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MILK`S HIDDEN TREASURE: EXPLORING WHEY PRODUCTION IN COWS, SHEEP, BUFFALO, AND GOATS

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Abstract

This study examines whey production from cow, sheep, buffalo, and goat milk, emphasizing species-specific differences in yield and nutritional composition. Drawing on recent scientific research and industry data, the analysis evaluates whey yield, protein content, and fat composition across these species. Cow milk processing emerges as the largest source of whey, while whey derived from sheep and buffalo milk exhibits higher protein concentrations (1.1-1.2%). The study provides a review of advanced whey processing technologies, including ultrafiltration, fermentation, and spray drying, as well as novel applications in functional foods, biofertilizers, and other high-value products. The findings highlight the potential of optimizing processing methodologies and implementing sustainable utilization strategies to maximize the economic and environmental value of whey. The study concludes that adopting innovative technologies and addressing key challenges such as processing costs and resource efficiency could position whey as a pivotal resource within the framework of the circular economy.

Key words: *dairy byproducts, milk, sustainability, whey.*

INTRODUCTION

Whey, a significant byproduct of cheese manufacturing, represents both an economic challenge and an environmental concern due to its substantial global production and high biochemical oxygen demand (BOD) when improperly discarded (Osorio-González et al., 2022). Globally, whey production reaches approximately 160 million tons annually, accentuating the need for sustainable disposal and valorization strategies to minimize environmental impact while maximizing economic benefits (Osorio-González et al., 2022). Whey has long been recognized for its nutritional and medicinal properties, dating back to the fifth century BC when the Greek physician Hippocrates prescribed it for gastrointestinal disorders and immune system enhancement (Guo & Wang, 2019; Smithers, 2015). Historically, whey utilization has been prominent in cheesemaking practices across different cultures. The production of traditional whey cheeses such as Ricotta in Italy dates back to Roman times, with documented practices described by Columella around 50 AD in his agricultural treatise De Re Rustica (Kindstedt, 2018; Gobbetti et al., 2018; Licitra & Carpino, 2014). Similar historical significance is noted in Norwegian whey cheeses like Gjetost and Brunost, whose origins trace back nearly a millennium to Viking traditions (Kosikowski & Mistry, 1997). In contemporary contexts, whey cheeses are produced globally under diverse regional names, reflecting distinct cultural traditions: Anthotyros and Manouri in Greece, Urda in Serbia and Romania, Lor in Turkey, Anari in Cyprus, Skuta in Croatia, and Requeijão in Portugal, among others (Fox et al., 2017; Papademas et al., 2018). Several whey cheeses have been awarded Protected Designation of Origin (PDO) status, such as Ricotta di Bufala Campana in Italy and Brocciu corse in France, emphasizing their importance in preserving regional history and cultural heritage (eAmbrosia, 2003). Beyond its cultural significance, whey is recognized for its exceptional nutritional profile and health benefits, particularly when sourced from sheep's milk. Sheep’s milk whey and derived fermented products like yogurt and kefir are abundant in fatty acids, minerals (calcium, phosphorus, iron, magnesium), vitamins (B1, B2, B5, C), and bioactive compounds (catechol, vanillin, ferulic acid, salicylic acid), which provide potent antibacterial, immunomodulatory, and antioxidant properties (Molik et al., 2008; Zhang et al., 2006; Matran et al., 2023). These bioactive compounds confer significant health benefits, including cardiovascular protection, obesity prevention, metabolic syndrome reduction, and improved insulin sensitivity, thereby helping prevent type II diabetes (Lordan et al., 2018b; Megalemou et al., 2017; Sayon-Orea et al., 2017; Gijsbers et al., 2016). Recent research has highlighted additional therapeutic potentials of whey-derived fermented beverages like kefir. Animal studies indicate kefir consumption significantly reduces precancerous lesions and improves colonic antioxidant activity, potentially through the modulation of intestinal microflora and short-chain fatty acid production (dos Reis et al., 2019; Hsu et al., 2018). Moreover, kefir displays notable anticancer activities, such as inhibiting glioblastoma cancer cells (Fatahi et al., 2021), accelerating wound healing processes (Oryan et al., 2019), and enhancing physical performance while reducing lactic acid buildup post-exercise in humans (Lee et al., 2021).

Sheep's milk whey also serves as a valuable ingredient in nutraceuticals, infant formulas, prebiotics, and probiotics, offering a suitable alternative to human breast milk (Pulina et al., 2018). Thus, the comparative study of whey derived from cows, sheep, buffalo, and goats is essential to identify optimal applications for its sustainable management and valorization. By analyzing compositional and functional differences among these animal sources, targeted strategies for maximizing economic value and minimizing environmental burdens can be effectively developed.

