STUDY ON EMULSION STABILITY WITH EGG YOLK IN TONED MILK DRINK

A PROJECT REPORT

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APPROVAL

This Project titled **"Study on Emulsion Stability with Egg Yolk in Toned Milk Drink",** submitted by **Md. Atikur Rahman Sawon** to the Department of Nutrition and Food Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Nutrition and Food Engineering and approved as to its style and contents.

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We hereby declare that this project has been done by us under the supervision of **Dr. Nizam Uddin, Associate Professor and Head, Department of** Nutrition and Food Engineering, Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

This study examines the effect of different egg yolk concentrations (0–5%) on the emulsion stability and sensory characteristics of a toned milk beverage. Emulsion stability was assessed by viscosity measurements, creaming index (CI) analysis, and sensory evaluation involving 40 experienced panelists. A strong correlation was noticed between egg yolk concentration and viscosity (R^2 = 0.885), demonstrating the substantial emulsifying properties of egg yolk in improving the beverage's stability. Sensory assessment indicated that flavor attained the greatest mean score (μ = 8.07, SD = 0.768), whilst odor obtained the lowest score (μ= 6.65, SD = 0.860). CI research revealed less phase separation with escalating egg yolk percentages, underscoring its capacity to preserve homogeneity over time. The research concludes with the creation of a prediction algorithm that determines ideal egg yolk concentrations to improve physical stability and sensory appeal. This study enhances the optimization of emulsified dairy beverages, providing insights for higher quality and user pleasure.

Keywords: Emulsion Stability, Egg Yolk Concentration, Viscosity Analysis, Creaming Index (CI), Sensory Evaluation, Predictive Model.

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CHAPTER 1

INTRODUCTION

1.1. Introduction

Emulsified beverages form a vital part of the global food and beverage market due to their unique functional and sensory characteristics. These drinks, which depend on the dispersion of immiscible liquids stabilized by emulsifiers, are widely recognized for their capacity to amalgamate various ingredients into a cohesive and delicious product. The stability of such emulsions is vital for their shelf life, customer acceptance, and general quality. Viscosity, resistance to phase separation, and droplet size distribution are critical factors affecting stability, and their optimization is a primary study focus in food production science (McClements, 2015).

Egg yolk has historically served as a natural emulsifier owing to its abundant phospholipids and proteins. These components function synergistically to diminish interfacial tension and stabilize scattered droplets, hence preventing coalescence and phase separation. Despite substantial research on the emulsifying capabilities of egg yolk in high-fat emulsions like mayonnaise and dressings, its utilization in low-fat dairy systems, such as toned milk beverages, is still inadequately investigated (Damodaran et al., 2017).

Toned milk, a fundamental component of numerous South Asian cuisines, especially in Bangladesh, is a low-fat milk alternative that provides nutritional advantages without the caloric richness of full-cream milk. The rising demand for value-added dairy products offers a distinctive opportunity to innovate by utilizing toned milk as a foundation for emulsified beverages. Combining toned milk with natural emulsifiers like egg yolk has the ability to enhance both the physicochemical stability and sensory appeal of such compositions (Lawless & Heymann, 2010).

Globally, the market for functional and nutritional beverages is increasing fast, driven by customer desire for health-oriented and convenient dietary options. In Bangladesh, dairy-based beverages are gaining attraction, with an increasing interest in creative formulations that suit to local consumer preferences and tastes. Despite it, the development of emulsified beverages that use locally available materials like egg yolk and toned milk remains a comparatively underdeveloped field of research.

The current study shows the difficulty in making stable emulsions in low-fat goods, with limited studies evaluating the mix of sensory assessment and physicochemical evaluations. The correlation between egg yolk concentration and stability factors such as viscosity, sensory characteristics and creaming index has not been properly explored in toned milk emulsions. This study seeks to address these gaps by building a predictive model for emulsion stability and sensory acceptance, delivering actionable information for product development.

The outcomes of this study will not only aid to the scientific understanding of emulsified processes but also give practical answers for the dairy sector. By establishing the appropriate egg yolk concentration for stability and acceptability, this study hopes to allow

the creation of high-quality emulsified beverages that meet customer tastes while leveraging locally accessible ingredients.

1.2 Objectives

1.2.1. Primary Objectives

To examine the influence of various egg yolk concentrations on the emulsion stability of toned milk drinks.

1.2.2. Specific Objectives

- To analyze the sensory qualities of toned milk-based emulsions using a 9-point hedonic scale.
- To establish correlations between egg yolk concentration and important stability criteria (viscosity, creaming index, and sensory ratings).
- To discover the optimum acceptable egg yolk concentration for consumer choice and industrial use.

CHAPTER 2

LITERATURE REVIEW

Emulsified beverages are an essential part of the food and beverage business, known for their textural richness, sensory appeal, and storage durability. These drinks, which depend on the uniform dispersion of immiscible liquids like water and oil, encounter issues relating to creaming, phase separation, and sedimentation during storage. A prominent priority in food science study has been the optimization of emulsifiers, stabilizers, and formulation processes to assure both physical stability and customer acceptance (McClements, 2015).

