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A cross-sectional study of renal metabolic profile of one-humped camel in El-Bayadh province, Algeria

Estudio transversal del perfil metabólico renal del camello de una joroba en la provincia de El-Bayadh (Algeria)

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ABSTRACT

The composition of camel urine can vary depending on factors such as the camel's diet, health and environmental conditions. The aim of this study is to investigate the various components of camel urine in El-Bayadh province, Algeria, using macroscopic, microscopic examination and biochemistry of urine, as well as plasma analysis. 40 camels were analyzed and urine and blood sample were collected from each camel. The macroscopic urine showed amber yellow color and turbidity in dromedaries aged (2 and 6 years). So, Microscopic examination recorded the same moderate presence of epithelial cells and leucocytes in non-pregnant and lactating females (P=0.001). Adult camels have a moderate presence of leucocytes in the urine compared to young camels, while the Targui breed has a moderate level of leucocytes and erythrocytes (P=0.01). The pH (Hydrogen potential) of camel urine varies between 7 and 8, the density is between 1.02 and 1.04. However, high average ketone (8.3±3.07) in pregnant females (over 6 years) and glucose levels are important in lactating females and very low average levels of bilirubin and urobillin (0.16 and 1.26) were found. Therefore, high average protein levels were recorded in pregnant females (7.5±5.12), young camels (8±2.87) and total absence of ammonia. The biochemical plasma test showed that: a significant effect of age on creatinine with higher levels in lactating She-camels, 30.40 ± 0.71 mg/dL of total protein and 51.24 ± 1.02 mg/dL of albumin. This study highlighted the different components of camel urine and analyzed the renal function. Further studies are recommended.

Key words: Algeria; Camel; composition; plasma; urine

RESUMEN

La composición de la orina de camello puede variar en función de factores como la dieta del camello, su estado de salud y las condiciones ambientales. El objetivo de este estudio es investigar los diversos componentes de la orina de camello en la provincia de El-Bayadh, Argelia, mediante el examen macroscópico, microscópico y bioquímico de la orina, así como el análisis del plasma. Se analizó un total de 40 muestras de orina y 40 de plasma de camellos clínicamente sanos. La orina macroscópica mostró un color amarillo ámbar y turbidez en los dromedarios de 2 y 6 años de edad. Así, el examen microscópico registró la misma presencia moderada de células epiteliales y leucocitos en las hembras no gestantes y lactantes (P=0,001). Los camellos adultos presentan una presencia moderada de leucocitos en la orina en comparación con los camellos jóvenes, mientras que la raza Targui presenta un nivel moderado de leucocitos y eritrocitos (P=0,01). El pH (potencial de hidrógeno) de la orina de camello varía entre 7 y 8, la densidad se sitúa entre 1,02 y 1,04. Sin embargo, los niveles medios elevados de cetona (8,3±3,07) en las hembras gestantes (mayores de 6 años) y de glucosa es importantes en las hembras lactantes, y se hallaron niveles medios muy bajos de bilirrubina y urobilina (0,16 y 1,26). Por consiguiente, se registraron niveles medios elevados de proteínas en las hembras gestantes (7,5 ± 5,12), los camellos jóvenes (8 ± 2,87) y ausencia total de amoníaco. El análisis bioquímico del plasma mostró: un efecto significativo de la edad sobre la creatinina, con niveles más elevados en las camellas lactantes, 30,40 ± 0,71 mg/dL de proteína total y 51,24 ± 1,02 mg/dL de albúmina. Este estudio puso de manifiesto los diferentes componentes de la orina de camello y analizó la función renal. Se recomienda realizar nuevos estudios.

Palabras clave: Algeria; camello; composición; plasma; orina

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INTRODUCTION

The relative economic and demographic importance of camels across countries translates into the greater or lesser attention paid by academics and researchers to the study of the camel species [1]. Camels contribute hugely to human survival in less agroecological parts of African, Asian and Arabian deserts [2].

In Algeria, the camel is one of the mean sources of wealth and resources in the Saharan territory. Compared to other livestock, this species has been relegated to the background, despite a past that testifies to a preponderant role in a hostile environment [3 , 4]. This animal remains indispensable and plays a multifaceted role, providing desert dwellers with food, transport, trade and miraculous biofluids such as milk and urine, which have traditionally been used as remedies for a wide range of human ailments [5].

