



2024 INTERNATIONAL SYMPOSIUM SUPPORTING THE DEVELOPMENT OF THE CAMEL MILK SECTOR

Conference Proceedings



24 – 25
September 2024



08:00
17:00



Bab Al Qasr Hotel
Abu Dhabi




2024 International Symposium Supporting the Development of the Camel Milk Sector

24-25 September 2024, Abu Dhabi, United Arab Emirates

<https://doi.org/10.62975/yyvp2a29>

Approved 29 October 2025

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Acknowledgements

The jGFoRSS editorial team wishes to express its sincere appreciation to all colleagues at the Abu Dhabi Agriculture and Food Safety Authority (ADAFSA) for their outstanding leadership in organizing the International Symposium “Supporting the Development of the Camel Milk Sector” and in contributing to the preparation of these proceedings.

The team extends its utmost respect and gratitude to Her Excellency Dr. Mouza Suhail Al Muhairi, Deputy Director, Regulatory and Administrative Affairs at ADAFSA, and Chair of the UAE National Codex Committee, for her leadership and continued guidance that made this initiative possible.

Special thanks are also extended to Eng. Sonia Alkafy Baldi, Expert – Regulatory and Administrative Specialist; Dr. Jehad Al Bayari, Food Regulation and Policies Specialist; and Dr. Mohamed Taha, Food Regulation and Policies Specialist at ADAFSA, for their dedicated efforts, valuable contributions, and outstanding coordination throughout the development of this publication.

Contents

Background	4
Symposium Summary	5
Nutritional, Antimicrobial, Health-Promoting and Medicinal Properties of Camel’s Milk	7
Introduction	7
Development	8
Conclusion	9
References	9
Composition and Properties of Camel Milk	11
Introduction	11
The Gross Composition of Camel Milk	11
Fine Composition	12
Conclusion	13
References	13
Camel Milk Production Conditions in UAE: Economic Aspects, Safety and Innovation of New Products	17
Introduction	17
Conclusion	18
References	18
Good Practices in Camel Milk Production	19
Introduction	19
Discussion and Development	19
Conclusion	21
References	21
Review and Documentation of Adulteration in Camel Milk	22
Introduction	22
Adulteration in Camel Milk	22
Possible Types of Adulteration in Camel Milk	23
Industry Reporting of Camel Milk Adulteration	24
Conclusion	24
References	24
Conclusion – International Symposium “Supporting the Development of the Camel Milk Sector”	26

Background

The United Nations has designated 2024 as the International Year of Camelids (IYC 2024) to highlight the potential of camelids in agriculture and food production. Raising camels for food and agriculture production purposes has been practiced for centuries on more than one continent and has recently picked up with the development of food products resulting from this activity that are being traded internationally. Most of the countries where this activity is practiced are developing countries, with a strong focus on subsistence production. The recent development of studies highlighting the nutritional benefits of food derived from Camelids has resulted in the increased interest in such production, which would lead to added-value food products, contributing to the improvement of farmers' income and enabling the availability of these products, beyond domestic markets.

Raising awareness and encouraging increased investment in the camelid sector aligns with the objectives of the International Year of Camelids (IYC 2024), with added support to research, capacity development, and the adoption of the best production practices and new technologies enabling further development of this sector.

Camelids, through the provision of milk and meat, would therefore contribute more significantly to the advancement of Sustainable Development Goals (SDGs) adopted by the Food and Agriculture Organization, specifically those addressing hunger, the elimination of extreme poverty, the empowerment of women, and the sustainable utilization of terrestrial ecosystems.

Camels have been at the centre of life in the United Arab Emirates for decades and have played key roles in transportation, food, entertainment, and other activities. As such, camels are a symbol of Emirati heritage and remain intrinsic to the country's traditions and cultural practices. For instance, camel milk is highly consumed between the Emirati populations and is now chosen by foreign communities as per its health benefits. Camel meat has been an important part of Emirati cuisine served to commemorate significant occasions such as Eid and National Day. Camel milk is used to make chocolates and biscuits and is often listed as a must-try for visitors to the country.

The Abu Dhabi Agriculture and Food Safety Authority (ADAFSA), being the local entity of Abu Dhabi Emirate, mandated for agriculture and food safety, is implementing huge efforts to preserve camels' resources and to promote the production of camel milk and meat in the Emirate.

