

Development of Healthy Food Products: Keto Chicken Breast Meatballs Blended with Prasakaprao Recipe

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Abstract

The present study aimed to develop a healthy food product in the form of keto blended chicken breast meatballs formulated with Prasakaprao herbs and to evaluate their nutritional and chemical characteristics in accordance with ketogenic dietary principles. A controlled experimental research design was applied. Chicken breast meatballs were prepared using a standardized Prasakaprao herbal formulation and classified into two sample groups: before steaming and after steaming. Purposive sampling was employed, using 500 g of chicken breast per experimental batch, and all experiments were conducted in triplicate. Nutritional evaluation focused on protein content, amino acid composition, carbohydrate and fat contents, sugar and starch presence, and beta-carotene levels using standard analytical methods. The results showed that protein content increased from 19.39 g/100 g before steaming to 19.75 g/100 g after steaming. Amino acid analysis identified a total of 20 amino acids, including both essential and non-essential amino acids, with lysine being the most abundant essential amino acid in both samples. No detectable sugars or starch were found in either pre- or post-steaming samples, confirming suitability for ketogenic dietary consumption. Carbohydrate content increased slightly after steaming but remained at a very low level, while fat content decreased following steaming. Beta-carotene content decreased after steaming but remained detectable, indicating the presence of bioactive compounds derived from Prasakaprao herbs. Overall, the developed keto chicken breast meatballs exhibited favorable nutritional characteristics and potential as a health-oriented food product aligned with ketogenic dietary principles.

Keywords: Chicken Breast Meatballs, High-protein Food, Keto Diet, Ketogenic Product, Prasakaprao Herbs.

Introduction

In recent years, consumer lifestyles have shifted towards health-oriented behaviors, particularly focusing on dietary patterns that support disease prevention and long-term well-being. Among these trends, dietary strategies emphasizing high-quality protein intake, healthy fats, and reduced carbohydrate consumption have gained popularity, especially among individuals seeking improved metabolic health and weight management. One of the most widely adopted dietary approaches is the ketogenic diet, which promotes very low carbohydrate intake to stimulate the utilization of stored fat as the primary energy source (1). This popularity has intensified since the COVID-19 pandemic, as consumers have become more aware of the importance of nutrition, functional foods, and lifestyle practices that support immune function and overall health (2).

Protein plays a crucial role in human physiology and is essential for numerous biological processes, including tissue development, muscle repair,

enzyme production, and hormonal regulation (3). Adequate protein consumption is also linked to improved metabolic function, muscle maintenance, and physical performance (4). Among dietary protein sources, poultry meat, particularly chicken breast, is widely recognized as a high-quality protein source due to its favorable amino acid composition, high digestibility, and relatively low-fat content (5), making it an ideal raw material for high-protein food products aimed at health-conscious consumers.

The incorporation of herbs and plant-derived ingredients into meat products has garnered increasing research interest. Plant-based ingredients are known to contain bioactive compounds such as phenolic compounds, flavonoids, carotenoids, and essential oils, which exhibit antioxidant and anti-inflammatory properties (6). The inclusion of herbal ingredients in processed meat products has been shown to enhance nutritional value, improve oxidative stability, and contribute to the development of

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(Received 10th January 2026; Accepted 26th March 2026; Published 06th April 2026)

functional foods with potential health benefits (7). Among traditional herbal ingredients in Thai cuisine and medicine, Prasakaprao herbs are a notable example of a plant-based formulation with functional properties. The formulation typically includes holy basil (*Ocimum tenuiflorum*), garlic (*Allium sativum*), chili (*Capsicum spp.*), and other aromatic herbs containing bioactive phytochemicals like phenolics, flavonoids, and carotenoids. These compounds are associated with antioxidant activity, antimicrobial effects, and roles in lipid metabolism and glycemic regulation (8). Such properties are particularly relevant for dietary strategies targeting weight control and metabolic health improvement. Incorporating Prasakaprao herbs into meat products may enhance their nutritional profile and functional value while preserving traditional culinary characteristics (9). Despite the growing interest in ketogenic food products and functional meat products enriched with herbal ingredients, research exploring the integration of traditional Thai herbal formulations with high-protein meat products that comply with ketogenic dietary principles remains limited. There is insufficient empirical evidence regarding the nutritional composition, amino acid profile, carbohydrate restriction, and retention of bioactive compounds in processed chicken breast products formulated with Prasakaprao herbs. Addressing this research gap is vital for supporting the development of innovative functional foods that combine traditional herbal knowledge with modern nutritional approaches (10).

