Rheological characteristics salad mayonnaise with hens and quail egg yolks

Moslavac[1] T.. S. Jokić[1]. D. Šubarić[1]. K. Aladić[2]. V. Panzalović[1]

Original scientific paper

ABSTRACT

*In this paper. the influence of certain ingredients (oil phase. types of carbohydrates. milk components. peas powder. highly concentrated soy protein powder. hens and quail egg yolks) on the rheological characteristics of the salad mayonnaise were investigated. The oil phase of mayonnaise (60%) seems refined sunflower oil (linoleic type. high oleic type). Of carbohydrates used are glucose. lactose. sucrose and inulin HD. For dairy component of mayonnaise whole milk. skim milk. whey powder. soy drink. highly concentrated soy protein and peas powder were used. Samples of mayonnaise were prepared with hens and quail egg yolks (fresh. pasteurized. granules). Mechanical homogenization process of mayonnaise was conducted in 10 000 rpm and the preparation time was 1.5 minutes. at room temperature. Measuring rheological properties was conducted on a rotational viscometer with concentric spindles at 10 ˚C and 25 ˚C. Effect of hens and quail egg yolks on change of color salad mayonnaise was studied with instrumental method. From the obtained data. rheological parameters. consistency coefficient. flow behavior index and apparent viscosity were calculated. The results showed that certain ingredients salad mayonnaise affect its rheological properties. By using a mixture of refined sunflower oil (linoleic type. and high oleic type 50:50). lactose. mixtures of whole milk powder and peas powder (50:50) and yolk granules (hens. quail) obtained higher values of rheological parameters. consistency coefficient. apparent viscosity and lower flow behavior index were obtained. By measuring of salad mayonnaise color with colorimeter using the L * a * b system. it is observed that hens egg yolks results a higher value of the observed parameter b which is describing the intensity of yellow color. compared to the quail egg yolks.*

Keywords: *salad mayonnaise. rheology. sunflower oil. hens and quail egg yolks*

INTRODUCTION

U Mayonnaise is probably one of the most commonly used sauces in the world. This is typical oil / water emulsion with a high content of vegetable oils. Among all ingredients egg yolk is very important for the stability of the product (Hasenhuettl. 2008; Wang and Narsimhan. 2008). According to the Regulations (1999) salad mayonnaise must contain at least 50% vegetable oil which makes the oil phase of the product. Vegetable oil as a basic ingredient of mayonnaise has a very important function in creating emulsion product. contributes to the taste. appearance. texture and oxidation stability of the emulsion in a very specific way (McClements and Demetriades. 1998). By applying different types of vegetable oils as well as a combination of oils to achieve desired fatty acid composition. nutritional and sensory properties of mayonnaise can be improved (Kostyra and baryłka-Pikielna. 2007). By adding high oleic sunflower oil (50%) in sunflower oil linoleic type. enriched oil phase with higher proportion of monounsaturated oleic acid and natural antioxidants are achieved. resulting in greater stability of the mayonnaise by oxidative deterioration. Rheological properties are an important factor for the quality of food (Mezger. 2002) as well as products that represent the emulsion type oil / water (sauces. dressings. mayonnaise). Knowing the rheological properties of these products is of great importance especially when creating a certain consistency of mayonnaise (Stern et al.. 2001). quality control during production. storage and transport (Juszczak et al.. 2003).