In this context, ADAFSA, in cooperation with the Global Food Regulatory Science Society (GFoRSS), the disciplinary group of the International Union of Food Science and Technology (IUFoST),

organized the international symposium “Supporting the Development of the Camel Milk Sector”, on 24 and 25 September 2024 in Bab Al Qasr Hotel in Abu Dhabi, with the participation of representatives from international organizations, government agencies, the private sector, and experts and researchers in camel breeding and milk production. The organization of the symposium coincided with the United Nations declaration of 2024 as the International Year of Camelids (IYC 2024), to highlight the potential and contribution of camelids in supporting agriculture and food production.

The symposium aimed to showcase the attributes of Camel Milk production as one of the food commodities derived from Camelids and was set to support on-going efforts made by United Arab Emirates to develop a New Work on a Camel Milk Commodity Standard under the auspices of the Codex Alimentarius Commission.

Symposium Summary

The symposium included introductory notes presented by Mr. Khaled AlZahrani, the regional coordinator for the Near East Codex Committee, and Mr. Hakim Mufumbiro, the regional coordinator for Africa Codex Committee, which played a great role in supporting the production of camel milk and ensuring its safe trade internationally. The forum witnessed the participation of the representative of the International Dairy Federation (IDF), an observer in Codex Alimentarius, who emphasized the importance of ensuring the fulfilment of Codex criteria for a new proposal.

In addition, the symposium included several scientific sessions presented by experts from international academic and research bodies, relevant regional and international organizations, in addition to camel milk producers and manufacturers.

Dr. Gaukhar Konuspayeva, an FAO Advisor and Professor of Food Biotechnology at Al-Farabi National University in Kazakhstan, presented a scientific lecture on the composition and functional characteristics of camel milk and its benefits as a distinctive commodity. Dr. Mutamed Ayash, Professor and Head of the Department of Food Sciences at the United Arab Emirates University, delivered a presentation on the nutritional and health attributes of camel milk based on the results of research conducted in the UAE and in cooperation with international scientific bodies.

In addition, the forum witnessed the participation of representatives of the camel milk industrials in the UAE, where Dr. Sergei Kiselev, a representative of Al Ain Dairy Company, gave a lecture on the conditions of camel milk production in the United Arab Emirates, economic aspects, product

safety and innovation. Dr. Peter Nagy, the reproductive specialist and Farm Director in Emirates Industry for Camel Milk and Products (Camelicious), delivered a presentation on the good practices in camel milk production.

The symposium also included speakers from the Sultanate of Oman and France, where the experts had the opportunity to talk about camel milk quality aspects as well as a description of the health benefits of camel milk according to research results. The speakers highlighted the importance of developing an international standard for Camel Milk in order to ensure the safe trade of this commodity, while ensuring the health of the consumers.

The second day of the symposium was dedicated to discussing the draft project document and the draft discussion paper as well as the initial draft standard of Camel milk developed by the United Arab Emirates, where Prof. Samuel Godefroy, the president of IUFoST, guided a discussion on the process of developing a Codex text as well as the Criteria for the Establishment of Work Priorities according to the Codex procedural manual. The attendees had the opportunity to participate in a moderated brainstorming session to define the scope of the standard as well as the composition and safety requirements proposed and the rationale supporting the suggested requirements.

The symposium concluded with a summary of input and the identification of next steps towards the development of a camel milk standard.

Nutritional, Antimicrobial, Health-Promoting and Medicinal Properties of Camel's Milk

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Abstract

Camel milk is increasingly recognized for its unique nutritional, antimicrobial, and therapeutic properties. Rich in β -casein, vitamins, and essential fatty acids, it is a valuable dietary alternative for individuals with allergies. Studies highlight its benefits in promoting gut health, controlling hypertension, diabetes, and even its potential anticancer and anti-inflammatory properties. However, the development of national and international standards for camel milk production and quality remains essential to maximize its global market potential and therapeutic applications. This paper explores the multifaceted health benefits of camel milk and underscores the need for standardization in the industry.

