Journal homepage: www.fia.usv.ro/fiajournal
Journal of Faculty of Food Engineering,
Ştefan cel Mare University of Suceava, Romania
Volume XXIV, Issue 4 -2025, pag. 251 - 261

FOOD AND ENVIRONMENT SAFETY

# OBTAINING AND QUALITY CONTROL OF AN EXPERIMENTAL PROTOTYPE OF ORANGE JUICE WITH THE ADDITION OF SPINACH

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Received 19 September 2025, accepted 24 December 2025

**Abstract:** *The aim of this research is to create an experimental prototype of a beverage with nutraceutical potential made from orange juice with spinach powder. As collateral objectives, the values of the quality indicators for seven juice samples were compared and the influencing factors that stood out were analyzed. Thus, the greatest influence was given by the percentage of spinach powder addition and the juice storage time The results showed that with the increase in the amount of spinach powder added in the assembly stage, after the finishing stage, (0.2%; 0.4%; 0.6%), the following quality indicator values were obtained: titratable acidity (TA) =1.06-1.19 g/100mL expressed in citric acid, increasing during the preparation and decreasing during the storage. Total soluble solid (TSS) = 9-9.9 oBx is very little influenced by the addition, but rather by the orange variety. The ascorbic acid content increases with the percentage of powder and decreases during the juice storage and during the transition from fruit to juice. The value of water activity(aw) = 0.982-0.979 is not influenced by the type of powders nor by their rehydration capacity. The turbidity (maximum 6540 NTU- S23) is specific to the cloudy juices and the influence of the powder addition is visible in the storage duration. The type of powder chosen influences the results, but within the range of values already obtained for the cloudy juices. The obtained juice, with the additions, is green with a persistent orange aroma and quality indicators that are specific to the cloudy juices. This juice can be applied to the mass production level and it is recommended to be analyzed for stability and nutritional content.*

**Keywords**: *orange juice, spinach powder, color juice, process, turbidity*

## 1. Introduction

Fruit juices are defined, in the general sense, as "the extractable fluid content of tissue cells" according to the "Full definition of Juice" [1]. The turbid juices are unclarified juices that have not undergone clarification treatments, in which all particles are smaller than 2.5 µm [2]. These particles are made up of proteins, polysaccharides (pectin), lipids, and polyphenols and give relative stability to the turbidity [1]. At present, there is a growing appreciation of the important role of beverages, such as juice, in anticipating and managing health. The functional and nutraceutical beverages that combine taste with health benefits have experienced significant diversification. The most dynamic category of functional foods with bioactive compounds, including plant extracts, omega-3 fatty acids, fiber, minerals, vitamins, prebiotics, antioxidants and probiotics are beverages, including juices [3]. These have various additions of: vitamins, apple, strawberry, and orange flavors; there are detox juices (with chlorophyll, spirulina, activated charcoal), with the addition of vegetable proteins from peas, chickpeas, rice. For the vegetarians, athletes, or seniors, attractive fruit juice blends are used that are combined with ginger. There are energizing juices with

DOI: https://doi.org/10.4316/fens.2025.023

ginseng extract, vitamin B12, immune-boosting drinks with zinc, echinacea and vitamin C, vitamin A, manganese, iron, zinc and also omega-3), anti-stress juices such as relax juice with Ashwagandha, magnesium, L-theanine [4-5]. In addition to the most well-known raw material, the following fruits are also used in the preparation of juices: grapes, apples, cranberries, peaches, blueberries, pomegranates, mangoes, cherries, blackcurrants, plums, kiwi [6]. Also, there have been experiments with juices with addition of mushrooms, watermelon and oranges which have been reported to be a suitable carrier of lactobacilli [7]. The functional juice industry has experienced rapid growth, meeting the demands of the modern consumers. Recent examples prove that these products can be sustainable, efficient and safe, while complying with strict legislative standards. It has been noticed that spinach is less used and this variant was chosen to be used in this research along with the famous orange, the most commonly used raw material for juices in the world. Spinach (Spinacia oleracea L.) is cultivated worldwide and is used in natural therapy and consumed raw or cooked as well as in edible films [8]. It contains minerals such as: magnesium, calcium, iron, phosphorus, potassium, sodium, vitamins (C, vitamins from group B, A, D, K, tocopherol), essential amino acids. It has antimicrobial, antioxidant, hypoglycemic, and cardioprotective properties [9]. This chemical composition is influenced by the cultivation and growth of spinach [10]. There are also powdered spinach variants that are obtained by hot air dehydration (70oC), by convection. The composition of dried spinach is very well preserved and is close to that of the fresh version. The spinach varieties used are: Matador, Viking Monnopa, Gamma F1, Bloomsdale Long Standing, Butterflay, Popey F1+. It is cultivated in Romania on large areas. Spinach has a humidity of 91.4% [11], its pH ranges from 5.5 to 6.8, contains proteins 2.9 g/100 g, lipids 0.4 g/100 g, vitamin A, C, K, B6, B12, quercetin (bioflavonoid), lutein, has a caloric value of 23 kcal/100g [12]. Oranges (Citrus sinensis) have a composition similar to that of the orange juice, which is one of the most widely consumed juice in the world. It is rich in nutrients and energy, in addition to its refreshing and antioxidant properties. The health benefits of this juice are remarkable [13]. The premium orange juice is a food product with an increasing consumption level in Europe and North America and represents a profitable business [14].

