Antioxidant characteristics of non-traditional spicy-aromatic vegetable raw materials for restaurant technology

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Keywords:

Spicy-aromatic
Vegetable
Antioxidant
Redox
Restaurant

Article history:

Received 21.09.2020
Received in revised form 11.12.2020
Accepted 30.06.2021

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DOI:
10.24263/2304-974X-2021-10-2-8

Abstract

Introduction. The aim of the study is to determine the antioxidant capacity of non-traditional for restaurant technology spicy-aromatic vegetable raw materials.

Materials and methods. Antioxidant capacity of spicy-aromatic plant raw materials: *Hyssopus officinalis L.*, *Dracocephalum moldavica L.*, *Agastache foeniculum L.*, *Melissa officinalis L.*, *Ocimum basilicum L.*, *Foeniculum vulgare Mill.*, *Glebionis coronaria L.*, *Satureja hortensis L.* were determined by redoxmetry and pH-metry of water-alcohol infusions; sensory indicators – by expert method; the results of mathematical and statistical processing – by the method of linear Pearson correlation.

Results and discussion. The hydrogen index for water-alcohol infusions from spicy-aromatic raw materials has a value of 5.28 units pH (*Hyssopus officinalis L.)* to 6.69 units pH (*Agastache foeniculum L.*). The minimum theoretical value of redox potential (*RP*) for plant water-alcohol infusions, which varies from 258.6 mV (*Agastache foeniculum L.*) to 343.2 mV (*Hyssopus officinalis L.*), was obtained. The actual measured *RP* of infusions was established – from 93 mV (*Hyssopus officinalis L.*) to 148 mV (*Glebionis coronaria L.*). Water-alcohol infusions from plant raw materials and a volume fraction of ethanol of 40% have a value of reduction energy (*RE*) in the range from 120.6 mV (*Agastache foeniculum L.*) to 250.2 mV (*Hyssopus officinalis L.*). Water-alcohol infusions from spicy-aromatic raw materials have values of sensory evaluation (*S.e.*) from 9.50 to 9.68 points. The greatest value of *S.e.* – 9.68 points characteristic of *Melissa officinalis L.*: color – light brown; taste – moderately burning, grassy; aroma – herbal, lemon.

The use of spicy-aromatic vegetable raw materials for restaurant technology is promising. Studies have confirmed the biological value of aromatic herbs for enriching tea and herbal compositions, white and red basic sauces, compotes and improving sensory evaluation.

Conclusion. The use of spicy-aromatic vegetable raw materials from *Hyssopus officinalis L.* and *Melissa officinalis L.*, which received increased antioxidant characteristics *RE* – 250.2 mV and *RE* – 184.6 mV, respectively, and positive sensory evaluation S.e. – 9.53 and S.e. – 9.68 points.

Introduction

Currently, the use of vegetable raw materials (Andreou et al., 2018; Belemets et al., 2016; Chandrasekara, Shahidi, 2018; Fotakis et al., 2016; Halliwell, Gutteridge, 1990; Hrabovska et al., 2015, 2018; Iannitti, Palmieri, 2009; Kawa-Rygielska et al., 2019; Kochubei-Lytvynenko et al., 2017) in restaurant business is very relevant (Gnytsevych et al., 2018; Gubskyi et al., 2015; Deinychenko et al., 2020; Ianchyk et al., 2016, 2018; Niemirich et al., 2015–2017; Sylchuk et al., 2016, 2017).

Current demand for high-quality spicy-aromatic vegetable raw materials involves the development of new technological methods for its preparation, with increased quality control, environmental friendliness, higher energy efficiency, lower cost and safer operation (Dainelli et al., 2008; Mujumdar, Law, 2010). These methods will allow to preserve biologically active substances (Swasdisevi et al., 2009) – volatile aromatic substances, phenolic compounds, reduce their losses (Ruan et al., 2021; Pavlyuk et al., 2018), increase organoleptic properties (Mayor, Sereno, 2004).

These biologically active substances are very sensitive to the conditions of preparation, especially to solvents – water (Tülek et al., 2020), ethyl alcohol, water-alcohol mixture (Kuzmin et al., 2020). Therefore, the conditions necessary for the efficient extraction of these compounds are specific to each plant, and this is an important issue in the process of their extraction (Tülek et al., 2020). Despite some achievements, a number of issues remain related to the preparation of spicy-aromatic plant raw materials (Priecina et al., 2018), which has antioxidant capacity. These are rare plant crops in Ukraine that are unconventional for restaurant technology (Kuzmin et al., 2020).

Spicily-aromatic vegetable raw materials contain different chemical substances that display a broad spectrum of biological activities (Frolova et al., 2019; Gerolis et al., 2017; Imark et al., 2000; Kamdem et al., 2013; Pyrzynska, Sentkowska, 2019; Sentkowska, Pyrzynska, 2018; Siddiqui et al., 2018; Steenkamp et al., 2004; Wong et al., 2020).

They have gained growing interest among scientists and consumers due to their antioxidant properties (Breiter et al., 2011; Dube et al., 2017. The ability of plant phenolics to act as free radical scavengers has led to increased interest in their ability to act as antioxidants (Herrera et al., 2018; Humia et al., 2020; Keating et al., 2014; Oh et al., 2013). Antioxidants are able to reduce the output of oxidation products: hydroperoxides, alcohols, aldehydes, ketones, fatty acids.

Spicy-aromatic raw material that exhibits antioxidant and tonic properties (Kurylo et al., 2018; Vergun et al., 2018; Vergun et al., 2019). At present, the antioxidant characteristics of all prescription components, food additives, biologically active substances and their combinations have not been sufficiently studied (Buglass et al., 2012; Grunert et al., 2018; Gullón et al., 2018; Gulua et al., 2018; Joubert, Beer, 2012).

These circumstances determine the relevance of this work, which is to develop water-alcohol extracts of vegetable raw materials in the technology of restaurants. Creating restaurant products with reduced toxicity through the introduction of spicy-aromatic infusions with antioxidant properties, allows restaurant establishments to create new products, which favorably differentiates them from competitors, creating a favorable image of the institution, which cares for the protection of consumers.

