STATISTICAL EVALUATION ON SENSORY INDICATORS OF MAYONNAISE PRODUCTS ENRICHED WITH HERBAL EXTRACTS

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Abstract

Statistical analyzes to determine the sensory indicators of developed new mayonnaise products, enriched with six different types of medicinal plants: thyme (Thymus callieri Borbás ex Velen), St. John's wort (Hypericum perforatum L), ligulate thistle (Cirsium ligulare Boiss), hawthorn-berries (Crataegus monogyna Jacq.), hawthorn-flowers (Crataegus monogyna Jacq.) and juniper-berries (Juniperus communis L) were performed. The herbs were collected from the region of Dospat, Western Rhodopes, Bulgaria and their respective identification was performed. For their use in mayonnaise products, the preparation of oil and water extracts prepared by them and a mixture of oil and water extracts was performed. New technological recipes were developed and the exact concentrations of each of the ingredients were determined. The food emulsions were developed on the basis of vegetable refined high oleic sunflower oil and added extracts of the six herbs. An analysis of these new products was performed to determine their organatoleptic parameters. Statistical data processing was performed, including descriptive analysis and assessment of correlations. The used statistical methods make possible to determine the deviation and statistical error in the organoleptic analyzes performed for the qualification of the new products. Therefore, there were statistically significant differences between the average scores in terms of odor, aroma, taste, aftertaste, as well as in the general characteristics of mayonnaise sauces, because for them $p < 0.05$. For the other indicators $p > 0.05$, i.e. the average scores of herbs on each of these indicators were not differed significantly. Regarding the salad dressing, there were no statistically significant differences between the average scores on any of the indicators, because for all of them $p > 0.05$.

Keywords: Herbal extracts, statistical processing, sensory characteristics, mayonnaise sauce, salad dressing, food emulsion.

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1. INTRODUCTION

Food emulsions are often used culinary products in the field of culinary technology. They are the basis of many culinary products, a significant part of which are of the mayonnaise type, sweet or salty emulsion sauces and dressings. They include not only glyceride oils, which are rich in polyunsaturated fatty acids, but also oil extracts containing various biologically active substances (Boeva et al., 1990; Georgiev and Stoyanova, 2006). A major problem in the technological practice for maintaining the quality of foods, in which emulsions are involved, is the emulsion stability of the dispersed systems. Many natural

(milk) and industrial (mayonnaise, salad dressings, cream, punches, butter and margarine) products exist partly or in complete as emulsions. Unlike natural emulsions, most food emulsions are the product of forced emulsification associated with the combination of different raw materials, which can be with synthetic or natural origin (Mc Clements, 2005; 2015). Many foods are completely or partially emulsion products, or at some stage of their production are in an emulsified state - milk, cream, fruit drinks, soups, dressings, mayonnaise, sauces, desserts, ice cream and others. Different types of salad dressings, ice cream, desserts and cocktails are examples of foods that were emulsions in an intermediate stage during their production, but were subsequently converted into another form. According to Friberg (2003), food emulsions can be used both for direct consumption and as a product involved at an intermediate stage in the food production. Such a product is mayonnaise. A number of research teams are working on the sensory analysis of mayonnaise products. In support of this, a sensory analysis of traditional mayonnaise enriched with basil, rosemary and a mixture of marjoram and thyme based on various vegetable oils in the laboratory conditions was performed by Salgado et al., (2006). A 9-point hedonistic scale was used, evaluated by 28 experts in the indicators - appearance, taste and texture. There were a differences ($p > 0.05$) for mayonnaise prepared from olive oil and herbal flavored mixture of marjoram and thyme, compared to the control test, and in the significance level of 5% for mayonnaise prepared with soybean oil (Salgado et al., 2006). Organoleptic and microbiological analysis were made, but without mathematical processing, of mayonnaise products and Russian salad enriched with the herb oregano (Brazilian origin), and the tasting panel gave a higher rating to these non-traditional products compared to their classic counterpart. The results of the sensory analysis of these new products correlate with their established antimicrobial activity, which proves that the added raw materials of herbal origin can serve as a natural biopreservatives, and this leads to improved safety of the obtained food products (Lima da Silva et al., 2016).

Mayonnaise products, which are the most commonly used in culinary practices, have been the subject of research by many research teams (Kishk et al., 2013). The structure, the creamy consistency, the appearance, the rheological behavior and their parameters of stability are of great importance for the formation of their sensory parameters. Quality and texture have a direct impact on consumer's choice and satisfaction (Mattia et al., 2015; Gomes et al., 2017).