Keywords: camel milk, antimicrobial properties, gut microbiota, antidiabetic effects, nutritional composition, bioactive peptides, milk standardization

Introduction

Camel milk has been consumed for centuries in arid and semi-arid regions due to its nutritional and medicinal properties. In recent years, its profile has risen globally, not just as a food source but as a potential therapeutic agent. Unlike bovine milk, camel milk is rich in easily digestible β -casein and free from β -lactoglobulin, a major allergen. These attributes makes it suitable for individuals with milk protein allergies (Kamal-Eldin et al., 2021).

Its composition, including high levels of vitamins like Vitamin C, essential fatty acids, and immunomodulatory proteins, offers unique health benefits. Camel milk has demonstrated potential in managing chronic diseases such as diabetes, hypertension, and certain cancers. It is also promising in supporting gut health, liver and kidney function, and reducing inflammation (Alhaj et al., 2024).

Despite these advantages, the camel milk industry faces challenges in standardizing its production and products' quality. Developing national and international standards will play a critical role in ensuring safe consumption of Camel milk and in expanding its therapeutic applications (Abdalla et al., 2022; Mbye et al., 2022). This paper aims to shed light on the unique attributes of camel milk, the scientific evidence supporting its health claims, and the importance of developing global standards for its production (Ali et al., 2024).

Development

1. Nutritional Composition

Camel milk is rich in proteins like β -casein, which enhance digestibility, and contains high levels of Vitamin C, iron, and antioxidants. These nutrients make it an ideal choice for individuals with specific dietary needs. The absence of β -lactoglobulin makes it hypoallergenic, a feature unmatched by bovine milk.

2. Health Benefits

- **Digestive Health:** Camel milk proteins are easily hydrolyzed by digestive enzymes, aiding nutrient absorption. Its oligosaccharides support beneficial gut microbiota, enhancing gut health and potentially reducing the risk of diseases like irritable bowel syndrome (Ali et al., 2024).
- **Antimicrobial Properties:** It contains peptides and proteins with antibacterial effects, acting against pathogens like *Listeria*, *Salmonella*, and *Klebsiella*, presenting a natural alternative to synthetic antibiotics (Abusheliabi et al., 2017a; Abusheliabi et al., 2017b).
- **Anti-inflammatory Effects:** Bioactive proteins such as lactoferrin and lysozyme have shown anti-inflammatory properties, aiding in the management of inflammatory conditions and autoimmune diseases (Kamal-Eldin et al., 2021; Li et al., 2023).

3. Therapeutic Applications

- **Antidiabetic Properties:** Insulin-like proteins in camel milk improve glycemic control, reduce HbA1c levels, and assist in regenerating pancreatic β -cells (Ali et al., 2023a).
- **Anti-Hypertensive Effects:** Camel milk peptides inhibit ACE, lowering systolic and diastolic blood pressure (Ali et al., 2023b).
- **Anticancer Potential:** Antioxidants in camel milk suppress oxidative stress and inhibit cancer cell proliferation, particularly in colon, liver, and breast cancer studies (Abdelazez et al., 2024).
- **Organ Protection:** It has demonstrated protective effects against liver and kidney injuries by reducing oxidative stress and inflammation.

4. Challenges and Future Directions

The camel milk industry needs robust standards to ensure quality and safety. These standards will pave the way for product commercialization and clinical trials exploring its therapeutic

potential. Developing standards will also enhance consumer trust and market accessibility (Ayyash et al., 2022).

Conclusion

Camel milk represents a unique convergence of nutrition and therapy, offering benefits for a range of health conditions from digestive issues to chronic diseases. Its antimicrobial, antidiabetic, and anticancer properties are supported by an increasing body of evidence. However, the industry's full potential can only be realized through the establishment of stringent national and international standards. Standardization will not only promote consumer safety but also bolster global trade and therapeutic research, ensuring camel milk becomes a staple in the functional food industry.

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Composition and Properties of Camel Milk

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Abstract

Many references are published almost every month to vent the health claims of camel milk, attributing to it many “therapeutic virtues” without a critical investigation. However, camel milk cannot be considered as a medicine because it is first and foremost a food, even if some health effects and undeniable dietetic properties can be attributed to some of its components, such as fats, proteins, minerals and vitamins.

Keywords: camel milk, composition, protein, fat, vitamins

Introduction

A number of review papers and even sometimes “review of reviews,” repeating the same references and often published by “predator editors,” are emphasizing the health effects of a regular consumption of camel milk (for example, the more recent, Mohammad abadi, 2020; Seifu, 2022; Muthukumaran et al., 2023). However, camel milk is firstly a food (sometimes qualified as “superfood”; see Mustafa et al., 2023) and not a “medicine” substituting medical treatment.