The aim of the study is to determine the antioxidant capacity of non-traditional for restaurant technology spicy-aromatic vegetable raw materials.

To achieve this goal, the following research objectives were set:

– To confirm the prospect of using non-traditional for restaurant technology spicy-aromatic vegetable raw materials;

– To establish the value of antioxidant capacity of spicy-aromatic vegetable raw materials;
– To carry out the mathematical and statistical analysis of indicators of antioxidant ability of spicy-aromatic vegetable raw materials and to establish internal correlation;
– To identify the richest sources of natural antioxidants due to spicy-aromatic plant raw materials for use in restaurant technology;
– To investigate the compositions of spicy-aromatic vegetable raw materials for restaurant technology.

Materials and methods

Materials

The study used plant raw materials that are allowed to be used in the production of restaurant products. In the *M.M. Gryshko National Botanic Garden of NAS of Ukraine* was created new cultures of spicy-aromatic plants, which became the subject of these studies (Rakhmetov, 2011).

The studies used spicy aromatic vegetable raw materials: *Hyssopus officinalis L.; Dracocephalum moldavica L.*; *Agastache foeniculum L.*; *Melissa officinalis L.*; *Ocimum basilicum L.*; *Foeniculum vulgare Mill.*; *Glebionis coronaria L.*; *Satureja hortensis L.* For preparation of extracts used the following basic raw materials: ethanol rectified, water, cardboard filtering.

Description of research procedure

Drying of spicy-aromatic vegetable raw materials was carried out in natural conditions for 6-8 days to constant humidity – not more than 14 %. Collected and inspected raw materials were laid out on clean white paper, each type separately.

The first stage – the preparation of infusions. Plant raw materials were minced into a size of 3x3 mm, suspensions of 4 g were placed into the glass bottles, were filled by 100 ml of alcohol solvent with volume fraction of rectified ethyl alcohol 40 %. The resulting infusions were cooled to 20 °C for 7 days, stirring periodically.

Next, the infusions were filtered and studies were performed to determine the indicators of active acidity, which was measured on a *pH* meter in the mode of *pH* measurement with a combined glass electrode. The *RP* was measured in the potential measurement mode with a combined redoxmetric platinum electrode.

Description of methods

Expert method of sensory evaluation

The expert method of determination of values of indexes of quality is based on the account of opinions of group highly skilled specialists-experts. (The expert of – it a specialist on the certain type of object which owns the increased sensitiveness to properties of this object) (Kuzmin et al., 2016).

Methods for determining antioxidant capacity

RP is an important indicator of the biological activity of solutions (Kuzmin O. et al., 2016; Merwe et al., 2017). It characterizes the deviation from the ionic balance of free electrons in a liquid medium. Changing the concentration of free electrons leads to a change in its electron charge and, accordingly, the *RP*. If the *RP* is positive, it indicates the oxidizing ability of the solution, negative indicates recovery ability. The value of *RP* allows to estimate the energy of processes, that is, characterizes the activity of ions in redox reactions (Bahir, 1999; Priluckij, 1997). Therefore, in order for the human body to optimally use in the exchange processes water-alcohol solutions and food, the *RP* values must correspond to the *RP* values of the internal environment of the organism, or have more negative values (Bahir, 1999).

To evaluate the antioxidant properties of the obtained water-alcoholic plant extracts, the method (Priluckij, 1997), based on the difference of *RP* in inactivated inorganic solutions and complex biochemical media. The main criteria of this method were its clarity, simplicity, specificity, reproducibility of results and efficiency. A number of researchers also emphasize that method allows to determine the total antioxidant activity of liquid products, including in total in a complex mixture, and multifunctional antioxidants (Kuzmin et al., 2016).

Formula (1) holds for inactivated inorganic solutions in equilibrium. This formula links the active acidity of the *pH* and the *RP* (Priluckij, 1997):

$$Eh_{min}=660–60\cdot pH, \text{ mV} \tag{1}$$

where Eh_{min} – the minimum theoretically expected value of the *RP*;
pH – active acidity of the test solution.

Acquired *RP* values were compared with actual measurements of Eh_{act} solution. The change of the *RP* toward the recovery energy (*RE*) was determined by the formula (Priluckij, 1997):

$$RE = Eh_{min}–Eh_{act}, \text{ mV} \tag{2}$$

where *RE* – the shift of *RP* to the side of recovered meanings (resilence);
Eh_{min} – minimal theoretically expected meaning of *RP*;
Eh_{act} – actual measured *RP*.

Mathematical and statistical methods

Pearson correlation coefficient measures the strength of the linear association between variables. Each variable should be continuous, random sample and approximately normally distributed. There are many rules of thumb on how to interpret a correlation coefficient, but all of them are domain specific. For example, here is correlation coefficient (Table 1) interpretation for behavioral sciences offered by Hinkle et al., 2003.

The correlation coefficient can take a range of values from +1 to -1. Positive correlation coefficient means that if one variable gets bigger, the other variable also gets bigger, so they tend to move in the same direction. Negative correlation coefficient means that the variables tend to move in the opposite directions: If one variable increases, the other variable decreases, and vice-versa. When correlation coefficient is close to zero two variables have no linear relationship (Hinkle et al., 2003; Shendrik et al., 2019).

Table 1

Correlation coefficient interpretation

Absolute value of coefficient (*r*)	Strength of correlation
0.90–1.00	Very high
0.70–0.90	High
0.50–0.70	Moderate
0.30–0.50	Low
0.00–0.30	Little, if any

Results and discussions

Sensory evaluation

The results of sensory evaluation (*S.e.*, points) of the obtained infusions on the extractant are presented in the Table 2 and Figures 1.