The researcher, being an expert in nutrition and holding a professional certification, conducted this study to develop and evaluate the nutritional and chemical characteristics of keto chicken breast meatballs blended with Prasakaprao herbs before and after thermal processing. This study will analyze protein content, amino acid composition, carbohydrate and fat levels, sugar and starch presence, and beta-carotene content in the developed product. The findings are expected to contribute to the development of functional ketogenic food products by using high-quality animal protein and nutritionally rich Thai herbal ingredients.

Theoretical Framework

The development of functional food products is often grounded in the integration of nutritional science, food processing technology, and

functional ingredient utilization. Functional foods are defined as foods that provide health benefits beyond basic nutrition through the presence of bioactive compounds that may contribute to improved physiological functions or disease prevention (11). In recent years, increasing attention has been given to the development of functional meat products by incorporating plant-derived ingredients with antioxidant and bioactive properties (12).

From a nutritional perspective, the ketogenic dietary concept provides an important theoretical basis for the development of high-protein and low-carbohydrate food products. The ketogenic diet emphasizes a significant reduction in carbohydrate intake while increasing the proportion of protein and fat to induce metabolic ketosis, a physiological state in which the body utilizes fat as its primary energy source. Such dietary strategies have been associated with weight management, improved metabolic regulation, and better control of blood glucose levels (13).

In addition, the application of herbal ingredients in food product development has been supported by the concept of nutraceuticals, which highlights the role of natural bioactive compounds in promoting health and preventing chronic diseases. Herbal plants commonly contain phytochemicals such as phenolic compounds, flavonoids, and carotenoids that exhibit antioxidant and anti-inflammatory properties (14). When incorporated into processed foods, these compounds may enhance both the nutritional quality and functional value of the final product (15).

Therefore, the theoretical foundation of this study integrates three main concepts: high-quality animal protein sources, functional herbal ingredients, and ketogenic dietary principles. This integrated perspective provides the basis for developing innovative food products that combine nutritional benefits with functional properties, particularly for consumers seeking healthier dietary alternatives.

Conceptual Framework of the Study

Based on the theoretical considerations discussed above, this study proposes a conceptual framework that integrates high-quality protein sources, functional herbal ingredients, and food processing techniques in the development of ketogenic-oriented food products.

In this framework, chicken breast is selected as the primary protein source due to its favorable amino acid profile, high digestibility, and relatively low-fat content (16). Prasakaprao herbs are incorporated as functional ingredients because they contain bioactive phytochemicals such as phenolics, flavonoids, and carotenoids that may contribute to antioxidant activity and metabolic health (17). The incorporation of these herbs is expected to enhance the functional value and nutritional profile of the developed food product. Furthermore, food processing techniques, particularly thermal processing through steaming, may influence the stability of nutrients and bioactive compounds in the final product (18).

Therefore, the processing method represents an important factor that may affect the nutritional composition of the developed food product.

Based on this conceptual framework, the present study evaluates the nutritional and chemical characteristics of keto chicken breast meatballs blended with Prasakaprao herbs by comparing samples before and after steaming. The evaluation focuses on key indicators including protein content, amino acid composition, carbohydrate and fat levels, sugar and starch presence, and beta-carotene content to assess the nutritional quality and functional potential of the developed product, as illustrated in Figure 1.

