South African Journal of Animal Science 2024, VOL 54

Carcass yields in the main Algerian populations of camels: Sahraoui, Targui, steppe camel, and Reguibi (*Camelus dromedarius* L., 1758)

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(Submitted 21 September 2023; Accepted 6 March 2024; Published 26 March 2024)

ABSTRACT

The carcass yield varies from one animal species to another and depends on various factors, such as the age of the animal, its health condition, diet, and activity level. The main objective of this study was to determine the yield of meat production from the main Algerian population of dromedaries (*Camelus dromedaries* L, 1758), namely, Sahraoui, Targui, steppe camels, and Reguibi, while minimizing unnecessary losses to guide the choices for development in camel meat production. A total heterogeneous sample of 240 dromedary camels was collected, distributed as follows: 60 camels from each population (Sahraoui, Targui, steppe camels, and Reguibi). Within each population, the animals were further divided into the following categories: 15 young adult males, 15 adult males, 15 young adult females, and 15 adult females. Live weights were determined before slaughter using body measurements and calculated using the Boué (1949) method. The weights of the hot carcasses were collected from the slaughterhouses (the sum of the weights of the nine separated parts constituting the carcass): Ouargla for the Sahraoui and Targui populations, Biskra for the steppe camel population, and Tindouf for the Reguibi population. These animals were from extensive breeding populations. The average carcass yields of the different dromedary populations indicate that, among adult males, Reguibi had the highest yield (64.86 ± 7.17%), whereas the lowest average yield was observed in Targui males (49.99 ± 6.27%). For females, the highest average value of 53.65 ± 7.17% was recorded in the Reguibi camels and the lowest was in the Targui population (44.48 ± 6.27%).

Keywords: Algeria**,** carcass yield, dromedary, population, Reguibi, Sahraoui, steppe camel, Targui
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URL: http://www.sasas.co.za
ISSN 0375-1589 (print), ISSN 2221-4062 (online)
Publisher: South African Society for Animal Science
http://dx.doi.org/10.4314/sajas.v54i1.08

INTRODUCTION

The dromedary is one of the animals most adapted to the desert climate, which has allowed for the sustainability of life in these regions. Its meat and milk are highly nutritious, and their commercialization provides a significant source of income in the oases. The dromedary is an important component of the desert ecosystem. In arid regions, this animal is raised alongside other livestock animals (such as cattle, sheep, goats, horses) for its produce (milk, meat) (Guintard and Babelhadj, 2018). According to Denis & Digard (2019), after goats, camelids are the herbivore species with the highest increasing numbers in the world. Indeed, the dromedary provides animal proteins (meat and milk) essential for the Saharan population. In fact, the current interest in consuming dromedary meat as red meat is partly based on its attributed therapeutic or medicinal virtues (Abdelhadi et al., 2017; Ayyash et al., 2019; Popova et al., 2021). Today, multidisciplinary research is being conducted in many countries on dromedary meat and milk for the adoption of efficient production systems, improvement of their processing, and commercialization.

According to Harek et al. (2017), 97 populations of dromedaries are recorded on Earth, with 26 in Africa and 10 in Algeria. The Targui and Sahraoui populations are the most widespread. According to Ezzahiri (1988), animals from the Sahraoui population are tall, strong, and robust. Messaoudi (1999) describes the Targui dromedary as a tall animal with slender and dry limbs, grey coat with very short and fine hair. The camel population of the Ouled Naïl tribes, or steppe camel, is believed to be very ancient (11th century) and may correspond to a morphotype adapted to steppe areas, indicating a relatively small but well-formed animal with little selection. In this sense, the steppe camel holds importance, and even though its numbers are not large, it is interesting to characterize it precisely (Harek et al., 2017). The Reguibi population consists of excellent racing camels and is distributed in the western Sahara, southern Oran (Béchar, Tindouf); its origin, Oum El Assel (Reguibet) (Benaissa, 1989).

The aim of this study was to evaluate the carcass yield of the main Algerian populations of dromedary (*Camelus dromedarius* L., 1758), namely the Sahraoui, Targui, steppe camel, and Reguibi. This assessment will help guide the development of camel meat production strategies in the arid and semi-arid regions of Algeria in order to meet the needs of the inhabitants for proteins of animal origin.

