JAP&T
TPA-Timisoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2021, *27*(2), 164-171

Journal of Agroalimentary Processes and Technologies

Edible flowers in novel foods: primary studies in the manufacture of flower compote of acacia (*Robinica pseudoacacia*), rose (*Rosa damascena*) and elder (*Sambucus nigra*)

Maria Lidia Iancu

"Lucian Blaga" University of Sibiu, Faculty of Agricultural Sciences, Food Industry and Environmental Protection, 5-7, Ion Raţiu Street, Sibiu, 550012, Romania

Abstract

Conservation technique according to the biological principle of anabiosis, physioanabiosis is used for the preparation of innovative food, edible flower compote, roses, elder and acacia, individual and the well-known white grape compote, peaches, cherries, black grapes, chopped plums and quinces, as well as two samples of commercial peeled peach compote and apricot halves, a total of 11 samples. They were analyzed, the three new products, from edible flowers, compared to those already on the market. We used: sensory analysis, refractometric technique, analytical determinations, gravimetric to obtain the values of primary quality indicators. For new edible flower products, a database was created containing values for: the proportion of flowers 8-21%; TSS = 10.7-13.9 ºBx; pH = 3,328-3,738; titratable acidity 0.54-0.86 % w/w expressed in citric acid; kinematic viscosity 1,587-1,923 cSt; ºBx/acidity of 14-20 and sensory grade 27.7-30.76 points out of 45, as the main primary quality indicators. It is recommended to consume innovative edible flower products because they are a way to use free sources of raw materials.

Keywords: *Robinica pseudoacacia*; *Rosa damascena; Sambucus nigra*; compote technologie, physico-chemical indicators

1. Introduction

The consumption of flowers in the diet is reported in some culinary cultures around the world as traditional cuisine or alternative medicine, along with their use as ornaments. Many species of edible flowers are considered delicacies with nutritional value [1]. Although edible flowers have been used since ancient times for their smell and beauty, the world discovers the value of flowers as food as long as consumers seek in them innovative natural sources of bioactive compounds [2].The activity of most edible flowers fits well in the current trend to search natural and healthy foods. On the other hand, some species of edible flowers already have extensive literature on their nutritional composition and biological activity and are used worldwide, such as *S. nigra* and *M. oleifera*. The consumption of edible flowers is also related to the development of functional foods [1].

Compote is a dessert originating in medieval Europe, obtained from whole fruits or pieces of fruit in sugar syrup [3]. Whole fruits are cooked in water with sugar or sweeteners, vanilla peels, lemon or orange, cinnamon sticks or powder, cloves, ground almonds, coconut, candied fruit, raisins. The fruits used are strawberries, apricots, peaches, apples, rhubarb, plums or cherries in a large volume of water. It is obtained by pasteurization at about 90 ºC for 10 minutes and is completed by storage for 15-20 days [4, 5]. It is a cheap food product with a very good production yield and a shelf life of at least 8 months [4].

Many flowers are used in food but those of interest for this study are those of acacia, rose and elder.

Robinia pseudoacacia L.(acacia), belongs to the family *Fabaceae*, it is a honey tree, with tall stem, up to 25-30 meters. It is acclimatized in North America, Europe, South Africa and Asia, Europe.

Corresponding authors: maria.iancu@ulbsibiu.ro, Tel: +40-(269) 21.13.38

The flowers are used in food and natural pharmacy. Acacia flower it is white and is an inflorescence with a length of 10-15 cm and is edible and nutritious. In traditional medicine it is used as a diuretic, sedative, anti-inflammatory of the biliary tract [6,7]. They are high in protein and microelements, flavonoids, robinin, polysaccharides [8-10], zinc, magnesium, iron, calcium, copper, nickel and boron arsenic in very small quantities ng.[11]. They have a nice smell that is given by β-carene, linalool (21%), (Z)-β-farnesene and anthranylated aldehyde [12]. Bioactive components are phenols, ascorbic acid [13-16]. They are used in food in the preparation of cakes, in functional products as sources of antioxidants [17]. They are also used in the preparation of syrup [11].