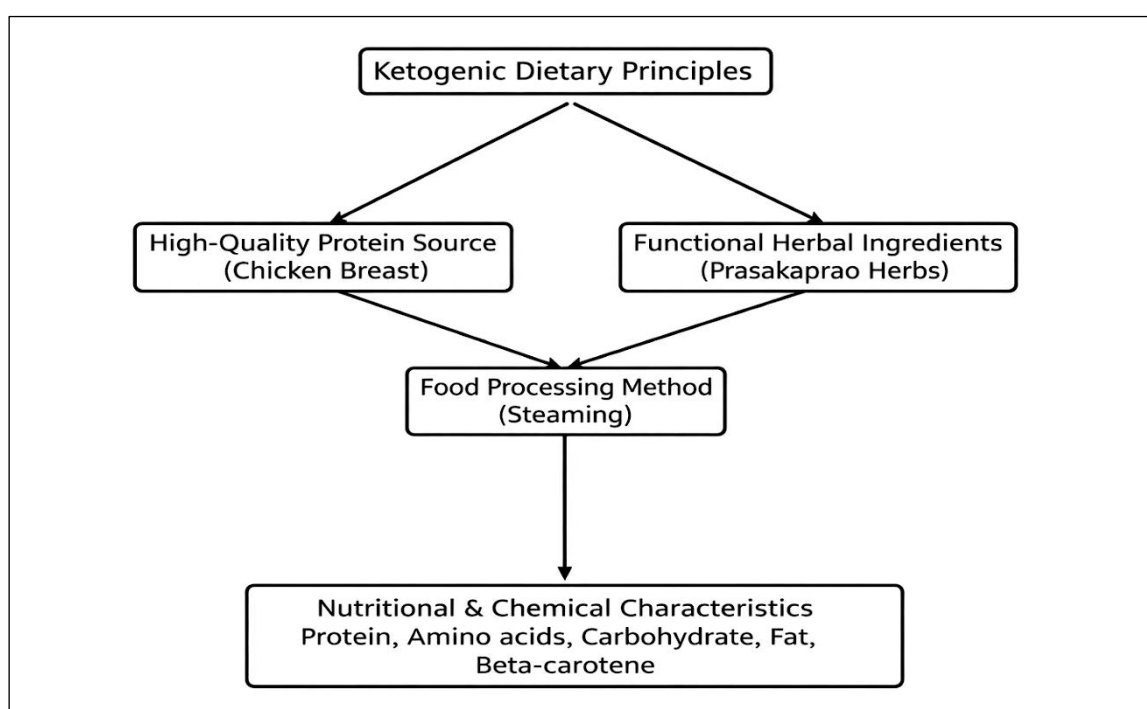


Figure 1: Conceptual Framework of the Study

Methodology

Research Design

This study employed a controlled experimental research design to evaluate the effects of thermal processing on the nutritional and chemical characteristics of keto blended chicken breast meatballs formulated with Prasakaprao herbs. The experimental design compared two sample conditions: meatball samples before steaming and meatball samples after steaming. The investigation focused on determining the nutritional composition of the developed product, including protein, carbohydrate, and fat contents, as well as

the presence of individual sugars (glucose, fructose, sucrose, maltose, and lactose). In addition, qualitative analysis of starch presence was performed to ensure that the developed product complied with the principles of ketogenic dietary requirements.

Sample Preparation

Fresh chicken breast was used as the primary raw material for the preparation of keto chicken breast meatballs. The chicken breast was obtained from the same supplier to maintain consistency in raw materials. For each experimental batch, 500 g of chicken breast was prepared and mixed with egg

and Prasakaprao herbal ingredients according to the formulated recipe. The mixture was blended using a food blender until a homogeneous texture was achieved and subsequently shaped into meatballs of similar size.

The prepared meatballs were divided into two experimental groups: (a) samples prior to steaming and (b) samples after steaming. The steaming process was conducted at approximately 100 °C using a temperature-controlled electric stove. After steaming, the samples were allowed to cool to room temperature before further analysis. All samples were placed in labeled containers and stored at -18 °C until laboratory analysis was performed. To ensure reliability and reproducibility of the results, all experiments were conducted in triplicate.

Research Instruments and Analytical Materials

The research instruments consisted of laboratory equipment and analytical instruments used for nutritional and chemical analyses. Protein content was determined using a Kjeldahl digestion and distillation apparatus following the standard analytical procedure for nitrogen determination in food samples (19). Individual sugar analysis was conducted using a high-performance liquid chromatography (HPLC) system based on established chromatographic analytical methods for sugar determination in food products (20).

Additional laboratory equipment included a temperature-controlled electric stove for steaming, a food blender for sample preparation, a high-precision digital balance for weighing samples, and standard laboratory glassware. Analytical-grade chemicals were used in all laboratory procedures, including sulfuric acid, sodium hydroxide, boric acid and Kjeldahl catalysts for protein determination. Reference standards for sugar analysis were also used for calibration and validation of the HPLC system.