The Gross Composition of Camel Milk

Compiling published data from 82 references on the gross composition of camel milk, Konuspayeva et al. (2009) reported values (in g/100 mL) of 3.82 ± 1.08 for Fat Matter (FM), 3.35 ± 0.62 for total proteins (TP), 4.46 ± 1.03 for lactose, 12.47 ± 1.53 for Dry Matter (DM) and 0.79 ± 0.09 for ash. Later, adding some new references (n=121) published between 1905 and 2019 (Konuspayeva, 2020), the mean reported values were 3.68 ± 1.00 for FM, 3.28 ± 0.59 for TP, 4.47 ± 0.66 for lactose and 0.81 ± 0.19 for ash with DM varying between 8.25 and 16.70% (mean= 12.2 ± 1.62 %). Finally, the gross composition appeared comparable to that of cow milk.

In the meta-analysis achieved by Al-haj et al (2022) by compiling the composition of 7298 camel milk samples, relatively comparable values were reported: 3.47 % for fat, 3.17% for total protein, 4.38% for lactose, and 0.78% for ash, the total solids being 11.31% on average. Later, another meta-analysis was achieved regarding total caloric count of camel milk, which is linked to its global composition (Al-Haj et al., 2024).

However, the gross composition cannot explain by itself the “therapeutic properties” of camel milk systematically highlighted by several reviews. Indeed, the particularities of this milk are in the fine composition.

Fine Composition

Regarding the fine composition, the specificities of camel milk are in the fatty acid composition, cholesterol content, type of proteins, lactose metabolites, major and trace minerals, and vitamins.

Fat matter in camel milk contains higher proportion of unsaturated fatty acids (FA), notably medium chain, compared to other milk (Dreiucker and Vetter, 2011; Wang et al., 2022). Its atherogenicity index (2.7) is lower than in cow milk (Konuspayeva et al., 2008) and, consequently, is regarded as more beneficial for the human diet, contributing to decrease the risk of cardiovascular failure (Dowelmadina et al., 2019). The FA composition can be modulated by the diet (Faye et al., 2013) and could vary according to the management system (Chamekh et al., 2020), the intensive system being less beneficial due to lower contents of total Conjugated Linoleic (CLA), Rumenic, Vaccenic, linoleic, α -linolenic, and other polyunsaturated FA compared to less intensive management. The question of cholesterol content in camel milk is, at reverse, controversial as it was emphasized by Faye et al., (2015a). The ratio cholesterol/fat seems comparable to that of cow milk (Faye et al., 2015b). So, the content in cholesterol should be more important in high-fat milk from Central Asia and less in low-fat milk samples from other parts of the world (Konuspayeva et al., 2008).

The part of caseins (CN) in total proteins is 76% only, i.e. less than in cow milk (82%), and the distribution of the different types (α 1, α 2, β , κ) is quite different from cow milk (Kappeler et al., 1998). The absence of β -lactoglobulin and the low concentration of α S1-CN in camel milk are highlighted in most of the references to state that there is no allergy for consumers; these 2 proteins being the most important milk allergen in cow milk (Monaci et al., 2006). Yet, some cases of allergy with camel milk were described, provoking cutaneous urticaria and/or angioedema and even anaphylaxis (Ehlayel and Bener, 2018). Thus, it is not correct to consider that camel milk never provokes allergy, despite its interest in consumers specifically allergic to β -lactoglobulin. Moreover, camel milk is characterized also by the presence of two specific proteins, namely Whey Acidic Protein (WAP) and Peptidoglycan-recognition protein (PGRP). WAP is contributing to the regulation of the proliferation of mammary epithelial cells and could have a bacteriostatic activity (Ryskaliyeva et al., 2019) while PGRP, a pathogen recognition protein, has also antimicrobial and immunostimulant properties (Kappeler et al., 2004; Maurya et al., 2023). The proteomic composition of dromedary, Bactrian and hybrid camel milk was investigated recently,

showing a high complexity with the presence of 1010 functional groups of proteins. Among them, 893 were common to the three species, 31 were unique to Bactrian, 5 to dromedary and 12 to hybrids (Ryskaliyeva et al., 2018). Globally, these proteins are divided in four groups, including caseins, whey proteins, proteins of the fat globule membrane and enzymes.

