

## NUTRITION AND FOOD SCIENCE

# Evaluation of mayonnaise-like food emulsions with extracts of herbs and spices

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### Abstract

This paper investigates mayonnaise-like food emulsions with natural spices and herbs and new type of extracts. The microbiological quality, oxidative stability and sensory perception of the food emulsions were analyzed. Mayonnaise and salad dressing were prepared with extra virgin olive oil at 50% and 25% oil-phase volume, respectively. Results demonstrate that the microbiological contamination of spice extracts is significantly lower than that of the corresponding natural spices. Food emulsions with spice and herbs extracts were not microbial contaminated. The differences in the oxidation processes were evaluated by measuring the formation of primary oxidation products. Mayonnaise with olive oil and natural spices proved to be most susceptible to oxidation. When comparing samples, these with extracts were more resistant to oxidation, and this was expressed most strongly in salad dressing with basil. Sensory evaluation indicated that there were little differences in the degree of perception in investigated sensory attributes of the emulsions with natural spices and herbs and their extracts. Consumers scored the samples with a higher fat content higher than the low-fat ones.

*Key words:* Food emulsions, Herbs and Spices extracts, Oxidative stability, Sensory evaluation

### Introduction

Different mayonnaise-like food products like mayonnaise, mayonnaise with addition of different ingredients and dressing sauces are used in the food and catering industries. All such products are in the form of oil-in-water emulsions. One current trend in food technology is to incorporate plant oils as an oil phase in emulsions, with an emphasis on oils perceived as healthy, such as walnut, olive oil, canola oil, etc. (O'Donnell, 1995; Brandt, 1999; Paraskevopoulou et al., 2006). However, because of their unsaturated character, such oils are susceptible to oxidation (Chaiyasit et al., 2007). There are many articles concerning quality changes of bulk oils. In contrast, the oxidative and hydrolytic degradation that occurs in oil-in-water emulsions are less studied.

The addition of spices into food emulsions improves their consumer acceptance and flavour characteristics. Besides sensory profile, spices also improve oxidative stability of vegetable oils. They may serve as natural food preservatives, too.

Different authors have considered antioxidative activity spices and herbs added to pure oils (Özcan, 2003; Abdala and Roozen, 1999), but not many references have been found concerning the effect of spices on the oxidative stability of oil-in-water emulsions.

In present days several new techniques for extraction of spices and herbs are industrially involved – supercritical extraction, sub-critical liquefied gas extraction, etc. (McHugh and Krukonis, 1994). In this paper is considered the influence of new type of extracts ([www.buy-extracts.com](http://www.buy-extracts.com)) derived through food grade sub-critical liquefied gas on some foods. There are no attempts for substitution of traditional researched spices with their type of extracts in mayonnaise-like food products.

As regards microbiological contamination, mayonnaise-like food products are relatively stable, because of their low values of pH (Smittle, 1977; Radford and Board, 1993). Moreover, high fat content is inappropriate environment for microbial grow. Nevertheless, extracts of natural herbs and spices can be used as additional ingredients for improving microbiological quality. On the other hand, if they are not microbial clean, some herbs and spices may contaminate the end product.

The objective of this research was to evaluate and compare the replacement of natural spices and

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herbs with their new type of extracts in mayonnaise-like food emulsions from the point of their microbiological, antioxidative and sensory characteristics.

## Materials and Methods

### Materials

Table 1 shows the recipes for mayonnaise and salad dressing with natural spices and herbs.

Skimmed milk powder containing 4% moisture, 1.25% fat and 38% proteins was obtained from the local market. Cold-pressed extra-virgin olive oil, produced in Greece, had the followed characteristics: acidity (% oleic acid) – 0.27; peroxide value (meq O<sub>2</sub>/kg of oil) – 1.2; K<sub>232</sub> [where K=absorbance/C (g/100 ml oil)] - 1.6. Modified corn starch, Instant Clearjel SD” obtained from

National Starch and gum “Lygomme KCT 45” obtained from Cargill Texturizing Solutions was used as thickening agents.

The other ingredients for the recipes were supplied from local market: dried basil herb (*Ocimum basilicum*), country of origin Bulgaria, crop 2009; Fresh leaves of parsley (*Petroselinum crispum*), country of origin Bulgaria; Ground black pepper fruits (*Piper nigrum* L.), country of origin Vietnam, crop 2009; Hot Paprika (*Capsicum annuum* L.) country of origin China, crop 2009; salt, sugar and vinegar, country of origin Bulgaria.