In recent years, traditional practices have led to renewed scientific interest in camel urine; many modern studies have reported that it has numerous therapeutic indications, as it contains several compounds known to have anti-inflammatory, antioxidant, antihypertensive, hepatoprotective, antimicrobial, and antimycobacterial properties [6].

However, the use of urine (either consumed or applied locally) has attracted the interest of health academics and intellectuals since ancient times due to the widespread belief in the many preventive and curative potentialities of this biofluid as a treatment against several diseases [7].

The traditional therapeutic benefits of camel urine can be summarized as the treatment of cancer and certain infectious, gastric and cardiovascular abnormal and diseases [8 , 9]. Urine analysis is therefore one of the most important diagnostic tests that can help to localize disease, determine the causes of discolored urine and to identify inflammatory diseases of the urinary tract [10 , 11]. Among these numerous activities, Camel urine also remains effective against microbes [2].

However, the composition of camel urine is known to be different from that of bovine urine. It contains 30 different compounds and 28 essential elements [9]. As well as, camel urine's alkalinity (high levels of potassium and magnesium, albuminous protein, and low concentrations of uric acid, sodium, and creatine), unlike other animal urine, may be the reason for the comparatively higher historical prevalence of its use [12]. This variability of compounds is due to diverse factors such as sex, age, feeding, seasonality, metabolic pathways and gut microbiota [1].

In this regard, the renal blood parameters measurement is useful in determining the animal health status [13], monitoring renal response to treatment, and measuring the course of renal diseases using blood reference ranges [14 , 15]. Observing variations of some blood parameters from normal limits could be a guide for differential diagnosis of diseases [16].

Concretely, urine and the detailed characterization of its metabolic profile are scarce and often unrelated and the composition and bioactivity of camel urine has resulted in limited knowledge of this important biological matrix [1]. In this context, the aim of this study is to determine the renal metabolic profile of dromedaries from El-Bayadh province in Algeria, based on the physico-chemical camel urine examination and biochemical analysis of blood.

MATERIALS AND METHODS

Ethical approval

All experiments were conducted in accordance with the guidelines of the Institutional Animal Protection Committee of Algerian Higher Education and Scientific Research (agreement number 45/DGLPAG/DVA.SDA.14). All animal studies were conducted with the utmost respect for animal welfare. No animal suffered in the course of this research.

Study sites

A cross-sectional study was carried out between February and June 2024 on camels in the Bougtob province of El-Bayadh. This province is located in the south-west of Algeria, 600 km from the capital Algiers. It covers an area of 71,697 km2 w, with latitude: 33°40'59" north and longitude: 1°01'09" east. El-Bayadh is characterized by a very intense, semi-arid continental climate, with cold winters and hot, arid summers (FIG. 1). Camel numbers in the province of El-Bayadh are estimated at 16 250 head in 2019 [17]. There are three main camel populations in the province of El-Bayadh: Ouled Sidi-cheikh, Sahraoui in the south and the Steppic dromedary in the northern high steppe plains.

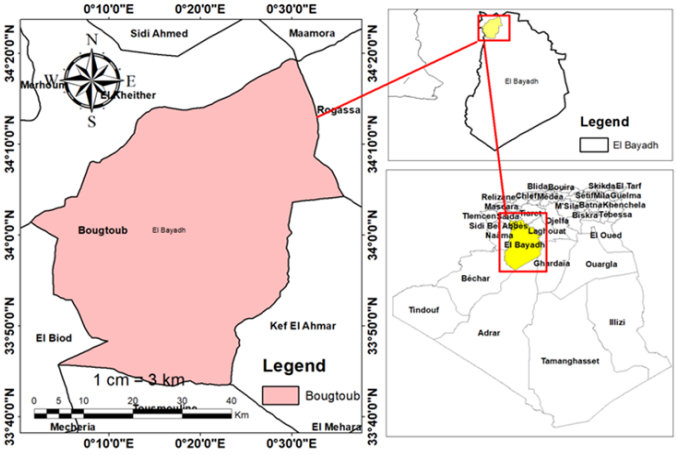

FIGURE 1. The Bougtob study area of El-Bayadh province (Algeria)

Animal study

This study aims to carry out an analysis of the physicochemical properties of urine and blood of camels in Bougtob area of El-Bayadh province. To conduct this study, we selected a total of 40 clinically healthy camels (37/40 females; 03/40 males), clinically healthy at different ages ranging from 1 month to 13 years (divided into three categories: [0-2] years, [2-6] and animals up to 6 years old. Two camel's breeds (Sttepic and Targui) were selected for this study. The dromedaries used in this study are reared in a semi-extensive system and their daily feed consists of

5 to 8 kg of wheat bran (*Triticum aestivum)*, in addition to their pasture Triplex (*Atriplex canescens*), known locally as "arroche".