Table 2

Quality indicators of extracts on extractant

Plant raw materials	*t*, ºC	*pH*	Eh_{min}, mV	Eh_{act}, mV	*RE*, mV	*S.e.*, points
1. Hyssopus officinalis L.	20	5.28	343.2	93	250.2	9.53
2. Dracocephalum moldavica L.	19	6.14	291.6	113	178.6	9.57
3. Agastache foeniculum L.	18	6.69	258.6	138	120.6	9.65
4. Melissa officinalis L.	18	6.09	294.6	110	184.6	9.68
5. Ocimum basilicum L.	19	6.22	286.8	105	181.8	9.62
6. Foeniculum vulgare Mill.	18	6.51	269.4	115	154.4	9.50
7. Glebionis coronaria L.	19	6.38	277.2	148	129.2	9.51
8. Satureja hortensis L.	19	6.03	298.2	108	190.2	9.63
9. Extractant – water-alcohol mixture	19	7.96	182.4	180	2.4	9.57
min	**18**	**5.28**	**258.6**	**93**	**120.6**	**9.50**
max	**20**	**6.69**	**343.2**	**148**	**250.2**	**9.68**

where: *t* – temperature of infusion; *pH* – active acidity of the test solution;
Eh_{min} – minimal theoretically expected meaning of *RP*; Eh_{act} – actual measured *RP*;
RE – recovery energy; *S.e.* – sensory evaluation of extracts

Antioxidant capacity

Physicochemical studies, namely determination of the *pH* level and *RP* (Nicoli et al., 2004; Prévost, Brillet-Viel, 2014), were performed according to the method (Priluckij, 1997) and calculations given above (Kuzmin et al., 2016). As a result of extraction received infusions (Andreou et al., 2018; Chandrasekara, Shahidi, 2018; Halliwell, Gutteridge, 1990; Iannitti, Palmieri, 2009; Kawa-Rygielska et al., 2019), physicochemical indicators (Breiter et al., 2011; Dube et al., 2017) of which are presented in the Table 2.

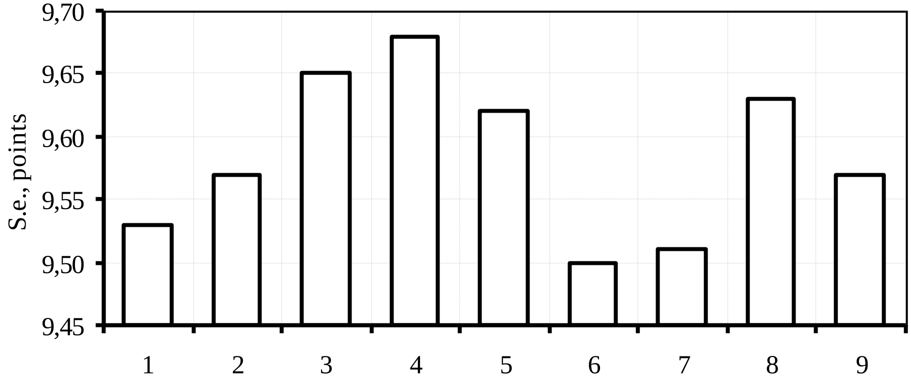

Figure 1. Sensory evaluation indicators of extracts on the extractant:
1 – Hyssopus officinalis L.; 2 – Dracocephalum moldavica L.; 3 – Agastache foeniculum L.; 4 – Melissa officinalis L.; 5 – Ocimum basilicum L.; 6 – Foeniculum vulgare Mill.; 7 – Glebionis coronaria L.; 8 – Satureja hortensis L.; 9 – Extractant – water-alcohol mixture

Figures 2–5 show graphically the change in the physicochemical indicators of the quality of extracts of spicy-aromatic raw materials on the extractant.

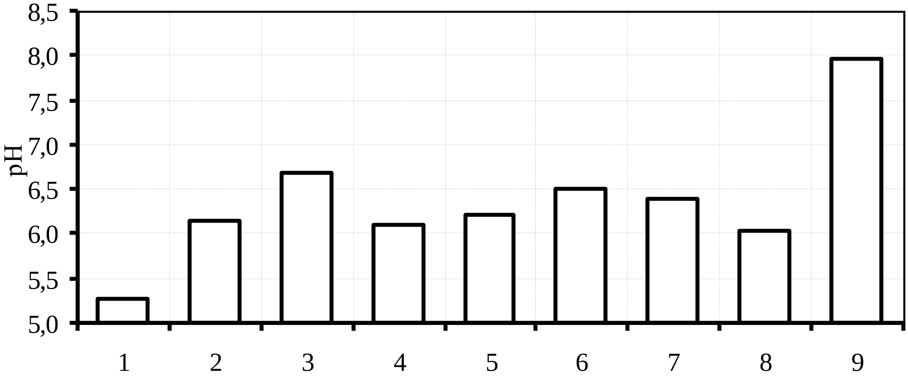

Figure 2. Hydrogen index (*pH*) of infusions of the investigated raw material:
1 – Hyssopus officinalis L.; 2 – Dracocephalum moldavica L.; 3 – Agastache foeniculum L.; 4 – Melissa officinalis L.; 5 – Ocimum basilicum L.; 6 – Foeniculum vulgare Mill.; 7 – Glebionis coronaria L.; 8 – Satureja hortensis L.; 9 – Extractant – water-alcohol mixture

The minimum theoretical value of *RP* (Eh_{min}) for plant water-alcohol infusions (Priluckij, 1997) was obtained, which has a value from 258.6 mV (*Agastache foeniculum L.*) to 343.2 mV (*Hyssopus officinalis L.*). The actual measured *RP* of infusions (Eh_{act}) was established – from 93 mV (*Agastache foeniculum L.*) to 148 mV (*Glebionis coronaria L.*). The hydrogen index for water-alcohol infusions from spicy-aromatic raw materials has a value of 5.28 units *pH* (*Hyssopus officinalis L.*) to 6.69 units *pH* (*Agastache foeniculum L.*).

