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Original Research Article

SENSORY AND QUALITY EVALUATION OF MAYONNAISE AND ITS EFFECT ON STORAGE STABILITY

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Abstract

This study aimed to evaluate the addition of skim milk powder to replace egg yolk in preparation of mayonnaise. Egg yolk was pasteurized at 150ºF (65.6ºC) about 1 minute for its safety. Mayonnaise was prepared from sunflower oil with the level varied from 65-75% and egg yolk from 9-15%. Mayonnaise made from 70% oil and 12% egg yolk was found to be best. Then skim milk powder (SMP) was added to replace 12% egg yolk in the ratios 0:100, 25:75, 50:50, 75:25 and 100:0 other constituents remaining constant. Sensory evaluation demonstrated that mayonnaise substituted with 25% skim milk powder was best.The chemical composition of the product, as well as fatty acid composition and peroxide value was analyzed.Coliform and Salmonella was not detected in microbial analysis. Sensory studies for its storage stability confirmed that the product was acceptable up to 28th days at refrigerate temperature whereas sample stored in room temperature was deteriorated after 14th days.

key words: mayonnaise, skim milk powder, sensory optimization, storage stability, peroxide value

INTRODUCTION

Mayonnaiseis the oil-in-water emulsion where oil is the discontinuous phase and water is the continuous phase obtained by emulsifying edible vegetable oil(s) in an aqueous phase consisting of vinegar, being produced by egg yolk.[1]It comes under the class of foods commonly referred to as salad dressings or salad cream.[2]The emulsion is formed by slowly blending oil with a pre-mix that consists of egg yolk, vinegar, and mustard and then slowly feeding the oil, resulting in closed-packed foam of oil droplets or coarse emulsion. Because of its low pH and high fat content, mayonnaise is relatively resistant to microbial spoilage.[3]
Sunflower oil is a combination of monounsaturated and polyunsaturated fats with high in essential vitamin E and shows cardiovascular benefits. In pharmacy it is used for the treatment of cholesterol and atherosclerosis. Death rate of *Salmonella enteritidis* was always faster in mayonnaise made from sunflower oil.[4] The emulsifying capability of egg yolk is mainly related to its content of lecithin (about 1.22% of the yolk).[5] Lecithin is a phospholipid and is not affected by the acid/heat pasteurization process and remains an effective emulsifying agent in the pasteurized egg yolk/acid mixture. The procedure of safety is accomplished by diluting and acidifying yolk of eggs and heating mixture to a pasteurizing temperature [for 100,000-to-1 CFU/g (5D) reduction]. This procedure ensures the destruction of vegetative cells of *Salmonella spp.* and other pathogenic bacteria such as *L. monocytogenes* and *Escherichia coli O157:H7*. However, the amount of acid in these foods is recognized as a critical hazard control.[6] Although egg possesses excellent functional properties, it suffers from some disadvantages such as high cholesterol content about 213 mg cholesterol.[7]It has been shown that saturated fats increase cholesterol synthesis by the liver cells and result in elevation of blood LDL (low-density lipoprotein) -cholesterol.[8]These considerations have led to a search for egg replacers and egg extenders.[9]
Egg and milk is a good source all essential amino acids and is considered as a complete food.Skim milk powder acts as binder for improving the functional properties and maintaining the nutritional value of low value binder's used.[10]Stabilizers can be used 1g/kg or in combination.[1] Stabilizers used mainly are carboxymethylcellulose (CMC), sodium alginate, Guar gum,

pectins, etc used singly or in combinations. Water is used to make 100% in the mayonnaise formulation.[3]

Hence, a study was carried out to check the addition of skim milk powder could replace the egg yolk with the use of stabilizer like CMC and sodium alginate in the ratio 1:1 to stabilize the emulsion without affecting the quality of mayonnaise. The main motivation behind this work is that consumers have demanded that the use of egg yolks be reduced because of the inherent cholesterol and take advantage of the milk protein interaction; formulate a mayonnaise with similar characteristics prepared with egg yolk.