Urine and blood samples collection

Urine samples

Urine samples were collected in the morning at a rate of 10 samples by day (d), using sterile jars stored. It must be collected carefully and sterilely, to avoid contamination with other micro-organisms. Urine was collected at mid-micturition, while waiting for the animals to urinate spontaneously in the pen (FIG. 2). The urine samples were transported at 4°C in a Clatronic brand cooler, reference KB3714N, with a capacity of 28 liters, made in Algeria.

Immediately, the urine samples were transferred to the laboratory at the local hospital in Bougtob province of El-Bayadh for analysis. However, according to Coles [18], these samples were subjected to a physico-chemical examination using test strips (UVOX^{VET} brand, made in France).

Blood samples

Blood samples were collected via jugular vein (FIG. 2) of the dromedaries after severs restraint in sternal decubitus position by the breeder, into 4 mL vacum tubes containing heparin. The samples were transported to the biochemistry laboratory at Tiaret's Institute of Veterinary Sciences. Upon arrival, the samples were centrifuged with Biobase digital centrifuge, made in China at 1006 g for 10 minutes (min); the separated plasma was transferred to sterile Eppendorf tubes and stored in a Haier Biomedical freezer (made in China) at -20ºC until the analysis of biochemical parameters.

(a) (b) (c) (d)

FIGURE 2. Collecting of camel urine and blood samples (a,b): Camel urine collected early morning in sterile bottles by bladder stimulation. ; (c, d): The camel is restrained; a blood sample is collected via the jugular vein for biochemical examination of the plasma

Macroscopic urine examination

According to Florent and Herman [9], Urine examination is a source of information easy to obtain and interpret in individual and population medicine. In this study, the examination of urine samples starts with macroscopic assessment of color, clarity and turbidity (FIG.3).

Microscopic and chemical examination

The components of urine were analyzed to detect different abnormalities and cells identification such as leukocytes, erythrocytes and epithelial cells, as well as crystals and foreign bodies such as bacteria and parasites. A drop of urine from each sample is applied to a slide and read under a light microscope (OPTIKA brand, Reference: B-193, made in Italy) at different magnifications (10x- 40x-100x). To perform the chemical analysis of animal urine, we used urine strips (KING DIAGNOSTIQUE®;UVOXVET brand, made in France), which are considered a simple complement to the clinical examination and can provide valuable information on the animal's state of health, which allow the analysis of 10 components such as: nitrites, urobilinogenes, proteins, glucoses, bilirubins and ketone bodies.

These strips are used after collecting fresh urine in a dry, sterile container. However, the analysis must be performed on homogeneous urine samples not centrifuged within two hours (h) after collection. The use of strips test at room temperature with an automatic reader type (MINDRAY UA-66®, made in France) is necessary for this method. The correct calibration of the meter was achieved, as was the shaking of the urine sample container to homogenize the sample, and the complete immersion of the test strip in the urine sample for a few seconds, according to VIDAL guidelines [19].

Plasma biochemistry analysis

The plasma from the dromedaries was tested biochemically using a Secomam® semi-automated biochemistry analyzer and commercial kits manufactured in France. This investigation was carried out in the biochemistry laboratory at Tiaret's Institute of Veterinary Sciences. Total protein was measured with BIOLABO® kits of the BioSed® brand of PCBs made in France using the Biuret method, while albumin and urea were determined by a colorimetric method. Glucose was analyzed with CYPRESS DIAGNOSTICS® kits made in Belgium using a colorimetric method, and creatinine was evaluated by BIOMAGREB® kits manufactured in Tunisia using an enzymatic method.

Statistical analysis

SPSS statistical software version 22 was used to analyses the data. Chi-square test was used to determine the effect of several physiological characteristics. Since the data did not follow a normal distribution, non-parametric tests, specifically the Kruskal-Wallis test were used to investigate the effect of these factors on the variation of other urinary and blood parameters. Results obtained were expressed as Mean ± standard error of the mean (SEM). To compare the two groups, post-hoc analysis was performed using the Mann-Whitney test, with a P-value < 0.05 considered statistically significant.

