Ministry of Education and Science of Ukraine
Black Sea Universities Network

ODESA NATIONAL UNIVERSITY OF TECHNOLOGY

International Competition of Student Scientific Works

BLACK SEA SCIENCE 2022

PROCEEDINGS

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Proceedings of International Competition of Student Scientific Works «Black Sea Science 2022» contain the works of winners of the competition.

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INTRODUCTION

International Competition of Student Scientific Works “Black Sea Science” has been held annually since 2018 at the initiative of Odesa National University of Technology (formerly Odesa National Academy of Food Technologies) with the support of the Ministry of Education and Science of Ukraine. It has been supported by Black Sea Universities Network (the Association of 110 higher education institutions from 12 countries of the Black Sea Region) since 2019, and by Iseki-FOOD Association (European Integrating Food Science and Engineering Knowledge into the Food Chain Association) since 2020.

The goal of the competition is to expand international relations and attract students to research activities. It is held in the following fields:

- Food science and technologies
- Economics and administration
- Information technologies, automation and robotics
- Power engineering and energy efficiency
- Ecology and environmental protection

The jury includes both Ukrainian and foreign scientists. In the 4 years that the competition has been held, the jury included scientists from universities of 24 countries: Angola, Azerbaijan, Benin, Bulgaria, China, Czech Republic, France, Georgia, Germany, Greece, Israel, Italy, Kazakhstan, Latvia, Lithuania, Moldova, Pakistan, Poland, Romania, Serbia, Slovakia, Switzerland, Turkey, USA.

At the same time, every year the geography has expanded and the number of foreign jury members has increased: from 46 jury members representing 25 universities from 12 countries in 2018, to 73 jury members of the 46 universities from 19 countries in 2022.

More than a thousand student research papers have been submitted to the competition from both Ukrainian and foreign institutions from 25 countries: China, Poland, Mexico, USA, France, Greece, Germany, Canada, Costa Rica, Brazil, India, Pakistan, Israel, Macedonia, Lithuania, Latvia, Slovakia, Romania, Kyrgyzstan, Kazakhstan, Bulgaria, Moldova, Georgia, Turkey, Serbia.

The interest of foreign students in the competition grew every year. In 2018, the students representing 15 institutions from 7 countries have submitted 33 works. In 2021 the number of submitted works increased to 73, authored by the students of 40 institutions from 18 countries.

The competition is held in two stages. In the first stage, student research papers are reviewed by members of the jury who are experts in the relevant fields. In the second stage of the competition, the winners of the first stage have the opportunity to present their work to a wide audience in person or online.

All participants of the competition and their scientific supervisors are awarded appropriate certificates, and the scientific works of the winners are included in the electronic proceedings of the competition. Every year the competition receives a large number of positive responses from Ukrainian and foreign colleagues with the desire to participate in the coming years.

1. FOOD SCIENCE AND TECHNOLOGIES

DEVELOPMENT OF TECHNOLOGY FOR THE PRODUCTION OF NON-ALCOHOLIC BEVERAGE WITH NATURAL VINEGAR AS A NATURAL CONSERVANT

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Abstract. *White wine vinegar is characterized by various uses in household and cooking, but also has significant health benefits due to its acetic acid content, including blood sugar control, appetite control, weight management, reduced cholesterol and antimicrobial properties etc. Despite all the usefulness of vinegar, it is seldom used in the food industry. Although there is a current trend in the food and beverage market to diversify vinegar categories, to obtain new products with increased prophylactic properties that will be able to prevent diseases and better sensory characteristics compared to conventional products and beverages. The aim of this study is to develop a new soft drink technology based on local fruits/ berries, aromat herbs and natural white wine vinegar.*

The process includes the use of natural ingredients in the following ratio of components, in % mass: fruits or berries: 20%, sugar: 20%, natural white wine vinegar 6% acidity: 10%, aromatic herbs: 1% or spices: 0.2 %. The method of obtaining the drink includes the following steps: washing fruits / berries and herbs, adding and grind it with sugar, maturation for 5 hours at T = +2 ... 4± 1 °C, adding vinegar warmed up to T = +50±1 °C, homogenization, maturation for 3 days at T = +2...4±1 °C, filtration, dilution like commercial juices to 10-12° Brix and packaging.

