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A Comparative Analysis of the Impact of Incorporating Modified Potato and Corn Starch on the Textural, Rheological, and Sensory Attributes of Low-Fat Mayonnaise

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ABSTRACT

In response to the detrimental effects of dietary fat on consumer health, particularly its association with cardiovascular diseases, obesity, and various other health-related issues, there has been a concerted effort in contemporary food production to develop low-fat food products. The objective of this study is to evaluate the production of low-fat mayonnaise with oil content levels of 20%, 25%, and 30%. This investigation employs modified potato and corn starches at concentrations of 2. 5%, 3%, and 3. 5% The study aims to systematically assess the relative impact of these formulations on key parameters, including viscosity, pH, acidity, stability, and physical properties, throughout a storage period of six months. Additionally, sensory properties will be evaluated to provide a comprehensive analysis of the product's quality and consumer acceptability. The findings indicated that the incorporation of both starches and elevated fat levels resulted in significant increases in pH values, viscosity, emulsion stability, tissue stiffness, and the adhesion properties of mayonnaise, concurrently leading to a reduction in the acidity of the samples. During the storage period at refrigeration temperatures, a significant reduction in viscosity, pH, firmness, and tissue adhesion was observed in the mayonnaise samples, accompanied by an increase in acidity and creaminess ($p<0.\ 05$) The findings from the sensory evaluation demonstrated that elevated levels of starches and fats significantly improved the scores of sensory parameters ($p < 0.\ 05$) The sensory evaluation revealed that the formulation of low-fat mayonnaise, which comprised 30% fat and 3. 5% modified potato starch, exhibited the highest level of sensory acceptance among the tested samples. The present study demonstrated that low-fat treatments utilizing modified potato starch exhibited superior quality characteristics in comparison to samples incorporating corn starch. In conclusion, the incorporation of 30% fat and 3. 5% modified potato starch as a fat substitute yields beneficial physicochemical and sensory properties in mayonnaise.

1- Introduction

Mayonnaise is widely recognized as one of the most prevalent salad dressings globally. This formulation represents a semi-solid oil-in-water (O/W) emulsion, composed of approximately 70-80% vegetable oil, along with vinegar, salt, egg yolk, and a thickening agent. Nonetheless, the elevated oil content of this product categorizes it as an unhealthy food option, as excessive consumption may result in elevated lipid levels within consumers' bodies. Increased consumption of dietary fats is associated with elevated cholesterol levels, contributes to the development of obesity, and markedly heightens the risk of cardiovascular disease [1]. The growing apprehension regarding the detrimental effects of excessive fat consumption on human health has prompted considerable initiatives within the industry to formulate products with lower fat content. Fat is integral to the structural and organoleptic properties of food products, significantly influencing their aroma, flavor, and mouthfeel. This reliance on fat presents considerable challenges in the formulation of low-fat food products [2]. In the formulation of low-fat products, it is essential to incorporate additives that are capable of replicating the critical organoleptic characteristics of fats. These additives serve as viable alternatives, facilitating the reduction of fat content in these products while maintaining desirable sensory attributes [3] .Starches represent a notable alternative to fats in food formulations, and prior research has examined the influence of various starch types on the quality characteristics of low-fat mayonnaise [2] [4].

Starches serve as significant additives in the food processing industry, contributing to enhancements in both the aesthetic qualities and sensory attributes of food products. These substances function as bulking or thickening agents, improving the visual appeal and texture of food products without contributing additional nutritional value. In the industry, a diverse range of starch sources, including potato, corn, cassava, and sweet potato, is utilized for this objective [5]. Approximately 80% of the total global starch production is ascribed to corn starch [6]. This starch serves a dual purpose; it is employed in the production of corn syrup and functions as a thickening agent in the formulation of a diverse range of food products [7]. Potato starch is a significant and extensively utilized polysaccharide in the food industry, functioning as a stabilizing, gelling, and thickening agent in the formulation and processing of various food products. This particular starch exhibits elevated transparency and viscosity, along with a relatively low gelatinization temperature. Nevertheless, the applicability of native and natural starches in the food industry is constrained by factors such as the variability of pH levels, low temperature conditions, and the mechanical processes involved in food preparation[8].

Modified starch is a derivative of starch that is produced through various physical and chemical treatments applied to raw starch. Through these modifications, the processed starch develops novel properties that fulfill distinct requirements across multiple industries, in contrast to raw starch, which does not possess such functionalities. It demonstrates functionality [9] . Modified starch can be synthesized through various techniques, including chemical, physical, enzymatic, and genetic methods, or through a combination of these approaches. Chemical methods represent the oldest and most prevalent approaches to starch modification. In this methodology, the incorporation of specialized chemical moieties, including ester functional groups, distinct ions, and acetyl groups, onto starch molecules facilitates the emergence of novel properties. Acetate starch, octenyl succinyl starch, and monophosphate starches are highly regarded in food applications due to their remarkable stability during the defrosting process [10]. Acetylated starch has been recognized for approximately one century and is utilized to enhance concentration, stability, and texture in various applications. Acetylated starch is synthesized through the process of esterification, wherein natural starch is reacted with anhydrous acetic acid in the presence of an alkaline catalyst. Acetylation enhances various physicochemical properties of starch, notably increasing solubility, swelling capacity, viscosity, and stability in relation to thermal processing and prolonged storage. Furthermore, it contributes to a reduction in gelatinization temperature and mitigates detrimental alterations in food products that may arise from starch retrogradation during processing and storage. The acetylation of starch is influenced by various parameters, including the concentrations of the reactants, the duration of the reaction, the pH of the reaction medium, and the presence of a catalyst. These factors collectively determine the extent of substitution of the target functional groups within the starch polymer [11]. The objective of this research was to examine the impacts of utilizing acetylated corn and potato starch as fat replacers on the qualitative and organoleptic characteristics of low-fat mayonnaise.

