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Consumer profile: blackberry processing with different types of sugars

Natália Ferreira SUÁREZ[1], Rafael Azevedo Arruda de ABREU[1], Letícia Alves Carvalho REIS[2], Paula Nogueira CURI[1], Maria Cecília Evangelista Vasconcelos SCHIASSI[3]*, Vanessa Rios de SOUZA[3], Rafael PIO[1]

Abstract

Due to its high medicinal and nutritional values, blackberries have become increasingly interesting to producers and consumers. People are looking for healthier options to consume sugar with greater nutritional enrichment. However, replacement of the type of sugar is associated with significant changes in some parameters, finding suitable replacements that result in satisfactory products can be challenging. The aim of this study was to evaluate the influence of different sugars (white refined sugar, white crystal sugar, demerara sugar, brown sugar and coconut sugar) on the physicochemical, physical and sensory aspects of blackberry juices and jellies. The type of sugar influenced the physicochemical and physical characteristics of blackberry jelly and juice, which reflected the differences in acceptability of the final product. Information on the type of sugar and its benefits influenced the sensory acceptance of blackberry jelly and juice.

Keywords: *Rubus spp*.; processing; jelly; juice; sensory.

Practical Application: It was possible to verify which types of sugars in the jelly and blackberry juice are most suitable.

1 Introduction

The demand for healthier foods with a low energy percentage, as well as the restriction of sugar consumption by the population has been increasing in recent years. It requires the development of products with low sugar levels, or with the use of healthier similar products (Barros et al., 2019). However, the absence or replacement of the type of sugar in processed products alters the moisture retention, which can cause changes in the color, flavor, texture and aroma parameters (Viana et al., 2015). Physicochemical assessments of processed foods have a great importance in order to confirm the maintenance of the physical, nutritional and sensory qualities of foods (James & Zikankuba, 2017). People around the world are looking for better options for the consumption of quality sugar, with greater nutritional enrichment and health support (Yang et al., 2020), such as brown, demerara and coconut sugar. However, the substitution of the type of sugar is associated with significant changes in texture, color, flavor and expiration date (Souza et al., 2013), so it is a challenge to find suitable substitutions that result in satisfactory products (Riedel et al., 2015). Processing can alter the nutritional value and quality of food (Iqbal et al., 2017). Brown sugar has higher nutritional values compared to refined sugars, due to the higher concentration of minerals and vitamins (Jaffé, 2012; Ducat et al., 2015). Brown sugar also has micronutrients with nutritional and medicinal qualities, such as anticarcinogenic and antitoxic activity (Kumar & Singh, 2020). Brown sugar is composed of glucose, fructose and sucrose, in addition to other components such as proteins, insoluble solids and a group of minerals (K, Ca, P, Mg, Na, Fe, Mn, Zn and Cu).

Another healthier sugar is coconut sugar, extracted from the coconut flower (Cocos nucifera L.). Coconut sugar is rich in proteins, minerals, antioxidants and vitamins (Hebbar et al., 2015). The collected sap is heated over an open fire, constantly stirred until it thickens and crystallizes (Levang, 1988). Due to the manufacturing process, the color of the sugar can vary from light brown to dark brown. Finally, the sugar is sieved and selected manually to obtain a fine grain product (Philippine Coconut Authority, 2015). In contrast, white crystal sugar production process goes through several stages, such as milling, refining, evaporation, cooking and crystallization (Gunawan et al., 2018). White crystal sugar experiences less production processes compared to white refined sugar, which is is conventionally produced from an intermediate product (raw sugar), produced from sugar cane extract by means of crushing, clarification, evaporation and crystallization. Raw sugar then goes through refining operations, including refining, remelting, primary and secondary discoloration, evaporation, crystallization, centrifugation, drying and conditioning (Vu et al., 2019). Due to its purity, the nutritional value of white sugar is very low, and provides a large amount of empty calories (Varzakas & Chryssanthopoulos, 2012). In addition, the consumption of white refined sugar has been associated with several health problems, including obesity, tooth decay, cardiovascular disease, and diabetes (Moynihan & Kelly, 2014). In recent years, due to the high medicinal and nutritional values (minerals, vitamins A and B, calcium and bioactive compounds) (Dawiec-Lisniewska et al., 2018) that are responsible for assisting in disease prevention (Segantini et al., 2015; Wen et al., 2016),