As a result, a unique drink is obtained that maintains all the organoleptic properties of natural ingredients, as well as all the beneficial nutritional qualities, free of artificial additives (dyes, preservatives, sweeteners). This gives us the possibility to expand the range of natural drinks and to expand the consumers circle. This research is extremely useful not only by expanding the range of soft drinks produced, but also by using local agricultural resources.

Keywords: *non-alcoholic beverages, natural white wine vinegar, fruit, berries.*

I. INTRODUCTION

Recently, there has been growing recognition of the key role of functional vinegar drinks in both the prevention and treatment of disease. Thus, the production and consumption of functional drinks has become of great importance as they provide health benefits beyond the basic nutritional functions. Currently, such drinks are the most developed category of functional foods due to the convenience and ability to meet consumer requirements for content, appearance, and ease of use as long-term storage products. In addition, they are an excellent delivery vehicle for nutrients and bioactive compounds, including vitamins, minerals, antioxidants, natural acids, plant extracts, and more.

II. LITERATURE ANALYSIS

In addition to the growing public interest in natural fruit vinegars, vinegar drinks containing a combination of phytochemicals found in fruits have gained popularity in recent years [1]. Farmers in the Republic of Moldova produce a large number of local fruits and berries that are potentially of interest to the food industry [2]. The value of these agricultural products is mainly due to their nutritional and therapeutic properties. A huge amount of research is focused on their effects when consumed and health benefits, claiming that they are natural sources of bioactive compounds with antioxidant and anti-inflammatory properties [3]. In addition, when combined with vinegar, they have a positive effect on several chronic conditions such as obesity, diabetes, cardiovascular and neurodegenerative diseases [4].

In earlier studies, we have developed a technology for producing white wine vinegar by natural fermentation using walnut peel as a substrate [5, 6]. And also, for the production of one hundred percent local product, local acetic acid bacteria were isolated [7]. The result was a vinegar with very good taste characteristics that can be used not only as a condiment for salads, but also in the preparation of dishes and drinks, which is what this article describes.

The purpose of the study is to explore the possibility of using natural wine vinegar in the preparation of non-alcoholic beverages as a natural preservative, capitalization of local agri-food products, and obtaining natural drinks that can be a worthy replacement for commercial drinks containing artificial additives.

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

All raw materials of plant origin (plums *Prúnus doméstica*, peaches *Prúnus pérsica*, apples *Malus domestica Jonathan*, strawberries *Fragária ananássa*, raspberries *Rúbus idáeus rubin*, dry lavender *Lavandula L.*, fresh mint *Mentha L.*and basil *Ocimum L.*) and non-plant origin (vanillin, cinnamon, sugar and drinking water) were purchased from a local large supermarket. White wine vinegar was obtained during the work on the innovation and technology transfer project 18.80015.5007.222T "Development of biotechnology and implementation of modern production line of natural, high quality seasoned inherited vinegar, competitive on the internal and external market" [8].

Sensory evaluation

In total, a sensory study was carried out on 5 samples of the obtained drinks, which were coded with random letters. The tasting was carried out in a special room with tasting panels and a space between them so that the tasters did not influence each other by conversation or facial expressions. The tasters, consisting of employees and students of the Department of Nutrition and Food, were given an evaluation sheet.

The samples were evaluated by grading (1-5, whereas 1 – minimal, 5 – maximal) was carried out for the following sensory parameters: aspect, colour, taste and after-taste (acidity, sweetness, bitter-sweet taste, harmonious taste, astringency, mouth-feel and overall sensation), consistency and aroma. Sensory evaluation was carried out in batches with appropriate pauses [9].

Bacteriological analysis

Microbiological analysis included enumeration and identification of potential

pathogens and total number of microorganisms using Nutrient Agar, Sabouraud media was used to detect mold fungi. All the selective media were purchased from local distributor Ecochimia SRL from one manufacturer HiMedia.

Samples without dilution in the amount of 0.1 ml were inoculated into the media and incubated. All plates were incubated under aerobic conditions at 36±1°C for 24 hrs. The mean number of colonies counted was expressed as log colony forming units (cfu)/100 ml [10].

