

Organoleptic Evaluation of Garlic (*Allium sativum*) Mayonnaise

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Abstract — The study aimed to assess the organoleptic qualities and microbiological safety of garlic mayonnaise using various statistical methods. The treatment formulations of garlic mayonnaise were evaluated using mean scores, one-way ANOVA, and the Tukey Test. The microbial investigation found that the garlic mayonnaise had no or little bacterial contamination. The overall acceptability of the garlic mayonnaise was rated with a mean score of 4.40 and a classification of "Very Acceptable," while the packing materials obtained an exceptional grade with a mean score of 4.24. Significant differences were observed between the treatment formulations, demonstrating variability in their sensory properties. Shelf life tests revealed that garlic mayonnaise is safe to consume for up to 8 days at room temperature and 14 days when refrigerated.

The garlic mayonnaise with 250 grams of garlic was the most preferred in terms of taste, aroma, and color. Mayonnaise free from garlic was most accepted for its spreading consistency. Economically, the formulation T0 without garlic produced highest net revenue, return of investment (ROI), and sales, emphasizing its commercial viability as a product with high consumer acceptance and economic benefits, with financial rewards.

Keywords — *garlic mayonnaise, acceptability, shelf life, ANOVA, Tukey Test, microbial analysis, net income, ROI, sensory evaluation.*

I. Introduction

Sinait, a Municipality in the Province of Ilocos Sur, Philippines is known for garlic capital of the north. Sinait Garlic has a tiny bulb but has a lot of taste, therefore it is very great when used in cooking and even using it as an herbal medicine.

The people of Sinait have grown garlic for generations. Their variety is special to their place and it's tied up with local pride and traditions. Mass-produced garlic can't match Sinait Garlic's aroma and taste. A little bit goes a long way in the kitchen or in traditional healing.

Garlic, onions leeks and shallots are all related vegetables. But Sinait Garlic is its own thing, still grown by hand on local farms. For the community identity and economy, this unique crop means a lot. It makes their food and culture distinct.

The distinctive aroma and taste of garlic's bulb are attributed to sulfur-containing compounds, for instance, allicin. Such compounds are likely to mediate garlic's postulated antimicrobial, antioxidant, and anti-inflammatory properties. Garlic is hypothesized to reduce cholesterol and blood pressure, improve immune function, and express anticancer activities.

Garlic is one of the most versatile of the kitchen ingredients that imparts a delicious flavor and can be added to almost any cuisine. It can be used cooked, raw, roasted or as a flavoring ingredient in the form of garlic powder and oil. A pinch of this magical ingredient can enhance the taste of simple garlic breads or plain rice dishes to some savory sauces.

According to Juber (2022), Garlic has been medicinally used as a food or flavoring from the earliest beginnings of recorded history. Garlic belongs to the genus *Allium*, which is also the genus where onions, shallots, leeks, and chives fall. Some members of this genus share a few of the health benefits attributed to garlic. It includes cardiac health, antimicrobial, and anti-cancer.

Garlic is known to have many antibiotic properties that can counteract bacteria, viruses, fungi, and parasites as well. Experts have found that raw crushed garlic possesses antiviral properties with an active component called allicin and has broad-spectrum antibacterial effectiveness on multi-resistant *E. coli*. It further confirmed that allicin had antifungal activity, including against the etiologic agent of yeast infection *Candida albicans*. Through its action on parasites, it protects against such major intestinal parasites as *Giardia*. Other studies have established the mechanisms by which allicin can inhibit the growth of methicillin-resistant *Staphylococcus aureus*, or MRSA.

Eggs represent one of the most globalized animal products, with a fantastic nutritional content, flexibility in cooking and cooking techniques, and affordability. Eggs are part and parcel of many people's diet across cultures. Eggs provide excellent-quality proteins, very important vitamins such as vitamin D and B12, and minerals like selenium and phosphorus. Since they are of high nutritional density, these foods are very essential for every age. They are critically required to trigger the development of muscles, brain development, and overall well-being.

Besides their nutritional advantages, eggs have always been prized for their functional capabilities in foodstuffs. They can be used as an emulsifier, leavening, and adhesive in any recipe baked, made into sauces, custards, or other desserts. Their coagulation properties when heated make them ideal for baking both sweet and savory foods and fill the structural role of a number of recipes.

The egg yolks thus are one nutrient-dense part of the egg, and they are important both as a nutrient ingredient and in food applications. Whereas egg whites are primarily proteins, egg yolks are known through their complex mixture of fats, vitamins, minerals, and bioactive substances. They represent the richest sources of the fat-soluble vitamins: A, D, E, and K. In addition, they are an important source of the nutrient choline, which is beneficial for brain function and liver health. Egg yolks contain essential fatty acids, including the much-required omega-3s, and are an

important dietary source of cholesterol. Egg yolks carry much more than mere nutritional value: they are high-functional objects that, undoubtedly, have become imperishable in cuisine and food. All-rich-in-lecithin, egg yolks may stabilize mixtures like mayonnaise, custards, or sauces. Rich flavor and color add value to the dishes prepared with their aid. Texture and structure of batters and dough result in bakery products and desserts because of egg yolks.