RESULTS AND DISCUSSION

Physico-chemical analysis of camel urine

Macroscopic camel urine examination

The examination urine samples starts with macroscopic assessment of color and turbidity (FIG. 3). A combination of urobilin and urobilinogen with a peptide is thought to be responsible for this coloration [20]. Also, urine turbidity, such as color observation, can be assessed semi-quantitatively by clearly viewing the background newspaper in a clear container under good light from a well-mixed urine sample [21].

The three age groups, physiological state and camel breed studied showed the following results (FIG. 3; TABLE I).

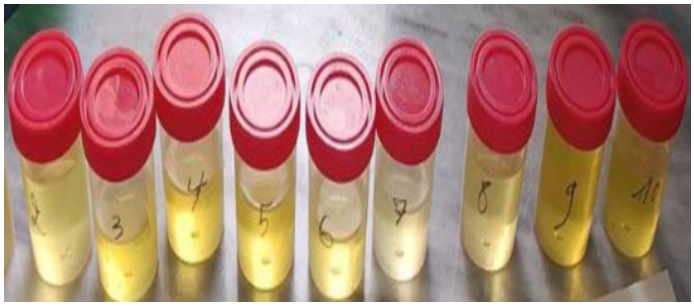

FIGURE 3. Macroscopic exam of camel urines samples (After collecting the samples of dromedary urine, macroscopic observation in a well-lit area is carried out to determine the colour and turbidity of the urine)

The results illustrated in FIG. 3 are similar to the findings of Fowler [22] who indicates that the normal camel urine sample is yellow to amber colour.

Macroscopic examination of camel urine (TABLE I) revealed a high proportion of amber yellow colour in dromedaries aged between 2 and 6 years old and a high turbidity rate was observed in the same group. Therefore, the transparent urine is more important in camels older than six years. However, Ressmi *et al*. [6] did not report any colour changes in camel urine with age, despite the different uses of camel urine. Thus, the results of El- El-Hady *et al*. [23] reported that dromedary urine has a pale yellow colour and a clear appearance. In this study, the camel urine colour of males generally ranges from pale yellow to amber yellow, while female camel urine is completely clear yellow. Aitekenov *et al*. [24] pointed out that little is currently known about the possible effect of age on the quantitative changes in the urine and its chemical composition Few studies have also addressed the breed variability [25]. Therefore, urine colour plays a role in the diagnosis of diseases, particularly in animal health care.

TABLE I
Macroscopic camel urine examination

Parameter	*Colored urine (%)*			*Turbidity (%)*	
	Yellow pale	*Yellow Clear*	*Yellow to amber*	*Transparent*	*Turbid*
			Age		
≤0-2Y	**15.38(2/13)**	**61.54(8/13)**	23.08(3/13)	84.61(11/13)	15.38(2/13)
2-6Y	00.00	40.00(6/15)	**60.00(9/15)**	80.00(12/15)	**20.00(3/15)**
≥6Y	8.33(1/12)	58.33(7/12)	33.33(4/12)	**91.67(11/12)**	8.33(1/12)
p-value		0.23		0.7	
			Female Physiological state		
Non preg.	00.00	50.00(3/6)	50.00(3/6)	83.33(5/6)	16.67(1/6)
Preg.	00.00	33.33(2/6)	**66.67(4/6)**	66.67(4/6)	**33.33(2/6)**
Lactating	**10.00(1/10)**	**70.00(7/10)**	20.00(2/10)	**90.00(9/10)**	10.00(1/10)
p-value		0.36		0.5	
			Sex		
Female	**08.11(3/37)**	**51.35(19/37)**	**40.54(15/37)**	**86.49(32/37)**	13.51(5/37)
Male	00.00	**66.67(2/3)**	33.33(1/3)	66.67(2/3)	**33.33(1/3)**
p-value		0.81		0.39	
			Breed		
Sttepic	**08.88(3/34)**	**55.88(19/34)**	35.29(12/34)	**88.32**(30/34)	11.76(4/34)
Targui	00.00	33.33(2/6)	**66.67** (4/6)	66.67 (4/6)	**33.33 (2/6)**
p-value	0.32			0.21	

*Y: Years; Preg: pregnant

Microscopical and chemical camel urine examination

The results of the microscopic analysis indicated the significant presence of leucocytes depending on the physiological stage of the female camels, as well as the presence of erythrocytes, epithelial cells and crystals (TABLE II).