Measurement of brix value

The Brix value of samples was calculated by refractive index using precision refractometer MASTER-53α (Atago, Honshu, Japan) [11].

Determination of pH and titratable acidity

The pH of each beverage (50 mL) was determined by using a H-meter laboratory inoLab® pH 7110 (WTW, Germany) - basic desktop pH/mV meter, previously calibrated with pH 4.0 and 7.0 buffers. The titrable acidity was then measured by adding 1.0-mL aliquots of 0.1 M NaOH to each beverage until the pH reached 7.0 [12].

Color measurements

CIELab chromatic parameters, L* (lightness axis), a* (red-green axis) and b* (yellow-blue axis) were obtained using a portable tristimulus colour analyzer Chroma Meter CR-400 (Minolta, Japan) [13].

IV. RESULTS

The aim of the present research is to develop the technology of soft drinks with the application of natural white wine vinegar and other local ingredients. In table 1 are presented recipes for beverages elaborate for 1 liter.

Table 1. Composition of non-alcoholic beverages prepared for 1 liter *

№	Name of beverages	Components, %					
		Fruits / Berries[1]	Sugar	Aromatic plants	Spices	Vinegar	Water
1.	Plum with lavender	20	20	0,2	-	10	70
2.	Peaches with cinnamon	20	20	-	0,2	10	70
3.	Apple with vanilla	20	20	-	0,2	10	70
4.	Strawberry with basil	20	20	1	-	10	70
5.	Raspberry with mint	20	20	1	-	10	70

*Note: * - developed by the author, [1]-fruit / berry norm is indicated for the net mass.*

The technology of obtaining the non-alcoholic beverage consists of two stages. The first stage involves the preparation of the concentrate, which consists of water base - natural vinegar with a concentration of 6%, obtained from white wine and solid - fruits or berries, herbs or spices and sugar. The fruits or berries are pressed and crushed with sugar. Leave until a syrup forms in 1-6 hours. The vinegar is pasteurized at +90 ± 2°C for 2 minutes, cooled to +50 ± 2°C, poured over the syrup formed and mixed. Maturation is carried out for 1 ... 3 days at a temperature of +2 ...+4°C, after which the liquid is filtered on the solid side, with the addition of drinking water in a ratio 1:1,

which is gradually poured through the solid side to reduce syrup losses.

The second stage consists in dissolving the concentrate obtained up to the value of the 12-15° Brix with drinking water and bottling it in appropriate and sterile packaging. The technological scheme for obtaining the elaborated drink is shown in figure 1.

