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Evaluation of Physical and Chemical Characteristics of Selected Commercial Green Tea Brands in the Libyan Market

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تقييم الخصائص الفيزيائية والكيميائية لعلامات تجارية مختارة من الشاي الأخضر التجاري في السوق الليبي

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Abstract:
This study evaluated and compared the physical and chemical properties of three commercially available green tea brands in Libya: Ahmad Tea, Al-Jawhara Tea, and Al-Sahm Tea. Samples were randomly collected from retail stores in Wanazrik Al-Shati, Libya. Analytical methods included determination of moisture content, total solids percentage, tea leaf weight, foreign matter proportion, and potassium concentration (measured via wet digestion and flame photometry using a Corning 400 instrument). Significant variations were observed. Al-Sahm Tea exhibited the lowest moisture content (2.415%) and highest total solids (97.585%). Al-Jawhara Tea showed the lowest foreign matter (15.938%) and lowest potassium (12,180.00 mg/L). Ahmad Tea contained the highest foreign matter (21.728%) and highest potassium (23,008.46 mg/L), potentially due to jasmine leaf additives. These findings highlight quality disparities in locally available green teas, suggesting Al-Sahm Tea excels in moisture control, while Al-Jawhara offers superior purity. Results provide critical data for consumers and food quality regulatory bodies.

Keywords: Green tea, Physical properties, Chemical properties, Moisture content, Potassium, Libya.

الملخص
قامت هذه الدراسة بتقييم ومقارنة الخصائص الفيزيائية والكيميائية لثلاث علامات تجارية للشاي الأخضر متوفرة تجاريًا في ليبيا: شاي أحمد، وشاي الجوهرة، وشاي السهم. جُمعت العينات عشوائيًا من متاجر البيع بالتجزئة في منطقة ونزرك الشاطئ، ليبيا. شملت الطرق التحليلية تحديد محتوى الرطوبة، ونسبة المواد الصلبة الكلية، ووزن أوراق الشاي، ونسبة المواد الغريبة، وتركيز البوتاسيوم. ولوحظت اختلافات كبيرة. أظهر شاي السهم أقل نسبة رطوبة (2.415%) وأعلى نسبة مواد صلبة كلية (97.585%). أظهر شاي الجوهرة أقل نسبة مواد غريبة (15.938%) وأقل نسبة بوتاسيوم (12,180.00 ملغم/لتر). احتوى شاي أحمد على أعلى نسبة مواد غريبة (21.728%) وأعلى نسبة بوتاسيوم (23,008.46 ملغم/لتر)، ويحتمل أن يكون ذلك بسبب إضافات أوراق الياسمين. تُسلّط هذه النتائج الضوء على تفاوت جودة أنواع الشاي الأخضر المتوفرة محليًا، مما يُشير إلى تميّز شاي السهم في التحكم بالرطوبة، بينما يُقدّم شاي الجوهرة نقاءً فائقًا. تُوفّر هذه النتائج بياناتٍ بالغة الأهمية للمستهلكين والهيئات التنظيمية لجودة الأغذية.

الكلمات المفتاحية: الشاي الأخضر، الخصائص الفيزيائية، الخصائص الكيميائية، محتوى الرطوبة، البوتاسيوم، ليبيا.

Introduction

Tea (*Camellia sinensis* L.) ranks among the most widely consumed plant-based beverages globally, with its origins tracing back millennia to ancient China, where it was initially used for medicinal purposes before evolving into a ubiquitous daily drink [1]. This evergreen perennial plant, characterized by leathery lanceolate leaves, small white flowers, and capsule-shaped fruits containing propagation seeds, serves as the source material for all true teas [2], [3], [4].

Tea leaf quality is governed by multiple factors, including cultivar genetics, leaf position on the stem, growth stage, and post-harvest processing conditions. These variables induce significant variations in chemical composition, flavor profile, and health-promoting properties [5], [6]. Tea leaves contain bioactive compounds such as caffeine, astringent tannins, theobromine, theophylline, and volatile oils responsible for characteristic aroma [7]. Green tea, distinguished by minimal oxidation during processing, retains most endogenous phytochemicals.

