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Obtaining and characterization of some sugar-free red beet and apple jellies

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Abstract

Making sugar-free jellies is a way to diversify and meet the demands of the consumer market, which is increasingly looking for quality products, especially with a high nutrient content and lower caloric value, whether for aesthetic, physiological reasons or health restrictions. Fruit jellies prepared with natural sweeteners with low or zero calories are healthier and can also be consumed by people suffering from diabetes as they do not affect blood sugar levels. A first objective of this work was to obtain innovative assortments of natural, vegan, sugar-free, agar-agar gelled jellies in four variants: apple juice jelly, plain (AJ1) and with added cinnamon essential oil (AJ2), respectively red beet juice and apple juice jelly, plain (RBAJ1) and with added tangerine essential oil (RBAJ2). The second objective of the work was the analysis of apple juice, red beet juice and finished products in terms of total polyphenol content and antioxidant activity, and the analysis of proximate composition, energy value and organoleptic characteristics of the finished products. Red beet juice was richer in total polyphenols and had stronger antioxidant activity (9.07±0.15 mg gallic acid/g, respectively RSA=48.82±0.32% for 1:1000 dilution) than apple juice (4.82±0.04 mg gallic acid/g, respectively RSA=44.64±0.28% for 1:1000 dilution). Also RBAJ1 and RBAJ2 had a higher amount of total polyphenols and higher antioxidant activity than AJ1 and AJ2; within the same category of jelly, those with added essential oil were richer in total polyphenols and with better antioxidant action. Organoleptic analysis using the 5-point hedonic scoring scale method resulted in scores above 4 on all sensory characteristics for both categories of jellies.

Keywords: sugar-free jellies, red beet, apple, polyphenols, antioxidant activity.

1.Introduction

Jellies are made from filtered fruit juice, without solid fruit pieces or parts. The base of the jelly is firm but elastic and the mass may be transparent, clear. The raw material from which the jellies are made is fresh fruit juice with added sugar or natural sweeteners and pectin or agar-agar, which is boiled until it thickens and becomes gel-like [1-3]. Although fruit jellies contain natural fruit juice, they are often high in added sugars and lack the fiber and other nutrients found in whole fruit.

They are therefore considered a less healthy option compared to fresh fruit and should be eaten in moderation as part of a balanced diet [4]. Due to increasing consumer awareness of health issues, there is a growing demand for non-carbohydrate, sugar-free, or low-sugar, low-calorie confectionery products. Thus, in recent years, studies have been conducted to develop formulations for low-sugar and even sugar-free agar-based jellies. This has been achieved by replacing sucrose and glucose syrup with a combination of sugar substitutes: erythritol, xylitol, sucralose, oligofructose, *Stevia*

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rebaudiana extracts. In terms of texture and sensory properties, low-sugar and sugar-free jellies processed with these formulations were comparable to standard sugar-containing products [4-6]. Red beet (*Beta vulgaris* L.) belongs to the genus *Beta* L., of the family *Betoideae*. Red beetroot is a vegetable consumed worldwide due to its high content of biologically active substances such as betalains, inorganic nitrates, polyphenols, polyols, and numerous minerals and vitamins. This plant has a high content of compounds with antioxidant and anti-inflammatory properties, and is considered an important aid in the treatment of many diseases: cancer, cardiovascular problems, digestive disorders, inflammation and others [7-9]. Apples are a type of fruit that are commonly grown and eaten all over the world. They are rich in fiber, polyphenols, vitamin C and other antioxidants and have been associated with many health benefits. Apples come in many different varieties, which can vary in size, color and flavor [10-13]. Essential oils are volatile, natural, complex compounds characterized by a strong odor and formed by aromatic plants as secondary metabolites. They are usually obtained by vapor- or hydro-distillation, first developed in the Middle Ages by the Arabs. Known for their antiseptic (bactericidal, virucidal, fungicidal) and medicinal properties, as well as for their fragrance, they are used in embalming, in food preservation and as antimicrobial, analgesic, sedative, anti-inflammatory, spasmolytic and local anesthetic remedies. To date, these characteristics have not changed much, except that more is now known about some of their mechanisms of action, particularly at the antimicrobial level [14-16].

This work aimed primarily at obtaining innovative assortments of natural, vegan jellies, without added sugar, in four variants: apple juice jelly, plain and with added cinnamon essential oil, respectively red beet juice and apple juice jelly, plain and with added tangerine essential oil. Another aim of the work was to characterize the finished products in terms of total polyphenol content, antioxidant activity, proximate composition, energy value and sensory properties.