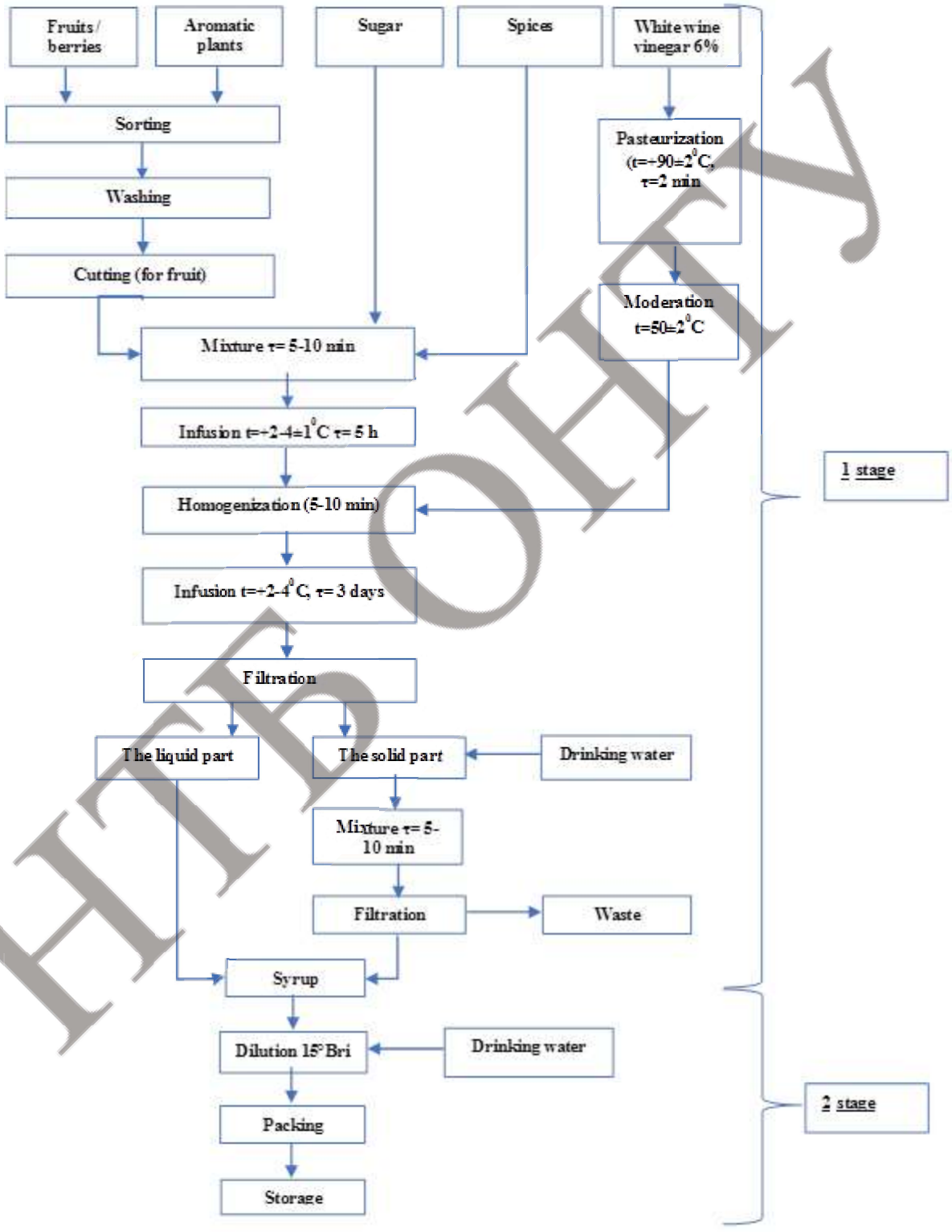

Fig. 1. Technological scheme for obtaining a non-alcoholic beverage

The consumer primarily pays attention to sensory characteristics such as appearance, taste and aroma. Thus, the second stage of the work was to determine the influence of the vinegar on the organoleptic indicators of beverages. The organoleptic evaluation of the quality of non-alcoholic beverages was performed by a group of tasters consisting of teachers and students of the Department of Food and Nutrition. The sensory qualities (appearance, consistency, taste, aftertaste, aroma, color) of the assortment of non-alcoholic beverages made were assessed according to the scoring scale, presented in the sensory analysis sheet. Based on the results of the average scores of the sensory analysis of five samples of non-alcoholic beverages made from various natural ingredients was built in Figure 2.

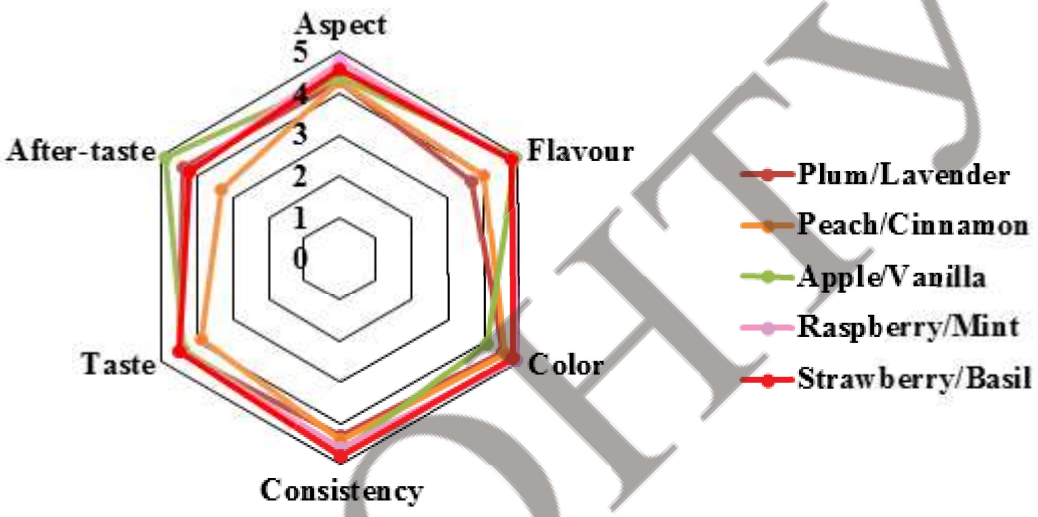

Fig. 2. Spider-graph for the sensory profile of beverages samples.

