PHYSICO-CHEMICAL PARAMETERS OF FRESH STANDARD AND LIGHT MAYONNAISE

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ABSTRACT

Mayonnaise is an oil-in-water (O/W) emulsion and is widely consumed as a traditional seasoning due to its creamy mouth feel and special flavor. The standard mayonnaise contains 65%–80% fat, which contributes to its texture, appearance, flavor, and shelf life. However, demand for low-fat mayonnaise has been rising. To produce light mayonnaise, fat from the basic formula for the preparation of mayonnaise shall be replaced by other ingredients while preserving its viscosity, texture, mouth feeling, taste and flavour to a highest possible degree. The sensory and physiochemical properties of mayonnaise are significantly affected by the elimination of fat. The objective of this study was to investigate the relationship between the type of mayonnaise and physico-chemical parameters - pH value, acid value and water activity. The experiment is based on analysis of mayonnaise of three Serbian manufacturers, standard and light mayonnaise for each of them. The samples of the fresh mayonnaise coming from the same manufacturer and of different mayonnaise type (standard and light) did not differ in terms of their pH values. Each manufacturer had specific pH value of mayonnaise. Type of mayonnaise had a very high impact on acid values and water activities. Acid values of fresh light mayonnaises were higher than of standard one regardless of the manufacturer. Fresh standard mayonnaises from all three manufacturers had similar water activities. The same was true for light mayonnaise. Fresh light mayonnaise had higher values of water activity compared to standard mayonnaise regardless of the manufacturer.

Key words: type of mayonnaise, pH value, acid value, water activity

INTRODUCTION

Mayonnaise is an oil-in-water (O/W) emulsion and is widely consumed as a traditional seasoning due to its creamy mouth feel and special flavor. The conventional mayonnaise contains 65%–80% fat, which contributes to its texture, appearance, flavor, and shelf life. It is produced using vegetable oil, emulsifier (egg lecithin), acidic components (acetic acid, citric acid, and maleic acid), flavoring agents (sweetener, salt, mustard, or garlic), texture enhancers, stabilizers, and an inhibitor for unwanted crystals (Chirife et al., 1989; Delgado-Vargas et al., 2000; Ghorbani Gorji et al., 2016; Harrison, L., & Cunningham, 1985; Mirzanajafi-Zanjani et al., 2019).

Today, the public knowledge about diet and health has been incremented. Thus, consumers, aware of the considerable influence of the diet on their health, demand nutritious and healthier food. The substitution of a part of fat without decreasing the taste is a key factor in producing low-fat foodstuffs. Mayonnaise is usually cited by health-related issues due to its high cholesterol and fat content. Overconsumption of fat leads to obesity and is associated with several human health problems. However, removal of fat can cause significant changes in the sensory and bulk physicochemical properties of dressing and mayonnaise products which may be undesirable for consumers, as fat imparts properties such as texture, lubricity, stability, color, and flavor to foods. Conventional wisdom tells us that flavour of food with low fat content or fat-free ones differs considerably in flavour from food with normal fat content. Food with a high fat content produces a pleasant, smooth flavour, which can even linger on the palate long after eating it. Reducing the fat level would result in the increment of the water content and aqueous phase, as well as inducing the decrease in the firmness and viscosity of emulsion. Furthermore, fat substitutes are used to produce mayonnaise with a texture near to those of traditional ones. Viscosity, in a low-fat mayonnaise, is incremented by additives, especially hydrocolloids, which would result in the increase of density and stability of the emulsion by reducing the coalescence (Chirife et al., 1989; Karas et al., 2002; Ma & Boye, 2013; Mirzanajafi-Zanjani et al., 2019). Mayonnaise manufacturers now tend to produce low-fat mayonnaise, because oil is commonly the most expensive ingredient of mayonnaise (Mirzanajafi-Zanjani et al., 2019).