The history of juice extraction dates back to the 19th century. Considering that, a combination of the two plant materials, namely the premium orange juice and the spinach powder, would make an interesting topic for research. The main objective of this research is to experiment with the creation of a prototype of orange juice with an addition of spinach powder. The secondary objectives are to create a database following the physicochemical analyses of the working variants obtained (juices with powder addition), at the time of preparation and after 30 days of storage in order to monitor the evolution of the quality indicators over time. These objectives are the basis for supporting the novelty elements. Thus, in consumer psychology it was found that green juices are less preferred although they are very nutritious. They taste like spinach, broccoli and other green vegetables. To improve this aspect, orange juice was used in this study, with a strong flavor in which spinach powder was added to give it a green color, without modifying the orange taste which is very popular.

## 2. Materials and methods

### 2.1. Materials

Plant material and sample preparation

"*Navelina*" oranges were purchased from the market. The spinach powder used is from the collection of materials of the SAIAPM/ULBS, ccbia. Fruit and Vegetable Processing Technology Laboratory. A commercially purchased "*Bio*" spinach powder variant is also used.

**2.1.1 Preparation of orange juice with spinach**

The quantity of oranges was processed in the form of juice. The oranges were cut in half and squeezed by twisting using the GORENJE CJ 1000 HE (Slovenia) citrus juicer. The orange juice was obtained in the premium version (finished, without added sugar, water, fruit). This is the characteristic of the control sample (C). Spinach powder was added for the work variants. The following types of powders were used: from the "Bio spinach powder" from the market: C (control) "*Navelina*" variety oranges; S11- orange juice with the addition of 0.2% Bio powder; S12 - 0.4%, S13 - 0.6%, and using the "*spinach powder*" obtained in the Home-Made system: S21-0.2%; S22-0.4%; S23-0.6%. These work variants were treated the same as follows. The dosing juice was done at cold, in the bottles with twist off closure, with space for creating vacuum. Pasteurization was carried out according to the scheme (5'-5'-5')/83 °C, using a pasteurizer with water circulation in the mantle, for the packaging unit, with adjustable temperature, Adler model, with temperature control (LCD screen). The bottles were stored at a constant temperature of 15 °C, at the dark, in a vertical position, closed.

**2.2. Methods**

**2.2.1 Technological studies**

To calculate some important technological indicators, the following formulas were used:

Losses were calculated using the formula:

$$l_t = \frac{W_{in} - W_{out}}{W_{in}} \cdot 100, (\%) \qquad (1)$$

Yield production was calculated with formula:

$$Y_p = \frac{W_j}{W_O} \cdot 100, (\%) \qquad (2)$$

The specific raw material consumption was calculated using the formula:

$$c_{sorange} = \frac{W_O}{W_j}, (kg/kg) \qquad (3)$$

in wich: lt-total technological losses; Win-weight entered; Wout- output weight; Yp-production yield; Wj-weight juice; WO-weight orange reception; csorange-specific consumption of orange

These calculations are based on gravimetric determinations.

