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THE INFLUENCE OF DIFFERENT FACTORS ON THE QUALITY OF MAYONNAISE

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Abstract

The objective of this paper was to investigate how different parameters of mayonnaise production may affect the quality of mayonnaise, respectively the formation and breaking of the emulsion.

In the production of mayonnaise, it is important to obtain a high quality product and avoid reversing phases. The standard recipe (R1) is best suited to obtain a high quality mayonnaise. The whole egg recipe (R4) comes close to the qualities of the standard recipe, but does not contain a sufficient amount of emulsifiers. Both the recipe with low egg yolk content (R2) and egg yolk powder (R3) are affected by the reversal process in the emulsification phase. The viscosity, density and pH of the four recipes are influenced by the mixing speed and time.

Key words: mayonnaise, phase inversed mayonnaise, full-fat mayonnaise

INTRODUCTION

Mayonnaise is a thick creamy sauce that contains vegetable oil, acidic component (e.g.acetic acid), egg yolk (contains a natural emulsifier — egg lecithin), sugar, salt and spicesand other emulsifying and thickening agent.

Mayonnaise is a pale yellow sauce with a thick and creamy texture. Mayonnaise can be divided into two main types depending on the amount of oil that is used in the recipe. Low fat mayonnaise contain around 30-65% oil while full-fat mayonnaise contains around 75-80%.

Due to the consumers' preferences, majority of the mayonnaise products on the market are low-fat mayonnaises. Low-fat mayonnaises have fat content around 20-40 % (Depree and Savage 2001; Yildirim, Sumnu, and Sahin 2016; Saarela et al. 2010).

In this paper only full-fat mayonnaise was investigated. The oil is dispersed in a water phase to form an oil-in-water (O/W) emulsion.

The ingredients that can be found in the water phase are: egg, vinegar, salt, sugar, mustard and water. The oil-water interfaces are stabilized by egg yolk which contains emulsifying agents.

In order to form the O/W emulsion the oil needs to be broken up into small droplets. This is achieved by applying high amount of energy in the

form of stirring. Generally the more energy that is applied the smaller the droplets become and smaller droplets makes the emulsion more stable.

When making mayonnaise at home there is always a risk of a phase inversion, resulting in a water-in-oil (W/O) emulsion.

Phase inversed mayonnaise, or broken mayonnaise, is characterized by a low viscosity which is close to the viscosity of oil. Every mayonnaise maker has their own tips and tricks for preventing this phenomenon, including everything from whipping technique to the temperature of the ingredients.

The best tip according to both Jamie Oliver and Martha Stewart is to pour the oil in slowly (Oliver, 2013; Stewart, 2017).

MATERIAL AND METHOD

The objective of the paper was to investigate how different parameters of mayonnaise production may affect the quality of mayonnaise, respectively the formation and breaking of the emulsion.

The mixing speed, temperature, oil content, egg content and type were modified in order to see how mayonnaise quality is affected.

The objectives I have pursued in this paper were: to analyze the variation of the viscosity of the mayonnaise according to time at low, medium and high speed; analysis of the variation of mayonnaise density according to time at low, medium and high speed; analysis of the variation of pH of mayonnaise according to time at low, medium and high speed; analysis of factors that influence the stability and quality of the mayonnaise; analysis of parameters that may affect the quality of the mayonnaise: mixing speed (low, medium and maximum speed (unit of measure is m / s)), quantity and type of emulsifier.

Mayonnaise is an oil-in-water (O/W) emulsion, in which the dispersion medium (oil) represents 60-80% of the total quantity (Le Denmat et all, 2000). The emulsifying agents used for the preparation of mayonnaise are egg yolk and mustard. The emulsifier used may vary between whole eggs (common in the USA), the liquid egg yolk (common in Europe) and the dry egg yolk (common in Russia) (Cedergårdh, 2014).

The reversal of the phases of an emulsion consists in transforming one type of emulsion into another type of emulsion. It can be produced by: changing the temperature by changing the concentration of one of the phases (Andersson, I., 2015; Kumar et all, 2015).

Phase reversal occurs when the emulsion is transformed from an oil-in-water (O/W) emulsion into a water-in-oil (W/O) emulsion.

Oil is the main ingredient of mayonnaise and therefore has a great influence on the quality of the final product. The quantity of oil dispersed in the mayonnaise contributes to the viscoelastic behavior, the stability and the

high viscosity of the product. The smooth texture and appearance are also dependent on the amount of oil present in the product. (McClements and Demetriades, 1998).