Antimicrobial agents, sodium benzoate and potassium sorbate, were obtained from Qingdao Rich Trading Co. Ltd (China).

Table 1. Recipes for mayonnaise and salad dressing with olive oil and natural spices and herbs.

Products (Ingredients) g/100g	Mayonnaise (MO)	Salad dressing (SD)
Olive oil	50	25
Merigel 314	1.2	2
Lygomme KCT 45	0.1	0.2
Skimmed milk powder	3	3
Salt	1	1
Sugar	1	1
Sodium benzoate + potassium sorbate	0.15	0.15
Citric acid	0.4	0.4
Vinegar	2.1	2.1
Parsley	0.32	-
Ground black pepper	0.2	-
Basil	-	0.08
Hot Paprika	-	0.12
Water	40.53	64.95

The samples of mayonnaise with extracts of parsley and ground black pepper (MOE) and salad dressing with extracts of basil and hot paprika (SDE), were with the same composition, and the content of added extracts were aliquot of the natural ingredients.

### Obtaining of herbs and spices extracts

The extracts were derived on a semi-industrial scale extraction unit using sub-critical liquefied gas 1,1,1,2-tetrafluoroethane (CAS-No. 811-97-2, Solkane 134a), as food grade solvent according to EU flavoring regulations. The extraction raw materials were the same as used for food emulsions flavoring.

The standardized extract Botfex™ Black pepper has the following technical data: INCI-Name (CTFA) Piper Nigrum Extract, CAS-No. 84929-41-9, EINECS-No. 284-524-7, appearance - brown clear oily liquid with yellow crystals, pungent taste and strong characteristic smell and

taste of raw material, volatile oil content – min. 50% (v/w), piperin content – min. 40% (w/w), yield 25-32 kg raw material per kg extract. The extraction parameters were: extraction time 60 min, temperature 20-23°C.

The standardized extract Botfex™ Basil has the following technical data: INCI-Name (CTFA) Ocimum Basilicum Extract, CAS-No. 84775-71-3, EINECS-No. 283-900-8, appearance - dark green brown oily liquid with strong characteristic smell of raw material, volatile oil content – min.50% (v/w), yield 350-400kg dried raw material per kg extract. The extraction parameters were: extraction time 90 min, temperature 20-23°C.

The standardized extract Botfex™ Parsley has the following technical data: INCI-Name (CTFA) Apium Graveolens Extract, CAS-No. 89997-35-3, EINECS-No. 289-668-4, appearance - dark green oily liquid with strong characteristic smell of raw material, volatile oil content – min. 40% (v/w), yield 250-300 kg fresh raw material per kg extract.

The extraction parameters were: extraction time 60 min, temperature 20-23°C.

The standardized extract Botfex™ Hot Paprika has the following technical data: INCI-Name (CTFA) Capsicum Annuum Extract, CAS-No. 84625-29-6, EINECS-No. 283-403-6, appearance - red brown clear oily liquid with strong characteristic smell and taste of raw material, volatile oil content – min. 15% (v/w), yield 40-60 kg dried raw material per kg extract. The extraction parameters were: extraction time 180 min, temperature 30-35°C.

### **Preparation of the mayonnaise-like food emulsions**

The control samples were prepared in a homogenizer “Disho-Labor V 60/10” (“Koruma”), operated at 3900 min<sup>-1</sup>.

Milk powder, salt, and sugar were blended in water and homogenized for 60 sec. The starch and gum were blended with part of the oil in a ratio of 1:3. The mixture was slowly added to the water phase under continuous mixing. After the entire quantity was added, the rest of the oil phase was slowly emulsified into the water phase. The duration of the process of emulsification was 150 sec for mayonnaise and 90 sec for salad dressing. Finally, the citric acid, dissolved in vinegar, was added to the emulsion and additional homogenization for 60 sec was done. The natural spices and herbs were added into the continuous phase; their extracts were blended with the oil phase.

Four samples were prepared: two with natural spices and herbs - Mayonnaise (MO) and Salad dressing (SD), and two with their extracts - Mayonnaise with extracts (MOE) and Salad dressing with extracts (SDE).

After preparation, emulsions were kept in refrigerator at 0°C to 4°C until their analysis.