2. Materials and method

The jellies were obtained from the following raw and auxiliary materials (purchased on the Romanian market): Golden delicious variety apple, red beetroot, agar-agar, cinnamon essential oil, tangerine essential oil.

Jellies obtaining method

Four types of jellies were prepared: apple juice jelly plain (AJ1), apple juice jelly with added cinnamon essential oil (AJ2), red beet juice and apple juice jelly (RBAJ1) and red beet juice and apple juice jelly with added tangerine essential oil (RBAJ2). The recipes used are shown in Table 1.

Table 1. Recipes used to make jellies

Jelly assortment	RBAJ1	RBAJ2	AJ1	AJ2
Red beet juice (%)	71.00	71.00	-	-
Apple juice (%)	27.00	27.00	98/00	98.00
Agar-agar (%)	2.00	1.96	2.00	1.96
Tangerine essential oil (%)	-	0.04	-	-
Cinnamon essential oil (%)	-	-	-	0.04

To make the jellies, the beetroot and apples were peeled, washed and divided, then put in a juicer. The juice obtained from the apples and beetroot was weighed according to each recipe, then put into a pot and brought to the boil, stirring continuously over low heat. The agar-agar powder was then added and stirring continued for 5 minutes until the mixture thickened. Allow the jelly to cool slightly, stirring constantly, then add the essential oil and pour the mixture into the molds. The jellies were placed in the refrigerator for about 30 minutes, then drained from the molds and packed. Samples were taken from each type of jelly for analysis. Figure 1 shows the RBAJ and AJ types jellies.

(a) (b)

Figure 1. The the RBAJ (a) and AJ (b) types jellies

Assessment of total polyphenol content, antioxidant activity and sensory analysis

To determine the total polyphenols content (TPC) in juices and finished products, the Folin-Ciocalteu method was used and for the sensory analysis of jellies the 5-point hedonic scale assay was applied by 40 panellists, following the same working methodologies as those described by Dumbrava *et*

al., (2020) [17]. To characterize the antioxidant properties of both juices and finished products, the free radical scavenging activity (RSA) of 2,2-diphenyl-1-picryl-hydrazyl (DPPH) was determined using the same method as Dumbrava *et al*, (2022) [18].

Assessment of proximate composition and energy value

USDA Nutritional Database was used to determine the proximate composition and energy value of jellies.

Statistical analysis

The mean values and standard deviations of all replicates were calculated for TPC and RSA using Excel software (Microsoft Office 2010).

3. Results and discussion

Total polyphenol content

The TPC analysis of raw materials and finished products using the Folin-Ciocalteu method led to the results shown in Table 2.

Red beet juice had a 46.86% higher total polyphenol content (9.07±0.15 mg gallic acid/g) than apple juice. Of the finished products, red beet juice and apple juice jelly with added tangerine essential oil (RBAJ2) had the highest concentration of total polyphenols (38.41±0.27 mg gallic acid/g), followed by RBAJ1 (35.02±0.22 mg gallic acid/g), and the lowest concentration of these compounds was recorded in AJ1 (28.93±0.18 mg gallic acid/g). The addition of tangerine and cinnamon essential oil, respectively, increased the content of total polyphenols in the jellies

Table 2. Total polyphenols content of juices and finished products

Sample	TPC (mg gallic acid/g)
Apple juice	4.82±0.04
Red beet juice	9.07±0.15
RBAJ1	35.02±0.22
RBAJ2	36.41±0.27
AJ1	28.93±0.18
AJ2	30.95±0.21

Desseva *et al*., (2020) [19] reported for red beet juice TPC of 30.81±2.96 mg gallic acid per gram of dry matter however. Wootton-Beard and Ryan (2011) [20] found for various commercial red beet juices lower values: between 0.47 and 1.45 mg gallic acid/g. For Golden delicious apple juice Marszałek *et al*., (2018) [21] reported TPC values between 0.67 and 0.71 mg gallic acid/g - lower than those found in present paper. Jamal (2023) [22] found for a classic red beetroot jelly prepared with sugar addition TPC of 1.50 ± 0.01 mg gallic acid/g, a much lower value than those determined in the present work. For apple juice jellies prepared with added sugar Hasani and Yazdanpanah (2020) [23] reported very low TPC values: between 11.80±1.04 and 34.70±1.44 μg/g).

