Electronic Journal of University of Aden for Basic and Applied Sciences

EJUA-BA Vol. 6 No. 3 (2025)

https://doi.org/10.47372/ejua-ba.2025.3.453

ISSN: 2708-0684

RESEARCH ARTICLE

EVALUATION OF THE CHEMICAL COMPOSITION AND TOTAL CALORIC CONTENT OF SELECTED TRADITIONAL YEMENI FOODS SOLD IN SANA'A, YEMEN

Mohammed Alsebaeai[1,2,*], Lutf Al-Rahbi[3], Wadhah Edrees[4], Nabil Aldoubai[1], Ramzi Gazem[1], and Zakarya Al-Zamani[1]

[1] *Dept. of Food Science and Technology, Faculty of Agriculture and food Science, Ibb University, Yemen*
[2] *Dept. of Therapeutic Nutrition Queen Arwa University, Sana'a City, Yemen*
[3] *Dept. of Dentistry, Faculty of Medical Sciences, Queen Arwa University, Sana'a City, Yemen*
[4] *Dept. of Medical Laboratory, Faculty of Medicine and Health Sciences, Hajjah University, Hajjah, Yemen*

***Corresponding author: Mohammed Alsebaeai; E-mail: malsobaee22@gmail.com; Tel: (+967) 774488038**

Received: 18 July 2025 / Accepted: 03 August 2025 / Published online: 30 September 2025

Abstract

Traditional Yemeni foods such as Sabaya, Maloje, Lahouh, Al-Zum, and Fahsa lack documented data on their chemical composition. This study aimed to evaluate the moisture, protein, fat, carbohydrate content, and total caloric value of these five foods. Laboratory analyses were conducted at Queen Arwa University and Sana'a University. Moisture content ranged from 26.46% in Maloje to 84.09% in Al-Zum, this variation is primarily attributed to differences in the composition and preparation methods of the foods. Fahsa, a meat-based dish, showed the highest protein content (8.45%), while Maloje had the highest carbohydrate content (63.09%) due to its wheat flour base. Sabaya recorded the highest fat (36.34%) and caloric content (462 Kcal/100g), attributed to the use of butter or ghee. In contrast, Al-Zum had the lowest energy value at 74 Kcal/100g. The findings reveal significant variations in the nutritional composition of these dishes, reflecting their diverse ingredients and preparation methods. This study provides valuable insights into the dietary contributions of traditional Yemeni foods. These findings also emphasize the importance of a balanced intake of traditional Yemeni foods to support health, suggesting Fahsa for protein, Maloje and Lahouh for energy, and limited consumption of high-fat dishes like Sabaya.

Keywords: Food, Traditional, Chemica Analysis, Yemen.

1. Introduction

Yemeni cuisine is one of the most important, richest and diverse Arab cuisines, as it combines a large number of foods and meals that represent the cultural heritage of this ancient country and the land of successive civilizations, and these customs differ from one region or city to another. These foods have become famous in most Arab countries and all countries of the world because these dishes are distinguished by a distinctive flavor and aroma that gives them a prominent place on international food menus, and no country is devoid of a restaurant that offers distinctive Yemeni food [1]. Traditional Yemeni foods are an essential component of the country's cultural and dietary heritage, providing key macronutrients and energy needed for daily sustenance. These foods are diverse, often consisting of grains, legumes, meats, dairy products, and a variety of spices, each contributing to the overall nutritional intake of the population. However, despite their widespread consumption, limited research has been conducted on their chemical composition and total caloric content. Understanding these factors is crucial for evaluating their nutritional value and potential health implications [2]

Food composition analysis is essential for assessing the macronutrient distribution, including carbohydrates, proteins, fats, fiber, and micronutrients. This information helps in dietary planning, especially in populations at risk of malnutrition or metabolic diseases. Moreover, caloric evaluation is necessary for understanding the energy contribution of these foods, which plays a significant role

in maintaining a balanced diet and preventing lifestyle-related disorders such as obesity and diabetes [3].

