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Original article

Impact of Long-Term Camel Milk Consumption on Hepatic and Renal Biomarkers of Camel Nomads—An Observational Cross-Sectional Study from Southern Punjab, Pakistan

Maria Khan[1] Saeed Akhtar[2] Iqra Akram[1] Asher Abdur Rehman[3] Tariq Ismail[4]

[1] Department of Human Nutrition, Bahauddin Zakariya University, Multan, Pakistan
[2] Faculty of Food Science and Nutrition, Bahauddin Zakariya University, Multan, Pakistan
[3] Higher School of Medicine, Faculty of Medicine and Health Care, Al-Farabi Kazakh National University, Almaty, Republic of Kazakhstan
[4] Department of Food Science and Technology, Bahauddin Zakariya University, Multan, Pakistan

Address for correspondence Tariq Ismail, PhD, Department of Food Science and Technology, Bahauddin Zakariya University, Multan 60800, Pakistan (e-mail: tariqismail@bzu.edu.pk).

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Abstract

Objectives Camel milk is gaining popularity worldwide owing to its unique biochemical composition and therapeutic benefits. In persona to available data on camel milk's potential health attributes against noncommunicable diseases, this study examined camel milk's effect on hepatic and renal biomarkers of milk consumers.

Materials and Methods An observational cross-sectional study was conducted on 51 camel nomads in the periurban areas of South Punjab, Pakistan. Structured questionnaire based on sociodemographic, dietary assessment, and blood sampling was done following simple random sampling technique to evaluate hematological, hepatic, and renal biomarkers.

Results The results indicate hematological parameters including mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and mean corpuscular volume (MCV) to vary significantly between camel and cow milk consumers. Comparatively higher mean values of MCH, MCHC, and MCV, that is, 29.55 pg, 32.76 g/dL, and 89.61 fL, respectively, in male camel milk consumers than in females of the same group were observed. Camel milk consumption for the extended duration was found to anticipate significantly ($p < 0.05$) higher total serum protein contents, 17.38 g/dL in males and 15.23 g/dL in females than observed in cow milk consumers.

Conclusion The study validates that camel milk chronic consumption impacts some hematological changes to a significant level while indicating nonsignificant changes in renal and hepatic markers. Our study entertained sample population from one camel rearing region of the country. To better understand preventive and therapeutic properties of camel milk consumption against hepatic or renal disorders, sample populations from different regions may be enrolled and monitored for camel milk consumption, dietary patterns, and disease prevalence.

Keywords
- camel milk
- cow milk
- chronic diseases
- hematological markers
- renal and hepatic markers

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Introduction

Camel milk is quoted as "The White Gold of the Dessert."[1] Camel milk has an opaque white appearance, a subtle sweetish odor, a strong flavor, and can be salty at times.[2] Finely homogenized fats present throughout the milk is responsible for its opaque white color, while the taste varies due to the type of feed used and the quality of drinking water for milking animals.[3] Camel milk has remained a source of nutrition and energy for communities in arid and semiarid areas of Africa, Middle East, and Asia.[4] Its output is 2.9 million tons per annum worldwide[5] and its products are consumed by around 6 billion people globally, contributing majority from the developing countries.[6]

Camel milk is used as milk or in the form of yogurt in Pakistan.[7] In north-eastern Balochistan, Pakistan, the most commonly manufactured products from camel milk are *kurth* (cheese), *dahi* (yoghurt), and *lassi* (sour milk).[8] High contents of lactoferrin and α-lactalbumin in camel milk, and absence of β-lactoglobulin give it a similarity to human milk.[9] Studies showed that camel milk provides nutritional value superior to bovine milk and is considered analogous to human milk, thus making a good replacement for human milk in the times of need. Moreover, in contrast to cow's milk, camel's milk holds significantly higher mineral contents including Ca, Fe, Mg, P, K, Zn, Cu, Na, and the vitamins such as vitamin A, B1, C, and E.[10] Vitamin C concentration of camel's milk is two to three times higher when compared with cow's milk.[11] High acid contents anticipate comparatively low pH which supports its prolonged storage without forming a cream layer.[12]

Camel milk has tremendous therapeutic properties as it is nonallergic, antidiabetic, antihypertensive, anticarcinogenic, antibacterial, and antiulcer. Camel milk enhances immune defense mechanism due to the presence of bioactive proteins including immunoglobulins, lysozyme, lactoferrin, lactoperoxidase, peptidoglycan recognition protein, and whey acidic protein.[13–18] Due to its medicinal benefits, camel milk has received a lot more attention in recent years as a substitute for milk and dairy products. Curative properties of camel milk are claimed to be associated with its composition, mainly the proteins, peptides, low sugar and cholesterol, fewer lactose and fat contents, high unsaturated fatty acids, and higher concentration of insulin.[19–21] In camel rearing regions, camel milk is a traditional remedy for type 2 diabetes.[22] In Rajasthan, India, camel milk consumption had shown a significant effect on prevalence rate of type 2 diabetes.[23]