Antioxidant properties analysis

The antioxidant properties expressed by DPPH free radical scavenging activity (RSA) determined for apple juice and red beet juice, respectively, for the finished products are shown in Table 3.

Table 3. RSA for juices and finished products

Sample	Dilution	RSA (%)
Apple juice	1:1000	44.64±0.28
Red beet juice	1:1000	48.82±0.32
RBAJ1	1:1000	38.92±0.27
RBAJ2	1:1000	40.92±0.30
AJ1	1:1000	35.37±0.13
AJ2	1:1000	37.24±0.23

Red beet juice had a higher DPPH free radical scavenging activity (48.82±0.32 %) than apple juice (44.64±0.28 %). Among the finished products, RBAJ2 had the strongest antiradical activity (40.92±0.30 %), followed by RBAJ1 (38.92±0.27 %), and AJ1 had the lowest RSA value (35.37±0.13 %). It is found that the addition of tangerine and cinnamon essential oil, respectively, causes an increase in the RSA of the finished products.

Proximate composition and energy value

The results on proximate composition and energy value of jellies are shown in Figure 2. and Figure 3. Because the addition of essential oil does not influence the proximate composition and energy value, calculations were made for jelly obtained from red beet juice and apple juice (RBAJ) and jelly obtained from apple juice (AJ), respectively.

For both types of jellies, lipids and proteins are missing from the proximate composition (Figure 2), the products being characterized only by the total carbohydrate content, i.e. sugars and dietary fiber as component parts of the carbohydrate class. Of the two types of jellies the AJ apple jelly had a higher content of total carbohydrates and sugars (41.12 g/100g and 36.42 g/100g, respectively) with 11.23% and 14.89% higher than the RBAJ combined jelly, respectively, which also led to a higher caloric intake of AJ (145.3 kcal/100g) with 12.48% higher

than RBAJ, as shown in Figure 2. Cho and Sin (2020) [24] found lower total carbohydrate (33.07 g/100g), but dietary fiber missing in apple jelly, while Panchal *et al*. (2018) [25] reported much higher sugar content value (65.1 g/100g) for passion fruit jelly.

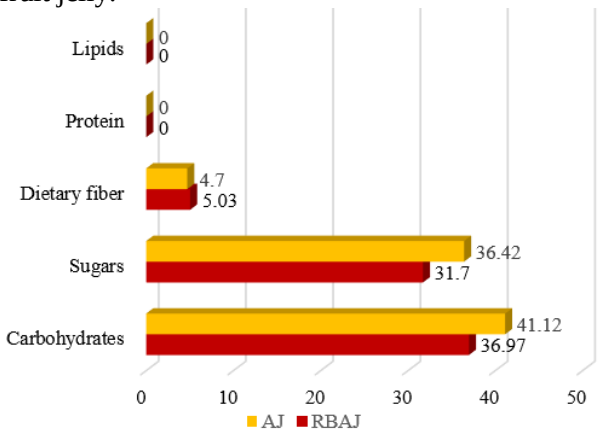

Figure 2. Proximate composition of jelly assortments (g/100g)

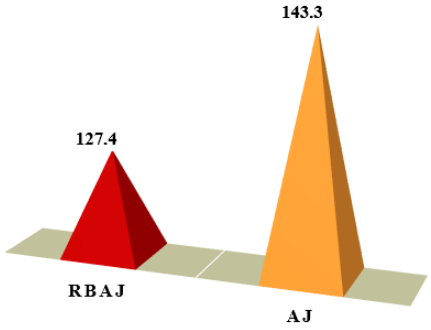

Figure 3. Energy values (kcal/100g) of finished products

Sensory analysis

Sensory analysis of the developed jellies led to the results shown in Figures 4 and 5.

All types of jellies scored well (above 4) on all organoleptic properties. The characteristic with the lowest score was texture: 4.2 for all 4 types of jellies, which is different (firmer) from the gelatinous texture of classic jellies made with gelatine. All other sensory characteristics were rated with scores above 4.5, being in the very high acceptability category. In terms of aspect and color, RBAJ1 and RBAJ2 were rated higher by tasters (4.85 respectively 4.8) than AJ1 and AJ2 (4.55 respectively 4.5). Taste, aroma, smell and overall acceptability were positively influenced by the addition of essential oils, leading to increases in scores for both apple juice jelly and red beet and apple juice jelly.