1 **Tihomir Moslavac. PhD**. associate prof.. **Stela Jokić. PhD**. assistant prof.. **Drago Šubarić. PhD**. full prof.. **Valentina Panzalović**. student; Josip Juraj Strossmayer University of Osijek. Faculty of Food Technology Osijek

2 **Krunoslav Aladić. PhD** - Croatian Veterinary Institute. Branch - Veterinary Institute Vinkovci. Josipa Kozarca 24. 32100 Vinkovci

Correspondence author: Tihomir.Moslavac@ptfos.hr

The rheological properties of mayonnaise. toppings and sauces are usually determined by proportion and composition of the oil phase. presence of emulsifiers. stabilizers and thickeners (Wendin and Hall. 2001). Quality of thus obtained product. oil/water emulsion. stability and viscosity depends on the process of homogenizing (Wendin et al.. 1999). dispersion of droplets of vegetable oil in the aqueous continuous phase of the mayonnaise. egg yolk (Guilmineau and Kulozik 2007; Xiong and al.. 2000; Laca et al.. 2010). types of carbohydrates (Ruiling et al.. 2011). and proportion and type of milk components (Dybowska. 2008). where the importance is given to milk proteins. In thus obtained emulsion. oil droplets are dispersed by mechanical treatment in a continuous vinegar-aqueous phase with adding natural emulsifier (egg yolk) which allows greater stabilization of the whole system (Kiosseoglou. 2003; Castellani et al.. 2006). One of the main problems is the high proportion of cholesterol in egg yolk of hens. so various researches are conducted in order to obtain mayonnaise with small amounts of cholesterol but with similar characteristics as a real mayonnaise. Some components of yolk is difficult to separate. but plasma and granules can be easily fractionated and have application on an industrial scale (Anton et al.. 2001). Since the yolk granules have a small amount of cholesterol (Anton. 2007) and still have good emulsifying properties can be used as a functional ingredient in the food industry (Ibanoglu and Ercelebi. 2007; Sirvent et al.. 2007). Rheological behavior of mayonnaise is continuously studied since it affects to the attitude of consumer's by composition. consistency. flavor or the applicability to the salad. French fries or other dishes (Franco et al.. 1995; Akhtar et al.. 2005; Abu-Jdayil. 2003).

In this paper the influence of the composition of the oil phase. components of milk. the type of carbohydrates. peas powder. soy drink. highly concentrated soybean protein powder and hens and quail egg yolk on the rheological properties of salad mayonnaise at temperatures 10 ° C and 25 ° C. The addition of peas powder and the highly soy protein powder as a substitute to ½ whole milk wanted to increase the nutritional value and stability of mayonnaise. Also. we studied the influence of hens and quail egg yolk (fresh. pasteurized. granules) on change of salad mayonnaise color applying instrumental methods.

MATERIALS AND METHODS

Materials

Materials used for making salad mayonnaise are:

- Refined sunflower oil (linoleic type and high oleic type)
- Hens and quail egg yolk
- Carbohydrates
- Alcoholic vinegar
- Sea salt
- Mustard
- Milk Component
- Soy drink in powder
- Highly concentrated soy protein powder
- Peas powder
- Tartaric acid
- Distilled water

Refined sunflower oil (linoleic type) was obtained from the Oil factory Čepin. Refined high oleic sunflower oil. vinegar (9% acetic acid). salt and mustard to produce salad mayonnaise were purchased at a local store. Hens and quails egg yolk was purchased from private suppliers and are prepared as a fresh. pasteurized (68 °C. 3 min) and the yolk granules. Hens and quails yolk granules were prepared from fresh egg yolk by mixing with distilled water (1:1.5). adjusting pH to 7.0 with 1N NaOH and centrifugate to separate granules (Laca. 2010). Carbohydrates glucose. lactose and inulin HD were purchased from the company Claro-prom d.o.o.. Zagreb. and sucrose from sugar factory in Osijek. Tartaric acid (acidity regulator) from manufacturer Alkaloid. Skopje. Macedonia. Milk components - whole milk powder (protein 26.3%. 39.8% sugars. fats 26%) and skimmed milk powder (min. 1.5% fat) were purchased from the company Dukat d.d. and whey powder (milk fat in the dry matte up to 1%. 12-14% protein. lactose 73-75%) of the company Zdenka d.d.. Soy drink powder (proteins 4.8%. sugars 63.3%. fat 26.9%) is the company Vitalia d.o.o.. a highly concentrated soy protein (protein 88%. sugar 1%. fat 3.7%) are from company Dr. Ritter. Allos. Schwartzwald. Germany and peas powder (protein 22%. sugar 55%. fat 2%) of the company DLG Food Grain Asaa. Denmark.