Based on the data obtained, we can conclude that all the non-alcoholic beverages analyzed had a sweet taste and aroma with a sour hue corresponding to the ingredients from which they were obtained. Some tasters noticed a hint of vinegar, but this did not negatively affect opinions about the quality of soft drinks. The tasters also assessed the ability of the drinks to give a feeling of lightness and freshness, which is especially important for summer soft drinks. The appearance and consistency of the non-alcoholic beverages made are similar to ordinary carbonated water, with a light color of the raw materials used (light yellow, light pink, etc.), figure 3.

Fig. 3. The visual aspect of the elaborated beverages

Based on the data presented in the figure 2, the leaders of the non-alcoholic drinks appreciated were "Peach drink with cinnamon" and "Raspberry drink with mint", with a total rating of 5 points, in second place was placed "Strawberry drink with basil" with a score of 4.9, on the third place was established “Drinking apples with vanilla” with 4.85 points and on the fourth place was placed “Drinking plums with lavender” accumulating 4.7 points. "Plum beverage with lavender" has accumulated the fewest points because not all tasters like the taste of lavender. The overall average for all types of non-

alcoholic beverages appreciated was 4.89 points out of a possible 5.0, which is an indicator high enough to meet the demand of a large number of consumers and become a competitive product with non-alcoholic beverages on the market.

Non-alcoholic beverages are, as mentioned above, are products of current consumption, appreciated by most consumers. For the human body they have a rehydrating action due to the high water content. Non-alcoholic beverages containing carbon dioxide and organic acids ensure proper gastric acidification.

During the summer, when the water intake is high, the gastric acidity decreases, which favors the appearance of bacterial and viral infections in the digestive tract. During this period, the consumption of soft drinks increases and obviously the demand for them in commercial establishments increases, in which some non-alcoholic drinks due to their high sugar content, high acidity, use of synthetic dyes, preservatives, etc. are not recommended by doctors.

Table 2 shows the calculated energy and nutritional value for elaborated beverages.

Table 2. The nutritional and energy value of processed beverages

Type of beverages	Raw material	Mass, g	Protein, g	Fats, g	Carbohydrates, g	Energy value	
						kJ/g	kcal/g
1	2	3	4	5	6	7	8
	Plums	30	0,24	0,09	2,88	52,75	12,60
	Sugar	10	0,00	0,00	9,97	166,63	39,80
	White wine vinegar	10	0,00	0,00	0,30	13,39	3,20
	Lavender dry	0,2	0,00	0,00	0,00	0,00	0,00
	Potable water	70	0,00	0,00	0,00	0,00	0,00
Total 100 g			**0,21**	**0,08**	**10,94**	**193,80**	**46,29**
	Peaches	30	0,27	0,03	3,39	57,77	13,80
	Sugar	10	0,00	0,00	9,97	166,63	39,80
	White wine vinegar	10	0,00	0,00	0,30	13,39	3,20
	Cinnamon	0,2	0,01	0,01	0,16	57,77	0,52
	Potable water	70	0,00	0,00	0,00	0,00	0,00
Total 100 g			**0,23**	**0,03**	**11,5**	**199,66**	**47,69**
	Mere	30	0,12	0,12	2,94	59,03	14,10
	Sugar	10	0,00	0,00	9,97	166,63	39,80
	White wine vinegar	10	0,00	0,00	0,30	13,39	3,20
	Vanilla	0,2	0,00	0,00	0,03	2,42	0,58
	Potable water	70	0,00	0,00	0,00	0,00	0,00
Total 100 g			**0,10**	**0,10**	**11,01**	**200,88**	**47,98**
	Strawberry	30	0,24	0,12	2,25	51,49	12,30
	Sugar	10	0,00	0,00	9,97	166,63	39,80
	White wine vinegar	10	0,00	0,00	0,30	13,39	3,20
	Fresh basil	1	0,03	0,01	0,04	1,13	0,27
	Potable water	70	0,00	0,00	0,00	0,00	0,00
Total 100 g			**0,22**	**0,1**	**10,38**	**192,29**	**45,93**

