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RESEARCH ON OBTAINING A SOFT DRINK WITH NUTRACEUTICAL POTENTIAL, BASED ON *COCA COLA* AND ORANGE JUICE

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Abstract: Iconic *Coca-Cola* and premium orange juice are the most consumed soft drinks and juices in the world. In the present study the obtention five samples of soft drink by mixing the two beverages in different proportion, 1:0.125, 1:0.25, 1:0.5, 1:1 and 1:2 was described. The physicochemical and sensory characteristics were described. The determined quality indicators were the following: the relative density, the soluble dry matter, the total acidity, the turbidity, the kinematic viscosity, the soluble dry matter/titratable acidity, the carbon dioxide, the vitamin C, the sensory analysis. Compared to the *Coca-Cola* and premium orange juice control samples, the consumer's favorite was the sample with *Coca Cola*: premium orange juice - ratio 1:2. The values of the quality indicators of this innovative combination are in the range of known values for the non-alcoholic beverages, but the CO_2 content is 1.52 g/100 cm^3 and that of the ascorbic acid is 467 ppm. The 467 ppm increase in the vitamin C content as compared to *Coca-Cola*, which contains 0 ppm, can place this sample in the category of the nutraceutical beverages naturally enriched with vitamin C.

Keywords: *Coca-Cola, nutraceuticals, orange juice, quality indicators, vitamin C*

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INTRODUCTION

The COVID-19 epidemic has led to an increase in the consumption of natural foods, opening this niche for the alternative nutraceuticals from fruits and vegetables [1 – 3].
The nutraceuticals are considered to be natural medicines that can be used in the prevention and treatment of some diseases. The global market figures show a substantial growth of nutraceutical consumption over the last five years and in the future [4]. It has been demonstrated that fruits have a very high nutraceutical potential. Thus, studies have been conducted on: cherries (*Prunus avium* L.), cranberries (*Vaccinium macrocarpon*), acai berries (*Euterpe oleraceea*) [5]. The natural raw materials, such as the ones mentioned above or others, must comply with the sanitary conditions [6]. Also, there are guidelines to guarantee the quality, safety, and efficacy of these raw materials, specifying the minimum conditions to be met, the fruits' bioavailability, allergenicity, nutritional and toxicological information. The authentication of a nutraceutical product requires an authorized confirmation study [7, 8]. The trend is to conduct studies in order to obtain nutraceuticals based on plants and fruits, especially fruits, as an excellent supply of phytochemicals, carbohydrates, vitamins, amino acids, peptides and antioxidants [1]. The components of the fruits, namely the reason why these fruits are used, are the ones that have effects on the consumer too. They are the anthocyanins, the vitamins, the glycosides, and the terpenes. Thus, fruits become a raw material for the nutraceuticals [1]. There are studies on the development of certain nutraceutical compounds based on fruit, which have been patented and used [9]. These can be pharmaceutical products that are consumed by dissolution in beverages. This is how we got to the idea of this study, namely to combine *Coca-Cola* with premium orange juice.
Coca-Cola is one of the most well-known soft drinks and manufacturing companies in the world, with the largest distribution system, servicing consumers in approximately 200 countries [6, 10]. Currently, the owners of the company claim that the original *Coca-Cola* formula has been well guarded, and it is inaccessible [11]. Some say it's just a marketing strategy developed by the company. Nowadays, the beverage contains: water, sugar, carbon dioxide, E 150d food coloring, phosphoric acid acidifier, natural flavors, and caffeine. *Coca-Cola* was invented by John Pemberton in 1885 but it has undergone important changes since then [11]. Some ingredients have disappeared from the recipe, such as: the coca leaf (*Erythroxylum coca*) extract and sometimes the caffeine and the sugar. The latter can be replaced by non-caloric sweeteners [12, 13]. However, the flavor remains even after removing the cocaine from the coca leaves and it is still being used [14 – 16]. An old *Coca-Cola* recipe contained: 28 g of caffeine citrate, 85 g of citric acid, 30 mL of vanilla extract, 946 mL of lime juice, 71 g of "flavoring", alcohol, orange oil, cinnamon oil, lemon oil, coriander, nutmeg, orange blossom, 14 g of sugar, 118.3 mL of fluid coca extract and 9.51 liters of water [11]. Nowadays *Coca-Cola* contains 44 calories/100g, with the glycemic index of 70; 0.1 % protein; 12 % carbohydrates of which 12 % sugars, without lipids, without vitamins, with a sodium content of 4.2 g/100g, without caffeine and alcohol [11]. The therapeutic effect of consuming *Coca-Cola* consists in improving the gastric discomfort symptoms in children and adults such as: nausea, vomiting, fecaloma, or gastric reflux. It has an antibacterial effect on *Escherichia coli*, *Escherichia coli* O:157 H:7, *Salmonella enteriditis*, *Enterococcus faecalis*. This is due to the content of phosphoric acid currently used in the production of some medicines for digestive disorders [17].