As hepatitis C virus (HCV) infection has turned out to be a global health concern, the patients in Egypt frequently use camel milk as an alternate therapy.[24] Lactoferrin in camel milk had antiviral effect against genotype 4 HCV that relates to lactoferrin inability in inhibiting virus entry into leucocytes.[25] Lactoferrin is also a defense agent on the cell surface against mucosal infections as it inhibits viral adherence and penetration into host cells, inhibits virus interactions with heparan sulfate receptors, binds host cells, and prevents nuclear localization.[26] It has previously been reported that consuming 250 mL of camel milk each day for 4 months improves liver functions such as alanine transaminase (ALT) and aspartate transaminase (AST) in HCV patients.[24] Camel's milk higher in vitamin C levels are significant from nutritional perspective and potent higher antioxidant activity.[12] Studies on animal models with carbon tetrachloride (CCL_4)-induced hepatic and renal changes have shown ameliorative effect of camel milk.[27]

Preventive effect of camel milk has attracted the interest of researchers to comprehensively explore the therapeutic potential of camel milk. This study was therefore planned to identify the effect of long-term consumption of camel milk on renal and hepatic health of the camel nomad's population and susceptibility of the camel milk consumer to risk of chronic diseases was compared with cow milk consumers.

Materials and Methods

Study Design

This observational cross-sectional study was planned to evaluate the therapeutic role of long-term camel milk consumption on the risk of hepatic and renal disorders in nomads from different areas of South Punjab, Pakistan. The targeted sample population included agricultural workers, laborers, and animal rearers. Among them, the people consuming camel and cow milk since childhood were preferred. The age group was kept 25 to 55 years for both males and females, and participants younger than 25 and older than 55 years were excluded from the study. Subjects with noncommunicable diseases, that is, diabetes, hypertension, and heart diseases were included, while pregnant and lactating mothers were excluded.

The study protocol including the study questionnaire was approved by the Bioethical Committee of the Faculty of Agricultural Science & Technology, Bahauddin Zakariya University, Multan, Punjab, Pakistan vide approval no. 01-2021. All selected participants were informed about the purpose of study, nature of the information being collected, and methods of the data collection including blood sampling, anthropometric and dietary assessment. For respondents who agreed to be part of the study, written consent was taken prior data and blood sample collection.

Subject and Site Selection

Nomads were selected from *Nag Shah* 30°11′52″N 71°28′ o11″E and Head *Nou Bahar Fatima* Town 30°9′41″N 71° 30′14″E, Multan, Punjab, Pakistan and cow milk consumers were selected from *Mauza Kayan Pur* Multan 30.2249°N, 71.6540°E, Punjab, Pakistan. Fifty-one participants of all genders in age between 25 and 55 years having at least 3-year history of camel milk consumption were selected for the study, 26 subjects were camel milk and 25 were cow milk consumers. Gender differentiation of the camel milk consumer was 50% males and 50% females, whereas the sample population from cow milk group was with 40:60 male to female ratio. All participants were asked for the average amount of camel and cow milk they consumed per day.

Table 1 Frequency distribution for the meal patterns of camel milk consumers

Servings	Meat N (%)	Dairy N (%)	Cereals N (%)	Pulses N (%)	Fruits N (%)	Vegetables N (%)	Fats and oils N (%)	Beverages N (%)
Never	1 (3.8)	–	–	1 (3.8)	6 (23.1)	–	–	–
More than once a day	–	17 (65.3)	26 (100)	–	1 (3.8)	8 (30.7)	26 (100)	15 (57.6)
2–3 times/wk	8 (30.7)	–	–	12 (46.1)	8 (30.7)	8 (30.7)	–	5 (19.2)
4–6 times/wk	–	9 (34.6)	–	7 (26.9)	1 (3.8)	10 (38.4)	–	5 (19.2)
Once a week	17 (65.3)	–	–	6 (23.1)	10 (38.4)	–	–	1 (3.8)

Demographic and Nutritional Assessment Data Collection

Demographic survey, hepatic and renal biomarkers were assessed qualitatively and quantitatively, respectively, via simple random sampling technique. Self-designed proformas were developed in consultation with data analyst from Faculty of Food Science and Nutrition, as predesigned proformas were not covering all aspects of the study. The questionnaire included information such as traits name, age, gender, occupation, socioeconomic status, subject's physical appearance, dietary intake (food frequency questionnaire), health history, contemporary health status, and current weight and height for body mass index (BMI). Health history was also taken into consideration, to check if the subjects were suffering from noncommunicable diseases in the past, reports were analyzed as whether the subjects had been affected recently by some disease and were taking any treatment. Complete diet history was recorded focusing primarily on their existing milk consumption patterns to explore whether subjects had been consuming camel or cow milk, the duration, quantity, and form (raw, boiled, etc.) of milk. Food frequency checklist was designed according to basic food groups and beverages. Food groups included meat, cereals, dairy, fats and oils, fruits, and vegetables (►**Tables 1** and **2**) (►**Figs. 1** and **2**).

