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Medical Significance of Camel Urine and Camel Milk: A review

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Abstract

The quest for an alternative form of medicine aside from the orthodox one is ever-increasing. Nowadays, herbal medicine and other forms of alternative medicine are now being integrated into modern medicine. For more than 14 centuries, the Arabian Peninsula has used mammary secretions and urine of camels in the treatment of chronic infections. *Camellus spp* (Camel) are the most common animal whose milk and urine are used in traditional medicine. In the last decade, various studies have documented the potential antimicrobial, anti-inflammatory, anticancer, and antioxidant properties of camel urine and milk. The major challenges in camel urine and camel milk research are low public awareness, accessibility, availability, religious beliefs and non-authorization by health regulatory agencies. However, Chemical synthesis, clinical trials, and elucidation via advanced research of bioactive elements of camel urine and camel milk are potential possibilities where researches can be channeled.

Keywords: Camel urine, camel milk, Camellus spp, pathogens

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Introduction

Camellus spp (Camel) is a one-of-a-kind animal that lives and reproduces in harsh climatic environments, which are unsuitable for most domestic animals. The camel remains an important source of food and transportation for desert dwellers in Asia and Africa regions (Kandil et al., 2023). Figures 1 and 2 are maps showing Camel population in Africa and Asia respectively Camels' products of high value with global demand include meat, milk, wool, and its natural value as an ultimate beast of burden (Kadim et al., 2013; Ali et al., 2019).Camel milk and urine have long been used to cure a host of diseases (Galali and Al-Dmoor, 2019). They may have acquired healing properties as a result of the camel's intake of active substance-rich desert shrubs. They contain bioactive compounds with antiinflammatory, antimicrobial, anticancer, and antioxidant properties, which can be used to treat variety of diseases. Camel milk has antiviral and antibacterial effects, making it helpful in killing viruses and bacteria and protecting the body against a variety of diseases, including curing cancer in some cases. According to Shaban et al. (2023), camel milk impedes proliferation of cancer cells including HepaRG, MCF7, Hl60, and These potential are due to its PANC1. beneficial antimicrobial constituents which include lactoferrin, lysozyme, immunoglobulin G, lactoperoxidase, and Nacetyl-D-glucosaminidase (Hamed et al., 2024). Furthermore, camel urine has anticancer effects inhibiting the growth potential and metastatic ability of 4T1 cancer

cell line in vitro and in vivo. This potential is due to the presence of nanomaterials in it's urine, which can effectively attack cancer cells while preserving healthy cells in a cancer patient (Romli et al., 2017). Many chemical constituents contained in camel urine have been shown to have biological activities, including antibacterial, antifungal, antiviral, and anticancer properties (Alhaider et al., 2011; Al-Yussef et al., 2012; Romli et al., 2017). Profiling of urinary acids and metabolites by NMR and GC-MS is becoming increasingly important in clinical studies (Ahamad et al., 2017). While there aren't enough scientific trials, camel milk, and urine have long been thought to be a high-quality alternative treatment for a variety of ailments (Soliman et al., 2016), particularly chronic imbalance of the liver (Zuberu et al., 2017). Salwa and Lina (2010) studied the ability of camel milk to inhibit the micronucleated polychromatic erythrocytes (MnPCEs) in the bone marrow of experimental mice and potential to improve the mitotic activity produced by cisplatin (a widely used drug in the treatment of cancer). Camel milk was possess antigenotoxic found to and anticytotoxic effect causing a decrease in MnPCEs compared to experimental mice treated with cisplatin alone.

Numerous studies have recently been conducted on these potential therapeutic effects of camel urine and milk, and there is now a growing body of scientific evidence describing the components of camel products, as well as their medicinal constituents. These findings provide empirical evidence to back up the current trend of using camel milk and urine for medicinal purposes. Some factors, however, can limit the use of raw camel urine and milk. This review explored the plausibility of using camel urine and milk as a therapeutic intervention, as well as challenges and potential possibilities.

Chemical Composition of Camel Urine/Milk and Possible Active Agents

The active constituents that confer on camel urine its unique healing potential was researched by Read (1925). It was mainly nitrogenous compound, hippuric acid and chlorine. A recent study was also conducted by Antakly (2012) via a Liquid chromatography-Mass spectrometry (LC-MS). The LC-MS is a recent advancement in science and expected to give a detailed information on camel urine's medical constituents when compared with the report of Read (1925). According to Antakly (2012); "Benzoic acid, urea, creatinines and hippuric acid" are the camel urine main constituents. This is also similar to the report of Read (1925) except that benzoic acid was not reported. Benzoic acid is a unique compound mostly found in urine of some ruminants, wild animals and lower animals.