Mayonnaise has a low pH value (3.7–4.2) (Chirife et al., 1989; Ghorbani Gorji et al., 2016). The most important role of vinegar is pH adjustment. Besides having distinct contribution to taste, acidification has a large impact on viscoelastic properties of the emulsion, where the highest viscoelastic properties and physical stability are supposed to be in pH range from 3.5 to 3.9. Due to its acidity and high fat content, mayonnaise is considered as a microbially stable product and might be stored at room temperature, although with a risk of quality loss due to auto-oxidation of unsaturated fatty acids (Aganovic et al., 2018; Chirife et al., 1989; Ghorbani Gorji et al., 2016; Mirzanajafi-Zanjani et al., 2019). An acidic environment with a pH value of 3.0 to 4.5, together with the preservative effect of undissociated acetic acid (typically added in the form of vinegar, lactic acid, or other weak acids), is important for ensuring the microbiological stability of such products (Ma & Boye, 2013; Rabbani et al., 2021). The growth of *Salmonela* and *L. monocytogenes* in a typical reducedcalorie mayonnaise was decreased by 4 log in 3 days when the products had a pH below 4.1 and 0.7 % acetic acid in the aqueous phase (Ma & Boye, 2013). Examination the relations between ingredients and pH value of mayonnaise showed that salt and sugar decrease pH value of mayonnaise, while oil, mustard and pepper increase it (Xiong et al., 2000).

Water activity (a_w) is the measurement used to indicate the amount of "free water" in a sample, i.e., the water molecules that are not chemically or physically bound in the sample. Free water can serve as a medium for microbial reproduction, migration, and contamination. Therefore, water activity is an important parameter for evaluating the quality and safety of salad dressing and mayonnaise products (Ma & Boye, 2013). Knowledge and control of water activity (a_w) is an important aspect in food preservation, mainly for the development of intermediate moisture foods (Chirife et al., 1989). The NaCl is main water activity lowering agent and its concentration in the aqueous phase of light mayonnaises is lower than in the standard ones (Chirife et al., 1989).

The sensory and physiochemical properties of mayonnaise are significantly affected by the elimination of fat. The objective of this study was to investigate the relationship between the

type of mayonnaise (standard and light) and physico-chemical parameters - pH value, acid value and water activity.

MATERIALS AND METHODS

The experiment is based on analysis of mayonnaise of three Serbian manufacturers, standard and light mayonnaise for each of them. Commercially available samples of standard and light mayonnaises were purchased from local supermarket in Nish in Serbia, selecting those brands with the greatest market share.

The oil content in the analyzed samples was as follows:
Manufacturer A:
1. Standard mayonnaise containing 78% of oil, and
2. Light mayonnaise containing 30% of oil.
Manufacturer B:
1. Standard mayonnaise containing 77% of oil, and
2. Light mayonnaise containing 37% of oil.
Manufacturer C:
1. Standard mayonnaise containing 75% of oil, and
2. Light mayonnaise containing unknown % of oil (oil content is not listed in the declaration).

Ingredients common to standard and light mayonnaises were the same. Standard mayonnaise of all three manufacturers contain: egg yolk, vinegar, mustard, sugar, spices, salt, acidity regulator (citric acid or citric acid and lactic acid) and antioxidant (E385). Light mayonnaise of all three manufacturers contain vinegar, mustard, spices, salt, acidity regulator (citric acid) modified starch, thickeners (guar gum and xanthan gum) and preservatives (K-sorbate), antioxidant (E385) and color (β carotene).

2.1. Chemicals and reagents

Standard solution of sodium hydroxide was from MosLab (Beograd, Serbia). Phenolphtalein was from Sigma-Aldrich Chemie GmbH (Steinheim, Germany). Aqueous solutions were prepared from deionised water (MicroMed high purity water system, TKA Wasseraufbereitungsszstem GmbH, Thermo Fisher Scientific Inc, Germany);

2.2. Physico-chemical analyses

The physico-chemical parameters - pH, acid value and water activity of each of mayonnaise were determined.