Egg yolk, as a natural emulsifier, has gained great attention for its double function includes stabilizer and a sensory enhancer in dairy-based processes. Its phospholipid and protein content, particularly lecithin, aids droplet dispersion by lowering interfacial tension and improving the cohesiveness of dispersed droplets (Damodaran et al., 2017). This review analyzes the impact of egg yolk and similar emulsifying ingredients on emulsion stability and sensory performance, building on data from recent studies.

2.1. Egg Yolk as an Emulsifier

The beneficial qualities of egg yolk as a natural emulsifier comes from its biochemical structure. Lecithin, the major phospholipid in egg yolk, is particularly effective in oil-in-water emulsions. Studies have proven that lecithin molecules align at the interface of oil in water, lowering surface tension while providing a steady contact that avoids coalescence. Proteins in egg yolk further contribute to stability by creating a network that protects the dispersed phase (McClements, 2015).

Xiao and his team emphasized the stabilizing characteristics of egg yolk in milk-based drinks, demonstrating significant enhancements in viscosity and overall sensory acceptance. They observed that increasing egg yolk concentrations lowered droplet size and phase separation, hence boosting the homogeneity of emulsions (Xiao et al., 2019). This coincides with the findings of the current investigation, where viscosity rose linearly with egg yolk content, indicating greater emulsifying effectiveness.

2.2. Viscosity and Stability

The physical stability of emulsions is commonly examined by metrics such as viscosity, droplet size distribution, and creaming index (CI). Higher viscosity not only lowers the mobility of dispersed droplets but also slows phase separation, adding to product uniformity and prolonged shelf life (Lawless & Heymann, 2010). Chen and his team examined the function of lecithin in lowering interfacial tension in oil-in-water emulsions and discovered that greater emulsifier concentrations considerably increased viscosity. Their findings support the pattern found in this investigation, where a clear association was established between egg yolk levels and viscosity (Chen et al., 2020).

Yadav and his team investigated egg yolk and other natural emulsifiers in dairy products. Their study demonstrated how proteins and phospholipids work together to maintain droplet dispersion and inhibit coalescence (Yadav et al., 2018). Additionally, the study

showed that natural emulsifiers stabilized dairy emulsions just as well as synthetic equivalents, highlighting their potential for clean-label food items.

2.3. Creaming Index and Phase Separation

Creaming Index analysis is an important measure to assess the long-term stability of emulsions. Lower CI values indicate higher stability, as the cream layer produced during storage is decreased. Study demonstrates that natural emulsifiers like egg yolk are particularly efficient in decreasing CI. The current work indicates a steady drop in CI with increasing egg yolk concentrations, indicating its involvement in lowering phase separation over time.

Yadav and his team also observed comparable patterns, stressing the potential of egg yolk to preserve homogeneity in dairy beverages. Their investigation demonstrated that emulsions with higher egg yolk contents had lower CI values considerably, even after extended storage periods (Yadav et al., 2018). This conclusion is repeated in (Chen et al., 2020), where lecithin-based systems displayed greater phase stability.

2.4. Sensory Attributes and Consumer Acceptance

Sensory evaluation bridges the gap between product formulation and consumer preferences. Attributes such as flavor, texture, and appearance are critical determinants of consumer acceptance. Stone and Sidel emphasized the importance of sensory testing in correlating formulation changes with market success (Stone and Sidel, 2004).

The findings of Xiao and his team illustrate how egg yolk concentration influences sensory perception in milk-based beverages. Greater amount of concentrations increased sensation like mouthfeel and flavor, keeping with consumer preference for smooth and creamy textures. However, the research showed decreasing benefits above a specific concentration, when high emulsifier levels severely impacted flavor and scent (Xiao et al., 2019).

Li and his team examined the role of predictive modeling in improving sensory characteristics. Their study stressed the importance of finding ideal emulsifier concentrations to achieve a balance between physical stability and sensory appeal. This fits with the predictive model established in the current study, which provides a quantitative method for finding ideal egg yolk amounts (Li et al., 2021).

2.5. Predictive Modeling for Optimization

The merging of sensory and physicochemical data into prediction models gives useful insights for food product creation. Predictive modeling allows researchers to establish links between key factors, such as emulsifier concentration and stability parameters, simplifying the optimization process.

Li and his team showed the usefulness of regression models in correlating emulsifier levels with viscosity, CI, and sensory characteristics. Their results showed the value of such models in reducing trial-and-error experimentation, eventually improving formulation efficiency (Li et al., 2021). The current work builds on this method, presenting a regression

model that predicts viscosity based on egg yolk concentration. The model's high R^2 value (0.885) underlines its reliability in leading formulation choices.

2.6. Comparative Analysis

A comparison review of related studies shows stable trends in the role of egg yolk and similar emulsifiers in stabilizing dairy-based emulsions. Xiao with his team and Yadav with his team both underline the dual benefits of egg yolk in increasing viscosity and sensory performance (Xiao et al., 2019; Yadav et al., 2018). Chen and his team corroborate the relevance of lecithin in lowering interfacial tension (Chen et al., 2020), whereas Li and his team emphasizes the potential of predictive modeling in improving emulsion systems (Li et al., 2021).