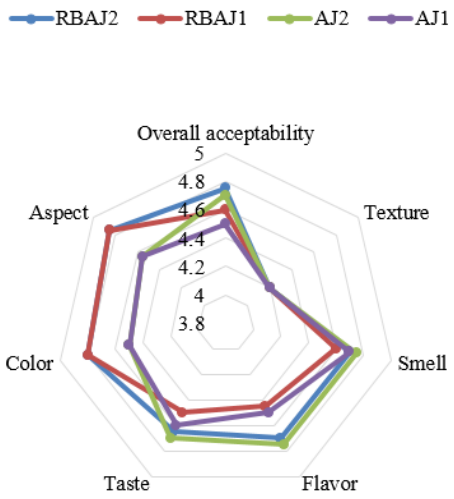

Figure 4. Global values of the developed jellies sensory evaluation

Thus, for AJ2 the score for taste, aroma, smell, and overall acceptability increased from 4.6 to 4.7, 4.5 to 4.75, 4.7 to 4.75, and 4.5 to 4.7, respectively; for RBAJ2 the scores increased from 4.5 to 4.65, 4.45 to 4.7, 4.6 to 4.7, and 4.6 to 4.75, respectively.

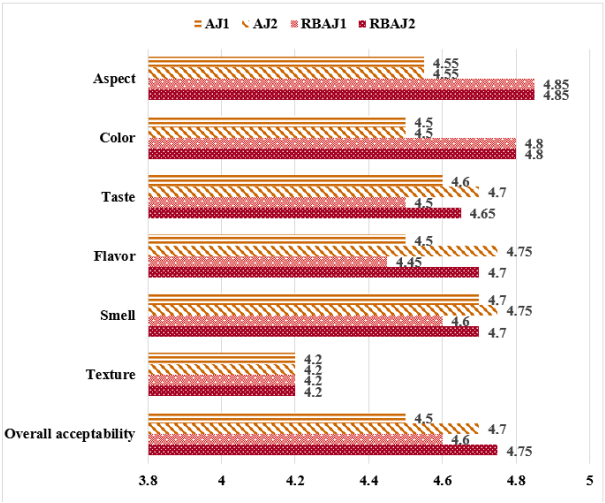

Figure 5. Organoleptic characteristics of jellies

4. Conclusions

Four types of natural, vegan, sugar-free jellies were obtained using agar-agar as gelling agent: two types of Golden delicious apple juice jelly - one plain (AJ1) and the second with added cinnamon essential oil (AJ2), respectively two types of red beet juice and Golden delicious apple juice jelly - one plain

(RBAJ1) and the second with added tangerine essential oil (RBAJ2). Analysis of total polyphenol content revealed that red beet juice was richer in these compounds than apple juice, also RBAJ1 and RBAJ2 had a higher content of total polyphenols than AJ1 and AJ2; within the same category of jelly, those with added essential oil were richer in total polyphenols. Of the two juices used to make jellies, red beet juice showed the highest DPPH free radical scavenging activity (RSA). Of the finished products, RBAJ1 and RBAJ2 showed better RSA than AJ1 and AJ2, and within the same category of jelly, those with added essential oil showed stronger DPPH free radical scavenging activity than the variants without added essential oil. From a nutritional point of view, both apple juice jellies and mixed apple juice and beetroot juice jellies are low in fat and protein and the carbohydrate and sugar content is higher in AJ than RBAJ. Organoleptic analysis by a panel of 40 inexperienced volunteer tasters using the 5-point hedonic scale method resulted in scores above 4 on all sensory characteristics for both categories of jellies. Jellies with added essential oils were better rated by the panelists on the characteristics of taste, aroma, smell as well as overall acceptability. The poorest score for all types of jellies was obtained for texture (4.2) which was firmer and less elastic than the classic jellies obtained with added sugar and gelatine. Thanks to their high content of total polyphenols, very good antioxidant activity, lack of added sugar and superior organoleptic characteristics, the 4 varieties of natural vegan jellies are a healthy and tasty alternative to classic jellies made with added sugar and gelatine. These products can be consumed not only by vegans and vegetarians, but also by those with sugar restrictions, as well as by all those who want to eat as healthily as possible. Jelly variants with added essential oils are not only more sensory appealing, but also have a higher protective value through higher total polyphenol content and stronger antioxidant activity.

Compliance with Ethic 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 exists) respect the specific regulation and standards.

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