In another study conducted by Al-Attas (2009) via a neutron analysis, sodium and potassium were found to be abundant in camel urine and camel milk. Sodium and potassium are maior elements critical for the maintenance of osmotic balance in all living cells. Furthermore, zinc presence was also reported. Zinc generally acts as an inhibitor to proliferation of diarrhea causing the pathogens. Hence, its common usage alongside oral rehydration solutiom for diarrhea infected patients. A recent study by Al-Yousef et al. (2012) revealed that the aforementioned constituents are responsible for the camel urine's bad smell.

Camel urine is rich in organic and inorganic chemical constituents. PM701 (a natural selective anticancer extract of camel urine) is characterized by nanoparticles of different sizes. Furthermore, it's not surprising when researchers like Ahmed *et al.* (2015a) and Ahmed *et al.* (2015b) reported the same constituents of PM701 (extracted from camel urine) with that of Read (1925) and Antakly (2012). El-Shahawy *et al.* (2010) also reported the presence of cations like Ca²⁺, Cd²⁺, Th⁴⁺, and Zn²⁺ in camel urine.

Camel milk is rich in vitamin C and protective proteins such as lactoferrin, lactoperoxidase, immunoglobulins, and lysozyme. Camel milk lacks β -lactoglobulin and is used as an option for individuals intolerant to lactose in cow's milk. Therefore, camel milk is extraordinary in terms of antioxidative agents, antibacterial, antiviral, antifungal, anti-hepatitis, antiarthritis, treatment for paratuberculosis, preventing ageing, remedy for autoimmune diseases, and cosmetics.

Lactoferrin: Lactoferrin-rich camel milk has potent antimicrobial and anti-inflammatory properties, including bacterial inhibition, antiviral, anticancer and antifungal effects and immune supportive and immunomodulatory functions (Kanwar *et al.*, 2015). Li *et al.* (2019) was the first person to quantify camel milk lactoferin based on the peptide derived from the tryptic hydrolysates of camel lactoferrin using an ultrahigh-performance liquid chromatography-tandem mass spectrometry method (UHPLC-MS/MS). The limit and quantification of camel milk lactoferin were 3.8 mg kg/1 and 11 mg kg/1, respectively.

Globulins: Gamma globulins and other immune components, including immunoglobulins, present in camel urine and milk could also be linked to the medicinal properties of both camel milk and urine (Alhaider et al., 2013). Camels possess unique antibodies wherein half of their circulating antibodies consist of just two heavy chains without any light chains, as discovered by Hamers-Casterman et al. (1993). Due to their minute size, these antibodies are easily found in milk of lactating camels. Their minute size enables them to traverse the blood-brain barrier and be excreted in urine after dilution. Furthermore, these antibodies are easily be absorbed from the gastrointestinal tract into the bloodstream of individuals consuming camel milk or urine.

Microbiological importance of camel urine

Antimicrobial effect: The adverse effect of pathogens on human and animal health cannot be over-emphasized. The majority of human and animal infections are attributed to pathogens of bacterial, fungal, and viral origin (Leeds, 2006). Antimicrobial agents involved in the control of pathogens have been classified into natural and synthetic. Ye et al. (2020) classified natural antibacterial drugs into; daptomycin, fidaxomicin, tigecycline, and natural antifungal drugs into; caspofungin acetate and micafungin sodium as approved by the Food and Drug Administration (FDA). Van Vuuren et al (2017) on the other hand classified natural antimicrobials into medicinal plants and essential oils. Common examples are found in marine products (such as peptides, alkaloids, polypeptides, and many more), camel milk, and camel urine. In the last two (2) decades, the efficacy of some natural and synthetic antimicrobial agents has become questionable due to increasing reports of antimicrobial resistance by pathogens. Shinashal (2015) reported the efficacy of camel urine against pathogenic bacteria when compared with established antibiotics against pathogens. Camel urine exhibited a complete bactericidal effect on clinical bacterial pathogens with the disappearance of signs and

symptoms within a limited time than that achievable with standard antibiotics of such pathogens. In the antibacterial efficacy of camel urine study reported by Sumia et al. (2016), different concentrations of camel and sheep urine were tested for growth inhibition of Staphlococcus aureus, Escherichia coli, Salmonella spp, Pseudomonas aeruginosa and Enterobacter cloacae via the disc diffusion test and agar well diffusion. Sumia et al (2016) concluded that concentrated camel urine is best for treating the aforementioned pathogens tested in this study. Abdullahi et al. (2021) also reported antimicrobial property of camel urine against S. aureus susceptible to gentamycin via the disc diffusion method. Abdullahi et al. (2021) stated further that the potency of camel urine on pathogens irrespective of the camel gender. El-Desoukey (2020) also successfully tested camel urine as an antimicrobial against S. aureus and Bacillus spp achieving 23 mm and 11 mm zones of inhibition respectively via the disc diffusion method.

