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TEXTURAL AND SENSORY PROPERTIES OF FALSE ACACIA (*ROBINIA PSEUDOACACIA* L.) JELLIES WITH FUNCTIONAL COMPONENTS

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ABSTRACT
The aim of this study is to present the possibility of using *Robinia pseudoacacia* L. flowers in the composition of high-sugar pectin jelly. Basil seeds (*Ocimum basilicum*) are included in jelly's composition in order to improve its functional and sensory properties. The texture of the jellies was evaluated by the methods of penetration, durability and hardness. Relatively comparable indicators of the structural and mechanical properties of the gels were reported. No significant differences were noted in the maximum deformation at the point of destruction and the energy used to destroy the jellies. The basil seed-containing jelly showed higher gel strength, requiring greater both force (0.203 N) and energy (0.567 N.mm) for destruction. The sensory profiles clearly showed the higher panelist's preference of the seed-containing jelly, receiving 53% approval, with 14% for the plain jelly. The results obtained show good possibilities for the application of false acacia flowers in pectic jellies with the participation of basil seeds.

1. Introduction

The use of flowers from traditional and non-traditional plant species has been the subject of several studies (Oyeyemi *et al.*, 2017; Navarro-Gonzalez *et al.,* 2015). Some authors emphasize the benefits of using plant flowers, both fresh and processed (Oyeyemi *et al.,* 2017; Stankov *et al.,* 2018). Their processing in the form of extracts, freeze-dried, frozen, as well as used in the production of jams, marmalades and jellies, causes their wide application during all seasons (Stankov *et al.,* 2018). In this case, food stabilization is achieved - besides the thermal treatment - by increasing the soluble solids content and the acidity. It could be achieved through the usage of different types of hydrocolloids (Genovese *et al.,* 2010) which, in addition to increasing the level of dry matter, also alter the texture of the model matrix. In another aspect, they improve the nutritional and biological value of the product (Kumar *et al.,* 2018). Such ingredients are textural moderators that alter the sensory perception of the product (Löfgren *et al.,* 2005). Most commonly, the production of jellies in industrial production uses highly esterified pectin (Endress *et al.,* 2005). There are studies about the effect of pectin concentration, pH, type, and concentration of cosolvent, on the viscoelastic properties of high methoxyl pectin gels (Löfgren *et al.,* 2005; Tsoga *et al.,* 2004). This may be attributed to the more complex structure and composition of jams, jellies, and marmalades, compared to model pectin gels. Rheological properties are useful in determining ingredient functionality in the product development, quality control, and correlation of food texture to sensorial attributes (Dervisi *et al.,* 2001).

The use of various seeds, cereals, plant extracts, and other functional components in the composition of jellies and jams can have a beneficial effect on the quality of the product. Basil seeds offer great potential for use as an emulsifying, foaming, thickening, gelling, binding, fat replacing, binding, and stabilizing agent in the food industries (Naji-Tabasia *et al.,* 2017).

Despite extensive studies on the presence of substances with pronounced functional properties, the consumption of some plant species and individual parts of them is limited. This necessitates the search for alternative technological solutions for the production of the foods in which they are included, in the form of extracts, biologically active substances, structure-forming agents, and others.

The aim of this study was to analyze the textural and sensory indices of model false acacia pectin jelly with basil seeds.

2. Materials and methods

2.1. Materials

Materials: Acacia flowers (*Robinia pseudoacacia* L.) were collected in May 2018 from a ten-fifteen years old false acacia (black locust) tree, naturally growing in the foot of the Eastern Stara Planina Mountain, in Sliven, Bulgaria. Samples were identified and certified by an expert from the Agricultural University of Plovdiv, Bulgaria. High methylester (HM) pectin Ceampectin type MRS-4610 (CEAMSA, Porriño, Spain) was used as a gelling agent. Anhydrous citric acid Parafarm (Saporiti, Argentina) was used to regulate the pH.

Food grade sucrose, organic basil seeds (Basilikumsamen, Davert), and potable bottled water, each from the same batch, were bought in the local market.