### **Microbiological analysis**

The following microbiological analyses of spices and spice extracts were performed: aerobic colony count according to ISO 4833:2004, yeasts and moulds according to ISO 7954:2002, *Escherichia coli* according to ISO 16649-2:2002, *Salmonella* spp. according to ISO 6579:2002, coliforms according to ISO 16649-2:2002, coagulase-positive staphylococci according to ISO 6888-1:2005+A1:2005, anaerobic sulfite-reducing bacteria according to ISO 15213:2003.

Food emulsion samples were analyzed for aerobic colony count according to ISO 6610:2002, yeasts and moulds according to ISO 6611:2002,

coagulase-positive staphylococci according to ISO 6888-1:2005+A1:2005 and anaerobic sulfite-reducing bacteria according to ISO 15213:2003 at the first day of the cold storage.

### **Oxidative stability evaluation**

#### **Experimental design**

The olive-oil samples, mayonnaise-like food products, and sauces were stored in screw-capped glass containers (200 ml) at 4°C prior to analysis. Oil was separated from the O/W emulsions by repeated freeze-thaw cycles, followed by centrifugation (Jacobsen et al., 1998). Containers were sampled every five days. Two containers of each sample were independently analyzed in each sampling, and each parameter was measured twice. The results below are expressed as mean values.

#### **Analytical determinations**

The quality of olive oil and progress of lipid oxidation was assessed by measuring free acidity, peroxide value (PV), and specific extinction coefficient  $K_{232}$ . These quality indicators were determined according to European Union standard methods (Annexes II and IX in European Community Regulation EEC/2568/91).

Free acidity, given as % oleic acid, was determined by titration of an oil solution dissolved in ethanol/ether mixture with ethanolic solution of potassium hydroxide.

Peroxide value, given in milliequivalents of active oxygen per kilogram of oil (mequiv/kg), was determined as follows: a mixture of oil and chloroform/acetic acid 3:2 (v/v) was left to react in darkness with saturated potassium iodine solution; the free iodine was then titrated with a sodium thiosulfate solution.

The determination of the absorbance in the UV spectrum of the samples was measured at 232 nm as conjugated dienes according to standard methods (IUPAC, 1987), with minor modifications. Mayonnaise emulsions (0.15g) were dissolved in methanol (20 ml). The samples were centrifuged at 12 000 rpm for 5 min, and the absorbance of the supernants was measured. Two measurements were performed on duplicate samples, and the results were computed according to the following formula:  $CD = A_{232} / c \times d$ , where A is the absorbance reading at 232 nm, c denotes the concentration of the solution in gram per 100 ml and d is the length of the cell, in centimeters.

#### **Sensory analysis**

The sensory analysis was carried out in a sensory laboratory. Sensory evaluation was performed by a trained sensory panel consisting of

15 trained assessors. Panellists were trained in 2 h sessions prior to evaluation to be familiar with attributes and scaling procedures of food samples. Sensory evaluation was conducted on the samples after one day cold storage at 0°C to 4°C. The samples were tempered at 10°C±1°C before tasting. Each assessor was served representative mayonnaise samples of 5g placed on white plastic glass and labelled with a three-digit code at a temperature of 10°C±1°C. The performance conditions were standard, during day time, and under regular room temperature (20°C).

The following list of specific attributes and sensory descriptors was defined:

- **Appearance:** color (intensity of yellow color), brightness (mat to bright), emulsion stability (separate oil- stability);
- **Texture:** consistency (thin to thick), oiliness (watery to oily), homogeneity (homogenous to heterogeneous);
- **Smell** (weak to strong): olive, basil (for salad dressings) and parsley (for mayonnaise), rancid;
- **Taste** (weak to strong): salty, sour, bitter, chili, basil (for salad dressings) and parsley (for mayonnaise), rancid;
- **Aftertaste** (weak to strong): bitter, basil (for salad dressings) and parsley (for mayonnaise);
- **Overall acceptability:** bad to very good.

The analysis was performed by scoring attributes on a structural scale from 0 to 9 points, where higher score means more expressed attribute.

Each attribute had its own individual scale. After a statistical evaluation, the results were graphically presented, and sensory profiles were demonstrated.

Sensory characteristics: appearance, texture, smells, and taste were evaluated on a nine-point hedonic scale, with 1 being “dislike extremely” and 9 being “like extremely”.