Preparing mayonnaise

All salad mayonnaise samples for testing rheological properties are prepared in the traditional way. without using preservatives in the laboratory conditions. at ambient temperature in an amount of 200 g for each sample. Standard pattern salad mayonnaise prepared with 60% oil phase consisting of a mixture of refined sunflower oil and linoleic type high oleic type 50:50. The first three samples of salad mayonnaise are made for testing the influence type of oil (the oil phase composition) on rheological properties of mayonnaise. Mayonnaises are made with fresh hens and quail egg yolk in ratio 50:50 and from the weight ratios of ingredients: distilled water (13.9%). vinegar (4%). sea salt (1%). mustard (2%). glucose (4%). tartaric acid (0.1%) and whole milk powder (7%). Other samples of mayonnaises are made with different amount of ingredients and rheological properties are also investigated. For the production of salad

Table 1 The basic recipe for preparing salad mayonnaise (standard sample)

Ingredients	Sample	
	Portion (%)	Weight (g)
Refined sunflower oil (linoleic type)	30	60
Refined sunflower oil (high oleic type)	30	60
Fresh hens egg yolk	4	8
Fresh quail egg yolk	4	8
Glucose	4	8
Alcoholic vinegar	4	8
Sea salt	1	2
Mustard	2	4
Tartaric acid	0.1	0.2
Whole milk powder	7	14
Distilled water	13.9	27.8
Total	100	200

mayonnaise. laboratory homogenizer model D-500 (Wiggenhauser. Germany-Malaysia) with the area of the rotation speed of the rotor (10000-30000 rpm.) was used. Mayonnaise was made with rotor type ER30 and stator type S30F. The samples were prepared by weighing all necessary ingredients. In 1/2 of sunflower oil (60 g). weighted ingredients are added as followed: egg yolk. vinegar. water and other ingredients. then turning on homogenizer and slowly added remaining part of sunflower oil with homogenizing 1.5 min at 10 000 rpm. Sample preparation of mayonnaise is made at room temperature of all ingredients. and after the preparation rheological properties measurement was carried. All samples were prepared in the same manner. except that they are changed depending on the particular ingredients of the mayonnaise sample recipe.

Rheological properties

Measuring rheological properties of tested samples salad mayonnaise was carried out on rotational viscometer. model DV-III + Rheometer Digital-Brookfield Engineering Laboratories (USA). using the concentric cylinder type SC4-28 and SC4-29. Viscometer is connected to a PC equipped with software tool Rheocalc 3.2 which controls the measurement of rheological properties and carried out the data processing. Testing rheological properties of freshly prepared salad mayonnaise samples was carried out at temperatures of 25 °C and 10 °C. To maintain a constant temperature of the samples during measurement with viscometer thermostat model TC-501P (Brookfield Company) was used. Dependence of shear stress (τ) and apparent viscosity (μ) on shear rate (D) by shear rate of 2.18 s^{-1} to 137.1 s^{-1} in the ascending and descending way was measured. On the base of this dependence. type of fluid is determined where is concluded that all investigated samples of mayonnaise had non-Newtonian properties and belong to the pseudoplastic type of liquid. Calculation of rheological parameters. consistency coefficient (k) and flow index (n) are carried out by Microsoft Excel program. using the method of linear regression.