2.1.1. Preparation of acacia syrup

The acacia flowers were stored at 5 °C for 24 hours. They were subjected to extraction with a boiling water-sugar solution (50%) for 30 min. Citric acid (1% by weight of the finished product) was added to the syrup. Total soluble solids content reached 70 °Brix; water activity - 0.67±0.01 (LabSwift-aw, Novasina, Switzerland); pH - 3.19±0.02. The prepared syrup was filtered and chilled stored in closed glass bottles.

2.1.2. Preparation of acacia jellies

Standard jellies (63 °Brix) were prepared by boiling the required amount of acacia syrup before the addition of pectin solution (5%). The desired pH-value (3.20±0.03) was adjusted by adding a 50% citric acid solution at the end of the cooking process. For the seed-containing jelly basil seeds (1% of the mass of finished product) were pre-hydrated in water at a ratio of 1:5 for 20 min; the prepared mucilage was mixed with the acacia syrup at 65 °C. The finished products were filled in cylindrical syringes with a volume of 60 cm^3, d^2 = 28.5 mm, and stored at 5 °C for 48h.

2.2. Method of analyses

2.2.1. Texture analysis

For the studies of instrumental texture parameters, a Stablemicrosystems TAXT2 texture analyzer was used in the laboratory of Food Research and Development Institute, Plovdiv with three different methods and probes on 2 slices of syringes. After the gel formation, the cylinder shape packs were immediately cut before measurement for slices of 10 mm height (6 slices of one syringe). The exact height was measured with the texture analyzer during the experiments. The methods used were determined: Penetration - (d1 = 5 mm; a1 [area] = 19.6 mm^2) to a relative deformation of 80%, a deformation speed of 1 mm/s and a unloading speed of 10 mm/s., and derived values for the consistency, Rupture stress, [kPa]; maximum deformation at break point, [mm], deformation energy, [kPa.mm], maximum unloading stickiness in pull out,

[kPa], sticky, area below unloading deformation axis, [kPa.mm]. Gel strength testing was performed by cone probe penetration (operating angle ∠45 °) to a relative deformation of 80%, a deformation speed of 1 mm/s and an unloading speed of 10 mm/s and results obtained for Rupture force [N], or as energy [N.mm], stiffness, the area below deformation axis, [N.mm]. Compression was performed with a cylindrical probe (D2 = 50 mm, A2 [area] = 1963.5 mm^2, d2 [probe diameter] = 28.5 mm, a2 [probe area] = 637.9 mm^2), obtained metrics: hardness, gel strength, such as rupture stress, [kPa] or rupture energy [kPa.mm] and maximum deformation at break point, plasticity [mm].

2.2.2. Sensory evaluation. Acceptance test.

A total of 100 untrained panelists (40 males and 60 females, 20 - 65 years old) participated in the study. They were students and staff of the University of Food Technologies (Plovdiv, Bulgaria), identified (in a survey previous to the test) as regular consumers were considered those who declared to consume these products at least 2 to 3 times per week. Samples were presented to the panelist coded and in random order. Plastic flat spoons were provided to the panelists, water was offered to cleanse their palates between sample tasting. Panelists were instructed to consider appearance, colour, flovour, taste, consistency, sweetness intensity, acidity intensity, succulence, aftertaste, and general perception of each sample on a 9 - point hedonic scale (1 - dislike extremely; 2 - dislike very much; 3 - dislike moderately; 4 - dislike slightly; 5 - neither like nor dislike; 6 - like slightly; 7 - like moderately; 8 - like very much; 9 - like extremely), (Stone *et al.*, 1993).

3.Results and discussions

3.1. Textural parameters

The textural parameters of the jellies obtained are crucial for their use in the food industry. In order to provide detailed information on the conduct of the jelly during processing and distribution, a number of studies have been carried out influence on its quality. When penetrating the homogeneous the plain gel (jelly without basil seeds) showed, we get lower penetration values compared to the gel with pre-hydrated basil seed. There were no significant differences in the maximum deformation at the jelly breakpoints, as well as differences in the energy, required for gel breakage. The values of stickiness of the seed gel (jelly with added basil seeds) are significantly greater than those of the pure plain gel towards tension (stress) and breakout energy (Figure 1).