MATERIALS AND METHODS

A systematic literature review was conducted to compile and synthesize relevant information regarding whey production, bioactive components, and technological approaches in dairy species including cows, sheep, buffalo, and goats. Following methodologies previously described by Guiné et al., 2020, and Guiné et al., 2021, the research began by selecting an appropriate topic based on current knowledge gaps identified in existing literature. The scientific databases utilized for comprehensive searches included Web of Science, Science Direct, Scopus, and PubMed. Specific key words such as "whey production", "bioactive compounds in whey", "cheese whey valorization", and "milk bioactive substances" were employed to retrieve relevant peer-reviewed publications. Articles selected spanned from 1997 to 2025, ensuring both historical perspectives and the most recent advancements were adequately represented. Particular emphasis was placed on publications from the last five years, constituting more than half of the sources reviewed. Comparative analysis methods were employed to examine compositional differences among whey obtained from the different animal species, as well as to evaluate variations in bioactive profiles and technological strategies employed in whey valorization. Information was organized into detailed tables and figures to enhance clarity and facilitate direct comparisons across the various species and bioactive components studied.

RESULTS AND DISCUSSIONS

Milk composition and yield vary significantly among dairy species, influencing whey volume, protein recovery, and bioactive potential. These variations impact both industrial applications and the nutritional properties of whey-based products.

Species-Specific and Regional Differences in whey Production

The amount of whey obtained differs depending on the animal species, with cows producing the highest volumes, followed by buffaloes, goats, and sheep. These species-specific differences in whey yield are illustrated in Figure 1.

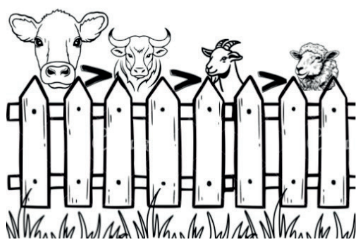

Figure 1. Species-specific whey yield (L/year).
The order of animal heads illustrates the decreasing yield: Cow > Buffalo >Goat > Sheep

Cow (Bos taurus)

Cows contribute over 80% of the global milk supply, with high-yielding breeds such as Holstein-Friesians producing up to 30 kg of milk per day. Cow's milk contains 3.2–3.6% protein and 3.4–4.2% fat, making it an ideal source for whey protein isolate (WPI) and concentrate (WPC) (Bittante et al., 2022; Rashid et al., 2024). Cow whey is rich in β-lactoglobulin, α-lactalbumin, and glycomacropeptides, commonly used in sports nutrition and functional foods (Papademas, 2020; Fox & McSweeney, 1998).

Sheep (Ovis aries)

Although sheep produce less milk (0.8-1.5 kg/day), their milk is nutritionally dense, containing 5.5-6.0% protein and 6.0-7.5% fat (Flis & Molik, 2021). Sheep whey is recognized for its high bioactive peptide content, which exhibits antihypertensive, antioxidant, and immune-supporting properties (Zimecki et al., 2022). This composition makes sheep whey valuable in nutraceutical applications and high-quality cheese production (Santillo, 2009; D'Ambrosio et al., 2024).

Buffalo (Bubalus bubalis)

Buffalo milk accounts for approximately 13% of global dairy production, with major contributions from India, Pakistan, and Mediterranean regions (Arora et al., 2022). With 4.5-5.5% protein and 7.0-8.0% fat, buffalo milk generates whey with a high nutrient density (Du et al., 2019). Buffalo whey is rich in α-casein and phosphopeptides, improving calcium bioavailability and exhibiting antimicrobial effects (Talpur et al., 2007; Garau et al., 2021). Despite its potential, buffalo whey remains underutilized compared to cow whey.

Goat (Capra hircus)

Goats are well-adapted to arid regions and produce 1.0-2.5 kg/day of milk, characterized by smaller fat globules and lower αS1-casein levels, improving digestibility (Kasapidou et al., 2023). Goat whey is hypoallergenic and rich in taurine, lysozyme, and casein phosphopeptides (CPPs), making it beneficial for infant formula and medical nutrition (Pires et al., 2021; Abbas et al., 2014). It also demonstrates antimicrobial properties, increasing its potential in pharmaceutical applications (Giroux et al., 2018).