2- Materials and Methods

2-1-Materials

Oil, sugar, salt, eggs, and vinegar were procured from a local retail establishment in Tehran. Mustard powder and sodium benzoate were sourced from Adonis Goldaro in Iran, citric acid was procured from Merck in Germany, while acetylated corn starch was obtained from Roquette in France, and acetylated potato starch was acquired from Lyckeby in Sweden. The chemicals utilized in the experiments were procured from Merck (Germany) [3].

2-2- Preparation of Mayonnaise Treatments

The formulations of the low-fat mayonnaise treatments examined in this study are presented in Table 1. In the preparation of mayonnaise utilizing an oil substitute, xanthan gum and guar gum were combined with modified starches in a single container. Concurrently, other powdered ingredients were placed in a separate container. Initially, water was introduced into the tank, following which the spatula and homogenizer were activated. Subsequently, the powder materials excluding starch, comprising sugar, salt, citric acid, mustard, potassium sorbate, and sodium benzoate, were introduced into the tank via the funnel valve designated for powder materials.

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Following a duration of two minutes, the egg yolk was subsequently introduced. Less than fifty percent of the oil was combined with the starch powders, specifically xanthan, guar, and modified starch. Subsequently, this mixture was gradually introduced to the other ingredients through a funnel while being stirred for a duration of three minutes. After a duration of three minutes, the homogenizer was calibrated to a setting of 53, at which point vinegar was introduced through the funnel valve into the liquid material. The valve was gradually opened to facilitate the incremental addition of vinegar, while oil was simultaneously introduced through the adjacent funnel valve. The homogenizer was set to a speed of 59, adhering to the protocol that vinegar should be added prior to the incorporation of oil. Upon the completion of the oil extraction, the valves were systematically closed. Subsequently, after a duration of five minutes, the homogenizer was adjusted to an operational setting of 70. Subsequent to an additional five minutes of operation, the homogenizer was deactivated, and the vacuum pump was engaged for a duration of one minute to establish a vacuum. After a duration of one minute, the valve for the liquid material was activated, and the homogenizer was calibrated to a setting of 7/33 in order to facilitate the filling of the mayonnaise jars [12] .

Table 1. Formulations of low-fat mayonnaise

Ingredients	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**T_9**
Sugar	150	150	150	150	150	150	150	150	150
Salt	51	51	51	51	51	51	51	51	51
Mustard	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Xanthan	9	9	9	9	9	9	9	9	9
Citric acid	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Guar	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Potassium sorbate	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Sodium benzoate	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Egg yolk	68.1	68.1	68.1	68.1	68.1	68.1	68.1	68.1	68.1
Vinegar	165.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0
Water	1940.4	1790.4	1640.4	1865.4	1850.4	1835.4	1865.4	1850.4	1835.4
Oil	600	750	900	600	600	600	600	600	600
Starch L	0	0	0	75	90	105	0	0	0

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Starch R	0	0	0	0	0	0	75	90	105

Ingredients	**T10**	**T11**	**T12**	**T13**	**T14**	**T15**	**T16**	**T17**	**T18**
Sugar	150	150	150	150	150	150	150	150	150
Salt	51	51	51	51	51	51	51	51	51
Mustard	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5
Xanthan	9	9	9	9	9	9	9	9	9
Citric acid	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Guar	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Potassium sorbate	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Sodium benzoate	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Egg yolk	68.1	68.1	68.1	68.1	68.1	68.1	68.1	68.1	68.1
Vinegar	165.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0
Water	1715.4	1700.4	1685.4	1715.4	1700.4	1685.4	1565.4	1550.4	1535.4
Oil	750	750	750	750	750	750	900	900	900
Starch L	0	0	0	75	90	105	0	0	0
Starch R	75	90	105	0	0	0	75	90	105

Ingredients	**T19**	**T20**	**T21**
Sugar	150	150	150
Salt	51	51	51
Mustard	10.5	10.5	10.5
Xanthan	9	9	9
Citric acid	0.9	0.9	0.9
Guar	2.7	2.7	2.7

Potassium sorbate	1.2	1.2	1.2
Sodium benzoate	1.2	1.2	1.2
Egg yolk	68.1	68.1	68.1
Vinegar	165.0	165.0	165.0
Water	1565.4	1550.4	1535.4
Oil	75	90	105
Starch L	0	0	0
Starch R			

2-3-Viscosity Measurement

The viscosity of mayonnaise was assessed utilizing the DV-π+ Pro viscometer manufactured by Brookfield Engineering Laboratories. To achieve this objective, a total of 500 grams of the sample were transferred into a 600 mL beaker. Subsequently, the viscosity of the samples was measured in pascal-seconds (centipoise) utilizing spindle number 7 at a rotational speed of 100 revolutions per minute (rpm) [13].

2-4- Measurement of pH and Acidity

The pH levels of the mayonnaise treatments were determined utilizing a pH meter, in accordance with the procedure outlined by the Iranian National Standard No. The temperature was recorded at 2454 Kelvin under ambient conditions. To assess the acidity of the treatments, the methodology delineated in Standard Number 2454 was utilized, and titration was conducted utilizing 0. 1 N sodium hydroxide.