### Statistical analysis

All experiments were performed on duplicate samples. Statistical analysis was conducted with a software package implementing the one-way ANOVA method. Significant differences between means (at the level of  $p < 0.01$ ) were determined using the Student's *t*-test.

### Results and Discussion

#### Microbiological analysis

Results from microbiological analysis of natural spices and herbs and their extracts (Table 2) used for food emulsions production showed higher contamination with *Escherichia coli* counts of basil in comparison with ground hot paprika and black pepper. This herb had higher contamination with moulds, coliforms, other *Enterobacteria*, anaerobic sulfite-reducing bacteria counts, and other anaerobic bacteria. Small differences were found in yeasts, coagulase-positive and anaerobic sulfite-reducing bacteria counts of natural spices and herbs. The obtained results showed higher contamination with microorganisms in comparison with their natural extracts.

Table 2. Microbiological quality of spices and herbs and their extracts used for making of mayonnaise-like food products.

Microorganisms groups	Sample					
	Hot Paprika		Ground black pepper fruits		Dried basil herb	
	Row material	Extract	Row material	Extract	Row material	Extract
	CFU/g	CFU/cm <sup>3</sup>	CFU/g	CFU/cm <sup>3</sup>	CFU/g	CFU/cm <sup>3</sup>
Aerobic colony count	6x10 <sup>4</sup>	1x10 <sup>2</sup>	1.7x10 <sup>6</sup>	2.5x10 <sup>2</sup>	5x10 <sup>5</sup>	<10 <sup>1</sup>
Moulds	<10 <sup>1</sup>	<10 <sup>1</sup>	<10 <sup>1</sup>	<10 <sup>1</sup>	2.8x10 <sup>2</sup>	<10 <sup>1</sup>
Yeasts	1x10 <sup>2</sup>	<10 <sup>1</sup>	2x10 <sup>3</sup>	<10 <sup>1</sup>	<10 <sup>1</sup>	<10 <sup>1</sup>
<i>Escherichia coli</i>	<10 <sup>2</sup>	<10 <sup>2</sup>	<10 <sup>2</sup>	<10 <sup>2</sup>	5.4x10 <sup>3</sup>	<10 <sup>2</sup>
<i>Salmonella</i>	ND	ND	ND	ND	ND	ND
Coliforms	<10 <sup>2</sup>	<10 <sup>2</sup>	<10 <sup>2</sup>	<10 <sup>2</sup>	1x10 <sup>5</sup>	<10 <sup>2</sup>
Other						
<i>Enterobacteria</i>	<10 <sup>2</sup>	<10 <sup>2</sup>	<10 <sup>2</sup>	<10 <sup>2</sup>	2x10 <sup>5</sup>	<10 <sup>2</sup>
Coagulase-positive staphylococci	10 <sup>2</sup>	<10 <sup>2</sup>	1.3x10 <sup>3</sup>	<10 <sup>2</sup>	2x10 <sup>4</sup>	<10 <sup>2</sup>
Anaerobic sulfite-reducing bacteria	7x10 <sup>1</sup>	<10 <sup>2</sup>	8x10 <sup>1</sup>	<10 <sup>1</sup>	6x10 <sup>2</sup>	<10 <sup>1</sup>
Anaerobic sulfite-reducing bacteria / vegetative cells /	<10 <sup>1</sup>	<10 <sup>1</sup>	<10 <sup>1</sup>	<10 <sup>1</sup>	1x10 <sup>3</sup>	<10 <sup>1</sup>
Other anaerobic bacteria /vegetative cells/	<10 <sup>1</sup>	<10 <sup>1</sup>	<10 <sup>1</sup>	<10 <sup>1</sup>	1x10 <sup>5</sup>	<10 <sup>1</sup>

ND – not detectable

Table 3. Microbiological quality of mayonnaise-like food products.

Microorganisms Groups	Sample			
	MO	MOE	SD	SDE
	CFU/g	CFU/g	CFU/g	CFU/g
Aerobic colony count	$1 \times 10^4$	$< 1 \times 10^2$	$1.7 \times 10^3$	$< 1 \times 10^2$
Moulds, Yeasts	$< 10^1$	$< 10^1$	$< 10^1$	$< 10^1$
<i>Escherichia coli</i>	$< 10^2$	$< 10^2$	$< 10^2$	$< 10^2$
<i>Salmonella</i>	ND	ND	ND	ND
Coliforms	$< 10^2$	$< 10^2$	$< 10^2$	$< 10^2$
Coagulase-positive staphylococci	$< 10^2$	$< 10^2$	$8 \times 10^2$	$< 10^2$
Anaerobic sulfite-reducing bacteria / vegetative cells/	$< 10^1$	$< 10^1$	$1 \times 10^1$	$< 10^1$

