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COMPARATIVE ANALYSIS OF THE QUALITY INDICATORS OF ORANGE JUICE OBTAINED BY DIFFERENT EXTRACTION METHODS

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ABSTRACT

The samples used for the extraction of raw juice from oranges were prepared as follows: the first sample was pulp peeled and subjected to centrifugation for juice extraction, the second sample was made from oranges cut in half and squeezed by twisting, the third sample was made from whole oranges, chopped and juiced by centrifugation, and a sample was taken from commercially available orange juice. The raw juice was compared to the commercial juice that is processed and pasteurized. The impact of the type of extraction on the production yield and on the specific consumption was examined. The quality parameters such as soluble dry matter, relative density, pH, total acidity, SSC/TTA ratio, refractometric index, viscosity, color, turbidity were assessed and compared. The non-sensory and sensory analyses were used to compare the quality of the juices and the consumer preference. The values of the determined quality parameters were real and dependent on the juice extraction method. The values which were the closest to the reference were the ones resulted for the OJCW sample (taken from the whole fruit and de-juiced by centrifugation), and these values are 10.75ºBx, pH=3.8, TTA = 0.41g/100g expressed in citric acid, the refractive index is 1.3484.

The sensory analysis proved that the most favorable preferences were obtained for sample 278 (OJSQ - orange cut in half and squeezed by twisting). For the development of the technologies at an industrial level, the Squeeze Juicer for the, *Valencia* orange variety is recommended.

1. Introduction

The orange juice is one of the most consumed juices in the world because it is rich in nutrients and energy, in addition to its refreshing characteristic and antioxidant abilities. The health benefits of this juice are remarkable (Pontifex *et al.*, 2021). The premium orange juice is a food product with a rising consumption trend in Europe and North America and is a lucrative business (Business-Wire, 2020). The history of juice extraction dates back to the 19th century. The methods of extracting juice from fruit has progressed enormously from the old boring method of squeezing to an automatic juicer used worldwide, making it an essential tool for citrus farmers. The juicing machines are generally classified into four types: centrifugal juicers, masticating juicers, triturating juicers and presses, which can be manually or electrically operated (Ugwu *et al.*, 2020). Conventionally, various types of pressing machines have been used to extract juice from fruits and vegetables, and the juices have been used fresh or minimally processed (Mushtaq, 2018). The juice can be obtained using extraction machines that have progressed in recent years (Ugwu *et al.*, 2020). Further processing of the juice can also influence its quality characteristics (Wang *et al.*, 2022; Gomes *et al.*, 2022).

The classification of juice extractors can be done as follows: centrifugal juicer (net 2); masticating juicer (Cold Press Juicers) (net 2); triturating Juicer (net 2); press Juicer (citrus juicer) (net 3), manual citrus juice extractor like hand presser (net 1), hand Squeeze Juicer, Hand-held Juicer, dome shape juicer (net 4), cup hand- held citrus Juicer, an orange juice Extractor (Aye *et al.*, 2012) and electric power operated orage Juice Extractors ca masticating machiness, Juice pulping machine (Emelike *et al.*, 2015), Juice extractor machine (Adewumi, 2005; Odewole *et al.*, 2018), mini orange juice extractor (Olaniyan, 2010); monitorized Fruit Juice Extractor (Bamidele, 2011), a multi fruit juice extractor (Odewole *et al.*, 2018), mechanized fruit juice extracting (Gbasouzor *et al.*, 2014), fruit juice extractor machine (Boih, 2015), Modified fruit juice machine (Nwoke, 2017), motorized juice extractor machine (Omoregie *et al.*, 2018), centrifuge beach juicer machine (net 5) and triturating and citrus orange extractor machine like automatic orange extractor (net 5). The high content of peel oil and the pasteurization process decrease the loss of pulp in the orange juice. The extraction and the degree of processing, the pasteurization and the oil content are major factors influencing the flavor of the orange juice (Baldwin *et al.*, 2012). There are approximately 200 volatile components that form the aroma and taste of the oranges (Maarse, 1991; Baldwin,1993; Johnson *et al.*,1996) and they consist of esters, terpenes, aldehydes, hydrocarbons, ketones, alcohols (Plotto *et al.*, 2008; Plotto *et al.*, 2004). When processing the raw juice, a large part of these substances are lost (Perez-Cacho *et al.*, 2008; Jordan *et al.*, 2001). Many substances are found in the juice but also in the peel oil. The predominant ones are limonene, linalool, myrcene, α-pinene, and sabinene (Coleman *et al.*, 1971; Pin *et al.*, 1992; Verzera *et al.*, 2004). In order to reach the consumer, the raw juice is subjected to processing, the floating and sinking pulp content is corrected, the flavoring components in the form of peel oil are added, then the juice is pasteurized or it can be subjected to different preservation methods.

The aim of this study was to compare the quality indicators of the orange juice of the same variety and lot, which was obtained from peeled pulp and subjected to juice extraction by centrifugation, oranges cut in half and squeezed by twisting, whole oranges, crushed and de-juiced by centrifugation and a sample of commercially available orange juice. The values of the quality indicators will be compared with those of the commercial sample. The influence was also studied on some technological parameters such as yield, losses and specific consumption.

2. Materials and methods

2.1. Materials

2.1.1. Samples collection

Commercial oranges of the "*Valencia*" variety were purchased. For the reference sample, OLIMPUS orange juice, 100% natural, cloudy juice, pasteurized, which was purchased from the refrigerated sector, was analyzed.