The literature concludes by highlighting the function of egg yolk as a natural emulsifier, which improves emulsion stability and sensory appeal. There are still gaps in the thorough integration of sensory assessments with stability parameters, despite works like Xiao with his team and Yadav with his team highlighting its influence on viscosity and homogeneity (Xiao et al., 2019; Yadav et al., 2018) and Li with his team advancing predictive modeling methodologies (Li et al., 2021). By fusing sensory research with predictive modeling, this study fills these gaps and provides a quantitative foundation for improving egg yolk-based dairy beverage compositions.

CHAPTER 3

MATERIALS AND METHODS

3.1. Materials

The ingredients were procured from the local market Baipail Bazar, Baipail, Savar, Dhaka, while the chemicals used for analysis were sourced from the Nutrition and Food Engineering Laboratory, Room No. 307.

- Toned Milk (2% fat)
- Egg yolk (separated from fresh eggs)
- Carrot juice
- Icing Sugar
- Salt
- Cardamom powder
- Flavoring agents
- Mixer
- Gas Stove
- Homogenizer
- Rotational Viscometer

3.1.1. Formulation

The composition of the toned milk beverage (as specified in Table 01) comprises 375 ml of toned milk (2% fat), 100 ml of carrot juice, 23.5 g of sugar, 0.35 g of salt, 1 g of cardamom powder, and several drops of vanilla flavor, resulting in a total volume of 500 ml of the finished product. The primary variable in this formulation is egg yolk, included at concentrations between 0% and 5% of the whole formulation, with precise weights for each sample being 0, 5, 10, 15, 20, and 25 grams. This variant seeks to examine the effect of egg yolk content on the stability of the emulsion and the sensory characteristics of the beverage.

Table 01: Formulation of toned milk drink

Ingredients	Percentage
Toned Milk (2% fat)	375 ml
Carrot juice	100 ml
Sugar	23.5 gm
Salt	0.35 gm
Cardamom powder	1 gm
Vanilla Flavor	Few drops
Egg yolk (separated from fresh eggs)	For each sample: 0, 5, 10, 15, 20, 25 gm

3.2 Sample Preparation

To prepare the six samples of the toned milk beverage, a structured process was followed, as illustrated in Figure 1. First, toned milk (2%) was boiled for 30 seconds and cooled to room temperature. The cooled milk was mixed with carrot juice, sugar, salt, cardamom powder, and vanilla essence to form the base mixture. This mixture was homogenized at 10,000 rpm for 2 minutes to ensure uniform blending. Egg yolk was then added at varying concentrations (0%, 1%, 2%, 3%, 4%, and 5% by weight) to the respective samples. The egg yolk-enriched samples were further homogenized to promote consistent emulsion formation. The samples underwent heat treatment by heating them to 90°C with continuous stirring for 2 minutes to enhance stability and pasteurization. Finally, the samples were cooled to room temperature and transferred into sterilized bottles for storage and analysis.

