

Nutritional and Therapeutic Characteristics of Camel Milk in Children: A Systematic ReviewSaid Zibae¹, Syed Musa al-reza Hosseini², Mahdi Yousefi³, Ali Taghipour⁴, Mohammad Ali Kiani⁵, Mohammad Reza Noras⁶¹ Ph.D. of Microbiology, Assistant Professor, Razi Vaccine and Serum Research Institute of Mashhad, Iran² M.D., Assistant Professor, Department of Gastroenterology, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran³ Ph.D. of Iranian Traditional Medicine, Assistant Professor, School of Iranian Traditional Medicine and Complementary Medicine, Mashhad University of Medical Sciences, Mashhad, Iran⁴ Ph.D. of Epidemiology, Assistant Professor, school of Health, Mashhad University of Medical Sciences, Mashhad, Iran⁵ M.D., Assistant Professor, Department of Pediatrics Gastroenterology, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran⁶ Ph.D. Candidate, School of Iranian Traditional Medicine and Complementary Medicine, Mashhad University of Medical Sciences, Mashhad, Iran**Type of article:** Systematic review**Abstract****Introduction:** Camel milk is the closest to a human mother's milk. Camel milk is different from other milks, however, having low sugar and cholesterol, high minerals (sodium, potassium, iron, copper, zinc and magnesium, and vitamin C). The milk is considered have medicinal characteristics as well. This systematic review is aimed at determining and reporting nutritional values and medicinal characteristics of camel milk in children.**Methods:** The search strategy of the current review is "(camel AND milk) AND (autism OR food allergy OR milk allergy OR children OR diarrhea)." The search was conducted via PubMed, Scopus, and Google scholar. Also two Persian scientific databases (SID and Iranmedex) and international congresses were investigated. Full-text papers and abstracts on the topic of camel milk, evaluating nutritional value and medicinal properties, were included in this systematic review.**Results:** Out of the 472 records found in the resources, 35 related studies were included in the final analysis. The result showed that camel milk is highly nutritious and is safe for consumption by children.**Conclusion:** It seems that many researchers did not follow a specific guideline for reporting and confirming the therapeutic properties of camel milk in children, but there is evidence denoting the importance, trials, and investigations of its usability and benefits. Camel milk as a supplemental treatment seems less invasive and costly than specialist care, medications, alternative treatments, and behavioral interventions. Based on our findings, camel milk is safer for children, effective in the treatment of autism, improves general well-being, promotes body natural defenses, is a good nutritional source, and can help the daily nutritional needs of humans.**Keywords:** camel milk, autism, food allergy, milk allergy, children, diarrhea, intolerant to lactose**1. Introduction**

Milk is an important food for children. Camel milk has been used for centuries as a medicinal drink in Middle Eastern, Asian, and African cultures (1-3). Camel milk products in the world are popular due to increasing demand and are typically available in pharmacies (4). This systematic review has been conducted to evaluate the nutritional value and medicinal properties of camel milk in children, based on historical and clinical evidences. Camel milk has

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been used for centuries in Middle Eastern societies, and its many medicinal benefits need to be established by conventional medicine. The camel is an animal that has been integrated into daily life of many societies in the pre-modern world and is still greatly respected in the cultures of these societies. Thus, traditional medicine books and documents provide many quotes about the camel's mild benefits and nutritional values. Avicenna stated therapeutic effects for camel milk in spleen, kidney, liver, cancer, and children diseases have been reported (8). Thus, in this comparative review, we aim to investigate the issues discussed with referring to the conventional medicine evidence. According to traditional Iranian medicine (TIM), the composition of camel milk is closer to human milk and of high nutritional value and therapeutic effects (5-7). Subsequently, the main aim of this research is to understand the various diseases that might be alleviated or prevented with camel milk and relating them to the biochemical content of camel milk and discussing the causality of these benefits based on traditional resources and conventional medicine research. Besides, we aim to evaluate camel milk in the cases or conditions for treatment of disease.