MATERIALS AND METHODS

Method for Controlling Salmonellae Contamination in Egg-Based mayonnaise

Egg yolk mixture and acid (vinegar and lemon juice and ½ amount of water from the recipe) was heated to 150°F (65.6°C) about 1 minute, during this process the egg yolk proteins do not get heated sufficiently to denature and coagulate because of the acid and water dilution.The mixture was stirred continuously with frequent measurement of temperature. The pan was removed immediately after pasteurization, containing the yolk/acid mixture from the hot-water heat source and was used in the preparation of mayonnaise.

Optimization of oil and egg yolk level in mayonnaise

Nine samples were prepared by making variation in the proportion 9%, 12%, 15% egg yolk each with all the percentage of oil i.e. 65%, 70% and 75%, where water was used to make 100% and other ingredients as presented in Table 1 was kept constant. The samples were coded as A, B, C, D, E, F, G, H and I respectively.The pasteurized yolk/acid mixture was used and remaining ingredients salt, sugar, stabilizers and half portion of water were mixed separately. Both the mixed ingredients were mixed for 5 minutes in high speed mixer blender. The oil was added drop-wise 5ml per minutes with continuous mixing. After complete addition of oil, mixing was continued for additional 5 minutes until a thick emulsion was formed. Then remaining vinegar was added and mixing was continued for additional 10 minutes. Thus the mayonnaise was prepared and was drawn for sensory analysis and the scores so obtained were subjected to statistical analysis to get optimum level of oil and egg yolk.

Table 1Constituents used in mayonnaise preparation

Ingredients	Weight %
Salt	1.2
Sugar	2
Lemon juice	0.5
Vinegar (4% acetic acid)	8
Stabilizers	0.5
Mustard powder	0.3

Substitution of egg yolk by skim milk powder

Mayonnaise was prepared by using optimized proportion of oil (70%) and egg yolk (12%) obtained through sensory analysis; five samples of mayonnaise was prepared by incorporating skim milk powder in optimized egg yolk (12%), as skim milk powder: egg yolk in the proportion 100:0, 75:2, 50:50, 25:75 and 0:100. The samples were coded as K, L, M, N and O respectively. The remaining process was used same as above in the preparation of mayonnaise.These samples were subjected to sensory evaluation and the scores so obtained were subjected to statistical analysis to get optimum level of skim milk powder : egg yolk.

Storage stability

For storage stability, optimized mayonnaise was kept in polyethylene jars at room temperature 28ºC and refrigeration 4ºC for 28 days. The mayonnaise was spread on bread to view the spread-ability and served to the panelist for the sensory evaluation. Sensory characteristics: taste (flavor/ aroma), consistency, color/ appearance, spread-ability and overall acceptability were evaluated on 9-point hedonic scale.[11]

Analytical methods

Physiochemical analysis of oil such as Cold test (winterization test), Saponification Value, Peroxide Value, Free-fatty acid and acid value, Kries test was carried out.[12] Physiochemical analysis of mayonnaise such as Moisture content, pH, Crude fat, Crude protein, Ash content, During storage; Titrable acidity, Acid Value, Peroxide Value and pH were determined at regular interval i.e. at the interval of 7 days up-to 28 days.[13] Microbial analysis was carried out such as Coliform count, TPC, Yeasts and Molds count and Salmonella spp. Count.[14]

RESULTS AND DISCUSSION

Chemical composition of oil

Table 2.Physiochemical analysis of sunflower oil

Parameters	Sunflower oil*
Cold test (winterization test)	Good Quality
Saponification Value	188.3 (0.577**)**
Peroxide Value (meqv/kg oil)	0.627 (0.0305)
% Free-fatty acid as oleic acid	0.082 (0.0005)
Acid value (mg of KOH/gm of oil)	0.164 (0.001)
Kries test	0.083 (0.005)

* The values in the Table 2 are the means of triplicates. Figures in the parentheses are the standard deviation.