TABLE II
Microscopic analysis of dromedary urine

Parameter	*Leucocyte (%)*			*Erythrocyte (%)*			*Epithelial cells (%)*		*Crystals (%)*	
	-	+	++	-	+	++	-	+	-	+
					Age					
≤2years(13)	46.15(6)	46.15(6)	7.69(1)	61.54(8)	23.08(3)	15.39(2)	61.54(8)	38.46(5)	**76.92**(10)	23.08(3)
2-6years(15)	60(9)	26.67(4)	13.33(2)	13.33(12)	20(3)	ND	66.67(10)	33.33(5)	**86.67(13)**	13.33(2)
≥ 6years(12)	41.67(5)	41.67(5)	16.67(2)	**66.67(8)**	25(3)	8.33(1)	66.67(8)	33.33(4)	**75.00(9)**	25.00(3)
p-value		0.79			0.61		0.95		0.71	
					Female Physiological state					
No Preg(6)	66.67(4)	33.33(2)	ND	66.67(4)	33.33(2)	ND	83.33(5)	16.67(1)	83.33(5)	16.67(1)
Preg (6)	16.67(1)	16.67(1)	66.67(4)	33.33(2)	**50.00(3)**	16.67(1)	50.00(3)	50.00(3)	**83.33(5)**	16.67(1)
Lact; (10)	60.00(6)	**40.00(4)**	ND	**90.00(9)**	10.00(1)	ND	**70.00(7)**	30.00(3)	80(8)	20.00(2)
Pvalue		**0.01**			0.15		0.45		0.98	
					Sex					
Female(37)	54.05(20)	35.13(13)	10.81(4)	70.27(26)	24.32(9)	5.40(2)	67.57(25)	32.43(12)	**81.08(30)**	18.92(7)
Male(3)	ND	**66.67(2)**	33.33(1)	66.67(2)	ND	33.33(1)	33.33(1)	**66.67(2)**	66.67(2)	33.33(1)
P-value		0.17			0.16		0.27		0.49	
					Breed					
Sttepic(34)	52.94(18)	35.29(12/34)	11.76(4/34)	76.47(26)	14.70(5)	8.82(3/34)	64.70(22)	35.29(12)	**79.41(27)**	20.59(7)
Targui (6)	33.33(2)	**50.00(3)**	16.67(1)	33.33(2)	**66.67(4)**	ND	66.67(4)	33.33(2)	**83.33(5)**	16.67(1)
P-value		0.67			**0.01**		0.9		0.8	

preg: pregnant; lact: lacting; (-): absent ;(+): moderate presence error, (++): Strong presence, ND: Not detected

Moreover, Microscopic examination of the urine samples (TABLE II) showed moderate proportion of leucocytes in non-pregnant, pregnant and lactating females, with a significant difference (P=0.01), leucocytes are therefore more abundant in adult males than in young camels; probably because young camels are still developing their immunity. Regarding the breed, the Targui have a moderate level of erythrocytes, with a significant difference for this type of cell (P=0.01), which can be explained by the fact that the presence of these cells is a consequence of the desquamation of the epithelial layer [26]. The moderate presence of crystals has been observed in camel urine, as demonstrated by Tharwat *et al.* [27]. So, chemical analysis of dromedary urine showed a significant value for density (P=0.03) depending on the two camel breeds (Sahraoui and Targui). However, the glucose in camel urine showed a significant difference depending on age P=0.04 (TABLE III).

TABLE III
Chemical component of camel urine

Comp	*Urobilin*	*Bilirubin*	*Prot*	*KB*	*Den*	*pH*	*Glucose(%)*		*Nitrite(%)*	
	M±SE						-	+	-	+
						Age				
≤2Y	1±0.29	0.46±0.14	**8.07±3.22**	3.84±1.15	1.02	7.64±0.27	9.23(9/13)	30.77(4/13)	**76.92(10/13)**	23.08(3/13)
2-6Y	0.72±0.25	0.46±0.13	**8±2.87**	4.66±1.5	1.03	7.45±0.21	100(15/15)	ND	66.67(10/15)	**33.33(5/15)**
≥6Y	0.68±0.16	0.33±0.14	5±2.13	**5.41±1.43**	1.02	7.58±0.21	66.67(8/12)	**33.33**(4/12)	75.00(9/12)	25(3/12)
P-value	0.50	0.75	0.82	0.66	0.53	0.86	**0.04**		0.81	
						Female Physiological state				
Non P	1.26±0.61	0.66±0.21	5±3.16	5±2.23	1.02	7.33±0.21	83.33(5/6)	16.67(1/6)	50.00(3/6)	**50.00**(3/6)
Preg	0.60±0.17	0.16±0.16	**7.5±5.12**	**8.3±3.07**	1.04	7.63±0.26	83.33(5/6)	16.67(1/6)	66.67(4/6)	33.33(2/6)
Lactat	0.52±0.13	0.50±0.16	6±2.44	4±1.45	1.02	7.33±0.24	80.00(8/10)	**20.00**(2/10)	70.00(7/10)	30.00(3/10)
p-value	0.67	0.21	0.96	0.56	0.13	0.62	0.98		0.71	