**2.2.2 Determination of quality indicators for fruit and juices**

To determine the values of quality indicators for fruits and juices, the following methods and devices were used: moisture content [15], total dry matter (100-u), titratable acidity(TA)(g/100g or 100 mL expressed in citric acid) [16]; Specific Gravity at 20/20° [17]; pH-value (pH-meter, Orion) [18]; total soluble solid (TSS) (°Brix) [19]; turbidity (NTU) (with portable turbidimeter TB 100, China) [20]; vitamin C (iodometric method, test kit Hanna) [21], TSS/TA (total soluble solid/titratable acidity). water activity ($a_w$) (water activity analyzer Novasina, LabMaster)

**2.2.3 Sensory analysis**

This important analysis was carried out by colleagues present in the laboratory, boys and girls aged between 19-22, students of the Faculty of Agricultural Sciences, Food Industry and Environmental Protection, in number of 17. The method is qualitative, simple descriptive with recording of existing differences with the description of several characteristics. The final decision of the descriptions is made by the panel leader based on the results of the questionnaires. It cannot be correlated with the instrumental results but is the basis of the quantitative sensory analysis (scoring method). The method has a high setup time, a detailed level of description of the characteristics and is used in the quality control of juices. The results of the descriptive analysis for the quality characteristics: appearance, color, fluidity, smell was obtained following discussions with the panel, during training. These were done for 2 hours/week in the department's sensory analysis laboratory (18-20 ℃, φ=62%, uniform lighting). The samples were served in transparent cups. The result of this stage can be the basis of superior sensory analysis methods of juice [22].

**2.3. Data analysis**

The experiments were repeated 3 time and analyzed by one-way of variance (ANOVA) with significance level α=0,05. For descriptive statistics the mean value of the results of the quality indicators, the mean value of the results of the quality indicators and the corresponding standard deviations were calculated using IBM-SPSS software.

**3. Results and discussion**

**3.1. Physicochemical analysis of oranges and spinach powder**

Gradation, organography, titratable acidity, pH-value, vitamin C content, moisture, total dry matter, total soluble solid, total soluble solid/titratable acidity ratio are primary quality indicators that are very important for the choice of raw materials used in the manufacture of juices and are shown in Table 1.

The values of the organographic elements, the physicochemical indicators are real and fall within the range of values for similar plant materials. In other studies, a production yield of 40.45-41% was obtained with a specific consumption of oranges of 2.39-2.47 kg oranges/ kg juice [23]. Regarding the spinach powder, the disruption of the cell membranes through various treatments as a way of preservation leads to a considerable decrease in the ascorbic acid content from 624 mg/100 g DW in fresh spinach to 62 mg/100 g DW, during the drying [24]. Therefore, this would explain the low values, along with all the other known factors, for the ascorbic acid content in the spinach powder samples.

**3.2 Experiments on realization prototypes, technological studies (orange juice with spinach)**

Various amounts of spinach powder that was obtained in different ways are added to the orange juice, which is preserved by pasteurization and is analyzed immediately and after a storage time of 30 days.

**3.2.1 Technological studies on obtaining premium cloudy orange juice with spinach powder**

The flow stages, the image of the juices obtained and the values of technological indicators are shown in figure 1. The technological scheme is a classic one and highlights the stage in which the spinach powder is added (the assembly stage). The extraction yield of the orange juice is low, as shown in other studies regardless of the extraction method [25]. Spinach may be a source of the green porphyrin pigment, chlorophyll.

When dried and ground, it turns into powders with various particle sizes, depending on the drying method [26] which give green hues to the orange juice. The technological scheme is a classic one and highlights the stage in which the spinach powder is added (the assembly stage). The extraction yield of the orange juice is low, as shown in other studies regardless of the extraction method [25]. Spinach may be a source of the green porphyrin pigment, chlorophyll.

**3.3 Physicochemical analysis of experimental prototypes**

The determined quality indicators of the obtained juices are presented in Figure 2. They were determined at the time of preparation of the working variants (one control sample and 6 working variants with additions) and 30 days later, in order to monitor the evolution of the quality indicators over time.

**Table 1**

**Organographic elements and physicochemical indicators of ”*Navelina*” variety oranges (A) and for spinach powder (B; C)**