2.1.2. Orange juice preparation

The quantity of oranges was divided into three. For the preparation of juices, the juicer BOSCH MES 25 A0, centrifugal, juicer was used. Samples for analysis are: OJSQ – orange juice hand squeezer; OJM – Orange juice from market; OJCW-Orange juice from the whole fruit; OJCP-orange juice from pulp used centrifugal juicer. The codes for sensory analysis were: 456– OJCP; 278 – OJSQ; 369-OJM; 765-OJCW.

2.2 Methods

2.2.1. Technological studies

For calculating production and extraction yield the formula was used:

$\eta = (W_{juice} \times 100)/W_{orange}$, (%) and for calculating specific consumption, the formula was used $c_{orange} = W_{orange}/W_{juice}$ (kg/kg), in wich: η is yield; W_{juice} is the weight of the juice; W_{orange} is the weight of the orange; c_{orange} is specific consumption.

2.2.2. Physical and chemical analyses

To determine the values of the quality indicators for the work options mentioned for orange juice, the methods used were:titratable acidity (TTA)(expressed as citric acid g/100g) (EN 12147:1998); relative density (EN 1131-1993-pycnometer, DMA-35 and areometer); pH-value (NMKL 179:2005, pH-meter, Orion Type 2-STAR, England); soluble solid content (SSC)(°Brix), refractive index at 20°C (AOAC 932.12, refractometer *Krüss,* Germany, connected to a bath room ultrathermostated *Brookfield*, with the outer circulation, Germany); kinematic viscosity (cSt)(ISO 3105:1994, Ubbelhode viscometer with 3 tube); turbidity (NTU)(Method 180.1,TB 100 Portable Turbidity Meter, China); vitamin C (iodometric method, Helmenstine, 2019), SSC/TA.

2.2.3. Determination of color characteristics

Color characteristics were measured using Chroma Meter-CR-400/410 (HunterLab, Japan)(Hsu *et al.*, 2003) and were measured L^*CIE lightness coordinate, a^*CIE red (+)/green(-) color atribute, b^*CIE yellow (+)/blue(-) color attribute. They were calculated: C^*–croma using the equation (Granato and Mason, 2010)

$$C* = \sqrt{a*^2 + b*^2} \quad (1)$$

h^*- hue angle, using the equation (Barreiro *et al.*,1997; Lopez *et al.*, 1997)

$$h* = \tan^{-1}\left(\frac{b*}{a*}\right) \quad (2)$$

YI – Yellowness index, using the equation: (Rhim *et al.*, 1989).

$$YI = \frac{142.86b*}{L*} \quad (3)$$

The samples were studied in 3 replicates.

2.2.4. Sensory analyses

The method of preferential organoleptic analysis was used which adopted for the characteristics: color, smell, taste, aroma, freshness, general impression, stages of appreciation of the hedonic scale with 9 levels (extremely pleasant, very pleasant, pleasant, slightly pleasant, indifferent, slightly unpleasant, semi-unpleasant, completely unpleasant, extremely unpleasant), in a first working version. For appreciation the intensity of some taste descriptors, at first impression were analyzed: herbal taste, bitter, sour, astringent, natural orange, boiled. Intensity testing it was done using the preference method with a 5-level hedonic scale: extremely, with the characteristic of, regardless, very little, it is not. They were used a group of trained panelists, students of the Faculty of Agricultural Sciences, Food Industry and Environmental Protection," Lucian *Blaga*" University, girls and boys aged between 19 and 38 years.

2.2.5. Non sensory analyses

The nonsensory analysis was carried out by filling in an online questionnaire containing general questions related to the consumption of orange juice and 22 people answered.

2.2.6. Statistical analysis

The samples ware study 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.

3.Results and discussions

3.1. Non sensory analysis

In order to justify the appropriateness of this study, an assessment was carried out by means of non-advised consumers using online questionnaires. The results are shown in figure 1. Thus, the feedback received from 22 consumers can be summarized as follows: the yellow color of the juices can attract the consumer in proportion of 48%; if it is premium orange juice, 44% of the interviewed would choose it; it is consumed occasionally say 100% of the orange juice consumers. 68%

of the consumers consider that the juice that is freshly squeezed is preferred (52%) and consumed mainly for health purposes. Taking into account the results shown in figure 1, the yellow drinks and the orange juice seem to be the most preferred by consumers, by the general public. The orange juice is consumed occasionally, fresh, for health purposes and mandatorily of premium quality.

3.2. Technological studies

The samples to be studied were prepared by following the steps shown in the technological diagram in figure 2. The peculiarity of obtaining the raw juice can be observed. It consists in the method of preparing the fruit for extraction. The physical process used was the extraction by centrifugation and cold pressing. The values of the important technological indicators are shown in table 1. The production yield is slightly affected and the extraction yield has the highest value when using the variant obtained by centrifugation from the peeled pulp (OJCP). The specific fruit consumption is also 3.23% lower in the OJCP sample compared to OJSQ and OJCW samples. This is a technological advantage. The best production and extraction yield (64%) was obtained in the OJCP sample and a specific consumption of 2.39 kg/kg. In the literature, the production yield for the orange juice is between 23 and 72%. Losses in this juice sector are known to be high due to the special morphology of the oranges.