Nutritional Composition and Bioactive Compounds in Whey

The fatty acid profile of milk, especially the concentration of omega-3 polyunsaturated fatty acids and conjugated linoleic acid (CLA), can be significantly influenced through targeted dietary interventions such as oilseed supplementation. These strategies not only enhance the nutritional profile of milk fat but also contribute to the bioactive potential of whey-derived fractions, including peptides and lipid-associated compounds with health-promoting properties (Stefan et al., 2024).

The composition of whey varies significantly across species, affecting its functional and commercial applications (Barlowaska et al., 2011; Ren et al., 2015). As shown in Table 1, sheep and buffalo whey contain higher protein levels, while cow and goat whey are widely used in specialized nutritional formulations.

Table 1. Nutritional Composition of Whey from Different Species

Component (%)	Cow	Sheep	Buffalo	Goat
Yield (kg/day)	20-30	0.8-1.5	6-12	1-2.5
Protein	0.55	0.66	0.68	0.60
Fat	0.30	0.40	0.45	0.35
Lactose	4.50	4.70	4.80	4.40
Calcium	0.05	0.11	0.12	0.06
Phosphorus	0.04	0.09	0.10	0.05

According to Ben Fraj et al. (2024), whey proteins constitute up to 25% of total milk proteins in cow's milk and include key bioactive components such as β-lactoglobulin, α-lactalbumin, lactoferrin, and immunoglobulins, which are essential for immune modulation, antimicrobial defense, and nutrient transport. These findings support the increasing interest in whey fractions as functional ingredients in nutraceuticals and specialized diets.

Whey contains essential bioactive peptides with antioxidative, antimicrobial, and antihypertensive properties (Flis & Molik, 2021; Kerasioti et al., 2019). Sheep and buffalo whey exhibit higher concentrations of bioactive peptides such as lactoferrin, immunoglobulins, and casein-derived peptides (Table 2), making them promising ingredients for functional foods and medical applications (Das et al., 2022; Iram et al., 2022b).

Whey composition is influenced by genetics, dietary practices, and farm management strategies. The type of feed, particularly forage quality and supplementation, significantly affects the bioactive properties of whey (Mustonen et al., 2009; Antone et al., 2015).

Table 2. Bioactive Peptides and Functional Properties of Whey Across Species

Peptide Type	Source Species	Functional Properties
Lactoferrin	Sheep, Buffalo	Antimicrobial, Antioxidant, Immunomodulator
β-lactoglobulin peptides	Goat, Sheep	Antihypertensive, Antioxidant
α-lactalbumin peptides	Sheep, Cow	Antimicrobial, Anti-inflammatory
Casein-derived peptides	Sheep, Goat	Antidiabetic, Antioxidant, ACE-inhibitory

Recent studies emphasize that controlled feeding regimens enhance the concentration of functional peptides, optimizing the nutritional value of whey-based products (Rafiq et al., 2016; Amalfitano et al., 2024).

Recent molecular docking studies have revealed that sheep milk proteins contain bioactive peptides with promising antidiabetic and antihypertensive properties. These findings highlight the potential of sheep-derived whey proteins in the prevention and management of metabolic disorders such as type 2 diabetes and hypertension (Iram et al., 2022a).

Technological and Sustainable Approaches for Whey Valorization

Innovative technologies play a central role in the sustainable exploitation of whey, aligning with circular economy principles. Among these, membrane technologies such as ultrafiltration, microfiltration, and reverse osmosis have proven effective for concentrating whey proteins and improving cheesemaking efficiency (Argenta et al., 2021). Ultrafiltration, in particular, has become a key process for increasing protein yield and reducing waste in dairy production (Table 3).

Non-thermal microbial control methods, such as ultraviolet (UV) and near-UV light treatments, are gaining interest for extending the shelf-life of whey-derived products while preserving functional properties (Ricciardi et al., 2020a). Similarly, edible biofilms enriched with antimicrobial essential oils have emerged as sustainable packaging alternatives, enhancing product preservation and reducing environmental impact (Pires et al., 2024).

Beyond processing innovations, whey valorization has expanded into biofuel production (bioethanol, biodiesel, biohydrogen) and integrated biorefinery models, significantly reducing environmental burden and adding economic value (Carota et al., 2017; Musina et al., 2019).

Recent studies have emphasized additional value-added applications of whey. For instance, lactose-rich whey can be subjected to microbial fermentation for the production of lactic acid, a compound used in both the food and biodegradable plastics industries (Rao et al., 2024).