The mineral composition of camel milk is not fundamentally different from cow milk. Regarding main minerals, there are relatively more Na and Cl, compared to cow milk, notably due to the frequent feeding in salty ranges rich in halophytes (Abu El-Ezz et al., 2015). In contrast, comparative studies led to the conclusion that main minerals such as Ca, P and Mg are in lower concentrations in camel milk compared to cow, goat, sheep, or buffalo milk (Al-Wabel, 2008; Chen et al., 2020; Al-Haj et al., 2022; Khaldi et al., 2022).

Camel milk is poor in vitamin A and in carotenoid pigments (pro-vitamin A). With a range of 50 to 390 µg/L, the concentration is lower on average than cow, goat, sheep and buffalo milk (Claeys et al., 2014; Singh et al., 2017; Siddiqui et al., 2023). If the richness in vitamin C is currently evoked regarding camel milk, its richness in vitamin D is less reported and the references are scarce. Yet, milk from camel contains 8 times more vitamin D than milk from cow, 15.6 ng/mL vs 1.78 ng/mL on average (Sboui et al., 2016). Moreover, the concentration is stable all along the lactation (Zhang et al., 2005).

Conclusion

In conclusion, camel milk stands between traditional legends of medicinal attributes and modern development as a food. It is true that camel milk possesses specific components that contribute to its classification as a functional food. However, further studies are needed to explore the impact of geographical, physiological, and genetic factors. It is also important to consider farm management and processing conditions.

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Camel Milk Production Conditions in UAE: Economic Aspects, Safety and Innovation of New Products

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Abstract

Camel milk, a traditional Emirati staple, is transforming into a modern industry with growing global demand. Rich in nutrients and hypoallergenic, it supports health-conscious consumers and offers potential benefits like glycemic control. Despite challenges such as high production costs and environmental constraints, government support and technological advancements drive its growth. Innovations include probiotics, fortified beverages, and sustainable packaging, aligning with global trends. With increasing exports and a focus on R&D, the UAE aims to lead the global camel milk market. Camel milk stands out as a superfood, merging tradition with innovation for a sustainable future.

Keywords: UAE, camel milk, nutrition, sustainability, economy diversification, superfood

Introduction

Camel milk has long been a staple of Emirati culture and is now emerging as a globally sought-after product. Its nutritional benefits, sustainable production potential, and economic contributions position it as a unique player in the dairy industry (Ismail et al., 2022).

Camel milk is integral to the UAE's efforts to diversify its economy beyond oil. While the majority is consumed locally, exports to Europe, the U.S., and Asia are increasing. Supported by government subsidies and research investments, this niche market is growing despite challenges like high production costs and limited yields compared to cow milk (Cornall, 2021).

Environmental factors such as high temperatures and water scarcity add complexity to camel milk production. However, advances in technology, sustainability practices, and research facilities are paving the way for improved efficiency and innovation. New products like probiotics, fortified beverages, and eco-friendly packaging cater to global consumer trends.

Camel milk offers unique advantages: it is rich in vitamins, minerals, and immune-boosting components. The absence of β -lactoglobulin makes it suitable for allergy sufferers, and research highlights its potential in managing glycaemic levels and supporting overall health (WebMD, 2025).

Conclusion

The UAE is poised to become a global leader in camel milk production, focusing on R&D, market expansion, and sustainability. The industry's ambition includes positioning camel milk as a premium, health-focused product that aligns with circular economy principles.

In conclusion, camel milk bridges tradition and innovation, offering immense potential for economic and global impact. With strategic growth and sustainability efforts, it is set to thrive as a superfood for the future.

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Good Practices in Camel Milk Production

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Abstract

Camels rank as the fifth most significant dairy animals and serve as a vital food source in arid and semi-arid regions. Historically, camel milk production was confined to nomadic and semi-intensive farming systems, consumed locally without integration into national markets. The camel dairy industry began its intensification only 15 to 20 years ago and remains relatively uncommon, though it is anticipated to expand in the coming decades. Furthermore, the emergence of national and international camel milk markets necessitates the development of international standards and statutory requirements to support the sector's continued growth.