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[1]*Departamento de Agricultura, Universidade Federal de Lavras – UFLA, Lavras, MG, Brasil*
[2]*Department of Plant Agriculture, University of Guelph, Guelph, ON, Canada*
[3]*Departamento de Ciência dos Alimentos, Universidade Federal de Lavras – UFLA, Lavras, MG, Brasil*
*Corresponding author: vasconcelosmariaufla@gmail.com

blackberries (Rubus spp.) have gained interest from producers and consumers. Due to the population's growing interest in healthier foods, this study aimed to evaluate the influence of different sugars (white refined sugar, white crystal sugar, demerara sugar, brown sugar and coconut sugar) on the physical-chemical, physical and sensory juices and blackberry jellies.

2 Materials and methods

2.1 Ingredients

Blackberry jellies and juices were prepared with the cultivar Tupy with five types of sugar: white refined sugar, white crystal sugar, demerara sugar, brown sugar and coconut sugar. The blackberry fruits were harvested in a commercial orchard in the municipality of Aiuruoca-MG, Brazil, at their physiological maturity, determined by the color and size of the fruit and were immediately transported to the Fruticulture sector at the Department of Agriculture of the Federal University from Lavras, Lavras-MG, Brazil, and cold stored until processing. The city of Airuoca is located at 21°55' south latitude and 44°37' west longitude, at an average altitude of 1108 meters, and Lavras at 21°14' south latitude and 45°00' west longitude, at an average altitude of 918 meters. The climate is defined in high altitude tropical climate, with dry winter and rainy summer, according to the Köppen classification (Alvares et al., 2013). For the preparation of the jellies, the following ingredients were used: blackberry fruit juice, different sugars, high methoxylation pectin (Danisco, SP, Brazil) and citric acid. For the preparation of juices, filtered water, blackberries and different types of sugars were used.

2.2 Jelly and juice processing

Five jellies and five types of blackberry juice were prepared and the variation between the formulations was only in relation to the type of sugar used (white refined sugar, white crystal sugar, demerara sugar, brown sugar and coconut sugar).

Initially, the fruits were washed with water and hypochlorite and selected for physical and microbiological damage. To obtain the pulp used in the preparation of the jellies, the fruits were homogenized with 50% water for about 5 minutes in an industrial Poli LS-4 blender with a capacity of 4.0 L at 3500 rpm (Metalúrgica Siemsen Ltda, Brusque, Brazil). The pulp obtained was then finely sieved to obtain the clarified juice for preparing the juices and jellies. The juices were prepared with 60% clarified blackberry pulp and 40% sugar (differing between treatments), and then homogenized, subjected to heat treatment at 90 °C/30s and then bottled in 500 sterile glass bottles mL. The juice was stored under refrigeration at a temperature of 4-8 °C until analysis. No preservatives were added to the product, because physical-chemical and sensory analyzes were performed within 48 hours after processing. The percentages of ingredients used to prepare the jams were 60% clarified blackberry pulp, 40% sugar (differing between treatments), 1.5% high methoxylated pectin, and 0.5% citric acid. For the preparation of the jams, different sugars were added to the fruit pulp and the processing was carried out in an open manner, in pots heated by a gas flame (Macanuda, SC, Brazil). After boiling, pectin (powder) and citric acid were added. Finally, when the soluble solids reached 65° Brix, heating was stopped. The total soluble solids were determined using a portable refractometer RT-82. While still warm, the jellies were conditioned in sterile 250 mL glass bottles, cooled in the room temperature and stored at 7 °C.