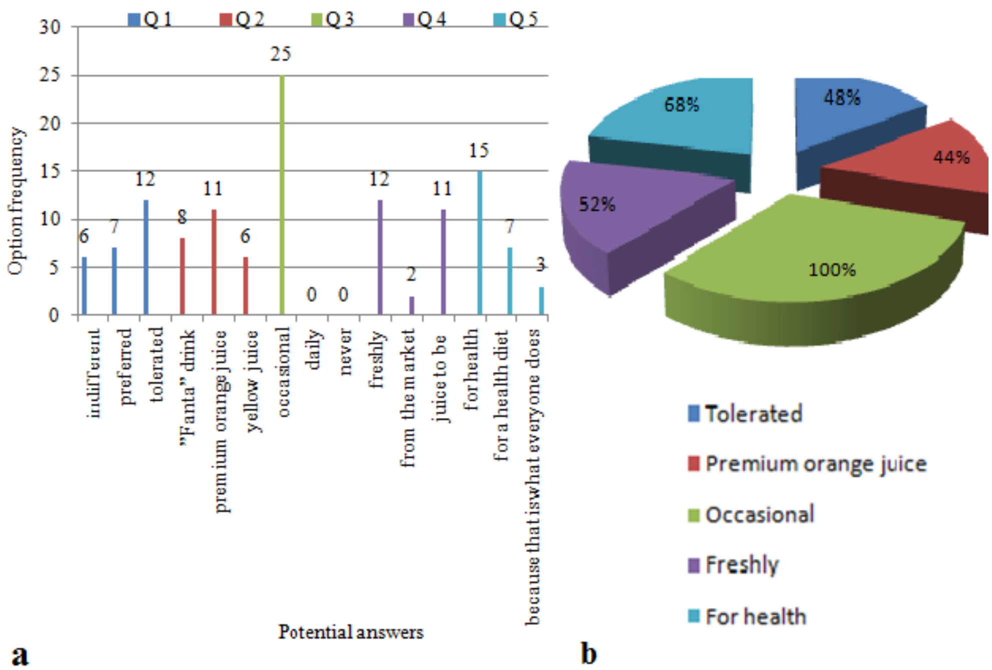

Figure 1. Results of the nonsensory analysis (a), about the consumption of orange juice and yellow juices in the Transylvanian region of Sibiu and the answers with the highest percentage (b).

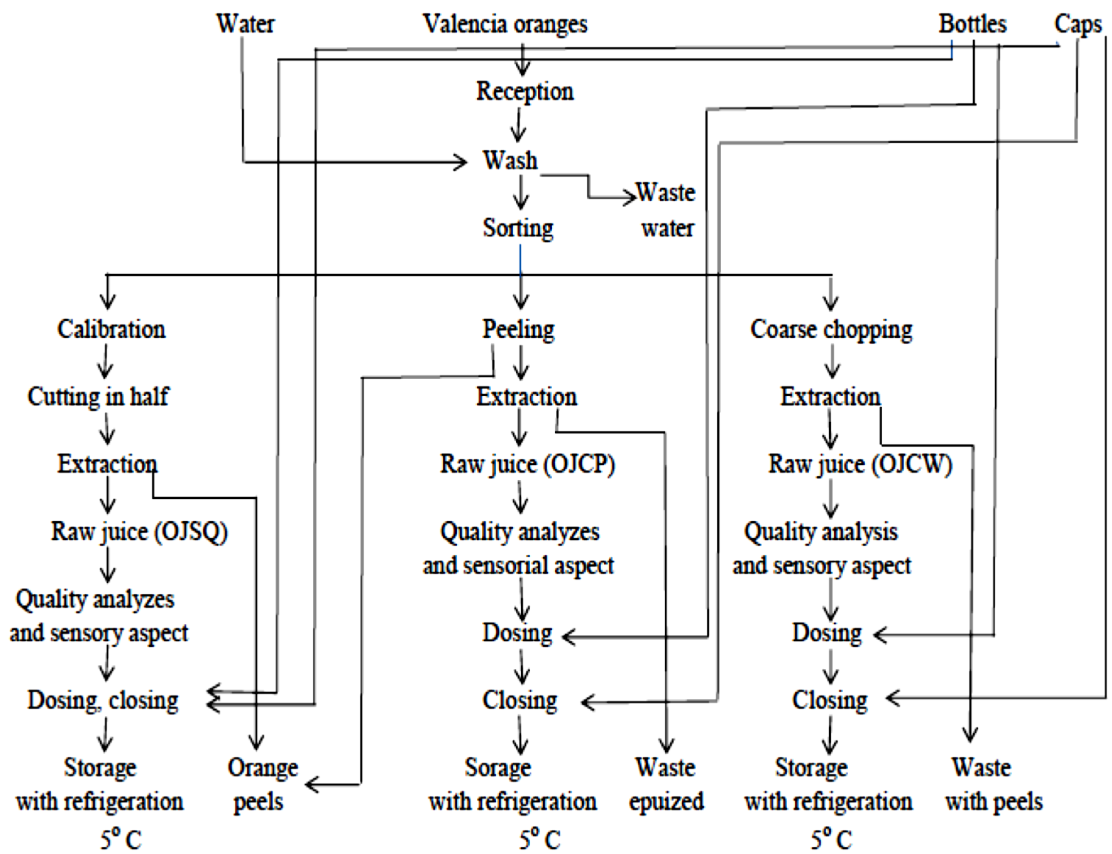

Figure 2. Overview of orange juice production using various modalities of processing before extraction and analysis of samples

Table 1. Basic technological indicators upon obtaining through various procedures, of orange juice. Result are means ±SD (n =3) for singnificant level P ≤ 0,05