Collection of Blood Samples

Syringes (3 mL) and blood collection tubes (EDTA vials and clot activator vials for serum analysis) were used for blood sample collection. For hepatic and renal markers, diagnostic kits were purchased from DiaSys Diagnostic System, Germany. Serum analysis for renal and hepatic parameters was performed on Blood Chemistry Analyzer; Model- BioSystems BTS-350, Spain, as per kits protocol. A trained nursing staff was engaged to collect blood samples from the respondents. Blood samples were collected in accordance with the standard method; 3 mL of the collected blood was shifted to a vacutainer, kept in icebox, and centrifuged for 10 minutes at 5,000 rpm for serological analysis. Blood samples were processed for complete blood cell (CBC) count, while serological samples were tested for hepatic and renal functioning. Serological testing was performed on Blood Chemistry Analyzer; BTS-350 using diagnostic system kits, in accordance with manufacturer's guidelines and 1 mL of blood sample was run on the hematology analyzer for CBC count.

Hematological and Serological Analyses

Hematological parameters tested were hematocrit, red blood cells (RBCs), white blood cells, hemoglobin, mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), lymphocytes, platelets, neutrophils, monocytes, and eosinophils. Hepatic parameters examined were albumin, total bilirubin, cholesterol, triglycerides, total protein, AST and alkaline phosphatase (ALP), and renal parameters urea and creatinine.

Statistical Analysis

All analyses were performed in triplicates. The technique used for statistical analysis of data was two-way analysis of variance (ANOVA). ANOVA was done by using Statistix 8.1 to find significant and nonsignificant effect of the parameters of blood. Fisher's least significant difference test was performed to separate the means. Analysis results were presented as mean $\pm$ standard deviation and the level of significance was set as $p < 0.05$.

Results

Demographic Variables of Selected Participants

Age of participants was in range between 25 and 55 years in both the camel and cow milk consumer groups. Gender distribution data for camel milk consumers indicate 38% of the participants were male, while 27% were female, whereas 20% males and 48% females constituted cow milk consumer group. Age distribution data suggest 15% males and 8% females were in age between 36 and 45 years in camel milk group. The proportion of male and female in cow milk consumer for same age group was 16 and 8%, respectively, 46 to 55 years males from camel milk group were 4% and females were 8%, and males from cow milk group were 4% and females were also 4%.

BMI of Selected Subjects

Most of the participants' BMI was normal. Among male camel milk consumers, 12% were underweight, 27% were of normal BMI, 12% were overweight and results from females showed that 8% were underweight, 38% were normal, and 3% were overweight. BMI for male cow milk consumers represented 8% as underweight, 28% were normal, and 4% were overweight. As in case of females, 4% were underweight, 40% were normal, and 16% were overweight.