To calculate rheological parameters. consistency coefficient (k) and flow index (n) was applied Ostwald-Reiner's "gradual law":

$$\tau = k \cdot D^n$$

τ - the shear stress (Pa)

D - shear rate (s^{-1})

k - consistency coefficient (Pa • s^n)

n - flow index

Calculation of the apparent viscosity (μ) mayonnaise samples was carried out using the following expression:

$$\mu = k \cdot D^{n-1}$$

Determination of salad mayonnaise color

Salad mayonnaise color was measured using a tristimulus colorimeter Minolta CR-300. This type chromometer measure the light reflecting from the surface of the object (specimen). Reflected light is measured by six very sensitive silicon photocells. Computer data are recorded and expressed in five different systems (XYZ; YXY; Lab; LCH; Hunter Lab). The most used systems are Lab and Hunter Lab where system Lab gives approximate values as the human eye.

L * - value that evaluates whether something is bright or dark. If the value of L * = 100. the result is white. and if L * = 0 is black object.

a * -value (positive and negative). If positive. the result is red color. if negative. the result is green.

b * -value (positive and negative). If positive. the color is yellow. if it is negative. the result is blue.

Results and Discussion

Investigation on the influence of ingredients (oil phase. carbohydrate. egg yolk of hens and quails. milk components. peas powder. highly concentrated soy protein powder) on the rheological behavior of salad mayonnaise with 60% in oil phase at temperatures of 25 ° C and 10 ° C are shown in Table 2 to 6.

Effect of the oil phase on the rheological parameters of mayonnaise made with fresh egg yolk of laying quails and 50:50. at 25 °C and 10 °C is shown in Table 2. Salad mayonnaise with sunflower oil (linoleic type) has apparent viscosity (1.242 Pa · s) shear rate 137.1 s^{-1}. consistency coefficient (27.76 Pa · s^n) and flow behavior index (0.367). at temperature of 25 °C. By replacing the oil phase mayonnaise with high oleic sunflower oil comes to the impairment of the apparent viscosity (1.235 Pa · s) and consistency coefficient (26.61 Pa · s^n). and an increase in flow index (0.376). Mixing these two types of oil in the ratio of 50:50 result an oily phase for prepara-

tion the salad mayonnaise with considerable increased rheological parameters salad mayonnaise. The reason for this behavior is change in the composition of the oil phase by adding high oleic oil which results increasing of the viscosity of mayonnaise. The same phenomenon change of rheological parameters was observed when measuring the rheological properties of these samples mayonnaise at a temperature 10 °C. By measuring at 10 °C higher values of rheological parameters of mayonnaise were obtained. which was expected because the viscosity and consistency of these products are dependent on temperature.

Table 2 The effect of the oil type (the composition of the oil phase) on the rheological parameters of salad mayonnaise. (egg yolk: fresh hens + fresh quail 50:50. glucose. whole milk)

Oil phase	μ pri 137.1 s^{-1} (Pa·s)	k ($Pa·s^n$)	n	R^2
	25 °C			
SUN	1.242	27.76	0.367	0.99659
VOS	1.235	26.61	0.376	0.99696
SUN + VOS (50:50)	1.531	43.25	0.321	0.98813
	10°C			
SUN	1.274	28.19	0.369	0.99848
VOS	1.268	27.60	0.374	0.99589
SUN + VOS (50:50)	1.796	46.90	0.337	0.99385

SUN – Sunflower oil – linoleic type; VOS – High oleic sunflower oil
μ Apparent viscosity at shear rate 137.1 s-1 (Pa·s); k – consistency coefficient (Pa·sn);
n – flow index (-); R2 – coefficient of determination

Table 3 shows results of testing the influence of types of carbohydrates (glucose. sucrose. lactose and inulin HD) on the rheological parameters salad mayonnaise measured at 10 °C and 25 °C. Standard sample of mayonnaise was made with glucose and measured at 25 °C has apparent viscosity (1.948 Pa ·s) shear rate (103.9 s^{-1}). consistency coefficient (43.25 Pa · s^n) and flow behavior index (0.321). By using of sucrose in the preparation of mayonnaise lowest value. measured at 25 °C. of the apparent viscosity and coefficient of consistency of mayonnaise. a higher flow index. were obtained. Compared with glucose and sucrose used inulin HD obtained mayonnaise with higher apparent viscosity and consistency. The highest values of the examined rheological parameters salad mayonnaise were obtained by using lactose. Measured at 25 °C. apparent viscosity (2.252 Pa · s). consistency (58.71 Pa · s^n). and the smallest flow index (0.301) were registered. By measuring the rheological properties of tested samples salad mayonnaise at a temperature of 10 °C were obtained higher values of rheological parameters in relation to the measurement at 25 °C. Same impacts are noticed for every one of carbohydrates on the rheological properties of mayonnaise as for measurements at 25 °C.