2-4- Measurement of Emulsion Stability

To assess the physical stability of the mayonnaise emulsion, a sample weighing 15 grams was placed in a centrifuge tube with an inner diameter of 15 mm and a height of 125 mm. Subsequently, the tubes were subjected to centrifugation for a duration of 30 minutes at a rotational speed of 5000 revolutions per minute (rpm). The percentage of emulsion stability was determined utilizing the following equation [14]:

$$\text{Emulsion Stability } (\%) = \frac{\textit{The initial weight of the sample}}{\textit{Sample weight after oil separation}} \times ۱۰۰ \quad (۱)$$

2-5- Texture Analysis

The textural characteristics of the mayonnaise samples were assessed using a CT3 texture analysis system manufactured by Brookfield (USA). A cylindrical probe with a diameter of 57 mm and a load cell capacity of 4500 grams was employed in this study. It is essential to acknowledge that the instructions supplied by the

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manufacturing entity were adhered to in order to select the appropriate type of probe and to determine the other relevant parameters employed in the process. The probe exhibited a penetration speed of 1 mm/s, achieving a penetration depth of 30 mm into the sample. The present study examined tissue parameters, specifically focusing on tissue stiffness and adhesion [15].

2-6- Sensory Evaluation

A sensory evaluation of mayonnaise samples was performed utilizing a hedonic testing method based on a 5-point hedonic scale. In this scale, a score of 1 was designated as the lowest evaluation, while a score of 5 represented the highest assessment for each sensory attribute. The sensory attributes examined in this study encompassed taste, texture, coloration, and overall acceptability [16] .

2-7- Data Analysis

The experiments were executed utilizing a completely randomized design, comprising three repetitions for each condition. The results were subjected to a two-way analysis of variance (ANOVA) using SPSS software version 22 to assess the presence of significant differences among the data. To conduct a comparison of the mean values associated with the various treatments, Duncan's multiple range test was utilized, with a significance threshold set at 5% ($p < 0.05$) The graphs presented herein were generated utilizing Microsoft Excel software.

3- Results and Discussion

3-1- Viscosity of Mayonnaise

The findings regarding the variations in viscosity observed across various mayonnaise treatments throughout a six-month storage duration under refrigerated conditions are presented in Table 2. The viscosity of mayonnaise exhibited a significant dependence on both the formulation of the sauce, specifically the type of starch employed and the proportion of fat utilized, as well as the duration of storage ($p < 0.05$) The data presented in the table indicates a significant decrease in viscosity over the storage period, specifically from the initial day to the conclusion of the sixth month ($p < 0.05$) It was observed that an increase in fat content from 20% to 30% resulted in a significant enhancement in the viscosity of all tested samples. A comparative analysis of the produced samples infused with modified potato and corn starch demonstrated that, at equivalent concentrations, the formulations incorporating potato starch exhibited superior viscosity. Increasing the fat content in mayonnaise formulation from 20% to 30% contributes to the attainment of the requisite fat necessary for the formation of a stable oil-in-water emulsion. Moreover, the escalation in the quantity of fat and the proliferation of oil droplets resulting from agitation contribute to the viscosity of the emulsion. This phenomenon occurs through the establishment of a continuous structural framework and the formation of spatial barriers [17]. Furthermore, an increase in the concentration of modified starch resulted in elevated viscosity levels. This phenomenon can be attributed to the hydrophilic characteristics and water absorption capacity of these compounds. Upon the immersion of modified starches in water, a notable absorption of water occurs, resulting in an increase in their hydrodynamic volume. Hydrodynamic

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volume refers to the spatial extent occupied by an individual polymer molecule following its immersion in water and subsequent absorption of water. An increase in the volume occupied by the polymer corresponds to a pronounced influence on the rheological properties, as it is associated with a greater capacity for water retention [18], Consequently, an increase in the quantity of potato starch is expected to promote a greater hydrodynamic volume in comparison to corn starch. This enhancement is likely to result in an elevated viscosity of emulsions utilizing potato starch when contrasted with those employing corn starch. Conversely, the incorporation of higher quantities of modified starches into mayonnaise formulations enhances viscosity in the aqueous phase. This phenomenon can be attributed to the hydrophilic characteristics of modified starches, which facilitate the formation of hydrogen bonds with water molecules via their hydroxyl groups. This subsequently results in an enhancement of both the viscosity and the stability of the overall emulsion system [19]. The observed reduction in viscosity across various mayonnaise samples during the storage period is likely attributable to the concomitant decrease in pH and the increase in acidity levels. As the pH level decreases, the stability of the emulsion tends to decline, resulting in a concomitant reduction in viscosity [20]. Pishan et al., 2019 revealed that the incorporation of starch into a low-fat and low-calorie mayonnaise formulation resulted in an augmentation of the viscosity of the resulting samples [21]. Consistent with these findings, Wang et al., 2022 research indicated that the apparent viscosity of the samples exhibited an increase following the incorporation of modified corn starch (hydroxypropylated starch) into the formulation of low-fat mayonnaise [22] . The research conducted by Agyei-Amponsah et al., 2021 revealed an increase in the viscosity of low-fat mayonnaise following the incorporation of starch-based fat substitutes [23].