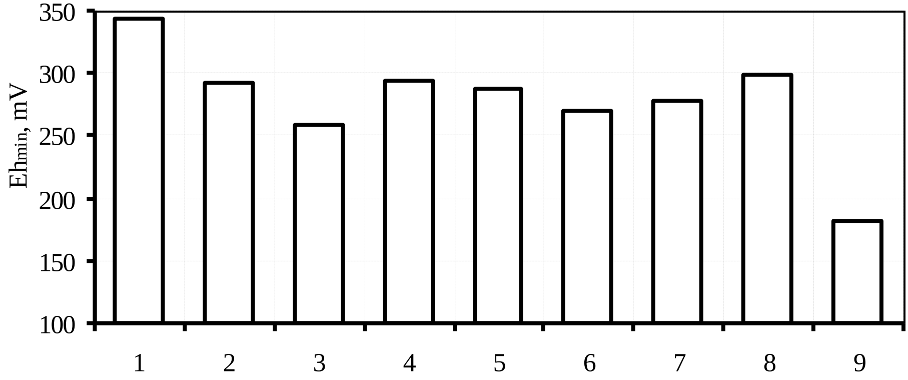

Figure 3. The minimum theoretical value of *RP* (*Eh_{min}*) of infusions of the investigated raw material:

1 – Hyssopus officinalis L.; 2 – Dracocephalum moldavica L.; 3 – Agastache foeniculum L.; 4 – Melissa officinalis L.; 5 – Ocimum basilicum L.; 6 – Foeniculum vulgare Mill.; 7 – Glebionis coronaria L.; 8 – Satureja hortensis L.; 9 – Extractant – water-alcohol mixture

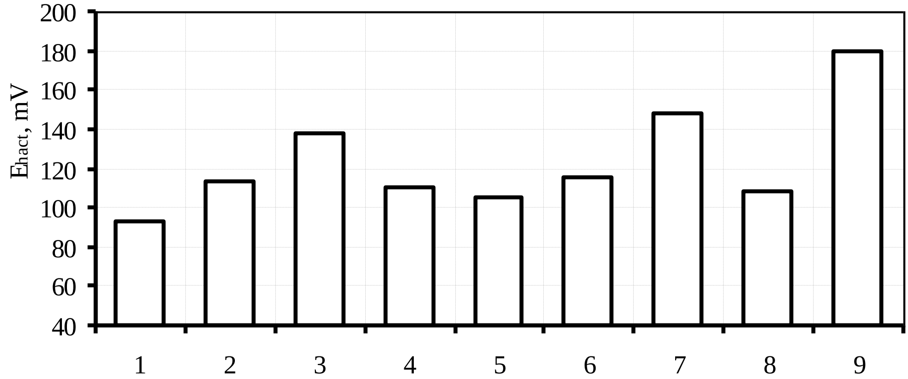

Figure 4. The actual measured *RP* of infusions (*Eh_{act}*) of infusions of the investigated raw material:

1 – Hyssopus officinalis L.; 2 – Dracocephalum moldavica L.; 3 – Agastache foeniculum L.; 4 – Melissa officinalis L.; 5 – Ocimum basilicum L.; 6 – Foeniculum vulgare Mill.; 7 – Glebionis coronaria L.; 8 – Satureja hortensis L.; 9 – Extractant – water-alcohol mixture

Water-alcohol infusions from vegetable raw materials and a volume fraction of ethanol of 40% have the value of regenerative capacity (recovery energy – *RE*) in the range from *RE* – 120.6 mV (*Agastache foeniculum L.*) to *RE* – 250.2 mV (*Hyssopus officinalis L.*). For the restaurant business in the manufacture of beverages are promising water-alcohol infusions of *Hyssopus officinalis L.* and *Melissa officinalis L.*, which received increased antioxidant characteristics *RE* – 250.2 mV and *RE* – 184.6 mV, respectively, and positive sensory evaluation (*S.e.*) – 9.53 and *S.e.* – 9.68 points.

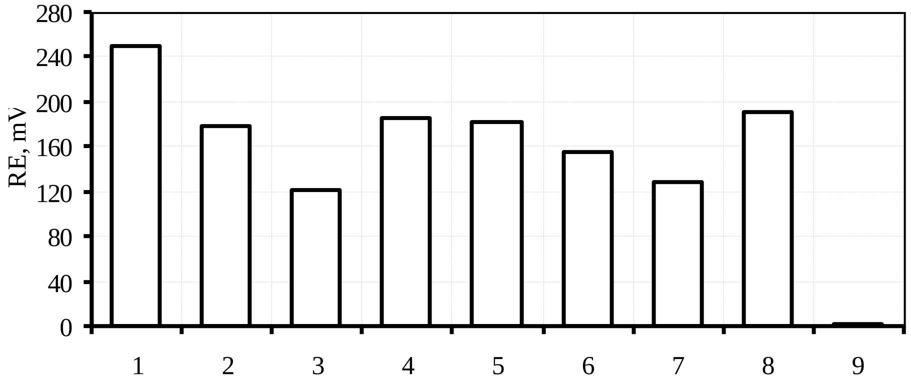

Figure 5. Recovery energy (RE) of infusions of the investigated raw material:
1 – Hyssopus officinalis L.; 2 – Dracocephalum moldavica L.; 3 – Agastache foeniculum L.; 4 – Melissa officinalis L.; 5 – Ocimum basilicum L.; 6 – Foeniculum vulgare Mill.; 7 – Glebionis coronaria L.; 8 – Satureja hortensis L.; 9 – Extractant – water-alcohol mixture

The prescription composition of alcoholic beverages may include water-alcohol infusions.

Determination of Pearson's linear correlation

According to the physicochemical and sensory evaluation, mathematical and statistical analysis (Hinkle et al., 2003; Shendrik et al., 2019) was performed in the Pearson correlation matrix (Table 3).