Sex										
Female	0.80±0.15	0.43±0.08	6.48±1.59	4.32±0.80	1.02	7.57±0.13	**81.08**(30/37)	18.92(7/37)	75.67(28/37)	24.32(9/37)
Male	0.73±0.26	0.33±0.33	**15±8.66**	8.33±3.33	1.03	7.33±0.83	66.67(2/3)	**33.33(1/3)**	33.33(1/3)	**66.67**(2/3)
p-value	0.73	0.74	0.20	0.14	0.58	0.50	0.49		0.14	
Breed										
Sttepic	0.81±0.16	0.41±0.08	6.61±1.69	4.26±0.79	1.02	7.59±0.15	79.41(27/34)	**20.59**(7/34)	76.47(26/34)	23.53(8/34)
Targui	0.73±0.16	0.50±0.22	**10±5**	**6.66±2.78**	1.04	7.31±0.23	83.33(5/6)	6.67(1/6)	50.00(3/6)	**50.00**(3/6)
p-value	0.61	0.69	0.46	0.45	**0.03**	0.58	0.90		0.31	

Comp: Component; Des: density; Y: years; prot: protein; KB: ketone; (-): absent ;(+): moderate presence; M±SE: mean± standard error

In this study, the pH of dromedary urine is alkaline ranging from 7 to 8, and the density is between 1.02 and 1.04, with a significant difference in density depending on the breed of dromedary (P=0.03). The same finding was reported by Alebie *et al*. [28] and Ahamad *et al*. [9] who indicated that the dromedary has a basic pH of 7.8 and the density is between 1.045 and 1.06. The same finding was reported by Amer and Amer and Al-Hendi [29] on the specific gravity of camel urine of s (5-10 years old) is 1.01 to 1.07, while the pH is weak to strong alkaline. Therefore, for ketone bodies and glucose, high levels of ketone bodies were found a in pregnant females older than 6 years, which is related to the high energy demand in this category [28]. On the other hand, Tharwat *et al*. [27], indicate that, the camel pregnancy is susceptible to high glucose levels with ketones in their urine during late gestation as a composition of ketonuria caused by excessive amounts of beta-hydroxybutyrate, excessive fat mobilization, and lack of animal activity. Glucose was also found to be highest at 40, 55 and 80 days of pregnancy [30]. High average protein levels were found in pregnant females and young camels, while Kamalu *et al.* [31], Mostafa and Dwedar [32] reported that camel urine contains high concentrations of albumin protein and low levels of creatine. As well as, other components (Urobilin, Bilirubin, Nitrite) were found in dromedary urine with moderate presence. This explains why camel urine is rich in many organic and inorganic compounds [28]. Furthermore, the urinary biochemical profile differs between the sexes of dromedary camels and even depends on the physiological status of the females [6].

Biochemical blood parameters of camel plasma

The results of this analysis showed (TABLE IV) a significant difference Creatinine (P≤0.001) and Protein (P=0.001) depending on the camel's age. Also, Creatinine (P=0.05) Albumin (P=0.02) and Glucose (P=0.009) showed significant values (TABLE IV).