According to AOCS (1967)[15], specification for sunflower oil for the parameters i.e. saponification value must be in the range (188-194), peroxide value less than value 10 can be consumed, FFA value ≤ 0.25, Kries test ≤ 3.0. During cold test, if the oil remained perfectly clear. If the oil did not develop a voluminous mass of crystal fats, mayonnaise prepared from such oil would not break down under refrigeration and would not be spoiled.[16]

Optimization of proportion of oil and egg level

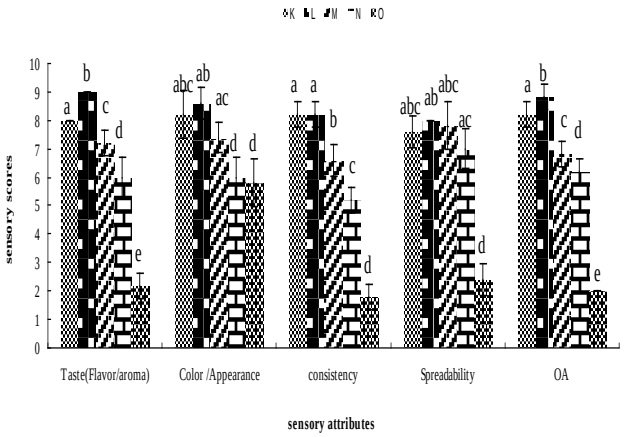

Figure 1. Effect of variation of oil and egg proportion on the sensory score of egg based mayonnaise*

*Where OA= overall acceptability. The values in the Fig. 1 are the means scores of panelists. Values on top of the bars bearing similar superscript are not significantly different ($p<0.05$).

Sensory parameters revealed that sample E has the highest mean score, the product made by blending (70% oil and 12% egg yolk) was found to be best.

Optimization of skim milk powder in replacing egg yolk

Sample K containing 100% egg only is taken as control. Sample K, L, M, N, and O were significantly different ($p<0.05$) from each other in terms of overall acceptance and taste (flavor & aroma) are presented in Fig. 2.

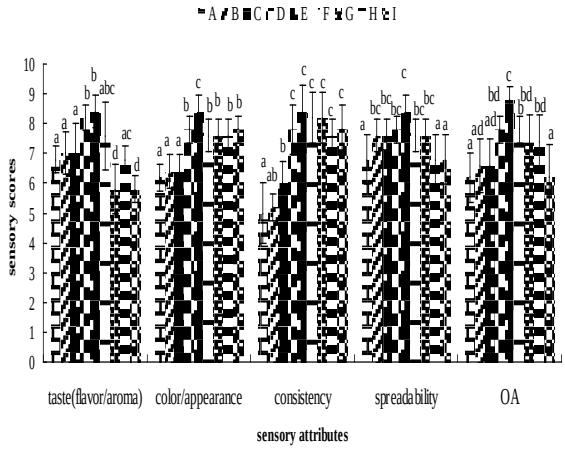

Figure 2. Effect of skim milk powder to reduce egg yolk on the sensory score of mayonnaise*

*Where OA= overall acceptability. The values in the Fig. 2 are the means scores of panelists. Values on top of the bars bearing similar superscript are not significantly different ($p<0.05$)

Sample L, the product made by blending (egg: skim milk powder = 75:25) is significantly superior. This might be due to yellowness was slightly reduced in sample L with the addition of skim milk powder in egg proportion which gave a good appearance. But whiteness gradually increased for the sample M, N and O with addition of skim milk powder which was not preferred in terms of color. This might be due to skim milk powder suppress the flavor of egg which made skim milk powder added mayonnaise highest score.

The emulsion was not formed in sample O; there was separation of oil with skim milk powder. This also showed that skim milk powder did not contained lecithin as egg yolk. According to Miller *et al*., (1999) the proteins in milk powders can quite successfully act at oil/water interfaces to form and stabilize emulsions. The ability of dairy proteins to stabilize oil/water emulsions is affected by pH and ionic strength of the aqueous phase. [17]

Final recipe of the product made is given in Table 3.