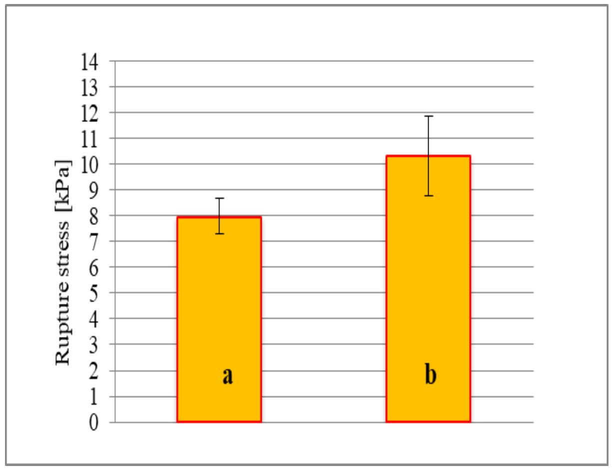

Figure 1. Consistency (stress) graphs of rheological analysis of jelly: (a) acacia jelly and (b) acacia jelly with basil seeds

As observed from the endurance tests, it was found that the seed gel was more durable than the pure plain HM-pectin jelly gel. The energy required to destroy the seed jelly (0.567 N.mm) with the seeds was significantly higher, indicating stronger gel due to the formation of a denser network microstructure. This assumption is supported by the recent findings (Samateh *et al.,* 2018), confirming the involvement of a nanoscale 3D network in the gelation process of the basil seed mucilage. By controlling the gel's microstructure, a wide variety of physical properties can be attained ranging from hard rubbery plastics to soft hydrogels.

Seed gel viscosity with seeds is significantly greater than that of the plain (pure) gel in terms of strength and energy. It was not reported observed stress difference at the breakpoint during the compression, but in the deformation and the energy, the seed gel showed significantly higher values for the seed gel (Figure 2).

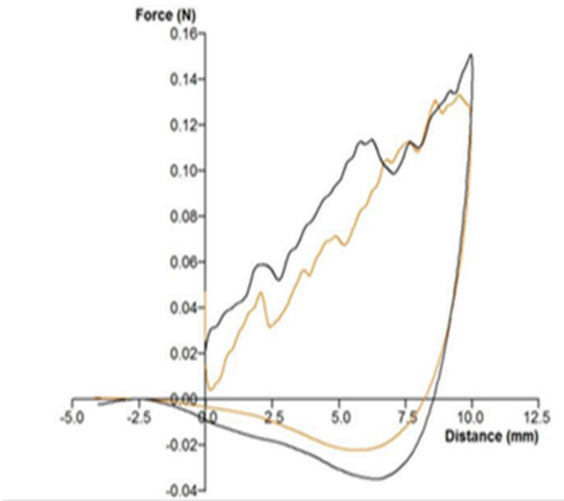

Figure 2. Graphs of rheological texture analysis of acacia jellies: red line – plain jelly; black line – jelly with acacia and added basil seeds.

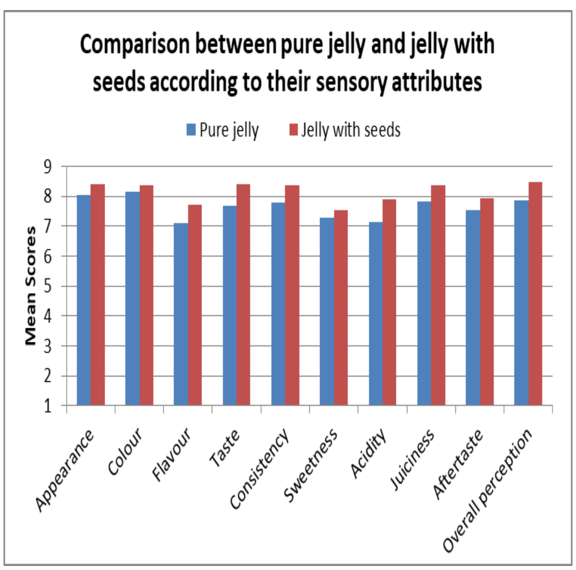

Figure 3. Comparison between pure jelly and jelly with seeds sensory evaluation scores of acacia jellies

The presence of basil seeds in the hydro molecular layer of the acacia gel changes its structural and mechanical performance. Because of the basil seeds applied, the energy used to destroy the gel (0.567 N.mm) was significantly increased compared to the gel without added basil seeds.