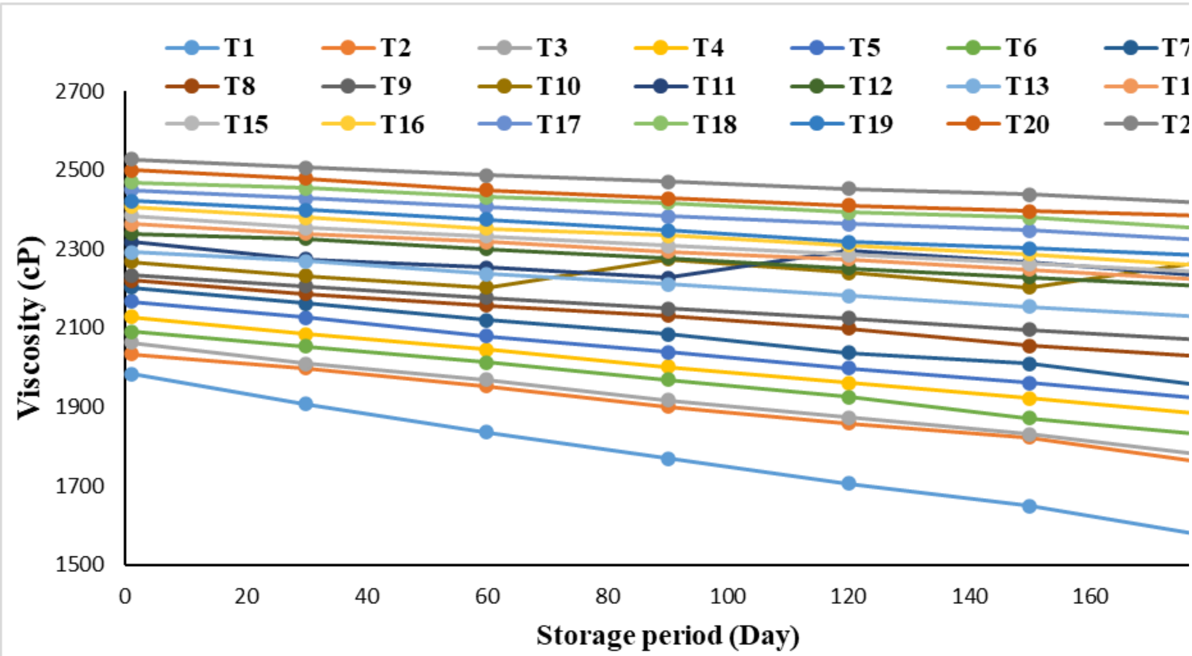

Fig 1. Changes in viscosity (cP) values of low-fat mayonnaise treatments during storage period

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3-2- pH and Acidity of Mayonnaise

The alterations in the mean values of pH and acidity across various mayonnaise treatments throughout the storage duration are presented in Tables 3 and 4, respectively. The findings indicate that on the initial day of observation, there were no statistically significant differences in pH and acidity among the samples ($p < 0.05$). The incorporation of higher proportions of both modified starches in the formulation of low-fat mayonnaise resulted in a significant increase in pH, accompanied by a notable decrease in acidity ($p < 0.05$). Nevertheless, the data indicated a significant decrease in pH levels and a corresponding increase in acidity with prolonged storage duration ($p < 0.05$). Furthermore, an analysis comparing the treatments that incorporated modified corn and potato starch throughout the storage period revealed that the formulations containing potato starch exhibited a statistically significant increase in pH and a corresponding decrease in acidity. The observed increase in total acidity and the concomitant decrease in pH during storage are likely attributable to the metabolic activity of lactic acid bacteria present in the aqueous phase of mayonnaise [24]. The observed elevation in acidity and concomitant reduction in pH may also result from the hydrolytic and oxidative activities of the enzymes present in the eggs utilized in the formulation of mayonnaise sauce [25]. In accordance with Iranian Standard No. According to the established standards, the minimum acidity level of mayonnaise must be 0. 6% when measured in terms of acetic acid percentage. The findings of this research indicated that the acidity levels of all treatments analyzed fell within the parameters established by the national standards of Iran, specifically ranging from 0. 61% to 01% It is probable that an increase in the concentration of starches will result in a decrease in the water activity of mayonnaise. Furthermore, the utilization of potato starch may prove to be more efficacious in diminishing water activity. As the water activity diminishes, the quantity of water accessible for the metabolic activities of lactic acid microorganisms, along with other microbial entities present in the sauce, correspondingly decreases. As a result of the diminished activity of these microorganisms, there will be a reduced production of acid, leading to a lesser alteration in acidity and pH levels when compared to treatments characterized by lower starch content [26]. Amiri *et al*., 2019 conducted a study to assess the impact of incorporating uncoated barley beta-glucan as a fat substitute on the physicochemical properties of low-fat mayonnaise. The findings of this study indicated that the incorporation of beta-glucan, along with an increase in its concentration, led to an elevation in pH levels and a reduction in acidity when compared to treatments involving lower quantities of beta-glucan. Conversely, extending the storage duration of various mayonnaise treatments resulted in an elevation of acidity levels, which subsequently led to a reduction in the pH of the products [13]. An increased pH in low-fat mayonnaise resulting from the incorporation of native sago, tapioca, and corn starches was evidenced in the research conducted by Paramitasari *et al*., 2024, aligning with the findings of the current study. Hakimian et al., 2022 observed a reduction in pH and an increase in acidity of mayonnaise sauce over the course of the storage period [28].