Table 3: Recipe for the preparation of the mayonnaise

Ingredients	Weight %
Sunflower oil	70
Egg yolk	9
Skim milk powder	3
Vinegar (4.5% acetic acid)	8
Lemon juice	0.5
Sugar	2
Salt	1.2
mustard powder	0.3
Stabilizers	0.5
Water	5.5

Analysis of the product

The proximate analysis of best obtained product from sensory analysis is presented in Table 4.

Table 4 Proximate and microbiological analysis of final product mayonnaise i.e. skim milk and egg yolk based

Parameters	Value*
Moisture content (%)	15.6 (0.01)
PH	3.96 (0.005)
Fat (%)	70.6 (0.066)
Protein (%)	4.6 (0.055)
Ash content (%)	0.2 (0.01)
Titrable acidity (%)	0.5 (0.05)
Acid value (mg of KOH/gm of oil)	0.27 (0.01)
Peroxide value (meqv/kg oil)	1.12 (0.02)
Total plate count (cfu/g)	150
Yeast and mold count (cfu/g)	<100
Coliform count	ND
Salmonella count	ND

*Where ND= not detected. The values in the Table 4 are the means of triplicates. Figures in the parentheses are the standard deviation.

The moisture content obtained in this work were within the range 16-18% obtained by Morales-Aizpur and Tenuta-Filho, (2005).[18] Snyder, (2008) suggested that to make salmonella free mayonnaise, the PH should be in the range of 4.1 or less (called the safe PH value) for the mayonnaise safety and is within the safe PH range i.e. 3.96. Fat and ash content for commercial mayonnaise i.e. 70 and 0.23% respectively.[6] Protein content in this product is slightly higher than mayonnaise made by egg.[8]Titrable acidity was higher in the result; this might be due to addition of vinegar in high amount in preparation of mayonnaise.[19] Acid value obtained result was nearly similar to the finding.[20] Peroxide value was higher than Karas*et al.*, (2002) this might be due to the hydrolysis of triglyceride to free fatty acid which might be due to presence of moisture in the oil and activity of lipase enzyme coming from the contaminating microorganism.[19]

Lsd (5%)	Titrable acidity	PH	Acid value	Peroxide Value
Days	0.01317	0.0648	0.5178	1.832
Temperature	0.00931	0.0458	0.3662	1.295

Egg could be replaced by milk without loss of emulsifying properties.[21]Thus, the composition of mayonnaise depends mainly on the oil, egg and acetic acid used.

The data represented in Table 4 showed that the microbiological analysis of mayonnaise contained lower total plate count as compared to 6.4×10^2 cfu/g.[20] Yeast and mold was found in the range of lower than 100. As egg was pasteurized earlier, therefore no Coliform and salmonella was detected in the product.

Physicochemical changes during storage

The data on changes during storage in the product are presented in Table 5.

*The values in the Table 5 are the means of triplicates. Figures in the parentheses are the standard deviation.The values having same first alphabet in the superscript represents the significantly similar in terms of days in each row and same second letter in the superscript represents the significantly similar in terms of temperature in same days bearing similar superscript are not significantly different ($p<0.05$).

Significant difference ($p<0.05$) was observed among the products, the acidity (Table 5) increased slightly from 0-28th day in case of refrigerate but increased more in stored at room temperature as the time of storage increased. The pH value decreased slightly in refrigerate stored sample but decreased higher in room stored sample. The increased in acidity and declining of pH values might be due to the growth of lactic acid bacteria and continued acid

production during storage.[20] Although the percentage of increasing acidity in this investigation was lower than that recorded, that the acidity increased from 4% during storage at temperatures between 4°C and 10°C.[22]

Table 5 Summary of chemical test for difference between two temperature at different storage periods*