In mayonnaise only egg yolk and egg white are used as emulsifying, stabilizing and coloring agent (the only source allowed) (Li-Chan et all, 1995; Matsumura, Y. and Matsumiya, K., 2012).

The egg yolk is more commonly used compared to egg white, due to its larger emulsifier properties.

The vinegar used in mayonnaise contributes to antimicrobial preservation, mayonnaise aroma and low pH. By keeping the pH of the product low, the antimicrobial safety and preservation of the product increases. The low pH used in mayonnaise is close to the isoelectric point of the proteins in the egg yolk.

Salt contributes to the aroma and stability of mayonnaise (Depree and Savage 2001). Salt helps neutralize protein loads so they can adsorb more efficiently at the droplet interface. As a result of flocculation, the packing of mayonnaise becomes tighter and the viscosity increases.

Sugar contributes to the aroma of mayonnaise and is added mainly to counteract the aroma of vinegar. (Duncan, 2004)

The mustard facilitates emulsification, contributes to the aroma and color of the mayonnaise. Most of the mustard taste comes from isothiocyanates. Mayonnaise acid stabilizes these aromatic compounds. (Depree and Savage, 2001). Mustard used in mayonnaise can be added as mustard flour instead of regular mustard (Duncan, 2004).

Four recipes were used to achieve the objectives of the paper:

- standard (R1) with liquid egg yolk;
- mayonnaise (R2) with a low egg content;
- mayonnaise (R3) with egg yolk powder;
- mayonnaise (R4) with whole egg.

The standard temperature of the ingredients was 8 °C.

The differences between the 4 recipes of mayonnaise consist of changing the recipe, namely the quantity of water, salt, egg yolk and oil, the quantity of the other ingredients remaining unchanged.

In the standard recipe (R1) I used 8.5% egg yolk, 5.8% water, 0.3% salt, 2.10% vinegar and 80.5% oil.

As for the second recipe (R2), I modified it, reducing the amount of yolk to 6%, but I increased the amount of water to 8.10% and salt to 0.5%, the amount of oil and vinegar being unchanged, in order to maintain the concentration and the total amount of aqueous phase as in the standard recipe.

In the third recipe (R3) I replaced the liquid egg yolk with egg yolk powder, increased the water quantity to 9.8%, salt to 1.04%, vinegar to 3% and decreased the oil quantity to 79%.

In the fourth recipe (R4) I used both whole egg 3.61% and egg yolk 1.96%, reducing the water quantity to 7.10%, salt to 1.04%, the amount of oil and vinegar remaining the same as in R3.

To achieve the objectives, taking into account the physical properties of the analysed product, we made the following determinations: pH determination; density determination; viscosity determining and stability of the samples.

The pH determination was performed using the Inolab WTW pH Meter, pH 720. The viscosity analysis was performed after one day storage at ambient temperature using the Brookfield Viscometer. In the preparation of mayonnaise we used a hand mixer with 7 steps, power 250 W, Hausberg brand.

RESULTS AND DISCUSSION

The first determination consisted of measuring the viscosity at the 4 recipes of mayonnaise, at low, medium and high speed.

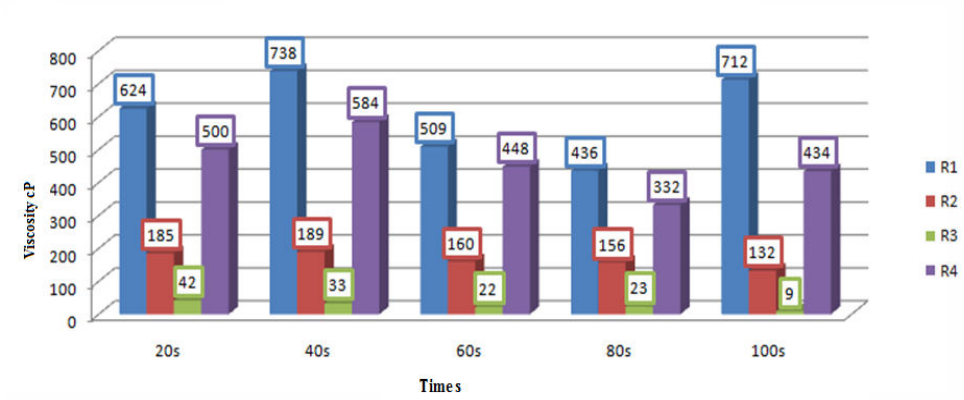

Fig. 1. Variation of mayonnaise viscosity as a function of time at low speed

The structure and consistency do not change when changing gears to the standard recipe, the color has changed from intense yellow, at low speed, to pale yellow at maximum speed.