| Characteristics | Orange” Navelina ” variety (A) | Spinach” Bio” Powder (B) | Spinach powder Home Made (C) |
|---|---|---|---|
| Form | Elongated spherical ellipsoidal |  | |
| Diameter, [cm] | 7.50 ±* 0.60 | | |
| Weight, [g] | 202.00 ± 0.80 | | |
| Shell, [%] | 26.70 ± 0.15 | | |
| Pulp, [%] | 68.00 ± 0.80 | | |
| Seeds, [%] | 0.58 ± 0.05 | | |
| Total soluble solid (TSS), [ºBx] | 9.60 ± 0.30 | - | - |
| Moisture, [%] | 89.10 ± 1.30 | 7.10 ± 0.09 | 11.20 ± 0.03 |
| Total dry matter, [%] | 10.90 ± 0.00 | 92.90 ± 0.8 | 88.80 ± 0.20 |
| Titratable acidity (TA) [g/100 g, expressed in citric acid] | 0.96 ± 0.01 | 1.32 ± 0.09 | 1.42 ± 0.10 |
| TSS/TA | 10.00 | - | - |
| Vitamin C, [mg/100 g] | 21.00 ± 0.10 | 3.58 ± 0.20 | 4.88 ± 0.60 |
| pH-*value* | 3.50-4.00 | 5.50-6.00 | 5.50-6.00 |
| Rehydration capacity, [%] | 0.00 | 35.60 ± 0.30 | 75.60 ± 0.26 |

*Values are presented as mean, ± standard deviation, for all results (n = 3)

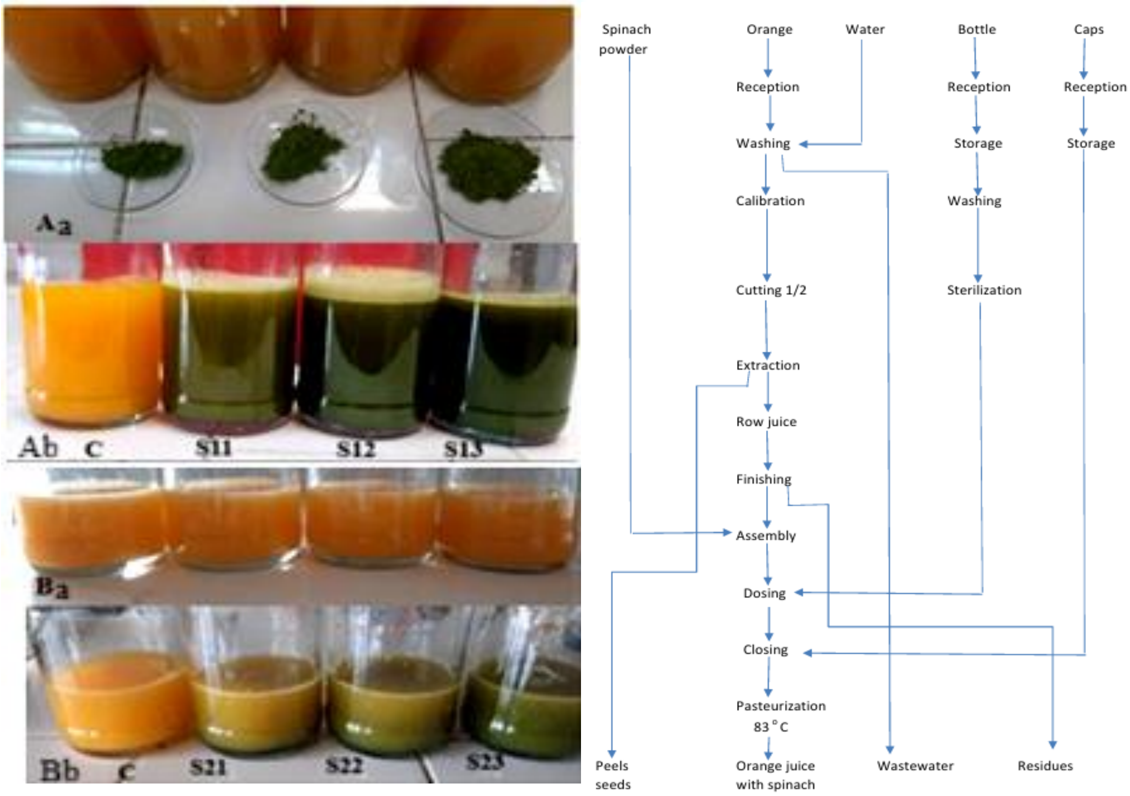


**Fig.1.** Technological scheme for obtaining orange cloudy juice with the addition of spinach powder. Experimental prototypes of orange juice with spinach powder: Aa- before adding ”Bio”powder; Ab after - $S_{11}$- orange juice with the addition of 0.2% ; $S_{12}$ - 0.4%; $S_{13}$-0.6%; and Ba - before adding spinach powder obtained Home Made and Bb- after- $S_{21}$orange juice with the addition of 0.2%; $S_{22}$- 0.4%; $S_{23}$-0.6.