Materials and Methods

The study focused on 240 dromedaries: adult dromedaries (over 10 years old) and young adults (between 5 and 10 years old) intended for slaughter, of both sexes (male and female), belonging to four different populations (Sahraoui, Targui, steppe camel, and Reguibi), originating from four distinct arid and semi-arid zones (Tindouf, Biskra, Ouargla, and Tamanrasset) in Algeria. The individual age of each animal was determined based on the knowledge of the owners of these animals and veterinarians using the dentition of the animals. Four classes were established for each population: young adult males or females (hereafter referred to as young males or females) between 5 and 10 years old, and older adult males or females (hereafter referred to as adult males or females) for animals over 10 years old.

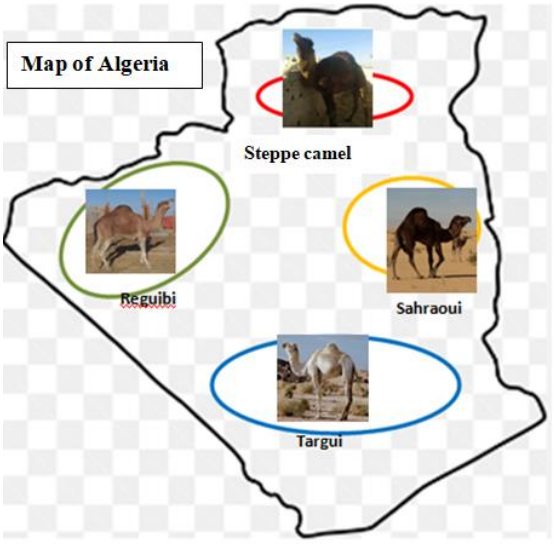

Figure 1 Geographic distribution of the four populations (© Baaissa BABELHADJ)

For each animal, two weight measurements were calculated: the hot carcass weight in kilograms, in the absence of appropriate weighing means and after the butchering process. It is the sum of the weights of the different separated parts constituting the carcass, which includes nine pieces: the neck, the two shoulders, the dorsothoracic part, the right ribs, the left ribs, the lumbar part, and the two hindquarters. Weighing of the different carcass parts was performed using a Crane Scale Cap electronic scale with a maximum capacity of 150 kg.
The live weight (LW) in kilograms was estimated using Boue (1949) biometric formula:

$$LW = 53 \times CT \times CA \times HG, \quad (1)$$

where CT is the thoracic circumference, CA the abdominal circumference and HG the withers height. the three biometric measurements in meters were taken prior to slaughter: the withers height (HG) using a 2.5 m measuring stick, the thoracic circumference (CT), and the abdominal circumference (CA) using a 5 m retractable measuring tape with a locking button according to the studies by Babelhadj *et al*. (2016a) and Babelhadj *et al*. (2021).
The slaughter yield of the studied animals was calculated using the following formula (Meyer 2014):

$$\left(R = \frac{\text{hot carcass weight}}{\text{live weight}} \text{x}100\right) \quad (2)$$

The variables were expressed as descriptive parameters: mean and standard deviation, minimum and maximum values separately for males (adults and young adults) and females (adults and young adults). The average values of the data obtained from several observations according to the parameters were calculated and represented with the standard deviation using Windows Excel software. Risk probabilities were assessed at the threshold of 0.05 using the Kruskal–Wallis test. In granting this authorization, our institution acknowledges the ethical review carried out by researcher, Atika BENAISSA, who serves as the principal investigator for this project. The review has affirmed the project's ethical soundness and compliance with our institution's regulatory framework for research activities.

Results and Discussion

The values of weight parameters and slaughter performance for the four populations of camels are grouped in Table 1 for the Sahraoui, Targui, Reguibi, and steppe camel populations. The mean values correspond to measurements recorded on animals from each population, with a total number of n = 60, including adult (over 10 y old) or young adult male (between 5 and 10 y old) and female camels for each sex.