- *pH value* was measured directly by using a pH meter (CyberScan pH 510, Eutech Instruments, Netherlands) with combined glass electrode.
- *acid value* (AV, mL NaOH/g) was determined according to the procedure Karas et al., (2002) by using 5.0 g of thoroughly stirred mayonnaise which was mixed with 100 mL of deionised water. Titration was carried out with 0.1 M NaOH, by using as indicator 1 % ethanol solution of phenolphthalein.

$$AV = \frac{V \cdot 10}{m} \quad (1)$$

V = volume of 0.1 M solution of NaOH (mL)
m = mass of mayonnaise sample (g)

- *water activity* (a_w) was measured using water activity meter (Pawkit, Decagon Devices, Inc. Pullman WA, USA).

2.3. Statistical analysis

All analytical measurements were performed in triplicates. The results were expressed as arithmetic mean values ± standard deviation.

RESULTS AND DISCUSSION

The results of physico-chemical analyses are shown in Table 1.

Manufacturer A

With measuring of the pH value, there were no significant differences between the fresh light mayonnaise containing 30% of oil and standard mayonnaise containing 78% of oil (manufacturer A), as previously reported by Karas et al., (2002) (Table 1). The measured pH values of both mayonnaise samples were similar to data referred in literature (Chirife et al., 1989; Karas et al., 2002; Martinez et al., 1998; Pons et al., 1994).

A comparison between fresh standard and light mayonnaise of manufacturer *A* showed differences in acid values and water activities. Acid value of fresh light mayonnaise was higher than of standard one (Table 1), as previously referred by Karas et al., (2002). Obtained acid values of both mayonnaise types were similar to data referred in literature (Karas et al., 2002).

The water activity of fresh light mayonnaise of manufacturer *A* was higher than of standard one (Table 1). Values for water activities of 0.95 and 0.93 have been reported for mayonnaise samples containing 37% to 41% oil and 77% to 79% oil, respectively (Chirife et al., 1989). The water activities of both mayonnaise types were slightly higher to these data. In the literature water activity of mayonnaises ranged from 0.93 to 1.00 were (Chirife et al., 1989; Martinez et al., 1998; Pons et al., 1994). The obtained values for water activities of both mayonnaise types were similar to data refered in literature (Chirife et al., 1989; Pons et al., 1994).

The combination of high water activities (0.85 to 0.89/0.93) and low pH (3.3 to 4.1) can inhibit the growth of both yeast and lactobacillus organisms in food products (Ma & Boye, 2013).

Manufacturer B

Compared to fresh standard mayonnaise containing 77% of oil, the pH of light mayonnaise containing 37% of oil (manufacturer *B*) was slightly higher (Table 1).

Two types of mayonnaise of manufacturer *B* differed in acid value and water activities. In comparison with fresh standard mayonnaise sample, the acid value of light mayonnaise was higher as previously reported by Karas et al., (2002). Acid values of mayonnaise of manufacturer B were lower compared to mayonnaise of manufacturer *A* and *C*. These values were also lower than data refered in literature (Karas et al., 2002).

The water activity of fresh light mayonnaise was higher than of standard one (Table 1) and were in accordance with previous reports (Chirife et al., 1989; Pons et al., 1994).

Manufacturer C

Fresh standard mayonnaise containing 75% of oil and light mayonnaise samples containing unknown % of oil (manufacturer *C*) did not differ in pH values (Table 1) as previously reported by Karas et al. (2002). pH value of our mayonnaise types was similar to data refered in literature (Chirife et al., 1989; Karas et al., 2002; Martinez et al., 1998; Pons et al., 1994).

In comparison with standard mayonnaise, the acid value of fresh light mayonnaise was higher in the case of manufacturer *C* (Table 1), as previously raported by Karas et al., (2002).

Obtained acid values of both mayonnaise types were similar to data refered in literature (Karas et al., 2002).