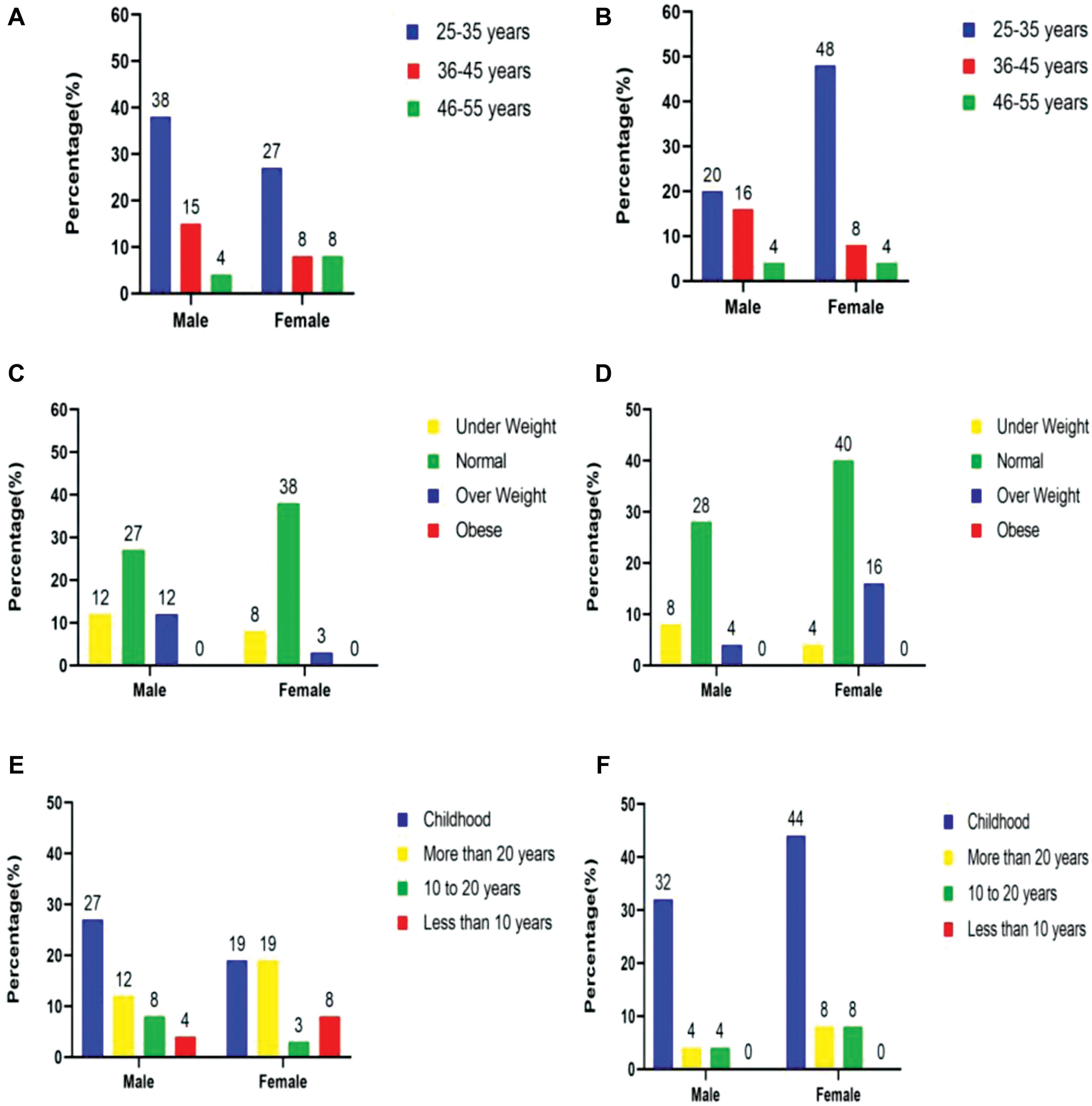

Fig. 1 (A–F) Demographic, nutritional, and dietary status of camel and cow milk consumers.

Prevalence of Chronic Diseases in the Subjects

Among selected subjects, some had noncommunicable diseases, that is, diabetes, hypertension, and heart diseases. High rates of hypertension and heart disease were present contemporarily in males, whereas diabetes percentage was comparatively high in females. Frequency distribution of the chronic diseases in camel milk respondents was diabetes (8%, 12%), heart disease (8%, 0%), respectively, in males and females and hypertension 12% in both genders. Frequency distribution of cow milk consuming male and female respondents with reference to prevalence of chronic diseases was diabetes (4%, 12%), hypertension (12%, 8%), and heart disease (8%, 0%), respectively.

Milk Consumption Duration and Patterns

Considering camel milk consumer group, 27% males and 19% females were consuming camel milk since childhood, 12% males and 19% females were taking camel milk for more than 20 years, 8% males and 3% females had a consumption duration somewhere between 10 and 20 years, 4% males and 8% females had less than 10 years of camel milk as part of their diet. Thirty-two percent males, 44% females had cow milk since childhood, 4% males and 8% females had more than 20 years intake, 4% males and 8% females had 10 to 20 years period of cow milk intake. There was no participant from cow milk group under less than 10 years category.

Thirty-one percent of camel milk consumers, that is, males reported two cups of camel milk in their daily diet, whereas 42% of females had same serving size in their daily dietary pattern. In cow milk group, males' daily input of milk is 4, 24, 12% and females' milk intake was 8, 40, and 12% for three cups, two cups, and one cup accordingly. It was identified from the milk consumption data that size of daily