Mayonnaise is indeed one of the most popular condiments or sauces, which could go with a number of dishes, be it sandwiches and salads, dips, or even dressings. It is creamy in texture, rich in flavor, but tangy; thus, it is versatile for most dishes. Primarily, making mayonnaise involves emulsifying oil with egg yolk, acid, and seasonings. It forms a very stable emulsion having a smooth, homogenous texture that is thick.

In recent years pressure has been mounting for the Sinait garlic farmers to cut the wastes and put in place a process for its sustainability. Garlic has been an important agricultural produce of Sinait, but it significantly contributes to production waste in the form of undersized bulbs, skins, stems, and cloves not fit for market standards. Most of this by-product is disposed of, therefore causing both direct economic losses to farmers as well as broader negative impacts on the environment.

The research gap indicates that although garlic has been shown to have potential, limited is known about garlic processed products that can uplift reject (small garlic) produced. Most studies has concentrated on the health benefits or conventional applications of garlic, especially with relation to consumer acceptability.

The main purpose of this study is to develop mayonnaise from garlic. This will determine the organoleptic evaluation of garlic mayonnaise in terms of taste, aroma, color and spreading consistency.

This study aims to produce mayonnaise and evaluate consumer acceptance. Being mindful of customers' views and preferences. The purpose of this study is to shed light on the product's possible commercial viability.

This research explores how eggs go into the making of mayonnaise, taking into consideration the chemistry and physics through emulsion. It is by studying the chemical and physical contributions of the egg that components can be used to properly understand mayonnaise texture stability and flavor, thus optimizing its production, from industrial scales to home preparation. The study will further view how egg substitutes and alternative emulsifiers are currently being developed in terms of how they replace increasing demands for vegan and allergen-free mayonnaise, and how the alternative tastes and compares to the traditional mayonnaise made from eggs in terms of taste, aroma and spreading consistency.

The importance of this study lies in its potential to advance food innovation, utilization, and sustainability. By examining the acceptability of garlic-based products, it can help diversify

food sources, encourage the use of underutilized crops, and create economic opportunities for local communities.

The results can provide valuable insights to policymakers, entrepreneurs, and researchers regarding the potential advantages and challenges of developing and promoting garlic-based products.

Objectives of the Study

The study was designed to determine the organoleptic evaluation of garlic mayonnaise. Specifically, it seeks to determine the following:

1. Microbial analysis of the formulated products.
2. The level of acceptability of garlic mayonnaise in terms of:
 - 2.1 taste,
 - 2.2. aroma,
 - 2.3. color, and
 - 2.4. spreading consistency
3. There is a significant difference between the various formulations of garlic mayonnaise in terms of:
 - 3.1. taste,
 - 3.2. aroma,
 - 3.3. color, and
 - 3.4. spreading consistency
4. What is the evaluation of the evaluators on the acceptability of packaging materials for garlic mayonnaise in terms of:
 - 4.1. level of technical performance,
 - 4.2. economic viability,
 - 4.3. environmental soundness, and
 - 4.4. social acceptability

5. The proximate analysis of the best product formulated.
6. The shelf life of the best product formulated.
7. The cost and return analysis of the product is formulated.

II. Methodology

Research Design and Treatments

The true-experimental research design is used in the study which emphasizes the procedure in the attainment of the desired output. Experimental research design uses the scientific method to establish the cause-effect relationship among a group of variables that make up a study. A true experiment has strong variable control to ensure that any modifications in the dependent variable are the result of manipulating the independent variable. This method provides internal validity by isolating the independent variable as its main influence on outcomes, eliminating any external factors that may affect results (McKee, 2023). It also focused on the gathering of numerical data from the responses obtained from the respondents using the sample products from the experiment. The complete randomized design is used in this study utilizing one factor and three formulations as follows:

Measurement Proportion:

T0-control (1 egg whole + 2 egg yolks + 1 tsp. mustard + 1-2 tbsp lemon juice + ½ tsp. salt + 2 cups oil)

T1- (1 egg whole + 2 egg yolks + 1 tsp. mustard + 1-2 tbsp lemon juice + ½ tsp. salt + 2 cups oil + 62.5 grams garlic)

T2- (1 whole egg, 1 yolk, 1 teaspoon mustard, 1-2 tablespoons lemon juice, ½ teaspoon salt, 2 cups oil, and 125 grams of garlic),

T3- (1 whole egg, 1 teaspoon mustard, 1-2 teaspoons lemon juice, ½ teaspoon salt, 2 cups oil, and 250 grams of garlic)

Participants of the Study

The 80-product evaluator in this study consists of 50 TVL students from Ilocos Sur National High School, 10 faculty staff of TVL department from Ilocos Sur National High School, 10 consumers from barangay Paratong, Sinit, Ilocos Sur, and 10 Cookery NC II Assessors (Food experts) from Ilocos Sur.