Sample	Production yield, (%)	Extraction yield, (%)	Total losses, (%)	Specific consumption of oranges, (kg/ kg)
OJCW	41 ± 0,1	43 ± 0,09	63,49 ± 0,16	2,47 ± 0,14
OJSQ	40,45 ± 0,2	41 ± 0,18	59 ± 0,09	2,47 ± 0,89
OJCP	41,5 ± 0,01	64 ± 0,01	43,15 ± 0,215	2,39 ± 0,09

OJCW-orange juice centrifugal of whole fruit; OJSQ-orange juice hand squezer juicer; OJCP-orange juice centrifugal without peel

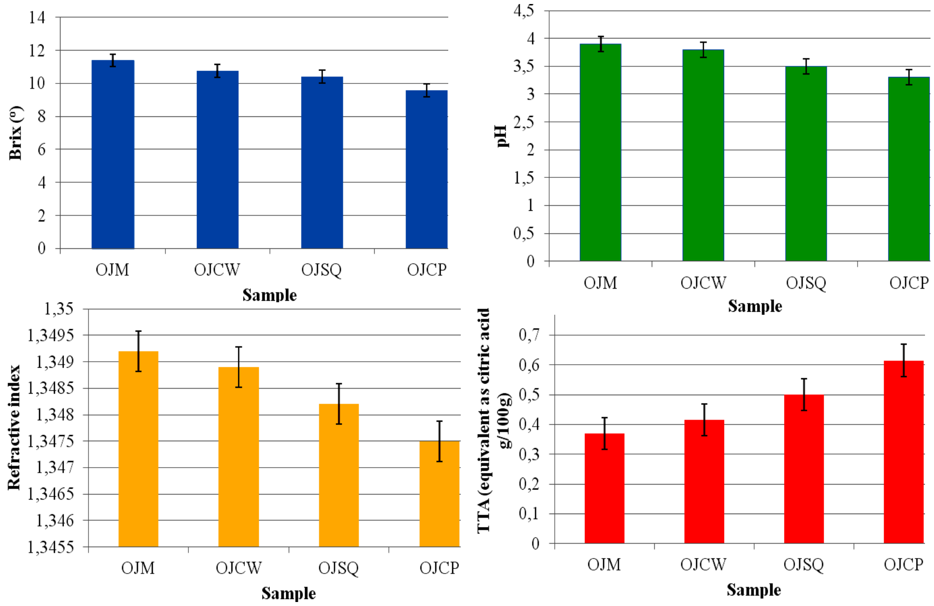

Figure 3. Variation of SSC, refractive index, pH and TTA in the studied orange juice samples: OJM – orange juice from market; OJCW- orange juice centrifugal of whole fruit; OJSQ- orange juice hand squezer juicer; OJCP- orange juice centrifugal without peel.
Result are means ±SD (n =3) for singnificant level P ≤ 0,05

3.3 Physicochemical indicators

3.3.1. Soluble solid content (SSC), pH, refractive index, total titratable acidity (TTA)

The soluble dry matter content in the orange juices indicates the sugar content and is the most important quality indicator. The variation of the values of the Brix, pH, refractive index, and titratable acidity are shown in figure 3. These quality indicators are the most important and are used in the classification of juices. They are also the ones that vary with any technological change. The SSC value ranges between 9.57 and 11.4º Bx, the pH decreases and the acidity increases compared to the commercial sample used as a reference sample. These values are comparable to those in the literature (IFU Analysis, 2005). There are also the determined or calculated values of the relative density that correspond to the determinations conducted in this study. In the literature, the orange juices subjected to different treatments show the value of SSC = 11.73-11.39 ºBx, pH=3.34-3.35 (Timmermans *et al.*, 2011, Wang *et al.*, 2022). The values of the SSC are also influenced by the presence of low molecular weight substances such as esters, aldehyde alcohols soluble in water (Perez-Cacho *et al.*, 2008). In the commercial juice (OJM), these flavor substances are dosed and the SSC is given by the sugars. In the raw juice, according to the graph, the SSC is decreasing, and this means that the quantity of sugars is decreasing. The acidity is increasing which means that the non-sugar is present in the juice. The sample of orange juice extracted from the whole crushed fruit in a centrifugal juice extractor (OJCW) was noted here.

3.3.2 Relative density, correlation indices

The relative density is an important quality indicator that is influenced by the temperature and the composition of the juice and that influences the values of the other quality indicators such as: the acidity, the viscosity, the color, and the pH. The standard (pycnometric and areometric) method is used for the determination, but also the method using DMA 35 is employed. Since the principles underlying these physical determinations are different, it is necessary to make some correlations between the results. Some regression equations are obtained and the corresponding correlation indices are calculated. These variations are shown in figure 4. The correlation indices were calculated and R^2=1 was obtained, based on certain polynomial regression equations as follows:

$y_{OJSQ} = -0{,}0026x^2 + 0{,}0111x + 1{,}0322$

$y_{OJCW} = 0{,}0006x^2 – 0{,}0029x + 1{,}0433$

$y_{OJCP} = 0{,}0091x – 0{,}0414x + 1{,}0804$

$y_{OJM} = - 0{,}0003x^2 + 0{,}0006x + 1{,}0398$

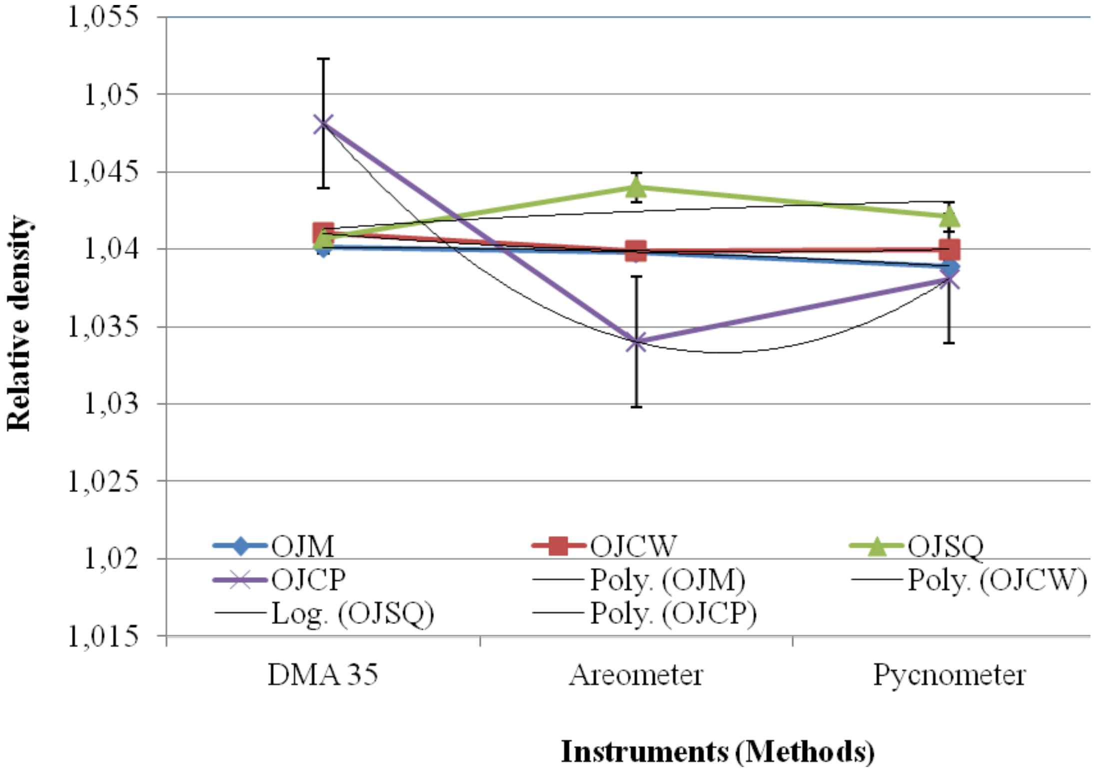

Figure 4. The variation of the relative density of orange juices and the correlation of the values that were obtained by measurement based on different physical principles. Result are means ±SD (n=3) for singnificant level P ≤ 0.05.

Devices operating according to different principles were used on the same samples and for the same quality indicator, namely the relative density. The best correlation was obtained on the reference sample considered to be the commercially available juice. These values are consistent with the values stipulated in the literature that are proportional to the values for the SSC (IFU Analysis, 2005). The size of the particles in the juice influenced by the extraction mode led to different results. Therefore, either of these methods can be used to determine the relative density of the orange juice.

3.3.3. Viscosity, turbidity, vitamin C, SSC/TTA

The values of the determined quality indicators: viscosity, turbidity, vitamin C, SSC/TTA, are shown in table 2. The values of the kinematic viscosity are increased compared to the reference value. These values are directly proportional to the percentage of the floating pulp and turbidity.

The values closest to the reference were those from the OJCP sample, i.e. the juices obtained from the peeled pulp and extracted by centrifugation. The vitamin C content is low because the method used is not sensitive enough. In the literature, the 2.6 dichlorophenolindophenol or HPLC method was used to determine the vitamin C content, which is 529 mg/l (Vermont *et al*., 2011). Thus, the orange juice has a vitamin C content of 40.91-33.33 mg/100g (Kujawińska *et al*., 2022). It seems that this content is influenced by the method of juice extraction and the storage time of the oranges after harvesting. The longer the juice was exposed to the oxygen in the air, the lower the vitamin C content. From this point of view, the OJCW sample (obtained from the whole fruit, with peel, by centrifugation) had the highest vitamin C content.

Table 2. Non-traditional quality characteristics of orange juice extracted by different methods. Result are means ±SD (n =3) for singnificant level P ≤ 0,05

Sample	Viscosity (cSt)	Floating pulp (%)	Turbidity (NTU)	Vitamin C mg/100g	ºBrix/TTA
OJCW	undetermined	87,00 ± 0,08	450 ± 3,7	53,71 ± 0,64	21,48
OJSQ	1,9628±0,054	18,24 ± 0,37	397,6 ± 0,74	43,02 ± 0,0025	20,8
OJCP	1,7459±0,0068	14,71 ± 0,03	382,7 ± 0,938	54,90 ± 0,469	15,36
OJM	1,573±0,0037	11,1 ± 0,009	384,5± 0,059	50,01 ± 0,292	30,8

OJM – orange juice from market; OJCW- orange juice centrifugal of whole fruit; OJSQ- orange juice hand squezer juicer; OJCP- orange juice centrifugal without peel. Result are means ±SD (n =3) for singnificant level P ≤ 0,05

3.3.4. Color characteristics

The values of the parameters characterizing the color can be found in table 3.

L* is the luminance and the closer it is to 100, the closer it is to the absolute luminance value. In the obtained juices for which it is considered that the reference is made to an assortment of juice existing on the market (OJM), the luminance value is different. The lowest value is observed on the sample OJCW, of 48.3 at a difference of 25% compared to the commercial sample (OJM). It is followed by the OJEP sample with 58.6. The OJSQ juice sample has the value of the L* closest to that of the commercial juice. This is because it is generally the most used method of extracting juice from oranges. An increased luminance value is a quality of the juice. It is influenced by the mechanical way of extracting the juice.

