MODERN MEDICINE AND PRACTICE
https://inovatus.es/index.php/ejmmp

EUROPEAN JOURNAL OF MODERN MEDICINE AND PRACTICE
Vol. 5 No. 12 (Dec - 2025) EJMMP ISSN: 2795-921X

ENRICHMENT OF MAYONNAISE PRODUCTS AND ASSESSMENT OF THEIR SAFETY

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Abstract: Mayonnaise is one of the most widely consumed emulsified food products in many countries due to its pleasant taste, creamy texture, and versatility in culinary applications. However, traditional mayonnaise formulations are often characterised by high fat content and limited nutritional value, which raises concerns regarding their long-term impact on human health. The present study aims to investigate approaches to enriching mayonnaise products with biologically valuable ingredients while simultaneously assessing their safety indicators. Particular attention is given to the incorporation of natural functional additives such as plant-based oils, dietary fibres, vitamins, and antioxidant-rich components that may enhance the nutritional profile of the product without compromising sensory quality. In addition to enrichment strategies, the research focuses on evaluating the microbiological, chemical, and toxicological safety of the improved mayonnaise formulations. Ensuring product safety is especially important due to the presence of eggs and oil, which create favourable conditions for microbial growth if processing and storage conditions are inadequate. Modern analytical and laboratory methods were applied to determine compliance with food safety standards and regulatory requirements. The findings of this study demonstrate that mayonnaise products can be successfully enriched with functional ingredients while maintaining acceptable organoleptic properties and meeting safety criteria. The results contribute to the development of healthier mayonnaise products that meet consumer demand for nutritious and safe foods. This research has practical significance for food technologists and manufacturers seeking to improve product quality and competitiveness in the functional food market.

Introduction

In recent years, growing consumer awareness of healthy nutrition has significantly influenced the food industry, encouraging the development of products with improved nutritional value and enhanced safety. Mayonnaise, as a popular high-fat emulsified sauce, is frequently criticized for its excessive calorie content and low concentration of essential nutrients. Despite this, its widespread consumption makes it a promising candidate for functional enrichment rather than elimination from the diet. The enrichment of mayonnaise involves modifying its formulation by introducing biologically active components that can provide health benefits beyond basic nutrition. These components may include omega-3 fatty acids, plant extracts, vitamins, minerals, and natural antioxidants. The challenge lies in achieving a balance between nutritional improvement, product stability, sensory acceptability, and microbiological safety. Changes in formulation can affect emulsion stability, shelf life, and susceptibility to spoilage, which necessitates comprehensive safety assessment. Food safety remains a critical issue in mayonnaise production due to the use of raw or pasteurized eggs, oil, and water, all of which may serve as potential sources of contamination. Pathogenic microorganisms, oxidation processes, and chemical hazards must be carefully controlled to ensure

consumer safety. Therefore, any attempt to enrich mayonnaise must be accompanied by rigorous evaluation of safety parameters. This study addresses the dual objective of improving the nutritional quality of mayonnaise products and ensuring their safety. By exploring enrichment strategies alongside safety assessment, the research responds to current trends in functional food development and public health protection.

Materials and Methods

The methodological framework of this study was designed to comprehensively evaluate both the enrichment potential and safety indicators of mayonnaise products under controlled laboratory conditions. A classical full-fat mayonnaise formulation was used as the control sample, while several enriched variants were developed as experimental samples. The selection of enrichment ingredients was based on their nutritional relevance, technological compatibility with emulsified systems, and proven safety for food applications. Particular attention was given to natural components that could enhance biological value without introducing synthetic additives.

Vegetable oils rich in unsaturated fatty acids were incorporated to improve the lipid profile of the product. Plant-derived dietary fibers were selected to increase functional value and improve textural characteristics. In addition, natural antioxidant sources were included to reduce oxidative degradation and support product stability during storage. All raw materials complied with food-grade standards and were stored under appropriate conditions prior to use.

Mayonnaise samples were prepared using a standardized emulsification process. Initially, liquid and dry ingredients were weighed with analytical precision to ensure formulation accuracy. The aqueous phase was prepared by mixing egg yolk, vinegar, salt, and water under continuous stirring. The oil phase was then gradually incorporated into the aqueous mixture at a controlled rate to achieve stable emulsion formation. Enrichment ingredients were introduced at predetermined stages of processing to ensure uniform distribution and minimize destabilization risks.

Physicochemical analyses were conducted to assess product quality and stability. The pH value was measured using a calibrated digital pH meter, as pH plays a crucial role in both emulsion stability and microbial safety. Moisture and fat content were determined using standard gravimetric methods. Emulsion stability was evaluated by centrifugation and thermal stress testing, allowing the identification of phase separation tendencies.

Sensory evaluation was performed by a trained panel using descriptive analysis techniques. Attributes such as appearance, color uniformity, aroma, taste balance, and texture were assessed under controlled conditions. This evaluation provided insight into consumer acceptability and the impact of enrichment on sensory quality.

Microbiological safety assessment included determination of total viable count, yeast and mold content, and screening for pathogenic microorganisms according to internationally accepted food safety protocols. Chemical safety evaluation focused on indicators of lipid oxidation, including peroxide value and acid value, measured at regular storage intervals.

All experiments were conducted in triplicate to ensure reproducibility. Statistical analysis of the obtained data was performed using standard analytical methods, allowing reliable comparison between control and enriched samples and ensuring objectivity of the results.

