

Camel Milk Protein Concentrate: Properties and Applications

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Camel milk is traditionally consumed in Asia, Middle East and Africa and has received a world-wide interest due to its excellent nutritional value and health-promoting features. It is regarded good for those with lactose intolerance or cow's milk protein allergy, due to its low lactose content and the absence of β -lactoglobulin. It is rich in minerals, vitamins, lactoferrin and immunoglobulins. These unique features add further to its potential as a functional meal in the therapy of diabetes and autoimmune illnesses. The dromedary camel represents around 95% of the world's camel population, estimated at around 29 million. The production of camel milk is increasing because of its nutritional value, functional characteristics and developing dairy sector. The demand for camel milk has also been expanding, which has led to an increased demand for efficient protein concentration technologies to improve protein content and functioning and generate value-added products.

Protein profile of camel milk

Camel milk contains 3.1–3.99% protein, which is mostly made up of caseins (53–86%), whey proteins (20–25%) and bioactive proteins such as lactoferrin, immunoglobulins, peptidoglycan recognition protein (PGRP), α -lactalbumin, lysozyme and lactoperoxidase. Camel milk is more digestible, less allergenic and compositionally closer to human milk as it has a high percentage of β -casein (65–67% of total casein), no β -lactoglobulin and larger casein micelles than cow milk. Camel milk proteins have antimicrobial, antioxidant, antiviral, anti-inflammatory and immunomodulatory activities which contribute to the high nutritional and therapeutic value of camel milk.

The protein content of camel milk is different but the relatively low protein concentration limits its direct use in high-protein food formulations. Therefore, membrane technologies like ultrafiltration and diafiltration are employed to concentrate the protein content and retain the important bioactive proteins in camel milk protein concentrate (CMPC). CMPC can be used as a viable ingredient in the development of high-protein dairy products, functional foods, nutraceuticals and specialised nutritional products

due to its enhanced nutritional quality, improved functional and processing properties, and improved storage stability.

Production of milk protein concentrate

High quality milk protein concentrates (MPCs) are produced from fresh skim milk or reconstituted non-fat milk of high microbiological quality. The milk is usually pasteurised by HTST (72–75°C for 15–20 s) before ultrafiltration but other heat treatments such as thermisation (65°C for 15 s) or pasteurisation at 85°C for 15 s have also been described. Microfiltration can be used for the removal of residual fat and to improve the functionality of the product and controlled heating of UF/DF retentates can change the solubility of calcium without significant alteration in buffering capacity.

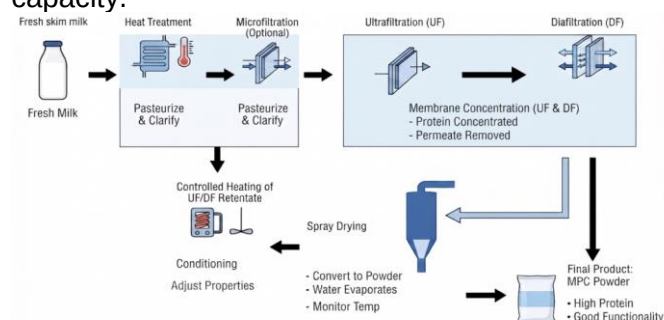


Fig 1: Production of milk protein concentrate

Ultrafiltration (UF) is the main technology used to produce milk protein concentrates. It retains proteins and fat, but allows water, lactose and minerals to pass through the membrane. After UF, diafiltration (DF) is often employed to remove lactose and soluble minerals, resulting in MPCs with better composition and >65% protein. Nanofiltration has also been studied but UF is still the most common method to produce MPC. MPCs are usually manufactured using single- and multi-stage spray dryers with pressure or rotary atomizers. Spray drying conditions, especially inlet and outlet air temperatures, greatly influence the stability of proteins and the functional properties of the final powder. In general, milk droplets are held below 70°C until most of the moisture is evaporated during drying and thus the temperature of the outlet air is crucial in reducing heat induced damage to proteins. Sufficient drying conditions resulted in a lower degree of denaturation of whey proteins and better retention of bioactive proteins.

On the other hand, higher drying temperatures encourage protein denaturation, casein aggregation and the formation of less soluble, deflated particles. Lower temperatures lead to the formation of more spherical particles with improved solubility and overall functionality.

Challenges and Limitations

The manufacture of camel milk protein concentrate (CMPC) encounters a number of difficulties. Acid-induced gelation of camel milk is weaker than that of cow milk because its proteins do not readily form a stable gel network. In one study, raw camel milk was heated to 40 °C and acidified with GDL (0.8, 1.0, and 1.2%, w/w), stirred at 400 rpm for 60 s, and incubated undisturbed for 4.5 h, with pH measured every 10 min. Although 1.0% GDL reduced the pH to ~4.3, gel formation did not occur. Gelation was subsequently improved by adding gelatin (0.6, 0.8, and 1.0%, w/w), dissolving it at 40 °C with 30 min of stirring, followed by 1.0% GDL, 60 s of mixing, 4 h of incubation, and storage at 4 °C for 18 h. The gels were evaluated for final pH, hardness, water-holding capacity, and rheological properties, confirming that gelatin supplementation is essential for improving the gelation behavior of camel milk (Ho et al., 2022). Its proteins have high foaming and emulsifying properties; however, they are not very stable. Furthermore, efficient large-scale manufacturing and commercialization are hindered by membrane fouling during ultrafiltration, heat-induced protein denaturation during drying, and the high cost and scarcity of camel milk. Camel skim milk was concentrated using a 30 kDa ultrafiltration (UF) membrane that retained the proteins and fat, but the water, lactose and minerals in the retentate passed in to the permeate. The process was run at 50 °C up to a five-fold volume concentration ratio (VCR) with sampling at various concentration steps for analysis. As VCR increased from 2 to 5, the protein and fat contents increased proportionally with almost complete protein retention (98-100%) whereas the lactose decreased due to its passage through the membrane. The results indicated that UF is an effective way to obtain camel milk concentrates that are rich in protein and low in lactose (Mehaia, 1996).

Applications of camel milk protein concentrate

Camel milk protein concentrate (CMPC) has become an attractive functional dairy ingredient because of its high nutritional value, distinct protein profile and rich source of bioactive compounds. CMPC is a desirable component for the preparation of functional and therapeutic dairy products due to the lack of β -lactoglobulin, the dominance of β -casein and the high levels of lactoferrin, immunoglobulins, α -lactalbumin,

lysozyme and lactoperoxidase. Its high protein content and superior amino acid profile allow it to be incorporated into high protein beverages, nutritional supplements, protein powders, meal replacement formulations and sports nutrition products. Besides, CMPC could be alternative sources of protein for people allergic or intolerant to cow milk proteins due to their lower allergenic potential than the proteins from bovine milk. Additionally, CMPC can be used to improve the protein content and functional value of fermented dairy products like yoghurt. It can be used to improve the protein content of bakery, confectionery, dairy desserts, beverages and protein fortified snacks without affecting product quality. It also exhibits excellent emulsifying, foaming and water-binding properties useful for microencapsulation of bioactive compounds.

Conclusion

Camel milk proteins are rich in bioactive compounds and are highly digestible and less allergenic, which makes camel milk protein concentrate (CMPC) a promising ingredient for functional foods. CMPC can be produced by membrane technologies such as ultrafiltration and diafiltration, but optimisation of processing, gelation and scale-up is necessary to increase its commercial applications.

References

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