Table 3. CIE color parameters L*, a*, b* measured and C*, h*, YI* calculated Result are means ± SD (n=3) for singnificant level P ≤ 0,05

Sample	L^*	a^*	b^*	C^*	h^*	YI
OJCW	48,3 ± 0,74	22,2 ± 0,84	28,23 ± 0,42	53,02	87,39	83,28
OJSQ	65,37±1,506	6,5 ± 0,24	31,33 ± 0,129	66,2	78,48	68,06
OJCP	58,6 ± 1,79	15,1±1,07	32,6 ± 1,2	60,39	65,11	79,36
OJM	64,75 ± 2,25	5,76 ± 0,27	37,5 ± 2,7	37,93	81,27	82,64

OJM – orange juice from market; OJCW- orange juice centrifugal of whole fruit; OJSQ- orange juice hand squezer juicer; OJCP- orange juice centrifugal without peel. Result are means ±SD (n =3) for singnificant level P ≤ 0,05

In the literature, the L* value ranges between 56.3 and 57.6 and is influenced by the treatments that are applied during the processing of the orange juice, such as: thermal treatments, high pressure, pulsed electric field processing (Vervoort *et al*, 2011). The addition of pulp, the pasteurization, the extraction and deacidification led to L* values between 53.95 (extraction) and 65.3 (deacidified juice) (Akyildiz *et al*., 2022; Wang *et al*., 2022). The non-frozen orange juice has L*= 61.43-73.41

and the thermally treated one 64.80-76.79 (Vervoort *et al*., 2011).

The values for the a* parameter are all positive, which means that it tends towards the reddish color. It is observed that compared to the OJM reference sample that was thermally treated, the value of a* increases. Thus, the highest value of 22.2 is obtained in the OJCW sample. In the literature, the values of a*=1.83-2.07 (for processed, untreated, treated at high pressure or pulse electric field processed orange juice) (Vervoort *et al.,* 2011). The method of extracting and processing can lead to a value of the a* parameter of 11-14.42. (Wang *et al*., 2022). The preservation treatment can increase the value of a* up to 13.94 and the thermal treatment can decrease it down to 3.41 (Vervoort *et al.,* 2011).

The values for the b* parameter are all positive, which means that it tends towards the yellow color. It is observed that compared to the OJM reference sample that was thermally treated, the value of b* decreases. Thus, the lowest value of 28.23 is obtained in the OJCW sample. Therefore, the extraction method can influence the color variation. In the literature, the value of the b* parameter is very high: 63.51 (Vervoort *et al*., 2011), 81.73 (Wang *et al*., 2022), 50.52 (Melendez-Martinez *et al.*, 2011), compared to the values obtained in this study.

The chroma (C*), considered the quantitative attribute of color fullness, is used to determine the degree of hue difference compared to a gray color of the same lightness. The higher the chromatic values, the higher the color intensity of the samples, perceived by humans. The values obtained in this study are increased compared to the pasteurized reference sample (OJM). This means that the consumer's eye perception of color intensity is high. The highest value was obtained for the unpasteurized OJSQ sample, namely 66.2. This is also confirmed by other studies. In the literature, values between 50.68 and 63.97 were obtained for the C* parameter (Melendez-Martinez *et al*., 2011).

The hue angle (h*), considered the qualitative attribute of color according to which colors were traditionally defined as: purplish-red, bluish-green, is used to define the difference of a certain color with reference to the gray color with the same lightness. This attribute is related to the differences in absorbance at different wavelengths, with a larger hue angle representing a smaller yellow property in the samples. An angle of 0° or 360° represents the red hue, while the angles of 90°, 180° and 270° represent hues of yellow, green and blue. It has been widely used in the assessment of the color parameters in green vegetables, fruits and meat (Barreiro *et al*., 1997; Lopez *et al*., 1997). In this study the values of h* are not high. They vary around 90º which means that the yellow property of the studied orange juices increases. This is also confirmed by other studies in which values between 82.62 and 86.64 were obtained for the h* parameter (Melndez-Martıinez *et al*., 2011).

The L* luminance is high, positive and close to the maximum value (100), which means that the samples have an intense color which is perceived by the consumer, tending towards the yellow hue of the spectrum (yellow-orange). This aspect is influenced by the presence of the pigments in the fruit, and the method of juice extraction, being lower where there are large particles in the slurry, respectively in the OJCW sample, which is not to be desired.