In the standard recipe, the viscosity increases from 624 cP to 738 cP, from 20 to 40 seconds of mixing at low speed.

The mayonnaise made according to the standard recipe, with a high oil content, has a firm texture, but is also more sensitive to over-shearing.

In the second recipe (R2) I decreased the quantity of liquid egg yolk from 8.5% (R1) to 6% (R2), but increased the water quantity to 8.10% and

salt to 0.5%, the amount of oil and vinegar remaining unchanged, in order to maintain the concentration and total amount of aqueous phase as in the standard recipe.

The increase of the water quantity and the decrease of the egg quantity in the mayonnaise obtained with a low egg content led to the reversal of the phases, caused by a change of the oil-water ratio. When the volume of the dispersed phase became too large, a phase inversion occurred. The phase reversal point depended on the intensity of the stirring and the speed of addition of the dispersed phase.

Increasing the amount of water, salt, **replacing the liquid egg yolk with egg yolk powder** and decreasing the amount of oil led to the reversal of the phases, caused by a change in the oil-water ratio.

The phase reversal of the mayonnaise occurred during the coarse emulsification stage. The inversion in the coarse emulsion phase was characterized by a very early phase inversion and, therefore, no mayonnaise was formed.

The viscosity of the **mayonnaise obtained with whole egg**, shows a decrease in viscosity compared to the standard recipe, from 624 cP to 500 cP, from 20 to 40 seconds of mixing at low speed. Recipes R2 and R3 have a low viscosity, compared to the standard recipe, both mayonnaises having a long texture that made them thinner and more elastic.

This is not a desired quality of mayonnaise and, therefore, we can say that these mayonnaises do not meet the requirements of adequate mayonnaise.

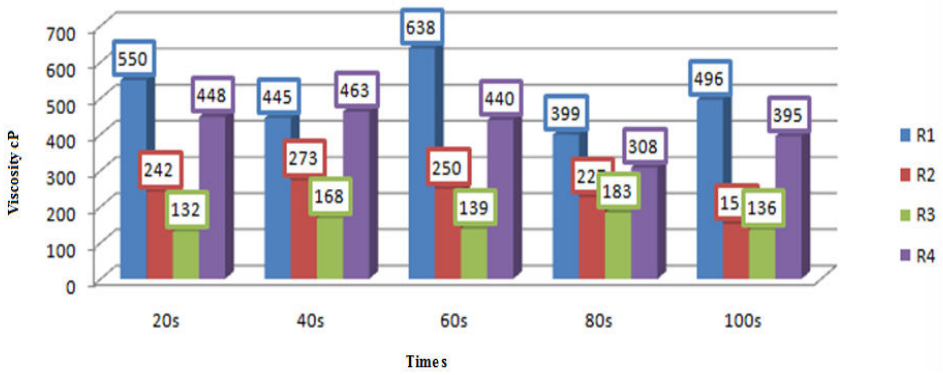

Fig. 2. Variation of mayonnaise viscosity as a function of time at medium speed

Regarding the variation of the mayonnaise viscosity at medium speed in the standard recipe, the viscosity decreases from 550 cP to 445 cP, from 20 to 40 seconds of mixing at medium speed.

The viscosity with egg yolk powder shows a decrease in the viscosity compared to the standard recipe and the second recipe, from 550 cP and 242 cP, to 132 cP, from 20 to 40 seconds of mixing at medium speed.

The viscosity of the mayonnaise obtained with whole egg shows a decrease compared to the standard recipe, from 550 cP to 448 cP, from 20 to 40 seconds of mixing at medium speed. By increasing the mixing time from 40 to 60 and 80 seconds, respectively, the viscosity of the mayonnaise decreases from 463 cP to 308 cP. At a longer mixing time, 100 seconds, the quality decreases, the mayonnaise becomes excessive and the viscosity increases to 395 cP.