Kabbashi and Omer (2016) proved the antifungal activity of camel urine against dermatomycosis-causing fungal genera like Trichophyton, Microsporum and Epidermophyton. Al-Abdalall (2010)affirmed antifungal potency of camel urine against fungal pathogens even when low concentrations are employed. Aspergillus niger isolated from coffee beans was tested in this study. The study showed that 3 - 10 %concentration of camel urine is enough to achieve plasmolysis of the Aspergillus hyphae and inhibit mycelial growth. Furthermore, Osman et al. (2016) affirmed that camel urine inhibited mycelial growth of Alternaria alternata at concentrations as low as 5 -15 %. From these results, camel urine proved its worth as an antifungal agent by inhibiting the growth of fungal pathogens.

Antagonistic effect on plant pathogens: The devastating effects of pathogens on plants and crops led to the introduction of biotechnologically improved seedlings in agriculture. However, research is still ongoing on finding ways to ameliorate the harmful effects of pathogens in plants. Current techniques in combating plant pathogens can be classified into "inducible and constitutive or chemical, structural and morphological" as described by Zaynab et al. (2019). Besides, primary metabolites (carbohydrates, proteins,

lipids. enzymes, and hormones) and secondary metabolites (alkaloids, flavonoids, and phenolics) confer immunity against plant pathogens (Zaynab et al, 2018; Zaynab et al, 2019). Similarly. The urine of ruminant animals has been reported to possess antimicrobial effects (Anami et al, 2012). However, no literature exists on the efficacy of animal urine against plant pathogens except the study of Nafie (2014). Nafie (2014) proved the potential of camel urine as an antagonist to plant pathogens. From the study, folial application of camel urine on tomato seedlings acted as a primary defense mechanism employed by tomato plants against the notorious tomato pathogen

Fusarium oxysporum. This study is an eyeopener to botanists regarding natural ways of combating plant pathogens which often require huge expenditure to combat. It is worthy of note that camels are the most enduring beast of burden and the only animal capable of adapting to changing weather and climatic conditions as reported by Hoffman (2010). However, camel and camel products research is still challenged despite their numerous benefits. Only a few countries are known to have Camel research institutes (Abri and Faye, 2019). Table 1 shows a comparison of the antimicrobial effectiveness of camel urine with known antimicrobial agents from previous works.



Figure 1. Camel population in Africa



Figure 2. Camel population in Asia

Isolate types	Antimicrobial used	Pathogen tested against	Camel urine	Antibiotics	Duration	Duration of	References
	as control		dosage (ml/kg)	dosage(ml/kg)	(hrs)	control (hrs)	
Clinical pathogens	Gentamicin and Dicloxacillin	E. coli, Staphylococcus aureus	3 ml/kg	1 ml/kg	48	72	Shinashal (2015)
		Salmonella spp,	I ml/kg		24-48		Sumia
		Pseudomonas aeruginosa	0				(2016)
		E. cloacae					
		Escherichia coli					
		Staphylococcus, Group A	25-100%		72		Al Bashan
		and B haemolytic					(2011)
		Streptococci, Enterics,					
		Aspergillus niger					
	Ervthromycin.	Staphylococcus aureus	4-20%		72		Al-Zahrani
	Clindamycin,	MRSA and Lactic acid					and Al-Harbi
	Cephalosporine,	bacteria					(2011)
	Aminoglycoside,	E.coli					
	Tetracycline and						
	Chloramphenicol	c	25 1000/		40		Nterrer
		S. aureus, E. coli:	25-100%		48		Nazar
		E. COII, Proteus mirabilis					Osman et
		Klebsiella pneumoniae					al.(2013)
Multidrug-		Methicillin-resistant	2.5-10%				Marwa and
Resistant Clinical		Staphylococcus					Reham
Bacterial and		aureus (MRSA),					(2016)
Fungal		Coagulase-negative					
Isolates		staphylococci (CoNS)	0 5 6 0 0 /		10		
Fungal isolates		Rhizoctonia solani,	25-50%		48		Al-Abdalall
		Fusarium moliniform,					(2010)
		flavus and A niger					
Gut nathogens		Lactobacilli	1.8ml/200g		336		Noor and
Car PuttoSens		Bifidobacterium,	1.0111.2005		220		Alenini
		Streptococci and Coliforms					(2017)