2. Material and Methods

2.1. Search strategy

In this review, the databases, including PubMed, Scopus, SID, Iranmedex, and Google Scholar, have been searched using the search strategy of: “(camel AND milk) AND (autism OR food allergy OR milk allergy OR children OR diarrhea)” for randomized controlled clinical trials, systematic reviews and/or meta-analysis, case series, case reports, and animal studies, which have been published from 1980 to 2014. The abstract of national (Iranian) and international congresses/meetings proceedings (including Congress of Camel) and university dissertations were also explored. Materials were sorted according to indications and novelties. Out of the 472 searched articles, 35 related studies were chosen for final analysis based on the noted criteria (Figure 1). Results were reviewed by two peer reviewers based on eligibility criteria. The third reviewer was asked if the agreement (Kappa coefficient) was less than 65%.

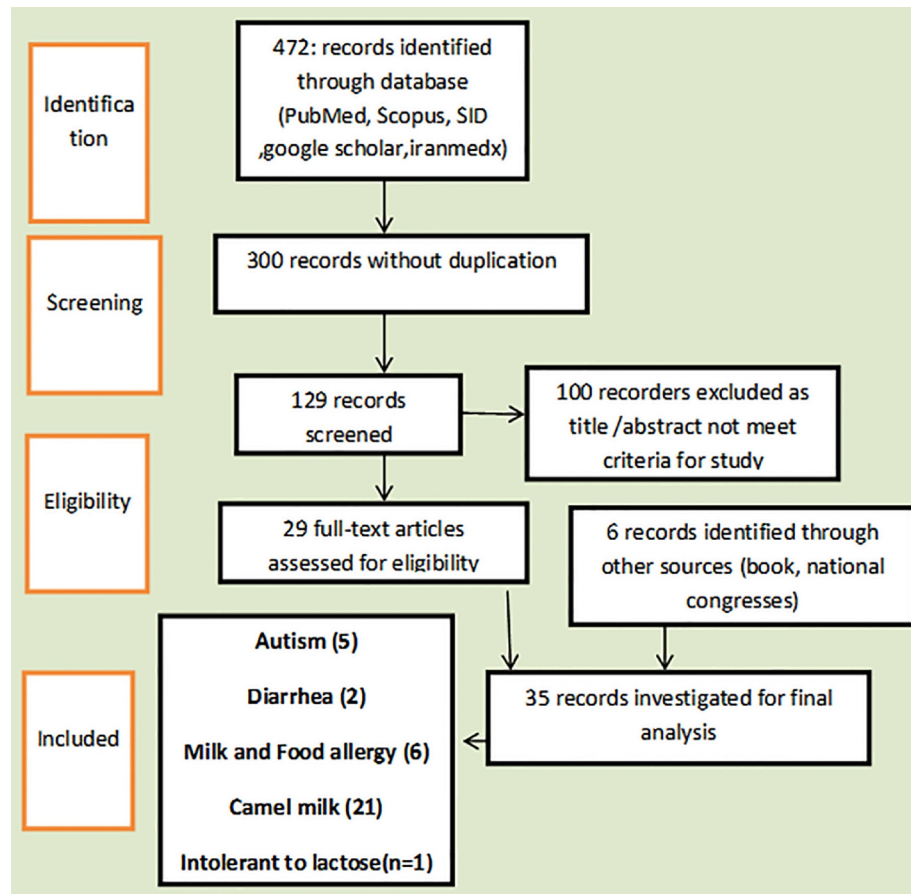


Figure 1. Flow chart showing the selection process and exclusion criteria.

2.2. Inclusion and exclusion criteria

As inclusion criteria, English, Persian, and Arabic language studies randomized controlled clinical trials, systematic reviews and/or meta-analysis, case series, case reports, and animal studies. The titles and abstracts of the relevant studies were evaluated. Irrelevant studies and the studies on other milks, other traditional resources (e.g., Chinese medicine), studies on animals, studies rejecting alternative medicine in general or studies with combined methods are excluded.

2.3. Quality assessment

For quality control, all parts of this article, including the abstract, introduction, search strategies and materials, finding, discussion, and results, were evaluated with STROBE (strengthening the reporting of observational studies in epidemiology) statement checklist (35). Based on the STROBE checklist, including 22 items, the strength quality of all articles was assessed. In addition, the sampling method, existence of valid instruments, the appropriateness of the statistical analysis, ethical considerations, identification of the RCTs with codes, and presence of inclusion and exclusion criteria were also controlled. The data were based on the search results, which identified 472 articles; although 434 studies were excluded from the review due to quality difficulties, and 35 articles remained for further consideration.