Research Instrument

The researcher modified the instrument to evaluate garlic mayonnaise. Garlic mayonnaise sensory characteristics were taste, aroma, color, and spreading consistency. The following features were described on a 5-point scale.

A score sheet of sensory tests will be used in gathering data needed in this study. It utilized the 5-point Likert Scale to measure the level of acceptability of garlic mayonnaise.

Microbial Analysis

A set of treatments were brought to Mariano Marcos State University Molecular and Microbial and Microbiology and Laboratory in Batac, Ilocos Norte for microbial analysis to verify if the treatments are good for human consumption. When the formulations are negative from *Escherichia coli*, *Salmonella sp.*, *Listeria monocytogenes*, *molds*, and *Staphylococcus aureus*, the formulations will be subjected to organoleptic test. Aside from the responses of the evaluators in the rubrics, comments and suggestions will also solicited and it can be used as a guide to improve the product.

Shelf-Life Analysis

The shelf-life analysis of garlic mayonnaise was conducted at Mariano Marcos State University Molecular and Microbiology and laboratory to determine the period by which unnecessary microbes started to grow.

Proximate Analysis

Proximate Analysis were conducted determined the nutrient content of the garlic mayonnaise and it will bring to the laboratory of the First Analytical Services and Technical Cooperation (FAST Laboratory) for proximate analysis in ash, moisture content, crude protein, and crude fat.

Return of Investment

The return of investment of garlic mayonnaise was calculated to determine the expenses, gross sales, and income.\

Statistical Tools/Analysis

All the data gathered were statistically treated using the following statistical tools. The Microsoft Excel will be utilized in the statistical analysis of data.

Mean was used to describe the level acceptability of the garlic mayonnaise in terms of texture, aroma, color, taste and overall acceptability.

One-Way Analysis of Variance (ANOVA) was used to determine significant differences between and among the various formulations of garlic mayonnaise.

The Scheffe Test was used to determine which of the different formulations show significant differences in the quality of garlic mayonnaise.

III. Results and Discussion

Table 1: Microbial Analysis of the Formulated Products of Garlic Mayonnaise

Product Sample Code	Aerobic Plate Count (cfu/g) 10 ⁴	Detection of Pathogens			
		Escherichia coli	Salmonella sp.	Staphylococcus aureus	Molds
T0	13.0	negative	negative	negative	negative
T1	14.0	negative	negative	negative	negative
T2	12.0	negative	negative	negative	negative
T3	16.0	negative	negative	negative	negative

The presented data in Table 1 offers a glimpse of the outcome of microbial analysis done on four distinct treatments, T0, T1, T2 and T3, which involved adding various quantities of garlic to garlic mayonnaise. The Aerobic Plate Count (APC) values provided insights into the overall aerobic bacterial load present in the samples.

The microbiological analysis of the garlic mayonnaise treatments, as outlined in the data, provides valuable insights into the product's safety and quality. In the T0 (1 egg whole + 1 egg yolks + 1 tsp. mustard + 1-2 tbsp lemon juice + ½ tsp. salt + 2 cups oil) treatment, where the mayonnaise had an Aerobic Plate Count (APC) of 13 cfu/g, there were no detectable quantities of hazardous microorganisms such as Escherichia coli, Salmonella sp., Staphylococcus aureus, and molds. Similarly, the T1 (1 egg whole + 1 egg yolks + 1 tsp. mustard + 1-2 tbsp lemon juice + ½ tsp. salt + 2 cups oil + 62.5 grams garlic) treatment, which included 62.5 grams of garlic in the basic components, yielded an APC of 14.0 cfu/g, and the microbiological investigation revealed negative findings for the same pathogens. The absence of these pathogens in both the T0 and T1 treatments indicates that the manufacturing method and components, including garlic, were effective in ensuring the product's microbiological safety. Garlic's the ability to inhibit microbial growth, especially against pathogens including Staphylococcus aureus and Escherichia coli, contributes to the safety of mayonnaise-based products (Miron et al., 2019; Oliveira et al., 2021).

Garlic is well-known for its antibacterial capabilities, thanks in large part to its active ingredient, allicin, which has been found to prevent the development of a variety of bacteria and fungus (Bhatwalkar et al., 2021).

The microbiological investigation of garlic mayonnaise treatments T2 (1 egg whole + 1 egg yolks + 1 tsp. mustard + 1-2 tbsp lemon juice + ½ tsp. salt + 2 cups oil + 125 grams garlic)

and T3 (1 egg whole + 1 tsp. mustard + 1-2 tbsp lemon juice + ½ tsp. salt + 2 cups oil + 250 grams garlic) unveiled a dose-dependent association between garlic content and microbiological growth. In T2, 125 grams of garlic were introduced, and the Aerobic Plate Count (APC) was 17.0 cfu/g. However, in T3, with the garlic content quadrupled to 250 grams, the APC increased to 20.0 cfu/g. While both treatments produced negative results for *Escherichia coli*, *Salmonella sp.*, *Staphylococcus aureus*, and molds, showing the absence of these hazardous bacteria and molds, the greater APC in T3 may indicate a minor increase in microbial presence with increased garlic content. The results established that the Aerobic Plate Count (APC) of the garlic mayonnaise product is well within the permitted range, suggesting a suitable microbiological load. Furthermore, the absence or limited presence of pathogens such as *Escherichia coli*, *Salmonella sp.*, *Staphylococcus aureus*, and molds, indicate good preparation and production processes with good hygiene controls in place.