Table 3

Marked correlations (*r*) are significant at p<0,05; N=9

	t	*pH*	Eh_{min}	Eh_{act}	*RE*	*S.e.*
t	1.00	-0.3	0.3	-0.16	0.27	-0.38
pH	-0.33	1.0	**-1.0**	**0.91**	**-0.99**	0.00
Eh_{min}	0.33	**-1.0**	1.0	**-0.91**	**0.99**	-0.00
Eh_{act}	-0.16	**0.9**	**-0.9**	1.00	**-0.96**	-0.13
RE	0.27	**-1.0**	**1.0**	**-0.96**	1.00	0.05
S.e.	-0.38	0.0	-0.0	-0.13	0.05	1.00

where: *t* – temperature of infusion; *pH* – active acidity of the test solution;
Eh_{min} – minimal theoretically expected meaning of *RP*; Eh_{act} – actual measured *RP*;
RE – recovery energy; S.e. – sensory evaluation

According to the obtained matrix 6*6, it was found that of the 6 indicators (*t, pH*, Eh_{min}, E_{hact}, *RE, S.e.*), only 4 indicators are statistically significant. As a result of research it was found that physicochemical parameters (*t*, *pH*, Eh_{min}, Eh_{act}, *RE*) are statistically insignificant for sensory evaluation (*S.e.*), because the correlation coefficient is very weak (*r* 0.0–0.3) and weak (*r* 0.3–0.5). Also, a weak (*r* 0.3–0.5) and very weak (*r* 0.0–0.3) relationship is observed between temperature (*t*) and other physicochemical and sensory evaluation. The range of values with very high correlation (*r* 0.9–1.0) includes the following indicators: *pH*, Eh_{min}, E_{hact}, *RE*.

Figure 6 shows the graphical dependence of *pH* on Eh_{min}. It was found that the *pH* is in the range of 5.28–7.96, and Eh_{min} – 182.4–343.2 mV. According to the obtained equation, at a *pH* value of 6.00 Eh_{min} is 300 mV. When the *pH* value changes by 1 (*pH* 7.00), the Eh_{min} decreases by 60 mV (Eh_{min} 240 mV). That is, the relationship between Eh_{min} and *pH* is very high, because *r*=-1, because it is inversely correlated, which leads to an increase in *pH* to a decrease in the level of Eh_{min}.

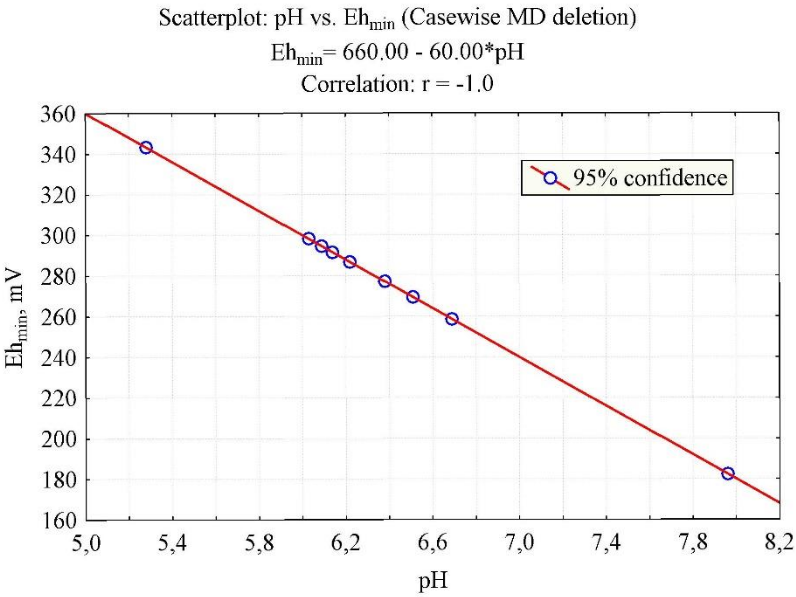

Figure 6. Dependence of *pH* level on the *RP* (Eh_{min})

Figures 7–11 show the graphical dependence of the *pH* level, Eh_{act}, Eh_{min}, *RE*.

It was found that Eh_{act} is in the range from 93 to 180 mV, and the *pH* is 5.28–7.96. At the value of Eh_{act} 111 mV, the *pH* level is 6.0. If you increase the *pH* to by one to 7.0 then the value of Eh_{act} will be 145 mV, i.e. Eh_{act} will increase by 34 mV. This is due to the fact that there is a very strong interdependence between the variables Eh_{act} and *pH* (*r*=0.9). As the *pH* value increases, the Eh_{act} index increases.

It was found that *RE* is in the range from 2.4 to 250.2 mV, and the *pH* is 5.28–7.96. When the value of *RE* 190 mV, the *pH* level is 6.0. If you increase the *pH* by one to 7.0, the value of *RE* will be 95 mV. Increasing the *pH* per unit from 6.0 to 7.0 leads to a decrease in *RE* by 94 mV. This is due to the fact that there is a very strong interdependence between the variables *RE* and *pH* (*r*=-1.0). As the *pH* value increases, the *RE* decreases.

The general graph of the three most correlation-significant physicochemical parameters is shown in Figure 12. In volumetric form, it is seen that some points (Eh_{act}, *RE*, Eh_{min}) are as close as possible to the surface, i.e. there is a very strong correlation between them. The farther the points are from the surface, the weaker the relationship.

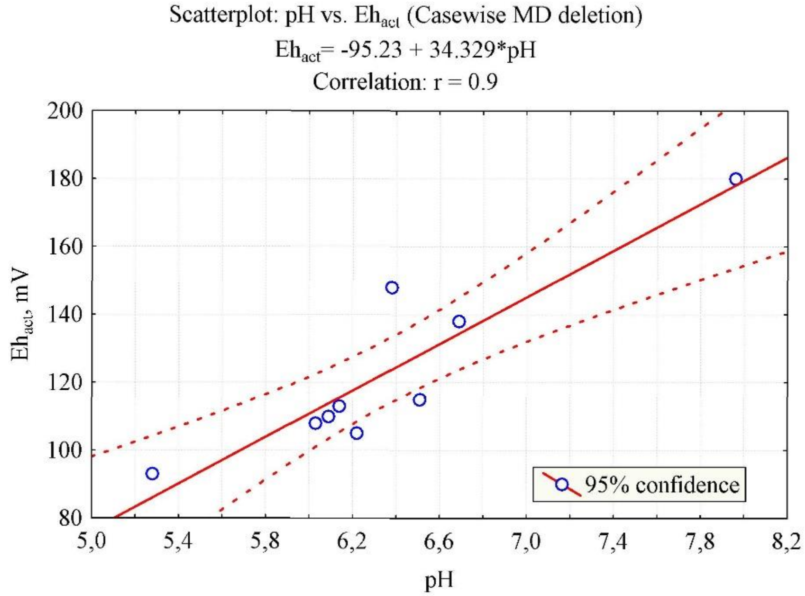

Figure 7. Dependence of *pH* level on the *RP* (*Eh$_{act}$*)