1	2	3	4	5	6	7	8
	Raspberry	30	0,24	0,15	2,49	57,77	13,80
	Sugar	10	0,00	0,00	9,97	166,63	39,80
	White wine vinegar	10	0,00	0,00	0,30	13,39	3,20
	Fresh mint	1	0,04	0,00	0,08	2,05	0,49
	Potable water	70	0,00	0,00	0,00	0,00	0,00
Total 100 g			**0,23**	**0,13**	**10,61**	**198,24**	**47,35**

The analysis of Table 2 shows that the beverages produced contain a significant amount of carbohydrates due to the components of sugar and fruit or berries, whose values are from 10.38 to 11.50g per 100ml. In order to correspond to the carbohydrate content (according to the norms) of the non-alcoholic beverages produced, it was resorted to compare the energy value with those selected from the trade shown in tab.3.

Table 3. The nutritional and energy value of commercial beverages

Product name	**Mass, g**	**Protein, g**	**Fats, g**	**Carbohydrates, g**	**Energy value**	
					kJ/g	**kcal/g**
CAPPY with grapefruit pulpy	100	0,00	0,00	12,10	**214,00**	**50,00**
PRIGAT, peach concentrate	100	0,00	0,00	14,00	**217,71**	**52,00**
OCHAKOVO, strawberry mojito	100	0,00	0,00	18,60	**320,00**	**75,60**
TEDDY, with apple and carrot juice	100	0,00	0,00	11,00	**188,40**	**45,00**
FANTA, strawberry and kiwi	100	0,00	0,00	10,20	**177,00**	**42,00**

The data presented in tables 2 and 3 demonstrates that the energy value of processed beverages is close to the energy value of the same amount of commercial sweet drinks. The difference is insignificant, but the advantage is that processed soft drinks are made from natural raw materials, while commercial ones contain artificial additives. Therefore, the drinks obtained can be offered as a healthy and natural alternative to commercial non-alcoholic beverages.

Table 4. Physico-chemical and chromatic characteristics of processed beverages

№	**Indices***	**Beverage samples**				
		Plum /Lavender	*Peach /Cinnamon*	*Apple /Vanilla*	*Strawberry /Basil*	*Raspberry/ Mint*
1.	pH	3,53±0,02	3,51±0,01	3,47±0,07	3,33±0,01	3,43±0,02
2.	Density, g/cm^3	1 056±0,03	1 045±0,05	1 050±0,03	1 047±0,05	1 047±0,01
3.	Brix^0	15±0,07	11±0,02	13±0,01	12±0,01	12,5±0,02
4.	Titratable acidity, %	15,2±0,15	14,2±0,23	14,1±0,05	15,4±0,14	15,1±0,11
5.	L*	15,46±0,02	26,95±0,32	28,93±0,31	17,94±0,06	14,27±0,03
6.	a*	5,41±0,03	4,31±0,19	5,73±0,14	15,17±0,10	9,89±0,05
7.	b*	2,78±0,03	13,53±0,52	19,26±0,38	7,71±0,05	2,97±0,05

** results are presented as mean ± standard deviation*

Analyzing table 4. similarity is observed in several parameters, such as: pH, density, acidity. The significant difference is observed in the color indices, determined by the CIELab method. For two samples "Peach beverage with cinnamon" (26.95) and "Apple beverage with vanilla" (28.93) the L-brightness value was obtained higher, which shows that the samples emit more light. The results of the "Plum beverage with lavender", "Strawberry beverage with basil" and "Raspberry beverage with mint" tests at the L value ranged from 14.27 to 17.94, which proves the darker color, ie the drinks emit less light. The values obtained at a * and b * are all positive, ie the color of the samples is in the range of red-orange-yellow. The dominant red color in the "Strawberry beverage with basil", "Raspberry beverage with mint" and "Plum beverage with lavender" samples is due to the extraction of anthocyanins from the fruit, at the same time the dominance of the yellow color in the "Apple beverage with vanilla" and "Peach beverage with cinnamon" samples is due to the extraction of carotenoids.