ND = not detectable

The most significant difference between spices and their natural extracts was established for their aerobic colony counts. Aerobic colony counts of ground black paper and dried basil herb were 4 lg higher in comparison with their extracts. These results suggest the conclusion that microbiological contamination of spice extracts is significantly lower than that of the corresponding natural spices. As is evident from the results for aerobic colony counts, spices could be a significant source of microbial contamination for food emulsions. In contrast, spice extracts had significantly lower microbial contamination.

Evaluation of the effect of replacing spices and herbs with their natural extracts on the microbiological quality of food emulsions was performed by analysis of the microbial contamination of control samples (Table 3). According to many authors mayonnaise-like food products are considered safe in terms of microbiology stability. In this regard, a number of studies (Perales and Garsia, 1990; Hathcox et al., 1995) demonstrated microbiology safety of these foods. The observed bactericidal effect was due to the presence of preservatives and organic acids (Radford and Board, 1993). The investigated emulsion products were characterized by pH of 3.9, for all products.

Salad dressing was found to have high contamination in terms of aerobic colony counts, as well as of coagulase-positive staphylococci and anaerobic sulfite-reducing bacteria counts. This was due to the addition of dried basil and ground black pepper in salad dressing, which was responsible for an incoming contamination.

The obtained results showed that the same products, but with spice and herbs extracts, were significantly less contaminated microbially.

The results displayed in Table 2 and Table 3 show that replacing hot paprika, ground black

pepper fruits, and dried basil herb with their extracts improved significantly the microbiological quality of food emulsions.

### Oxidative stability

The oxidative stability of olive oil and mayonnaise-like food products with olive oil and natural spices and herbs and their extracts were evaluated by means of measuring their acidity, free acidity, peroxide value (PV), and specific extinction coefficient  $K_{232}$  ( $K_{232}$ ) during a storage period of twenty days.

Figure 1 shows increasing values of acidity in olive oil, as well as in other mayonnaise-like food products. Acidity is the most fundamental quality measurement of olive oil. It is the primary indicator of olive oil purity and freshness. The highest values of acidity were determined in mayonnaise with olive oil (MO), whereas the bulk olive oil had the lowest acidity. The acidity of mayonnaise with olive oil exceeded the acceptable value for the quality of olive oil (0.9). Regarding PV (Table 4), the same sample (MO) showed the highest values at the end of the storage period. When comparing samples with natural spices and herbs with those that contained extracts, the samples with extracts were more resistant to oxidation.

Numerous studies have considered the antioxidant effects of spices and herbs added to pure oil (Özcan, 2003; Yanishlieva et al., 2006), and have shown their efficiency. However, Frankel et al. (1994, 1996) studied the antioxidant activity in oils and food emulsions, and described difficulties in evaluating the effectiveness of antioxidants in different lipid systems and oxidation condition. The observed differences in antioxidative stability may be explained by the presence of a droplet membrane and interaction between the ingredients.

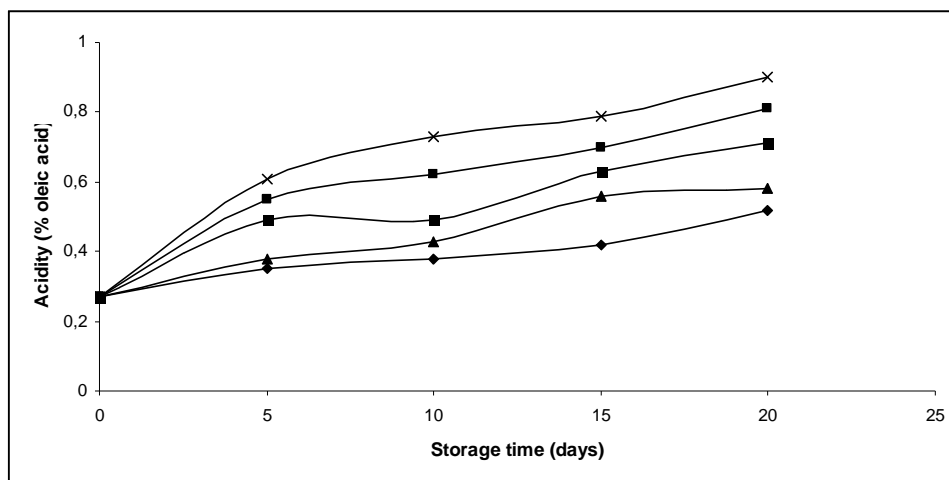


Figure 1. Changes in acidity over the storage period at 20°C in food emulsions with olive oil: olive oil (-♦-); salad dressing(-■-); salad dressing with extracts (-▲-); mayonnaise with olive oil (-x-); mayonnaise with olive oil and extracts (-■-).