To ensure the accuracy and reliability of analytical measurements, quality control procedures were implemented, including sample replication, calibration using reference standards, and the use of blank samples during laboratory analysis. All analytical procedures followed internationally

accepted methods for food composition analysis (21).

Data Collection Procedure

The experimental procedure consisted of several stages. First, 500 g of fresh chicken breast was prepared and combined with egg and Prasakaprao herbs based on the formulated recipe. The ingredients were mixed and blended until a uniform mixture was obtained. The mixture was then shaped into meatballs.

Second, the prepared meatballs were divided into two groups for comparison: samples before steaming and samples after steaming. The steaming process was conducted at approximately 100 °C. After steaming, the samples were cooled and stored under frozen conditions at -18 °C until chemical analysis was performed.

Third, the prepared samples were submitted for laboratory analysis to determine their nutritional and chemical composition. The analyses included determination of protein content, carbohydrate and fat contents, individual sugar profiles, and qualitative detection of starch. All analyses were performed in triplicate to improve the reliability of the experimental data.

Results

Protein content was determined using the Kjeldahl method for nitrogen analysis in food samples (22). Individual sugar components, including glucose, fructose, sucrose, maltose, and lactose, were analyzed using high-performance liquid chromatography (HPLC) following standard chromatographic procedures for sugar determination (23). The presence of starch was evaluated qualitatively using an iodine solution test according to standard food analysis procedures (24).

All laboratory analyses were conducted in triplicate, and the obtained values were used to calculate mean values for each parameter. Descriptive statistical analysis was applied to summarize the experimental results, and the findings were presented in tabular form accompanied by academic narrative explanations to facilitate interpretation of the data.

The experimental procedure of this study is illustrated in Figure 2.

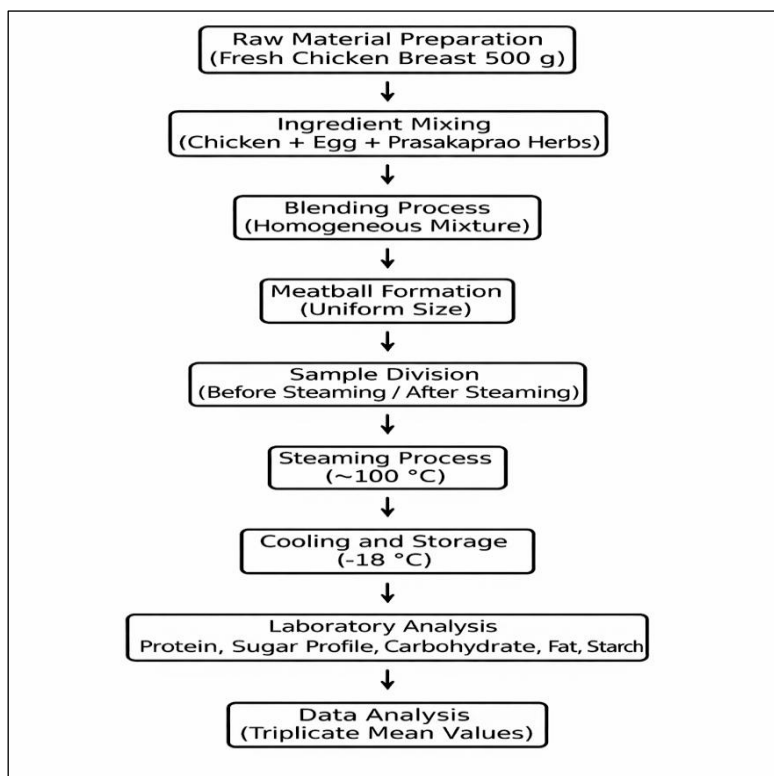


Figure 2: Experimental Procedure for the Preparation and Nutritional Analysis of Keto Chicken Breast Meatballs Blended with Prasakaprao Herbs

Table 1: Protein Content of Keto Chicken Breast Meatballs Before and After Steaming

Sample condition	Protein (g/100 g)	SD	SE
Before steaming	19.39	0.10	0.06
After steaming	19.75	0.12	0.07