The tendency of the soft drinks market is to move consumers away from varieties made from artificial ingredients. There is a shift towards products that claim to have functional health benefits [18]. In order to obtain these varieties, the juices of different citrus fruits can be used, such as: oranges, lemons, limes, either directly or as a concentrated juice. There are countries such as Australia where there are extra fees charged for sugary beverages (with added sugar) for this added ingredient [19]. Therefore, *Coca-Cola* Australia has changed its strategy. In Romania, there are varieties of soft drinks marketed by the *Coca-Cola* company such as: *Coca-Cola* Cherry, *Coca-Cola* zero Lime, *Coca-Cola* zero Peach, *Coca-Cola* specialty apricot and pine, *Coca-Cola* apple and elderberry, *Coca-Cola* blackberry and juniper, kiwi.
The most preferred and well-known juice in the world is orange juice. This is due to its sensory and nutritional properties. It is rich in nutrients such as: ascorbic acid (vitamin C), folic acid (vitamin B_9), potassium, magnesium and iron, calcium, carbohydrates. The health benefits associated with its regular consumption include: strengthening the immune system, reducing the risk of cancer, improving digestive health, protecting the cardiovascular system, reducing cholesterol levels, preventing kidney diseases, contributing to weight loss, reducing wrinkles, preventing hair loss, and more [20].
Taking into account these aspects, it can be expected that the combination of the two drinks, *Coca-Cola* and premium orange juice, results in a beverage variety having a nutritional potential and certain sensory qualities. The aim of this study is to achieve a combination between the two well-known representatives of the soft drinks and juices industry by preparing several samples and choosing the one which is most preferred by the consumer. The collateral objectives are to develop a database of quality indicators for this combination of raw materials and to demonstrate that the *Coca-Cola* can be naturally enriched with ascorbic acid and thus transformed into a nutraceutical variant of this type of beverage.

MATERIALS AND METHODS

Materials

Samples

The carbonated soft drink *Coca-Cola* and the oranges used to obtain the orange juice were purchased from the local market.

Orange juice preparation

The oranges were washed and cut in half. A hand squeezer juicer was used for the preparation of juices, by twisting. Cloudy premium orange juice (OJP) is obtained.

Obtaining soft drinks based on Coca-Cola *and premium cloudy orange juice*

Mix cloudy premium orange juice (OJP) with *Coca-Cola* (*CC*) in the following proportions to *Coca-Cola*: 1:1 (COJ_1); 1:2 (COJ_2); 1:0.5 (COJ_3); 1:0.25 (COJ_4); 1:0.125 (COJ_5).

Physicochemical Analysis

To determine the values of the quality indicators for the methods used were:

- titratable acidity (TTA) expressed as citric acid g/100g, was determined using European Standard Method [21];
- the relative density was measure using the pycnometer, areometer and portable electronic densitometer technique [22];
- the *p*H-value were determinate using a *p*H-meter Orion 2-STAR (England) [23];
- the soluble solid content (SSC) expressed in ºBx was determined using refractometer *Krüss*, connected to a bath room ultrathermostated, *Brookfield*, with the outer circulation, (Germany) [24];
- the kinematic viscosity expressed in cSt, using Ubbelhode viscometer with 3 tubes [25];
- the turbidity expressed NTU, using determination of turbidity by Nephelometry at TB 100 Portable Turbidity Meter, (China) [26];
- vitamin C [27], SSC/TTA and determining the carbon dioxide (CO_2) content by the volumetric method, by fixing the free carbon dioxide and titrating the excess of sodium carbonate with hydrochloric acid and is expressed in g/100 cm^3 [28].