Previous local research has focused on enhancing the nutritional quality of commonly consumed foods, such as enriching tomato sauce with dietary fiber to improve both sensory properties and health benefits[4], as well as on ensuring the safety and hygiene of food products like yogurt sold in Sana'a markets [5]. These studies underline a growing interest in nutrition-oriented research in Yemen, particularly in enhancing food quality and ensuring public health safety. Several studies have emphasized the importance of documenting the nutritional composition of traditional foods to support public health initiatives and food policy development [6].

Traditional Yemeni foods such as Lahouh, Sabaya, Fahsa, Al-Zum, and Malouj hold significant cultural and nutritional value in the daily lives of Yemenis. These dishes are not only staples in Yemeni households but also represent the country's rich culinary heritage, deeply rooted in historical and social traditions. Lahouh, a spongy sourdough flatbread, and Malouj, a type of baked flatbread, are commonly consumed as daily carbohydrate sources, especially during breakfast and lunch, contributing essential energy through their carbohydrate content. Fahsa, a hearty meat stew often cooked with fenugreek, is a protein-rich dish traditionally served during gatherings and special occasions, highlighting its social and nutritional significance. Sabaya, a layered pastry dish, is often enjoyed with honey or dates and is regarded as a celebratory item, particularly during religious festivals. Al-Zum, a fermented dairy-based soup made with buttermilk or dried yogurt, plays a crucial role in hydration and gut health, especially in rural areas where it serves as a cooling and nutritious meal in hot weather. The popularity of these foods across regions in Yemen underscores their integral role in sustaining dietary traditions, providing macronutrients, and reinforcing social cohesion through shared meals [7], [8]

In Yemen, traditional foods continue to serve as the cornerstone of daily nutrition for much of the population. Understanding their chemical composition is essential for developing informed dietary guidelines and promoting healthier eating habits. This study seeks to evaluate the macronutrient profile and total caloric content of selected traditional Yemeni dishes, offering valuable insights that can support nutritional education, inform public health policies, and guide future research in food science.

2. Material and methods

2.1. Samples collection

The five test foods were selected as highly reproducible and the most acceptable to all subjects. The selected foods were obtained from different popular restaurants in Sanaa that specialized in Yemeni foods and could prepare the foods from standardized recipes. The selected test foods were Lahouh, Sabaya, Fahsa, Al-Zum, and Maloje (Table 1, Fig 1,2,3,4,5).

Table 1: Main ingredients used in the preparation of five traditional foods commonly consumed in Yemen.

Dish	Main Ingredients
Lahouh	Sorghum flour, Water, Yeast and Salt
Sabaya	White flour, Ghee or butter, Water, Salt
Fahsa	Cooked meat, Fenugreek paste (hilbah), Tomatoes, Garlic, Onions and spices
Al-Zum	Sorghum flour, Water, Yogurt or fermented milk and Salt
Malouj	White flour, Water, Yeast and Salt

2.2. Transport and storage of samples

The traditional Yemeni foods-Lahouh, Sabaya, Fahsa, Al-Zum, and Maloje-were collected and transported under conditions that closely matched their preparation environment to preserve their original characteristics. Upon collection, all samples were stored at a controlled cooling temperature to prevent spoilage and maintain their quality until analysis.

2.3. Proximate Analyses of Traditional Yemeni Foods

The moisture content was determined using the forced air draft oven method, where 5 gram of each sample was weighed into aluminum dishes and dried at 105°C for 24 hours in a hot air oven. This test was performed in triplicate (n = 3) for each food item [9]. The ash content was analyzed by weighing 5 grams of each sample into pre-weighed crucibles and incinerating them in a muffle furnace at 525°C for 4 hours, with three replicates (n = 3) per food sample [9]. Total protein content was measured using the Kjeldahl method, where 1 gram of each sample were digested with sulfuric acid and catalyst. The nitrogen content was then converted to protein using a conversion factor of 6.25. Analyses were performed in triplicate (n = 3) for each sample [9]. Fat content was determined via Soxhlet extraction, using 3 grams of dried sample and light petroleum ether (boiling point 40–60°C) as the solvent. After a 6-hour extraction period, the fat residue was dried at 103°C and weighed. Each analysis was repeated three times (n = 3) [9]. Carbohydrate content was estimated by difference, subtracting the sum of measured moisture, ash, protein and fat from 100% for each sample. The calculation was done on triplicate measurements [10]. Finally, the energy content was calculated using the Atwater general factors, assuming 4 kcal/g for protein, 9 kcal/g for fat, and 4 kcal/g for carbohydrates [11].