Notes: SD: Standard Deviation, SE: Standard Error

Amino Acid Composition

The amino acid profiles of keto chicken breast meatballs before and after steaming are shown in Table 2. A total of 20 amino acids were identified, comprising both essential and non-essential amino acids. The concentrations of most amino acids were higher after steaming. Lysine was the most

abundant essential amino acid, increasing from 1619.90 mg/100 g before steaming to 1789.62 mg/100 g after steaming. Histidine showed a slight decrease following steaming. Among the non-essential amino acids, glutamic acid, aspartic acid, alanine, and arginine were present at relatively high levels in both samples. Hydroxyproline and hydroxylysine were not detected.

Table 2: Amino Acid Composition of Keto Chicken Breast Meatballs Before and After Steaming (mg/100 g)

Amino Acid	Before Steaming (mg/100 g)	After Steaming (mg/100 g)	SD	SE
Essential amino acids (9 types)				
Lysine	1619.90	1789.62	30	17
Leucine	1541.70	1699.83	28	16
Valine	953.75	1058.19	20	12
Histidine	942.29	899.53	15	9
Threonine	879.61	960.06	18	10
Isoleucine	821.94	930.70	17	10
Phenylalanine	782.40	862.89	14	8
Methionine	467.03	481.20	10	6
Tryptophan	190.08	204.50	5	3

Amino Acid	Before Steaming (mg/100 g)	After Steaming (mg/100 g)	SD	SE
Non-essential and conditionally essential amino acids (11 types)				
Glutamic acid	3044.71	3335.27	30	17
Aspartic acid	1999.03	2169.76	28	16
Arginine	1196.26	1279.67	20	12
Alanine	1135.57	1217.83	15	9
Serine	917.31	972.32	18	10
Glycine	841.38	884.95	17	10
Proline	633.75	686.77	14	8
Tyrosine	612.52	716.88	10	6
Cystine	200.00	200.00	5	3
Hydroxyproline	ND	ND	0	0
Hydroxylysine	ND	ND	0	0

Notes: ND: Not Detected, SD: Standard Deviation, SE: Standard Error

Sugar and Starch Content

The presence of sugars in the keto chicken breast meatballs is summarized in Table 3. No detectable levels of sugars were found in either the pre-steaming or post-steaming samples. Starch was not detected in any samples.

Carbohydrate and Fat Contents

Carbohydrate and fat contents before and after steaming are presented in Table 4. Carbohydrate content increased from 0.48 mg/100 g before steaming to 3.00 mg/100 g after steaming. In contrast, fat content decreased from 3.02 mg/100 g to 1.40 mg/100 g following steaming.

Table 3: Sugar and Starch Content of Keto Chicken Breast Meatballs Before and After Steaming

Parameter	Before steaming	After steaming	SD	SE
Glucose	ND	ND	0	0
Fructose	ND	ND	0	0
Sucrose	ND	ND	0	0
Maltose	ND	ND	0	0
Lactose	ND	ND	0	0
Starch	ND	ND	0	0

Notes: ND: Not Detected, SD: Standard Deviation, SE: Standard Error

Table 4: Carbohydrate and Fat Contents of Keto Chicken Breast Meatballs Before and After Steaming

Component	Before steaming	After steaming	SD	SE
Carbohydrate (mg/100 g)	0.48	3.00	0.20	0.12
Fat (mg/100 g)	3.02	1.40	0.15	0.09

Notes: ND: Not Detected, SD: Standard Deviation, SE: Standard Error

Table 5: Beta-carotene Content of Keto Chicken Breast Meatballs Before and After Steaming

Sample condition	Beta-carotene ($\mu\text{g}/100\text{ g}$)	SD	SE
Before steaming	6.14	0.30	0.17
After steaming	4.02	0.25	0.14

Notes: ND: Not Detected, SD: Standard Deviation, SE: Standard Error

Beta-carotene Content

Beta-carotene content of the keto chicken breast meatballs before and after steaming is shown in Table 5. The average beta-carotene content decreased from 6.14 $\mu\text{g}/100\text{ g}$ in the pre-steaming samples to 4.02 $\mu\text{g}/100\text{ g}$ in the post-steaming samples.