Keywords: camel milk production, herd management, intensive farming, international standards, food safety.

Introduction

Camels rank as the fifth most significant dairy animals and serve as a vital food source in arid and semi-arid regions. Historically, camel milk production was limited to nomadic and semi-intensive farming systems, consumed locally without integration into national markets. The camel dairy industry began its intensification only 15 to 20 years ago and remains relatively uncommon, though it is anticipated to expand in the coming decades (Nagy et al., 2022).

One of the most important constraints is the lack of funding. Intensive camel milk production requires an initial investment that includes a continuous water and electricity supply, a regular and reliable feed source, well-trained professionals and veterinary services, a processing facility, and reliable access to markets. Unfortunately, meeting these requirements is challenging in most arid and semi-arid countries where camels are kept naturally. However, if these conditions are met, dromedaries can be efficiently integrated into an intensive production environment by applying best practices in camel milk production. These practices are also encouraged by relevant national and international guidelines and regulations, facilitating the emergence and development of national and international camel milk markets (Konuspayeva et al., 2022).

Discussion and Development

Increased intensification of camel dairy production in the coming years can be attributed to several factors. Firstly, there is a growing world population in arid and semi-arid regions. Additionally, there is an increased demand for products of animal origin in general. Moreover, public awareness of camel milk and meat is rising. Finally, livestock species that are well-adapted

to arid environments are expected to gain more prominence due to decreasing water resources and increased land desertification.

Intensive camel dairy production offers several benefits. Firstly, it allows for the efficient and cost-effective production of high-quality raw camel milk and meat, suitable for further processing and meeting the quality requirements of 21st-century consumers. Additionally, it ensures that the animal health and welfare requirements of the species are met, provided that national and international guidelines, statutory requirements, and standards are followed. Furthermore, it facilitates selective breeding and relatively fast genetic development of the species. Lastly, it supports the development of national and international trade.

The foundation of an intensive production system relies on three main pillars. Firstly, it requires robust infrastructure, facilities, and equipment, collectively summarized by the term “prerequisite programs (PRP)”. Secondly, it depends on competent, motivated, and well-trained staff. Finally, it necessitates comprehensive herd health and food safety management systems, applying operational PRPs and standard operating procedures. This foundation ensures that “happy and healthy” camels produce high-quality milk that is close to their maximum genetic potential.

To achieve this goal, a Herd Health Management must be implemented that encompasses three main elements: an animal health and biosecurity program, an animal welfare or well-being program, and a breeding and reproductive management program. These elements are interlinked and sometimes overlap, meaning they cannot be successfully managed independently of each other (Nagy et al., 2022).

Best practices in intensive camel dairy production are supported by international guidelines, codes of practice, and standards set by various organizations. These include guidelines for Good Agricultural Practices by FAO and standards established by the International Organization for Standardization (ISO), such as ISO/TS 22002-3:2011 and ISO 22000:2018 Food Safety Management System. The WOAHA also contributes to the OAI Terrestrial Animal Health Code 2024. Codex Alimentarius provides a wide range of food-related standards. However, there is currently no specific standard for camel milk.

The legal framework in the UAE is well established to control the camel dairy industry and support its development and further integration into international markets. The main element is a ministerial resolution (MR No. 106 of 2020) regarding the fulfillment of the European Commission requirements by exporting establishments of camel milk and its products. Additionally, there is a technical regulation for the GCC region concerning pasteurized camel milk (GSO 1970:2009 / Amd

1:2021). However, there is an obvious need for an international standard for camel milk developed by CAC that includes all regions of the world.

Conclusion

Camels have adapted to arid zones with unique characteristics and produce distinctive milk. Large-scale production remains close to natural conditions. Ensuring that camels are healthy and happy contributes to a longer production life. This approach yields a good quality and safe product to the consumers in a changing environment. The Farm to Fork Strategy and the One World One Health initiative highlights the importance of a holistic approach for intensive camel milk production. However, for the further development of international trade, it is essential that various stakeholders, including industry leaders, policymakers, scientists, and international organizations, collaborate and prioritize the establishment of an international camel milk standard. By working together, these stakeholders can create a unified framework that ensures the highest quality and safety standards, ultimately benefiting producers, consumers, and the global camel milk industry.