	Temperature	Days			
		7	14	21	28
Titrable acidity%	Room	0.67^{ak}	0.726^{bk}(0.002)	0.78^{ck} (0.001)	0.817^{dk}
	Refrigerate	0.544^{el}	0.58^{fl}(0.001)	0.61^{gl} (0.001)	0.64^{hl}(0.002)
PH	Room	3.76^{ak}	3.66^{bk}(0.057)	3.6^{bk} (0.0)	3.58^{ck} (0.057
	Refrigerae	3.93^{dl} (0.05	3.9^{dl} (0.0)	3.86^{dl} (0.057)	3.83^{dl} (0.057
Acid value (AV)	Room	0.56^{ak}	1.446^{bk}(0.030)	1.906^{bk} (0.041)	2.75^{ck} (0.030
	Refrigerate	0.31^{dk}	0.34^{dl} (0.057)	0.35^{dl} (0.057)	0.39^{dl} (0.057
Perox Value (PV)	Room	6.486^{ak}	9.21^{bk} (0.045)	12.92^{ck} (0.07)	18.37^{dk}
	Refrigerate	2.926^{el}	3.45^{el} (0.030)	6.03^{fl} (0.152)	7.42^{fl} (0.230

The acid value (Table 5) obtained were observed to increase as the weeks progressed. There was no significant difference ($p<0.05$) between the samples at 7th day storage but the value range was higher in room temperature and after that there was Significant difference for 14, 21 and 28th days. The increase in acid values was probably due to the activity of hydrolytic and oxidative enzymes present in eggs.[22]The presence of free fatty acid in oil is an indication of lipase activity or other hydrolytic action andthe presence of the enzyme lipase. Therefore increase in free fatty acid level which is measured by the acid value suggests that as storage period increases the extent or proneness to rancidity increases.[23]

The peroxide values (Table 5) showed significant difference ($p<0.05$) among the products stored in room and refrigerate temperature for 14th, 21st and 28th days. The peroxide values were noticed to increase gradually over the weeks indicating that mayonnaise gets rancid gradually on storage.[2] The observed above data indicates that all the values were less than 10 indicating that the mayonnaise samples were safe in refrigerate condition.

Effect of temperature on sensory parameters on 7th day and 14th day of storage

Significant difference ($p<0.05$) was observed among the products stored in room and refrigerate on 7th day, in case of taste and color. It may be due to growth of lactic acid bacteria and some yeast. For comparison purpose, sensory parameters of mayonnaise stored in room and refrigerate temperatures on 7th day of storage are presented in Fig. 3

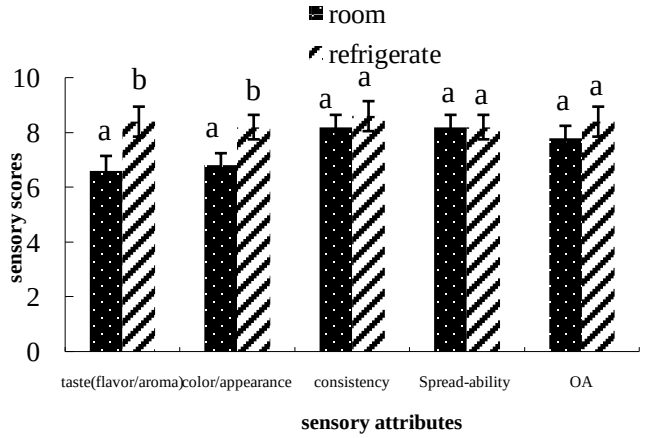

Figure: 3 Comparison of sensory parameters of mayonnaise stored in room and refrigerate temperatures on7th day of storage*
*Values on top of the bars bearing similar superscript are not significantly different ($p<0.05$).
For comparison purpose, sensory parameters of mayonnaise stored in room and refrigerate temperatures on 14th day of storage are presented in Fig. 4

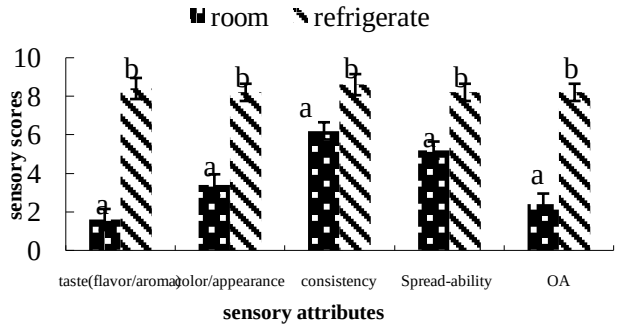

Figure: 4 Comparison of sensory parameters of mayonnaise stored in room and refrigerate temperatures on 14th day of storage*