Determination of vitamin C content

Ascorbic acid ($C_6H_8O_6$) undergoes an oxidation reaction with potassium iodate in acidic condition. The quantity of potassium iodate consumed is determined iodometrically using the HI 3850A-0 kit. To calculate the concentration of Ascorbic Acid multiply by 10 the number of drops of HI 3850C-0 titration reagent used [29].

Sensory analyses

The scoring method was used for the sensory analysis (low number of points) which adopted for the characteristics: appearance, color, clarity, smell, taste, levels of appreciation with points, from 0 to 5. The results are quantified using the importance of coefficients as: 1 for appearance, 2 for color, 1 for clarity, 2 for smell and 4 for taste. Questionnaires were drawn up and filled in by 21 trained panelists, students of the Faculty of Agricultural Sciences, Food Industry and Environmental Protection from the "Lucian Blaga" University of Sibiu, girls and boys aged between 19 and 25.

In the second part of the questionnaire, the panelists were tested only online, in an opinion poll. They answered 4 questions: Q1. How often do you drink soft drinks? Q2. Do you drink soft drinks like *Coca Cola*? Q3. If the *Coca Cola* product contained vitamin C, would you buy it? Q4. Do you think something needs to be changed about the innovative product obtained?

Because they are consumers of *Coca-Cola* and orange juice, they were a very good target, trained for this marketing survey regarding the promotion of the new product obtained, i.e. Coke with orange juice.

In order to carry out the sensory analysis, the samples were coded with numbers as follows: 881- CC; 893- OJP; 783-COJ_1; 873- COJ_2; 378- COJ_3; 387- COJ_4; 738- COJ_5

Statistical analysis

The samples were realized in triplicates. The mean value, deviation from the mean, squared probable error, mean squared error, mean squared error of the selection mean, confidence interval were calculated, tabular "*t*" was used for a 0,05 significance levels and two degrees of freedom and then the actual value of the quality indicator was calculate. The Excel program from Microsoft Office Windows 7 was used for the graphical representations.

RESULTS AND DISCUSSIONS

Through the volumetric technique, the volumes were measured and the two drinks were combined at room temperature in the proportions presented in Materials and Methods. The obtained samples are shown in Figure 1.

Figure 1. *The control samples - Coca-Cola (CC) and orange juice premium (OJP) and the obtained samples obtained by combined CC and OJP in different proportions*

A change in color and appearance can be noticed in the first five samples, from left to right. These are influenced by the blending ratio. However, the food coloring in the *CC* remains predominant, which gives the dark hue of the samples and OJP.

Specific gravity d_{20}/d_{20}

Specific gravity is a quality indicator that is very sensitive to the change in the recipe of innovative soft drinks. The results obtained are significantly variable ($p > 0.05$). Thus, the correlation indices resulting from the generation of the linear regression equations (Figure 2) are the following: $R_{CC2} = 0.8242$; $R_{OJP}^2 = 0.750$; $R_{COJ1}^2 = 0.4286$; $R_{COJ2}^2 = 0.998$; $R_{COJ3}^2 = 0.4286$; $R_{COJ4}^2 = 0.9968$; $R_{COJ5}^2 = 0.75$. The best correlation of the relative density values was recorded for COJ_2, COJ_4 and CC work samples.

The latter is a clear beverage, without suspended solids content. In the case of the POJ, due to the large-sized particles specific to the cloudy juice, the correlation of the values is not higher than 42 %. This aspect can influence the measurement accuracy depending on the operating principle of the device used to determine the density of the sample. When the two liquids are mixed, these particles are diluted and thus the density values correlate better.