Table 4. Changes in peroxide values over a storage period at 20°C in olive oil and mayonnaise-like food emulsions.

	PV (meq O <sub>2</sub> /kg)				
	Day				
	0	5	10	15	20
Olive oil	1.2±0.02a	1.35±0.11a	7.23±0.23a	11.61±0.22a	13.64±0.21a
SD	1.2±0.02a	1.48±0.02b	8.95±0.22b	13.44±0.16b	15.21±0.07b
SDE	1.2±0.02a	1.45±0.07b	8.01±0.31c	12.50±0.29c	14.53±0.15c
MO	1.2±0.02a	2.62±0.16c	10.20±0.56d	14.87±0.10d	17.25±0.22d
MOE	1.2±0.02a	1.95±0.05d	10.03±0.16e	13.32±0.11b	16.26±0.13e

Mean ± SD Values in the same vertical column with different superscripts are significantly different (P < 0.01).

The measurement of the  $K_{232}$  coefficient was used to determine the level of conjugated dienes present in olive oil. The oxidation products of oils display characteristic spectra in the ultraviolet region and at 232 nm, and the determination of the  $K_{232}$  specific extinction coefficient is an indication of the state of oil oxidation. No significant differences ( $p < 0.05$ ) were measured between the samples of olive oil, salad dressing and mayonnaise

with extracts during the storage period (Table 5). The  $K_{232}$  coefficient was slightly higher for MO in comparison with SD. However, by the 20<sup>th</sup> day, the values of this coefficient did not exceed the quality limit of 2.5. Clearly, in this relatively short period of study, it was not possible to measure significant processes of decomposition reactions in lipids, and therefore changes in the sensory properties in mayonnaise-like food products were not detected.

Table 5. Changes in specific extinction coefficient values ( $K_{232}$ ) over the storage time at 20°C in olive oil and mayonnaise-like food emulsions.

	$K_{232}$				
	Day				
	0	5	10	15	20
Olive oil	1.5±0.14a	1.63±0.11a	1.81±0.07a	2.02±0.09a	2.24±0.07a
SD	1.5±0.14a	1.84±0.06b	1.96±0.07b	2.17±0.26b	2.36±0.29b
SDE	1.5±0.14a	1.65±0.13a	1.80±0.07a	2.08±0.05a	2.25±0.02a
MO	1.5±0.14a	1.87±0.11b	2.11±0.22c	2.33±0.13c	2.47±0.12c
MOE	1.5±0.14a	1.70±0.07a	1.92±0.13b	2.03±0.07a	2.22±0.12a

Mean ± SD Values in the same vertical column with different superscripts are significantly different (P < 0.05).

### Sensory analysis

Figure 2 shows a graphic representation of the intensity of appearance and texture for the salad

dressing samples. Differences between the attributes of color and homogeneity were established. Although the recipe did not contain

eggs, the color of salad dressings was evaluated as yellowish. This color was perceived well by consumers, as it is typical for this type of food products. The actual reason is the typical yellow-green color of olive oil. The salad dressing with extracts was evaluated to have a more expressive, typical yellow color. Regarding the homogeneity of

the sample, the salad dressing with natural spices and herbs (SD) was perceived by the panelists as a product with more homogenous consistency. The panelists did not find differences between other attributes (oiliness, consistency, stability and brightness) of the evaluated samples.