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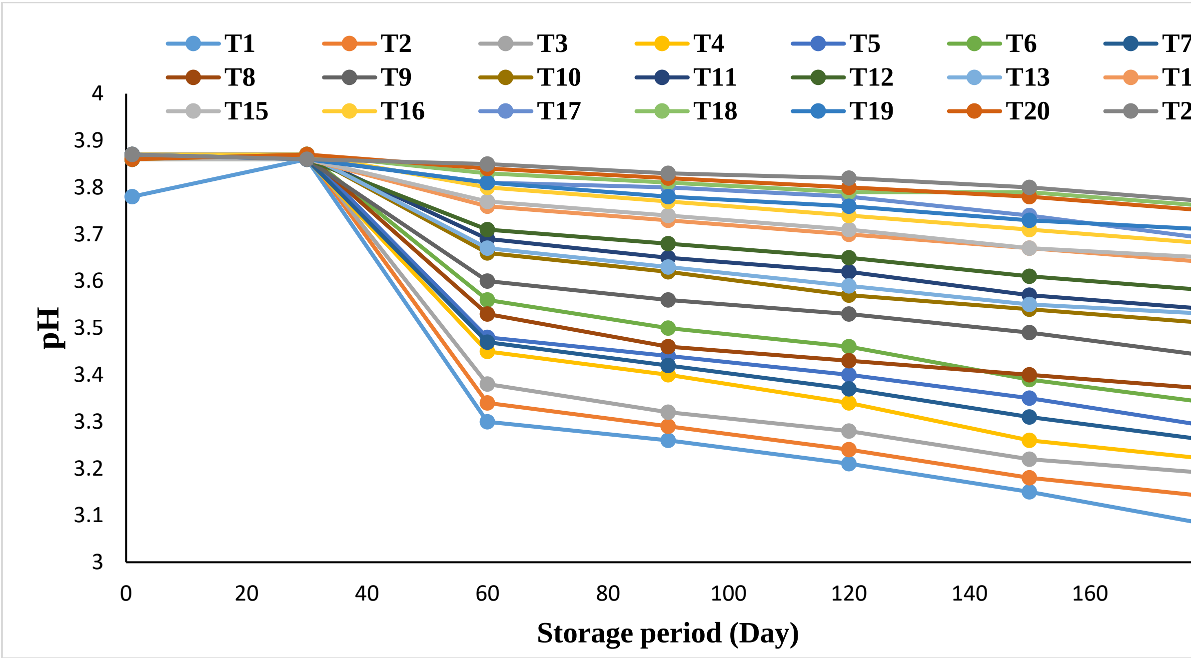

Fig 2. Changes in pH values of low-fat mayonnaise treatments during storage period

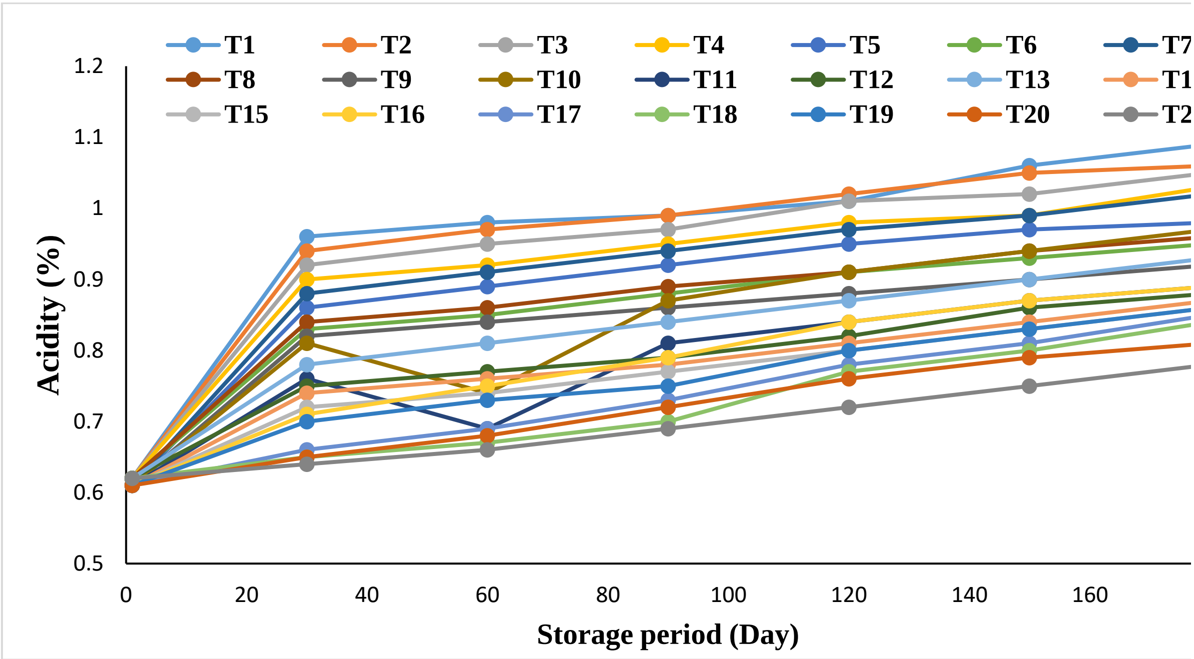

Fig 3. Changes in acidity (%) values of low-fat mayonnaise treatments during storage period

3-3- Emulsion Stability of Mayonnaise

A stable emulsion is typically characterized by the absence of coalescence, flocculation, and creaming processes. The phenomenon of creaming is observed less frequently in high-fat mayonnaise samples characterized by elevated oil content (80%). This reduced incidence can be attributed to the close interactions between oil droplets, which generate significant friction. Such friction

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serves as a deterrent to the creaming process. This phenomenon is predominantly observed in low-fat formulations, such as low-fat mayonnaise. However, it can be mitigated through the incorporation of thickening agents and appropriate fat substitutes, including xanthan gum and modified starch [13]. The evaluation of the stability of emulsion-treated mayonnaise sauce (refer to Table 5) indicates that variations in stability across different treatments are significantly influenced by the sauce formulation, specifically the type of starch utilized and the quantity of fat incorporated, as well as the duration of storage ($p < 0.05$) The findings of this research indicate a significant reduction in stability correlated with increased storage time, as evidenced by a p-value of less than 0. 05 Furthermore, the augmentation of fat and modified starch content within the formulation of mayonnaise sauces resulted in a statistically significant enhancement of sample stability ($p < 0.05$). A comparative analysis of treatments incorporating corn and potato starch indicates that mayonnaise samples formulated with corn starch exhibit significantly lower stability than those formulated with potato starch, with a statistical significance of $p < 0.05$ The stability results exhibited a direct correlation with the viscosity findings, and these results demonstrated internal consistency. The enhanced stability observed in treatments containing elevated concentrations of fats, modified starches, and, in particular, modified potato starch can likely be attributed to the increased viscosity associated with these formulations. The incorporation of fat substitutes in the formulation of mayonnaise may mitigate the occurrences of coalescence, flocculation, and creaming. This phenomenon may be ascribed to the elevated viscosity of this sample relative to others, which can be attributed to the incorporation of a stabilizer [29]. The findings of this study were consistent with the results reported by other researchers in the field. Nikzade et al., 2012 conducted an investigation into the physical properties of low-fat mayonnaise formulated with soy milk and a variety of stabilizers. The findings of the researchers indicated that the incorporation of various stabilizers significantly enhanced the stability, consistency, and viscosity of the final product. This fortification effectively inhibited the phase separation and preserved the creaminess characteristic of low-fat mayonnaise 15. In the study conducted by Werlang et al., 2021 , it was demonstrated that low-fat mayonnaise formulated with corn starches displayed superior emulsion stability in comparison to the control mayonnaise [30]. Park et al., 2020 demonstrated that low-fat mayonnaises formulated with arrowroot starches exhibited greater emulsion stability in comparison to the control group. These results are also in alignment with the findings reported by Pishan et al., 2019.