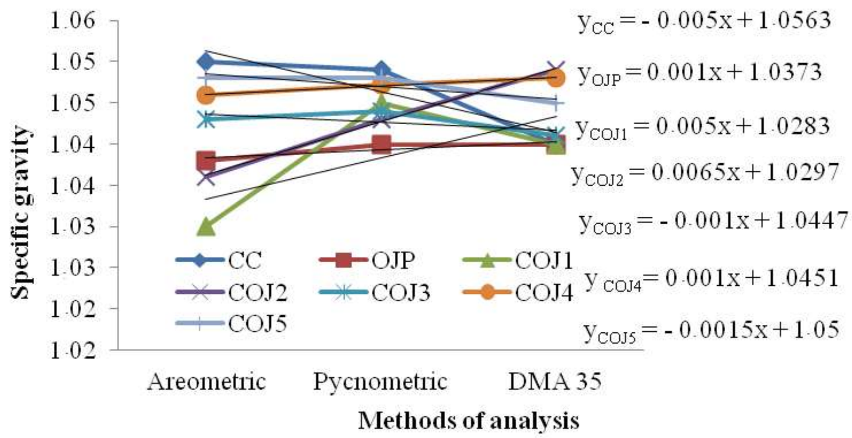

Figure 2. *Variation of relative density values obtained using the areometric technique, pycnometric and using the portable electronic densitometer of the soft drinks in combination with orange juice*

However, the obtained values have correlation indices very close to 50 % and higher than 50 %, a fact which support the idea that these methods of determining the relative density of the liquids can characterize these types of innovative beverage combinations. It is important to note that the values obtained for the studied samples range within the standard values for juices and soft drinks. The relative density of the work samples is d^{20}_{20} = 1.03 - 1.04.

Soluble solids content (SSC), pH, total titratable acidity (TTA), SSC/TTA

In juices, SSC indicates the content of soluble sugars and is one of the most important quality indices. For the working variants, the values obtained are from 10.0 to 11.3 °Bx, so in the range of values for juices. It is influenced by the coupling ratio of CC with OJP. The *p*H is influenced by the recipe, of the combine ratio and the strength of the acids used. It is higher the lower the CC replacement percentage. It has values between 2.846 (COJ_5) and 3.505 (COJ_2). The other values are located in this interval (Figure 3).

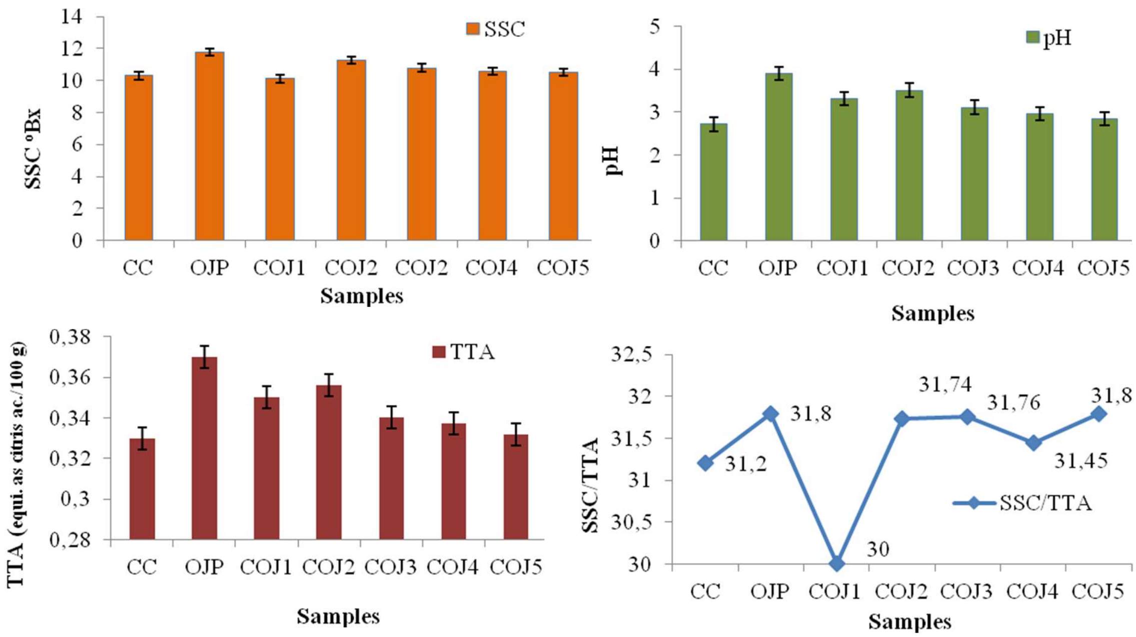

Figure 3. *Variation of SSC, TTA, pH and SSC/TTA in juices and soft drinks and their combination in different proportions*