Notable traditional varieties include Chinese "Dragon Well" and Japanese "Matcha" used in ceremonial preparations. The physicochemical properties of green tea, particularly moisture content, total solids, and foreign matter, have garnered significant scientific attention due to their critical role in assessing product quality, safety, and storage stability [8]. Analytical studies confirm that moisture control and purity directly influence product integrity by preventing chemical degradation and microbial spoilage [9], [10], [11].

Chemical characteristics encompass essential minerals (e.g., potassium, magnesium) and bioactive compounds, including polyphenols, catechins, flavonoids, and alkaloids. These constituents collectively determine flavor attributes while conferring antioxidant and anti-inflammatory properties that underpin green tea's nutritional value [12]. Additional components include vitamins (A, C, B-complex, E, K), fiber, enzymes, essential oils, and trace minerals (phosphorus, manganese, fluoride, copper, sodium) [13], [14].Epidemiological evidence associates regular green tea consumption with improved digestive function, reduced LDL-cholesterol, regulated blood pressure and glucose levels, hepatorenal protection, and potential cancer prevention [15], [16].

Nevertheless, excessive intake may cause adverse effects, including tachycardia, insomnia, and gastric irritation, particularly when brewed intensely or consumed [12]. Additives such as milk may diminish polyphenol bioavailability through protein-binding interactions [17], [18]. Optimal preparation involves steeping 1.5–2 g of leaves in freshly boiled water for ≤3 minutes. Culinary enhancements (e.g., mint, sage) may improve palatability and bioactivity. Beyond beverage applications, green tea derivatives serve in dermatological preparations, wound care, and nutritional oils comparable to olive oil in value [19], [20], [21].

This study focuses on three commercially dominant green tea brands in the Libyan market, Ahmad Tea, Al-Jawhara Tea, and Al-Sahm Tea, selected for their substantial market penetration and heterogeneous pricing, sourcing, and packaging. We aim to evaluate and compare their physicochemical properties to elucidate quality variations in locally available products. The findings are expected to provide scientific data supporting informed decisions by consumers and regulatory authorities regarding tea quality standards in Libya.

Materials and Methods

Sample Collection

Three commercial green tea products were randomly purchased from retail outlets in Wanazrik Al-Shati, Libya as shown in Figure 1.

Analytical Methods

Tea Leaf Weight & Foreign Matter: Samples were boiled (15 min), separated into leaves/foreign material, and weighed pre-/post-drying.

Moisture Content:

Calculated gravimetrically per [8]:

Moisture (%) =(W1−W2) Sample Weight×100Moisture (%) =Sample Weight(W1−W2)×100

Total Solids:

Total Solids (%) =100−Moisture (%) Total Solids (%) =100−Moisture (%)

Potassium Concentration:

Samples (0.5 g) underwent wet digestion with HNO_3/$HClO_4$. Potassium was quantified using a Corning 400 flame photometer:

$[K^+]$ (mg/L) =Sample Emission×Avg. Standard $[K^+]$ Avg. Standard Emission$[K^+]$ (mg/L) =Avg Standard Emission Sample Emission×Avg. Standard $[K^+]$.

Table 1: Sample Characteristics.

Product	Manufacturer	Origin	Production Date	Expiry Date	Weight (g)
Ahmad Tea	Ahmadani Co.	Egypt	01/04/2013	01/03/2017	250
Al-Jawhara Tea	Al-Jawhara Co.	Egypt	01/07/2013	01/06/2016	100
Al-Sahm Tea	Shaboub Al-Khair	China	01/04/2013	01/03/2017	100

Results and Discussion

Physical Properties

Table 2: Physical Characteristics of Green Tea Samples.

Sample	Weight Diff. (%)	Tea/Solids (%)	Leaves (%)	Foreign Matter (%)	Moisture (%)	Total Solids (%)
Ahmad Tea	13.360	91.583	78.272	21.728	4.352	95.647
Al-Jawhara Tea	11.980	99.397	84.072	15.938	7.153	92.847
Al-Sahm Tea	10.460	98.730	83.794	16.206	2.415	97.585

Table 2 demonstrates significant variations in the physical properties of the three examined commercial green tea varieties, reflecting disparities in processing and packaging quality. Al-Sahm Tea exhibited the lowest moisture content (2.415%), indicating superior drying efficacy and preservation methods that enhance product stability during storage. Conversely, Al-Jawhara Tea displayed the highest moisture level (7.153%), a parameter that may adversely affect product integrity and safety during storage.