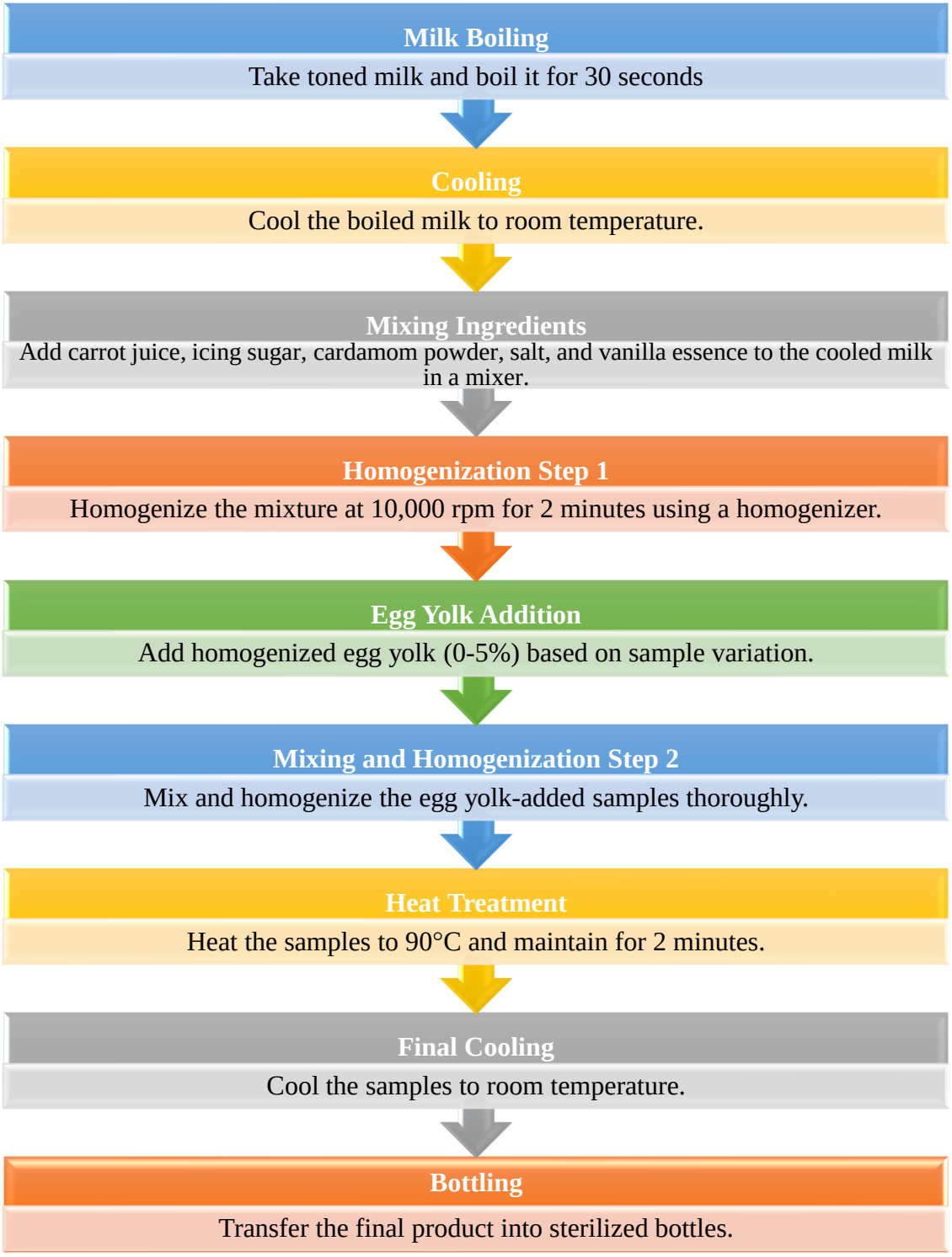

Figure 01: Flowchart of the preparation process for toned milk beverage samples with varying egg yolk concentrations.

3.3. Viscosity Measurement

Viscosity was measured using a rotational viscometer (Figure 2: IKA Viscometer—ROTAVISC lo-vi) at 26°C (McClements, 2015; Singh et al., 2020). . The measurements were performed using spindle 1 (SP-1) at 200 rpm. The viscosity measurements (in mPa.s) were recorded for each sample and compared among egg yolk concentrations.

	
Figure 02: One of the finished samples.	**Figure 03: IKA Viscometer - ROTAVISC lo-vi for Viscosity measurement.**

3.4. Creaming Index Measurement

The creaming index was obtained by visually evaluating the separation of the cream layer with time. The samples were left undisturbed in a 10 cm tall graduated cylinder for 72 hours, and the height of the cream layer was recorded at 6, 12, 24, 48, and 72 hours. The creaming index (CI) was derived using the following equation (Lawless & Heymann, 2010; McClements, 2015; Yadav et al. 2018):

$$CI\ (\%) = (\text{Height of Cream Layer} / \text{Total Height of Emulsion}) \times 100$$

3.5. Sensory Measurements

Sensory evaluation was performed to determine the acceptability of six samples of the toned milk drink produced with different egg yolk concentrations (0%, 1%, 2%, 3%, 4%, and 5%). Total 40 experienced panelists took part in the evaluation. Each sample received an assessment for seven sensory attributes: texture, flavor, odor, color, taste, appearance, and overall acceptance. The evaluation employed a 9-point hedonic scale, where 1 indicated "dislike extremely" and 9 represented "like extremely." The mean scores for each sensory attribute were calculated to determine panelist preferences and the overall impact of egg yolk concentration on the sensory properties of the samples. Sensory evaluation is an essential tool in food product development, helping correlate consumer preferences with formulation adjustments (Stone & Sidel, 2004; Lawless & Heymann, 2010; Xiao et al. 2019)

CHAPTER 4

RESULTS AND DISCUSSION

4.1. Viscosity Analysis

Viscosity, a key indicator of emulsion stability, was tested for each sample to examine the effect of egg yolk concentration (Lawless & Heymann, 2010; Chen et al. 2020). The findings, reported in Table 2 and Figure 3, reveal a linear rise in viscosity with increased egg yolk contents.