Rosa damascena (Damascus rose) is a hybrid of roses, derived from *Rosa gallica* and *Rosa moschata*, so it is part of the cultivated flora. The flowers are famous for their fine fragrance. The aromatic profile includes β-citronellol, nerol, trans geraniol, eugenol metal, nonadecanes, from the 103 flavor components, depending on the time of harvest and shelf life [18]. The flowers are harvested commercially and for rose oil used in perfumery and to make rose water. Flower petals are also used for flavoring food, as a vegetable garnish and preserved in sugar. Rose water and powdered roses are used in Persian, Indian cuisine and from the Middle East. Meat dishes are sprinkled with rose water, while rose powder is added to sauces. Chicken with rose is a popular dish in Persian cuisine. However, the most popular use is in flavoring desserts such as ice cream, jam, Turkish delicacies, rice pudding and yogurt [19].

Sambucus L. (elder) is a genus of plants in the group of shrubs, with 20-30 species.The genus is part of the *Adoxaceae f*amily. The best known species is the black sambucus (*Sambucus nigra*). Usually, flower heads are used in the preparation of soft drinks, in Northern Europe and the Balkans. In Europe, Romania, flowers are used to prepare ”socată”. The flowers can be, also, immersed in a light stew and then fried to make elder flower steaks. The flowers, as well as fruits can be turned into wine, brandy. In southwestern Sweden, it is traditional to make a liqueur with shock flower, slightly alcoholic champagne. Elder flower extracts possess anti-inflammatory, antioxidant biological activities [20, 21]. Antioxidant activity is given by flavonoids (cyanidin, cyanidin-3 glucosides). The polyphenol content is low in elder flowers [22].

This study aims to as the main objective preparation of assortments of flowers compote rose, elder and white acacia, individually, as innovative products, using adapted technology, and as a secondary objective, determination of primary quality indicators and impact on consumers.These indicators are compared with those of some assortments of compote known in Romania: white grape compote, black grape, plums, sour cherries, apricots, peaches and chopped quinces.

2.Materials and methods

2.1 Materials

2.1.1. Raw materials: For this study, raw materials from the wild flora of Romania were used, fresh elder flowers, acacia, from the culture flora *Damascus rose*, the fruits of fruit trees such as: plum, sour cherry, peach, quince, fruiting shrubs like white and black grapes from the geographical area Sibiu, Romania, sugar, citric acid, and compote of peaches halves peeled, apricot halves from trade.

2.1.2 Preparation of compote: Is made according to known technological schemes containing the operations: reception, sorting, washing, removal of inedible parts, peeling, dividing, syrup preparation, dosing in jars, closing, pasteurization at specific parameters, storage for at least 20 days at 8-10 ^{o}C. For new products, innovation the manufacturing scheme is represented in the results and discussions chapter.

2.1.3. Compote samples-codes: Compote samples-codes are RpC- rose petals compote; EFC-elderflower compote; AFC- acacia flower compote; WGC-white grapes compote; PWC-hole peaches compote; CHC- cherry compote; AhC- Apricots halves compote; BGC- black grapes compote; PC – plums compote; QC – quince cut compote; PpC – peeled peaches compote.

2.2. Methods

2.2.1. Chemical analysis: The appropriate choice of the analysis package was made so as to highlight the quality indicators that change the most. Thus used: TA-titratable acidity (g/100g, expressed in anhydrous citric acid) [23]; TSS-soluble solid content (w/w%) [24] (refractometer Krűss, connected to a bath room ultrathermostated Brookfield, with the outer circulation, Germany); Kinematic viscosity (m^2s^{-1}(cSt))(Ubbelhode viscometer with 3 branches no.1) [25], relative density [26] (DMA 35, Spain); pH (pH meter type

Orion 2-STAR-England); as well as for the product as a whole: net weight and proportion of fruit [27].