Table 1. Comparison of Antimicrobial effectiveness of Camel Urine with known antimicrobial agents

Pharmacological and Physiological Basis of the Camel Urine Therapy

The consumption of camel urine for medicinal purposes is commonly found in areas with high camel presence (Alhaidar et al., 2011). Furthermore, Islamic religious adherents do relate convincing evidences linked to Prophet Muhammed (Peace be upon him) on the medicinal significance and healing potential of camel urine for internal organs related problems. The medicinal significance of camel urine includes its anticancer, antimicrobial and reversal of heart related abnormalies. Alkhamees and Alsanad (2017) linked the healing potential of camel urine to desert shrubs been consumed by camels. Desert shrubs are known to contain numerous active substances which have antimicrobial activities. The medical significance of camel urine against pathogens has been affirmed via several trials conducted over the years (Alkhamees and Alsanad, 2017).

According to Muyldermans et al., (2009), many academic reports on therapeutic potentials of camel urine were linked to the organic and inorganic compounds naturally present in camel urine as well as the nanobodies extracted from it. All these responsible constituents are for its immunoprotective, antimicrobial and anticancer properties. Camel milk and urine have been used as medicines in certain parts of the world since ancient times, but only recently have scientists shown interest in exploring the claimed therapeutic benefits of camel products (Abdel Galil and Abdulgader, 2016). The report of Abdel Galil and Abdulgader (2016) revealed that mixture of camel urine and camel milk is effective in the treatment of numerous life threatening health conditions. Yagil and Berlyne (1976) were the first to report the alkalininty of camel urine. In addition, camel urine can't be filtered with filters less than 0.45µ.

The mechanism of action by which the constituents of camel urine collectively exhibit their antimicrobial activities on disease causing organisms was studied by Shoeib and Ba-hatheq (2008) via an electron microscopy. Growth inhibition and

suppression, acceleration of stationery and death phase of microbial growth, alteration of genes responsible for virulence are some mechanisms employed to achieve the antimicrobial potential of camel urine Camel urine has been observed to be effective on multi drug resistant bacteria and Candida albicans and non albicans Candida (Mostafa and Dwedar, 2016). Two identical heavy and light chains with a covalent bonding to a sulfide bond forms the composition of camel antibodies (Padlan, 1994) which are in nanoparticles form. The nanobodies of camel urine are characterized by small size, miscibility. thermostability and The nanobodies have been employed as tools in cancer therapy. Nanobodies selectively target cancer cells without affecting healthy cells (Van de Broek et al., 2011). The introduction of camel urine nanobodies is not only limited to cancer therapy but also diagnosis and disease protection (Hu et al., 2017). The work of Al-Yousef et al. (2012) is one of the recent works on the anti-cancer activity of camel urine. Different cancer cells were treated with 16 mg/ml of camel urine. The result showed that camel urine resulted in death of 80% breast cancer cells and never affected healthy cells. This further shows the cytotoxic effect of camel urine most especially on breast cancer cells. The cytotoxic effect of camel urine has been likened to cyclophosphamide, a common drug for cancer patients. This is because studies on anticancer property of camel urine reported decreasing levels of nucleic acids and glutathione which forms major mechanism of action the of cyclophosphamide.

Anti-diabetic action of camel milk

Diabetes mellitus is a chronic health condition marked by the inability of the body to produce insulin. Agrawal *et al.* (2005) is one of the first scientists to report the antidiabetic role of camel milk by lowering of glucose level in diabetic patients. Although, the claim was not widely accepted. This prompted further research. Agrawal *et al.* (2007) later reported the presence of insulinlike protein in camel milk which is readily absorbed in the body. Furthermore, Agrawal *et al.* (2007) attributed this glucose level

lowering property to the small size immunoglobulins camel's of milk. Experimental studies were conducted with diabetic rats treated with fresh camel's milk. The result showed a reduction in glucose level (Al-Numair and Alsaif, 2011). In addition, the work of Badr (2013) showed that camel milk has the potential of reducing glucose level in diabetic experimental mice by 57.5 %. Furthermore, Agrawal et al. (2011) reported that consumption of camel milk in Type I diabetic patients' achieved a significant reduction in daily insulin need.

Camel insulin effectiveness is second-tonone compared to other bovine and human insulin when administered on experimental mice. Its natural antioxidants against free radicals is responsible for its actions against hyperglycaemia, hyperlipidaemia, and insulin resistance. This thus prevents complications associated with *Diabetes mellitus*.