Discussion

The results of this study demonstrate that the development of keto blended chicken breast meatballs formulated with Prasakaprao herbs produced a food product with nutritional characteristics consistent with the principles of

ketogenic dietary patterns. The product maintained high protein levels while containing minimal carbohydrate and fat contents, indicating its suitability as a functional meat product designed for health-conscious consumers. These findings support previous research emphasizing the growing potential of value-added meat products developed with functional ingredients and improved nutritional profiles (16).

Protein and Amino Acid Content

The observed increase in protein content after steaming suggests that thermal processing did not negatively affect protein quality. Instead, the slight increase may be attributed to moisture loss during heat treatment, which concentrates the protein fraction per unit weight. Similar findings have been reported in previous studies investigating thermal processing in meat products, where controlled heating resulted in increased apparent protein concentration without compromising protein functionality (17, 18). These observations are consistent with established meat science principles, which indicate that moderate heat treatment may alter the physical properties of proteins while preserving their nutritional value (19). Furthermore, the analytical procedures applied in this study align with standard protein determination methods recommended by AOAC International (20), supporting the reliability of the results.

The amino acid analysis further confirmed that the developed product contains a complete profile of essential and non-essential amino acids. Essential amino acids such as lysine, leucine, valine, and isoleucine were present at relatively high concentrations, which are known to play key roles in muscle protein synthesis and metabolic regulation. These findings are consistent with previous studies that identified poultry meat as a nutritionally valuable protein source suitable for high-protein dietary patterns and ketogenic diets (21). In addition, the absence of hydroxyproline and hydroxylysine suggests a relatively low collagen content in the product, which is characteristic of chicken breast meat. This structural property contributes to improved digestibility and desirable texture, as reported in previous research on poultry meat composition (22).

Sugar and Starch Content

The absence of detectable sugars, including glucose, fructose, sucrose, maltose, and lactose, together with the absence of starch, indicates that the formulation and ingredient selection used in this study were appropriate for ketogenic dietary requirements. The ketogenic diet requires strict carbohydrate restriction to maintain metabolic ketosis and prevent rapid postprandial increases in blood glucose levels. Therefore, the results obtained in this study support the suitability of the developed product for individuals following ketogenic or low-carbohydrate dietary patterns. Similar findings have been reported in studies investigating the formulation of health-oriented processed meat products designed to minimize carbohydrate content and improve metabolic health outcomes (23, 24). In addition, previous research on functional meat product development has demonstrated that eliminating added sugars and starch can improve the nutritional profile of processed meat products while maintaining acceptable product quality (25).

Carbohydrate and Fat Content

Although a slight increase in carbohydrate content was observed after steaming, the measured values remained extremely low and within acceptable limits for ketogenic dietary consumption. This minor increase may be explained by moisture loss during steaming, which can lead to proportional changes in the concentration of nutrients measured per unit weight. Similar phenomena have been reported in previous studies examining the effects of thermal processing on the proximate composition of meat products (26). In contrast, the reduction in fat content observed after steaming is consistent with findings from earlier research indicating that heat treatment can cause partial fat melting and loss during cooking processes (27). These compositional changes further enhance the nutritional suitability of keto chicken breast meatballs as a high-protein and low-fat food option for individuals seeking healthier dietary choices or weight management strategies.

Beta-carotene Content and Herbal Functional Properties

The decrease in beta-carotene content after steaming reflects the thermal sensitivity of carotenoids and other bioactive compounds commonly found in plant-based ingredients. Previous studies have reported that carotenoids

may undergo partial degradation when exposed to high temperatures during cooking or food processing (28, 29). Nevertheless, the detection of beta-carotene in the steamed samples indicates that a portion of these bioactive compounds remained stable after thermal processing. This finding highlights the potential contribution of Prasakaprao herbs as functional ingredients in the developed product. The presence of these compounds supports the growing body of research suggesting that the incorporation of herbs and plant extracts into meat products can enhance antioxidant properties and contribute to the development of functional foods with added health benefits (30).