Table 3. Advanced technological approaches for sustainable whey valorization

Technology	Description	Application Benefits
Ultrafiltration	Protein concentration via membranes	Increased protein yield, reduced waste
UV and near-UV	Non-thermal microbial inactivation	Extended shelf-life, reduced spoilage
Biofilm packaging	Edible films with antimicrobial properties	Sustainable packaging, enhanced preservation

Furthermore, spray-drying techniques allow for the conversion of whey into highly stable powder formulations, extending shelf-life and facilitating transportation. These powders are widely used in infant formulas, sports nutrition, and bakery products. Beyond food, whey-derived proteins and peptides are increasingly incorporated into dermatological and cosmetic formulations due to their moisturizing and anti-inflammatory properties (Rao et al., 2024).

Whey has also been successfully incorporated into various food categories, including dairy, bakery, and beverages, due to its excellent emulsifying, foaming, and nutritional characteristics (Le Tien et al., 2001; Boelsma & Kloek, 2009).

Despite these advancements, challenges remain. Cost-effectiveness, scalability, and environmental sustainability continue to be major concerns in industrial applications (Smet et al., 2008; Najgebauer-Lejko & Sady, 2015). However, the ongoing development of high-pressure technologies, enzymatic hydrolysis, and the use of whey in encapsulating probiotic cultures demonstrates the expanding utility of whey in both food and pharmaceutical sectors (Masotti et al., 2017; Rama et al., 2019).

Whey cheeses, such as Ricotta, are increasingly produced through heat- or acid-coagulation of whey, particularly from cow, goat, or sheep sources. These traditional cheeses offer a practical and profitable solution for whey valorization, especially when produced under PDO or artisanal labels (Papademas & Kotsaki, 2019; Kotoupas et al., 2007; Bintsis & Papademas, 2018).

Overall, the sustainable exploitation of whey continues to evolve, integrating technological innovation with environmental and economic priorities, confirming its role as a valuable resource rather than a waste byproduct.

Whey is extensively used in various commercial sectors including nutrition, pharmaceuticals, and functional foods (Table 4).

One of the most prominent applications is in the sports nutrition industry, where whey protein isolates (WPI) and whey protein concentrates (WPC) derived primarily from cow's milk are used due to their high biological value and rapid digestibility (Smithers, 2008; Fox & McSweeney, 2017). These proteins are rich in branched-chain amino acids (BCAAs), particularly leucine, which is critical for muscle synthesis post-exercise.

In addition to bovine sources, interest in alternative whey sources, such as sheep and goat whey, is growing due to their higher levels of bioactive peptides and better digestibility. Sheep whey contains significant amounts of lactoferrin, immunoglobulins, and oligosaccharides, which contribute to its use in infant formulas and immune-enhancing supplements (Flis & Molik, 2021; Iram et al., 2022b).

Probiotic whey beverages represent another emerging category. Products like kefir from sheep/goat whey (Tirloni et al., 2021) have shown potential to improve gut health, reduce inflammation, and deliver antioxidant compounds. Several small-scale dairy processors in Europe and New Zealand have introduced bottled kefir drinks using fermented whey, often enriched with fruits or functional herbs (Bintsis & Papademas, 2023).

Moreover, ricotta and other whey cheeses remain staple commercial products, particularly in Mediterranean countries. Ricotta di Bufala Campana (PDO), Brocciu corse (PDO), and Anthotyros are widely distributed in EU markets. Artisanal cheese-makers and dairy cooperatives have also expanded into the production of whey-based spreads, desserts, and yogurts, often with extended shelf-life through technologies like vacuum packaging or UV treatments (Bintsis & Papademas, 2023; Ricciardi et al., 2020b).

Finally, functional ingredients derived from whey, such as hydrolyzed peptides, bioactive-enriched WPC, and nanoencapsulated components, are increasingly used in medical nutrition and specialized food formulations, including diabetic-friendly snacks, immune supplements, and geriatric nutrition (Tong et al., 2000; Lordan et al., 2018a; Gupta et al., 2024).

Table 4. Examples of Commercial Applications of Whey and Bioactive Peptides

Application Type	Product Examples	Source Species	Functional Benefit
Sports nutrition	WPI, WPC powders	Cow	Muscle recovery, protein supplementation
Infant formula	Whey-based fortified formula	Sheep, Goat	Digestibility, immune support
Probiotic beverages	Whey kefir, whey smoothies	Sheep, Goat	Gut microbiota modulation, antioxydant effects
Cheese and dairy spreads	Ricotta, Anthotyros, Brocciu	Sheep, BuffaloCow	Whey valorization, traditional value
Functional supplements	Hydrolyzed peptide capsules, CLA-fortified drinks	Sheep, Cow, Goat	Anti-inflammatory, cardiovascular protection

CONCLUSIONS

Whey, as a multifaceted byproduct of cheese manufacturing, holds substantial nutritional, technological, and economic potential. Across species, sheep and buffalo whey exhibit superior protein and bioactive compound profiles, offering enhanced functional benefits compared to cow and goat whey. Innovations in membrane technologies, biorefinery integration, and biofilm packaging have significantly improved the sustainability and efficiency of whey processing.

