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RECOLLECTION: CAMEL MILK PROTEINS, BIOACTIVE PEPTIDES AND CASEIN MICELLES

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ABSTRACT

Camel milk is mostly known through its unique proteins and bioactive peptides. Its protein pattern is more close to human milk than bovine milk. Camel milk similar to human milk lacks β-lactoglobulin, the most allergen protein in bovine milk. Bioactive peptides produced from both casein and whey proteins of camel milk have shown great bioactivity compared to peptides from different sources. Camel milk bioactive peptides have shown high antioxidant activity, ACE inhibitory activity as well as antimicrobial activity. The casein micelles of camel milk are an excellent nano carrier for bioactive components. Therefore, camel milk is considered as a new traditional superfood. Traditionally, it has been used since ancient times in some part of the world and it has been noticed as a new source for producing superfood in developed countries. Consuming milk and milk products is part of a healthy diet. Commercial milk is mostly bovine milk which has become one of the main sources of producing functional products through fortification and enrichments. Investment on camel milk has earned a good attention in today's food industries. In this recollection, we have pointed out some of the most important and recent works examined on camel milk and its components by our laboratory.

Key words: Bioactive peptides, camel milk, casein micelles, milk proteins, nutraceuticals, superfood

Commercial milk is mostly derived from bovine origin, which has become one of the main sources of producing functional products through fortification and enrichments. Camel milk is a nutritious food, consumed traditionally in some parts of the world. More recently, camel milk was considered as a superfood in developed countries as well. Because of similarities between camel and human milk, camel milk has earned a good attention in today's food industries. The objective of this recollection was to elaborate some of the recent works conducted in our laboratory on protein content, bioactive peptides and casein micelles derived from camel milk. Nowadays, the focus of food industry is on the production of functional, nutraceutical and or medicinal foods by fortifying and enriching the available source of food such as milk. Camel milk is a natural enriched product without any particular additives. Camel milk differs from bovine milk in composition and structure of its protein, vitamins and minerals, which influences its functional and biological properties. Camel milk composition is much closer to human milk than that of bovine milk. In camel milk similar to the human milk, α-lactalbumin (α-La) is the main protein of whey fraction; whereas, β-lactoglobulin (β-Lg) is absent. In contrast, in bovine milk, as a base of commercial infant milk powder, β-Lg is the main protein of whey fraction, which is considered as a potential source of food allergy in newborns. We have shown that bioactive peptides derived from camel milk proteins could have promising therapeutic properties such as anticancer, antioxidant, anti-hypertensive, antimicrobial and mineral binding effects in human body (Khalesi *et al,* 2017; Salami *et al,* 2008). Bioactive peptides are usually inactive in the native proteins and can be produced *in vivo* and *in vitro* by different digestive and microbial enzymes and by fermentation (Moslehishad *et al,* 2013. Angiotensin converting enzyme (ACE) inhibitory peptide is one of the bioactive peptides resulted from both enzymatic digestion and fermentation that can act actively to control blood pressure (Salami *et al,* 2011). Hydrolysis of camel and bovine milk whey proteins has shown that camel milk had more antioxidant and antimicrobial properties (Rahimi *et al,* 2016 and Salami *et al,* 2010). The anti-glycation of human serum albumin (HSA) and antioxidant effect of aloin, a major component of *Aloe vera*, in the presence and absence of casein-derived peptides from camel milk was studied (Moosavi-Movahedi *et al,* 2015). The presence of aloin and peptides reduced the number of glucose-attached lysine residues. Accordingly, aloin and camel casein derived peptides showed a synergic anti-glycation effect and inhibited

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the formation of fibrils during the HSA glycation. This effect can be related to the antioxidant activity of aloin–peptide complex (Moosavi-Movahedi *et al,* 2015). Curcumin is a protective component with anti-fibrils, antioxidant and anti-inflammatory properties. It is a potential component against various malignant diseases, diabetes, allergies, arthritis, Alzheimer's disease, cancer and other chronic illness (Mazaheri *et al,* 2015a and Mazaheri *et al,* 2015b). Curcumin is a natural polyphenol but poorly soluble in aqueous solutions. Fortunately, camel beta casein micelles are capable of increasing curcumin solubility up to 2500 folds (Esmaili *et al,* 2011). Accordingly, curcumin can be solubilised by camel beta casein for therapeutic purposes in human medicine.

A novel artificial enzyme was produced using camel β-casein (Cβ-casein). Peroxidase-like artificial enzyme, named "caseoperoxidase", was biomimetically designed using a nano artificial amino acid apo-protein hydrophobic pocket. This four-component nano artificial enzyme containing heme–imidazole–β-camel casein–SDS exhibited high activity growth and kinetics performance toward the native horseradish peroxidase. Cβ-casein was selected as an appropriate apo-protein for the heme active site because of its innate flexibility and exalted hydrophobicity. Camel β-casein as a hydrophobic protein has very suitable hydrophobic pocket that could accommodate the haeme prosthetic group inside its cavity (Moosavi-Movahedi *et al,* 2015).

In conclusion, camel milk can be revisited as superfood food with respect to protein content, bioactive peptides and casein micelles activities.

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