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Prospect of using the mixtures of sunflower and walnut oils for production of functional mayonnaise emulsions

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Abstract

The solution regarding the problem of improving the structure of food ration is related to creation of functional food-stuff with a balanced content of the major nutrient materials enriched in missing micronutrients. Multicomponent structure of vegetable oils provides ample opportunities for construction of products preventing deficiency in essential fatty acids, vitamins and other physiologically functional ingredients. This research covers studies of functional mayonnaise emulsion made on the basis of sunflower and walnut oils with the natural lipid extracts of walnut leaves and shell. Therefore, oxidative stability of oils, their mixture and emulsions, based on determination of intensity of primary and secondary oxidation products formation, antioxidant potential of vegetable oils and the physical stability of functional mayonnaise emulsions were studied. The oil extracted from walnut exhibits high contents of polyunsaturated fatty acids ω-6 (linoleic acid) and ω -3 (linolenic acid) and natural antioxidants. Natural extracts from walnut leaves and shell had inhibitor effect on the intensity of the accumulation of primary and secondary products of oxidation and is manifested by subtracting of acidity and peroxide values, content of diene/triene and *p*-anisidine value for the whole period of storage. Natural extracts had a significant influence on the structure, size and arrangement of fat cells, increasing the degree of dispersion of vegetable oils in the aqueous phase, stabilizing structure for a long-term.

Keywords: mayonnaise emulsion, sunflower oil, walnut oil, oxidative stability, antioxidant activity, physical stability

1. Introduction

The development and production of food products with a balanced composition and high bioavailability, which are at the same time convenience food products, is one of priority directions of modern food industry. Mayonnaises hold a special place among high-fat foods for prospective production, since they contain vegetable oil in dispersed state, which increases their assimilability and nutritional value.

These research is aimed at developing formulas and evaluating physical and chemical quality indices of functional mayonnaises with prophylactic properties. With a view to enhancing mayonnaise bioavailability it was suggested that sunflower seed oil be partially replaced with walnut oil (*Juglans regia* L.) which is represents a biological active composition that differs by an increased content of polyunsaturated fatty acids as well as relevant amounts of tocopherols which exhibit a high antioxidant potential [1, 2].

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Because a high content of polyunsaturated fatty acids involves a high oxidative degree of the product, oxidative stability of the product was the essential criterion of acceptability.

The increased resistance to antibiotics and the problems presented by synthetic antioxidant agents added in food (resistance, mutagenesis and carcinogenesis effects, for example) and public's pressure on the food industry to avoid chemical preservatives are the main factors justifying the search and development of new antioxidant agents, especially those of natural origin. Walnut leaves and shell are considered an important source of healthcare compounds for its antidiarrheal. Anthelmintic, depurative and astringent properties [3,4]. These products have a major phenolic compounds, which exhibit a high antioxidant potential. They have been shown to possess free radical-scavenging and metal chelating activity in addition to their reported anticarcinogenic properties [5].

To prevent the possible oxidation processes of the created functional mayonnaise emulsions. as well as increase the storage limits and assortment`s variety of fat products it was proposed to use natural lipid extracts of walnut leaves and shell, which exhibits a high antioxidant activity due to the content of polyphenols.

2. Materials and method

2. 1. Materials

The components utilized to obtain experimental samples of mayonnaise were used: sunflower oil double-refined and deodorized, walnut oil extra virgin, sugar, mustard powder, vinegar, salt and emulsifier. All foodstuff used in work corresponded to requirements of quality of the specifications and technical documentation [6, 7].

2.2. Technology of samples preparation

For research was prepared four experimental samples of mayonnaise. To obtain samples of mayonnaise with functional properties 25% of sunflower oil was replaced with walnut oil and the natural lipid extracts of walnut leaves and shell in a ratio 1:100. The obtained samples of mayonnaise were placed in sterile plastic food containers with sealable lids and stored for 24 hours at 4 ^{0}C, then carry out corresponding analyses.

2.3. Determination of the basic indicators of quality

Acid, peroxide values of the mayonnaise/oil samples were determined in accordance with the requirements of corresponded normative and technical documentation of product [7]. Measurement of *p*-anisidine value, diene and triene content was performed using a standard method of analysis proposed by IUPAC and researcher BIRD, respectively [8, 9].

2.4. Total polyphenol content and antioxidant activity DPPH·

The total polyphenol content was determinate by the spectrophotometric method proposed by Singleton using Folin-Ciocaltau reagent [10]. The antioxidant activity was studied by the Brand-Williams method [11].