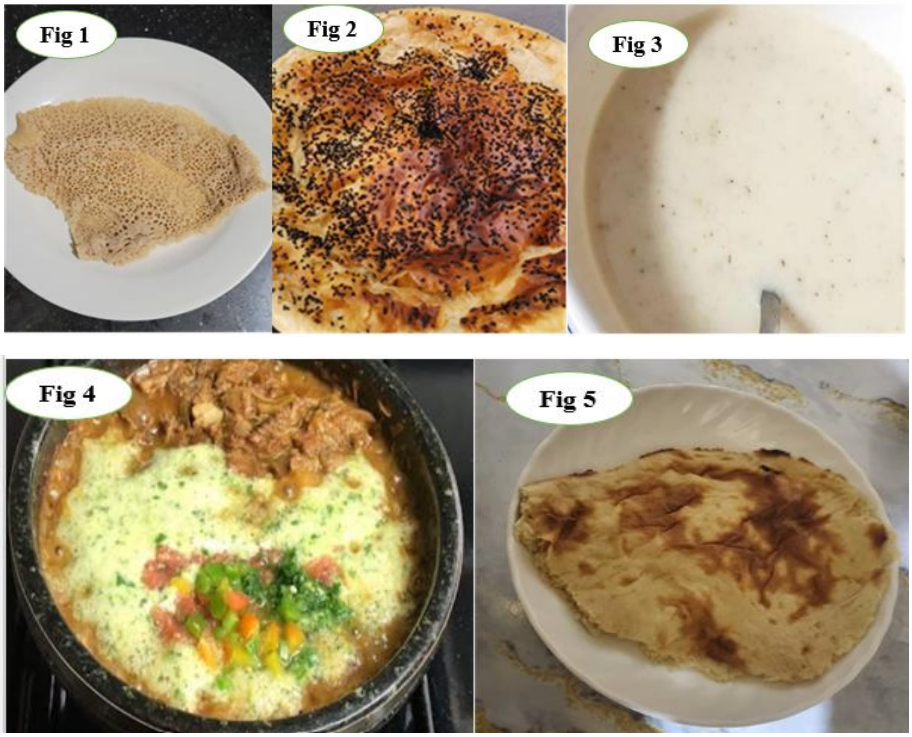

Fig. 1: Lahouh sample **Fig. 2:** Sabaya sample **Fig. 3:** Al-Zum sample

Fig. 4: Fahsa sample **Fig. 5:** Photo of Maloje

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2.5. Data Analysis and Statistics

The collected data were statistically analyzed using one-way analysis of variance (ANOVA) to determine significant differences among the tested groups. Following the ANOVA, mean comparisons were conducted using the Least Significant Difference (LSD) test to identify which specific groups differed significantly from one another. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 26.0. A significance level of $p < 0.05$ was used to determine statistical significance.

3. Result and Discussion

3.1. Proximate chemical composition

3.1.1. Moisture

Moisture content is a critical factor influencing the freshness, texture, and shelf life of food products [12]. Significant variation in moisture levels exists among traditional Yemeni foods, primarily due to differences in ingredients, cooking methods, and water retention properties. As illustrated in Figure 6, Al-Zum and Fahsa demonstrated the highest moisture contents at 84.08% and 73.97%, respectively. These elevated values are likely attributed to their preparation as soups or stews, which inherently contain a higher proportion of water. Foods with high moisture content generally have shorter

shelf lives and require stringent storage conditions to minimize microbial growth and spoilage [13]. Conversely, Maloje exhibited the lowest moisture content (26.45%), reflecting its dry and dense characteristics. Low-moisture foods tend to be more shelf-stable and less susceptible to microbial contamination, thus allowing for extended storage periods [14].