For all variables, the average value for males was greater than that for females in all four populations. Adult camels had the highest average live weights for all studied populations, weighing 557.63 ± 75.07 kg, 512.42 ± 41.51 kg, 545.80 ± 98.58 kg, and 559.05 ± 41.25 kg, for the Sahraoui, Targui, Reguibi, and steppe camel populations, respectively. The average carcass weights were 310.13 ± 55.99 kg, 255.53 ± 33.88 kg, 354.53 ± 77.74 kg, and 302.66 ± 39.54 kg for the Sahraoui, Targui, Reguibi, and steppe camel populations, respectively. This resulted in carcass yield averages of approximately 55.50 ± 5.57%, 49.98 ± 6.26%, 64.85 ± 7.16%, and 53.98 ± 4.66%, for the Sahraoui, Targui, Reguibi, and steppe camel populations respectively. This difference in carcass yield can be explained, as stated by Babelhadj *et al*. (2021), by the morphological difference, physical characteristics, and their structures between the samples, which is correct for the rustic populations (Sahraoui and Targui with 49.5% and 48.2% carcass yield, respectively) despite the higher live weight of Targui camels.

The variability expressed by the coefficient of variation was significant for weight variables in all four populations. The coefficient ranged from 9.12% (Targui) to 30.46% (Reguibi) for carcass weight and from 7.38% (steppe camel) to 18.06% (Reguibi) for live weight. The standard deviation of weight measurements was also significant, ranging from 98.58 for live weight in the Reguibi population to 23.40 in the animals from the steppe camel population. These results are consistent with those obtained by Babelhadj *et al*. (2016).

Table 1 Values of weight parameters and slaughter yield

Parameters		Pd carc (kg)				Pd vif (kg)				R (%)			
		Sah	Tar	Reg	Stp	Sah	Tar	Reg	Stp	Sah	Tar	Reg	Stp
Ml J/A	n	15	15	15	15	15	15	15	15	15	15	15	15
	min	180	230	170	230	376,19	419,15	329,44	334,5	42,859	34,87	40,989	47,68
	max	280	298	471	350	508,52	696,71	627,54	629,09	61,155	58,213	90,61	69,37
	µ	225,8	256,60	263,20	298,33	441,17	517,51	469,14	543,36	51,27	50,16	55,83	55,80
	σ)	28,64	23,40	80,19	45,18	46,19	73,24	81,65	72,84	4,96	5,64	12,36	5,90
	CV %	12,68	9,12	30,46	15,14	10,47	14,15	17,40	13,40	9,67	11,25	22,13	10,58
Ml A	n	15	15	15	15	15	15	15	15	15	15	15	15
	min	244	215	262	210	450,85	433,43	439,85	464,4	44,33	39,38	53,40	42,78
	max	400	332	467	350	669,93	578,88	594,96	618,06	62,42	66,24	79,93	60,14
	µ	310,13	255,53	354,53	302,66	557,63	512,42	545,80	559,05	55,50	49,98	64,85	53,98
	σ)	55,99	33,88	77,74	39,54	75,07	41,51	98,58	41,25	5,57	6,26	7,16	4,66
	CV %	18,05	13,26	21,92	13,06	13,46	8,10	18,06	7,38	10,04	12,53	11,04	8,63
Fml J/ A	n	15	15	15	15	15	15	15	15	15	15	15	15
	min	132	103	151	300	258,74	314,93	323,58	498,7	36,70	31,34	44,85	60,15
	max	280	250	281	330	508,11	512,99	520,35	547,95	61,22	52,35	63,84	60,22
	µ	194,13	184	223,93	233,36	420,41	408,99	416,77	487,55	46,23	44,47	53,64	47,96
	σ)	42,98	47,79	40,48	45,63	72,54	65,01	60,51	64,91	6,54	6,51	5,03	7,11
	CV %	22,14	25,97	18,08	19,55	17,25	15,89	14,51	13,31	14,16	14,65	9,38	14,83
Fml A	n	15	15	15	15	15	15	15	15	15	15	15	15
	min	140	160	195	180	310,29	365,15	375,77	374,6	32,25	39,14	44,64	37,36
	max	267	245	306	350	563,41	507,17	551,24	587,66	54,75	57,02	66,52	66,54
	µ	194,66	203,66	251,53	254	431,05	425,61	472,25	477,62	45,16	47,87	53,32	52,82
	σ)	43,83	25,20	37,55	64,23	61,94	35,55	49,62	56,47	7,52	4,62	6,52	12,68
	CV %	22,51	12,37	14,93	25,28	14,36	8,35	10,50	11,82	16,65	9,66	12,22	24,02
Total population	n	120	120	120	120	120	120	120	120	120	120	120	120
	min	132	103	151	180	258,74	314,93	323,58	334,5	32,25	31,34	40,99	37,36
	max	400	332	471	350	669,93	696,71	627,54	629,09	62,42	66,24	90,61	69,37
	µ	230,52	224,35	273,38	271,27	462,04	466,15	476,61	516,11	49,46	47,99	56,84	52,57
	σ)	62,87	46,53	74,66	56,98	83,30	74,26	86,11	68,59	7,34	6,15	8,89	8,57
	CV %	27,27	20,74	27,31	21,01	18,03	15,93	18,06	13,29	14,84	12,82	15,64	16,31