**Table 2**

**Basic technological indicators for obtaining orange juice from the "*Navelina*" variety**

| Sample | Production yield (%) | Total losses (%) | Specific consumption (kg/ kg) |
|---|---|---|---|
| *C | 38.00 ± 0.10 | 52.55 ± 0.16 | 2.57 ± 0.14 |

* Control sample - orange juice without additions, values are presented as mean ± standard deviation (n = 3) for all results.

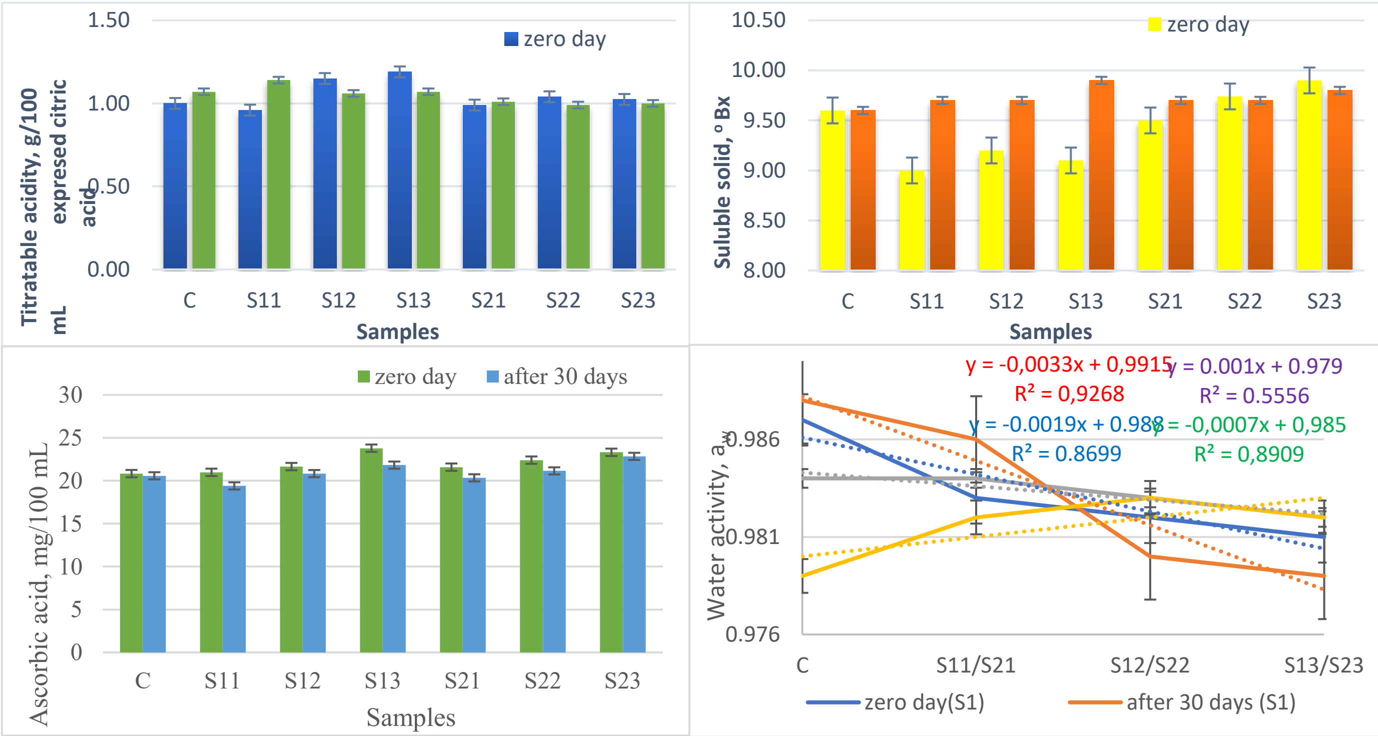


**Fig. 2.** Evolution of titratable acidity, total soluble solid, ascorbic acid content, aw in orange juice with the spinach powder: with C- control, S11- orange juice with the addition of 0.2% "Bio" powder; S12 - 0.4%; S13- 0.6%; Using the "spinach powder" obtained in the Home Made: S21orange juice with the addition of 0.2%; S22-0.4%; S23-0.6%; The values are presented as mean ± standard deviation (n = 3) for all results.

### 3.3.1 Titratable Acidity

The titratale acidity is a primary, very important quality indicator that is determined by chemical dosing. It is a measurement of the acidic components in the system. Its evolution is shown in figure 2.