Results are means ± SD (n=3) for significant level $p \leq 0.05$

TTA has very close values between 0.33 - 0.37 g/100 g expressed in citric acid. It is influenced by the mixing ratio. The closest value of the working variants to that of CC is in sample COJ_5 (0.332 g/100 g expressed in citric acid). The SSC/TTA ratio has close values between 30 and 31.8, so there is a slight imbalance between the taste components (sweet, sour). The variants studied fall into the category of very sweet drinks. In the literature, the content of soluble dry matter in orange juice is SSC = 11.73 - 11.39 ºBx, and *p*H = 3.34 - 3.35 and in *Coca-Cola* it is 10.3 - 10.6 6 [30, 31], so in the range of values that were also obtained in this study.

Turbidity, kinematic viscosity, carbon dioxide content

The values for turbidity, kinematic viscosity and CO_2 content are shown in Table 1, with a variation of $p \leq 0.05$. Turbidity is a measure of the degree of clarity. The values obtained for the coupled variants are between 665.7-1871 NTU, depending on the coupling ratio. It is higher in samples containing more orange juice. The values of this quality indicator fall within the range of values for cloudy juices. Consistent with turbidity, kinematic viscosity is also highly influenced by blending ratio and ranges from 1.4373 cSt to 2.0751 cSt.

As done in this study, that is, by combining the two drinks after carbonating the *CC* mix, the carbon dioxide content decreased a lot by up to 39.2 %, in the sample containing the largest amount of orange juice. So, another factor that influenced, again, is in addition to the coupling ratio and the moment of carbonation.

Table 1. *Physico-chemical characteristics of CC and OJP control samples and COJ mixed samples*

Samples	Turbidity [NTU]	Kinematic viscosity [cSt]	Carbon dioxide [g/100 cm^3]
CC	56 ± 1.305	1.3058 ± 0.0085	2.4 ± 0.458
OJP	2572 ± 2.93	2.4593 ± 0.00013	0
COJ_1	1292 ± 2.08	1.8843 ± 0.001	1.75 ± 0.022
COJ_2	1871 ± 2.79	2.0751 ± 0.0023	1.52 ± 0.00052
COJ_3	894.6 ± 0.526	1.6924 ± 0.00043	2.13 ± 0.423
COJ_4	665.7 ± 0.526	1.5394 ± 0.0001	2.3 ± 0.343
COJ_5	3355 ± 0.938	1.4373 ± 0.00034	2.33 ± 0.0016

Vitamin C (ascorbic acid) content

The content of ascorbic acid can define the nutraceutical character of the working variants obtained. The variation of the values is shown in Figure 4. The obtained values range from 95 ppm and 467 ppm. Vitamin C was not detected in CC and in the studied samples an increase of 467 ppm (COJ_2), was noticed. Here another influencing factor on the vitamin C content can appear, namely the carbon dioxide content.

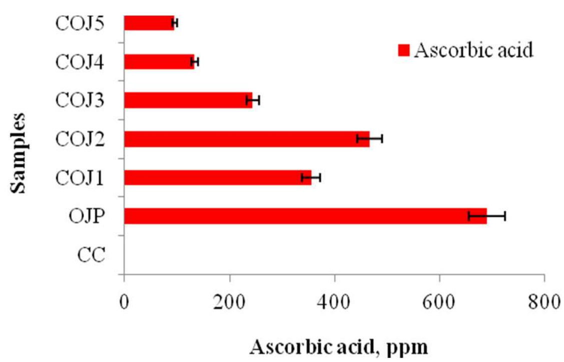

Figure 4. *Evolution of the content of ascorbic acid (vitamin C) in beverages based on CC and OJP*

Automatically, all other known nutritional principles of OJP can be said to be found in working variants and their variation will be influenced by the same factors as ascorbic acid. In the literature, the vitamin C content of raw orange juice is in the range of 33.33 - 66.67 mg/100 mL using the method with the 2.6 dichlorophenolindophenol solution [32] and 529 mg·L^{-1} using the HPLC method [33] depending on the method of juice extraction.