3.2. Sensory evaluation

Figure 3 presented the differences in consistency, juiciness, and overall perception between pure jelly and jelly with seeds.

The addition of raw materials in different quantity and quality, such as basil seeds, changed the textural and sensory characteristics of the food matrix (Table 1).

Table 1. Mean scores of the consistency, juiciness and overall perception ratings of pure jelly and jelly with seeds

Attribute	Acacia jelly	Jelly with basil seeds	Wilcoxon Signed Rank Test (two-tailed)	
			Z-values	p-values
Consistency	7.79	8.36	-5.13	2.76-07
Juiciness	7.84	8.38	-4.35	1.36E-05
Overall perception	7.86	8.47	-4.78	1.76E-06

Table 1 represents the mean scores for each combination between the jellies and these three attributes. The chosen level of significance is $\alpha = 0.05$.

In order to choose the appropriate method for statistical analysis, the Shapiro-Wilk test for normal distribution was performed. It showed that the samples were not from normally distributed populations. Hence, the non-parametrical Wilcoxon Signed Rank Test was used in order to conduct the comparisons. Since the samples were big enough (n = 100) Z-values were used as an approximation to the W-values.

The last two columns of Table 1 represent the z and p-values of the test. All z-values are less than the negative two-tailed table value ($z_{(\alpha/2)}=\pm 1.96$) and p-values are less than the significance level $\alpha = 0.05$. Therefore there are significant differences between the ratings of the consistency, juiciness, and overall perception of the pure jelly and the jelly with seeds and the ratings for the jelly with seeds score better.

The sensory evaluation revealed a positive influence of the added seeds on the colour, flavour, and consistency indicators (Figure 4).

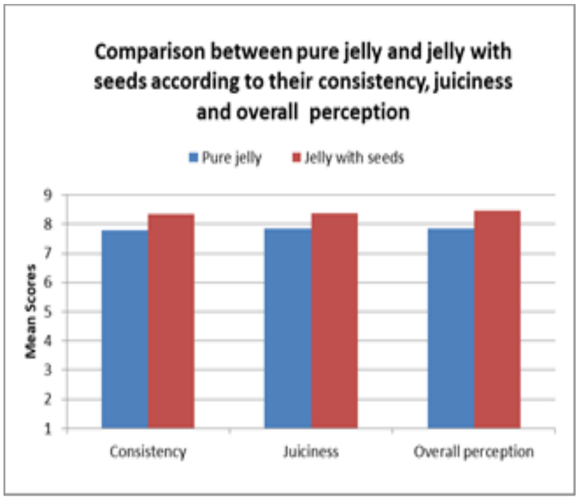

Figure 4. Comparison between pure jelly and jelly with seeds according to their consistency, juiciness, and overall perception.

When the textural and sensory characteristics of the two acacia gels were compared, it was determined that the pure gel had more pronounced juiciness.

Compared to the gel with the participation of basil seeds, confirming the experimentally established penetration hardness. It is observed that 47% of the panelists estimated the appearance of gel with the presence of basil seeds as "extremely liked", while only 24 % of the panelists assessed the pure gel as "extremely liked". The results showed that 56% of the panelists gave the highest mark for the colour of the gel with basil seeds, while only 37% of the panelists ranked the colour of the pure gel with the highest mark. Most of the evaluators (68%) assessed highly the gel with basil seeds, toward the remaining 22% of the panelists, who shared that they would prefer the natural, pure jelly without basil seeds.

4. Conclusions

The present study has shown good possibilities for the application of white false acacia in pectin jelly production. The light colour of the obtained jellies provided the opportunity to combine with other raw materials, such as seeds, nuts, and others, to improve the textural, sensory, and functional properties of the final product. It was proven the positive effect of basil seeds addition on the flavour, and overall evaluation of the jellies. The present study created opportunities for new researches with a view to the possibilities of combining different plant raw materials in composite solutions. Object of subsequent studies will be the determination of biologically active substances, chemical composition, and the possibilities of obtaining low sugar jelly with the participation of white false acacia (*Robinia pseudoacacia* L.).

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