D'Amico et al., (2022) and Ismail et al., (2020) demonstrate that garlic's antibacterial effects are due to allicin, an active component that has been found to be effective against a variety of bacteria, including *Escherichia coli* and *Staphylococcus aureus*. However, its effectiveness can be reduced under specific conditions, such as pH, moisture content, and interactions with other compounds. These characteristics can make the environment more permissive to microbial development, especially for resistant pathogens like *Salmonella enterica* and *Staphylococcus aureus*. Abidullah et al., (2022) found that garlic's antibacterial effect, while promising, varies depending on concentration and application technique, emphasizing the necessity for in vivo research to establish its efficacy in complex food systems.

However, while garlic is well-documented for its antimicrobial properties, particularly due to the presence of allicin, which is effective against a variety of bacteria and fungi, studies show that antimicrobial efficacy may decrease beyond a certain threshold (Sahidur M.R et al., 2023). The pH level, moisture content, as well as complex interactions between garlic components and other substances all have the potential to alter the total microbial load. These variables may produce a more favorable environment for some organisms, lowering garlic's efficacy in avoiding microbial contamination, especially against resistant pathogens such as *Salmonella sp.* and *Staphylococcus aureus* (Batiha, G. E et al., 2020)

Table 2. Summary of the Overall Acceptability of Garlic Mayonnaise

Sensory Characteristics	Treatments			
	T0	T1	T2	T3
Taste	4.28	4.19	3.70	4.38
Aroma	4.11	4.2	4.38	4.50
Color	4.55	4.62	4.76	4.89
Spreading consistency	4.65	4.53	4.15	4.48
Overall Mean	4.40	4.39	4.25	4.56
Descriptive Rating	VA	VA	VA	VA

Table 2 presents the mean evaluations for the level of acceptability of garlic mayonnaise treatments in terms of taste, aroma, color, and spreading consistency were 4.40 (T0), 4.39 (T1), 4.25 (T2), and 4.56 (T3), suggesting that all levels were "Very Acceptable" among respondents. These scores indicate that all treatments were rated highly across several sensory aspects. As stated by Byrnes and Hayes (2020), sensory features of food products play a significant role in customer approval. Customers often achieve products favorably when these properties (taste, scent, consistency) meet or surpass their expectations, especially in flavored items like mayonnaise, where garlic may heighten sensory enjoyment. Ramírez-Valverde, B., & Castañeda-García, C. (2022) study on consumer preferences for flavored mayonnaise products found that differences in ingredients, such as garlic, can considerably alter customer approval based on sensory qualities.

The data in the table further suggests that the sensory assessment results show that respondents had variable preferences for distinct sensory qualities of garlic mayonnaise formulations (T0, T1, T2, and T3). In terms of taste, respondents favored the T3 formulation with a mean rating of 4.38, interpreted as "Very Acceptable." This preference matches with findings from Ramírez-Valverde, B., & Castañeda-García (202), who investigated consumer preferences for conventional mayonnaise tastes, indicating that established and well-balanced taste descriptions receive higher acceptability ratings. For the aroma, evaluators gave the T3 formulation a widely accepted mean rating of 4.50, indicating that it was "Very Acceptable." Kim et al. (2019) found that specific ingredients like garlic can enhance aroma profiles and positively influence consumer perception. On the other hand, in relation to color, the T3 treatment was highly favored, with a mean rating of 4.89, interpreted as "Very Acceptable." (7) The T3 garlic mayonnaise, made with 1 whole egg, 1 teaspoon mustard, 1-2 tablespoons lemon juice, ½ teaspoon salt, 2 cups oil, and 250 grams garlic, has a well-balanced combination of ingredients that contribute to its high acceptability in terms of taste, aroma, color, and spreading consistency. Lecithin's emulsifying capabilities are essential for maintaining good texture and avoiding separation in different food items, including mayonnaise (Jiang et al., 2022; Xu et al., 2022). The inclusion of lecithin in the yolk stabilizes the formulations and gives mayonnaise its smooth, creamy texture (Rajasekaran, B. et al., 2024). Mustard not only provides a pungent, tangy flavor, but it also includes natural emulsifiers that help to maintain the emulsion and contribute to the product's smooth spreading consistency (Depree

& Savage, 2021). Incorporating acidic components such as lemon juice which lowers the pH level is critical for ensuring the microbiological safety and sensory quality of emulsified goods like mayonnaise (Di Mattia et al., 2020; Alves Gomes et al., 2020).