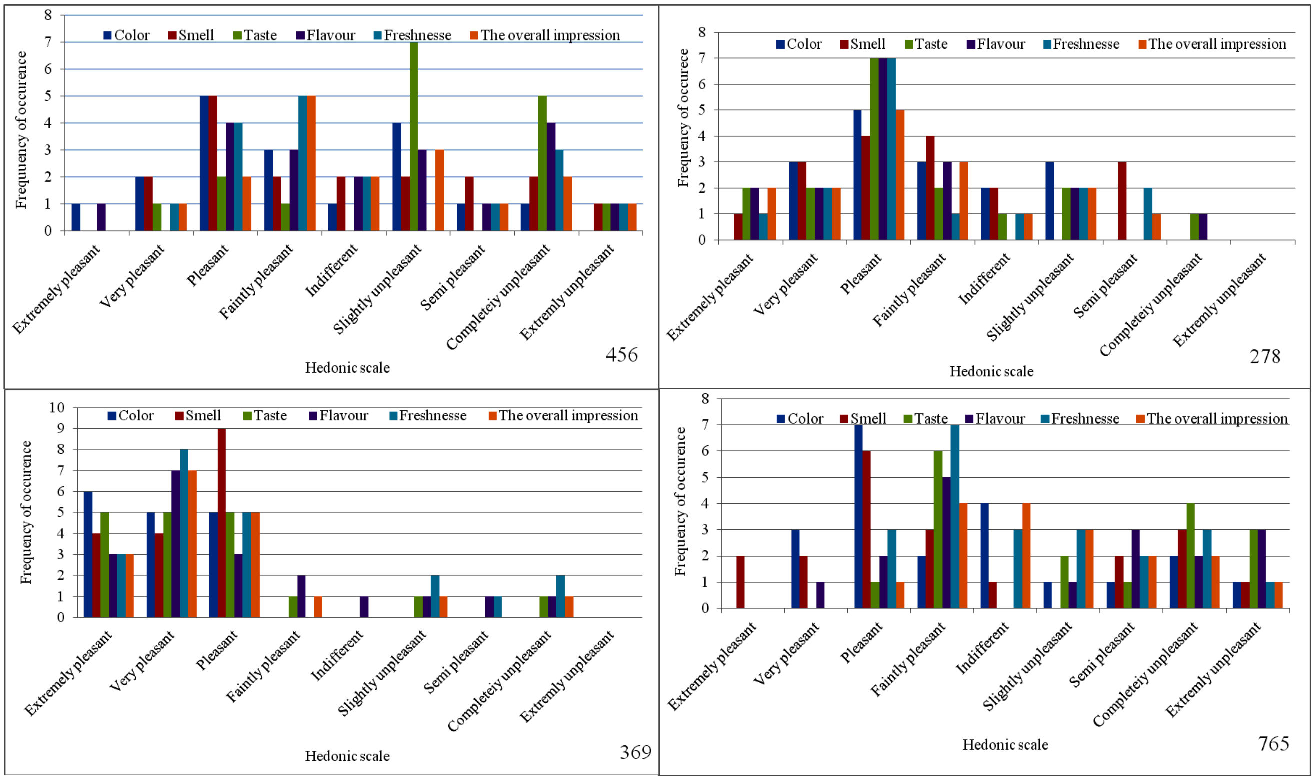

Figure 5. Sensory profiles, preferences (hedonic scale from 9 points), for all characteristics and general impression of the studied orange juices: 456 (OJCP); 278 (OJSQ); 369 (OJM); 765 (OJCW)

The values of the a* parameter, CIE red (+)/green(-), are positive, therefore tending towards red and increasing in the raw juices compared to the reference sample which is pasteurized.The values of the b* parameter, CIE yellow (+)/blue(-), are positive and therefore tending towards yellowness, and decreasing compared to the reference sample. The C* chroma, has large, positive values, higher than the reference sample, OJM, which means that the color intensity of the sample, as perceived by the human eye, is high. The hue angle h* has values around 90°, which means that the yellowish hue in the studied juices is increased. The orange-yellow pigments found in the juice vesicles of the pulp and the membranes adhering to the particles in the peel, the oil, cause the redness to diminish. These particles improve the light diffusion effect (Baldwin *et al.*, 2012).

3.3.5. Sensory Analysis

These aspects are regulated in the juice processing and preservation process and therefore it has higher values in this study. 22 male and female panelists aged between 19 and 38 were used. They were trained for 60 days, in 2-hour sessions, once a week. The types of juices similar to those studied here were tasted during training. They were also trained on the taste descriptors that were used in this study to be able to create the taste profile. The panelists have thorough knowledge of the biochemistry of juices, the technology of obtaining and preserving them and the quality control. They are generally consumers of this type of food. Using these graphic representations (figure 5) of the results, both the sensory characteristics and the intensity of the taste descriptors were highlighted. Thus, the method of extraction of the studied samples influenced the options of the panelists. For example, the overall impression decreased in the following order: 369 (very pleasant → pleasant), 278 (pleasant→mildly pleasant), 456 (mildly pleasant); 765 (mildy pleasant→indifferent). For sample 369, which is the commercially available juice, the most feedback was of very pleasant to pleasant. In the other studied samples, on average, the level of pleasant → mildly pleasant was chosen. The description of one of the most important sensory characteristics, namely the taste, the results of which are shown in figure 6, led to numerous conclusions. In sample 456, juice obtained by extraction only from the pulp, the descriptors of bitter, sour, astringent with no boiled or herbal flavor were noted. In sample 278, squeezed by twisting, the descriptor of natural taste of orange, bitter sour, no boiled or herbal taste was observed. Sample 369, which is a commercial sample, stood out for its natural orange taste as a basic characteristic, balanced, perfect, very close to what the consumer is used to.