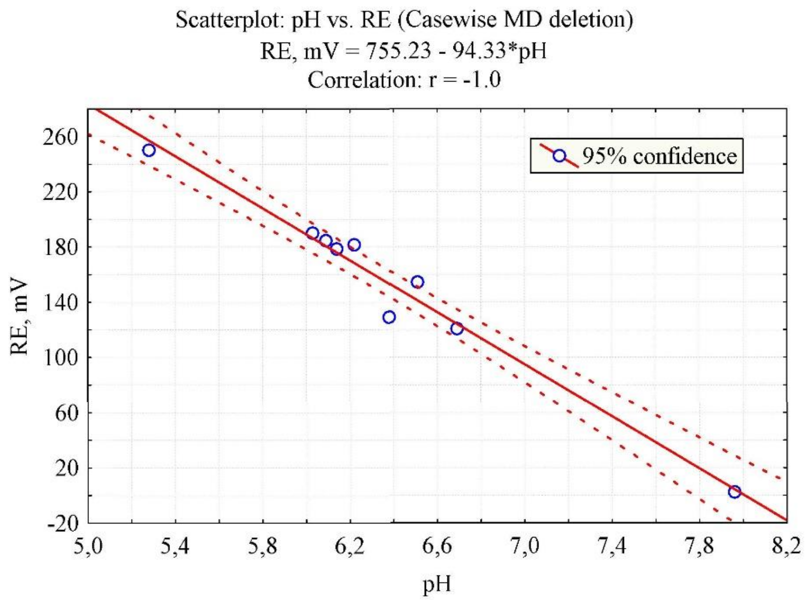

Figure 8. Dependence of *pH* level on reduction energy (*RE*)

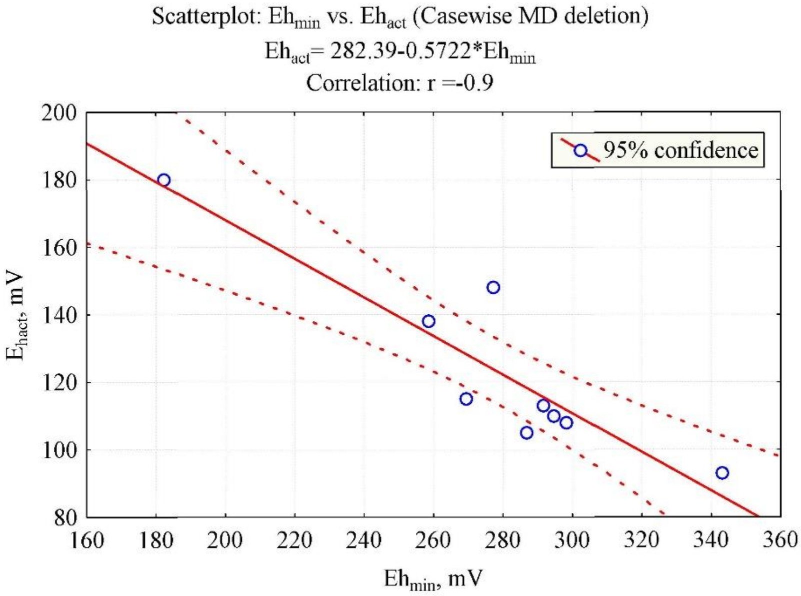

Figure 9. Dependence of *RP* (*Eh$_{min}$*) on *RP* (*Eh$_{act}$*)

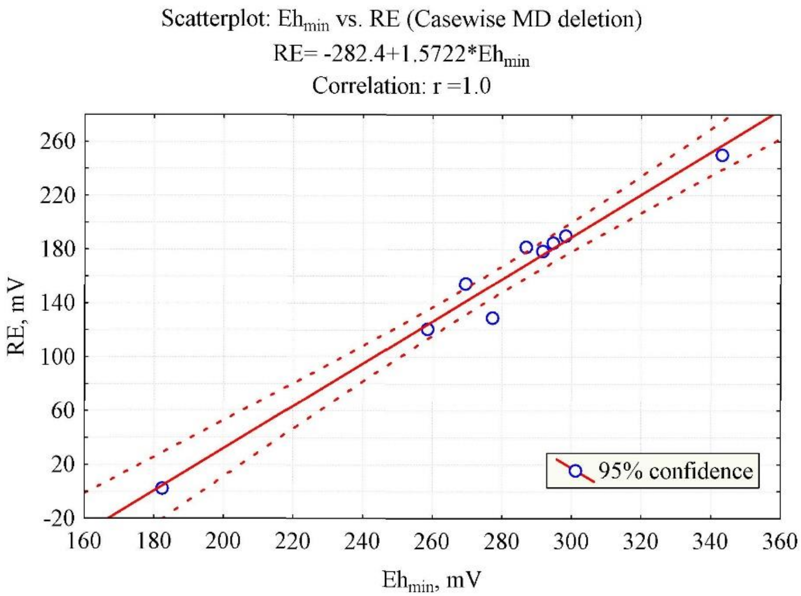

Figure 10. Dependence of *RP* (*Eh$_{min}$*) on reduction energy (*RE*)