2.3 Physical and physical-chemical analysis

The analyses of fruits, juices and blackberry jellies were performed at Pomaces' Laboratory - Fruticulture Sector (Lavras-MG), in three replications. To characterize fresh blackberry fruits, length, diameter, unit weight, total soluble solids (SS), total acidity (TA), solids/acidity (ratio), pH and color (L *, C * and h°) were measured. Analyzes of soluble solids, pH, total acidity, and color were also performed on juices and jellies. The analysis of the texture profile was also performed on the jellies (TPA). Fruit length and diameter were measured with a 150 mm digital caliper (Kingtools, São Paulo, Brazil), and the average fruit weight was determined by weighing each fruit individually on an AUX220 semi-analytical scale (Shimadzu do Brasil, São Paulo Brazil). Total acidity, soluble solids and pH analysis were performed according to the Instituto Adolfo Lutz - IAL (Instituto Adolfo Lutz, 2008). The color was determined by the Minolta CR 400 colorimeter (Konica Minolta, São Paulo, Brazil) with standards and D65 operating in the CIELab system, where L * ranges from 0 (black) to 100 (white); C* (chromaticity) and h° (hue). The texture profile analyzes (TPA) of the jellies were performed in the penetration mode under the following conditions: pre-test speed of 1.0 mm/s, test speed of 1.0 mm/s, post-test speed of 1.0 mm/s, a time interval between penetration cycles of 10s, a distance of 40.0 mm and a compression with a 6.0 mm diameter aluminum cylindrical probe using a texturometer (TAXT2i, Stable Micro Systems, Goldaming, England). The jelly samples were compacted by approximately 30%. The parameters analyzed were Cohesiveness - Coh, Gumminess - Gum, Chewiness - Chew and Resilience - Resil (Souza et al., 2014).

2.4 Sensory analysis

Before performing the analysis, the project was approved by the local Ethics Committee (1,755,177). The blackberry jellies and juices prepared with the use of different sugars were subjected to sensory analysis that took place over four days; two days were for the evaluation of juices and two days were dedicated to the evaluation of jellies. On the first day of each stage, participants evaluated the five formulations of juices and jellies without identifying the treatments. On the second day, the participants evaluated the jellies and juices with the treatments identified and the description of the nutritional characteristics of each of the sugars used. For the sensory analysis, tasters were recruited at random, with ages ranging from 18 to 60 years old, who stated that they regularly consume fruit juices and jellies and that they did not present restrictions related to the consumption of any ingredients of the products. Acceptance tests were carried out with 100 consumers per day, in which the evaluated attributes were color, flavor, consistency and general impression, using a 9-point structured hedonic scale (1 = extremely disliked, 9 = extremely liked) (Stone & Sidel, 1993). Each taster evaluated, on average, 5 g of each jelly and 5 mL of juice. Within two days, the samples were served in 50 mL plastic cups encoded with 3 digits in a monadic way and in a balanced block (Wakeling & Macfie 1995).

2.5 Statistical analysis

To compare juices and jellies in relation to physical, physical-chemical and sensory characteristics, statistical analysis (ANOVA) and mean test (Tukey, $p \leq 0.05$) were performed.

3 Results and discussion

3.1 Physical-chemical analysis of blackberries

The average values of the physical and physical-chemical properties were evaluated in blackberry fruits, shown in Table 1.

As for the parameters of size and weight of blackberry fruits from Table 1, it can be verified that the fruit has dimensions of 27.22 mm of average length, 24.22 mm of average diameter and a unit mass of 10.06 g. Curi et al. (2015) obtained lower results for unit mass (6.80-8.60 g) in different cultivars and similar results for length (27.70-28.50 mm) and diameter (24.00-22.40 mm) when comparing two productive cycles. The soluble solids content was 8.50 °Brix, the acidity was 1.12 g of citric acid/100 g, the ratio was 7.58 and the pH reached 3.20. Similar results were reported by Curi et al. (2015), with a soluble solid content of 8.40 °Brix, acidity of 0.90 g of citric acid/100 g when evaluating two productive cycles of blackberries. The blackberries had a soluble solid content in the range found by other authors, which varied between 8.20 and 12.90 °Brix (Soto et al., 2019; Van de Velde et al., 2016; Yang & Choi, 2017). These parameters are extremely important, as they indicate the best outcome for fruits, whether consumed in fresh or processed form. The soluble solid content and the titratable acidity are the main characteristics used to evaluate the quality of fruits, as well as the time to perform harvesting. The soluble solid content is expressed in °Brix, which refers to an estimate of the sugars content, organic acids, soluble amino acids and pectins (Silva et al., 2002). For fruits, those with the highest levels of soluble solids are those with the highest acceptability. In addition to the soluble solid content, the acidity also influences the flavor of the fruit, which helps attain a desirable balance of sugary acids necessary for a pleasant taste (Mditshwa et al., 2017).