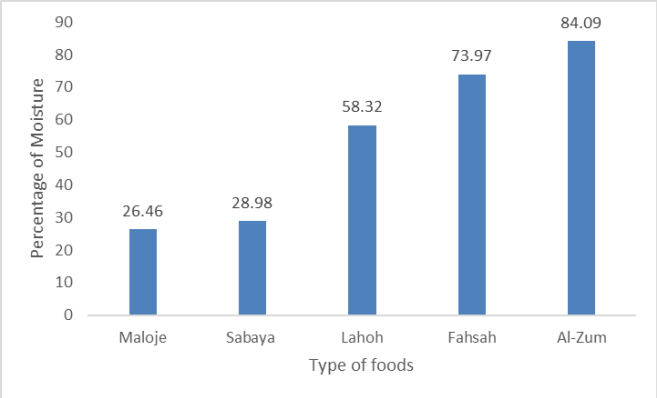

Fig. 6: Moisture content in Traditional Yemeni foods

Intermediate moisture levels were observed in Lahoh (58.32%) and Sabaya (28.98%), highlighting the diversity in water content among these traditional dishes. The observed variation in moisture content is largely influenced by the composition of the foods, including the presence of grains, dairy, or meat, and the specific cooking techniques applied—such as boiling, steaming, baking, or frying [15]. Furthermore, moisture content impacts the energy density and digestibility of foods; high-moisture items like Fahsa and Al-Zum are less energy-dense but provide hydration, while low-moisture foods such as Maloje and Sabaya offer more concentrated energy per gram. Understanding these moisture differences is essential for effective dietary planning, especially in regions facing challenges in food preservation and storage [16]. Statistical analysis confirmed significant differences in moisture content among nearly all food pairs ($p < 0.05$). Notably, Maloje and Sabaya showed a smaller yet significant difference ($p = 0.032$), suggesting relatively similar moisture levels. All other comparisons, including those involving Lahoh, Fahsah, and Al-Zum, revealed highly significant differences ($p = 0.000$), underscoring distinct moisture profiles likely resulting from ingredient composition and preparation methods. These variations contribute to the differing textures, shelf lives, and freshness perceptions characteristic of these traditional Yemeni foods.

3.1.2. Protein

Protein is an essential macronutrient involved in muscle growth, immune function, and overall metabolism. The protein content of traditional Yemeni foods varies considerably depending on their ingredients and preparation methods. As illustrated in Figure 7, Fahsa exhibited the highest protein content at 8.45%, attributable to its meat-based composition. Fahsa, a renowned Yemeni dish primarily consisting of slow-cooked beef or lamb enriched with broth and spices, serves as a rich source of high-quality protein. High-protein foods like Fahsa play a critical role in fulfilling dietary protein requirements and supporting muscle maintenance and physiological functions [17].