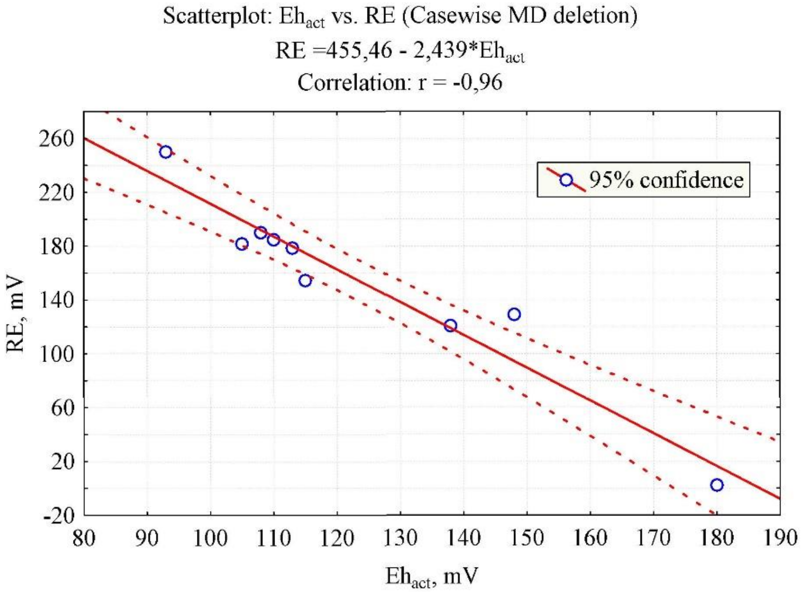

Figure 11. Dependence of *RP* (*Eh$_{act}$*) on reduction energy (*RE*)

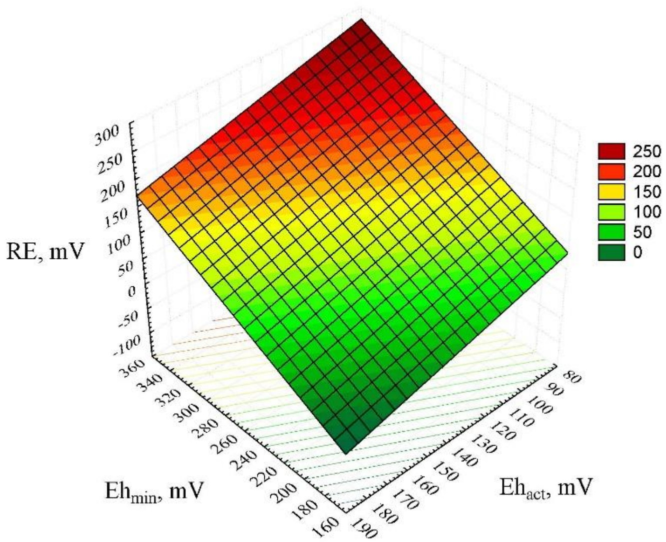

Figure 12. Response surface of *RP* (*Eh$_{act}$*) from reduction energy (*RE*) and *RP* (*Eh$_{min}$*)

Based on mathematical and statistical analysis, it was found that physicochemical parameters (*pH*, Eh_{min}, Eh_{act}, *RE*) are statistically insignificant for sensory evaluation (*S.e.*) and infusion temperature (*t*). The range of values with very high correlation (*r* 0.9–1.0) includes the following indicators: *pH*, Eh_{min}, Eh_{act}, *RE*.

Sensory evaluation of tea-herbal compositions with the addition of spicy-aromatic vegetable raw materials

The results of sensory evaluation of tea-herbal compositions are shown in table 4.

Table 4

Sensory evaluation of tea-herbal compositions

Compositions	Appearance, points	Aroma, points	Color, points	Taste, points	*S.e.*, points
Long black tea	5.0	5.0	4.9	4.8	4.925
Melissa officinalis L.	5.0	5.0	5.0	4.9	4.975
Satureja hortensis L.	4.9	4.8	4.6	4.6	4.725
Agastache foeniculum L.	5.0	5.0	4.9	4.9	4.950
Melissa officinalis L. + Satureja hortensis L.	4.9	4.9	4.9	4.7	4.850
Melissa officinalis L. + Agastache	5.0	5.0	5.0	4.9	4.975
Melissa officinalis L.+ Hyssopus officinalis L.+ Dracocephalum moldavica L.	5.0	5.0	4.9	4.6	4.875
Melissa officinalis L.+Agastache foeniculum L.+ Hyssopus officinalis L. + Dracocephalum moldavica L.	5.0	5.0	4.7	4.9	4.900

The highest score was obtained by tea-herbal compositions based on *Melissa officinalis L.* and a mixture of *Melissa officinalis L.+Agastache foeniculum L.* (1:1) – S.e. 4.975 points. The prospects of creating tea-herbal compositions based on ready-made dried mixtures have been confirmed by many authors (Alaşalvar, Çam, 2019; Tülek et al., 2020).

Sensory evaluation of white main sauce with the addition of spicy-aromatic vegetable raw materials

Evaluation of spicy-aromatic plants in mixtures showed that unsurpassed in taste, aroma and overall tasting evaluation of white main sauce based on meat broth with the addition of spicy spices (bay leaf, black peas, ground black pepper) and experimental samples of plants (broth) from beef + bay leaf + black pepper peas + ground black pepper + greens + *Hyssopus officinalis L. + Ocimum basilicum L. + Dracocephalum moldavica L.*) (Table 5).

The undoubted advantage of non-traditional for restaurant spicy-aromatic vegetable raw materials is its biological value. The presence in the composition of substances that have antimicrobial, antioxidant, hepatoprotective properties, improve digestion when used daily in small doses. They do not cause allergies, have a positive effect on the psychophysical state of man. Studies have confirmed the value and availability of spicy-aromatic vegetable raw materials to culinary dishes and can be successfully used instead of the traditional set of spices or supplement them.

Table 5

Sensory evaluation of white main sauce

Compositions	Appearance, points	Aroma, points	Color, points	Taste, points	*S.e.*, points
White sauce (main) on beef broth (control)	5.0	5.0	4.8	4.6	4.850
White sauce + bay leaf + black pepper peas + ground black pepper + greens	5.0	5.0	4.8	5.0	4.950
White sauce + *Hyssopus officinalis L.*	4.6	4.6	4.2	4.1	4.375
White sauce + *Ocimum basilicum L.*	4.9	5.0	4.6	4.6	4.775
White sauce + *Dracocephalum moldavica L.*	5.0	4.8	4.3	4.3	4.600
White sauce + *Hyssopus officinalis L.+ Ocimum basilicum L. + Dracocephalum moldavica L.*	5.0	5.0	4.3	4.8	4.775
White sauce + bay leaf + black pepper peas + ground black pepper + greens + *Hyssopus officinalis L.+ Ocimum basilicum L. + Dracocephalum moldavica L.*	5.0	5.0	5.0	5.0	5.000

Sensory evaluation of red main sauce with the addition of spicy-aromatic vegetable raw materials

The addition of spicy-aromatic vegetable raw materials to the red main sauce significantly enriched it and increased the tasting score (Table 6).