The blackberry fruits evaluated had a pH in the observed range, from 2.20 to 3.40 (Soto et al., 2019; Van de Velde et al., 2016; Yang & Choi, 2017). The pH value found shows that the fruit has good processing potential, especially for products that require gelation. Garcia et al. (2017) stated that the ideal pH range for gel formation is 3.00 to 3.20. The observed acidity values show that blackberry fruits have a high probability of acceptance for fresh consumption. One of the most common ways to evaluate the taste of fruit is through the SS/TA ratio (Antunes et al., 2010). The highest values for this variable are due to the high level of soluble solids and the low level of acidity. Curi et al. (2015) obtained a higher ratio value (9.50) compared to the present study (7.58), which means that the fruits have less sweetness and greater acidity, which generally reflects in a lower sensory acceptance. For the color of blackberry fruits, the color parameter L* was 15.58. The L* value, measures how light or dark the fruit is, so the decline in the L value indicates the darkening of the fruit. The Chroma value was 22.08 and the °Hue was 20.71. The tonality angle, measured in degrees (0 to 360°), clearly represents the color of the fruit, as it unites the information obtained from a* and b*, from the equation °h = tangent arc (b*/a*). The hue value found indicates that the fruits have a dark hue. The chroma (C *) represents the vividness of the color, the greater the vividness, the greater the value of C*. Lago et al. (2020), evaluating blackberry fruits in 5 ripening stages, found that there was a decrease in the vividness of the colors in the last two ripening stages and this decrease is associated with the darkening of the fruit.

Several methods are used to define the most appropriate period to harvest blackberries. However, coloring is the characteristic most used by producers and traders. In post-harvest handling, attention should be paid mainly to the color parameters, firmness and organoleptic characteristics of the fruit (Muniz et al., 2014).

3.2 Physical-chemical and physical properties of blackberry jellies

The results of the physical-chemical and physical analyzes evaluated for the different formulations of blackberry jelly are shown in Table 2. All parameters were significant for the jelly made with different types of sugar, except for the results of soluble solids and resilience.

Regarding soluble solids, all formulations had the same processing time, aiming to reach 65 °Brix, therefore, there was no significant difference between treatments (Table 2). The jellies had a content of soluble solids suitable with the legislation, which establishes a minimum jelly content of 62 °Brix (Brasil, 2009). Regarding acidity, the pH of the jellies ranged from 2.91 to 3.98. These values are similar to those observed by Schiassi et al. (2019), who reported a pH of 3.57 for blackberry jellies. According to Jackix (1988), the optimum pH for making jellies is around 3.50, a similar value found in the present study. The total titratable acidity ranged from 1.23 to 1.50 g citric acid/100 g (Table 2). According to Table 2, the jelly produced with coconut sugar is characterized by higher pH values, whereas jellies produced with crystal, refined and demerara sugars showed greater acidity. High levels of soluble solids associated with a low pH minimize the development of microorganisms and favor the formation of sucrose crystallization, which is responsible for improving the viscosity and texture of the product (Oliveira et al., 2019; Barros et al., 2019). Regarding color, the L* color parameter

Table 1. Medium length (ML), average diameter (AD), unit weight (UW), total soluble solids (SS), total acidity (TA), solids/acidity (ratio), pH, and color (L*, C* and h°) in *Rubus spp.*