Challenges in the use of Camel Urine as alternative medicine

Undoubtedly, the medical benefits embedded in the use of camel urine cannot be overemphasized despite its low level of awareness in many parts of the world and the lack of authorization for its usage by governmental and non-governmental health regulatory authorities both locally and internationally. Challenges in camel urine research are numerous. To be recognized as a potent medical concern, a long list of medical, psychological, and religious hurdles need to be crossed. The authors of this review came up with the following as challenges militating the recognition and acceptance of camel urine by health authorities.

Safety and Clinical Trials: The authorization of a drug translates into a successful clinical trial. The authors of this review explained the numerous medicinal benefits of camel urine. It is worthy of note all researches mentioned that were by independent studies conducted researchers in academia. Unfortunately, the detection of MERS (Middle East Respiratory Syndrome) in camels in the Middle East shifted global attention towards the adverse effects of camel urine. According to World Health Organization (WHO), MERS that threaten humans can also be found in camels, hence, urging people to stay away from camel milk and urine (WHO, 2015). This truncated the work of intending researchers on the medicinal potential of camel urine coupled with an embargo placed by nations on camel products to arrest any possibility of an epidemic from a zoonotic route.

The efficacy of camel urine has been reported by patients worldwide who believe in its medicinal benefits. The patients took camel urine without prescription by a certified medical practitioner and attested to its miraculous healing ability. The issue of safety and side effects is unknown since clinical trials are majorly concerned with efficacy, safety, and the presence or absence of side effects. Furthermore, there is no medical dosage approved for camel urine. This challenge will pose a danger to the physiological role of the camel urine when consumed. There is a need for an acceptable dosage to validate its efficacy.

Availability: Camel populations are found in a certain region of the world (most especially desert areas) unlike other domesticated animals. Figures 1 and 2 clearly show that camels are very much available across two continents of the world, unlike others. This acts as an impediment to the all-year-round availability in non-camel populated areas of the world. Camel urine is frequently transported to neighbouring countries making it available to consumers. However, the effects of changing weather conditions from a desert to a non-desert area on the physical and chemical potency of camel urine are unknown. No research have been conducted on this issue to date. In addition, more studies need to be conducted on the effect of changing weather on the preservation of camel urine.

Hypersensitivity: The consumption of raw camel urine is a herculean task considering the warm piss taste and disgusting smell. It is even worse when mixed with raw camel milk as it is the traditional practice. There is difficulty in getting rid of the musk after taste that overtakes the mouth of the consumer. This is a mitigating factor that prevents many

people from consuming camel urine. Camel urine is characterized by a choky smell and a burning sensation when taken for the first time or on an empty stomach. Some individuals with an allergy to choky materials may find it difficult to consume. In the same vein, individuals with digestive allergies may feel irritated due to the burning sensation associated with its consumption.

Religious belief: Camel urine consumption is common amongst Muslims. The Holy Prophet of Islam, Muhammad (Peace be on Him) in his reported sayings emphasized the medical significance of camel urine and ordered its consumption for internal medicalrelated problems. This had been an age-long tradition amongst the Arabs and Non-Arabs inhabitants of the Middle East region of the world with success stories. Presently, a camel research institute exists in the Kingdom of Saudi Arabia. It is worth mentioning that individual religious inclination may affect the public acceptance and certification of its consumption by individuals and health regulatory authorities respectively.

Conclusion and Potential Possibilities

Interestingly, camel urine therapy has been found to a commonplace in traditional medicine. Camel milk as well may similarly serve not only as a source of nutrients but also as a source of biologically active compounds with medicinal potentials. The latest scientific evidence for the therapeutic activity of camel milk and urine continues to unfold and attempts are ongoing to classify the medicinal constituents more accurately. As preventive and curative agents in humans, camel milk and urine warrant further studies. These are required, despite the reported results, to investigate the precise mechanisms of the therapeutic effects of camel milk and urine, as well as the active compounds responsible for a particular therapeutic action. Urokinase, for example, is a thrombolytic agent that can be isolated from (human) urine. Premarin, a hormone therapy drug, contains estrogens derived from the urine of pregnant mares (Brügger, 2019). Purified camel milk lactoferrin has also been shown to have an important inhibitory effect on HCV (genotype4) entry via direct

interaction with viral molecules (Redwan and Tabll, 2007). Similarly, the bioactive elements of camel urine and milk that are responsible for the well-known medicinal effects can be chemically synthesized and tested in clinical trials. Thus, we encourage scientists worldwide to help elucidate the bioactive components of camel milk and urine through advanced research and then develop affordable, safe, and potent drugs against actual diseases from this source which has proven to be a treasure trove for researchers.

Conflict of Interest

No conflict of interest exists among the authors of this review

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