, at the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca.

Determinations made primarily concerned those parameters which can help in recommending a variety for production and processing. Fruit quality measurements (physical and chemical properties) were carried out on 30 fruits/cultivar in three repetitions, in laboratory conditions. The physical and yield parameters of fruits including fruit height, fruit diameter, fruit weight, were determined by using a digital caliper and an electronic scale while yield parameters were determined as yield per linear meter and yield/ha. Soluble solid content, titratable acidity and vitamin C were determined through refractometry, by titration with 0.1 N NaOH solution in the presence of phenolphthalein as an indicator and iodometric method (Rózsa et al. 2021).

To obtain the jam and syrup the following procedures were applied:

Jam preparation: The fruits were washed thoroughly with tap water and the pulp of 1 kg fresh raspberries grinded was used for jam making. After 3 hours of rest in the refrigerator, the mixture was filtered to remove the seeds. The fruit pulp was then placed in an open pan. In addition to the fruits, 100 ml of water, 300 g of sugar and 30 ml of lemon juice were also added for conservation. The jam was than heated and boil on an electric hot plate on medium heat until consistency test. The jam was the dispensed into 250 ml sterile glass jars. Figure 1 describes the jam-making process, step by step. The total soluble solids were determined by using a portable refractometer model RT-82 and the °Brix were measured at ±25 °C.

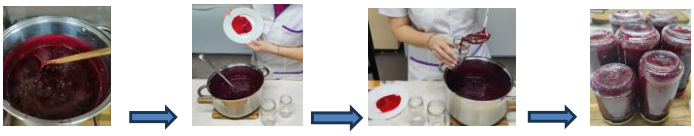


Figure 1. Steps followed for jam preparation

Syrup preparation: The fruits were washed thoroughly with tap water and the pulp of 1 kg fresh raspberries grinded was used for syrup preparation. After 3 hours of rest in the refrigerator, the mixture was drained using a fine mesh strainer to remove the seeds and obtain as much liquid as possible. The resulting juice were transferred into a saucepan. In addition to the juice 150 ml of water, 300 g of sugar and 30 ml of lemon juice were added. To dissolve sugar, the mixture was stirred occasionally for 10 minutes. After the sugar was dissolved the syrup was poured in glass bottles and double-sterilized. Figure 2 shows the steps used in syrup preparation.

Figure 2. Steps followed for syrup preparation

RESULTS AND DISCUSSIONS

The results of fruit physical and yield parameters are presented in Table 2. The results show that the highest fruits were recorded in ‘Tulameen’ cultivar with an average height of 23.09 mm followed by ‘Canby’ (20.14 mm) and ‘Willamette’ (18.14 mm). Fruit diameter followed the same pattern as fruit height, the highest value being

recorded in ‘Tulameen’ cultivar with an average diameter of 17.64 mm, followed by ‘Canby’ (15.23 mm) and ‘Canby’ (20.14 mm). Regarding fruit weight, ‘Tulameen’ cultivar had the heaviest fruits with an average fruit weight of 4.62 g, followed by ‘Canby’ (3.67 g). The lowest average fruit weight was observed in ‘Willamette’ ultivar (3.56 g). Similar values for physical fruits traits were also reported by Yu et al. (2022). The total yield/ha was also monitored in this research and the results revealed that ‘Willamette’ had the highest yielding potential with the highest average yield of 8.62 t/ha followed by ‘Tulameen’ (7.63 t/ha) and ‘Canby (6.42 t/ha).

Table 2

Physical fruit traits and yield parameters

Cultivar	Fruit height (mm)	Fruit diameter (mm)	Fruit weight (g)	Yield per 5 linear meters		Yield/ha (kg/ha)
				kg/lm	(kg/plant)	
‘Canby’	20.14	15.23	3.67	11.54	0.86	6.42
‘Wilamette’	18.14	13.49	3.56	15.82	1.09	8.62
‘Tulameen’	23.09	17.64	4.62	13.76	1.36	7.63

It is well established that numerous factors influence the physical and chemical attributes of fruits — including average fruit weight, soluble solids content (SSC), titratable acidity, vitamin C, and sugars. These factors include cultivar/genotype, environmental conditions (temperature, light, altitude), ripening stage, rainfall, and cultivation practices such as fertilization, irrigation, and plant protection (Durán-Soria et al., 2021; Dhatwalia et al., 2024). For example, Titirică et al. (2023) reported significant variations among 24 raspberry genotypes in terms of dry matter (10.0–12.7 %), reducing sugars, pectin, and acidity, emphasizing the strong influence of growing environment (soil, light, temperature). Similarly, studies analyzing the effect of altitude have shown that SSC tends to increase with elevation, likely due to higher light intensity and diurnal temperature variations (Dhatwalia et al., 2024), while excessively high temperatures may reduce fruit size and overall quality (Aguilar et al., 2025).