Table 3 Effect of carbohydrates on rheological parameters salad mayonnaise. (egg yolk: fresh chicken + fresh quail 50:50. oil phase: SUN + VOS 50:50. whole milk)

Type of carbohydrates	μ pri 103.9 s^{-1} (Pa·s)	k ($Pa·s^n$)	n	R^2
	25 °C			
Glucose	1.948	43.25	0.321	0.98813
Sucrose	1.871	41.04	0.335	0.98686
Lactose	2.252	58.71	0.301	0.99339
Inulin HD	2.227	55.11	0.309	0.99558
	10°C			
Glucose	2.158	46.90	0.337	0.99385
Sucrose	1.967	42.35	0.339	0.99439
Lactose	2.396	67.30	0.279	0.99353
Inulin HD	2.378	57.23	0.315	0.99195

Test results on the influence of milk components (whole and skimmed milk powder. whey powder). soybean drink powder. mixtures of whole milk and peas powder 50:50 mixture of whole milk powder and the highly concentrated soy protein powder 50:50 on rheological parameters of the salad mayonnaise measured at 10 °C and 25 °C are shown in Table 4. The standard pattern salad mayonnaise was made with whole milk powder and apparent viscosity was 3.307 (Pa · s) at a shear rate 44.1 s^{-1}. consistency coefficient was 43.25 (Pa · sn) and flow index was (0.321). measured at 25 °C. Mayonnaise prepared with whey powder obtained the lowest values of the apparent viscosity of 1.966 (Pa · s) and consistency coefficient 23.22 (Pa · s^n). By using the skimmed milk powder higher viscosity mayonnaise 4.931 (Pa · s) and consistency 67.74 (Pa · s^n) with a low flow index (0.308) measured at 25 °C were obtained. compared to mayonnaise made with mixture of whole milk and the whey powder. By using soy drink powder and mixtures of whole milk and a highly concentrated soy protein powder (50:50) achieves approximate values of apparent viscosity and consistency of salad mayonnaise. Mayonnaise made with a mixture of whole milk powder and peas powder (50:50) results highest rheological parameters values of the apparent viscosity of 5.955 (Pa · s). coefficient of consistency 83.69 (Pa · s^n). and the lowest flow behavior index (0.302). measured at 25 °C. The same observation was recorded at measurement on 10 °C. but with higher rheological parameters values.

In Tables 5 and 6 are visible results of the influence of the hen's and quail egg yolk (fresh. pasteurized. and the granular mixture of fresh egg yolk) to the rheological parameters of the salad mayonnaise. measured at a temperature of 10 °C and 25 °C. Salad mayonnaise made with fresh yolk quail has an apparent viscosity (2.191 Pa · s) at a shear rate 59.2 s-1. consistency coeffi-

Table 4 Effect of milk components on rheological parameters salad mayonnaise. (egg yolk: fresh hens + fresh quail 50:50. oil phase: SUN + VOS 50:50. glucose)