3. Results

3.1. Camel milk composition

Camel's milk is generally an opaque white color and has a faint sweetish odor but sharp taste; sometimes it can be salty (10). In a meta-analysis study (1905–2006), camel milk was examined and compared with other milks in five manuscripts. The results published in FAO are shown (below). The average amount of components of camel milk is protein 3.1%; fat 3.5%; lactose 4.4%; ash 0.79%, and total solids 11.9% (11–16). The most important factor in camel milk is water content. The total solid content is similar to that human milk (17).

3.1.1 Proteins

In previous studies, the total amount of camel milk protein has been reported as being from 2.9 to 4.9. Camel milk proteins can be divided into two groups: caseins and whey proteins. These proteins are important components of camel milk and have different functions. The amount and type of amino acids in camel milk are high except for lysine, glycine, threonine, and valine. The most important proteins in camel milk are whey proteins, which contain albumin, lactoferrin, immunoglobulins, etc. (11-16).

3.1.2. Fats, lactose, vitamins, and minerals

The fat content of dromedary camel milk is between 1.2% and 6.4% (11). Short chain fatty acids in camel milk are low, but the long chain fatty acids are high in content. The amount of linoleic acid and unsaturated fatty acids in camel milk is also high, which is important for nutrition (11-16). The total amount of camel milk lactose also has been reported (11-16). Camel milk has a lot of vitamins from different groups: fat and water-soluble, such as vitamin A, E, D, and B, and especially vitamin C (10-15). Camel milk is a good source of minerals, especially calcium and kalium (11-16).

3.2. Therapeutic uses of camel milk

Therapeutic effects of Camel milk were assessed in some clinical trials, case reports, and in vivo/ in vitro studies. Six review articles reported on camel milk, citing that it can be used in metabolic and autoimmune diseases, hepatitis, Rota viral diarrhea, tuberculosis, cancer, diabetes, liver cirrhosis, rickets, autism, and Crohn's disease (18-21). Related papers to children diseases including autism, food and milk allergies, intolerance to lactose and diarrhea were reviewed in this study as follows:

1) Intolerant To Lactose

Camel milk has lower lactose in comparison with cow's milk (13). Only one study indicated whether camel's milk can be consumed by patients intolerant to lactose without undesirable reactions; in 25 patients, it was seen that camel's milk can be considered an option for an individual's intolerance to lactose, who presents symptoms when ingesting cow's milk (22).

2) Diarrhea

Camel milk is a remedy for viruses causing diarrhea (such as Rota virus). Two studies overviewed the effects of camel milk on diarrhea. An animal study in 2010 indicated that fermented camel milk had a higher content of sodium and potassium and stopped diarrhea in model rats. It can be concluded that fermented camel milk can be considered as a good food for high nutritive and therapeutic applications (23). A review study reported improvement in Crohn's and autism diseases such as diarrhea; bowel movements were considered normal; thus, the authors offered a new perspective on the etiology of some diarrheal diseases (24).

3) Milk Allergy

The incidence of milk allergy in infants and young children is very high. Thus, finding suitable milk for alternative mothers or bovine milks in children was needed. Camel milk can safely be used as an alternative. Results of a prospective cohort study, performed in pediatric departments between April 2007 and February 2010 on 35 children aged 6–12 months with a cow's milk allergy (CMA), indicated that 80% of children with CMA were safely able to consume camel milk without developing any adverse allergic reaction (25). In the second study, entitled "To Determine Whether Camel Milk Is Safer than Goat Milk in CMA," 38 children with CMA were evaluated by the following tests: CBC, total IgE, cow milk-specific IgE, and SPT. Fresh camel and goat milks were given to the children. The tests in the children showed less allergic reaction to camel milk and that it can be a safe alternative to goat milk. (26). In another study, researchers tested two patients, aged 3 years 6 months and 2 years 3 months, respectively, with CMA, using a prick test with food antigens and prick-by-prick test with powder CM and full cream cow's milk. The patients were positive for the cow's milk and negative for the CM in the prick test. These observations agreed with the results reported by Ehlal on a cohort of 35 patients tested with fresh CM (27). In a similar study six, CMA patients aged from 14 months to 13 years using prick test with food antigens and prick-by-prick test with powder CM and full cream cow's milk were tested. All children resulted positive for full cream cow's milk and negative for CM at prick-by-prick test (28). Results of the above studies show that CM could represent a possible alternative to infant formulas in CMA. More studies are needed to confirm this finding. The researchers hypothesize that the children were able to tolerate the camel milk because it contains a different protein than cow's milk, which does not elicit an immune response.