These findings align with [11], who established that reduced moisture content in green tea serves as a critical indicator of optimal drying protocols and processing quality, preserving physicochemical properties throughout storage. [22] further corroborated a strong inverse correlation between moisture content and overall quality metrics, noting that elevated moisture increases susceptibility to bioactive compound degradation and microbial contamination.

Regarding tea purity, Al-Jawhara Tea contained the highest proportion of pure leaves (84.072%) and the lowest foreign matter content (15.938%), reflecting advanced sieving and sorting techniques. In contrast, Ahmad Tea showed the highest foreign matter contamination (21.728%), potentially attributable to inadequate packaging quality control or impurity infiltration during production. Previous studies [12] indicate that foreign matter adversely affects sensory characteristics, consumer acceptance, and market value.

Al-Sahm Tea recorded the highest total solids content (97.585%), consistent with its low moisture percentage. This inverse relationship between moisture and total solids previously documented by [11] reinforces the classification of Al-Sahm Tea as a product of superior physical composition. Collectively, these results highlight substantial quality variations among Libyan market green teas, underscoring how manufacturing, drying, and sorting processes fundamentally determine final product characteristics. These findings warrant consideration by both consumers and food quality regulatory authorities.

Chemical Properties

Table 3: Potassium Concentration (mg/L).

Sample	Potassium (mg/L)
Ahmad Tea	23,008.46
Al-Jawhara Tea	12,180.00
Al-Sahm Tea	20,300.00

Table 3 reveals significant variation in potassium concentration among the studied commercial tea samples. Ahmad Tea exhibited the highest concentration (23,008.46 mg/kg), while Al-Jawhara Tea showed the lowest (12,180.00 mg/kg). The elevated potassium levels in Ahmad Tea may be attributed to jasmine leaf additives, a common practice in commercial blends designed to enhance flavor profiles through botanical supplementation.

These compositional differences reflect variations in processing methodologies and botanical formulations. As established by [22] , mineral concentrations in tea are influenced by plant genotype, cultivation conditions, and manufacturing techniques. Furthermore, Matsuura et al. (2001) observed that mineral content - particularly potassium and calcium - contributes significantly to the sensory profile of green tea, with elevated concentrations potentially compromising desirable organoleptic properties when exceeding acceptable thresholds.

While potassium constitutes an essential nutrient, its balanced presence is critical for maintaining both sensory quality and consumption safety. This consideration is particularly relevant for individuals with renal impairments or electrolyte homeostasis concerns. Consequently, comprehensive chemical analysis emerges as an indispensable tool for implementing green tea quality control protocols and ensuring compliance with food safety standards.

Conclusion

This study demonstrates significant physicochemical variations among three commercial green tea brands prevalent in the Libyan market. Al-Sahm Tea exhibited the lowest moisture content (2.415%) and highest total solids (97.585%), indicating superior preservation characteristics. Conversely, Al-Jawhara Tea displayed the highest leaf purity (84.072%), lowest foreign matter (15.938%), and lowest potassium concentration (12,180.00 mg/kg). Ahmad Tea contained the highest foreign matter (21.728%) and elevated potassium levels (23,008.46 mg/kg), potentially attributable to jasmine leaf additives. These findings underscore the critical importance of quality-based product selection and provide actionable data for consumers and regulatory bodies monitoring tea quality in regional markets.

Recommendations

Based on the observed physicochemical disparities, the following recommendations are proposed:

- Manufacturers should optimize processing protocols to enhance moisture control and minimize foreign matter contamination.
- Regulatory authorities must establish and enforce stringent national quality standards for green tea, ensuring consistent compliance monitoring.
- Consumers require increased awareness regarding nutritional labeling (including ingredients, origin, expiration dates) and the impact of storage conditions on product integrity.

Future research should:

- Expand sampling to include broader product diversity.
- Conduct comprehensive analyses of bioactive compounds and potentially toxic elements.
- Evaluate organoleptic properties and storage stability under varied environmental conditions.

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