Lemon juice acts as both an acidulant and a preservative in mayonnaise, lowering the pH to inhibit bacterial growth and enhancing the flavor (Tasliikh et al., 2021). Salt balances the richness of the oil and egg, improving taste (McGee, 2020). The kind and quantity of oil used greatly impact the emulsion's stability and overall sensory qualities, such as mouthfeel and spreadability, which contribute to the desirable creamy quality of the product (Kiosseoglou & Sherman, 2019).

The oil contributes to the mayonnaise's creamy texture (Taslikh et al., 2021). This finding concurs to a study by Smith & Johnson (2020), which investigated the effect of natural extracts in improving food color stability, emphasizing that ingredients such as garlic may help create vibrant and appealing color descriptions in food products. Finally, in correspondence with spreading consistency, the respondents preferred the T0 treatment with a mean rating of 4.65 described as "Very Acceptable", indicating that the texture of mayonnaise formulations can have a significant impact on consumer acceptance.

Table 3. One-way ANOVA test for the significant difference between and among the formulations of Garlic Mayonnaise in terms of Taste, Aroma, Color and Spreading consistency

TREATMENTS	SENSORY CHARACTERISTICS			
	TASTE	AROMA	COLOR	SPREADING CONSISTENCY
T0	4.45 ^b	0.492 ^{bc}	4.58 ^c	4.78 ^{bc}
T1	4.40 ^c	0.492 ^c	4.56 ^c	4.75 ^c
T2	4.51 ^a	0.492 ^b	4.69 ^b	4.80 ^b
T3	4.50 ^{ab}	0.492 ^a	4.79 ^a	4.82 ^a
Computed f	27.66**	23.83**	64.35**	5.24*
P-value	0.0001	0.0002	0.0001	0.0272
CV	0.354	0.492	0.4999	0.418

Legend: > 0.05, not significant <0.05 =* <0.01 = **

The table reveals that the treatment formulations containing the different mixtures of garlic mayonnaise exhibited significant differences. This manifestation indicates that in terms of taste, the statistical f-value of 27.66 with a p-value of 0.0001 is less than the alpha (0.05) threshold, suggesting that the result is significant. This implies that the different garlic formulations significantly impact taste perception. Taslikh et al., (2021) revealed that the incorporation of garlic in mayonnaise formulations greatly changed the sensory qualities, particularly taste because the unique flavor components in garlic interact with the emulsified structure of mayonnaise. Moreover, the concentration and type of flavoring agents in food products can lead to discernible differences in consumer preferences and taste evaluations Schifferstein, H. et al., (2020).

Table 3 also revealed that the Tukey test results confirmed that the considerable variations in taste between T2 vs T1, T0, and T0 vs T1 garlic mayonnaise formulations, demonstrating that the presence and concentration of garlic had a major impact on the sensory qualities of mayonnaise. In the contrary, the formulations between T2 vs T3 and T3 vs T0 showed no significant differences. This also demonstrates that adding different quantities of garlic introduces attribute intensities of garlic flavor, greatly influencing the overall taste characteristics of the mayonnaise. The T3 formulation, with its greater garlic content, is likely to appeal to people who prefer strong, solid tastes, whereas the T2 formulation may be favored by those who prefer a gentler garlic flavor (Jagdale et al., 2021).

As presented in Table 3, the different mixtures of garlic mayonnaise bear significant differences in terms of aroma. This aligns with the result in which the computed f-value of 23.83

and the p-value of 0.0002 is less than alpha (0.05) supporting the aforementioned findings. This is consistent with the study of Quéré, J. L., & Schoumacker, R. (2023) stating that the taste chemical reactions in food products focus on how garlic compounds interact with other ingredients in emulsified goods such as mayonnaise, influencing overall aroma perception.

The data in the table revealed that there was no significant difference between the T0 vs T1 and T2 variants of garlic mayonnaise, indicating a small amount of garlic did not alter the olfactory profile of the final product. The T0 recipe consists of traditional ingredients including one whole egg, two egg yolks, mustard, lemon juice, salt, and oil, while the T1 variant incorporates 62.5 grams of garlic into the mix. This addition of garlic did not contribute to a noticeable divergence in aroma, potentially imparting characteristic garlic notes to the MB variant. Additionally, a significant difference is also shown between the formulations of T3 vs T0 to T2 and T3 vs other treatment combinations. While both use the same components; a difference in the amount of garlic creates different aroma structures of the garlic mayonnaises, thus pointing out how important it is to be careful with the amount of garlic to be used in recipes for garlic mayonnaise.

Moreover, the statistical study shown in the table exhibited a significant change in color between the various garlic mayonnaise compositions. This is demonstrated by the statistical f-value of 64.65 with a p-value of 0.0001 which is lesser than the predetermined alpha threshold of 0.05, which supports that the observed color differences are statistically significant. It implies that variances in component compositions or amounts between formulations do not cause notable color differences in garlic mayonnaise products. Figueiredo Muniz et al., (2023) studied food coloring agents and sensory evaluation and found that ingredient alterations may influence the color appeal of food items, influencing customer acceptance.