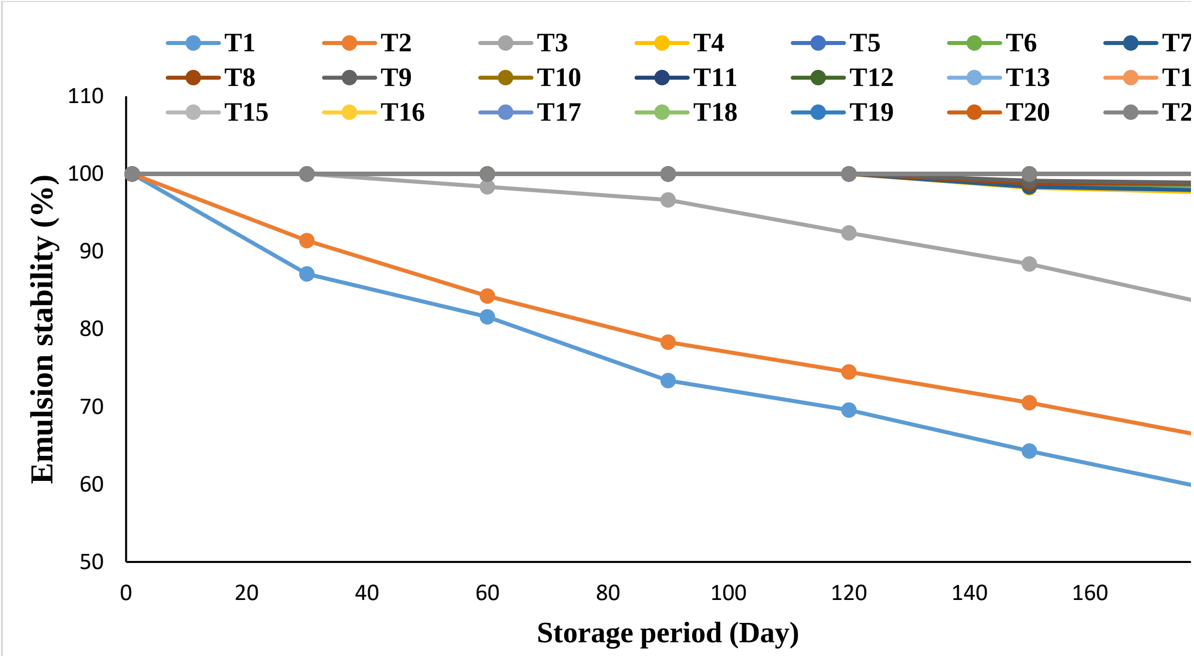

Fig 4. Changes in emulsion stability (%) values of low-fat mayonnaise treatments during storage period

3-4- Textural Properties of Mayonnaise.

Mayonnaise is classified as a food emulsion, a characteristic that leads consumers to anticipate a comparatively viscous texture. The observed thickness of the mayonnaise is attributable to the significant concentration of oil present in its formulation. In the event that a portion of the oil is extracted, it is imperative to give careful consideration to the appropriate textural qualities of this low-calorie product when selecting a fat substitute [16]. Figure 6 illustrates the variations in the average values of stiffness and adhesion of mayonnaise treatments throughout the storage period. The findings suggest that the incorporation of modified fats and starches in mayonnaise formulations resulted in a statistically significant enhancement of both stiffness and adhesion indices ($p < 0.05$) Conversely, an increase in storage duration was associated with a significant reduction in both stiffness and adhesion ($p < 0.05$). The stiffness and adhesion indices exhibit a direct correlation [32]. Wang et al., 2022 research indicated a notable decrease in both the stiffness and stickiness of control and starch-based mayonnaises over the course of the storage period [33]. The augmentation of fat content and the incorporation of modified starch resulted in an increase in textural indices. This phenomenon can be attributed to the elevated viscosity associated with these treatments, which is likely induced by the addition of modified starches. The presence of hydrocolloid compounds appears to facilitate the formation of a gel-like structure, which effectively entraps oil droplets and diminishes their mobility. This phenomenon subsequently results in an increase in viscosity, thereby enhancing the textural characteristics of the mixture [34]. Notably, as previously documented, an extension of the storage duration resulted in a reduction in the viscosity of the mayonnaise samples. This reduction is likely to contribute to a decrease in the quantitative measures of textural properties as storage time increases. The results obtained in this study align with the findings reported by other researchers in the field. Agyei-Amponsah et al., 2021

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documented an increase in both the viscosity and adhesive properties of low-fat mayonnaise following the incorporation of starch-based fat substitutes, this finding corroborates the results obtained in the current study.