4) Autism

Autism spectrum disorder (ASD) is a severe neurodevelopment disorder characterized by impairments in social orientation, communication, and repetitive behaviors (29). Camel milk provides many benefits, especially for autistic children. Camel milk is traditionally used in autism treatment in some areas of the world. A study published in the 2005 observed the effects of camel milk consumption, instead of cow milk, on several cases of children and adults with autism. Researchers discovered that, when a 4-year-old female participant consumed camel milk for 40 days, a 15-year-old boy consumed camel milk for 30 days, and several 21-year-old autistics consumed camel milk for two weeks, their autism symptoms disappeared. The patients were also observed to be quieter and less self-destructive. The authors reported in another study that camel milk consumption in children under 15 has been effective in controlling some of the symptoms, especially in the group under 10 years (30). Some parents report that their children were suffering from autism; then the children used camel milk, some of their symptoms improved such as better sleep; increased motor planning and spatial awareness; increased eye contact; better language and improved gastrointestinal function. In a study conducted on 60 patients with autism (2 to 12 years old) in Saudi Arabia, the effects of camel and cow's milk were evaluated when 500 ml of milk twice daily for 2 weeks were given to children. In the analysis, the baseline level of antioxidants of all the children was low. Results after two weeks showed significant improvement in cognitive and behavioral tests due to camel milk and lowered effects of oxidative stress. The researchers showed that camel milk plays an important role and reduces the effects of oxidative stress by adjusting the antioxidant enzymes and nonenzymatic antioxidant materials levels and improves psychological symptoms (31). In a case report published in 2013, a boy had been introduced in the third year of his life to recognize autism. The mother of this boy started, from the age of nine years, to give him a glass of camel milk at night. He was observed for six years (2007–2013) to see if camel milk would control the symptoms of autism (32). This report agreed with the results reported by Y. Shabo (30) that camel milk is especially useful for autistic children (ASD). Another clinical study investigated the effect of camel milk on biochemical markers. Forty-five children diagnosed with autism were randomly assigned to receive boiled CM for group I (n = 15), raw CM for group II (n = 15), and a placebo for group III (n = 15) for 2 weeks. CM administered for 2 weeks significantly improved clinical symptoms of autism and decreased serum level of "thymus and activation-regulated chemokine" (TARC) in autistic children (33).

5) Food Allergies

Camel milk proved its potential effect in the treatment of food allergies. A study has investigated the effect of camel milk on children who were allergic to cow's milk. Eight children who suffered from food allergies to different degrees participated in the study. They were only given camel milk to drink. (34). It appeared that camel milk has a positive effect in children with severe food allergies. The reactions are rapid and long lasting. A study by El-Agamy revealed that, when applying camel's milk protein-specific antisera in immunoblotting analysis, there was no immunologic cross reactivity between camel and cow's milk proteins. This study is laboratory work to obtain a better understanding of the competence of the greater camel of cow's milk for food allergies in children. For this purpose, molecular and immunological similarities of milk were evaluated. Milk proteins of camels, cows, and

humans, extracted by two different methods of electrophoresis, and were investigated. The results show that camel milk proteins can be used as a new protein source for food allergies (35).

4. Conclusions

The results showed the many benefits of camel milk, especially for children. These findings revealed that camel milk is safer for children, is effective in the treatment of autism, and improves general well-being. Also, the numerous nutrients in camel milk help to promote the body's natural defenses and thus can be considered as a good source of protein, calcium, phosphorus, vitamin C, and niacin and can meet part of the daily nutritional needs of humans. More large clinical trials are needed to support these findings. The researchers hope that these reports for pediatricians will lead to increased research on camel milk and its uses for children.

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Conflict of Interest:

There is no conflict of interest to be declared.

Authors' contributions:

All authors contributed to this project and article equally. All authors read and approved the final manuscript.

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