The microbiological characteristics were determined from the samples kept during the research in glass containers with airtight lids at a temperature of + 3 ± 1C. 2 types of media were used to determine the microbiological status of non-alcoholic drinkers: Sabouraud and Agar. The description of the cultural and morphological properties was performed after staining and microscopy of the colonies with the determination of the total number of microorganisms. The results of the analyzes are presented in Figure 4 depending on the dynamics of storage for up to 6 months.

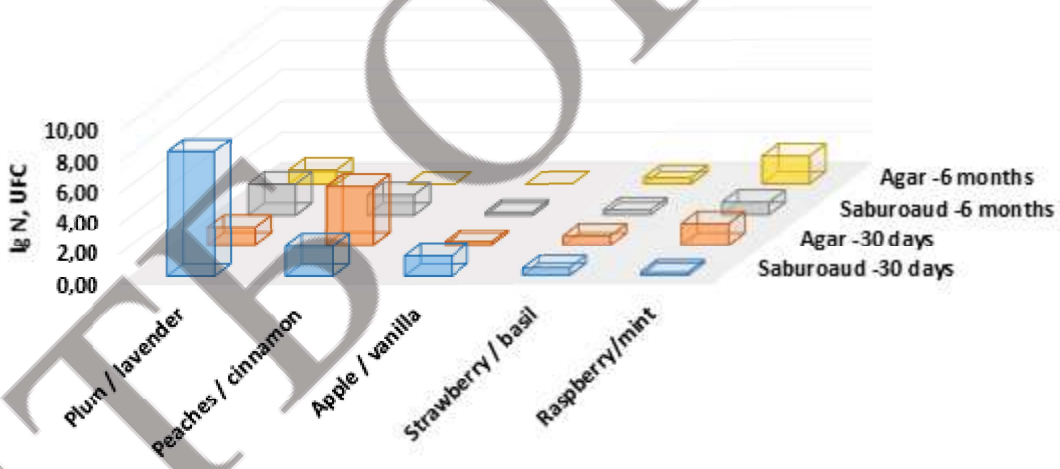

Fig. 4. Dynamics of microbiota development of beverage samples

It is known that fresh fruits and berries may contain various populations of bacteria and yeast. These microorganisms can be completely or partially removed by the washing process depending on the structure and surface condition of the product. Analyzing the evolution of the microbiota shown in Figure 4, it is observed that the samples are prepared in the correct hygienic conditions and plus the presence of acetic acid plays an important antimicrobial and preservative role. We can mention that during the preparation, under the action of acetic acid, some microorganisms in the drinks go into a state of anabiosis. Only after storage for 30 days at a temperature of 3 ± 1°C is observed an insignificant increase in the number of microorganisms, but falls within the allowable limit according to the standards of RM - GD no. 934 [14]. In conclusion, we can state that the shelf life of beverages can be longer than 30 days. For

some samples, kept for 180 days, the development of unique micromycete colonies is observed. This phenomenon is due to the specific microflora and anatomical structure of the berries (strawberry, raspberry), which is more numerous and varied compared to the microflora of fruits (apples, plums).

V. CONCLUSIONS

In this paper, the recipes and the technological production scheme for five types of non-alcoholic beverages from local fruits/berries, natural white wine vinegar and aromatic plants were elaborated, with the determination of the organoleptic, physico-chemical and microbiological characteristics. At the same time, a new way was proposed to capitalize on the natural vinegar from white wine produced in the food industry and to diversify the assortment of non-alcoholic beverages from local natural products.

Following the comparative analysis of the energy value of elaborate the non-alcoholic beverages (from 45.93 to 47.98 kcal / 100ml) and of the commercial non-alcoholic beverages (from 42.00 to 75.60 kcal / 100ml), it was found that processed soft drinks could be offered as a healthy and natural alternative to commercial ones.

The quality of processed soft drinks (from plum with lavender, from apples with cinnamon, from raspberries with mint, from strawberry with basil) is due to the addition of wine vinegar obtained from natural components, which have a significant impact on the nutritional, physico -chemical and microbiological characteristics of drinks.

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