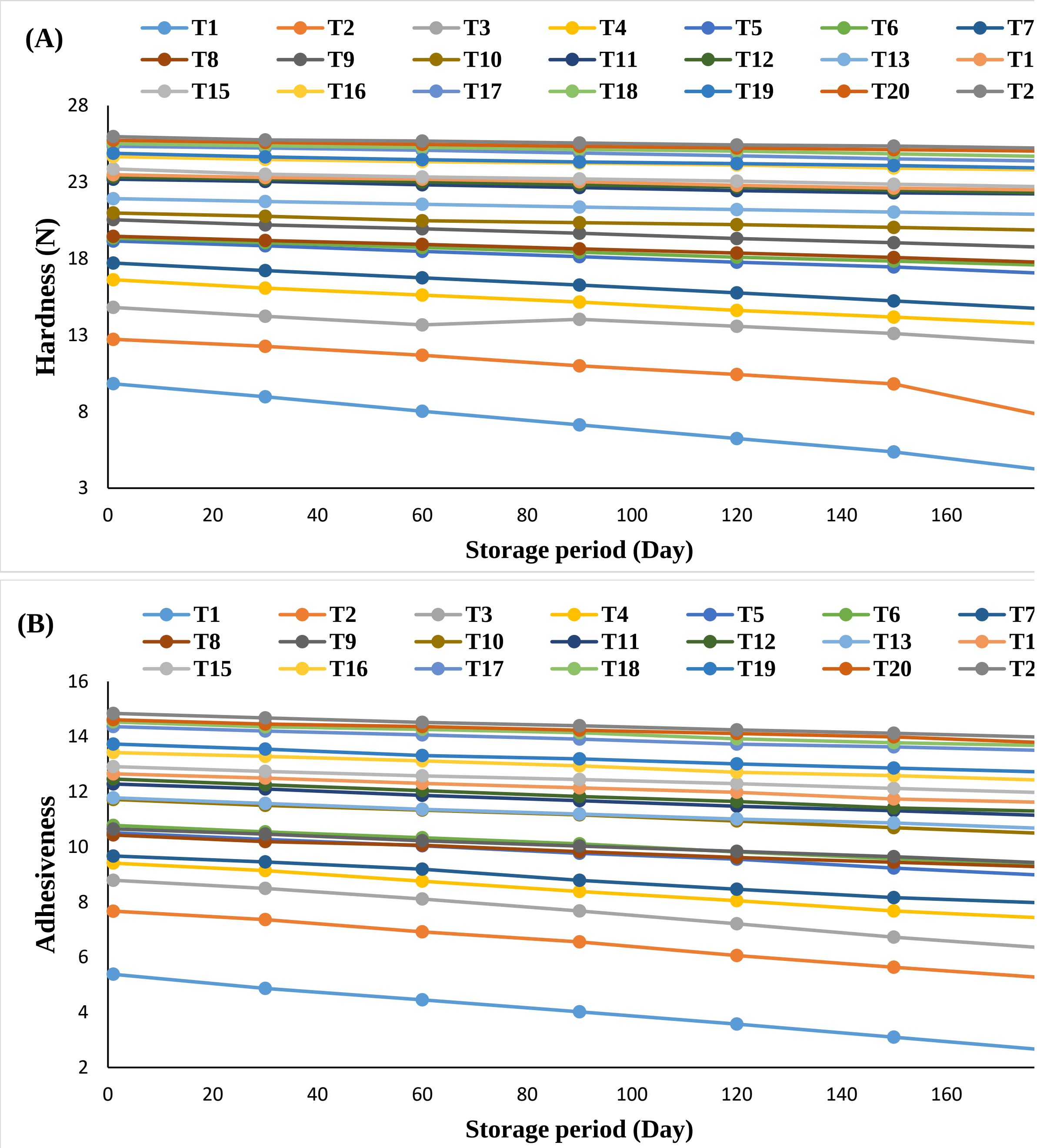

Fig 5. Changes in (A) Hardness (N) and (B) adhesiveness values of low-fat mayonnaise treatments during storage period

3-5- Sensory Evaluation of Mayonnaise

Figure 6 presents a comparative analysis of the sensory scores associated with various mayonnaise treatments. The findings demonstrated that treatments possessing elevated fat content and incorporating modified starches exhibited significantly higher sensory scores in comparison to alternative treatments ($p < 0.05$) The treatment designated as 21 exhibited the

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highest overall acceptance rate, with its scores for all sensory characteristics significantly surpassing those of other treatments ($p < 0.05$) Furthermore, the sensory evaluation of the treatments incorporating modified potato starch demonstrated superior performance relative to those utilizing modified corn starch. This phenomenon can be attributed to the observed enhancement in sensory scores, which correlates with the increased levels of fat and modified starches that influence the physical and textural characteristics of the products. Consequently, as articulated, an increase in the fat content of low-fat mayonnaise sauces, in conjunction with a rise in the concentration of modified starches, significantly contributes to improvements in viscosity, stability, and textural firmness. The augmentation of these factors consequently enhances the sensory indicator scores, which, in turn, elevates the overall acceptance score. Moreover, an analysis of the textural and physical properties of the formulations prepared with modified potato starch revealed these characteristics to be markedly superior to those of the formulations utilizing corn starch. Consequently, the sensory evaluations of the treatments incorporating modified potato starch yielded higher scores compared to those composed of modified corn starch.