Milk component	μ pri 44.1 s^{-1} (Pa·s)	k (Pa·s^n)	n	R^2
	25 °C			
Whole milk powder	3.307	43.25	0.321	0.98813
skim milk powder	4.931	67.74	0.308	0.98701
Whey powder	1.966	23.22	0.348	0.98644
soya drink powder	1.966	23.22	0.348	0.98644
Whole milk + peas powder 50:50	5.955	83.69	0.302	0.99604
Whole milk + highly concentrated soy protein powder 50:50	3.611	37.49	0.382	0.99683
	10°C			
Whole milk powder	3.810	46.90	0.337	0.99385
skim milk powder	5.307	85.80	0.265	0.99201
Whey powder	2.090	23.58	0.360	0.98909
soya drink powder	3.227	44.34	0.308	0.99277
Whole milk + peas powder 50:50	6.098	87.01	0.298	0.99186
Whole milk + highly concentrated soy protein powder 50:50	4.102	48.25	0.349	0.99187

cient (30.10 Pa · sn) and flow behavior index (0.358). measured at 25 °C (Table 5). Preparing mayonnaise with pasteurized quail egg yolk results an increase in viscosity and consistency of mayonnaise and decreasing of flow index. Using produced quail egg yolks granules for mayonnaise preparation resulted in a significant increase in the apparent viscosity (3.158 Pa · s) and consistency coefficient (92.69 Pa · sn). and lower flow index (0.172). measured at 25 °C. Salad mayonnaise made with a mixture of hens and quail fresh egg yolk (50:50) led to higher values of apparent viscosity

Table 5 Effect of quail egg yolk on rheological parameters salad mayonnaise. (oil phase: SUN + VOS 50:50. glucose. whole milk)

Quail egg yolk	μ pri 59.2 s^{-1} (Pa·s)	k (Pa·s^n)	n	R^2
	25 °C			
Fresh egg yolk	2.191	30.10	0.358	0.99752
Pasteurized egg yolk	2.666	40.23	0.335	0.99898
Egg yolk granules	3.158	92.69	0.172	0.99509
Fresh hens + fresh quail 50:50	2.707	43.25	0.321	0.98813
	10°C			
Fresh egg yolk	2.459	38.18	0.328	0.99264
Pasteurized egg yolk	2.767	43.28	0.319	0.99905
Egg yolk granules	3.680	108.45	0.171	0.99559
Fresh hens + fresh quail 50:50	3.133	46.90	0.337	0.99385

and consistency compared to samples prepared from individual fresh egg yolks. By measuring the rheological properties of these samples mayonnaise at 10 °C. noticed the same kind of impact of egg yolk on the rheological properties. Table 6 shows the effect of hen's egg yolk on a change of rheological parameters salad mayonnaise. From this data. we can see that the same effect of hen's egg yolk and quail egg yolk is present on rheological parameters salad mayonnaise. The results show that the salad mayonnaise prepared from the egg yolk of hens has a higher value of the apparent viscosity and consistency compared to the applied quail egg yolk.

Table 6 Effect of hens egg yolk hens on rheological parameters salad mayonnaise. (oil phase: SUN + VOS 50:50. glucose. whole milk)

Hens egg yolk	μ pri 59.2 s^{-1} (Pa·s)	k (Pa·s^n)	n	R^2
	25 °C			
Fresh egg yolk	2.638	39.33	0.338	0.99604
Pasteurized egg yolk	2.957	45.54	0.330	0.99881
Egg yolk granules	3.552	102.55	0.176	0.99308
Fresh hens + fresh quail 50:50	2.707	43.25	0.321	0.98813
	10°C			
Fresh egg yolk	2.747	39.96	0.344	0.99825
Pasteurized egg yolk	3.037	45.64	0.336	0.99886
Egg yolk granules	4.272	120.38	0.182	0.99280
Fresh hens + fresh quail 50:50	3.133	46.90	0.337	0.99385

Effect of hens and quail egg yolk (fresh. pasteurized and granules) on change of salad mayonnaise color is shown in Table 7. By measuring the color of mayonnaise samples with a colorimeter L * a * b system it has been noticed that the mayonnaise prepared with fresh hens egg yolk has the greatest impact on a color change. Greater measured value of yellow color (higher value of the parameter b) was registered. in relation to the application of other used yolks.