Table 02: Viscosity Values of Emulsions at Different Egg Yolk Concentrations

Egg Yolk (%)	Viscosity (mPa.s)
0	6.84
1	7.29
2	7.58
3	7.49
4	7.65
5	7.77

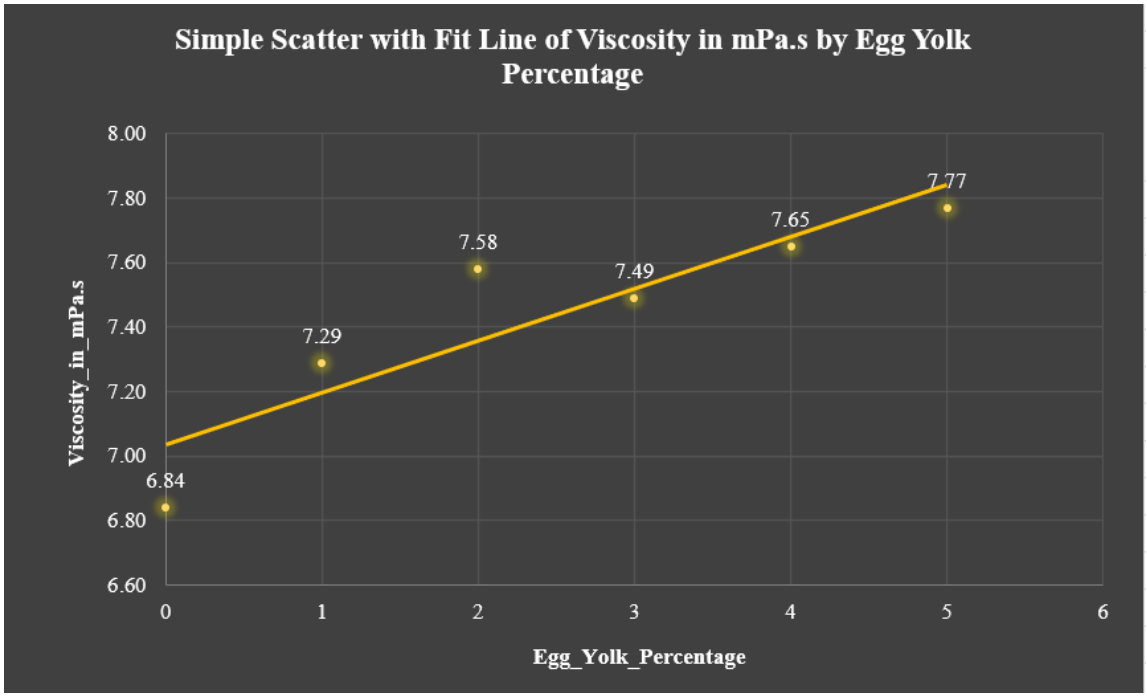

Figure 04: Simple Scatter Plot with Fit Line of Viscosity vs. Egg Yolk Concentration

The rise in viscosity with egg yolk concentration represents its emulsifying potential, contributing to thicker and more stable emulsions. The high positive correlation ($r = 0.903$, $p = 0.014$) between egg yolk and viscosity emphasizes its stabilizing effect. The minor drop at 3% concentration may suggest process-related irregularities during emulsification.

4.2. Creaming Index Analysis

Creaming Index (CI) values were assessed at various intervals (6, 12, 24, 48, and 72 hours) to assess phase separation in the emulsions. Lower CI values indicate better stability. Table 3 demonstrates the CI results in line graph, indicating a steady decrease in phase separation

with increasing egg yolk concentration. The most stable emulsion (5% egg yolk) had the lowest CI at all time points.

Table 03: CI Results Across Samples and Time Points

Egg Yolk (%)	CI at 6 Hours (%)	CI at 12 Hours (%)	CI at 24 Hours (%)	CI at 48 Hours (%)	CI at 72 Hours (%)
0%	0	10.0	15.0	20.0	30.0
1%	0	8.0	10.0	14.0	18.0
2%	0	6.0	8.0	11.0	15.0
3%	0	5.0	7.0	9.0	12.0
4%	0	4.0	6.0	8.0	10.0
5%	0	2.0	5.0	7.0	8.0

The data indicates a consistent trend of decreasing CI with increasing egg yolk percentages, indicating its efficacy in minimizing phase separation. The regression analysis indicated a strong inverse connection between CI and egg yolk levels ($p < 0.05$).

4.3. Sensory Analysis

Sensory evaluation was performed on six samples (0 to 5% egg yolk concentrations) to analyze the impact of egg yolk on sensory qualities, including appearance, flavor, texture, color, odor, taste, and overall acceptance. Each characteristic was scored on a 9-point hedonic scale by 40 experienced sensory panelists. Table 4 presents the mean sensory scores for all qualities across the samples. Flavor obtained the greatest mean score (μ = 8.07, SD = 0.768), showing strong panelist preference; however, odor received the lowest score (μ = 6.65, SD = 0.860). This shows that while the formulation was largely satisfactory, adjustments in scent may enhance overall consumer happiness.

Table 04: Mean Sensory Scores for Attributes Across Samples

Sensory Attribute	N	Minimum	Maximum	Mean (μ)	Std. Deviation
Appearance	240	6	9	7.59	0.863
Color	240	5	9	7.34	1.171
Flavor	240	6	9	8.07	0.768
Texture	240	5	9	7.73	0.945
Odor	240	5	8	6.65	0.860
Taste	240	6	9	7.99	0.906
Overall Acceptance	240	5	9	7.82	0.998

Sensory qualities, particularly look and feel, improved with increasing egg yolk concentrations, coinciding with the reported physical stability enhancements. This fits with prior research demonstrating that emulsifiers such as egg yolk contribute to enhanced consistency and mouthfeel in emulsified systems (McClements, 2015). Finally, the sample 4 which contains 3% of egg yolk is more preferred emulsified toned milk drink by the panelists.