Based on the interest in the sensory properties of this type products, the aim of the present study was formulated, namely to perform mathematical and statistical processing of the sensory characteristics of mayonnaise products enriched with extracts from various wild herbs, typical for the region of Western Rhodopes, Bulgaria.

2. MATERIALS AND METHODS

The developed new mayonnaise products were prepared, using oil extracts for the oil phase (OP) of the assortments. They were obtained from fresh or dried vegetable raw material with sunflower oil extractant by technologies of Stoyanova (1986) and Georgiev and Stoyanova (2007). The fresh raw materials were extracted for 24 ÷ 48 hours at 80 ° C with stirring. In cases where dry raw material was used, it was pre-wetted to a humidity of 70% (Georgiev, 1995). For the preparation of oil extracts were used in advance ground and wetted dry plant

raw materials from the studied plant species - six different types of medicinal plants - thyme (*Thymus callieri* Borbás ex Velen), St. John's wort (Hypericum perforatum L), ligulate thistle (Cirsium ligulare Boiss), hawthorn-berries (*Crataegus monogyna* Jacq.), hawthorn-flowers (*Crataegus monogyna* Jacq.) and juniper-berries (*Juniperus communis* L) were performed, which were extracted by the above technology. Such water extracts were included in the recipe compositions of mayonnaise sauce and salad dressings.

The organoleptic and physicochemical qualities of mayonnaise sauces and mayonnaise-type dressings depend on the quality of the raw materials used, on the precision in preparing the emulsion, its dispersion and stability, as well as on the flavoring and aromatic additives used.

The following raw materials were used for the experimental work: refined sunflower oil – olein type; Water that must meet the requirements for drinking water (Ordinance № 9 of 16.03.2001 on water quality); Additional and auxiliary raw materials: sugar (white, crystalline) - corresponds to BNS 1-77; salt (table, iodized) – with NaCl content - 99.5%; KI - 28 - 55 mg / kg., vinegar - 5% (apple).

The technology for obtaining mayonnaise and mayonnaise sauce type dressing was proposed by Perifanova-Nemska and Uzunova (2016).

The sensory evaluation was performed by the method for quantitative descriptive analysis by a commission (n = 10), previously trained in order to get acquainted with the characteristics of the analyzed products and the evaluation scale. The tested products were at room temperature and in equal quantities, placed in sterile containers, coded with numbers and presented to the evaluators in random order. Conditions for the assessment were standard - at room temperature and in daylight (ISO-5492; ISO 13301-1: 2000; Herbert and Sidel, 1998; Carpenter et al., 2000).

The sensory analysis of the new assortments was performed by applying a modified version of the hedonistic scale with scores from 1 to 5, where 5 corresponds to the highest and 1 - to the lowest score for the given indicator. According to the performed sensory analysis, the statistical data processing was performed. The conditions of the analysis and tasting cards and the importance of the numerical value of intensity of the main indicators characterizing mayonnaise sauce and salad dressing, the intensity of which should be changed by adding new ingredients to the recipe was described. For each assortment, six experimental variants were evaluated and compared with a control sample. The samples were evaluated according to the following quality indicators: appearance, consistency, color, smell, aroma, aftertaste.

Analysis of variance (ANOVA) at a significance level of 0.05 was used to compare the mean scores for the different indicators. In cases of significant differences, multiple comparisons were made (post hoc analysis) by the LSD method.

3. RESULTS AND DISCUSSION

The oil phase in the new culinary products was represented by oil extracts obtained from: thyme (*Thymus callieri* Borbás ex Velen), St. John's wort (Hypericum perforatum L), ligulate thistle (Cirsium ligulare Boiss), hawthorn-berries (*Crataegus monogyna* Jacq.), hawthorn-flowers (*Crataegus monogyna* Jacq.) and juniper-berries (*Juniperus communis* L). It should be noted that the mayonnaise sauce is typical emulsion product, with 50% oil phase and 25% oil phase. Salad dressing is an atypical emulsion product because it does not emulsify and lacks emulsifiers and stabilizers in it.

Table 1 shows the results of the performed statistical analysis for the evaluations of mayonnaise sauce with oil extracts on the seven indicators, as well as for the general characteristics. One-way dispersion analysis (ANOVA) was used at a significance level of 0.05, and it was previously established that the condition for homogeneity of the dispersions was fulfilled.

The last column shown the p-values obtained from the application of ANOVA. When $p < 0.05$, the scores on the respective indicator are with statistic differences, and conversely, if $p > 0.05$, the scores on the respective indicator do not differ statistically significant.