n: sample size, µ: arithmetic mean, min: minimum, max: maximum, σ: standard deviation, cv (%): coefficient of variation, Pd carc: carcass weight, Pd vif: live weight, R: slaughter yield, (kg): kilogram, J/A: young adult, A: adult, Fml: Female, Ml: Male, Sah: Sahraoui, Tar: Targui, Reg: Reguibi, Stp: Steppe

Weight values by sex

The highest average values of hot carcass weight and live weight by sex for each population were recorded in male animals, and they are respectively: 310.13 ± 55.99 kg and 557.63 ± 75.07 kg (Sahraoui males), 194.66 ± 43.83 kg and 431.05 ± 61.94 kg (Sahraoui females), 256.60 ± 23.40 kg and 512.42 ± 41.51 kg (Targui males), and 203.66 ± 25.20 kg and 425.61 ± 35.55 kg (Targui females), 354.53 ± 77.74 kg and 545.80 ± 98.58 kg (Reguibi males), and 251.53 ± 37.55 kg and 472.25 ± 49.62 kg (Reguibi females), and 302.66 ± 39.54 kg and 559 ± 41.25 kg (Steppe males), and 254 ± 64.23 kg and 487.55 ± 64.91 kg (Steppe females).

The average slaughter yields were also higher in males than in females, from 55.50 ± 5.57% (Sahraoui males) to 46.23 ± 6.54% (Sahraoui females), 50.16 ± 5.64% (Targui males) to 47.87 ± 4.62% (Targui females), 64.85 ± 7.16% (Reguibi males) to 53.64 ± 5.03% (Reguibi females), and 55.80 ± 5.90% (Steppe males) to 52.82 ± 12.68% (steppe camel females). The highest value was recorded in Reguibi males. The coefficient of variation (CV) also varied among males and females. This coefficient shows three types of variables: carcass weight, live weight, and slaughter yield. The live weight in males from the Steppe population has the lowest CV (7.38%).

Weight values by population

The variability expressed by the coefficient of variation shows two types of variables: Weight variable (carcass weight and live weight), with values ranging between 20.74% (Targui population) and 27.31% (Reguibi population) for carcass weight, and between 13.29% (Steppe camel population) and 18.06% (Reguibi population) for live weight. The standard deviation of these two measures was significant for the four populations studied. The slaughter yield (R) ranged between 12.82% and 16.31% for the Targui population and the steppe camel dromedary population, respectively. The slaughter yield for the Sahraoui population was 14.84%, which is similar to results noted by Benyoucef & Bouzegag (2006**)** and Babelhadj *et al*. (2016a). According to Benyoucef & Bouzegag (2006)**,** the Sahraoui population is a good milk producer but also fattens quickly.

Table 2 Significance of the differences in the global population of camels

Global	Population	Mean	Std. Deviation	Kruskal–Wallis value			Significance of differences
				Statistic	**number**	**Sig. value**	
Carcass weight (kg)	Global Saharawi	231.1833	64.13373	27.279	60	0.000	**
	Global Reguibi	273.3000	78.27879		60		
	Global steppe camel	272.0917	56.61987		60		
	Global Targui	224.9500	46.14400		60		
Live weight (kg)	Global Saharawi	462.5697	84.38798	21.314	60	0.000	**
	Global Reguibi	475.9948	86.53142		60		
	Global steppe camel	516.9012	68.26755		60		
	Global Targui	466.1368	73.81186		60		
Carcass yield (%)	Global Saharawi	49.5434	7.36800	34.762	60	0.000	**
	Global Reguibi	56.9145	9.32106		60		
	Global steppe camel	52.6458	8.49931		60		
	Global Targui	48.1278	6.11366		60		