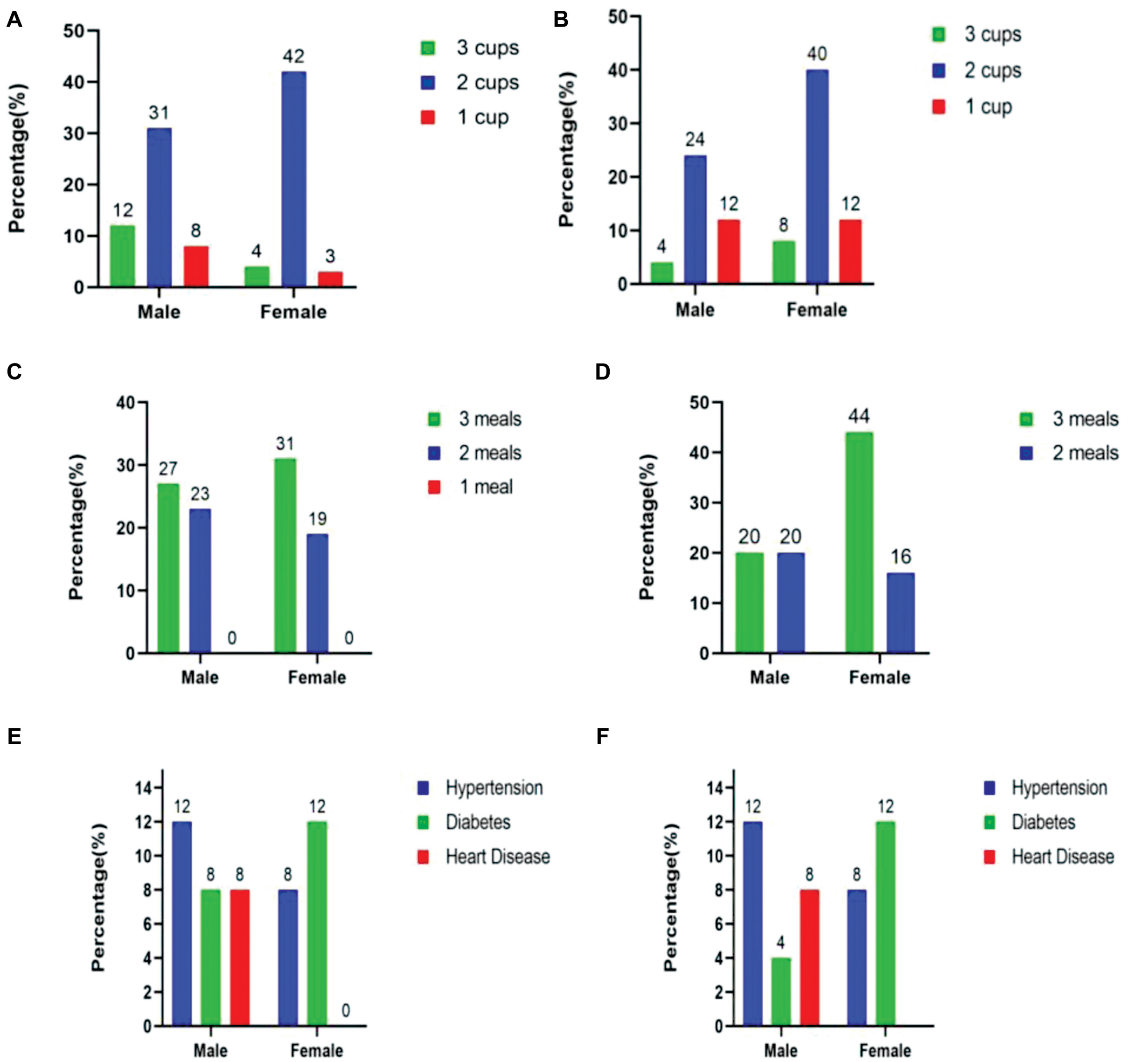

Fig. 2 (A–F) Dietary status and disease prevalence data of camel and cow milk consumers.

Table 2 Frequency distribution for the meal patterns of cow milk consumers

Servings	Meat *N* (%)	Dairy *N* (%)	Cereals *N* (%)	Pulses *N* (%)	Fruits *N* (%)	Vegetables *N* (%)	Fats and oils *N* (%)	Beverages *N* (%)
Never	–	–	–	1 (4)	3 (12)	–	–	–
More than once a day	–	22 (88)	25 (100)	–	2 (8)	2 (8)	24 (96)	20 (80)
2–3 times/wk	8 (32)	–	–	10 (40)	9 (36)	12 (48)	–	2 (8)
4–6 times/wk	2 (8)	3 (12)	–	3 (12)	3 (12)	10 (40)	1 (4)	2 (8)
Once a week	15 (60)	–	–	11 (44)	8 (32)	1 (4)	–	1 (4)

camel milk serving was significantly higher than cow milk consumption among two groups.

Dietary Intake Frequency of Camel and Cow Milk Consumers

Approximately, 27% of male camel milk consumers have a history of three meals a day, while 23% consume two meals, and 31% of females consume three meals and 19% had two meals per day. Among cow milk consumers, 20% of males had three meals and 20% had two meals, and 44% of females had three meals and 16% had two meals each day. Different food groups were added in self-designed proforma to analyze their food intake which concluded that the sample population was not consuming a balanced diet due to lack of resources with an average low monthly income, that is, 15,000 to 20,000 PKR. Highest dietary intake of camel and cow milk groups was from dairy, cereals, and fats and oils which they take more than once a day followed by pulses and vegetables at second highest, two to five times/week and then fruits and meat intake of both groups were at least, majority of them consuming once a week (►**Tables 1** and **2**).

Group and Gender-Based Mean Concentration of Hematological Markers

The data presented in ►**Table 3** indicate a significant difference between cow and camel milk consumer females for eosinophil levels that were higher in camel milk consumer female subjects than their counterparts having 2.92% mean eosinophil count. Mean hematocrit count was found nonsignificant for milk type; however, there was gender difference indicating females to have relatively low hematocrit count. A similar response was also observed for mean hemoglobin levels. Significant ($p < 0.05$) differences among camel and cow milk consumer groups were also observed for MCH, MCHC, and MCV levels. Comparatively higher mean values of MCH, MCHC, and MCV, that is, 29 pg, 32.8 g/dL, and 89.6 fL, respectively, were recorded in the male camel milk consumer group than females of the same group and the cow milk consumers. This suggests camel milk consumption anticipates RBCs modulatory response better than cow milk. Findings from the hematological studies also identify nonsignificant differences in total leukocyte count and neutrophil levels indicating both types of milk do not anticipate any undesirable or toxicological effect on prolonged consumption. Platelet count of the camel and cow milk consumers differed significantly with the highest count in cow milk consuming females, yet the values were in normal range.