Table 6

Sensory evaluation of red main sauce

Compositions	Appearance, points	Aroma, points	Color, points	Taste, points	*S.e.*, points
Sauce red (main) on beef broth (control)	5.0	4.2	5.0	4.0	4.550
Sauce red + *Ocimum basilicum L.*	5.0	5.0	5.0	5.0	5.000
Sauce red + *Agastache foeniculum L.*	5.0	5.0	5.0	4.8	4.950
Sauce red + *Hyssopus officinalis L.*	5.0	5.0	5.0	4.2	4.800
Sauce red + *Satureja hortensis L.*	5.0	5.0	5.0	4.7	4.925
Sauce red + Dracocephalum moldavica L.	5.0	5.0	5.0	4.5	4.875
Sauce red + Glebionis coronaria L.	5.0	5.0	5.0	4.7	4.925

For the production of red main sauce used a hybrid of tomatoes «Maximato F_1», which have an increased dry matter content – 5.2%; total sugar – 3.0%; vitamin C content – 20.9 mg/100 g; total acidity – 0.51 %, which significantly exceeds other tomato hybrids.

To enrich the aroma and taste of the red main sauce, it is recommended to add spicy-aromatic herbs, especially *Ocimum basilicum L. S.e.* – 5,000 points.

Sensory evaluation of compotes with addition of spicy-aromatic vegetable raw materials

Traditionally, the healing drink in Ukraine is dried fruit compote. The aroma and taste of compotes were improved by adding spicy-aromatic vegetable raw materials (Table 7).

Table 7

Sensory evaluation of dried fruit compotes

Compositions	**Appearance, points**	**Aroma, points**	**Color, points**	**Taste, points**	***S.e.*, points**
Dried fruit compote (control)	5.0	5.0	5.0	5.0	5.000
Dried fruit compote + *Hyssopus officinalis L.*	5.0	4.9	5.0	4.9	4.950
Dried fruit compote + *Dracocephalum moldavica L.*	5.0	4.8	5.0	4.9	4.925
Dried fruit compote + *Agastache foeniculum L.*	5.0	5.0	5.0	5.0	5.000
Dried fruit compote + *Melissa officinalis L.*	5.0	4.9	5.0	4.9	4.950
Dried fruit compote + herbal mixture (*Hyssopus officinalis L., Dracocephalum moldavica L., Agastache foeniculum L., Melissa officinalis L.*)	5.0	4.8	5.0	4.8	4.900

The samples with the addition of spicy-aromatic herbs in aroma, color and taste were at the level of control (compote made from dried apples), slightly lower scores on aroma and taste can be considered insignificant compared to the fact that herbs significantly enriched the biochemical composition of the product. The specimen with the addition of *Agastache foeniculum L.* (S.e. – 5,000 point), which was better than the control, was especially distinguished.

The data obtained are correlated with the basic scientific concepts which are displayed in the works (Buglass et al., 2012; Frolova, Ukrayinets, 2018; Frolova, Korablova, 2016; Gerolis et al., 2017; Grunert et al., 2018; Gullón et al., 2018; Gulua et al., 2018; Imark et al., 2000; Joubert, Beer, 2012; Kamdem et al., 2013; Naithani et al., 2006; Naumenko et al., 2015, 2017; Pyrzynska, Sentkowska, 2019; Ruiz-Ruiz et al., 2020; Sentkowska, Pyrzynska, 2018; Siddiqui et al., 2018; Silka et al., 2016; Steenkamp et al., 2004; Wong et al., 2020), regarding the processes of extracting of plant materials.

Improving restaurant technology (Andreou et al., 2018; Chandrasekara, Shahidi, 2018; Fotakis et al., 2016; Halliwell, Gutteridge, 1990; Iannitti, Palmieri, 2009; Kawa-Rygielska et al., 2019; Kurylo et al. , 2018; Vergun et al., 2018; Vergun et al., 2019) due to the addition of spicy-aromatic raw materials. It allows to increase the antioxidant properties of the product (Breiter et al., 2011; Dube et al., 2017; Herrera et al., 2018; Humia et al., 2020; Keating et al., 2014; Kurylo et al., 2018; Oh et al., 2013; Vergun et al., 2018; Vergun et al., 2019), will help to increase the immunity of the human body, improve the metabolism, positively affect the cardiovascular system, in addition it increases the consumer properties and will allow to reduce the cost of the finished product (Kumar et al., 2018; Peschel et al., 2006; Tan et al., 2020; Wang et al., 2019).

Conclusions

1. The expediency of using non-traditional for restaurant technology spicy-aromatic vegetable raw materials in the creation of tea-herbal compositions, sauces of white and red main, compotes, in order to increase the biological value and improve sensory characteristics.
2. Experimental studies show that all aqueous-alcoholic extracts of aromatic origin contain antioxidant systems. It was found that the recovery value of all the tested extracts is positive and ranges from (*RE*) 120.6 (*Agastache foeniculum L.*) to 250.2 mV (*Hyssopus officinalis L.*).
3. Based on mathematical and statistical analysis, it was found that the infusion temperature (*t*) has a statistically insignificant effect on physicochemical parameters (pH, Eh_{min}, Eh_{act}, RE), which have a statistically insignificant effect on sensory evaluation (*S.e.*). The range of values with very high correlation (r=0.9–1.0) includes the following indicators: pH, Eh_{min}, Eh_{act}, RE.
4. Improvement of restaurant technology by adding spicy-aromatic raw materials allows to increase the redox properties of the product, increases consumer properties and reduces the cost of the finished product.
5. Compositions of spicy-aromatic vegetable raw materials for restaurant technology in the production of tea-herbal compositions, white and red main sauces, compotes of high biological value and improved sensory characteristics have been studied.

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