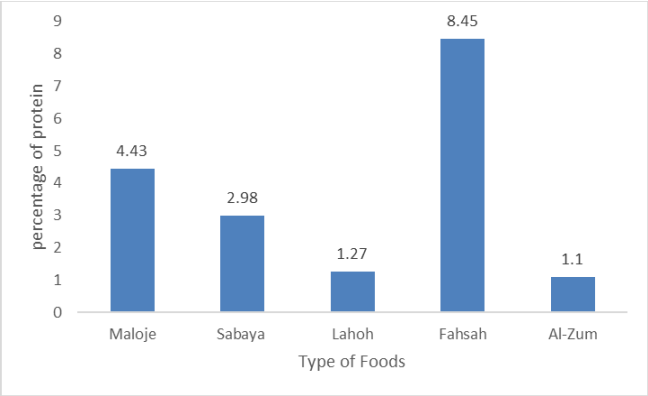

Fig. 7: Protein content in Traditional Yemeni foods

In contrast, Al-Zum (1.10%) and Lahouh (1.27%) showed the lowest protein levels, reflecting their primary composition from grains or fermented dough, which naturally contain lower protein concentrations compared to meat-based foods. Traditional grain-based Yemeni dishes tend to be carbohydrate-rich while providing moderate protein amounts [18]. Sabaya (2.98%) and Maloje (4.43%) had intermediate protein levels, likely due to the inclusion of wheat flour, eggs, or dairy in their preparation. Although these foods contribute to protein intake, their main macronutrient contributions are carbohydrates and fats. The observed variation in protein content among these traditional dishes underscores the importance of dietary diversity. High-protein foods like Fahsa are vital to meeting daily protein needs, particularly in populations at risk of protein deficiency. Conversely, lower-protein foods such as Al-Zum and Lahouh may require supplementation with legumes, dairy, or meat to ensure adequate intake of essential amino acids and balanced nutrition. Statistical analysis confirmed significant differences in protein content between nearly all food pairs ($p < 0.05$), except for a slightly higher p-value between Lahoh and Al-Zum ($p = 0.024$), which remains statistically significant. This broad significance indicates distinct protein profiles among the dishes, influenced by their unique ingredient compositions. Overall, these differences highlight the nutritional diversity of traditional Yemeni foods and their varied contributions to dietary protein requirements

3.1.3. Fat

Fat is an essential macronutrient that provides energy, supports cellular functions, and facilitates the absorption of fat-soluble vitamins. The fat content in traditional Yemeni foods varies considerably depending on the ingredients and cooking methods employed. As

illustrated in Figure 8, Sabaya exhibited the highest fat content at 36.34%, which is consistent with its preparation using butter or ghee. Sabaya, a layered pastry dish, is inherently rich in fats, rendering it an energy-dense food. While high-fat foods promote satiety and supply long-term energy, excessive consumption may increase the risk of obesity and cardiovascular diseases, warranting moderation [19]. In contrast, Al-Zum demonstrated the lowest fat content at 2.91%, indicative of a lean, grain-based dish with minimal added fats. Low-fat foods such as Al-Zum are advantageous for individuals aiming to manage body weight and reduce diet-related health risks [20]. The remaining foods showed moderate fat levels: Lahouh (8.59%), Fahsa (10.24%), and Maloje (4.66%). Lahouh, a fermented pancake, likely derives its fat content from ingredients like milk or cooking oil. Fahsa, a meat-based dish, contains fat from both meat and added oils, placing it between grain-based and pastry-based dishes in fat content.

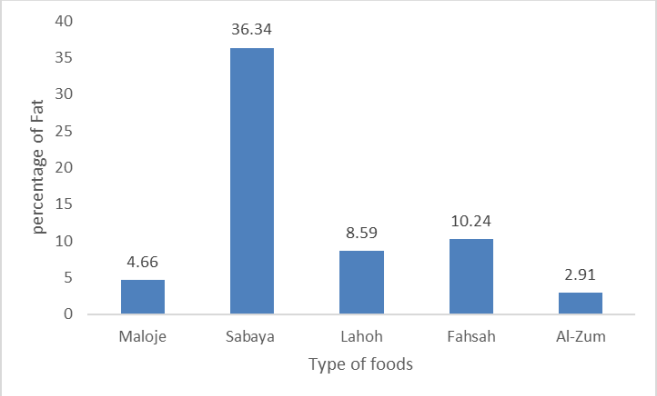

Fig. 8: Fat content in Traditional Yemeni foods

Maloje, a bread-like food, contains relatively low fat, reflecting its simpler preparation with minimal added fats. Statistical analysis of fat content revealed significant differences among nearly all food pairs ($p < 0.05$), highlighting substantial variation in fat composition. Notably, Maloje, Sabaia, Lahoh, Fahsah, and Al-Zum differed significantly in most comparisons, reflecting diverse ingredient profiles such as butter, meat, and oils. Although differences were significant overall, comparisons like Al-Zum versus Maloje showed a slightly higher p-value (0.011), indicating a smaller yet statistically meaningful difference. These findings underscore the wide range of fat content in traditional Yemeni dishes, contributing to their nutritional diversity and varied roles in energy provision within the Yemeni diet.