2.2.2. Sensory evaluation: The scoring method was used to evaluate the compote samples, was variant with 45 points. They were analyzed the following characteristics considered relevant for the study: color, taste, flavor. The scale for each feature and level within the feature was 1-5 points (5 point for very good, 4-good, 3-specific, 2-specific, 1-unsatisfactory); as follows: for color; taste, flavor. A panel of 18 members, boys and girls, was used, aged between 20-25 years, students of the "*Lucian Blaga*" University of Sibiu, Faculty of Agricultural Sciences, Food Industry and Environmental Protection who were trained for 2 weeks. The intensity of the flavor components was assessed. Flavor descriptors were perceived by smell and taste. Being food frequently consumed by panelists, the reference was the range of flavors memorized by panelists during their lives and training.

2.2.3 Statistical analysis: For the values of the measured variables the mean and standard deviation (SD) were calculated. The t-Test was used. The series had 6 values for each variable. It was used Standard Deviation and Variance [28] and Excel Word program, for graphical representation.

3.Results and Discussion

3.1 Technological studies

According to the classic technological scheme were obtained assortments of compote which are presented next to Table 1 and which were analyzed in this study. The order of operations that are used in the preparation of edible flowers compotes are shown in Figure 1. It resembles the ones used usually in the manufacture of the other compotes studied here. The peculiarities emerge from the nature of the raw materials and of the finished product. The flowers do not wash. At the rose the petals are separated from the peduncle. Pasteurization helps to destroy pathogenic microorganisms [11]. The pasteurization time is less than 10 minutes at atmospheric pressure and is influenced by: the size of the glass container and the botanical features of the solid fraction (proportion of flowers).

So, according to table1 the net mass has values between 236 g to 728 g. The analyzes were performed in six replicas and the results show a significant difference $p < 0.05$. This value is influenced by storage capacity of the jar used, density of the mixture, morphological parts of the plant and their shape. The proportion of fruit, according to the theory for compote cannot be less than 47% [3].

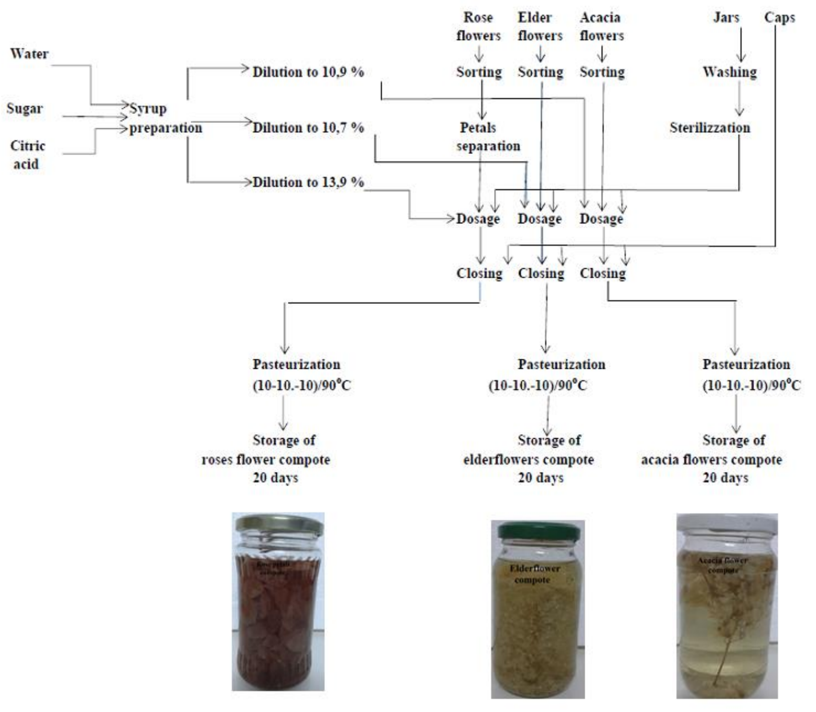

Figure 1. Technological scheme for the production of innovative varieties of compote from rose flowers, elder flowers and acacia flowers, individually prepared