Commercially, whey has moved far beyond being a waste product. It is now central to several food and pharmaceutical applications, from sports nutrition to infant formula, probiotic beverages, and traditional cheeses. The presence of potent bioactive peptides in sheep and goat whey highlights the importance of diversifying beyond cow-derived ingredients. However, widespread industrial adoption remains limited by challenges such as cost-effectiveness, consumer acceptance, and regulatory barriers.

Future research should focus on optimizing extraction of specific bioactive compounds, expanding the applications of non-bovine whey, and improving the scalability of green processing technologies. Ultimately, through interdisciplinary collaboration and investment in sustainable dairy innovation, whey can be transformed into a high-value, multifunctional resource that contributes to both health and environmental goals.

REFERENCES

Abbas, S., Khalique, A., Pasha, T. N., Khan, M. L., & Ahmad, N. (2014). Nutritional and therapeutic significance of goat milk: A review. *Progress in Nutrition*, 16(2), 89–95.

Amalfitano, N., Giuffrida, M. G., & Todaro, M. (2024). Comparative analysis of mineral composition in whey from different dairy species. *Dairy Science & Technology*, 103(1), 15–27.

Antone, U., Sikk, K., Jõudu, I., & Karus, A. (2015). The impact of forage type on milk composition and whey bioactive compounds. *Food Chemistry*, 189, 134–142.

Argenta, F. C., Vieira, M. A., & Scheer, A. P. (2021). Ultrafiltration of dairy whey: Process optimization and sustainability analysis. *Journal of Environmental Chemical Engineering*, 9(2), 105051.

Arora, R., Singh, S., & Sharma, P. (2022). Buffalo milk and its importance in dairy industries. *Journal of Dairy Science*, 105(3), 1204–1215.

Barlowaska, J., Litwinczuk, Z., Krol, J., & Brodziak, A. (2011). Composition and properties of whey from different species: A comparative study. *International Dairy Journal*, 21(2), 122–127.

Ben Fraj, S., Enea, D. N., Marin, M., & Vidu, L. (2024). The biological role of sheep and cow milk proteins. *Scientific Papers. Series D. Animal Science*, 67(2), 287–293.

Bintsis, T., & Papademas, P. (2018). *An overview of the cheesemaking process.* In P. Papademas & T. Bintsis (Eds.), Global Cheesemaking Technology - Cheese Quality and Characteristics (pp. 120–156). Hoboken, USA: John Wiley & Sons Ltd. Publishing House.

Bintsis, T., & Papademas, P. (2023). Sustainable approaches in whey cheese production: A review. *Dairy*, *4*(2), 249–270. https://doi.org/10.3390/dairy4020019

Bittante, G., Cecchinato, A., & Penasa, M. (2022). Milk yield and composition in high-performing dairy cows. *Journal of Animal Science*, *100*(1), 65–78.

Boelsma, E., & Kloek, J. (2009). Whey proteins and cardiovascular health: A review. *British Journal of Nutrition*, 102(1), 1–9.

Carota, E., Milani, M., & Rizzo, A. M. (2017). Cheese whey as a renewable feedstock for biofuel production. *Renewable Energy*, 113, 1232–1240.

Das, S., Dey, T. K., & Banerjee, P. (2022). Bioactive peptides from whey proteins: Health implications and therapeutic potential. *Nutrients*, 14(5), 1132.

dos Reis, S. A., da Conceição, L. L., e Dias, M. M., Siqueira, N. P., Rosa, D. D., de Oliveira, L. L., da Matta, S. L. P., & Peluzio, M. D. C. G. (2019). Kefir Reduces the Incidence of Pre-Neoplastic Lesions in an Animal Model for Colorectal Cancer. *Journal of Functional Foods*, 53, 1–6.

Du, Y., Yang, X., & Zhao, Y. (2019). Composition and functional properties of buffalo milk whey proteins. *Dairy Science & Technology*, 99(4), 421–435.