4.4. Integrated Analysis: Development of Predictive Model

To create a predictive model for emulsion stability, regression analysis was performed with the percentage of egg yolks as a critical predictor. Viscosity was selected as a crucial characteristic for stability due to its direct impact on the emulsion's resistance to phase separation (Damodaran et al., 2017). The regression model indicates a great predictive capacity for viscosity, with an R-value of 0.941, showing a substantial positive correlation between the predictors and viscosity. The model represents 88.5% of the variability in viscosity ($R^2 = 0.885$). Statistical examination via ANOVA validates the model's significance ($F = 11.593$, $p = 0.039$). Notably, egg yolk content plays a vital role in affecting viscosity, as indicated by its strong β coefficient ($\beta = 0.833$, $p = 0.026$), emphasizing its significant contribution to emulsion stability. The regression equation for viscosity (mPa.s) based on egg yolk percentage is:

$$\textbf{Viscosity (mPa.s)} = 6.298 + (0.149 \times \textbf{Egg Yolk (\%)})$$

This simplified model ignores sensory variables like overall acceptance due to their lack of statistical significance ($p > 0.05$). The regression model suggests that the value of the intercept is 6.298 mPa.s, reflecting the viscosity when egg yolk percentage and overall acceptance are zero. Egg yolk significantly impacts viscosity ($p = 0.026$), raising it by 0.149 mPa.s for each 1% increase in concentration. The results confirm the role of egg yolk as a natural emulsifier, with rising concentrations leading to higher viscosity and improved stability. The negative correlation between viscosity and CI underlines the emulsifying efficacy of egg yolk in reducing phase separation, thereby boosting stability. While sensory qualities like overall acceptance correlate positively with egg yolk content ($r = 0.255$), they are not significant predictors of viscosity.

4.5. Discussion

This study thoroughly investigated the impact of different egg yolk concentrations on the stability and sensory attributes of toned milk emulsions. The results correspond with and substantially enhance the current understanding of emulsified systems, particularly with dairy-based drinks. The following discussion synthesizes essential findings from the experimental data, juxtaposes them with current literature, and examines their practical ramifications.

The linear rise in viscosity with increasing egg yolk concentrations highlights the emulsifying efficacy of egg yolk in stabilizing dairy emulsions. The established association between viscosity and egg yolk concentration, shown by an R-value of 0.903, aligns with McClements' findings, which emphasized the function of natural emulsifiers in augmenting viscosity through the reduction of interfacial tension and the facilitation of droplet dispersion (McClements', 2015). The notable increase of 0.149 mPa.s in viscosity for each 1% elevation in egg yolk content confirms its ability to establish a stable emulsion matrix by generating cohesive interfacial films surrounding scattered droplets. The little discrepancy at 3% egg yolk content indicates potential process-related anomalies, such

insufficient homogenization or inconsistencies in sample handling. These discrepancies underscore the necessity for accuracy in emulsification processes to guarantee consistent outcomes. Yadav and his team emphasize that appropriate emulsifier dispersion is essential for enhancing the stability and functional characteristics of emulsions. The relationship between viscosity and other stability criteria, such as the creaming index (CI), further supports the role of egg yolk as an excellent emulsifier (Yadav et al., 2018). The negative association between viscosity and CI, as revealed in this work, implies that increased viscosity effectively mitigates phase separation by limiting the mobility of dispersed droplets. This correlates with findings by Chen and his team, who observed enhanced phase stability in lecithin-based emulsions due to higher viscosity (Chen et al., 2020).

The gradual decrease in CI with higher egg yolk concentrations highlights its effectiveness in reducing phase separation over time. The CI values reported in this investigation revealed a clear trend, with the most stable emulsion (5% egg yolk) having the lowest CI across all time periods. This discovery is congruent with the observations of Yadav and his team, who revealed that natural emulsifiers like egg yolk considerably minimize phase separation in dairy-based emulsions (Yadav et al., 2018). The substantial negative connection between egg yolk content and CI ($p < 0.05$) emphasizes the emulsifier's capacity to preserve homogeneity. This is related to the combined action of egg yolk's phospholipids and proteins, which reduce interfacial tension and generate a strong interfacial layer surrounding droplets, as emphasized by Damodaran and his team (Damodaran et al., 2017). Furthermore, the constant drop in CI over 72 hours shows that emulsions with increased egg yolk contents offer better long-term stability, a significant aspect for commercial applications. It is worth mentioning that while the 5% egg yolk concentration demonstrated the lowest CI, the sensory evaluation revealed declining results beyond a certain level, notably in odor and flavor. This trade-off between physical stability and sensory qualities underscores the significance of adjusting emulsifier concentrations to create a balanced formulation.