Table 1. Net mass values and fractions components of compotes prepared and studied

Samples	Net mass, [g]	Proportion of fruit (flowers) [%]	The proportion of liquid, [%]
RpC	309 ± 1.53	21 ± 2.8	79 ± 1.21
EFC	236 ± 0.52	12 ± 0.8	88 ± 0.63
AFC	323 ± 1.64	8 ± 1.77	92 ± 1.75
WGC	728 ± 0.24	57 ± 0.51	43 ± 0.49
PWC	299 ± 0.25	45 ± 0.75	55 ± 0.71
CHC	585 ± 1.48	63 ± 9.1	63 ± 8.7
AhC	717 ± 1.03	52± 0.82	48 ± 0.8
BGC	670 ± 1.03	50 ±1.03	50 ± 1.029
PC	715 ± 103	44 ± 0.19	56 ± 0.18
QC	642 ± 1.41	65 ± 0.16	35 ± 0.13
PpC	696 ± 2.07	58 ± 0.1	42 ± 0.09

The level of significance is P < 0,05 (n = 6). At the 0,05 level, the population mens are significantly different: RpC- rose petals compote; EFC-elderflower compote; AFC-acacia flower compote; WGC- white grapes compote; PWC-hole peaches compote; CHC- cherry compote; AhC- Apricots halves compote; BGC- black grapes compote; PC – plums compote; QC – quince cut compote; PpC – peeled peaches compote.

Table 2. Physicochemical indicators determined and calculated for the liquid fraction of compotes

Sample	**TSS [°Bx]**	**Correct value byrefractometer, [°Bx]**	**Sucrose [g/1000ml]**	**°Brix/ TA**	**Sample density at 20°C [g/cm³]**	**Apparent SG at 20/20°C**
RpC	13.9±0.037	13.98	147.08	16±0.15	1.0548±0.002	1.05692
EFC	10.7±0.023	10.77	112.02	14±0.1	1.0417±0.007	1.0438
AFC	10.9±0.092	10.94	113.85	20±0.09	1.0417±0.001	1.04376
WGC	19±0,053	19.02	204.52	22±0.08	1.0769±0.003	1.07908
PWC	14.4±0.079	14.54	153.53	10±1.01	1.057±0.023	1.05916
CHC	15.4±0.065	15.79	167.23	5±1.46	1.06203±0.01	1.06416
AhC	17.5±0.57	17.86	190.69	6±0.3	1.07129±0.006	1.07344
BGC	17.5±0.09	17.56	187.45	12±0.29	1.07009±0.005	1.07224
PC	17.4±0.021	17.46	186.37	24±0.21	1.06969±0.003	1.07184
QC	18.1±0.055	18.22	195.18	15±0.21	1.07273±0.004	1.07488
PpC	15.4±0.05	15.45	163.56	26±1.5	1.06067±0.005	1.0628

The evidence of cherry compote, grapes, whole apricots, half apricots, peeled peaches, quince, whole plums is between 44% to 65%, so accordingly. The lowest value is 44% for whole plum compote (PC) and the highest of 65% for chopped quince compote (QC). For samples of edible flowers the proportion of flowers is very small of 8% -21%, compared to the other varieties for which it is 44% -65%. The minimum fruit content is 47% [3]. These values are influenced by: vegetable shape, degree of division and their ability to occupy as much volume as possible. For the new assortments of compote from edible flowers, the numerical values of the flower quantity do not comply with standard rules. Used for a packaging unit an influence, because it was considered that is enough for ensure a specific flavor, typical for the smell known to consumers of rose flowers, elder and acacia.