2.5. Determination of a microstructure and the sizes of fatty droplets

By using an optical digital microscope the microstructure of mayonnaise emulsions it was determined. For this purpose a drop of the investigated sample of mayonnaise is placed on the subject glass, covered with its integumentary glass and then established in a microscope. Photos of mayonnaise samples are obtained by digital camera connected to Olympus-BX40 fluorescence microscope.

2.6. Statistical analysis

Experimental results were means ± SD (standard deviation) of three parallel measurements and processed statistically by the method of those small squares with application of coefficient Student and determination of interval of investigation.

3. Results and discussion

3.1. The evaluation of physico-chemical parameters of vegetable oils used to prepare the mayonnaise emulsions

In the present work were experimentally determined the basic qualities of the sunflower and walnut oils and their mixture. From the data presented in table 1 it can be seen that the mixtures of vegetable oils are characterized by high quality indices that correspond

to the requirements for vegetable oils used to create functional foods and meet all the standards set by regulatory documentation for these products

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3.2. Evaluation of total polyphenol content and antioxidant activity of vegetable oils samples

In the present study have been evaluated the total polyphenol content and antioxidant activity of walnut oil extra virgin, mixture of sunflower and walnut oils in a ratio 75:25 (% w/w) and sunflower oil double-refined and deodorized. The results obtained showed that the total phenolic content and antioxidant activity varied greatly among the samples, as indicated in Table 2. Thus, the highest values for both polyphenol content and antioxidant activity were obtained by the walnut oil extra virgin samples followed by the mixture of sunflower and walnut oils and sunflower oil.

Table 1. Physico-chemical parameters of the vegetable oils samples

Quality index	Period of storage	Vegetable oils samples		
		Sunflower oil	Walnut oil	Mixture of sunflower and walnut oils in a ratio 75:25 (% w/w)
Acid value. mg KOH/g, oil	0 month	0.215±0.01	0.620±0.04	0.436±0.07
	1 month	0.248±0.00	0.699±0.05	0.497±0.00
	2 month	0.259±0.02	0.760±0.06	0.555±0.01
	3 month	0.280±0.05	0.832±0.02	0.590±0.03
	4 month	0.323±0.01	1.115±0.03	0.680±0.02
Peroxid value, mmol/g oil	0 month	0.124±0.00	0.427±0.04	0.215±0.01
	1 month	0.130±0.01	0.455±0.01	0.295±0.01
	2 month	0.202±0.00	0.516±0.01	0.338±0.02
	3 month	0.240±0.02	0.596±0.03	0.400±0.05
	4 month	0.276±0.04	0.965±0.03	0.456±0.04
Conjugated diene content, µmol/g oil	0 month	0.380±0.00	0.867±0.05	0.497±0.05
	1 month	0.400±0.01	0.908±0.07	0.532±0.04
	2 month	0.523±0.04	1.048±0.03	0.647±0.07
	3 month	0.548±0.03	1.115±0.05	0.724±0.02
	4 month	0.615±0.02	1.423±0.04	0.996±0.04
Conjugated triene content, µmol/g oil	0 month	17.021±0.03	18.248±0.03	17.575±0.05
	1 month	17.195±0.05	18.374±0.06	17.669±0.07
	2 month	17.559±0.16	18.602±0.05	17.978±0.06
	3 month	17.690±0.05	18.745±0.06	18.140±0.03
	4 month	17.724±0.02	19.254±0.03	18.437±0.01
p-anisidine value, c.u.	0 month	1.135±0.03	2.250±0.02	1.386±0.01
	1 month	1.199±0.08	2.308±0.01	1.418±0.02
	2 month	1.241±0.02	2.399±0.04	1.450±0.03
	3 month	1.289±0.03	2.415±0.02	1.480±0.03
	4 month	1.324±0.02	2.580±0.04	1.567±0.02

*Average concentration of three measurements ± standard deviation.

Table 2. Total polyphenol content and antioxidant activity DPPH of the studied oils samples

№	Research sample	Total polyphenol content (TPC), [µg/ml]	Antioxidant activity (DPPH), [%]
1	Walnut oil extra virgin	981.24±1.69	93.80±0.09
2	Mixture of sunflower and walnut oils in a ratio 75:25 (%w/w)	349.10±1.35	57.61±0.15
3	Sunflower oil double-refined and deodorized	143.62±1.01	30.02±0.11

*Average concentration of three measurements ± standard deviation.