By pasteurization of egg yolk (chicken and quail) and separating the granules of fresh egg yolk and their application to the preparation of mayonnaise results by lowering the value of the parameter b (less pronounced yellow color mayonnaise). Using the hens egg yolks results the higher value of the parameter b (pronounced yellow mayonnaise) compared to the use of quail egg yolk.

Table 6 Effect of hens and quail egg yolk to change of salad mayonnaise color.

Egg yolk	Hens egg yolk		Quail egg yolk	
	L	b	L	b
fresh	75.58	+ 18.21	75.23	+ 16.70
pasteurized	75.20	+ 18.14	75.44	+ 16.10
granules	76.01	+ 15.04	75.66	+ 13.35

L - Value that evaluates whether something is bright or dark. If the value of L = 100. the result is white. and if L = 0. the object is black.
b - A value that can also be positive or negative. If positive. the result is a yellow color. and if it is negative. the result is blue.

CONCLUSION

Tested samples salad mayonnaise belong to non-Newtonian systems. pseudoplastic type.

Salad mayonnaise prepared with the oil phase consisting of sunflower oil (linoleic type) and high oleic sunflower oil (50:50) shows higher values of rheological parameters in relation to the application of the individual types of oil.

Type of carbohydrates affects the rheological properties of the salad mayonnaise measured at 10 °C and 25 °C. By making salad mayonnaise with lactose higher values of apparent viscosity and the consistency coefficient were obtained and flow behavior index decreased in comparison to the other tested hydrocarbons. Mayonnaise prepared with sucrose has the lowest viscosity and consistency. and the largest flow behavior index.

Type of milk components affect the rheological properties of the salad mayonnaise. measured at temperatures of 10 °C and 25 °C. By making salad mayonnaise with whey powder the lowest values of apparent viscosity and consistency were obtained. which result higher flow behavior index. Mixture of whole milk powder and peas powder in ratio (50:50) results with a mayonnaise with higher values of viscosity and lower flow index.

Hens and quail egg yolk affects the rheological properties of the salad mayonnaise. Salad mayonnaise made with freshly prepared granules quail egg yolk (or hens) has a higher apparent viscosity and consistency coefficient and lower flow behavior index compared to mayonnaise made with fresh or pasteurized egg yolks. Mixture of fresh egg chickens and quail (50:50) results in a higher viscosity and consistency of salad mayonnaise compared to a single application of fresh hens or quail egg yolks.

By measuring the salad mayonnaise color using the L * a * b system. it is observed that the addition of hens egg yolk results in a higher value of the parameter b which describe the intensity of yellow color. compared to the quail egg yolk. The addition of fresh egg yolk is achieved higher value of the parameter b (more pronounced yellow color mayonnaise) in relation to the application of pasteurized egg yolk or egg yolk granules.

LITERATURE

Abu-Jdayil. B. (2003): Modelling the time-dependent rheological behavior of semisolid foodstuffs. J. Food Eng. 57. 97-102.

Akhtar. M.. J. Stenzel. B.S. Murray. E. Dickinson (2005): Factors affecting the perception of creaminess of oil-in-water emulsions. Food Hydrocolloids 19. 521-526.

Anton. M. (2007): Composition and structure of hen egg yolk. In: Huopalati. R.. Lopez-Fandino. R.. Anton. M.. Schsde. R. (Eds.) Bioactive Egg Compounds.Springer-Verlag. Berlin. Heidelberg. 1-6.

Anton. M.. M. Le Denmat. V. Beaumal. P. Pilet (2001): Filler effect of oil droplets on rheology of heat-set emulsion gels prepared with egg yolk and egg yolk fractions. Colloids and Surfaces. B: Biointerfaces 21 (1-3). 137-147.

Castellani. O.. C. Belhomme. E. David-Briand. C. Guerin-Dubiard. M. Anton (2006): Oil-in-water emulsion properties and interfacial characteristcs of hen egg yolk phosvitin. Food Hydrocolloids 20. 35-43.