The values of the titratable acidity vary between 1.06-1.19 g/100 mL expressed in citric acid (C-S11-S13) and 1.06 – 1.024 g/100 mL(C-S21-S23). After 30 days the values are 1.07-1.06 g/100 mL (S11-S13), respectively 1.1-1.00g/100 mL expressed in citric acid (S21-S23).

The values are influenced by the amount of additions that contribute to the increase in the total acidity of the juices as well as in the pasteurization treatment (88 °C) at the packaging unit, due to which the acid groups are released [27]. It decreases over time due to the increase in the soluble dry matter. Lower acidity values of 0.739-0.965 g/100 mL expressed in citric acid have been found in the literature, because the orange variety that was used here had a different degree of maturation [28-29].

### 3.3.2 Total soluble solid (TSS)

The soluble dry matter content indicates the value of the sugar content and is an important quality indicator. The variation of the values is represented in figure 2. The values range between 9.1-9.5 °Bx (C-$S_{11}$-

$S_{13}$) and 9.5-9.9 ºBx (C-$S_{21}$-$S_{23}$) After 30 days of storage, the values are 9.6-9.9 ºBx and 9.6-9.8 ºBx respectively. The value of the TSS of the orange juice with and without the addition is 9-9.8 ºBx, which is very low, compared to the values found in the literature which are of 11.2ºBx [28]. The TSS increases when increasing the powder addition in both variants and decreases slightly during storage. The additions, namely the spinach powders, have a rehydration capacity of 35.6% (Bio) and 75.6% (Home Made) respectively (table 1). Water is absorbed from the mixture and the soluble dry matter increases. This is amplified over time. The liquid for rehydration is in juice. Thus, TSS increases over time until stabilization.

**3.3.3 Ascorbic acid content**

A measurement of the antioxidant and vitamin activity in the orange juice is vitamin C, as in the spinach powder. Their combination can define the nutraceutical characteristic of the obtained juice. The vitamin C content in these juices is within the range of 20.83-23.79 mg/100 mL and 20.83-23.31 mg/100 mL. 30 days later the values are 20.58-21.82 mg/100 mL and 20.58-22.84 mg/100 mL respectively (figure 2).

The ascorbic acid content is influenced by the amount of powder (the increase is 14%) and decreases after 30 days of storage. The variation of the ascorbic acid content is influenced by several factors such as: the presence of oxygen during dosing and mixing, which leads to the appearance of the dehydroascorbic acid, the pasteurization temperature (88 ºC), the initial ascorbic acid content of oranges, the conditions of obtaining the spinach powder. The ascorbic acid content of the fruit juice is extremely variable in the literature, ranging from 33.3 to 66.67 mg/100 mL [30] which was determined using the standard method, whereas in the case of the sweet ripe consumption oranges, it was 40.5-47.8 mg/100 mL [28] using the L ascorbic acid method (Sigma A5960). For the variant of orange juice with mango, the ascorbic acid decreases with the thermal treatment and with the combination of raw materials [29].

**3.3.4 Water activity**

Water activity is a measure of the energy state in the system. It plays an essential role in the activity of the microorganisms and the chemical reactions in the food products [31]. Its values are very close to 1. It is related to the other physical and chemical properties of juices, to the other constituents.

There are substances that are used in the food industry and that decrease the water activity values, thus increasing the stability of the food products. In the present research $a_w$=0.987-0.981 for (C-$S_{11}$-$S_{13}$), and after 30 days it is 0.984-0.982 whereas for the Home-Made powder variants it is 0.988 - 0.979 (C-$S_{21}$-$S_{23}$), and after 30 days it is 0.984-0.988.

The evolution can be considered insignificant depending on the additions and over time. The rehydration of the used powders did not influence the value $a_w$ much over time.

Using this graphical representation, regression equations were developed that can be used to predict the value of the water activity depending on the amount of addition used, other than the one experimentally achieved. The correlation between the water activity and the amount of addition is greater than 50%, which suggests that significantly different values of this preservation quality indicator could appear at higher additions [27].