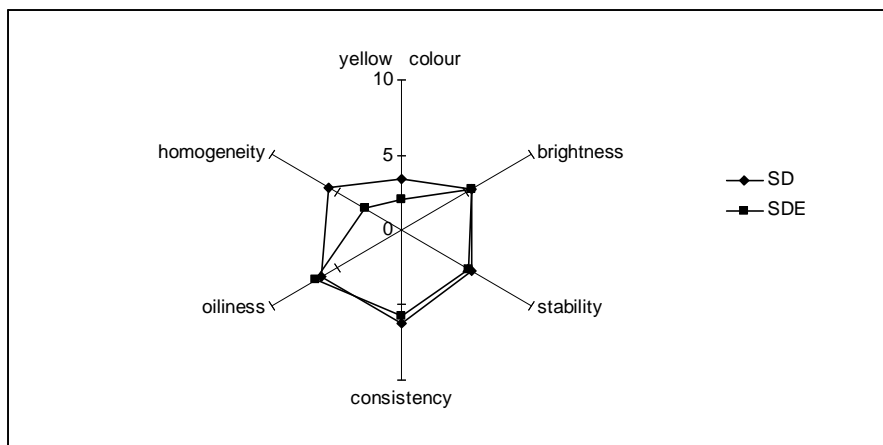


Figure 2. Sensory profiles of appearance and texture of salad dressing (SD) and salad dressing with extracts (SDE).

There was no significant difference among taste, smell, aftertaste profiles, and overall acceptability of the investigated food products

(Figure 3). The most noticeable difference was perceived in the attribute of basil aftertaste in the samples of salad dressing with extracts.

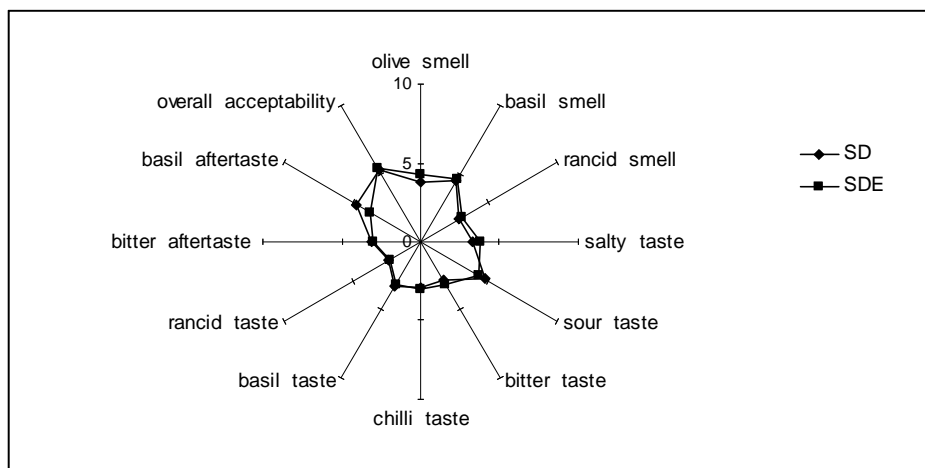


Figure 3. Sensory profiles of odor and taste of salad dressing (SD) and salad dressing with extracts (SDE).

The products with higher fat content mayonnaise with natural spices and herbs (MO) and their extracts (MOE) were evaluated as different

with respect to the attributes of homogeneity, color and brightness. The panelists determined MO to have high homogeneity and yellow color.

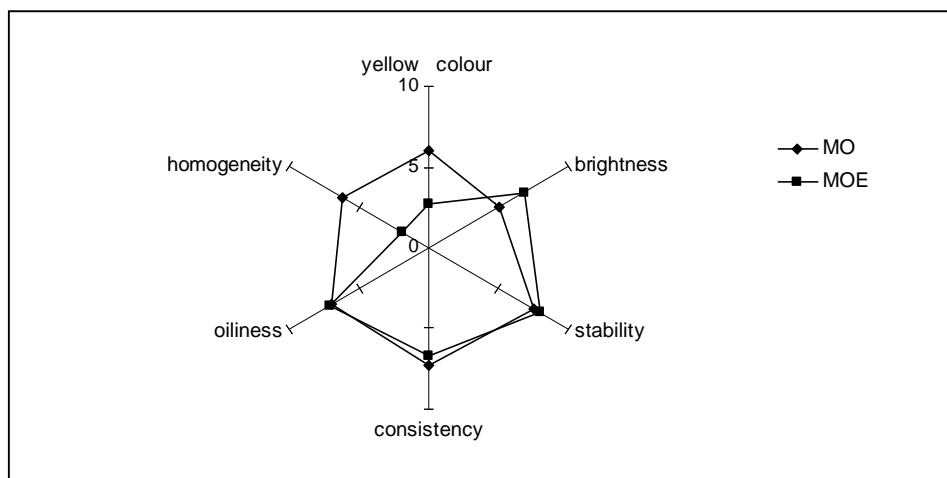


Figure 4. Sensory profiles of appearance and texture of mayonnaise (MO) and mayonnaise with extracts (MOE).