The water activity of fresh light mayonnaise was higher than of standard one as previously was reported (Chirife et al., 1989). Measured water activities (Table 1) were in good agreement with previously published data (Chirife et al., 1989; Pons et al., 1994).

Table 1. The pH values, acid values (mL NaOH/g) and water activities of fresh standard and light mayonnaise of different manufacturers.

Manufacturer	Type of mayonnaise	pH value	Acid value	Water activity
A	Standard mayonnaise	3.5 ± 0.6	5.00 ± 0.12	0.97 ± 0.01
	Light mayonnaise	3.6 ± 0.4	6.20 ± 0.20	0.99 ± 0.02
B	Standard mayonnaise	4.0 ± 0.5	4.00 ± 0.12	0.96 ± 0.01
	Light mayonnaise	4.4 ± 0.4	4.20 ± 0.12	0.99 ± 0.02
C	Standard mayonnaise	3.9 ±0.6	5.60 ± 0.20	0.96 ± 0.06
	Light mayonnaise	3.9 ± 0.5	6.40 ± 0.12	1.00 ± 0.06

Comparison of mayonnaises of three manufacturers

By comparing the pH values of mayonnaise from different manufacturers, it can be seen that there was a greater difference in the pH values of the fresh mayonnaise samples by different manufacturers than in the types of mayonnaise (standard and light) by one manufacturer. Each manufacturer had their own specific pH value of mayonnaise. The pH values of mayonnaise of manufacturer *B* were higher compared to mayonnaise of manufacturer *A* and *C*. It has been found that the pH of mayonnaise is mainly determined by the ratio of egg to vinegar and drops as the ratio decreases (Xiong et al., 2000). Possible explanation for higher pH values of mayonnaises of manufacturer *B* may lie in different ratio of egg to vinegar compared to other two manufacturers. It has been reported in the literature that the pH of fresh mayonnaise ranges from 3.0 to 4.4 (Chirife et al., 1989; Karas et al., 2002; Pons et al., 1994). Measured pH values of our fresh standard and light mayonnaise samples ranged from 3.5 to 4.4 and were in accordance with this reports.

Acid values for light mayonnaises were always higher than for standard mayonnaise regardless of the manufacturer. The acid values of mayonnaise with different oil content of manufacturer *B* were lower compared to the acid values of mayonnaise of the other two manufacturers. The acid values for fresh light mayonnaises of manufacturers *A* and *C* were similar for both manufacturers. The same was true for standard mayonnaise. The determined acid values ranged from 4.00 to 6.40 and were consistent with previously published data (Karas et al., 2002).

Measured water activities of fresh standard and light mayonnaise samples ranged from 0.96 to 1.00 and were in accordance with previous reports (Chirife et al., 1989; Martinez et al., 1998; Pons et al., 1994). Fresh standard mayonnaises from all three manufacturers had very similar water activities. The same was true for light mayonnaise. Fresh light mayonnaises had higher values of water activities compared to standard mayonnaises as previously was reported (Chirife et al., 1989). Obtained higher water activities for light mayonnaises can be explain by the lower concentration of NaCl (main water activity lowering agent) in the aqueous phase of light mayonnaises than in the standard ones (Chirife et al., 1989).

CONCLUSIONS

A comparison between fresh standard and light mayonnaises showed difference in acid value and water activity while the difference in pH did not appear. The samples of the fresh mayonnaise coming from the same (one) manufacturer but of different types (standard and light) did not differ in their pH values. Each manufacturer had their own specific pH value of

mayonnaise. It should be stressed that the differences in pH values were higher between manufacturers, than between two types of mayonnaises of same manufacturer. Type of mayonnaise had a very highly impact on acid values. Acid value of light mayonnaise was higher than of standard one mayonnaise regardless of the manufacturer. Fresh standard mayonnaises from all three manufacturers had very similar water activities. The same was true for light mayonnaise. Fresh light mayonnaise had higher values of water activity compared to standard mayonnaise.

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