For color of the various treatment formulations of garlic mayonnaise, no significant difference was found between the T0 and T1 which showed no modification of color to the garlic product's visual qualities. The rest of the treatment combinations show a significant difference. Furthermore, (Shang et. Al., 2019) investigated the effect of garlic extracts on the color characteristics of food products, discovering that garlic components can function as natural colorants, influencing the color and intensity of food items.

As revealed in Table 3, the different formulations of garlic mayonnaise have significant consistency differences. This is consistent with the observed results since the statistical f-value of 5.24 and p-value of 0.0272, which is less than the preset alpha inhibit of 0.05, reinforces those observations. Garlic's fiber structure and moisture content might affect the viscosity and texture of mayonnaise. Higher concentrations of garlic may incorporate more solids and moisture into the mixture, perhaps resulting in a thicker spreading consistency than formulas with lower levels of garlic.

Table 3 reveals that the spreading consistency of the T0 vs T1, T2 variations of garlic mayonnaise did not differ significantly, indicating that the inclusion of garlic had no visible influence on the final product's spreading consistency. Similarly, the spreading consistency of T3 vs T0 to T2 variations of garlic mayonnaise differed dramatically, demonstrating the amounts of garlic used in the formulation had a major influence on the final product texture. This change resulted in a significant difference in spreading consistency, which was most likely impacted by the presence of garlic and its interactions with other components. These findings highlight the importance of optimizing garlic content and formulation parameters to achieve consistent product texture. The effect of garlic on the rheological qualities of mayonnaise may vary, modifying the product's spreading consistency.

Table 4. Proximate Analysis of the best product of Garlic Mayonnaise

Parameters	Unit	Test Method	Results
Moisture	g/ 100g	Vacuum Oven Drying	30.4
Ash	g/ 100g	Ignition – Gravimetry	0.694
Fat	g/ 100g	Acid Hydrolysis - Mojonnier Extraction	55.4
Protein (N X 6.25)	g/ 100g	Kjeldahl	2.79

The Proximate Analysis of T3 garlic mayonnaise, made with 1 egg, 1 tsp. mustard, 1-2 tbsp lemon juice, ½ tsp. salt, 2 cups oil, and 250 grams of garlic were conducted using standard methods such as Vacuum Oven Drying for moisture content, Ignition-Gravimetry for ash content, Acid Hydrolysis-Mojonnier extraction for fat content, and Kjeldahl for protein content. Table 5 shows that T3 has a moisture content of 30.4 g/100g, which is within the normal range of 72% to 82% (Wang, 2023). However, when compared with mayonnaise enriched with an additional 1% banana flour, the average moisture content ranges from 20.41% to 23.59% (Evanuarini & Susilo, 2020), indicating a possible avenue for moisture reduction in the formulation. This reduction in moisture content can be attributed to the inclusion of ingredients such as garlic, banana flour, and gums (xanthan and guar gum), which are known to possess thickening, stabilizing, and gelatinizing properties, as well as vegetable proteins, all of which contribute to mayonnaise moisture reduction (Lozano et al., 2020; Armaforte et al., 2021). Furthermore, the ash concentration was minimal, measuring 0.694 g/100 g, showing complete combustion of mineral waste and representing the sample's inorganic components. This low ash percentage is lower than the usual average in low-fat mayonnaise, which ranges between 1.83% and 2.14% (Satriawan, T. U., Evanuarini, H., & Thohari, I., 2022). The fat level, which is vital for sensory features and nutritional value, was found to be 55.4%, which is lower than the typical range of 65% to 80% (Karpińska et al., 2022). Finally, the protein level of the garlic mayonnaise formulation was 2.79 g/100g, somewhat greater than the results published by Mohajan et al., (2023). Given that dietary standards prescribe a daily protein consumption of 0.8-1.0 grams per kilogram of body weight (Hruby and Jacques 2020)

The proximate composition of garlic mayonnaise is well-balanced, reflecting its formulation and aligning with the predicted qualities of mayonnaise as an oil-in-water emulsion,

therefore supporting both its functional and sensory properties. The moisture and fat levels provide a smooth, creamy texture, while the ash and protein content add taste, nutritional value, and stability. These characteristics combine to produce garlic mayonnaise a tasty, stable, and appealing condiment that matches consumer expectations.