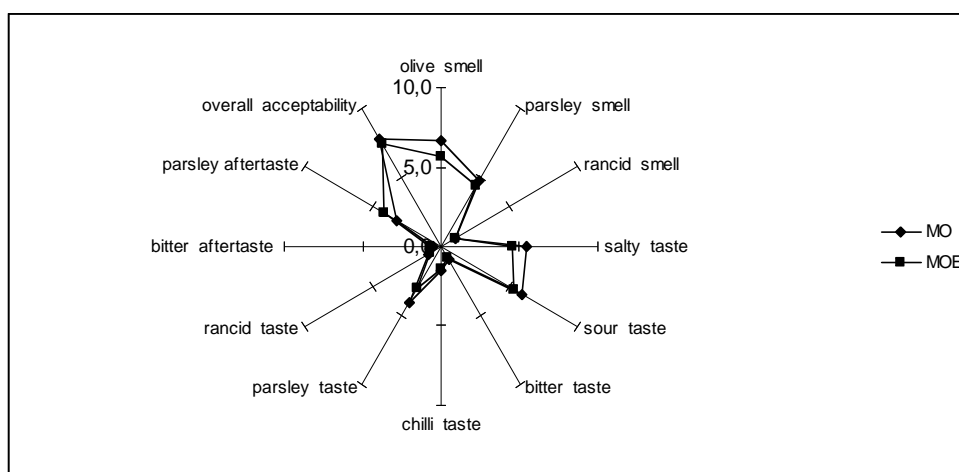


Figure 5. Sensory profiles of odor and taste of mayonnaise (MO) and mayonnaise with extracts (MOE).

The panelists did not perceive either rancid or bitter taste or bitter aftertaste, in spite of the high content of olive oil (50%) in the investigated

samples. The extract of parsley influenced the higher score of parsley aftertaste of MOE.

Results of sensory analysis by nine-point hedonic scale are shown in Table 6.

Table 6. Sensory scores for the degree of liking of mayonnaise-like food products.

Samples	Appearance	Texture	Smell	Taste
SD	5.8±0.35 <sup>a</sup>	6.1±0.27 <sup>a</sup>	6.1±0.51 <sup>a</sup>	5.4±0.37 <sup>a</sup>
SDE	5.8±0.44 <sup>a</sup>	6.2±0.35 <sup>a</sup>	6.0±0.64 <sup>a</sup>	5.8±0.44 <sup>b</sup>
MO	6.7±0.51 <sup>b</sup>	6.2±0.52 <sup>a</sup>	6.1±0.87 <sup>a</sup>	6.4±0.55 <sup>c</sup>
MOE	7.2±0.48 <sup>c</sup>	6.8±0.43 <sup>b</sup>	7.0±0.68 <sup>b</sup>	7.4±0.71 <sup>d</sup>

Mean ± SD Values in the same vertical column with different superscripts are significantly different ( $P < 0.01$ ).

The lowest score for the degree of liking was reported for the appearance and taste of the salad dressings. With regard to the degree of liking of texture and smell, it was the same for both salad dressings and mayonnaise with natural spices. The mayonnaise-like product with spice extracts

showed the highest consumer acceptance and degree of liking. Izidoro et al. (2007) and Karas et al. (2002) found that standard mayonnaise as opposed to low-fat mayonnaise gained higher grades for most sensory attributes.



## Conclusions

The focus of this study was to investigate mayonnaise-like food emulsions with extracts of herbs and spices, with emphasis on microbiological quality, oxidative stability, and sensory perception. The obtained results showed that replacing spices and herbs with their extracts improved significantly the microbiological quality of food emulsions. When spices were replaced by their extracts, pure olive oil, salad dressing and mayonnaise were less susceptible to oxidation, due to their high antioxidant activity. Food emulsions were found not to impact significantly various sensory descriptors. Mayonnaise with extracts had the highest score of the degree of liking for its sensory attributes.

The data show that new type of extracts of different spices and herbs could be used to improve the consumer acceptance and nutritional quality of food emulsions compared to traditional spicing. These extracts could be a viable technical and economical alternative to natural spices.

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