Table 3. Quality indices of functional mayonnaise emulsions

Research sample	Period of storage	Acidity, % acetic acid	Peroxide value, meq/kg product	Conjugated diene content, μmol/g product	Conjugated triene content, μmol/g product	Aniside value, c.u.
Control - mayonnaise on the basis of sunflower oil	0 month	0.735±0.00	0.989±0.02	1.056±0.06	19.701±0.06	4.817±0.04
	1 month	0.748±0.01	1.054±0.13	1.109±0.03	19.855±0.08	4.965±0.00
	2 month	0.786±0.02	1.206±0.00	1.260±0.05	20.208±0.01	5.115±0.02
	3 month	0.815±0.03	1.259±0.04	1.380±0.03	20.956±0.06	5.618±0.03
	4 month	0.935±0.01	1.617±0.03	1.623±0.03	23.521±0.03	6.743±0.02
Mayonnaise with 25% walnut extra virgin oil	0 month	0.911±0.02	1.312±0.01	1.408±0.04	21.647±0.05	5.557±0.04
	1 month	0.928±0.05	1.360±0.10	1.466±0.03	21.719±0.03	5.682±0.09
	2 month	1.086±0.07	1.507±0.01	1.522±0.02	22.045±0.01	5.719±0.054
	3 month	1.145±0.04	1.795±0.03	1.642±0.05	22.754±0.02	6.067±0.05
	4 month	1.299±0.02	2.315±0.05	2.024±0.05	26.016±0.05	7.134±0.02
Mayonnaise with 25% walnut extra virgin oil and natural lipid extract of walnut leaves	0 month	0.567±0.02	0.601±0.01	0.679±0.03	15.978±0.03	3.732±0.06
	1 month	0.582±0.06	0.627±0.01	0.710±0.01	16.420±0.05	3.839±0.07
	2 month	0.613±0.02	0.691±0.01	0.762±0.04	16.746±0.07	4.015±0.05
	3 month	0.654±0.04	0.725±0.04	0.830±0.05	17.345±0.06	4.156±0.02
	4 month	0.754±0.02	0.920±0.07	1.032±0.02	20.324±0.06	5.213±0.02
Mayonnaise with 25% walnut extra virgin oil and natural lipid extract of walnut shell	0 month	0.555±0.01	0.615±0.03	0.799±0.06	17.013±0.05	3.856±0.01
	1 month	0.568±0.01	0.629±0.01	0.835±0.05	17.568±0.10	3.995±0.04
	2 month	0.595±0.02	0.710±0.04	0.929±0.04	17.839±0.23	4.163±0.04
	3 month	0.623±0.03	0.749±0.02	1.112±0.02	18.234±0.07	4.301±0.06
	4 month	0.711±0.03	0.948±0.05	1.478±0.05	21.523±0.61	5.532±0.05

*Average concentration of three measurements ± standard deviation.

Also, were achieved and analyzed the kinetic curves of antioxidant activity of the samples. Experimental dare are presented in figure 1.

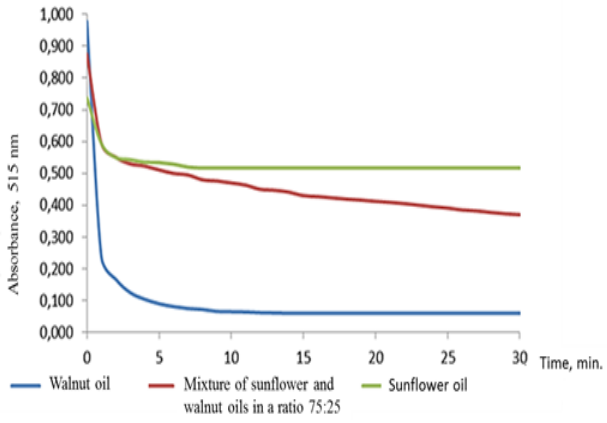


Figure 1. Kinetic curves of antioxidant activity (DPPH) of the vegetables oils

It is well known the fact that the faster it occurs the decrease of absorbance the faster it occurs the neutralization of free radicals [12,13].

By analyzing the curves of antioxidant activity of investigated vegetables oils it was found that walnut oil has reached the equilibrium state within 3 minutes while the other samples had achieved the equilibrium state within 5-7 minutes. Also, the decrease of absorbance for the walnut oil was faster compared with other samples.