	ML (mm)	AD (mm)	UW (g)	SS (°Brix)	TA (%)	Ratio	pH	L*	C*	h°
Blackberry	27.22 ± 0.55	24.22 ± 0.48	10.06 ± 0.03	8.50 ± 0.26	1.12 ± 0.59	7.58 ± 0.02	3.20 ± 0.14	15.58 ± 2.02	22.08 ± 3.62	20.71 ± 1.22

ranged from 7.50 to 14.20 (Table 2). The Chroma value varied from 2.55 to 6.36 and the °H from 22.00 to 67.13. According to Table 2, the jelly produced with refined sugar had a higher L* value and it was the clearest jelly formulation. However, the jellies prepared with refined, brown and coconut sugars showed higher values of C*, and the jelly prepared with coconut sugar also had a higher value of h°.

Regarding texture, the jellies produced with refined, crystal, demerara and brown sugars showed the highest values of cohesiveness, however, the jelly prepared with refined sugar also obtained greater gumminess and chewiness compared to the others. There was no difference between the jellies for the resilience attribute (Table 2). Cohesiveness measures the extent to which the material can be stretched before breaking irreversibly (Bourne 1968; Van Vliet 1991), while gumminess provides the energy required to disintegrate a semi-solid food to the point of being swallowed (Friedman et al., 1963; Bourne 1968; Van Vliet 1991). Chewability reflects the energy required to chew a solid food to the point of being swallowed. The refined sugar used to make the jelly gave rise to a firmer, more rigid, elastic and gummy product. There are several factors that may explain the variation in jelly texture, including pH, acidity, soluble solids content, soluble pectin content, the amount of sugar naturally present in each cultivar and the amount of added sugar (Souza et al., 2014).

3.3 Physical-chemical and physical properties of blackberry juices

The results of the physical-chemical and physical analyzes evaluated for the different formulations of blackberry juice are shown in Table 3. All parameters were significant ($p \leq 0.05$) for juices made with different types of sugars.

Regarding soluble solids, the juices prepared with refined and brown sugars showed the highest values compared to the others (10.16 and 10.23, respectively), (Table 3). Schiassi et al. (2020) reported inferior results (5.67 °Brix), for blackberry juice with addition of coconut water. As for acidity, the pH of the juices ranged from 3.22 to 3.79 and the total titratable acidity ranged from 0.47 to 0.58 g citric acid/100 g (Table 2). According to Table 3, the juice produced with coconut sugar is characterized by having the highest pH value, whereas the juice prepared with demerara sugar showed greater acidity. Schiassi et al. (2020) reported similar results, pH of 3.68 for blackberry juice with addition of coconut water. In studies with other small fruits by Curi et al. (2019), similar results and a pH of 3.55 were found. Regarding color, the L* color parameter ranged from 14.25 to 18.14 (Table 3). The C* value ranged from 17.05 to 25.42 and the h° from 11.89 to 17.79. According to Table 3, the juices produced with refined, crystal, demerara and coconut sugars showed higher L* values, meaning they were the clearest juice formulations. However, juices prepared with refined, crystal and demerara sugars showed higher values of

Table 2. Soluble Solids (SS), total acidity (TA), pH, color (L*, C* and h°), and texture parameters in blackberry jellies obtained from different sugars.