This is because the flower has a fragile morphological structure, which, initially occupies a large volume and after hydrothermal treatment it softens occupying a smaller volume. This proportion, however, ensures the specific aroma of fresh flowers, and that is actually the purpose. The highest value was obtained for the rose petals sample (RpC-21%) because only the petals were used and a larger quantity was needed to obtain a compote with an aroma similar to that of fresh flowers.

3.2. Comparative analysis of physicochemical indicators of compotes from flowers and other fruits

Because from new products, ie, rose petal compote, elder flower compote and acacia flower compote, prepared separately, we consume only the liquid fraction (syrup), further, physicochemical analyzes were performed only on this fraction for the 11 samples studied, except for sensory analysis.

These parts of the compote were called: solid fraction (fruct or flowers), and the liquid part, liquid fraction, because it has a more complex composition than sugar syrup. Primary quality indicators were determined,but which changes as soon as there are changes in the manufacturing technology, recipe, raw material used. In figure 2 are represented graphically variations in values for titratable acidity (TA), pH, kinematic viscosity (ν) and reference index (nD). The influence of the use of very different fruits and flowers was significantly different ($p < 0.05$). Titratable acidity is an important indicator of quality which is relevant for the degree of freshness and the ºBrix / acidity ratio. The values obtained in this study are between 0.54-3.3% w / w expressed in anhydrous citric acid. The maximum value 3.3% w/w expressed in citric anhydrous acid was obtained for the liquid fraction of cherry compote (CHC) and the lowest of 0.54% w / w citric acid anhydrous for acacia flower compote (AFC). In this study, these values are influenced by the acidity of raw materials, their degree of maturity, the addition of acid in the recipe, the preference of the beneficiary, especially for homemade ones. The pH is acidic and between 3.24-3.75. Newly prepared products fall within the pH range in this value range.

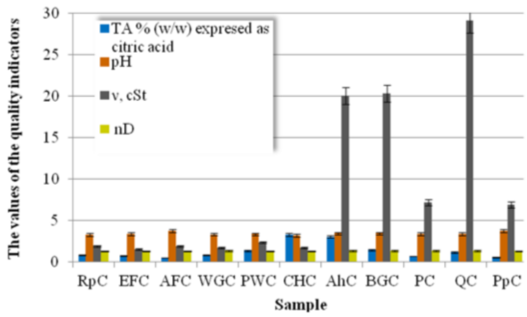

Figure 2. Variation of total acidity (TA), pH, viscosity (v) and refractive index (nD) for liquid fractions of compote samples. The level of significance is $P < 0,05$ ($n = 6$). At the 0,05 level, the population mens are significantly different: RpC- rose petals compote; EFC- elderflower compote; AFC- acacia flower compote; WGC- white grapes compote; PWC-hole peaches compote; CHC- cherry compote; AhC- Apricots halves compote; BGC- black grapes compote; PC – plums compote; QC – quince cut compote; PpC – peeled peaches compote

As the acidity increases lowers the pH. The new varieties of compote, from edible flowers, have a pH of 3.328 (RpC); 3.738 (AFC); 3.393 (EFC). These values fall within the range of values obtained for the other samples. The result is not influenced by the pH of the flowers, but only by the recipe. It will be the subject of a prospective study.

The kinematic viscosity is an expression of the flow behavior of the liquid. In this study, it has a higher value for all samples compared to that of water, which is 0.516 cSt. The values obtained for the studied samples are comparable with each other and in the range of 1.75cSt to 20.29 cSt. Exceptions are the kinematic viscosity values for the liquid fractions of samples of apricot compote halves (AhC) (20.044 cSt), black grapes (BGC) (20.288 cSt) and chopped quinces (QC) (20.049 cSt).