**3.3.5 Evolution pH-value, Specific Gravity at 20/20º, turbidity and TSS/TA**

Density is a very important quality indicator. The relative density was calculated based on the physical principle of "*U-tube*". The obtained values are variable (1.0374-1.040) (table 3) and comparable to those existents in the literature for the cloudy orange or apple juice, which was 1.05 [28], [32]. The density increases or

decreases depending on the additions in the samples containing them.
Turbidity is a measure of juice clarity. The values obtained in this research are significantly different ($p < 0.05$) and range between 2570-4676 NTU (C-$S_{11}$-$S_{13}$), and 2570-6540 NTU (C-$S_{21}$-$S_{23}$). After 30 days, these values decrease by up to 4% (Bio) and 0.74% (Home-Made). In the literature, turbidity values of up to 3400 NTU have been found for cloudy juices [33]; [34].
The TSS/TA ratio has values ranging from 7.64 to 9.79 (table 2). In the literature, the values of this indicator are 10-15 for juices and fruits recommended for juices. This is the value most preferred by consumers. It is a measure of the degree of maturation, the capacity to accumulate sugars and the choice of the harvest time of the respective fruit. It is recommended to use a sweeter orange variety for the orange juice with spinach, the addition of spinach not being responsible for the taste descriptor. The intensity of the sweetness descriptor must be naturally improved in these juice prototypes.

**Table 3**
**Evolution pH-value, specific gravity, turbidity and TSS/TA, in orange juice with and without spinach**

| Samples | Storage [days] | pH | Density water [g/cm$^3$], at 20° | Specific Gravity at 20/20° | Turbidity [NTU] | TSS/TA |
|---|---|---|---|---|---|---|
| *C | 0 | 3.56 ± 0.01 | 0.9970 ± 0,001 | 1.04 ± 0.24 | 2570.00 ± 1.7 | 9.60 |
| $S_{11}$ | | 3.57 ± 0.02 | | 1.0406 ± 0.22 | 3420.00 ± 0.47 | 9.37 |
| $S_{12}$ | | 3.57 ± 0.01 | | 1.04 ± 0.01 | 4520.00 ± 0.05 | 8.00 |
| $S_{13}$ | | 3.59 ± 0.09 | | 1.0398 ± 0.06 | 4676.00 ± 0.1 | 7.64 |
| C | | 3.56 ± 0.01 | | 1.039 ± 0.05 | 2570.00 ± 1.7 | 9.60 |
| $S_{21}$ | | 3.50 ± 0.00 | | 1.039 ± 0.004 | 2610.00 ± 0.07 | 9.59 |
| $S_{22}$ | | 3.52 ± 0.1 | | 1.040 ± 0.00 | 5740.00 ± 0.056 | 9.36 |
| $S_{23}$ | | 3.57 ± 0.09 | | 1.041 ± 0.01 | 6540.00 ± 0.068 | 9.66 |
| C | 30 | 3.86 ± 0.1 | 0.9976 ± 0,0009 | 1.0384 ± 0.005 | 2330.00 ± 0.9 | 8.97 |
| $S_{11}$ | | 3.84 ± 0.04 | | 1.0394 ± 0.07 | 3240.00 ± 0.03 | 8.50 |
| $S_{12}$ | | 3.80 ± 0.05 | | 1.0396 ± 0.004 | 4350.00 ± 0.7 | 9.15 |
| $S_{13}$ | | 3.80 ± 0.02 | | 1.0407 ± 0.009 | 4467.00 ± 0.21 | 9.25 |
| C | | 3.86 ± 0.00 | | 1.0374 ± 0.008 | 2330.00 ± 0.9 | 8.97 |
| $S_{21}$ | | 3.84 ± 0.01 | | 1.0379 ± 0.06 | 2361 ± 0.09 | 9.60 |
| $S_{22}$ | | 3.90 ± 0.2 | | 1.0388 ± 0.03 | 5450.00 ± 0.1 | 9.79 |
| $S_{23}$ | | 3.97 ± 0.1 | | 1.0394 ± 0.08 | 6491.00 ± 0.21 | 9.80 |

*C- control, S11- orange juice with the addition of 0.2% "Bio" powder spinach; S12 - 0.4%; S13- 0.6%; Using the "spinach powder" obtained in the Home Made: S21orange juice with the addition of 0.2%; S22-0.4%; S23-0.6%; The values are presented as mean ± standard deviation (n = 3) for all results.