Therefore, there were statistically significant differences between the average scores in terms of odor, aroma, taste, aftertaste, as well as in the general characteristics, because for them $p < 0.05$. In order to establish where the differences in the assessments of these indicators were, multiple comparisons (post hoc analysis) was performed by the LSD-method, the results of which were presented in the rows corresponding to the indicators in table. 1. Averages with at least one identical letter do not differ statistically according to the LSD test at a significance level of 0.05. For example, the average rating of thyme was the highest and differed significantly from the average ratings of all other herbs. The evaluations of the other herbs were not differ significantly in this indicator and therefore had the same letter "b" as an index, while the thyme was marked with "a". The average rating of the aftertaste of juniper-berries was the lowest and differed significantly from the average ratings of all other herbs, except those of thyme and hawthorn-berries. The evaluation of the aftertaste of thyme was the highest, statistically significantly different from the evaluations of all other herbs, except for the herb hawthorn-berries. The reasoning for the other indicators with $p < 0.05$ was similar.

The statistical analysis for the mayonnaise sauce type dressing with oil and water extracts are presented in table 2.

There are statistically significant differences between the average scores only in the indicators taste, aftertaste, as well as in the general characteristics (rows № 6, 7 and the last one in Table 2), because for them $p < 0.05$. For the other indicators $p > 0.05$, i.e. the average scores of herbs on each of these indicators do not differ significantly.

The results of the performed multiple comparisons for rows № 6, 7 and the last one of table 2 are presented by placing of letter indexes. Averages with at least one identical letter do not differ statistically according to the LSD test at a significance level of 0.05. For example, the average rating of the aftertaste of juniper-berries differed significantly from the average ratings of all other herbs, except that of St. John's wort, and was significantly lower than them. The evaluation of the aftertaste of hawthorn-berries was the highest, and statistically significant difference was established only from the evaluations of juniper-berries and St. John's wort.

Table 3 shows the results of the performed statistical analysis for the assessments of salad dressing with oil and water extracts on the seven indicators and for the general characteristics. There were no statistically significant differences between the average scores on any of the indicators, because for all of them $p > 0.05$.

4. CONCLUSIONS

The appearance, structure, creaminess, rheological behavior and stability parameters of mayonnaise products were of great importance for determination of their sensory parameters. After the tasting analysis, the following conclusions can be made: The data shown that in mayonnaise sauces, the sample with added ligulate thistle and hawthorn-flowers was the best perceived, and the sauces with hawthorn extracts (flowers and berries) were the most popular.

Table 1. Results of the tasting analysis of mayonnaise sauce with oil extracts

№	Indicators	Control Sample	Thyme	St. John's Wort	Ligulate thistle	Hawthorn-flowers	Hawthorn - berries	Juniper-berries	*p*-value
		Control	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5	Variant 6	
1	Appearance	4±0.7*	4.8±0.4	4.8±0.4	4±0.7	4.4±0.5	4.4±0.5	4±0.7	0.133
2	Texture	4.6±0.9	4.8±0.4	4.6±0.5	4.4±0.9	4.8±0.4	5±0	4.4±0.9	0.759
3	Colour	3.8±0.8	4.8±0.4	4.6±0.5	4.2±0.4	4.2±0.8	4.4±0.5	4±0.7	0.240
4	Odor	2.6±0.5^{b***}	4.8±0.4^{a}	3±1.2^{b}	3±1^{b}	3±1.2^{b}	3.4±0.5^{b}	3.4±0.9^{b}	**0.017****
5	Aroma	2.6±1.1^{c}	5±0^{a}	3.4±0.9^{b}	3.4±0.9^{b}	3.4±0.9^{b}	3.8±0.4^{b}	2.6±0.9^{c}	**0.001**
6	Taste	3±1^{cd}	5±0^{a}	3±1.6^{cd}	3.4±0.9^{bc}	3.4±0.5^{bc}	4±0.7^{b}	2.4±1.5^{d}	**0.013**
7	Aftertaste	2.6±1.1^{c}	5±0^{a}	3±1.6^{bc}	3.2±0.8^{bc}	3.2±0.8^{bc}	4±0.7^{ab}	2.4±1.5^{c}	**0.011**
General characteristic		23.2+3.2^{d}	34.2+1.3^{a}	26.4+4.8^{c}	25.6+2.1^{c}	26.4+3.6^{c}	29+3.1^{b}	23.2+5.4^{d}	**0.001**

* Values are mean ± standard deviation

** The bold values of p-value are less than 0.05, which indicates that there is a statistically significant difference between the average scores of the respective order.

*** In each of the lines with bold p-value, the averages with at least one identical letter do not differ statistically according to the LSD test at a significance level of 0.05.