These particularly high values compared to those of the other samples studied are given by the content of substances in the total dry matter that migrates into the liquid fraction of the compote during storage. These substances are: sugars, minerals, vitamins, pigments, essential oils, acids, glucosides that have the ability to increase the viscosity of solutions. For innovative products,

from flowers, the kinematic viscosity values are: ν_{RpC} = 1.902 cSt; ν_{EFC} = 1.587 cSt and for ν_{AFC} = 1.923 cSt.

The refractive index, nD (table 1), determined refactometrically, has values between 1.3443 to 1.3565, above the value of nD_{water} = 1.333. However, it does not have very high values in the samples in which high viscosity values were read which demonstrates that the substances that influence the increase in viscosity are not optically active.

TSS, totally soluble substance is an expression of the content of soluble substances measured using the phenomenon of light refraction. It was read soluble content (ºBx) (table 2). These results are relevant for the product as a whole even if they were made only in the liquid fraction, because during the completion of the product (at least 20 days) dry matter gradient between fruit, flowers and syrup disappear.

For the correction of TSS values and the rendering of the result at a temperature of 20ºC and depending on the acidity, a correction table was used [30]. The sucrose content expressed in g / l was determined tabularly according to the relative density of the sample.This, the latter was calculated according to the sample density and water density at 20 ºC (table 2).

The level of significance is P < 0,05 (n = 6). At the 0,05 level, the population mens are significantly different: RpC- rose petals compote; EFC-elderflower compote; AFC-acacia flower compote; WGC- white grapes compote; PWC-hole peaches compote; CHC-cherry compote; AhC-Apricots halves compote; BGC- black grapes compote; PC – plums compote; QC – quince cut compote; PpC – peeled peaches compote

In the edible flower compote samples the values are: 13.9 ºBx (RpC); 10.7 ºBx (EFC) and 10.9 ºBx (AFC) (Table 2). These are influenced by the amount of sugar in the recipe. The flowers do not have a TSS content, determined here, which would influence the ºBx/acidity, ratio. This is the subject of a prospective study.

Having the results can be determined in the end an important quality indicator namely ºBx / acidity ratio which is an indicator of quality with great influence on the sensory characteristic of taste which influences consumer acceptability.

A value of 15 of the ratio is considered gives a balanced taste (between sour and sweet components as a basis of taste). The values of 5 (CHC) and 6 (AhC) are small due to too high acidity. For flower compote the value of the ratio is 14 (EFC); 16 (RpC) and 20 (AFC) and are close to the ideal value, balanced in terms of the basic components of taste, so theoretically they should be accepted by the consumer.

The density of the liquid sample is influenced by the value of the soluble substance with all its influencing factors. It has high values compared to water (ρ = 0.998 g /cm^3) (table 2). The apparent SG was calculated by relating the value of the sample density to that at the same temperature (20 ºC). Similar results were obtained in the study presented on exotic fruit compote [28].

3.3. Sensory analysis

Samples that obtained higher score values for the appreciated features especially for flavor are: CHC (cherry compote) (8.58 points) and PpC (peeled peach compote) (16.63 points). So the consumer was captivated by the intensity of the flavor enhanced by the increased value of acidity and the content of glutamic acid, but also by the habit of consuming these dessert foods.

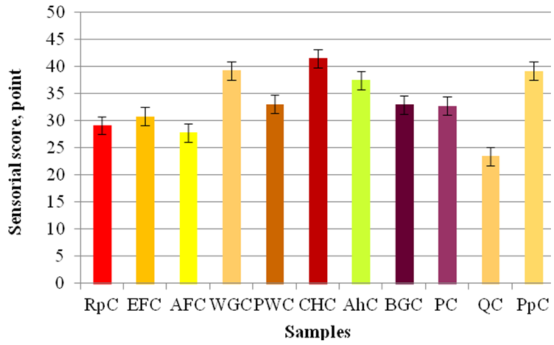

Figure 3. Total sensory score for compote samples prepared and studied (n = 6): RpC- rose petals compote; EFC- elderflower compote; AFC- acacia flower compote; WGC- white grapes compote; PWC-hole peaches compote; CHC- cherry compote; AhC- Apricots halves compote; BGC- black grapes compote; PC – plums compote; QC – quince cut compote; PpC – peeled peaches compote

Total sensory scor is the highest was obtained for the CHC sample, cherry compote (41.41 points) despite theoretical considerations. The kernel aroma given by amygdalin, that cyanogenic glycoside combined with sour cherry acidity is irresistible and common in consumption.