Table 3 Source of the differences in the global population

	Population	Mean	Std. Deviation	Adj-Sig	Significance of differences
Carcass weight (kg)	Global Targui	224.9500	46.14400	0.004	** Reguibi
	Global Reguibi	273.3000	78.27879		
	Global Targui	224.9500	46.14400	0.000	** Steppe camel
	Global steppe camel	272.0917	56.61987		
	Global Saharawi	231.1833	64.13373	0.008	** Reguibi
	Global Reguibi	273.3000	78.27879		
	Global Saharawi	231.1833	64.13373	0.001	** Steppe camel
	Global steppe camel	272.0917	56.61987		
		Mean	Std. Deviation	Adj-Sig	Significance of differences
Live weight (kg)	Global Saharawi	462.5697	84.38798	0.000	** Steppe camel
	Global Steppe camel	516.9012	68.26755		
	Global Targui	466.1368	73.81186	0.001	** Steppe camel
	Global Steppe camel	516.9012	68.26755		
	Global Reguibi	475.9948	86.53142	0.008	** Steppe camel
	Global Steppe camel	516.9012	68.26755		
		Mean	Std. Deviation	Adj-Sig	Significance of differences
Carcass yield (kg)	Global Targui	48.1278	6.11366	0.005	** Steppe camel
	Global Steppe camel	52.6458	8.49931		
	Global Targui	48.1278	6.11366	0.000	** Reguibi
	Global Reguibi	56.9145	9.32106		
	Global Saharawi	49.5434	7.36800	0.000	** Reguibi
	Global Reguibi	56.9145	9.32106		

According to Babelhadj *et al*. (2021), males are heavier whereas females are lighter in the three populations, Sahraoui, Targui, and steppe. Targui is the largest, the steppe camel is the smallest, and Sahraoui has an intermediate situation. Harek *et al*. (2017) state that the steppe population was smaller and lighter than the Targui and Sahraoui populations.

The average slaughter yields for the total population were 49.46% for Sahraoui and 47.99% for the Targui population. These results are consistent with those recorded by Babelhadj *et al*. (2021) (49.5% and 48.2% for Sahraoui and Targui, respectively). Reguibi and steppe showed the highest average slaughter yields with 56.84% and 52.57%, respectively. These results are correct for the four populations as the average live weights were 462.04 kg (Sahraoui), 466.15 kg (Targui), 476.61 kg

(Reguibi), and 516.11 kg (Steppe). According to Babelhadj *et al*. (2021), animals from the Sahraoui population are of certain interest as they make better use of lignocellulosic forages in Saharan pastures compared to the Sahraoui and Targui populations. The Reguibi population in the current study demonstrated this, followed by the steppe camel population. the current study shows that there are differences (P <0.05) between the populations of camel for carcass weight (P < 0.01), live weight (P < 0.01), and carcass yield (P < 0.01) (Table 2). There was a difference in favour of the Reguibi population from the Targui and Sahraoui populations (P <0.05) and steppe camels were different from the Targui, Sahraoui, and Reguibi populations (P <0.05) The results of this study confirmed that the camel population had an effect on the weight parameters (Table 3).
A high carcass yield is generally preferred as it indicates that the animal has been well-fed and well-developed, thus resulting in more usable meat.

CONCLUSION

In conclusion, the live weight of animals at slaughter exhibits variability, attributed to biological factors such as age and sex. This variability results in heterogeneity in carcass weights. Older and heavier animals demonstrate better yield. Reguibi and Steppe dromedaries show higher slaughter yields, making them more productive for meat production. This study aims to inform breeders and industry stakeholders, offering insights to enhance production efficiency, reduce waste, maintain quality standards, and minimize environmental impact. Such research supports sustainable and responsible breeding practices.