Dybowska. B.E. (2008): Properties of milk protein concentrate stabilized oil-in-water emulsions. Journal of Food Engineering 88. 507-513.

Državni zavod za normizaciju i mjeriteljstvo (1999): Pravilnik o temeljnim zahtjevima za jestiva ulja i masti. margarine i njima sličnim proizvodima. majoneze. umake. preljeve. salate i ostale proizvode na bazi jestivih ulja i masti. Narodne novine 39/99.

Franco. J.M.. A. Guerrero. C. Gallegos (1995): Rheology and processing of salad dressing emulsions. Rheologica Acta 34. (6). 513-524.

Guilmineau. F.. U. Kulozik (2007): Influence of a thermal treatment on the functionality of hens egg yolk in mayonnaise. J. Food Eng. 78. 648-654.

Hasenhuettl G. L.. R. W. Hartel (2008): Food emulsifiers and their applications. Springer Science.

Ibanoglu. E.. E.A. Ercelebi (2007): Thermal denaturation and functional properties of egg proteins in the presence of hydrocolloid gums. Food Chemistry 101 (2).626-633.

Juszczak. L.. T. Fortuna. A. Kosla (2003): Sensory and rheological propoerties of Polish commercial mayonnaise. Nahrung/Food 47. 232-235.

Kiosseoglou. V. (2003): Egg yolk protein gels and emulsions. Current Opinion in Colloid and Interface Science 8. 365-370.

Kostyra. E.. N. Barylko-Pikielna (2007): The effect of fat levels and guar gum addition in mayonnaise-type emulsions on the sensory perception of smoke-curing flavour and salty taste. Food Qual. Prefer. 18. 872-879.

Laca. A.. M.C. Saenz.B. Paredes. M. Diaz (2010): Rheological properties. stability and sensory evaluation of low-cholesterol mayonnaises prepared using egg yolk granules as emulsifying agent. Journal of Food Engineering 97. 243-252.

McClements. D.J.. K. Demetriades (1998): An integrated approach to the development of reduced-fat food emulsions. Critical Reviews in Food Science and Nutrition. 38. 511-536.

Mezger T. G. (2002): The rheology handbook. Vincentz. Hannover. Germany.

Narsimhan. G.. Z. Wang. (2008): Guidelines for processing emulsion-based foods. IN: Hasenhuettl. G.L.. Hartel. R.W. (Eds.). Food Emulsifiers and their Applications. Springer Science+Business Media. USA. 349-389.

Ruiling. S.. L. Shuangqun. D. Jilin (2011): Application of oat dextrine for fat substitute in mayonnaise. Food Chem. 126. 65-71.

Sirvente. H.. V. Beaumal. C. Gaillard. L. Bialek. D. Hamm. M. Anton (2007): Structuring and functionalization of dispersions containing egg yolk. plasma and granules induced by mechanical treatments. Journal of Agricultural and Food Chemistry 55 (23). 9537-9544.

Štern. P.. H. Valentova. J. Pokorny (2001): Rheological properties and sensory texture of mayonnaise. Eur. J. Lipid Sci. Technol. 103. 23-28.

Wendin. K.. G. Hall (2001): Influences of fat. thickener and emulsifier contents on salad dressing: static and dynamic sensory and rheological analyses. Lebensm.-Wiss. u.- Technol. 34. 222-233.

Wendin. K.. M. Risberg Ellekjar. R. Solheim (1999): Fat Contetnt and Homogenization Effects on Flavour and Texture of Mayonnaise with Added Aroma. Lebensm.-Wiss. u.- Technol. 32. 377-383.

Xiong. R.. G. Xie. A.S. Edmondson (2000): Modelling the pH of mayonnaise by the ratio of egg to vinegar. Food Control 11. 49-56.

Received: 13.3.2015. **Accepted: 23.3.2013.**