Sugars	White Refined	White Crystal	Demerara	Brown	Coconut
SS (°Brix)	67.50 ± 4.77a	62.83 ± 2.75a	65.00 ± 5.41a	56.00 ± 0.50a	57.16 ± 2.89a
TA (%)	1.48 ± 0.84a	1.44 ± 0.13a	1.50 ± 0.48a	1.29 ± 0.57b	1.23 ± 0.27b
pH	2.93 ± 0.01d	3.03 ± 0.01c	2.91 ± 0.03d	3.59 ± 0.00b	3.98 ± 0.02a
L*	14.20 ± 1.25a	8.73 ± 0.21cd	11.07 ± 0.64b	10.70 ± 1.15bc	7.50 ± 0.26d
C*	6.33 ± 0.49a	3.63 ± 0.31b	2.55 ± 0.40b	6.36 ± 0.71a	5.77 ± 0.45a
h°	31.17 ± 0.15d	22.00 ± 2.00e	55.70 ± 3.45b	44.93 ± 4.09c	67.13 ± 1.42a
Cohe	0.39 ± 0.03a	0.38 ± 0.04a	0.38 ± 0.02a	0.44 ± 0.15 a	0.12 ± 0.12b
Gum	2.42 ± 0.21a	1.21 ± 0.11b	1.48 ± 0.09b	0.03 ± 0.01c	0.0 ± 0.01c
Chew	2.38 ± 0.19a	1.18 ± 0.10b	1.44 ± 0.09b	0.02 ± 0.01c	0.02 ± 0.01c
Resil	0.02 ± 0.00a	0.02 ± 0.00a	0.02 ± 0.00a	0.02 ± 0.02a	0.02 ± 0.02a

Results are expressed as mean value ± standard deviation (n = 3). Mean values with common letters in the same column indicate that there is no significant difference between samples ($p < 0.05$) by Tukey's mean test. Cohe: Cohesiveness (dimensionless); Gum: Gumminess (N·mm); Chew: Chewiness (N·mm); Resil: Resilience. Mean values with common letters in the same column indicate that there is no significant difference between samples ($p < 0.05$) by Tukey's mean test.

Table 3. Soluble Solids (SS), total acidity (TA), pH and color (L*, C* and h°) in blackberry juice obtained from different sugars.

Sugars	White Refined	White Crystal	Demerara	Brown	Coconut
SS (°Brix)	10.16 ± 0.35[a]	9.40 ± 0.26[c]	9.93 ± 0.25[ab]	10.23 ± 0.06[a]	9.53 ± 0.21[bc]
TA (%)	0.49 ± 0.07[c]	0.47 ± 0.20[c]	0.58 ± 0.16[a]	0.54 ± 0.13[b]	0.47 ± 0.18[c]
pH	3.28 ± 0.03[c]	3.22 ± 0.03[c]	3.27 ± 0.02[c]	3.50 ± 0.03[b]	3.79 ± 0.02[a]
L*	17.34 ± 0.22[a]	18.14 ± 0.85[a]	17.53 ± 0.20[a]	14.25 ± 0.03[b]	17.28 ± 0.14[a]
C*	24.40 ± 0.36[a]	24.86 ± 0.86[a]	25.42 ± 0.44[a]	17.05 ± 0.35[c]	20.38 ± 0.36[b]
h°	16.69 ± 0.45[a]	16.77 ± 0.46[a]	17.79 ± 0.14[a]	11.89 ± 0.72[c]	15.29 ± 0.16[b]

C* and h°, characterized as greater purity of red, which will be more attractive to the consumer.

3.4 Sensory analysis

Table 4 presents the mean values of the sensory characteristics results. The samples differed from each other for all evaluated attributes.

In general, the jelly formulations showed good/intermediate sensory acceptance for all evaluated attributes during two evaluation days, with average scores varying between the hedonic terms "neither liked/nor disliked" and "somewhat liked it" (Table 4). Through the average table (Table 4), it can be seen that the jelly made with coconut sugar was the least accepted for all the sensory attributes evaluated, presenting means of "indifferent" acceptance, while the others formulations (crystal, refined, demerara and brown) were the most accepted, with higher average acceptance scores, ranging between the terms "somewhat liked it " and "neither liked/nor disliked". Schiassi et al. (2019) evaluating blackberry juice obtained similar results, with average sample scores between 6 and 8 on the hedonic scale ("I liked it a little" and "I liked it a lot"). Except for jelly prepared with coconut sugar, the jellies showed satisfactory results since according to Lawless & Heymann (2010), the assignment of scores with a score of 6 to 9 guarantees the product will be accepted by a marketing team from a sensorial.