Author contributions

1. Research design: Baaissa BABELHADJ
2. Data collection: Elhadi OUDINI and Rihab ARICHE
3. Data analysis: Atika BENAISSA and Yamina MIMOUNI
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5. Writing of the article: Atika BENAISSA and Baaissa BABELHADJ
6. Revision and correction: Claude CUINTARD, Rania RIDOUH, Faiza TEKKOUK-ZEMMOUCHI and Madjed DIB
7. Validation and responsibility: Baaissa BABELHADJ

Conflicts of interest

The authors declare no conflict of interest for this manuscript

References

Abdelhadi, O.M.A., Babiker, S.A., Bauchart, D., Listrat, A., Remond, D., Hocquette, J.F., Faye, B., 2017. Effect of sex on quality and nutritive value of dromedary camel (*Camelus dromedarius*) *Longissimus lumborum* muscle. Journal of the Saudi Society of Agricultural Sciences, 16, 242–249.

Ayyash, M., Liu, S-Q., Al Mheiri, A., Althamer, M., Raeisi, B., Al-Nabulsi, A., Osaili, T., Olaimat, A., 2019. *In vitro* investigation of health-promoting benefits of fermented camel sausage by novel probiotic *Lactobacillus plantarum*: A comparative study with beef sausages. LWT - Food Sci Tech. 99, 346–354.

Babelhadj, B., Adamou, A., Tekkouk-Zemmouchi, F., Benaissa, A., Guintard, C., 2016a. Biometric study of camels from two Algerian populations: the Saharaoui and the Targui (*Camelus dromedarius*, L.). Livest. Res. Rural Dev., 28:30.

Babelhadj, B., Adamou, A., Thorin, C., Tekkouk-Zemmouchi, F., Benaissa, A., Guintard, C., 2016b. Comparative osteo-biometric study of Saharaoui and Targui camel “breeds” (*Camelus dromedarius* L., 1758). Rev. Med. Vet., 167 (3-4): 77–92.

Babelhadj, B., Guintard, C., Benaissa, A., Thorin, C., 2021. Biometric characterization of the steppe camel (*Camelus dromedarius* Linnaeus 1758) in Algeria. Rev. Elev. Med. Vet. Pays Trop., 74 (1): 37–42, doi: 10.19182/remvt.36326.

Benaissa, R., 1989. The dromedary in Algeria, CIHEAM - Mediterranean Options, Series A Seminars, 2: 19–28.

Benyoucef, M. T., Bouzegag, B., 2006. Results of study of the quality of the meat of two camel breeds (Targui and Sahraoui) in Ouargla and Tamanrasset (Algeria), 27(1–2), 37–53.

Boue, A., 1949**.** Barymetry test in the North African dromedary. J Breed Vet Med Trop Count. 1(3), 13–16.

Denis, B., Digard, J.P., 2019. What future for camels and camels in Africa, Asia, and elsewhere? In: History and News Camelids of Africa and Asia, *Ethnozootechny* 106, 5.

Ezzahiri, A., 1988. Breeds of camels reared in the Ouazazate area, http://www.tarbiatlaksiba.com/elevagecamelin/les-races-des-dromadaires-lev-es-dans-la-zone-de-ouarzazate.pdf

Guintard, C., Babelhadj, B., 2018. Morphotypes and developed animal strength. Comparison of two populations of Algerian dromedaries: the Saharawi and the Targui (*Camelus dromedarius*, L.). In: Animal Source of Energy, Investigations in pre-industrial Europe, Guizard F., Beck C. (Dir.), Presses University of Valenciennes, France, pp. 133–147.

Harek, D., Ikhlef, H., Bouhadad, R., Sahel, H., Cherifi, Y., Djellout, N., Khelifa Chelihi, S., *et al*., 2017. Genetic diversity status of Camel's resources (*Camelus dromedarius* Linnaeus, 1758) in Algeria. Gen. Biodiv. J., 1 (1), 43–65.

Messaoudi, B., 1999. Update on camel breeding in Algeria:The first days of camel research. Ouargla, 25–27 May,1999. Pp. 13–14.

Meyer, C., 2014 Dictionnaire des Sciences Animales. Ed., Cirad Montpellier, France. http://dico-sciences-animales.cirad.fr/

Popova, T., Tejeda, L., Penarrieta, J.M., Smith, M.A., Bush, R.D., Hopkins, D.L., 2021. Meat of South American camelids - Sensory quality and nutritional composition. Meat Sci. 171, 108285.