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Review and Documentation of Adulteration in Camel Milk

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Abstract

Camel milk, valued for its rich nutritional composition and absence of β -lactoglobulin, is increasingly recognized for its health benefits and functional properties. However, the sector faces persistent challenges related to adulteration and authenticity assurance. This review compiles scientific and industry evidence demonstrating that camel milk is among the most fraud-prone foods globally, with intentional blending of 10–30 % cow or goat milk, dilution with water, and substitution of milk fat frequently reported. Such practices distort markets and may expose allergic consumers to bovine allergens. The paper summarizes detection methods, including immunological assays, DNA-based species identification, spectroscopic and chemometric techniques, and freezing-point analysis, and identifies knowledge gaps in establishing validated reference values specific to camel milk. The findings highlight the need for harmonized authenticity criteria and international standardization, which would support regulators, producers, and laboratories in safeguarding consumer trust and promoting fair trade in camel-milk products.

Keywords: fraud, adulteration, camel milk substitution, cow milk, Beta Lactoglobulin.

Introduction

Renowned for its unique nutritional composition; rich in immunoglobulins, the absence of beta-lactoglobulin and presence of essential micronutrients such vitamin C, D, iron, zinc, camel milk is increasingly recognized for its health effects relative to several disorders such as diabetes, autoimmune disorders, and lactose intolerance (Ansari et al., 2024). Despite these advantages, the camel milk industry faces systemic challenges that threaten its scalability and consumer trust.

Adulteration in Camel Milk

Adulteration of milk and dairy products is a global concern. Camel milk is considered as the second most likely food item in the risk of adulteration after olive oil (Calvanoet et al., 2012).

Adulteration and all types of fraudulent addition of camel milk is a problem in most countries. Camel milk costs 2–10 times more than cow milk. Since camel milk has a high nutritional value and diverse bioactivity characteristics, adulteration with other less expensive milk (as cow or goat milk) is common.

Apart from economic loss, such adulteration can create serious consequences for individual health, specifically among those who are allergic to cow milk or making lactose intolerance. According to a study carried out by Hui Yang et al. (2025), using DNA-based species identification to detect adulteration: out of 80 field samples, 66.67% of hand-milked samples contained cow milk, whereas mechanically milked samples showed significantly lower adulteration rates. The adulteration was typically intentional, involving 10–30% cow milk to increase volume without visibly altering camel milk characteristics.

Therefore, methods are urgently required to assess the authenticity of camel milk and its products to protect consumers from such fraudulent practice.

Qing Liang et al. (2025) reported that profit-motivated adulteration through blending with lower-cost milk sources (e.g., cow or goat milk) or dilution with water distorts markets. More critically, cross-species milk protein allergens introduced through adulteration threaten the safety of sensitized populations. The authors propose a novel, non-destructive method to detect adulteration (fraud) in camel milk using dielectric spectroscopy combined with deep learning / chemometric models.

Possible Types of Adulteration in Camel Milk

Among other species milks, camel milk is considered as being the most prone to adulteration due to its high price, demand, and nutritional value, because camel milk and camel milk products are more expensive than milk and milk products obtained from other milk producing animals, therefore, there are several possible ways to adulterate camel milk and camel milk products, such as the following:

- Added cow or goat milk to camel milk, therefore the methodology used to detect this kind of adulteration must detect the presence of beta-lactoglobulin, present in milk from cow or goat but not in camel milk (Shi-Xin Chi et al. 2024). The detection of beta-lactoglobulin can be done with simple and cheap Radial Immunological Diffusion (RID) technique, a method developed in the years 90, but unfortunately never commercialized despite its interest in field detection.
- Added water to increase camel milk volume: the methodology used to detect this kind of adulteration, is to test the freezing point of the camel milk (Konuspayeva, et al (2023). Until now no specific freezing point was well define for camel milk, because of used equipment's values change, and no data regarding level of added water is reported yet.

- Added vegetable fat to camel milk, therefore the methodology which may be used to detect this kind of camel milk adulteration, is the detection of phytocholesterol (Nurseitova et al., 2019).