The sensorial acceptance of the same formulations when the consumer had access to information on the type of sugar used as well as its health benefits, is demonstrated with the average table (Table 4) which shows that the sensory acceptance of all formulations for the color attribute remained unchanged. For the flavor attribute, without identifying the treatments, the best formulations were the jellies prepared with refined, crystal, demerara and brown sugars. However, when the sugars were identified, the jelly prepared with demerara sugar was the most well received. For the attribute consistency and global impression, without identifying the treatments, the jelly prepared with brown sugar was the most well received. However, when identified, the jellies prepared with brown and demerara sugars were the most accepted. On the other hand, in physalis studies that are also considered in small fruits group, the information on the type of sugar and its benefits had no influence on the sensory acceptance of the jam (Curi et al., 2017). In general, the most nutritious (coconut) sugar did not give rise to jellies with good sensory quality. However, it could easily replace crystal and refined sugars, typically used in the manufacture of sweets and jellies, with demerara sugar, which has higher nutritional quality and gives rise to more sensorially accepted jellies than traditional jellies (Curi et al., 2017).

In general, the juice formulations showed good/intermediate sensory acceptance for all evaluated attributes, in the two days of evaluation, with average scores varying between the hedonic terms "slightly disliked" and "somewhat liked it" (Table 5). Through the average table (Table 5), the juice made with coconut sugar was the least accepted for all the sensory attributes evaluated, presenting acceptance averages located between the terms "slightly disgusted" and "somewhat liked it". The other formulations (crystal, refined, demerara and brown) were the most accepted with higher average acceptance scores, placed between the terms "indifferent" and "liked moderately". Schiassi et al. (2020), evaluating red fruit juices, observed that the lowest acceptance was obtained for blackberry juice (100%) or when there was a mixture of three fruits in equal proportions, with averages that varied between the hedonic terms "slightly disgusted "and" slightly liked". Coconut sugar has a caramelized smell and taste, unlike other sugars from sugar cane, particularly due to its malted character (Wrage et al., 2019). This can mask the fruits flavor in processed foods, whether they are jellies or juices, and are consequently less preferred for all analyzed attributes. According to Schiassi et al. (2018), high acidity and viscosity also contribute to less likeability of juices, indicating

Table 4. Sensory characteristics of the jellies from different sugars analyzed in two days.

Sugar types	Identified	No Identified	Identified	No Identified
	Colour		Flavor	
White Refined	7.20 ± 1.63a	7.69 ± 1.39 a	6.54 ± 1.81b	6.96 ± 1.74a
White Crystal	7.29 ± 1.64a	7.69 ± 1.28a	6.76 ± 1.78ab	7.21 ± 1.39a
Demerara	7.19 ± 1.76a	7.73 ± 1.21a	7.32 ± 1.62a	7.35 ± 1.37a
Brown	7.02 ± 1.79a	7.35 ± 1.60a	6.78 ± 2.01ab	7.20 ± 1.99a
Coconut	5.24 ± 2.23b	5.64 ± 2.14b	5.19 ± 2.32c	5.51 ± 2.42b
	Identified	No Identified	Identified	No Identified
	Consistency		Global Impression	
White Refined	5.84 ± 2.04b	5.91 ± 2.10b	6.27 ± 1.65b	6.83 ± 1.57b
White Crystal	6.46 ± 1.96ab	6.42 ± 1.70b	6.77 ± 1.65ab	7.09 ± 1.31ab
Demerara	6.72 ± 1.92a	6.38 ± 1.86 b	7.10 ± 1.58a	7.24 ± 1.24ab
Brown	6.94 ± 2.03a	7.45 ± 1.53a	6.92 ± 1.87a	7.37 ± 1.65a
Coconut	5.86 ± 2.28b	6.24 ± 2.21b	5.40 ± 2.15c	5.78 ± 2.09c

Mean values with common lower letters in the same column indicate that there is not a significant difference between samples (P < 0.05) from Tukey's mean test. Mean values with common capital letters in the same line indicate that there is not a significant difference between samples (P < 0.05) from Tukey's mean test.