Effect of Cow and Camel Milk Consumption on Hepatic and Renal Markers

Data in ►**Table 4** present the effect of camel and cow milk consumption on hepatic and renal parameters. There were nonsignificant ($p > 0.05$) differences in serum creatinine, serum urea, and serum albumin levels between both study

Table 3 Mean concentration of hematological parameters in camel versus cow milk consumers

Parameters	Gender	Cow	Camel
Eosinophils, %	Male	$2.70^{ab} \pm 1.41$	$3.76^{a} \pm 1.73$
	Female	$1.80^{b} \pm 0.94$	$2.92^{a} \pm 0.86$
HCT, %	Male	$45.80^{a} \pm 3.73$	$46.46^{a} \pm 3.75$
	Female	$37.34^{b} \pm 2.81$	$36.15\ ^{b} \pm 4.18$
Hb, g/dL	Male	$15.33^{a} \pm 1.87$	$14.30^{a} \pm 0.96$
	Female	$11.32^{b} \pm 1.16$	$11.11^{b} \pm 1.19$
Lymphocytes, %	Male	$31.90^{a} \pm 5.36$	$29.15^{a} \pm 7.44$
	Female	$27.80^{a} \pm 6.98$	$29.23^{a} \pm 8.28$
MCH, pg	Male	$25.55^{b} \pm 3.59$	$29.00^{a} \pm 2.30$
	Female	$22.76^{c} \pm 3.55$	$23.07^{bc} \pm 3.06$
MCHC, g/dL	Male	$31.15^{b} \pm 1.98$	$32.76^{a} \pm 1.36$
	Female	$30.36^{b} \pm 1.58$	$29.84^{b} \pm 1.86$
MCV, fL	Male	$82.34^{b} \pm 7.21$	$89.61^{a} \pm 7.22$
	Female	$74.71^{c} \pm 8.45$	$77.07^{bc} \pm 8.56$
Monocytes, %	Male	$4.10^{bc} \pm 4.10$	$6.30^{a} \pm 3.30$
	Female	$2.66^{c} \pm 2.66$	$4.38^{b} \pm 1.50$
Neutrophils, %	Male	$61.30^{ab} \pm 61.30$	$60.46^{b} \pm 10.42$
	Female	$67.86^{a} \pm 67.86$	$63.23^{ab} \pm 8.71$
Platelets ($\times 10^3$/µL)	Male	$261.30^{b} \pm 261.30$	$192.69^{c} \pm 50.48$
	Female	$330.47^{a} \pm 330.47$	$288.77^{ab} \pm 19.05$
RBC ($\times 10^6$/µL)	Male	$5.55^{a} \pm 5.55$	$4.85^{b} \pm 1.34$
	Female	$4.99^{ab} \pm 4.99$	$4.73^{b} \pm 0.45$
TLC ($\times 10^3$/µL)	Male	$8.32^{a} \pm 8.32$	$7.97^{a} \pm 1.64$
	Female	$9.12^{a} \pm 9.12$	$7.99^{a} \pm 1.46$

Abbreviations: Hb, hemoglobin; HCT, hematocrit; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; MCV, mean corpuscular volume; RBC, red blood cell; TLC, total leukocyte count.
Note: Mean values sharing same letter in a column and row are nonsignificant ($p \geq 0.05$).

Table 4 Mean concentration of hepatic and renal parameters in camel versus cow milk consumers