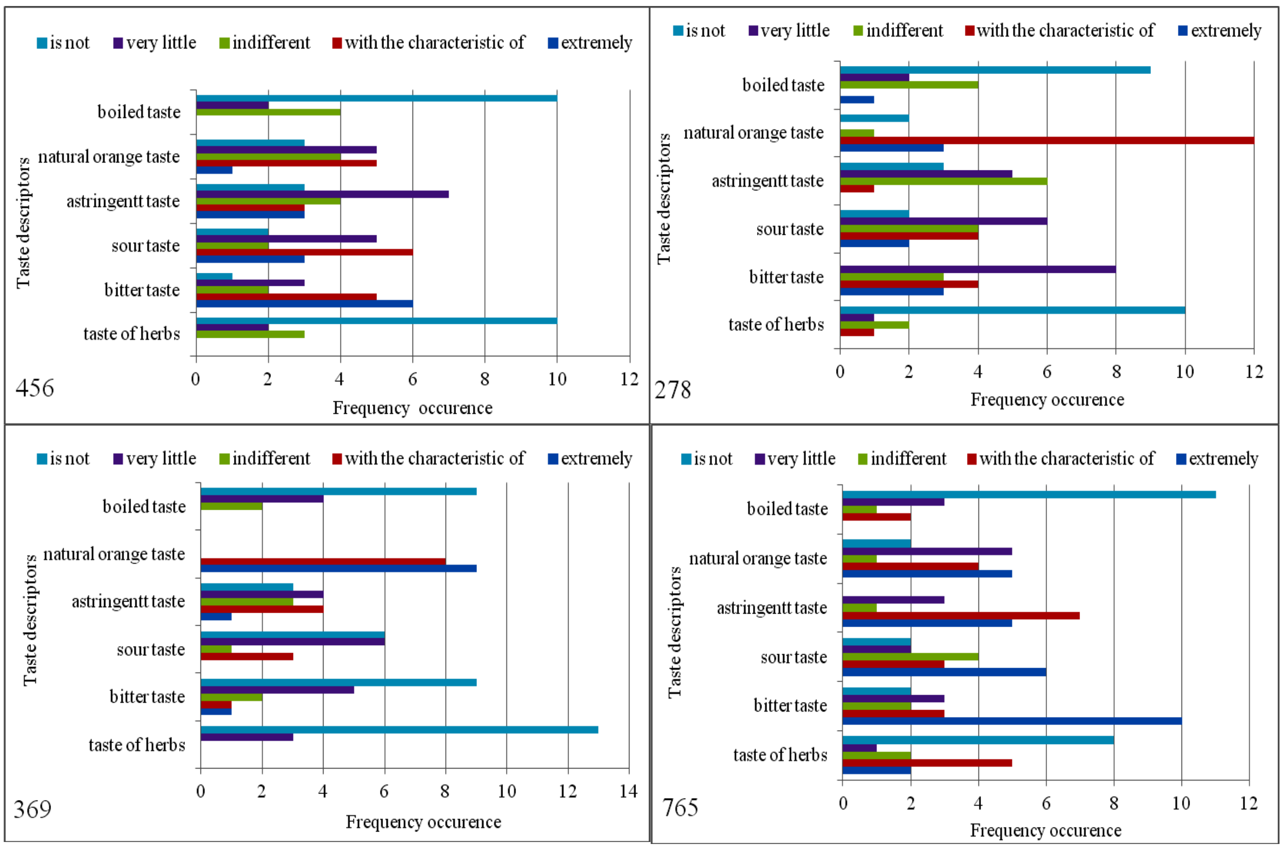

Figure 6. The taste profiles, preferential, with a hedonic scale with 5 levels of intensity of the specific descriptor, for the studied orange juices: 456(OJCP); 278(OJSQ); 369(OJM); 765(OJCW)

In sample 765, which is juice obtained from the whole split orange, the results are completely different from the others and from the commercial sample. The conclusion was reached that the juice was bitter, sour, astringent, but with a strong taste of oranges, without a boiled, herbal, unbalanced flavor. From a sensory point of view, the panelist clearly preferred the commercial sample (OJM). The sample closest to the reference sample was number 278 (OJSQ – which uses the squeezer juicer principle) and the descriptor of natural orange taste was noted in the taste profile. Since this work variant was distinguished from a sensory point of view, this is the variant that is also recommended in terms of technology and quality indicators. The soluble dry matter content of this working variant (OJSQ) is within normal values, 10.4 °Bx, pH=3.5, SSC/TTA ratio = 20.8. This ratio value indicates a balanced taste that is very close to that of the OJCW sample that stood out in terms of quality indicators. The analysis of the taste profile has shown that the OJCW sample is not preferred by the consumers. The OJCW coloration indicates a tendency towards yellowness, yellow orange, the weakest compared to all the studied samples. The vitamin C content is lower, and the turbidity is high just like its viscosity due to the presence of the particles in the slurry.

4. Conclusions

The comparative evaluation of the techniques of juice extraction from a single variety of oranges has proven that there are small differences between the values of the determined and calculated quality indicators and large differences in the sensory analysis. The technological studies revealed a better extraction yield in the OJCP sample (raw juice from peeled pulp and extracted by centrifugation) (64%) and with a specific orange consumption of 2.39 kg/kg. The composition of the raw juices is different from the OJM reference sample (the commercial sample). The OJCW sample (juice from the whole fruit with peel, split and extracted by centrifugation) is thus distinguished due to its SSC, pH, and relative density. The values of these indicators are the closest to those of the reference sample, but in the sensory analysis, this juice received an overall negative vote. The recommended methods of evaluating the density of the raw orange juice are the pycnometric method, the areometric method and the one using the "U-tube" principle (DMA-35). The color change is not visible to the naked eye, but using the instrumental method it was discovered that the luminance tends to intensify, a* tends towards red and b* is positive and oriented towards yellowness. The color intensity increases in the ordinary raw juices obtained using the squeeze juicer and the centrifugal method. The preferred sensory profiles revealed that the most appreciated sample, immediately after the reference sample, was sample 278 (OJSQ– extracted by twisting). The preferred taste profiles have highlighted that the most balanced sample was number 278 (OJSQ- orange juice obtained by twisting) in which the descriptor of natural orange taste was noted more than in the reference sample. The squeeze juicer method of orange juice extraction is recommended as the best option to combine the two important aspects in the juice industry, namely the advantageous extraction yield and the premium juice quality.

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