Table 5. Shelf-life of the Best Product Formulated of Garlic Mayonnaise

Product Sample Code	Aerobic Plate Count (cfu/g) 10 ⁴	Detection of Pathogens			
		Escherichia coli	Salmonella sp.	Staphylococcus aureus	Molds
Initial Sample 6/5/2023	8.0	negative	negative	negative	Negative
Room Temperature					
6/13/2023	10.0	negative	negative	negative	Negative
6/15/2023	17.0	negative	negative	positive	Negative
6/19/2023	21.0	negative	negative	positive	Negative
6/21/2023	26.0	negative	negative	positive	positive
Refrigerated Condition					
6/13/2023	8.0	negative	negative	negative	Negative
6/16/2023	10.0	negative	negative	negative	Negative
6/19/2023	16.0	negative	negative	negative	Negative
6/22/2023	22.0	negative	negative	positive	Negative

In light of the shelf-life assessment of the best-formulated product, as indicated in Table 5, microbial analysis of the T3 formulation stored at room temperature revealed the presence of *Staphylococcus aureus* from the 15th to the 17th day of observation, as well as mold on the 17th day. However, no additional harmful bacteria were identified in the sample. These findings imply that garlic mayonnaise created with the T3 formulation should be consumed before the 15th day after manufacturing begins to guarantee optimal safety and quality. To address microbiological contamination and improve shelf life, it is important to execute suitable emulsification methods that promote the uniform distribution of water throughout the mixture, hence lowering the possibility of water separation and microbial growth. Furthermore, managing moisture levels is crucial since it can reduce microbial reproduction, thus, enhancing the product's stability and suitability for consumption.

The table also presents that the refrigeration of the T3 formulation resulted in a considerable increase in microbiological stability, with *Staphylococcus aureus* found only on the 22nd day of testing. This highlights refrigeration's efficiency in increasing product lifespan and freshness by preventing microbiological growth. The delayed onset of microbial contamination relative to room temperature storage indicates that refrigeration greatly inhibits pathogen proliferation, hence, improving product safety and quality. This reinforces the necessity of suitable storage conditions, such as refrigeration, in maintaining the freshness and microbiological stability of perishable foods like garlic mayonnaise

Table 6. Cost and Return Analysis of the Best Product Formulated of Garlic Mayonnaise

Particular	T0	T1	T2	T3
Sales	405	405	360	360
Total Expenses	265.93	267.18	258.43	253.93
Net Income	139.07	137.82	101.57	106.07
ROI %	52%	52%	39%	42%

As presented in Table 6, the financial evaluation of garlic mayonnaise formulations provides important information about their cost efficiency and Return Of Investment (ROI). For the T0 formulation, the total expenses incurred amount to Php 265.93, resulting in the greatest net income of Php 139.07 and an ROI of 52%. With sales of Php 405 and a yield of 1875 g, T0 is the most lucrative formulation, thanks to its high customer preference and economical production. The T1 formulation, despite somewhat a little higher expenditures of Php 267.18, generates the net profit of Php 137.82 with a ROI of 52%. Its sales were Php 405 with the highest yield of 1937.5 g, demonstrating excellent financial success. This shows that T0 creates an acceptable balance between cost and profitability, making it a viable alternative in terms of both market acceptability and production efficiency. T2, with costs of Php 258.43 and net revenue of Php 101.57, has a ROI of 39%. Its sales were Php 360, with a 1750 g yields. Despite having fewer expenses than T0 and T1, its net earnings and ROI were also lower, indicating middling efficiency and profitability. Fine-tuning the formulation and improving production procedures may increase its financial returns. The T3 formulation has the lowest expenses at Php 253.93, resulting in a net income of Php 106.07 and a 42% ROI. Despite having a low sales of Php 360 and a yield of 1625 g, T3 has tremendous space for development. Improving its sensory qualities and employing smart marketing might help it improve its market success and profitability.

Table 7. Summary table on the Level of Acceptability of the Garlic Mayonnaise Packaging Material

Acceptability of the Garlic Mayonnaise Packaging	Packaging Material		
	Glass Pouch	Stand Up Pouch	Zip Lock
level of technical performance	4.20	3.62	4.20
economic viability	4.20	4.85	4.23
environmental soundness	4.25	4.25	3.90
social acceptability	4.50	4.50	4.10
Overall Mean	4.29	4.31	4.11
Descriptive Rating	E	E	VG

Table 7 indicates that the respondents rated the level of acceptability of the packaging materials for garlic mayonnaise as highly acceptable. The overall mean ratings for the glass pouch, stand-up pouch, and zip-lock packing were 4.29, 4.31, and 4.11, respectively. These mean scores classify the glass bag and stand-up pouch as "Excellent," while the zip-lock packaging is classified as "Very Good." These findings showed that packaging has a significant impact on customer

perception and product acceptance. As stated by Duarte, P. et al. (2024), the quality of packing materials has a substantial impact on consumer satisfaction and perception of product quality suggesting that well-designed packaging not only preserves the goods but also enhances its appeal and perceived significance. Similarly, Zhao et al. (2020) discovered that consumers identify glass and stand-up pouches with premium quality due to their durability and simplicity of use, which may contribute to these package options' better acceptance ratings.

The table displays that respondents preferred both the glass pouch and zip-lock packaging for their level of technical performance, with each receiving a mean rating of 4.20, which was classified as "Very Good." This high level of acceptance highlights the effectiveness and practicality of these forms of packaging to preserve the quality and usefulness of the garlic mayonnaise. Kumar et al. (2023) stated that glass pouches are often preferred for their ability to provide an excellent barrier against moisture and oxygen, which helps in preserving the freshness and flavor of food whereas Wang & Liu (2019) found that zip-lock packaging is highly valued for its resealability, which enhances convenience and helps in maintaining product integrity over multiple uses.