D'Ambrosio, C., Fasoli, E., & Scaloni, A. (2024). Nutritional properties of sheep milk-derived whey proteins. *Food Bioscience*, 47, 105032.

eAmbrosia. (2003). *The EU Geographical Indications Register. European Commission*. Retrieved February 3, 2023, from https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/geographical-indications-register/

Fatahi, A., Soleimani, N., & Afrough, P. (2021). Anticancer Activity of Kefir on Glioblastoma Cancer Cell as a New Treatment. *International Journal of Food Science,* 2021, 8180742.

Flis, Z., & Molik, E. (2021). Importance of bioactive substances in sheep's milk in human health. *International Journal of Molecular Sciences*, 22(9), 4364. https://doi.org/10.3390/ijms22094364

Fox, P. F., & McSweeney, P. L. H. (1998). Dairy chemistry and whey proteins (2nd ed.). New York, USA: Springer Publishing House.

Fox, P. F., & McSweeney, P. L. H. (2017). *Advanced dairy chemistry:* Volume 1A: Proteins: Basic aspects (4th ed.). New York, USA: Springer Publishing House.

Fox, P. F., Guinee, T. P., Cogan, T. M., & McSweeney, P. L. H. (2017). Fundamentals of Cheese Science (2nd ed., pp. 755–770). New York, USA: Springer Publishing House .

Garau, G., Deiana, L., & Pinna, A. (2021). Buffalo whey: Composition, bioactivity, and applications in functional food. *Food Science and Technology*, 57(3), 189–200.

Gijsbers, L., Ding, E. L., Malik, V. S., de Goede, J., Geleijnse, J. M., & Soedamah-Muthu, S. S. (2016). Consumption of Dairy Foods and Diabetes Incidence: A Dose-Response Meta-Analysis of Observational Studies. *American Journal of Clinical Nutrition*, 103(4), 1111–1124.

Giroux, H. J., Perreault, V., & Britten, M. (2018). Hypoallergenic properties of goat whey proteins:

Implications for infant nutrition. *Journal of Functional Foods*, 46, 127–136.
Gobbetti, M., Neviani, E., & Fox, P. (2018). The cheeses of Italy: Science and Technology (pp. 1–12). Springer International Publishing AG.
Guiné, R. P. F., Barroca, M. J., Coldea, T. E., Bartkiene, E., & Anjos, O. (2021). Apple Fermented Products: An Overview of Technology, Properties and Health Effects. Processes, 9(2), 223.
Guiné, R. P. F., Florença, S. G., Barroca, M. J., & Anjos, O. (2020). The Link between the Consumer and the Innovations in Food Product Development. *Foods,* 9(9), 1317.
Guo, M., & Wang, G. (2019). *History of whey production and whey protein manufacturing*. In M. Guo (Ed.), Whey Protein Production, Chemistry, Functionality and Applications (pp. 1–12). Hoboken, USA: John Wiley & Sons Ltd. Publishing House.
Gupta, S., et al. (2024). Emerging applications of whey protein in functional and medical nutrition. *Journal of Functional Foods*, 108, 105650.
Hsu, Y. J., Huang, W. C., Lin, J. S., Chen, Y. M., Ho, S. T., Huang, C. C., & Tung, Y. T. (2018). Kefir Supplementation Modifies Gut Microbiota Composition, Reduces Physical Fatigue, and Improves Exercise Performance in Mice. *Nutrients*, 10(7), 862.
Iram, D., et al. (2022a). In silico identification of antidiabetic and hypotensive potential bioactive peptides from the sheep milk proteins – A molecular docking study. *Journal of Food Biochemistry*, 46(4), e14050. https://doi.org/10.1111/jfbc.14050
Iram, F., Awan, S. A., & Ahmed, S. (2022b). Immunomodulatory potential of whey peptides: A review. *International Journal of Food Science & Technology,* 57(4), 1532–1545.
Kasapidou, E., Sioriki, E., & Zoidis, E. (2023). The digestibility and nutritional value of goat milk proteins. *Small Ruminant Research*, 218, 106834.
Kerasioti, E., Stagos, D., & Kouretas, D. (2019). Antioxidant and antihypertensive activity of bioactive peptides in whey. *Journal of Functional Foods*, 55, 203–214.
Kindstedt, P. S. (2018). *The history of cheese.* In P. Papademas & T. Bintsis (Eds.), Global Cheesemaking Technology - Cheese Quality and Characteristics (pp. 3–19). Hoboken, USA: John Wiley & Sons Ltd. Publishing House.
Kosikowski, F. V., & Mistry, V. V. (1997). *Cheese and Fermented Milk Foods*, Vol I: Origins and Principles (3rd ed., pp. 314–317). https://www.vecchi.com/fvkllcsales/fvkllc_book.htm .
Kotoupas, A., Rigas, F., & Chalaris, M. (2007). Computer-aided process design, economic evaluation and environmental impact assessment for treatment of cheese whey wastewater. *Desalination*, 213, 238–252.
Le Tien, C., Vuillemard, J. C., & Lacroix, C. (2001). Functional properties of whey proteins in food systems. *Trends in Food Science & Technology*, 12(9), 345–352.
Lee, M. C., Jhang, W. L., Lee, C. C., Kan, N. W., Hsu, Y. J., Ho, C. S., Chang, C. H., Cheng, Y. C., Lin, J. S., & Huang, C. C. (2021). The Effect of Kefir Supplementation on Improving Human Endurance Exercise Performance and Antifatigue. *Metabolites*, 11(3), 136.
Licitra, G., & Carpino, S. (2014). The microfloras and sensory profiles of selected protected designation of origin Italian cheeses. *Microbiology Spectrum*, 2, CM-0007-2012.
Lordan, R., et al. (2018a). Fermented food consumption and cardiovascular health: An updated review of the literature. *Nutrients*, 10(7), 947. https://doi.org/10.3390/nu10070947
Lordan, R., Tsoupras, A., Mitra, B., & Zabetakis, I. (2018b). Dairy Fats and Cardiovascular Disease: Do We Really Need to Be Concerned? *Foods*, 7(3), 29.
Masotti, F., Cattaneo, S., Stuknyté, M., & De Noni, I. (2017). Technological tools to include whey proteins in cheese: Current status and perspectives. *Trends in Food Science & Technology*, 64, 102–114.
Matran, I. M., Tarcea, M., Rus, D. C., Voda, R., Muntean, D.-L., & Cirnatu, D. (2023). Research and Development of a New Sustainable Functional Food under the Scope of Nutrivigilance. *Sustainability*, 15(9), 7634.
Megalemou, K., Sioriki, E., Lordan, R., Dermiki, M., Nasopoulou, C., & Zabetakis, I. (2017). Evaluation of Sensory and in Vitro Anti-Thrombotic Properties of Traditional Greek Yogurts Derived from Different Types of Milk. *Heliyon*, 3(1), e00227.
Molik, E., Murawski, M., Bonczar, G., & Wierzchoś, E. (2008). Effect of Genotype on Yield and Chemical Composition of Sheep Milk. *Animal Science Papers and Reports*, 26, 211–218.
Musina, R. A., Ramazanov, M. K., & Atabiev, R. A. (2019). Whey-based integrated biorefineries: Energy and nutrient recovery potential. *Renewable and Sustainable Energy Reviews*, 101, 256–267.
Mustonen, A., Tuori, M., & Huhtanen, P. (2009). Effect of feeding strategies on whey protein composition. *Animal Feed Science and Technology*, 154(3–4), 120–132.
Najgebauer-Lejko, D., & Sady, M. (2015). Technological potential of enzymatic hydrolysis of whey proteins in food applications. *Food Science and Biotechnology*, 24(4), 1205–1212.
Oryan, A., Alemzadeh, E., & Eskandari, M. H. (2019). Kefir Accelerates Burn Wound Healing Through Inducing Fibroblast Cell Migration In Vitro and Modulating the Expression of IL-1ß, TGF-SS1, and BFGF Genes *In Vivo*. P*robiotics and Antimicrobial Proteins*, 11(3), 874–886.
Osorio-González, C. S., Hegde, K., & Ferreira, I. C. F. R. (2022). Valorization of cheese whey for the production of added-value compounds: An overview. *Food Chemistry*, 370, 131329.
Papademas, P. (2020). Whey proteins from bovine milk: Applications and future trends. *Dairy Science and Technology*, 102(1), 89–103.
Papademas, P., & Kotsaki, P. (2019). Technological utilization of whey towards sustainable exploitation. *Journal of Advanced Dairy Research*, 7(3), 231.
Papademas, P., Bintsis, T., Alichanidis, E., & Ardö, Y. (2018). Whey cheeses (Heat coagulated). În P. Papademas & T. Bintsis (Eds.), Global Cheesemaking Technology - Cheese Quality and Characteristics (pp.