TABLE IV
Variation in blood biochemical parameters of camels plasma

Parameter	Urea (g/l)	Creatinine(mg/l)	Protein (g/l)	Albumin (g/l)	Glucose (g/l)
Age					
≤2 years	0.50±0.03 (0.52)	3.99±0.49 a(3.95)	69.57±4.91a (64.07)	38.99±1.86a(37.1)	2.02±0.12 (1.94)
2-6years	0.45±0.02 (0.42)	4.94±1.37 a(5.08)	63.18±2.86 a (62.92)	35.90±1.57a(34.7)	1.89±0.14 (1.92)
≥6years	0.45±0.01 (0.44)	0.78±0.32 b(0.19)	53.82±0.58b (52.21)	32.94±0.78b(32.6)	1.77±0.07 (1.56)
p-value	0.321	**≤0.001**	**0.001**	0.018	0.401
Sex					
Female	0.48±0.01(0.47)	4.15±0.33(4.25)	64.89±2.81(62.72)	36.95±1.24 (36.63)	2.01±0.09(1.93)
Male	0.47±0.09 (0.44)	3.66±1.92 (3.95)	67.20±9.68 (64.07)	38±4.28 (34.87)	1.65±0.14 (1.56)
Female Physiological state					
non preg	0.49±0.05 (0.56)	3.73±0.71ab(3.14)	60.18±3.29 (56.85)	39.84±1.09a(38.9)	1.93±0.01a (1.93)
preg	0.46±0.03 (0.42)	2.98±1.08 a(2.62)	61.36±3.96 (55.82)	33±1.93 b (31.03)	2.01±0.06a (2.05)
Lactating	0.41±0.03 (0.38)	5.59±0.58 b(6.86)	65.52±3.26 (63.10)	36.01±2 b (34.79)	1.50±0.23 b(1.16)
p-value	0.15	**0.05**	0.23	**0.02**	**0.009**
Breed					
Sttepic	0.48±0.01 (0.44)	3.39±0.39 (3.33)	63.99±2.37*(61.15)	36.87±0.98*(34.86)	1.91±0.08 (1.92)
Targui	0.42±0.01 (0.41)	3.36±0.96 (4.31)	53.71±2.77*(52.44)	31.19±1.92*(31.36)	1.84±0.14 (1.83)
p-value	**0.09**	0.98	**0.05**	**0.03**	0.81

The means followed by different letters in the same column represent significant differences. The value in parentheses indicates the median.

In the present study, the biochemical profile examination showed a higher creatinine concentration than that observed in Canarian camels (1.50 ± 0.36 mg/dL) [33]. However, it aligns to the values observed in Majaheem, Maghateer, and Awarik camels (3.95 ± 0.5 mg/dL) [34], as well as in Bactrian camels (3.0 ± 0.25 mg/dL) [35]. Thus, these results may be related to specific weather conditions. The urea values obtained are similar to those found by Faraz *et al*. [36] and higher than those reported by Wako *et al.* [37] (46.71 ± 4.28 mg/dL), (29.54 ± 1.62 mg/dL). Therefore, the total protein concentrations (30.40 ± 0.71 mg/dL) and albumin (51.24 ± 1.02 mg/dL) were slightly higher than the result of Abdalmula *et al*. [38] in Libyan dromedary camels, where the mean of total protein and albumin is (51.24 ± 1.02 mg/dL), (30.40 ± 0.71 mg/dL) respectively. Regarding, the result of blood glucose a higher concentration was found compared to the values (67.0 ± 4.49 mg/dL), (3.85 mmol/l) reported by Al-Zubaidy *et al.* [39] and Nazifi *et al.* [40] This increase could be attributed to the availability of protein and energy in the diet as blood glucose is an important measure metabolic health in camels.

Age effect

The results of this study indicate a significant effect of age on creatinine levels, with lower levels in camels aged 6 years and older. However, research by Abdalmula *et al*. [38], Deen [41] and Lamo *et al*. [35] reported no significant variations in creatinine levels between age groups. In contrast, Martín-Barrasa *et al*. [33] found higher creatinine levels in adult camels compared to younger camels. This could be explained by either increased protein intake, especially in lactating camel calves [42], or rapid growth and immature renal function affecting filtration and excretion of creatinine in urine [43]. However, age had no significant impact on urea levels in a study of Bactrian camels by Saeed *et al*. [44], Lamo *et al.* [35] and Roba *et al.* [46]. The decrease in total protein and albumin concentrations with age is in accordance with Roba *et al.* [37], and contradicts the findings of Abdalmula *et al*. [38] and Martín-Barrasa *et al.* [33], who did not observe any effect of age on protein and albumin levels. This statement may be explained by periodes of rapid growth, which require a higher metabolism to meet the increased demands associated with tissue development. In this study, age had no effect on blood glucose levels, which is comparable to the study by Ghodsian *et al*. [45]. For example, a number of researchers have shown that young camels, particularly those under five years of age, generally have higher glucose levels than adults [37 , 46]. This is in contrast to the results of Faye and Mulato [47], Ateeq *et al.* [48] and Souilem *et al.* [49] who reported that glucose levels change with age. In addition, severe intestinal parasitic infestation can lead to decreased glucose and total protein (TP) levels [50 , 51].