3.1.4. Ash

Ash content in food analysis represents the total mineral content within a sample, encompassing essential minerals such as calcium, magnesium, potassium, phosphorus, and trace elements. It serves as a valuable indicator of the overall mineral composition and nutritional quality of foods. As illustrated in Figure 9, Maloje exhibited the highest ash content at 1.37%, suggesting a greater concentration of minerals. This may be attributed to its flour-based composition and traditional preparation methods, such as cooking with burned wood, which can contribute to a higher mineral residue. In contrast, Fahsa recorded the lowest ash content at 0.32%, indicating a lower overall mineral presence. As a meat-based dish, Fahsa may naturally contain fewer mineral residues compared to grain-based dishes, although it remains a good source of specific micronutrients such as iron and zinc, which are critical for immune function and metabolic health [21]. Other foods such as Lahouh (0.40%), Sabaya (0.76%), and Al-Zum (0.95%) displayed moderate ash content levels. Lahouh and Sabaya, primarily composed of wheat flour, likely derive their mineral content from grain-based ingredients, while Al-Zum's mid-range ash level may be due to the inclusion of whole grains or other mineral-rich components.

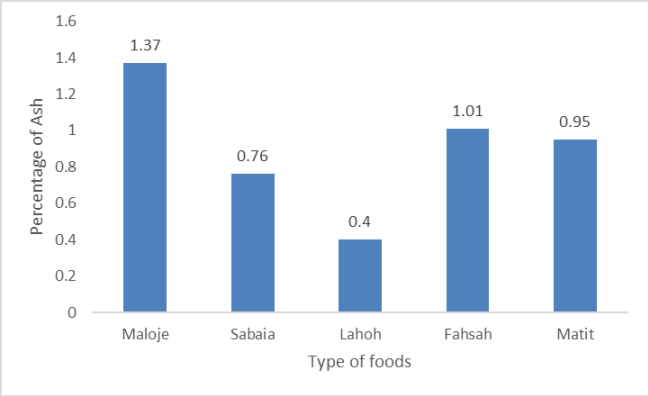

Fig. 9: Ash content in Traditional Yemeni foods

Statistical analysis revealed significant differences in ash content among most food pairs ($p < 0.05$), underscoring the variability in mineral composition across these dishes. Maloje, Sabaya, Lahoh, and Fahsa each differed significantly from one another, reflecting their diverse ingredient profiles and preparation techniques. However, Fahsa and Al-Zum did not show a statistically significant difference ($p = 0.393$), indicating similar mineral content, possibly due to shared components or similar cooking methods. This similarity was unique, as Al-Zum differed significantly from Maloje, Sabaya, and Lahoh, further highlighting the distinct mineral profiles of the majority of traditional Yemeni foods. These findings emphasize the importance of considering both the type of ingredients and cooking practices when evaluating the mineral value of traditional dishes

3.1.5. Carbohydrates

Figure 10 illustrates the percentage of carbohydrate content in the tested traditional Yemeni foods. Maloje exhibited the highest carbohydrate content at 63.09%,

confirming its status as a carbohydrate-dense food primarily composed of wheat flour. High-carbohydrate foods such as Maloje serve as essential energy sources, particularly in regions where grain-based and bread-like products form a dietary staple [22]. In contrast, Fahsa recorded the lowest carbohydrate content at 6.33%, consistent with its composition as a meat-based dish rich in protein and fats. This makes Fahsa particularly suitable for individuals following low-carbohydrate or high-protein diets. Among the other foods, Lahouh (31.43%), Sabaya (30.93%), and Al-Zum (10.95%) exhibited moderate levels of carbohydrates.