Sensorial analysis

Highlight consumer preference. Several types of interpretation of the results of direct sensory analysis and using marketing techniques are presented in Figure 5. Usually, the two types of drinks ie CC and OJP are consumed separately. Their combination achieved a good overall sensory score. The highest value for the work variants was 32.57 points out of a maximum of 50 points in sample 387 and in sample 873 and the lowest was 24.6 points out of a maximum of 50 points Figure 5a. So, the highest sensory score was obtained by sample 1:2 (*Coca Cola*: Orange juice). She got the highest score and to each organoleptic characteristic analyzed, visible in the spider diagram in Figure 5b. CC scored 41.95 out of 50 points and OJP 38.76 out of 50 points. In order to highlight the impact on the consumer, the answers to the online questions were analyzed and the graphs in Figure 5c were obtained.

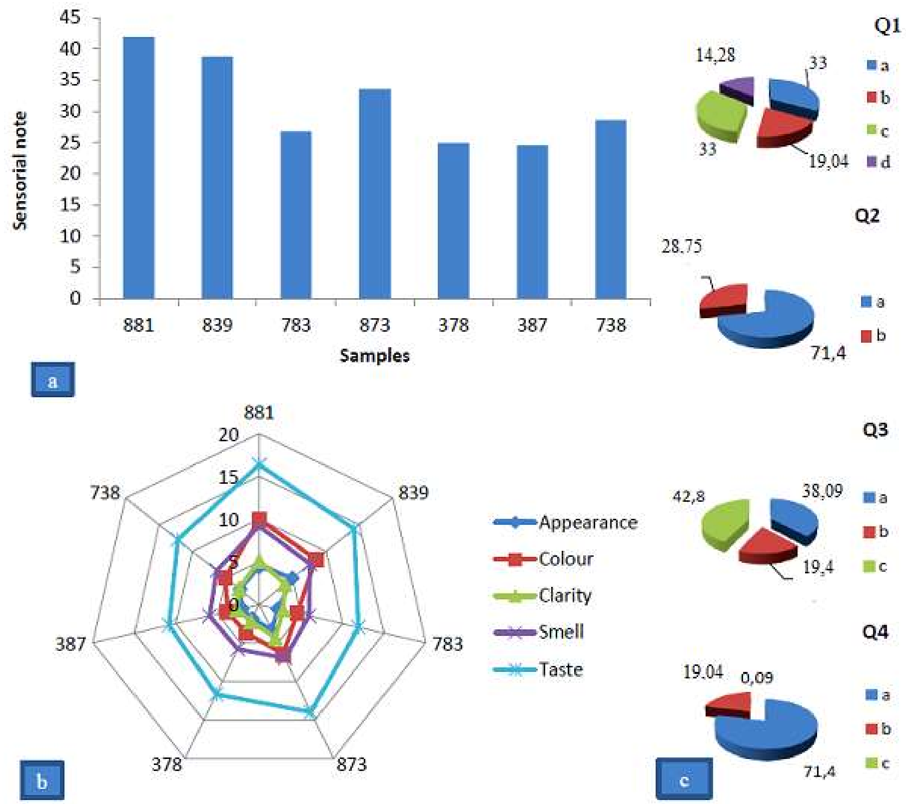

Figure 5. *Sensory analysis results of soft drinks based on CC and OJP: sensory note (a), organoleptic characteristics (b) and answers to online questions (c)*

The panelists answered as follows: 33 % consume soft drinks daily (Q_1), 71.4 % consume Coca-Cola (Q_2), 42.8 % if it were enriched with vitamin C (Q_3) and 71.4 % answered that they would not change anything about the innovative drink offered for consumption (Q_4).

CONCLUSION

The present research developed soft drinks by mixing *Coca Cola* and fresh orange juice in different proportions.
The overall results showed that the best received among the five samples obtained is the one with a ratio of 1:2 (*CC*:OJP).

The addition of orange juice to *Coca cola* brings an important intake of vitamin C, increasing the amount to 467 from 0 ppm. The new soft drink obtained in this study with low CO_2 content enriched with vitamin C has nutraceutical potential.

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