Effect of physiological state

The lactating camels had higher creatinine levels, which contrasts with the findings of Ebissy *et al.* [52], who noted higher creatinine concentrations during the prepartum period compared to the postpartum period, and Roba *et al.* [37], who reported higher creatinine levels in pregnant females. The increase was attributed to the higher protein requirements and reduced renal excretion rate associated with late pregnancy [42]. In lactating camels, the rise in creatinine levels may be linked to the increased muscle metabolism required to support milk production [53]. The analysis found no apparent influence on urea levels in relation to the physiological statue. However, Roba *et al.* [37] revealed a considerable rise in urea levels in pregnant females, whereas Faraz *et al.* [36] found no difference.

The present study, find that non-pregnant females had higher albumin levels. Thus, the findings of Faraz *et al.* [36] indicate that pregnant camels had higher levels of albumin and total protein (g/l) levels (7.16 ± 0.98, 3.23 ± 1.68), respectively, and non-pregnant camels had lower levels (2.86 ± 1.04, 6.28 ± 1.12). Elitok and Cirak [34] found that the total protein and albumin concentrations in non-pregnant camels were 5.95 ± 0.08 and 2.49 ± 0.02, while in pregnant camels, they were 6.43 ± 0.04 and 2.70 ± 0.05, respectively. The decrease in albumin concentration observed in pregnant and lactating females may be attributed to the utilization of albumin-derived amino acids to meet the metabolic needs of the fetus and milk production [54 , 55].

According to Kelanemer *et al.* [56], Camel blood glucose levels in camels are known to increase gradually during pregnancy and decrease during the first two weeks of lactation, which is consistent with the results of the current investigation. Contrary, to the results of Tharwat *et al.* [27], El Zahar *et al*. [57], Ebissy *et al.* [52], Faraz *et al*. [36] and Mohamed *et al.* [30], the non-significant hypoglycaemia in lactating camels compared to pregnant camels is likely due to its role as the primary precursor for lactose synthesis in the mammary gland [13].

Several studies have suggested that milk lactose production is associated with increased glucose uptake by the mammary gland [58]. Additionally, the reduction in glucose levels observed in non-pregnant camels may be due to energy utilization for growth. Furthermore, the rise of glucose levels during pregnancy is due to increased gluconeogenesis. In addition, Ayoub *et al.* [59] found no significant variations in glucose levels between pregnant and non-pregnant camels.

Breed effect

Results indicate a significant effect of breed on protein levels ($P \leq 0.05$) and albumin ($P < 0.03$) levels. In contrast, no significant variations were observed for the other parameters in relation to breed. Similarly, Aichouni *et al.* [60] also reported a non-significant effect on glucose, urea, creatinine, and total protein levels among three breeds of camels in Algeria. Furthermore, studies by Al-Zubaidi *et al.* [39] and Deen *et al.* [41] found no significant differences in urea levels among breeds. This significant difference in total protein and albumin values among breeds, particularly the increase in these parameters in the steppic breed compared to the Targui breed, is probably the reason for maintaining a high colloid osmotic pressure, which is necessary for blood water storage and water balance regulation. Additionally, it has been shown that when camels are transferred from semi-desert pastures to artificial feeding, albumin levels decrease by approximately 25% [61].

Sex effect

However, we found an increase in creatinine and glucose concentrations in females compared to males, whereas albumin and total protein levels were higher in males. On the other hand, the findings of Martín-Barrasa *et al.* [33] observed no significant variations in creatinine, albumin, and total protein concentrations between males and females. Similarly, the investigations of Babeker *et al.* [62] reported no statistical differences in blood creatinine levels between genders. In contrast, Alzubaidi *et al.* [39] found that females had a higher urea concentration while males had a much higher glucose concentration. However, the urine analysis is one of the most important diagnostic tests that can help to localize disease,

to determine the cause of discoloured urine and to identify inflammatory diseases of the urinary tract [10].

CONCLUSION

This study provided valuable information on the physico-chemical and biochemical analysis of camel urine and testing the renal function by plasma analysis of dromedaries from the elbayadh region in algeria. Certain risk factors were studied Further studies are needed to compare the physical and chemical properties, urine composition and renal metabolism, and even the therapeutic effect in dromedaries in Algeria. on the immunity and state of health of human patients.

Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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