Sensory assessment plays a vital part in assessing the commercial feasibility of food products. The outcomes of this study demonstrate that increasing egg yolk concentrations significantly improved sensory qualities such as texture, appearance, and overall acceptability. However, high egg yolk levels significantly impacted qualities including odor and flavor, underlining the necessity for balance. The highest overall acceptability was reported at 3% egg yolk content, when panelists evaluated the samples positively across numerous sensory aspects. This correlates with the findings of Xiao and his team, who observed that moderate emulsifier levels increase sensory perception by increasing mouthfeel and texture (Xiao et al., 2019). Conversely, larger concentrations may impart unwanted sensory features, such as off-flavors or excessive richness, as reported by Stone and Sidel (Stone and Sidel, 2004). The comparatively low scores for odor, particularly at greater egg yolk concentrations, show a possible area for improvement. Future research might study the use of complementing flavoring compounds or masking strategies to minimize the sensory impact of egg yolk while keeping its functional advantages. Additionally, combining consumer preference patterns into predictive modeling might assist uncover ideal formulas that appeal to specific populations.

The creation of a predictive model in this work marks a significant leap in the optimization of emulsified dairy drinks. The regression model, which explained 88.5% of the variability in viscosity (R^2 = 0.885), provides a strong framework for predicting stability characteristics based on egg yolk content. This correlates with the work of Li and his team, who stressed the efficacy of predictive modeling in expediting the formulation process and minimizing reliance on trial-and-error testing (Li et al., 2021). The strong R-value (0.941) reported in this investigation highlights the trustworthiness of the model in guiding formulation decisions. By quantitatively correlating egg yolk quantity with important stability parameters, the model enables producers to fine-tune formulas to achieve desired product attributes. However, it is critical to stress that the model's concentration on physicochemical characteristics, such as viscosity, may ignore intricate interactions that alter sensory properties. Incorporating sensory input into future versions of the algorithm might boost its forecast accuracy and usefulness.

CHAPTER 5

CONCLUSION

5.1. Conclusion

This study emphasizes how important egg yolk concentration is for boosting the emulsion stability and flavor of beverages made with toned milk. With an increase of 0.149 mPa.s for every 1% increase in egg yolk concentration ($p = 0.026$), the results show that egg yolk drastically affects viscosity. The stabilizing properties of egg yolk are further supported by Creaming Index analysis, which shows that phase separation decreases with increasing concentrations. Taste and texture are the most desired qualities, according to sensory evaluation, and they are correlated with better stability. A useful tool for maximizing egg yolk levels to attain better emulsion stability and customer satisfaction is the prediction model created in this study. This study highlights the value of combining sensory and physicochemical investigations in product development and aids in the creation of premium emulsified dairy beverages. To further improve the performance of the emulsion, future research could examine the effects of storage conditions and other stabilizers.

5.2. Recommendations

This study proposes using 3% egg yolk concentration for toned milk emulsions. This setting maximizes consumer acceptance while reducing phase separation by striking a balance between stability and sensory attributes. Given the rising demand for clean-label products, producers should think about using natural emulsifiers, such as egg yolk, in place of synthetic ones in dairy-based drinks. Although storage parameters such as temperature and duration need to be investigated to study the effects of egg yolk on the storage stability of the emulsion, exploring the use of additional natural stabilizers in combination with egg yolk may further enhance the stability and sensory appeal of emulsions. Furthermore, predictive modeling might be expanded to integrate characteristics such as droplet size distribution and consumer preference trends to optimize formulation techniques.

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APPENDICES

Appendix 1: Sensory Evaluation Form

Form of Sensory Evaluation of Toned Milk Emulsion Drink of 6 Samples.

Name:..... ID:.....

Date:.....Signature:.....

Instructions: 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, and 9 = like extremely

Samples

Rating	Sample 1	Sample 2	Sample 3	Sample4	Sample5	Sample6
Appearance						
Color						
Flavor						
Texture						
Odor						
Taste						
Overall Acceptance						

Feedback/Suggestion:

Department of Nutrition and Food Engineering (NFE),
Faculty of Allied Health Science (FAHS)
Daffodil International University
Daffodil Smart City, Birulia, Savar, Dhaka – 1216, Bangladesh

Appendix 2:

Synopsis of the thesis

1. Name: Md. Atikur Rahman Sawon
2. Id: 203-34-368

3. Project Title: Study on Emulsion Stability with Egg Yolk in Toned Milk Drink

4. Introduction:

Emulsified beverages are an essential segment of the food and beverage industry, valued for their sensory qualities, textural richness, and storage stability. These beverages often consist of immiscible liquids, such as oil and water, which must be uniformly dispersed to maintain stability throughout their shelf life. One of the primary challenges faced in the development of emulsions is preventing phase separation, creaming, and sedimentation during storage. To address these challenges, food scientists focus on optimizing emulsifiers and stabilizers, such as egg yolk, which has gained considerable attention due to its ability to improve both the physical stability and sensory properties of emulsions (McClements, 2015). This research explores the role of egg yolk as a natural emulsifier in a toned milk beverage, aiming to understand how varying concentrations of egg yolk affect emulsion stability and sensory attributes like flavor, texture, and odor.