Table 2. Mayonnaise sauce type dressing with oil and water extracts

№	Indicators	Control Sample	Thyme	St. John's Wort	Ligulate thistle	Hawthorn flowers	Hawtorn - berries	Juniper fruit	*p*-value
		Control	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5	Variant 6	
1	Appearance	3.50±1.3*	3.8±1.1	3.4±1.6	4.2±0.6	4.5±1.0	4.3±1.1	3.5±1.5	0.25
2	Texture	4.1±1.2	4.2±0.6	3.8±1.1	4.2±0.6	4.3±0.8	4.2±1.0	3.7±1.1	0.75
3	Colour	3.7±0.8	3.5±1.4	2.7±1.6	3.8±0.9	4.3±1.1	4.1±1.2	3.4±1.1	0.08
4	Odor	3.3±1.1	3.7±1.2	3.1±0.9	3.7±0.8	3.9±0.7	4.0±1.1	3.9±1.2	0.36
5	Aroma	3.2±1.1	3.6±1.1	3.3±0.9	3.6±0.7	4.1±0.9	4.1±1.0	3.0±1.2	0.10
6	Taste	3.2±0.8^{bcd}	3.6±1.5^{abc}	2.5±1.1^{d}	3.8±0.8^{ab}	3.7±1.5^{ab}	4.4±1.0^{a}	2.6±1.3^{cd}	**0.006****
7	Aftertaste	3.4±0.7^{ab***}	3.8±1.2^{ab}	3.1±1.2^{bc}	3.8±0.8^{ab}	3.7±1.5^{ab}	4.4±1.0^{a}	2.2±1.4^{c}	**0.003**
General characteristic		24.4+5.9^{cd}	26.2+5.5^{bc}	21.9+6.3^{d}	27.1+3.1^{abc}	28.5+5.9^{ab}	29.5+6.1^{a}	22.3+6.3^{d}	**0.000**

* Values are mean ± standard deviation

** The bold values of p-value are less than 0.05, which indicates that there is a statistically significant difference between the average scores of the respective order.

*** In each of the lines with bold p-value, the averages with at least one identical letter do not differ statistically according to the LSD test at a significance level of 0.05.

Table 3. Salad dressing with oil and water extracts

№	Indicators	Control Sample	Thyme	St. John's Wort	Ligulate thistle	Hawthorn flowers	Hawtorn - berries	Juniper fruit	*p*-value
		Control	Variant 1	Variant 2	Variant 3	Variant 4	Variant 5	Variant 6	
1	Appearance	4±0*	5.0±0.0	4.7±0.6	4.0±0.0	4.3±1.2	3.7±0.6	3.7±0.6	0.095
2	Texture	3.7±0.6	4.7±0.6	4.7±0.6	4.0±0.0	4.0±1.0	4.0±0.0	3.7±0.6	0.237
3	Colour	3.7±0.6	4.3±1.2	4.3±0.6	3.7±0.6	3.7±1.5	4.7±0.6	3.7±0.6	0.634
4	Odor	3.0±1.0	4.7±0.6	3.7±0.6	3.7±0.6	3.7±1.5	4.0±0.0	3.7±0.6	0.400
5	Aroma	3.0±1.0	4.7±0.6	4.0±1.0	4.3±0.6	3.7±1.5	4.3±1.2	3.7±0.6	0.472
6	Taste	3.0±1.0	5.0±0.0	4.0±1.0	4.3±0.6	4.0±1.7	4.3±1.2	4.0±0.0	0.393
7	Aftertaste	3.0±1.0	4.7±0.6	3.7±0.6	4.0±0.0	3.7±1.5	4.0±1.0	3.7±0.6	0.463
General characteristic		16.6±16.1	19.8±18.2	17.4±16	16.8±15.4	16.2±16.3	17.4±16.2	15.6±14.4	0.791

* Values are mean ± standard deviation

According to the evaluators, the dressings had a light, almost white color, which was due to the low volume of the oil phase. Added extracts of St. John's wort and juniper-berries were less perceived by consumers. The assortments had the same consistency and stability. In terms of viscosity, the evaluators defined the dressings as products with a flowable consistency.

On the basis of the performed sensory profile a statistical analysis has been made according to certain methods, which proved the accuracy of the determined sensory characteristics and the perspective for application of these new mayonnaise products in the field of nutrition.

The used statistical methods make possible to determine the deviation and statistical error in the organoleptic analyzes performed for the qualification of the new products. Therefore, there were statistically significant differences between the average scores in terms of odor, aroma, taste, aftertaste, as well as in the general characteristics of mayonnaise sauces, because for them $p < 0.05$. For the other indicators $p > 0.05$, i.e. the average scores of herbs on each of these indicators were not differed significantly.

Regarding the salad dressing, there were no statistically significant differences between the average scores on any of the indicators, because for all of them $p > 0.05$.

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