### 3.4 Sensory analysis

For this, the descriptive analysis of the juice made of orange and an addition is used. To describe the suggested working variants using spinach powder that was obtained in the laboratory or purchased from the market, a description of the organoleptic properties is used and a comparison to the standard admissibility conditions for the cloudy juice is drawn, as seen in table 3.
The creation of an experimental prototype with nutraceutical potential that can be called *juice* was achieved because the values of the determined quality indicators fall within the range of values for the cloudy juices. Their color is green and the

predominant flavour and taste are those of oranges. With the increase in the addition of green powder, the green color of the juice also intensifies (figure 1). This was found during preparation and after 30 days of storage.
It is the only notable change with an impact on the consumer.

**Tabel 4**

**Evaluation of organoleptic characteristics of cloudy orange juice with spinach powder**

| Sample | Storage days | Organoleptic characteristics | Description |
|---|---|---|---|
| C, $S_{11}$, $S_{12}$, $S_{13}$ | 0 | Appearance | Liquid with fine particles, no signs of fermentation or alteration with a slight separation into two layers that becomes noticeable with increasing percentage of spinach powder $C < S_{11} < S_{12} < S_{13}$ |
| | | Color | Yellow orange, characteristic of the orange variety, which turns into spinach green as the amount of addition increases $C > S_{11} > S_{12} > S_{13}$ |
| | | Fluidity | It is normal, a clody liquid with large particles that does not disappear with increasing addition percentage. |
| | | Impurities | Are not admitted |
| | | Taste, odor | Pleasant, orange flavor remains predominant; spinach notes may appear at higer additions |
| $S_{21}$, $S_{22}$, $S_{23}$ | 0 | Appearance | Liquid with fine particles, no signs of fermentation or alteration with a slight separation into two layers that becomes noticeable with increasing percentage of spinach powder, $C < S_{21} < S_{22} < S_{23}$ |
| | | Color | Yellow orange, characteristic of the orange variety, which turns into spinach green as the amount of addition increases $C > S_{21} > S_{22} > S_{23}$ |
| | | Fluidity | It is normal, a cloudy liquid with large particles, which does not disappear with increasing percentage of spinach powder. |
| | | Impurities | Are not admitted |
| | | Taste, odor | Pleasant, orange flavor remains predominant; spinach notes may appear at higer additions |
| | | After a storage period of 30 days | |
| C, $S_{11}$, $S_{12}$, $S_{13}$ | 30 | Appearance | Liquid with fine particles, no signs of fermentation or alteration with a separation into two layers that becomes noticeable with increasing addition percentage $C < S_{11} < S_{12} < S_{13}$ |
| | | Color | Yellow orange, characteristic of the orange variety, which turns into spinach green as the amount of addition increases $C > S_{11} > S_{12} > S_{13}$ |
| | | Fluidity | It is normal of cloudy liquid with large particles as in the preparation, which is not lost with increasing percentage of powder |
| | | Impurities | Is not |
| | | Taste, odor | Pleasant, orange flavor remains predominant; spinach notes may appear at higer additions ($S_{13}$) |
| $S_{21}$, $S_{22}$, $S_{23}$ | 30 | Appearance | Liquid with visible suspended particles from spinach powder, no signs of fermentation or spoilage with a separation into two layers that becomes noticeable with increasing addition percentage $C < S_{21} < S_{22} < S_{23}$ |
| | | Color | Yellow orange, characteristic of the orange variety, which turns into spinach green as the amount of addition increases $C > S_{21} > S_{22} > S_{23}$ |
| | | Fluidity | It is normal cloudy liquid with large particles which it is not lost as the percentage of addition increases |
| | | Impurities | Is not |
| | | Taste odor | Pleasant, orange flavor remains predominant; spinach notes may appear at higer additions. ($S_{22}$; $S_{23}$) |

## 4. Conclusions

We may conclude following the current research that the new obtained beverage, namely the cloudy orange and spinach juice, has values of the quality indicators, TA, °Brix, relative density, pH, $a_w$ descriptive macroscopic organoleptic characteristics, turbidity, ascorbic acid content, within the known range of values for the cloudy juices. Spinach powder can be added to orange juice at a percentage of up to 0.6% without affecting its taste or flavour, but only its color. The amount of spinach powder and the physicochemical stability over 30 days under stated storage conditions of the juice were noted as important influencing factors. Further research is needed on the stability and the nutritional composition of these juices with nutraceutical potential

## 5. Acknowledgments

This work was supported by the KING CAROL I research grant, financed by the Ministry of Research and Innovation of Romania, contract no. 14 RCI of 19.12.2024 and we worked in the Biotechnologies and Food Engineering Research Center, https://centers.ulbsibiu.ro/ccbia/

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