3.3. Evaluation of the quality indices of functional mayonnaise emulsions

To obtain mayonnaise emulsion with functional properties 25% of sunflower oil was replaced with walnut oil. Mayonnaise samples were prepared according to the following technology: mayonnaise paste preparation of milk powder, soda, mustard powder and emulsifier are mixed in a ratio of 1:2 with sunflower oil. All components were mixed with salt and sugar. Vegetable oils were added slowly through a thin jet mixing continuously in single direction. To prevent the oxidation processes it was proposed to use natural lipid extracts of walnut leaves and shell in a ratio 1:100.

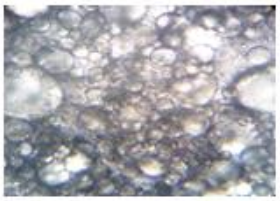
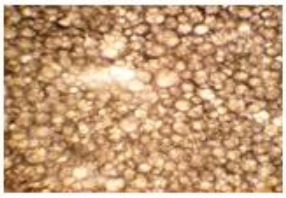
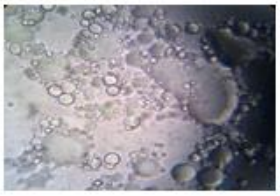
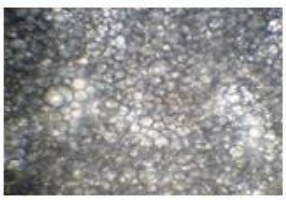
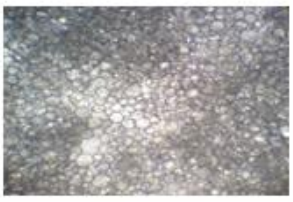
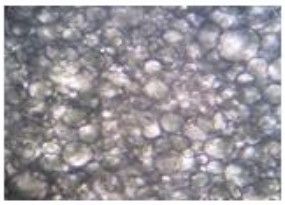
Dynamic accumulation of oxidation products in mayonnaise samples was monitored during storage for 4 months. Research results are presented in table 3.

On the basis of experimental data can be stated that natural lipid extracts have a major impact on the intensity of accumulation of primary and secondary products of lipid oxidation. The inhibitory effect is present in all samples with natural lipid extracts which was confirmed by the decrease of acid values, peroxide index, dienes/triene content and p-anisidine index for the entire retention period. Designed mayonnaise emulsions have high physico-chemical characteristics and corresponded to quality requirements for this product.

3.4. Evaluation of mayonnaises microstructure with functional properties

The quality of any food product is closely related by its structural properties. The study of the influence of added extra virgin coconut oil and natural extracts on the quality of food emulsions cannot be complete without analysis of the influence of these factors on emulsion structure. This index shows the degree of dispersion of fat which represent the main factor in determining the degree of assimilation of the finished product. Also, the degree of dispersion of fat influences the texture, oxidative stability and rheological properties of the food product. The images of the microstructure of the samples are shown in Table 4.

Table 4. Evaluation of mayonnaises microstructure with functional properties during storage

Samples	Microstructure of food emulsions - initial samples	Microstructure of food emulsions – samples after 4 month of storage
Control - mayonnaise on the basis of sunflower oil		
Mayonnaise with 25% walnut extra virgin oil		
Mayonnaise with 25% walnut extra virgin oil and natural lipid extract of walnut leaves		
Mayonnaise with 25% walnut extra virgin oil and natural lipid extract of walnut shell		

Analysing the microstructure of investigated emulsions have not been recorded significant changes during storage for all experimental samples. After 4 months of storage was recorded a mechanical destabilization only for control emulsions which was evidenced by flocking phase. Also, the microstructure of the emulsions with addition of natural extracts is significant different by the structure of control emulsions. The radius of fat globules of the emulsions with addition of natural extracts is much smaller compare with the control. Therefore, natural extracts have significant influence on the structure, size and arrangement of fat globules, increasing the degree of dispersion of the vegetable oils in the aqueous phase stabilizing structure for long term.

4. Conclutions

The composition of vegetable oils (sunflower and walnut) in a ratio of 75:25 (% w/w)) used to create a fat basis mayonnaise emulsion with a functional properties differs the most optimal ratio of polyunsaturated fatty acids ω-3: ω-6, the high total polyphenol content (349.095 µg/ml) and antioxidant activity (57.6 %). The advisability of the utilization of the walnut oil was proved by increasing the biological value and improvement the physical-chemical parameters of the emulsions quality.

Researches of the oxidative stability of mayonnaise emulsions in the process of preserving indicate that natural extracts of walnut leaves and shell have inhibitor effect on the intensity of the accumulation of primary and secondary products of oxidation and is manifested by subtracting of acidity and peroxide values, content of diene/triene and *p*-anisidine value for the whole period of storage.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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