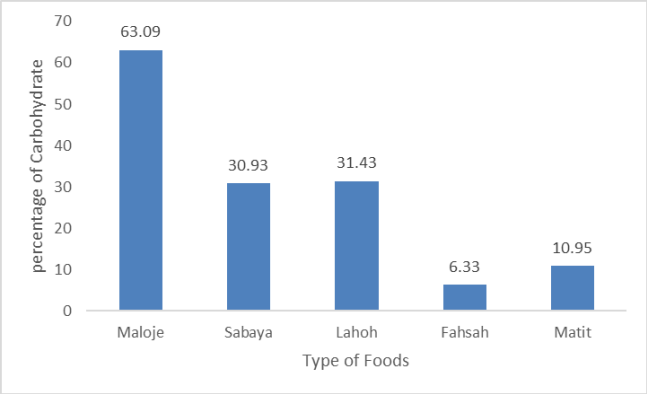

Fig. 10: Carbohydrate content in Traditional Yemeni foods

Lahouh and Sabaya, both traditionally prepared from wheat flour and often enriched with ingredients like dairy or eggs, offer a balanced profile of macronutrients, contributing both energy and essential nutrients. Al-Zum, with a lower carbohydrate content, likely reflects its unique composition or preparation technique, which involves fewer starchy components. Statistical analysis confirmed significant differences in carbohydrate content among nearly all food pairs ($p < 0.05$). Specifically, Fahsa and Al-Zum were significantly different from all other samples, likely due to their low carbohydrate levels, while Maloje also differed significantly from all other foods, aligning with its high carbohydrate concentration. Notably, Sabaya and Lahoh did not differ significantly from each other ($p = 0.652$), indicating a similar carbohydrate profile likely due to shared ingredients and cooking methods. However, both were significantly different from the remaining foods, underscoring their unique contribution to the overall carbohydrate intake in the traditional Yemeni diet. These variations highlight the nutritional diversity of these dishes and their respective roles in providing dietary energy.

3.2. Total Calories of different Traditional food sample

Caloric content is a key factor in determining the energy contribution of different foods, influencing dietary intake and nutritional balance. The total calories in the tested traditional Yemeni foods varied significantly, reflecting differences in macronutrient composition, including carbohydrates, fats, and proteins. As shown in Table 2, Sabaya had the highest calorie content at approximately 462 Kcal per 100g, which can be attributed to its high fat and carbohydrate content. Sabaya is a layered pastry often prepared with butter or ghee, making it an energy-dense food suitable for providing sustained energy but also requiring moderation to avoid excessive caloric intake.

Table 2: Total Calories of different Traditional food samples

Samples	Kcal\100g food
Malwj	312±6.12[a]
Sabaya	462±8.56[b]
Lahouh	208±5.01[c]
Fahsa	151±7.02[d]
Al-Zum	74±2.21[e]

*Mean ± Standard deviations (n = 3).

Means in the same column with different upper-case letters are significantly different ($P < 0.05$).

In contrast, Al-Zum had the lowest caloric content at approximately 74 Kcal per 100g, indicating that it is a low-energy food. This could be due to its high moisture content and relatively low fat and carbohydrate levels. Low-calorie foods like Al-Zum are beneficial for individuals looking to manage weight or maintain a balanced diet with lower energy intake. Statistical analysis revealed significant differences ($P < 0.05$) among all samples, as indicated by the distinct superscript letters.

The calorie content of other tested foods falls between these two extremes, reflecting their unique nutritional profiles. The variation in calorie values across different Yemeni foods suggests that high-calorie options like Sabaya can provide quick energy, which may be beneficial for individuals with high energy demands, such as laborers or athletes[23]. Meanwhile, lower-calorie foods like Al-Zum may be more suitable for those aiming to control calorie intake and maintain a healthier weight[24].

4. Conclusion

In conclusion, the evaluation of traditional Yemeni dishes—Lahouh, Sabaya, Fahsa, Al-Zum, and Maloje—revealed significant variation in their macronutrient profiles, reflecting the rich nutritional diversity of Yemeni cuisine. Fahsa stands out as a protein-dense dish, supporting muscle repair and maintenance, while Maloje, with its high carbohydrate content, serves as an essential energy source, especially for those with greater physical demands. Sabaya, known for its high fat content primarily from butter or ghee, provides long-lasting

energy but should be eaten in moderation to avoid the negative effects of excessive saturated fat intake. These findings underline the value of incorporating a balanced mix of traditional foods into daily diets to promote health and nutritional adequacy. Therefore, it is advisable to prioritize dishes like Fahsa for protein, utilize carbohydrate-rich items such as Maloje and Lahouh to meet energy needs, and consume high-fat options like Sabaya sparingly. These insights offer a foundation for developing culturally appropriate dietary guidelines and public health initiatives aimed at enhancing nutritional well-being across the Yemeni population.