Parameters	Gender	Cow	Camel
ALP, U/L	Male	$274.10^{a} \pm 84.26$	$223.46^{ab} \pm 66.06$
	Female	$214.20^{ab} \pm 75.36$	$201.85^{b} \pm 67.90$
AST, U/L	Male	$34.90^{a} \pm 7.53$	$27.07^{ab} \pm 8.40$
	Female	$25.80^{b} \pm 8.07$	$30.38^{ab} \pm 15.24$
Albumin, g/dL	Male	$4.43^{a} \pm 0.70$	$4.24^{a} \pm 0.56$
	Female	$3.46^{b} \pm 0.99$	$4.39^{a} \pm 0.73$
Cholesterol, mg/dL	Male	$173.10^{a} \pm 39.99$	$177.00^{a} \pm 37.27$
	Female	$185.47^{a} \pm 38.12$	$196.54^{a} \pm 47.60$
Creatinine, mg/dL	Male	$1.15^{ab} \pm 0.40$	$1.62^{a} \pm 1.18$
	Female	$0.87^{b} \pm 0.15$	$0.95^{b} \pm 0.23$
Triglycerides, mg/dL	Male	$146.50^{a} \pm 50.53$	$107.85^{a} \pm 69.59$
	Female	$99.27^{a} \pm 66.49$	$116.54^{a} \pm 84.43$
Urea, mg/dL	Male	$28.40^{ab} \pm 8.90$	$34.30^{a} \pm 16.50$
	Female	$26.53^{ab} \pm 11.23$	$23.61^{b} \pm 6.42$
Total bilirubin, mg/dL	Male	$0.38^{a} \pm 0.20$	$0.23^{a} \pm 0.11$
	Female	$0.60^{a} \pm 0.39$	$0.57^{a} \pm 0.96$
Total protein, g/dL	Male	$11.10^{b} \pm 4.17$	$17.38^{a} \pm 3.90$
	Female	$9.66^{b} \pm 2.63$	$15.23^{a} \pm 3.60$

Abbreviations: ALP, alkaline phosphatase; AST, aspartate transaminase.
Note: Mean values sharing same letter in a column and row are nonsiglnificant ($p \geq 0.05$).

groups. However, camel milk consumer males had significantly higher total serum protein, that is, 17.4 g/dL, while the cow milk consumer males were observed with 11.1 g/dL total serum protein content. The results thus, indicate camel milk consumption to not mark an indifferent effect on main renal parameters except total serum proteins which were higher than the counterpart.

Discussion

This study was designed on the basis of existing claims supporting camel milk ameliorative role in hepatic and renal illnesses. Several researches have shown a significant effect of camel milk on hepatic and renal biomarkers of hepatitis patients in rat's model with CCL_4, aluminum chloride, diethylnitrosamine (DENA) induced hepatic toxicity.[28–31] Our results demonstrated a significant effect of camel milk consumption on some hematological parameters contrary to earlier findings. Our results identified nonsignificant changes in the rate of hepatic and renal disease prevalence among camel and cow milk consumers.

Most researches claim a significant effect of camel milk based on animal model, as there is no other alternative.[32] In biomedical science, animal models in particular and animal testing in general are insufficient basis for predicting clinical outcomes in humans.[33] Animal models are observed under a controlled environment that might be a contributor toward significant results. Other reasons might be an inadequate understanding of the model-specific background of the disease, sensitivity and functional/anatomical variations among species. Concerns may arise from drug-induced studies, and is a probable factor of intrusion in regard to findings of animal researches. It is undeniable that not all conventional and alternate medicines that are effective in animals are also effective in humans and an animal's ailment is never exactly the same as of the human, and more crucially, the cause is never the same, either. As a result, a treatment for an animal's disease can be ineffective in human model.

Hamed et al (2017) concluded that CCL_4 treatment caused hepatic lesions with histopathological changes and oxidative damage in mice but according to them, camel milk's pretreatment could be a useful strategy to avoid CCL_4 toxicity as camel milk can regenerate hepatocyte membrane integrity. In another study, DENA 200 mg/kg and phenobarbitone 500 ppm in drinking water in rats group had initiated and promoted hepatocarcinogenesis, respectively. The study showed camel's milk antioxidant effect with cisplatin use to reduce hepatocarcinogenesis in Wister male rats.[34] Hussein and Al-Eknah (2014) designed their study to check the protective effect of camel milk and urine (in prophylaxis or treatment) in male rats against CCL_4 intoxication and pointed that camel's milk and urine potential protection opposed to CCL_4-induced damage.[35]

Importance of camel milk cannot be neglected, but it might be possible that a controlled environment of animal testing here showed significant results. To strengthen the translational effect of animal studies and to overcome their nonconclusive outcomes, validation of the model, appropriate management of controls and close attention to scientific experimentation, disease symptoms inductions, and critical data analysis are mandatory. Almahdy et al (2011) conducted a research in which HCV is directly interacted with camel's milk casein protein and mixed with different types of cells; casein was incubated with cells and then exposed to HCV. HCV preinfected cells were treated with different casein concentrations at different time intervals. In above-referred study, noninfected cells were used to rule out apoptotic and cytotoxic response of camel milk casein. The results conclude that casein of camel milk with or without α lactalbumin did not show anti-HCV activity.[36]

Until now, several clinical investigations have examined whether certain CBC characteristics are linked to particular diseases or could serve as indicators for specific pathological states. Öztürk et al (2018) believed that the main contributors to these parameters' popularity are their low cost, ubiquitous availability, and infection diagnosis. In the present study, CBC markers such as MCH, MCHC, and MCV of camel milk consumers were significantly different from cow milk consumers. Comparatively, higher mean values of MCH, MCHC, and MCV, that is, 29 pg, 32.8 g/dL, and 89.6 fL, respectively, were recorded in the male camel milk consumer group than females of the same group and the cow milk consumers. These parameters predict that subjects have lesser risk of chronic infections and diseases in the future related to liver and kidneys. According to human evidence, MCH and MCV are interrelated and are valuable blood parameters to identify blood disorders, including iron deficiency anemia.[37]