Industry Reporting of Camel Milk Adulteration

As per a communication with a main producer in a rural production area in Asia, a cooperative system of production is in place, giving rise to several adulteration cases:

- **Mixing milk:** Camel milk is collected or gathered from nomad farmers having no awareness about the consequences of mixing milk from different species. Also, farmers having a herd of 5-7 lactating animals (goat-cow-buffalo- camels), invariably, they used to mix the sheep and goat milk with the camel milk collected by the dairy factory resulting in rejections at the plant or collection centres.
- **Adding Chemicals:** due to long distances from farms to the collection points, farmers use some chemicals to preserve milk until reaching the collection point since there is no cold equipment for transportation.

Conclusion

In the absence of an international standard for camel milk that defines its specific compositional parameters, there are no internationally agreed minimum quality requirements. Most non–camel-milk-producing countries rely only on general safety parameters, which do not account for the unique characteristics of camel milk. Therefore, it is challenging to the official control authorities as well as producers to determine the adulteration cases by well adapted tools for camel milk. In this regard, both national authorities, producers and manufacturers will benefit from the development of an international standard for camel milk. The standard will help harmonize production conditions and create a level playing field, providing consistent guidance for producers and regulators worldwide.

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Conclusion – International Symposium “Supporting the Development of the Camel Milk Sector”

The jGFORSS Editorial Team

Abstract

The International Symposium “Supporting the Development of the Camel Milk Sector”, organized by the Abu Dhabi Agriculture and Food Safety Authority (ADAFSA) in collaboration with the Global Food Regulatory Science Society (GFORSS), the disciplinary group of the International Union of Food Science and Technology (IUFoST), convened experts, regulators, producers, and researchers to review advances in camel-milk science, production, and trade. Discussions highlighted camel milk’s distinct composition, including the absence of β -lactoglobulin, predominance of β -casein, and higher lactoferrin and vitamin C levels, which underpin its nutritional and hypoallergenic value. At the same time, evidence of economically motivated adulteration (blending with bovine milk, dilution, or substitution of milk fat) was presented, confirming authenticity as a key emerging challenge. Participants noted that the lack of harmonized international reference parameters hinders oversight and fair trade. The symposium’s conclusions helped establish the scientific and policy foundation for possible future standardization under the Codex Alimentarius, particularly regarding composition, authenticity, and quality assurance of camel-milk products.

Keywords: camel milk, β -lactoglobulin, β -casein, lactoferrin, vitamin C, hypoallergenic, authenticity, adulteration.

The International Symposium “Supporting the Development of the Camel Milk Sector”, organized by the Abu Dhabi Agriculture and Food Safety Authority (ADAFSA) in collaboration with the Global Food Regulatory Science Society (GFORSS), the disciplinary group of the International Union of Food Science and Technology (IUFoST), brought together experts, regulators, producers, and research institutions from camel-milk-producing regions to review recent scientific advances and developments in production, processing, and trade.

Held within the framework of the International Year of Camelids (2024), the Symposium underscored the growing nutritional, economic, and social importance of camel milk in contributing to food security, rural livelihoods, and sustainable development.

Scientific sessions highlighted the distinct compositional features of camel milk—its absence of β -lactoglobulin, predominance of β -casein, elevated lactoferrin and vitamin C levels, and favorable lipid and fatty-acid profile—which differentiate it from bovine milk and contribute to its hypoallergenic and functional properties. Industry participants described the rapid expansion and diversification of camel-milk production and product innovation, including pasteurized, fermented, powdered, and fortified beverages driven by increasing global demand.

At the same time, discussions revealed emerging authenticity challenges. Evidence presented during the meeting demonstrated that economically motivated adulteration, through blending with cow or goat milk, dilution, or substitution of milk fat, has been documented in several

producing and exporting countries. Such practices distort markets, erode consumer confidence, and may expose sensitive individuals to bovine allergens.

Participants agreed that while national and regional controls exist, the absence of internationally harmonized reference parameters for camel-milk composition and authenticity hinders consistent oversight and equitable trade. They therefore emphasized the need to develop common definitions, compositional benchmarks, and authenticity-verification principles that could serve as reference points for producers, regulators, and laboratories alike.

The Symposium's conclusions thus contributed to establishing the scientific and policy foundations for possible future standardization under the Codex Alimentarius, particularly in the areas of composition, authenticity, and quality assurance of camel-milk products. Advancing this work, within the Codex framework, would help ensure that this expanding and high-value sector continues to evolve safely, transparently, and in line with international best practices.