Table 5. Sensory characteristics of the juice obtained from different sugars analyzed in two days.

Sugars Types	Identified	No Identified	Identified	No Identified
	Colour		Flavor	
White Refined	7.46 ± 1.47 ^{a}	7.61 ± 1.39^{ab}	6.84 ± 1.72^{ab}	6.76 ± 1.48^{a}
White Crystal	7.68 ± 1.38^{a}	7.77 ± 1.35^{a}	6.90 ± 1.60^{ab}	6.81 ± 1.69^{a}
Demerara	7.67 ± 1.37^{a}	7.49 ± 1.53^{ab}	7.39 ± 1.41^{a}	6.49 ± 1.87^{a}
Brown	7.67 ± 1.54^{a}	7.84 ± 1.49^{a}	6.38 ± 1.95^{b}	5.62 ± 1.97^{b}
Coconut	6.80 ± 1.92^{b}	7.36 ± 1.68^{b}	4.68 ± 2.18^{c}	5.01 ± 2.22^{c}
	Identified	No Identified	Identified	No Identified
	Consistency		Global Impression	
White Refined	7.00 ± 1.72^{ab}	7.08 ± 1.57^{ab}	6.94 ± 1.59^{b}	6.99 ± 1.46^{a}
White Crystal	6.92 ± 1.63^{ab}	7.37 ± 1.37^{a}	7.01 ± 1.45^{b}	7.16 ± 1.52^{a}
Demerara	7.37 ± 1.54^{a}	7.10 ± 1.57^{ab}	7.61 ± 1.18^{a}	6.90 ± 1.64^{a}
Brown	7.12 ± 1.59^{a}	6.85 ± 1.68^{bc}	6.69 ± 1.92^{b}	6.38 ± 1.65^{b}
Coconut	6.52 ± 1.80^{b}	6.65 ± 1.78^{c}	5.29 ± 2.01^{c}	5.69 ± 1.93^{c}

Mean values with common lower letters in the same column indicate that there is not a significant difference between samples ($P < 0.05$) from Tukey's mean test.

that consumers prefer juices with low acidity and viscosity. This corroborates with the present study that obtained greater acidity and less acceptance for juices prepared with coconut sugar. Regarding the sensorial acceptance of the same formulations when the consumer had access to information on the type of sugar used as well as its health benefits. It can be seen through the average table (Table 5) that the sensory acceptance for the color attribute, without the identification of treatments, was greater for juices prepared with crystal and brown sugars. Nevertheless, when the sugars used were identified, the juices prepared with refined, crystal, demerara and brown sugars were the best. For the flavor attribute, without identifying the treatments, the best formulations were juices prepared with refined, crystal, and demerara sugars. However, when the sugars were identified, the juice prepared with demerara sugar was the best. For the consistency attribute, without identifying the treatments, the best juice was the one prepared with crystal sugar. But when identified, the juices prepared with demerara and brown sugars were the most accepted. The juices prepared with refined, crystal and demerara sugars were the most accepted in the global impression attribute, without identifying the treatments. However, when the sugars used in the preparation were identified, the juice prepared with demerara sugar was the best. There is an indication that the sensory acceptance of blackberry juice is related to nutritional and beneficial health characteristics, since there was an influence of the knowledge of the sugars used in the preparation in the evaluation. In general, the most nutritious (coconut) sugar did not give rise to juices with good sensory quality. However, it could easily replace the crystal and refined sugars, typically used in the manufacture of sweets and jellies, with demerara sugar, which has higher nutritional quality and gives rise to jams as sensorially accepted.

4 Conclusions

The type of sugar influenced the physical and physical-chemical characteristics of blackberry jellies and juices, which reflects the differences in product acceptability. Demerara and brown sugars are the most suitable for the processing of jelly. Demerara sugar was the most accepted by the tasters to produce blackberry juice. Information on the type of sugar and its benefits influenced the sensory acceptance of blackberry jelly and juice.

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