Table 3 presents the chemical properties of raspberry fruits under study. The highest soluble solids content (SSC) was recorded in cultivar ‘Willamette’ (12.2 %), followed by ‘Tulameen’ (11.6 %). These findings are consistent with values reported in the literature, by Eyduran and Agaoglu (2006) who revealed a SSC of 11.8 % for ‘Willamette’, while Kafkas et al. (2006) reported 9.9 % for ‘Canby’.

Table 3

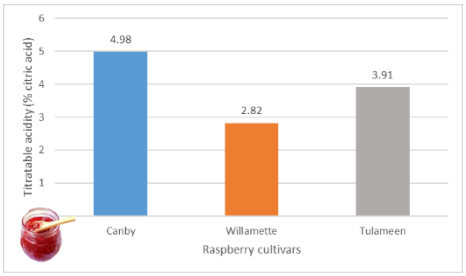
Chemical properties of raspberry fruits

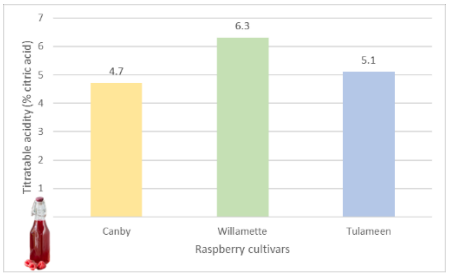
Cultivar	Soluble solid content (%)	Titratable acidity (%)	Vitamin C (mg/100 g FW)	Total sugars (g/L)
‘Canby’	10.4	1.64	24.12	85.5
‘Wilamette’	12.2	1.45	24.89	104.6
‘Tulameen’	11.6	1.58	23.92	98.2

Titratable acidity ranged between 1.45 % (in ‘Willamette’) and 1.64 % (in ‘Canby’). Similar results have been reported by other researchers, confirming the

reliability of our data (Orhan et al., 2006). As for vitamin C content, the highest value was found in 'Willamette' (24.89 mg/100 g FW), closely followed by 'Canby' (24.12 mg/100 g FW). These levels are within the range reported for raspberries, highlighting the nutritional value of the cultivars studied.

The titratable acidity values obtained for fresh fruits fall within the range specified by fruit jam manufacturing standards (Rozsa, 2021). In addition, the acidity of the processed products was evaluated, with results presented in Figure 3. The acidity of jams, expressed as % citric acid, ranged from 2.82 % (in 'Willamette') to 4.98 % (in 'Canby'). In the case of syrups, acidity values were higher, varying between 4.7 % (in 'Canby') and 6.3 % (in 'Willamette'). These results underline not only the influence of cultivar on product acidity but also the effect of processing method, as concentration during syrup production led to increased acidity levels compared to jams.

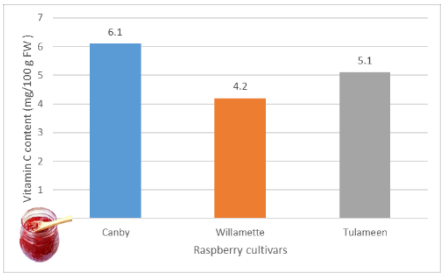


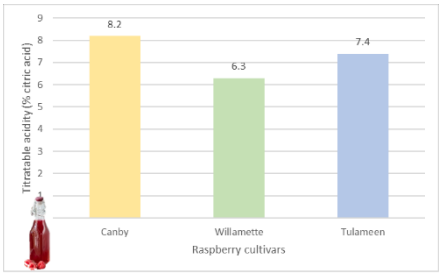


a b

Figure 3. Titratable acidity variation in jams (a) and syrups (b) among the three raspberry cultivars under study

The vitamin C content of jams obtained was relatively low (Figure 4). This was expected, since the technological process of jam production involves boiling, during which a large proportion of ascorbic acid is degraded due to heat sensitivity.





a b

Figure 4. Vitamin C content in raspberry jams (a) and syrups (b) of the three raspberry cultivars under study

The laboratory analyses showed values ranging between 4.2 mg/100 g FW (in 'Willamette') and 6.1 mg/100 g FW (in 'Canby') in jams. In syrup, these values were slightly higher, ranging from 6.3 mg/100 g FW (in 'Willamette') to 8.2 mg/100 g FW (in 'Canby'). These results are in line with previous findings indicating that thermal processing significantly reduces vitamin C content in berry-based products, highlighting one of the main limitations of traditional jam-making in preserving bioactive compounds.

CONCLUSIONS

The comparative assessment of the three raspberry cultivars revealed clear differences in fruit morphology, yield, and composition. Processing into jams and syrups significantly altered fruit quality. Jams complied with sugar content standards but exhibited substantial vitamin C losses due to thermal degradation, with values dropping to as low as 4–6 mg/100 g FW. Syrups retained slightly higher levels of vitamin C (6–8 mg/100 g FW) but showed increased acidity, reflecting the effect of concentration during production. These findings confirm that processing strongly impacts the nutritional profile of raspberries, particularly their ascorbic acid content.

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