The nonsignificant effect of type of milk and gender on hemoglobin status in this study showed that most of the females of both groups were at risk of iron deficiency anemia, as they were mainly relying on milk as a source of energy. The data from food frequency questionnaire showed that iron-rich food intake was limited in daily diets of camel and cow milk consumers (►**Tables 1** and **2**). The majority of selected subjects were animal rearers and laborers. Poor economic status, history of multiple pregnancies, and illiteracy are candid contributors to nutritional inadequacies including anemia. Several findings at the national level represented most females of reproductive age as anemic. According to Pakistan's national nutritional census, 41.7% women of reproductive age (15–49 years) are anemic, with a slightly higher prevalence rate of 44.3% in women from the country's 221 rural areas.[38] Apart from camel milk, a well-balanced diet plays a crucial role in alleviating micronutrient deficiencies and noncommunicable diseases. Meat and fruit consumption of the subjects was very limited to once a week. Likewise, sanitation and hygiene practices in residential settings of the study's subjects were extremely poor.

Total protein results of the current study showed a significant impact of camel milk consumption compared with cow milk consumption. Sarfraz (2014) has examined the supplementation effect of camel milk on blood biomarkers and liver functions of hepatitis patients. According to this research, camel milk was found to be useful in lowering high levels of liver enzymes AST, ALP, and ALT; it also enhanced the levels of albumin, total proteins, lymphocytes, and platelets in sick people. Camel milk, on the other hand, has the capacity to lower increased levels of bilirubin and globulin. Contrarily, our results identify no influence of camel milk consumption on lymphocytes and platelet levels as well as on AST, ALP, and ALT.[30]

As mentioned earlier, commonly prevailing communicable diseases in the sample population were diabetes, hypertension, and heart disease. Prevalence rate of diabetes, hypertension, and heart disease were 8 versus 12%, 12 versus 8%, and 8 versus 0% in camel milk consumer males and females, respectively. Camel milk's antidiabetic properties have been confirmed in dozens of clinical research. Within camel-rich regions, the use of its milk is a tradition to treat diabetes.[21] Consuming camel milk for 3 months, type I diabetic patients needed 30% less insulin. Additionally, after 1- and 2-year trials, the long-term effectiveness and safety of camel milk as an adjuvant therapy in the treatment of type I diabetes was validated.[23,39,40] In Rajasthan, India, a society that consumed camel milk had considerably lower diabetes prevalence than a community that did not consume it.[23]

Currently, hypercholesterolemia is also a major growing concern related to numerous life-threatening conditions such as hypertension, cancer, and cardiovascular disorders. Lately, it was found that bioactive peptides generated from camel milk had the ability to suppress some enzyme markers involved in hypercholesterolemia.[41] According to several recent studies, camel milk peptides and hydrolysates may have angiotensin-converting enzyme inhibitor effects,[42,43] anti-inflammatory effects, and antidiabetic activities.[41] Although many human and animal studies revealing camel milk preventive properties have been conducted till date, yet authenticity of the therapeutic claims linked to camel milk consumption is a question to be answered. Although our study entertained a small sample size and has been constrained to a sample population from one region. The results on long-term consumption of camel milk by the camel milk nomads demand better quality of data and valid information generation on the therapeutic effects of camel milk in human subjects. Therefore, more intense research providing strong evidences in favor to its benefits especially its role in chronic diseases prevention and to overcome this study gaps is needed.

Conclusion

This study concludes that camel milk impact on some hematological parameters is significant, whereas contrary to the earlier findings, our results identified nonsignificant changes in disease prevalence among camel and cow milk consumers as observed from liver and kidney parameters of study subjects. Above-stated results had indicated the mean of hematological parameters MCH, MCHC, and MCV, that is, 29 pg, 32.76 g/dL, and 89.61fL, respectively, to be significant among camel milk consumers group. Comparatively, higher mean values of MCH, MCHC, and MCV in male camel milk consumers than females of same group were observed. Mean total protein concentration was significantly higher in camel milk consumer group, that is, 17.38 g/dL. Creatinine, albumin, ALP, AST, urea, triglycerides, and total bilirubin parameters had shown both group and genderwise nonsignificant results. As many studies showed camel's milk role in chronic disease prevention, there is a need to learn more about its nutritional, chemical composition, and therapeutic characteristics/medicinal values. Future studies can be designed for larger human sample sizes from different areas, targeting populations with higher prevalence rates of chronic conditions to exhibit the potential health benefits of camel milk.

Authors' Contribution

M.K. conducted research trials and manuscript drafting. S.A. supervised the study. I.A. performed data analysis and interpretation. A.A.R. collected data. T.I. contributed to study design and manuscript review.

Conflict of Interest

None declared.

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