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مقالة بحثية

تقييم التركيب الكيميائي وإجمالي المحتوى الحراري لبعض الأطعمة اليمنية التقليدية المختارة والمباعة في صنعاء، اليمن

محمد السباعي[1،2،*]، لطف الرحبي[3]، وضاح إدريس[4]، نبيل الدبعي[1]، رمزي جازم[1]، زكريا الزماني[1]

[1] قسم علوم وتكنولوجيا الأغذية، كلية الزراعة وعلوم الأغذية، جامعة إب، اليمن
[2] قسم التغذية العلاجية، جامعة الملكة أروى، صنعاء، اليمن
[3] قسم طب الأسنان، كلية العلوم الطبية، جامعة الملكة أروى، صنعاء، اليمن
[4] قسم المختبرات الطبية، كلية الطب والعلوم الصحية، جامعة حجة، حجة، اليمن

*** الباحث الممثّل: محمد السباعي؛ البريد الالكتروني: malsobaee22@gmail.com؛ جوال: 774488038 (967+)**

استلم في: 18 يوليو 2025 / قبل في: 03 أغسطس 2025 / نشر في 30 سبتمبر 2025

المُلخّص

تفتقر الأطعمة اليمنية التقليدية مثل السبايا، الملوج، اللحوح، الزوم، والفحسة إلى بيانات موثقة حول تركيبها الكيميائي. هدفت هذه الدراسة إلى تقييم محتوى الرطوبة، البروتين، الدهون، الكربوهيدرات، والقيمة الحرارية الإجمالية لهذه الأطعمة الخمسة. أُجريت التحليلات المخبرية في جامعتي الملكة أروى وصنعاء. تراوح محتوى الرطوبة بين 26.46% في الملوج و84.09% في الزوم، ويُعزى هذا التفاوت بشكل رئيسي لاختلاف تركيب ومكونات الأطعمة وطرق تحضيرها. أظهرت الفحسة، وهي طبق قائم على اللحوم، أعلى محتوى للبروتين بنسبة 8.45%، في حين سجل الملوج أعلى محتوى للكربوهيدرات بنسبة 63.09% نظرًا لاعتماده على دقيق القمح. سجلت السبايا أعلى محتوى للدهون (36.34%) والسعرات الحرارية (462 كيلو كالوري/100 جرام) نتيجة لاستخدام الزبدة أو السمن. وعلى النقيض، كان الزوم الأقل في القيمة الطاقية حيث بلغ 74 كيلو كالوري/100 جرام. كشفت النتائج عن فروقات كبيرة في التركيب الغذائي لهذه الأطباق، مما يعكس تنوع مكوناتها وطرق تحضيرها. توفر هذه الدراسة رؤى مهمة حول المساهمات الغذائية للأطعمة اليمنية التقليدية، وتؤكد على أهمية تناول متوازن لهذه الأطعمة لدعم الصحة، مع التوصية بالفحسة كمصدر للبروتين، والملوج واللحوح كمصادر للطاقة، وتقليل استهلاك الأطباق الغنية بالدهون مثل السبايا.

الكلمات المفتاحية: غذاء، شعبي، تحليل كيميائي، سعرات حرارية، اليمن.

How to cite this article:

M. Alsebaeai, L. Al-Rahbi, W. Edrees, N. Aldoubai, R. Gazem, and Z. Al-Zamani, "EVALUATION OF THE CHEMICAL COMPOSITION AND TOTAL CALORIC CONTENT OF SELECTED TRADITIONAL YEMENI FOODS SOLD IN SANA'A, YEMEN", *Electron. J. Univ. Aden Basic Appl. Sci.*, vol. 6, no. 3, pp. 152-159, Sep. 2025. DOI: https://doi.org/10.47372/ejua-ba.2025.3.453