Conclusion

This study demonstrated that keto blended chicken breast meatballs formulated with the Prasakaprao herbal recipe possess favorable nutritional and chemical characteristics consistent with ketogenic dietary principles. The product exhibited high protein content, a complete amino acid profile, absence of sugars and starch, and low carbohydrate and fat levels, confirming its suitability as a ketogenic-oriented food product. Steaming influenced certain nutritional parameters, including proportional increases in protein and carbohydrate content and reductions in fat and beta-carotene levels; however, these changes did not compromise the overall nutritional quality of the product. The presence of essential amino acids and detectable bioactive compounds highlights the functional contribution of chicken breast protein and Prasakaprao herbs. Overall, the findings support the potential of keto chicken breast meatballs as a value-added, health-oriented processed meat product that meets current consumer demand for convenient, high-protein, and low-carbohydrate foods.

Strengths of the Study

This study has several notable strengths. First, it provides empirical evidence on the nutritional and chemical characteristics of a keto-oriented processed meat product formulated with chicken breast and Prasakaprao herbs, addressing a research gap in the development of ready-to-eat ketogenic foods using traditional Thai ingredients. Second, the study employed standardized analytical methods to evaluate protein content, amino acid profiles, sugar and starch presence, and

bioactive compounds, ensuring reliability and reproducibility of the results. Third, the comparison of nutritional parameters before and after steaming offers practical insights into the effects of thermal processing on product quality, which is relevant for food processing and product development. Finally, the integration of high-quality animal protein with functional herbs highlights the potential for developing value-added, health-oriented meat products that align with current consumer demand for high-protein and low-carbohydrate diets.

Limitations

Despite the strengths of this study, several limitations should be acknowledged. First, the study focused primarily on nutritional and chemical composition under controlled laboratory conditions; therefore, sensory attributes such as taste, texture, and consumer acceptability were not evaluated. Second, the product was assessed using a single cooking method, namely steaming, and the effects of alternative processing methods were not examined. Third, the study evaluated nutritional parameters at a single production scale, which may limit direct generalization to industrial-scale processing. In addition, the stability of bioactive compounds and nutritional quality during extended storage was not investigated. These limitations suggest that further studies are needed to comprehensively evaluate product quality, consumer acceptance, and processing feasibility in broader application contexts.

Abbreviations

AOAC: Association of Official Analytical Chemists, HPLC: High-Performance Liquid Chromatography, ND: Not Detected, SD: Standard Deviation, SE: Standard Error.

Acknowledgement

The research article titled “The Development of Healthy Food Products Keto Chicken Breast Meatballs Blender with Prasakaprao Recipe” is part of the study at the faculty of Applied Thai Traditional Medicine, Suan Sunandha Rajabhat University. The researcher would like to express sincere and deep gratitude to Dr. Supalak Fakham, the thesis advisors, for their dedicated guidance, insightful feedback, and constant encouragement throughout every stage of this study. Their academic expertise, meticulous attention to detail, and constructive comments have greatly enriched

the quality of this work. In addition, the researcher extends heartfelt thanks to the faculty members, academic staff, and educational leaders who contributed their knowledge and perspectives during the data collection process. Their participation and support were vital in shaping the findings and recommendations presented in this article. Finally, this research is also dedicated with love and gratitude to the researcher's family, whose unwavering support and encouragement provided the strength and motivation to complete this academic journey. Any remaining errors are solely the responsibility of the researcher.

Author Contributions

Kanasine Khongmaklum: conceptualization, conducted the study, data collection, data analysis, interpretation of the results, manuscript-draft, Supalak Fakham: conceptualization, data analysis, interpretation of the results. Both authors critically reviewed and approved the final version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

Data Availability

The datasets generated and analyzed during the current study are not publicly available but are available from the corresponding author upon reasonable request.

Declaration of Artificial Intelligence (AI) Assistance

This manuscript was written by the authors without the use of generative AI or AI-assisted technologies. All content is original and has been created by the authors themselves.

Ethics Approval

This study did not involve human participants or animals. All experiments were conducted under controlled laboratory conditions using food ingredients and standard analytical procedures. Therefore, ethical approval was not required for this research.

Funding

No funds were received to conduct the study.

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How to Cite: Khongmaklum K, Fakham S. Development of Healthy Food Products: Keto Chicken Breast Meatballs Blended with Prasakaprao Recipe. *Int Res J Multidiscip Scope.* 2026; 7(2): 430-439.

DOI: 10.47857/irjms.2026.v07i02.010505