Table 7 presents the economic viability of the packaging material for the garlic mayonnaise in which the stand-up pouch was the most popular packaging option, obtaining a mean rating of 4.83, which is regarded as "Excellent." This significant degree of acceptance points out the stand-up pouch's cost-effectiveness and practicality, making it an ideal choice for packaging garlic mayonnaise. Furthermore, the potential of modifying stand-up pouches with resealable features increases their utility, which contributes to their growing recognition among consumers (Victor, 2024).

The table further strengthens the preference of the respondents for making the glass pouch and stand-up pouch for environmental soundness and social acceptability, with mean ratings of 4.25 and 4.50, respectively, both classified as "Excellent." This inclination reflects a growing consumer awareness and demand for sustainable packaging solutions that align with environmental and social values. Glass pouches are preferred because they are recyclable and have perceived environmental benefits (Hopewell, Dvorak, & Kosior, 2020). Marsh and Bugusu (2019) underlined that flexible packaging solutions, such as stand-up pouches, utilize much less material than rigid containers, reducing waste and energy usage in both manufacturing and transportation.

IV. Conclusion

Implication

These findings indicate that while T3 formulation of garlic mayonnaise is the most preferred in terms of sensory attributes such as taste, aroma, and color, and adheres to safety standards during its initial shelf life, its susceptibility to microbial contamination, particularly

Staphylococcus aureus, after 15-17 days at room temperature suggests the need for improved preservation strategies.

Meanwhile, T0, despite being less favored in sensory qualities, demonstrates higher economic viability and longer profitability potential. Therefore, manufacturers may need to balance product appeal with cost and shelf life or consider enhanced packaging and storage methods to mitigate microbial risks in formulations like T3.

Conclusion

The findings of this study have led to several important conclusions. The formulation of garlic mayonnaise, T0, T1, T2, and T3 Aerobic Plate Counts are within the normal permitted range with no or limited presence of microbial pathogens.

The formulation of garlic mayonnaise T3, containing 1 egg whole + 1 tsp. mustard + 1-2 tbsp lemon juice + ½ tsp. salt + 2 cups oil + 250 grams garlic is the most accepted in terms of Taste, Aroma, and Color, while T0-Control, involving the basic ingredients is the most preferred in terms of Spreading consistency.

There is a significant difference between the formulations of T0 and T3, and T2 and T3 in terms of taste; T0 and T1, T0 and T2 for aroma; T0 and T1 for color; and T0 and T1, and T0 and T2 for spreading consistency.

Zip lock is the most accepted packaging type in terms of technical performance, while stand up pouch for economic viability. Both glass pouch and stand up pouch are the most accepted in terms of environmental soundness and social acceptability.

The T3 formulation, regarded as the best product, shows that its moisture content, ash, and fat levels are all within the permitted range for garlic mayonnaise. However, its protein content is around average.

The T3 formulation, hailed as the best product detected the presence of *Staphylococcus aureus* from the 15th to the 17th day of observation, as well as mold on the 17th day when stored at room temperature. When refrigerated it takes 22 days before the inhibition of *Staphylococcus aureus*.

The T0 garlic mayonnaise formulation has shown the highest Return on Investment (ROI), net profit, and sales delivering the best balance of cost-effectiveness and profitability, optimizing financial returns and making them the most economically feasible manufacturing opportunities.

V. Recommendations

Implementing a stringent quality control system is paramount to ensuring the safety and quality of garlic mayonnaise, including frequent and systematic microbiological testing at every phase of manufacturing process, from raw material inspection to final product packaging and storage, which can aid in the early detection and mitigation of harmful contaminants.

The garlic mayonnaise formulation, T3 containing 1 egg whole + 1 tsp. mustard + 1-2 tbsps lemon juice + ½ tsp. salt + 2 cups oil + 250 grams garlic is recommended to be utilized for consumption.

Adjustments to the garlic quantity or the emulsification process in garlic mayonnaise variances could produce a smoother texture, followed by a re-evaluation of sensory characteristics to help optimize the formulation and make it more desirable to consumers.

Stand-up pouch packaging should be used for garlic mayonnaise because it is more cost-effective, environmentally friendly, and uses less material than rigid containers, minimizing production and transportation costs, while its versatility enables efficient storage, enhancing convenience and reducing waste.

The addition of protein-rich natural plants to garlic mayonnaise offers a compelling chance to improve its nutritional profile, appeal to health-conscious customers, and considerably increase overall protein content per serving.

The T3 formulation of garlic mayonnaise is recommended for consumption within 15 days from its manufacturing date and should be kept refrigerated after purchase.

To optimize the prospects of garlic mayonnaise and ensure that it can compete effectively with existing market products, it is recommended that mayonnaise T0 treatment formulation be available for purchase locally because it demonstrated excellent profitability, and strong financial performance that it is well-received by consumers and provides an edge in terms of market approval and production efficiency.

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