Problem Statement and Justification

The formulation of emulsified dairy beverages often faces difficulties related to the optimization of emulsifiers. While synthetic emulsifiers are commonly used, natural emulsifiers like egg yolk offer a cleaner alternative with additional health benefits (Damodaran et al., 2017). Egg yolk, with its high content of lecithin and proteins, provides a natural mechanism for stabilizing emulsions by reducing interfacial tension and preventing phase separation. However, the ideal concentration of egg yolk that balances both physical stability and sensory acceptability remains unclear. Moreover, the lack of predictive models that integrate both physical and sensory data limits the optimization of egg yolk concentrations in food formulations. This study aims to fill this gap by investigating how different egg yolk concentrations impact viscosity, creaming index, and sensory properties of a toned milk beverage.

5. Objectives:

- To prepare a toned milk-based emulsion drink with varying concentrations of egg yolk.
- To assess emulsion stability across different egg yolk concentrations and establish their correlation.

- To develop a predictive model for emulsion stability, incorporating physicochemical parameters such as viscosity and creaming index.
- To get the most preferred drink formulation by sensory panel evaluation, focusing on taste, texture, and overall acceptance.

6. Materials:

6.1 Ingredients:

- Toned milk (2%)
- Egg yolk
- Carrot juice
- Sugar
- Salt
- Cardamom
- Flavoring agents

6.2 Instruments:

- Mixer
- Gas Stove
- Homogenizer
- Rotational Viscometer
- Beaker
- Spoon
- Pan

7. Methods:

7.1 Preparation of Emulsion Samples:

7.1.1 Base Emulsion Preparation:

i. Mix toned milk with carrot juice, sugar, salt, cardamom, and flavoring agents.
ii. Homogenize the mixture to ensure even distribution of ingredients.

7.1.2 Incorporation of Egg Yolk:

i. Separate egg yolks and homogenize them separately.
ii. Add egg yolk to the base emulsion in varying concentrations (e.g., 0%, 1%, 2%, 3%, 4%, 5% by weight).
iii. Homogenize each sample thoroughly to form a stable emulsion.

7.1.3 Heating the Final Solution (Drink):

i) Heat the drink at 90°C for 2 minutes.
ii) Make it cool at room temperature.

7.2 Analysis Methods:

7.2.1 Viscosity Measurement.

- **Method**: Rotational Rheometry
- **Alternative Method:** Brookfield Viscometry

7.2.2 Creaming Index

- **Method:** Visual Creaming Measurement
- **Alternative Method:** Centrifugation Test

7.2.3 Sensory Evaluation

- **Method:** Quantitative Descriptive Analysis (QDA)
- **Alternative Method:** Hedonic Testing

7.2.4 Data Analysis:

- Collect data from viscosity measurements and creaming index.
- Use statistical tools (e.g., regression analysis) to establish a correlation between egg yolk concentration and each parameter.

8. Place of the Study:

Food Processing Lab, Department of Nutrition and Food Engineering, Daffodil international University

9. Period of the Study: Starting date: 1st June, 2024.

10. Supervisions:

Dr. Nizam Uddin, Associate Professor and Head, Department of Nutrition and Food Engineering

11. Expected Outcomes:

- Identification of the optimal egg yolk concentration for maximum emulsion stability.
- A clear correlation between egg yolk concentration and emulsion stability parameters (viscosity and creaming index).
- Insights into the role of egg yolk as an emulsifier in toned milk-based drinks.

12. Conclusion

This study highlights the role of egg yolk as a powerful natural emulsifier in dairy-based beverages, enhancing both physical stability and sensory properties. The study confirms that egg yolk concentration directly influences viscosity and phase separation, while also improving key sensory attributes such as flavor and texture. By developing a predictive model that correlates egg yolk concentration with viscosity and sensory outcomes, this research provides actionable insights for optimizing formulations in dairy beverage production. Future work should focus on refining sensory profiles, particularly aroma, and investigating the effects of storage conditions on emulsion stability.

13. References:

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Signature of the Supervisor	Signature of the Student
Dr. Nizam Uddin Associate Professor and Head Department of Nutrition and Food Engineering Faculty of Health and Life Sciences Daffodil International University	**Md. Atikur Rahman Sawon** ID: 203-34-368 Department of Nutrition and Food Engineering Faculty of Health and Life Sciences Daffodil International University
	

Appendix 3: Plagiarism Percentage Results

ORIGINALITY REPORT

3%	3%	1%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	dspace.daffodilvarsity.edu.bd:8080 Internet Source	1%
2	VNUA Publication	1%
3	Ming-Jian Liu, Jie Gao, Hua-Yang Guo, Ke-Cheng Zhu, Bao-Suo Liu, Nan Zhang, Teng-Fei Zhu, Dian-Chang Zhang. "Influence of aquaculture environments on the muscle quality of Golden Pompano (Trachinotus ovatus) in the Beibu Gulf: A multifaceted analysis of nutritional, textural, and flavor profiles", LWT, 2024 Publication	<1%
4	www.coursehero.com Internet Source	<1%
5	classic.clinicaltrials.gov Internet Source	<1%
6	Miete Celus, Clare Kyomugasho, Julie Keunen, Ann M. Van Loey, Tara Grauwet, Marc E.	<1%