Results

The results of the study clearly demonstrate that enrichment of mayonnaise with biologically valuable ingredients had a positive impact on both nutritional quality and product stability. Comparative analysis

between the control sample and enriched formulations revealed noticeable improvements in functional characteristics without compromising safety indicators. All experimental samples maintained a stable emulsion structure throughout the observation period, indicating that the enrichment strategy was technologically appropriate. One of the most significant findings was the improvement in lipid quality of the enriched mayonnaise samples. The incorporation of vegetable oils rich in unsaturated fatty acids resulted in a more favourable fatty acid profile compared to the control formulation. This modification is particularly important from a nutritional perspective, as it supports the reduction of saturated fat intake while enhancing the biological value of the product. At the same time, fat content remained within acceptable regulatory limits, ensuring compliance with food standards.

Physicochemical analysis showed that the pH values of enriched samples were slightly lower than those of the control, which is considered beneficial for microbiological stability. The presence of dietary fibres contributed to improved texture and viscosity, resulting in a more uniform and creamy consistency. Emulsion stability tests confirmed that no phase separation occurred under centrifugation or thermal stress conditions, highlighting the compatibility of enrichment components with the mayonnaise matrix.

Microbiological examination confirmed the safety of all samples. Total viable counts and yeast and mould levels remained well below permissible limits during storage. No pathogenic microorganisms were detected in either control or enriched mayonnaise, indicating that hygienic processing conditions were effectively maintained. Furthermore, chemical safety analysis revealed that enriched samples exhibited lower peroxide and acid values, suggesting reduced lipid oxidation due to the presence of natural antioxidants. Overall, the enriched mayonnaise formulations demonstrated superior functional performance while maintaining high safety standards. These results confirm that enrichment can be successfully implemented without negatively affecting product quality or shelf life.

Table 1. Comparative quality and safety indicators of control and enriched mayonnaise samples

Indicator	Control sample	Enriched sample
pH value	4.1 ± 0.1	3.9 ± 0.1
Fat content (%)	67.0 ± 1.2	65.5 ± 1.0
Emulsion stability (%)	96.2 ± 0.8	98.4 ± 0.6
Peroxide value (meq O_2/kg)	4.8 ± 0.3	2.9 ± 0.2
Total viable count (CFU/g)	$<1\times10^2$	$<1\times10^2$

The data presented in Table 1 illustrate the improved physicochemical stability and oxidative resistance of enriched mayonnaise samples compared to the traditional formulation, while microbiological safety indicators remained within acceptable limits for both samples. Microbiological analysis confirmed that all samples met food safety requirements. Pathogenic microorganisms were not detected, and total microbial counts remained within permissible limits throughout storage. Chemical analysis indicated that the presence of natural antioxidants contributed to reduced lipid oxidation, as reflected by lower peroxide values in enriched samples.

Discussion

The findings of the present study highlight the practical potential of enriching mayonnaise products with biologically valuable ingredients while maintaining high standards of quality and safety. The observed improvements in nutritional and functional characteristics confirm that traditional high-fat emulsified products can be successfully reformulated to better align with modern dietary expectations. Rather than eliminating mayonnaise from regular consumption, enrichment offers a realistic and consumer-friendly strategy for improving its health profile.

One of the key outcomes of this research is the demonstrated stability of enriched mayonnaise formulations. Emulsion stability is a critical quality parameter, as even minor destabilization can negatively affect texture, appearance, and consumer perception. The results indicate that the selected enrichment ingredients were well integrated into the emulsion system, contributing to a stable structure without inducing phase separation. This finding is particularly important for food manufacturers, as it suggests that nutritional enhancement does not necessarily require complex technological modifications.

From a nutritional perspective, the improvement in lipid composition and the inclusion of dietary fibres represent meaningful advancements. Unsaturated fatty acids are widely recognised for their positive effects on cardiovascular health, while dietary fibres contribute to digestive well-being and improved satiety. The successful incorporation of these components into mayonnaise demonstrates its potential role as a functional food rather than merely a flavour-enhancing condiment.

Safety considerations play a decisive role in the acceptance of enriched food products. The absence of pathogenic microorganisms and the consistently low microbial counts observed in this study confirm that enriched formulations can meet strict food safety requirements when proper hygienic practices are followed. Additionally, the reduced peroxide values in enriched samples suggest enhanced resistance to lipid oxidation, which is essential for maintaining product quality during storage and distribution. The use of natural antioxidants appears to be particularly effective in slowing oxidative degradation. Overall, the results support the concept that mayonnaise enrichment can simultaneously address nutritional improvement and safety assurance. The outcomes of this study provide a scientific basis for further development of functional mayonnaise products and encourage continued research into the use of natural, health-promoting ingredients in emulsified foods.

Conclusion

This study demonstrates that mayonnaise products can be successfully enriched with biologically valuable ingredients while preserving their essential quality attributes and safety requirements. The incorporation of functional components such as unsaturated vegetable oils, dietary fibers, and natural antioxidants resulted in a product with improved nutritional value and enhanced oxidative stability. Importantly, these improvements were achieved without negatively affecting emulsion stability, sensory acceptability, or consumer-oriented characteristics.

The comprehensive safety assessment confirmed that enriched mayonnaise formulations fully complied with microbiological and chemical safety standards. The absence of pathogenic microorganisms and the maintenance of low microbial counts throughout storage indicate that enrichment does not increase safety risks when proper hygienic and technological practices are applied. Moreover, the reduction in lipid oxidation indicators highlights the protective role of natural antioxidants in extending shelf life and maintaining product freshness.

From a practical perspective, the findings support the feasibility of developing functional mayonnaise products that respond to current consumer demand for healthier food options. Enrichment offers an effective strategy for improving the biological value of traditional emulsified foods without requiring radical changes in production technology. Overall, this research provides a solid scientific foundation for further innovation in mayonnaise formulation and contributes to the advancement of safe, nutritious, and competitive food products in the modern food industry.

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