*The values in the above figures are the means scores of panelists. Values on top of the bars bearing similar superscript are not significantly different ($p<0.05$).
Significant differences ($p<0.05$) were observed between the samples stored in room and refrigerate temperatures for different sensory parameters for 14th day. The color of the product was slightly brown and the flavor was rancid, this was due to some fungal and yeast growth and room sample was discarded by panelists after 14th day; were not further evaluated

Effect of days on sensory parameters stored at Room and Refrigerate temperature

There is significant difference ($p<0.05$) between the samples stored in room condition in terms of days for different sensory parameters. The color of the product was slightly brown and the flavor was rancid due to some fungal and yeast growth and room sample was discarded by panelists after 14th day; were not further evaluated.

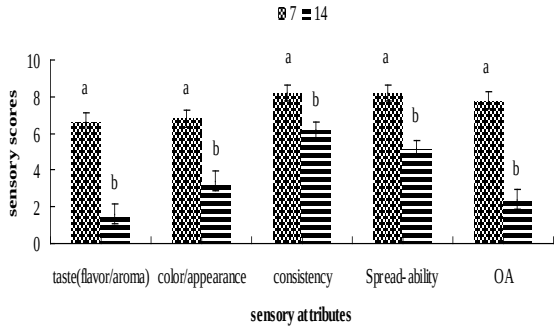

Figure:5Comparison of sensory parameters of mayonnaise stored in room temperatures on 7th and 14th days *

*Values on top of the bars bearing similar superscript are not significantly different ($p<0.05$)

For comparison purpose, sensory parameters of mayonnaise stored in refrigerate condition on the basis of days are presented in Fig.6

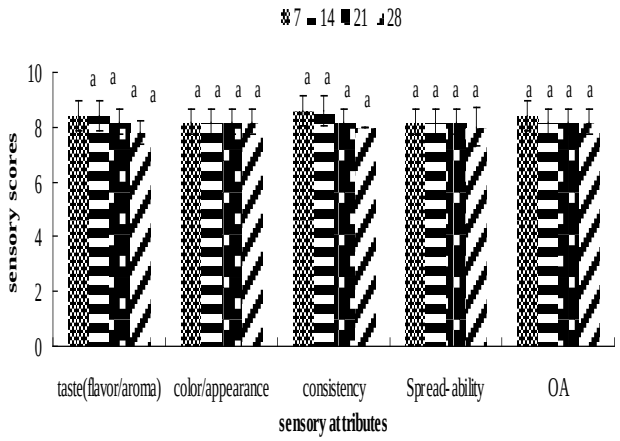

Figure 6. Comparison of sensory parameters of mayonnaise stored in RefrigerateTemperatures on 7th, 14th, 21st and 28th days*

*The values in the above figures are the means scores of panelists. Values on top of the bars bearing similar superscript are not significantly different ($p<0.05$).
Samples stored up-to 28 days revealed no significant difference ($p>0.05$) but sensory scores changed slightly in all parameters in refrigerate condition and was concluded that the product was sensorial good up-to 28 days and can be stored in refrigerator for longer period of time. Mayonnaise stored at room temperature soon deteriorates in terms of sensory and chemical parameters. Therefore, it is essential to keep mayonnaise at temperatures between 5°C and 8 °C, in order to better preserve its sensory and physico-chemical parameters.[19]

CONCLUSION

Skim milk powder can replace 25 part out of 100part of egg yolk in 12% without affecting the characteristics in mayonnaise preparation. The physiochemical changes during storage showed

that the refrigerate stored mayonnaise was sensorically best up to 28 days and can be kept for longer period of time but mayonnaise stored in room temperature was sensorial stable up to 14 days only. Cold stored mayonnaise had better sensory quality for the majority of evaluated attributes: lower acid and peroxide values, lower rancidity, better overall acceptability and higher pH value than mayonnaise stored at room temperature.

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