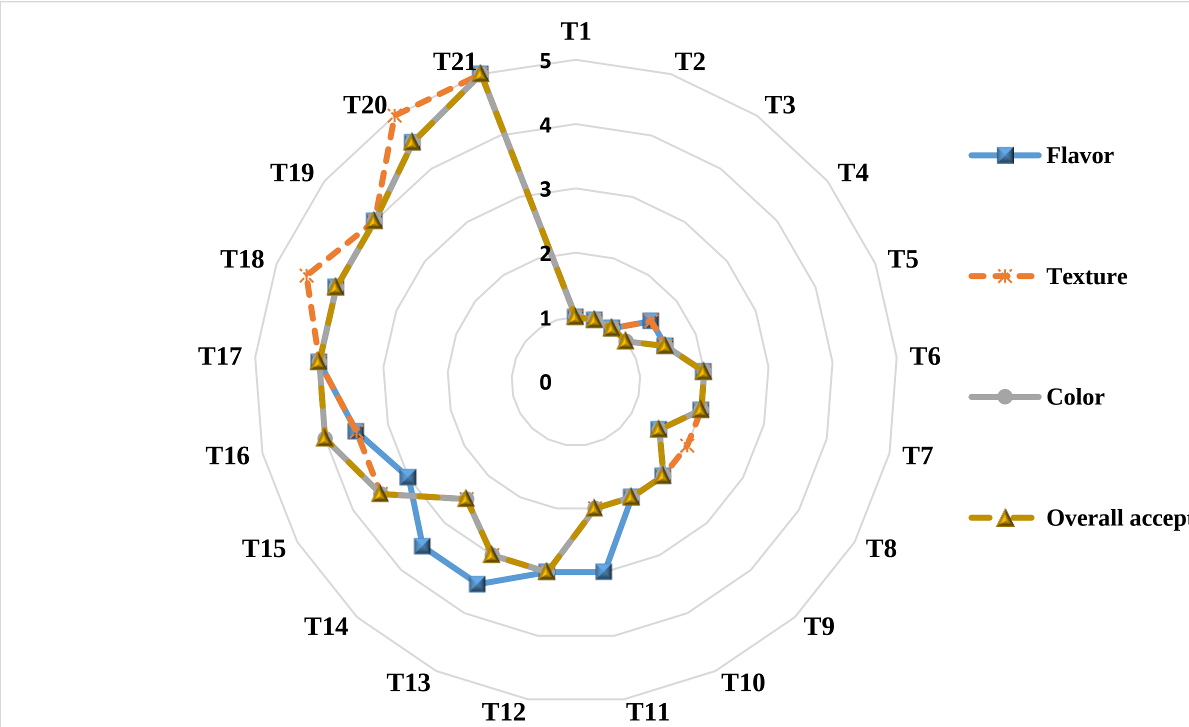

Fig.6. Sensory properties of low-fat mayonnaise treatments

4- Conclusion

The findings of this study indicate that the incorporation of modified starches, along with an increased fat content in the formulation of low-fat mayonnaise sauces, significantly improved the viscosity of the final product. The incorporation of modified starches demonstrated efficacy in mitigating drastic fluctuations in pH and acidity, while concurrently preserving the creaminess of mayonnaise over an extended duration. The incorporation of modified starches in the formulation of low-fat mayonnaise sauces yielded products

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characterized by enhanced firmness and increased stickiness in texture. The incorporation of modified starches in the formulation of low-fat mayonnaise sauces significantly enhanced the sensory attributes across all parameters assessed. Notably, the low-fat formulation comprising 30% fat and 3. 5% modified potato starch demonstrated the highest overall acceptability when compared to the alternative treatments. The findings of this investigation suggest that the incorporation of modified potato starch, specifically at a concentration of 3. 5% alongside 30% oil, can be employed to formulate low-fat mayonnaise that exhibits superior quality and sensory attributes.

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چکیده

به دلیل تأثیر نامطلوب چربی بر سلامت مصرف‌کنندگان و ارتباط آن با بیماری‌های قلبی–عروقی، چاقی و غیره، امروزه تلاش‌های بسیاری برای تولید محصولات غذایی کم‌چرب در حال انجام است. هدف از این مطالعه ارزیابی تولید سس مایونز کم چرب (۲۰، ۲۵ و ۳۰ درصد روغن) به وسیله نشاسته‌های اصلاح شده سیب‌زمینی و ذرت با سطوح ۲/۵، ۳ و ۳/۵ درصد و تأثیر نسبی آن‌ها بر ویسکوزیته، pH، اسیدیته، پایداری و خصوصیات فیزیکی به مدت ٦ ماه نگهداری و همچنین خصوصیات حسی بود. نتایج نشان داد که بکارگیری هر دو نشاسته و افزایش سطح چربی به‌طور معنی‌داری مقادیر pH، ویسکوزیته، پایداری امولسیون، سفتی بافت و چسبندگی مایونزها را افزایش داد، ولی موجب کاهش اسیدیته نمونه‌ها گردید. طی دوره انبارمانی در دمای یخچال، کاهش در میزان ویسکوزیته، pH، سفتی و چسبندگی بافت و افزایش در اسیدیته و خامه‌ای شدن تیمارهای سس مایونز مشاهده گردید ($p<۰/۰۵$). نتایج ارزیابی حسی نشان داد که افزایش سطح نشاسته‌ها و چربی به‌طور معنی‌داری منجر به افزایش امتیاز پارامترهای حسی شد ($p<۰/۰۵$). بالاترین پذیرش حسی مربوط به مایونز کم‌چرب با ۳۰ درصد چربی و حاوی ۳/۵ درصد نشاسته اصلاح شده سیب‌زمینی بود. نتایج این مطالعه نشان داد که تیمارهای کم‌چرب با نشاسته اصلاح شده سیب‌زمینی دارای خصوصیات کیفی بهتری در مقایسه با نمونه‌های حاوی نشاسته ذرت بودند. به‌طور کلی می‌توان نتیجه گرفت که استفاده از ۳۰ درصد چربی و ۳/۵ درصد نشاسته اصلاح شده سیب زمینی به عنوان جایگزین چربی منجر به خصوصیات فیزیکوشیمیایی و حسی مطلوب در سس مایونز می‌شوند.