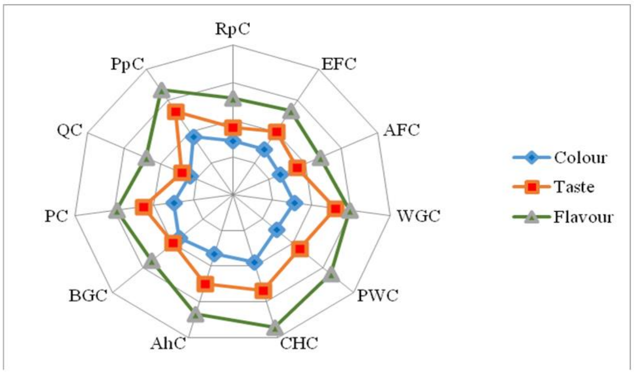

Figure 4. Sensory characteristics of the studied compotes: color; taste; flavor: RpC- rose petals compote; EFC- elderflower compote; AFC- acacia flower compote; WGC- white grapes compote; PWC-hole peaches compote; CHC- cherry compote; AhC- Apricots halves compote; BGC- black grapes compote; PC – plums compote; QC – quince cut compote; PpC – peeled peaches compote

For the new innovative products, sensory notes, RfC (29,11); EFC (30.76) and AFC (27.76) have values located at a distance of 12.3 points (RFC); 10.65 points (EFC) and 13.65 points (AFC) compared to the highest value obtained for the studied compotes (41.41) that is, cherry compot sample . Among the sensory characteristics determined as color, taste and aroma, the highest value obtained was for the aroma of 18.58 points for the cherry compote sample. At the same characteristic, the edible flower compote obtained low values of 12 points (RpC), 13.41 points (EFC) and 12 points (AFC). For the taste characteristic, the values 6.49 (AFC) were obtained; 7.29 (EFC) and 7 (RpC). The flowers used as raw material they failed to transmit an intensity of aroma comparable to the smell of uncollected flowers, aroma from the memory of the panelists. The values for flavor intensity, determined sensorially (figure 4) are the lowest and a supplement of the recipe with a natural concentrate of specific flavor obtained from the first evaporation fraction is recommended.

4.Conclusion

The results of this study are in line with the proposed objectives. They were obtained values of primary quality indicators for three new products, from rose flowers, elderflower, acacia, used separately and processed according to the technology of obtaining the compote.The values obtained improve the database of this type of product and are as a range of values in existing ones, except for the proportion of solid fraction (flowers) which is very small of 8% -21%, compared to other varieties where it is between 44% -65%. From sensory analysis for compote assortments it turned out that the new products obtained need improvements to the manufacturing recipe such as: increasing the acidity, increasing the soluble dry matter content and the intensity of the specific aroma of the flowers, known, by adding specific flavor concentrate. For samples of grape, apricot, peach, quince, plum, sour cherry compote is consumed both the solid fraction (fruit) and the liquid fraction (syrup). For the new products obtained from flowers does not consume the solid fraction. Is recommended specific filtration of the mixture before consumption. These results suggest that identified factors are: the particularities of the fruit, the requirement of the beneficiary, the recipe used, the consumer's preferences. Is recommendedto consume new innovative products from edible flowers because they are a cheap way to create products from free sources of raw materials.

Compliance with Ethics 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 exist) respect the specific regulation and standards.

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