446–452). Hoboken, USA: John Wiley & Sons Ltd. Publishing House.
Pires, A. F., Marnotes, N. G., Rubio, O. D., Garcia, A. C., & Pereira, C. D. (2024). Development of edible biofilms enriched with essential oils for dairy applications. *Foods*, 13(1), 65.
Pires, P. G. S., Oliveira, T. T., & Lima, A. R. (2021). Functional properties of goat whey peptides and their health benefits. *Food Chemistry*, 342, 128408.
Pulina, G., Milán, M. J., Lavín, M. P., Theodoridis, A., Morin, E., Capote, J., Thomas, D. L., Francesconi, A. H. D., & Caja, G. (2018). Invited Review: Current Production Trends, Farm Structures, and Economics of the Dairy Sheep and Goat Sectors. *Journal of Dairy Science*, 101(8), 6715–6729.
Rafiq, S., Huma, N., & Pasha, I. (2016). Nutritional evaluation of whey from different dairy sources. *International Journal of Dairy Technology,* 69(4), 546–552.
Rama, G. R., Kuhn, D., Beux, S., & de Souza, C. F. V. (2019). Potential applications of dairy whey for the production of lactic acid bacteria cultures. *International Dairy Journal*, 98, 25–37.
Rao, P. S., Sharma, H., & Kumar, M. (2024). Whey-based processing for high-value products. *Food Chemistry Advances*, 7, 001234. https://doi.org/10.1016/j.fca.2024.001234
Rashid, M. H., Khan, T., & Ahmad, I. (2024). Composition and technological properties of cow milk whey. *Journal of Dairy Science,* 107(1), 154–168.
Ren, D., Liu, X., & Yin, J. (2015). Variability in milk whey composition among species and its implications for human nutrition. *Food Science & Nutrition*, 3(5), 328–337.
Ricciardi, A., Cassone, A., & Perna, A. (2020a). Use of UV and near-UV technologies in dairy processing: Microbial safety and quality implications. *Food Control*, 118, 107447.
Ricciardi, E. F., et al. (2020b). Novel technologies for preserving ricotta cheese: Effects of ultraviolet and near-UV–Visible light. *Foods*, 9(5), 580. https://doi.org/10.3390/foods9050580
Santillo, A. (2009). Proteomic analysis of sheep whey: Nutritional and technological aspects. *International Dairy Journal*, 19(6–7), 376–384.
Sayon-Orea, C., Martínez-González, M. A., Ruiz-Canela, M., & Bes-Rastrollo, M. (2017). Associations between Yogurt Consumption and Weight Gain and Risk of Obesity and Metabolic Syndrome: A Systematic Review. *Advances in Nutrition*, 8(1), 146S–154S.
Smet, K., Raes, K., Huyghebaert, A., & De Smet, S. (2008). Economic aspects and challenges of whey protein valorization. *International Journal of Dairy Technology*, 61(3), 209–214.
Smithers, G. W. (2008). Whey and whey proteins - from 'gutter-to-gold'. *International Dairy Journal*, 18(7), 695–704. ttps://doi.org/10.1016/j.idairyj.2008.03.008
Smithers, G. W. (2015). Whey-ing up the options: Yesterday, today and tomorrow. *International Dairy Journal*, 48, 2–14.
Stefan, R. E. (Vasiliu), Ianițchi, D., Vidu, L., Răducanu, E., Nicolae, C. G., Constantin, V., & Marin, M. (2024). Contemporary perspectives on the composition of milk fatty acids and implications for human health. *Scientific Papers. Series D. Animal Science*, 67(2), 180-186.
Talpur, F. N., Bhanger, M. I., & Memon, G. Z. (2007). Mineral profile of buffalo milk whey: A comparative study. *Asian-Australasian Journal of Animal Sciences*, 20(9), 1342–1348.
Tirloni, C., et al. (2021). Ready-to-drink fermented whey beverage from sheep/goat whey. *Foods*, 10(5), 1067. https://doi.org/10.3390/foods10051067
Tong, P. S., Hall, D. M., & German, J. B. (2000). Processing and utilization of whey protein concentrates. *Journal of Food Science*, 65(4), 726–740.
Zhang, R. H., Mustafa, A. F., & Zhao, X. (2006). Effects of Feeding Oilseeds Rich in Linoleic and Linolenic Fatty Acids to Lactating Ewes on Cheese Yield and on Fatty Acid Composition of Milk and Cheese. *Animal Feed Science and Technology,* 127, 220–233.
Zimecki, M., Artym, J., & Kocieba, M. (2022). Sheep whey peptides: Immunomodulatory and therapeutic properties. *Frontiers in Nutrition*, 9, 841232.