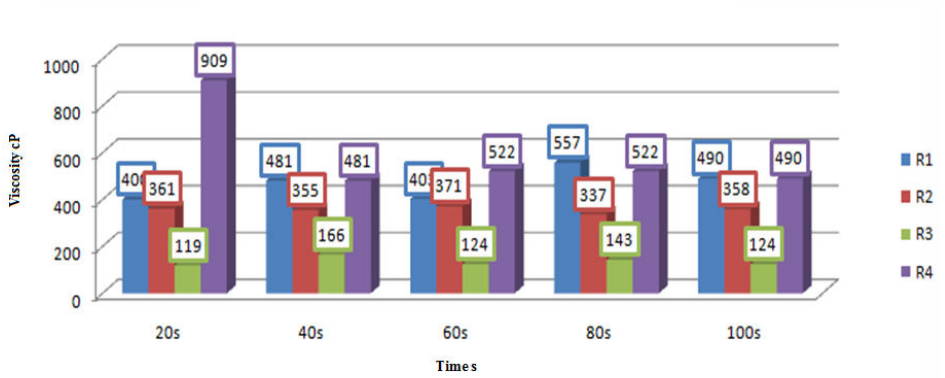

Fig. 3. Variation of viscosity of mayonnaise as a function of time at high speed

Regarding the variation of the mayonnaise viscosity at high speed in the standard recipe, the viscosity increases from 400 cP to 481 cP, from 20 to 40 seconds of mixing at high speed.

The viscosity of the mayonnaise obtained with a low egg content shows a great decrease in viscosity compared to the standard recipe, from 400 cP to 361 cP, from 20 to 40 seconds of mixing at high speed.

The viscosity with egg yolk powder shows a decrease in viscosity compared to the standard recipe and the second recipe, from 400 cP and 361 cP, to 119 cP, from 20 to 40 seconds of mixing at high speed.

The viscosity of the mayonnaise obtained with whole egg shows an increase compared to the standard recipe, from 400 cP to 909 cP, from 20 to 40 seconds of mixing at high speed. 909 cP is the highest value of mayonnaise viscosity obtained with whole egg, at high speed.

After analyzing the data, it was found that mixing speed, egg content, egg type and oil content influence the quality of the mayonnaise.

The quality of the mayonnaise changes during the emulsification process, presenting an optimum to the standard recipe. When the

mayonnaise is exposed to high speed for a long time, the egg yolk protein is irreversibly destroyed, leading to a decrease in viscosity.

As the oil content in mayonnaise increases, mayonnaise becomes more and more sensitive to over-shearing. The increase of the dispersed phase gives a firm texture and a higher viscosity. Higher viscosity makes the shear more intense, leading to a faster destruction of the proteins in the egg yolk (Hilma Elena, 2018).

In conclusion, the reversal of the emulsion phase occurred with the destruction of the proteins in the egg yolk (Thakur et all, 2008). This was observed in the low egg content recipe (R2) and in the egg yolk mayonnaise recipe (R3).

Mayonnaise density at low, medium and high speed does not have major discrepancies in values between recipes.

The standard mayonnaise recipe (R1) recorded a value close to each mixing time and speed, approaching the ideal mayonnaise value of ρ = 0.925 g/cm3

The closest recipe to the ideal pH value of mayonnaise (4.5) is the whole egg mayonnaise recipe (R4), which has a value between 4.15 and 4.39, with a maximum of 4.65 at 80s mixing time.

Standard mayonnaise recipes (R1) and mayonnaise recipes with low egg content (R2) show no changes during mixing, having similar and close values.

Physical stability was considered to be the period when the emulsions did not show separation of the visual phase. All samples were stable, the emulsions did not show separation of the visual phase after 7 days. The amount of oil dispersed in mayonnaise contributed to the viscoelastic behavior and stability.

CONCLUSIONS

The standard recipe (R1) is best suited to obtain a high quality mayonnaise. The whole egg recipe (R4) comes close to the qualities of the standard recipe, but does not contain a sufficient amount of emulsifiers. Both the low egg yolk (R2) and the yolk powder (R3) recipes suffer from the reversal process in the emulsification phase. The viscosity, density and pH of the four recipes are influenced by the speed and mixing time.

The stability of these samples does not change, the recipes having the same texture and color during the 7 days at room temperature.

With the increase of the mixing speed, the formation time of the mayonnaise and the viscosity decrease, also the increase in volume determined by the incorporation of air which is in accordance with the density is lower.

Therefore, it is recommended to take into account the time parameter, which increases with decreasing mixing speed, but at the same time favors the incorporation of air, improves the viscosity of the finished product, and therefore its sensory and commercial quality.

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