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Growth Performance, Body Measurements and Live Weight Estimation of *Tülü* (Bactrian × Dromedary F1) Calves from Birth to Six Months of Age

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ABSTRACT

A hybrid camel *Tülü* (Bactrian male x Dromedary female F1) males are preferred in camel wrestling, which is a culture unique to Anatolia. In this study, changes of live weight (LW), daily weight gain (DWG), and body measurements (BMs) of *Tülü* calves in the first 6 months of age in a farm in Aydın province, Türkiye, were determined as well as developing equations to estimate LW from body measurements. *Tülü* calves average birth weight (BW) was 34.7±1.80 kg and reached 175.3±3.38 kg at the age of 6 months with a 0.768±0.03 kg DWG during this time. Although the monthly total weight gains and monthly DWG averages of the calves in the first 6 months were similar, the changes in monthly LW and BMs were statistically significant (P<0.01). Abdominal girth (AG) alone can be used to predict LW in the analysis performed to estimate LW from body measurements by stepwise regression (R^2=95.62%). In conclusion, *Tülü* calves had relatively high growth rate in their first six months of age, and unlike other livestock species, instead of hearth girth (HG), AG that includes the hump can be used to estimate LW of *Tülü* calves.

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Introduction

Bactrian and Dromedary camels have been reared in Anatolia, Türkiye for centuries, partially as pure breed, mostly as hybrids between the two species, notably for wrestling, an activity dating back to BC and nowadays, organized in 100 cities and towns in Western Anatolia, living both in rural areas and in large settlements (Çalışkan, 2016; Ertürk and Şanlı, 2018). After a dramatic decrease by 97% from 1960 to 2000 (Faye, 2020), the Turkish camel population has increased for the last twenty years, mainly due to the growing popularity of camel wrestling and more recently, to the emerging dairy production.

It is assumed that camel breeding in Türkiye is practiced more for the camel wrestling than for the products obtained from camels (meat, milk, leather, etc.) (Yılmaz et al., 2022). The increasing popularity of camel wrestling in Türkiye encourages more people to participate in wrestling. It has become a social activity in which men, women and children participate as a family. For this purpose, it was important to get strong animal with solid skeleton and imposing muscular mass. The heterosis effect occurring in hybridization between Bactrian and dromedary camels allows getting, "hybrids", better than the pure two species in terms of size, bone strength (thickness), muscle development, and adaptation to environmental conditions (Yarkın, 1965). The first generation (hybrid F1 Bactrian ♂ x dromedary ♀) is regarded as the most valuable animal for work and wrestling ability (Dioli, 2020). Although the term "hybrid" is commonly used, the two genitors of F1 belonging to the same genus *Camelus*, and the product of the crossing being fertile, the hybrid named *Tülü* in Turkish language, is a crossbreed rather than a true hybrid (Faye and Konuspayeva, 2012). Only male *Tülü* is used for wrestling where it is called "*Besrek*". Usually, F1 hybrid male camels were brought to Türkiye legally or illegally from Iran, Afghanistan and Syria (Koç et al., 2022). However, some Turkish camel breeders aimed to produce wrestling camels in their farms instead of bringing them from abroad.

Camel breeders want to know if hybrid F1 male calves will be a good wrestler in the future. Although each wrestling camel has its wrestling style (arm taking, tying, arm tying, fork tie, rubbing scruff, flapping, hook, overlay hook, etc.), some camel riders believe that the front legs should be long because it provides an advantage over their opponents during wrestling. Since it is allowed to wrestle camels from the age of 7 years (Manav et al., 2018), studies on whether a male *Tülü* will be a good wrestler while he is still in the calf stage can be put forward with a long-term research that will enable the participation of many camels.

Breeders also want to take advantage of some practical measurements to be recorded on the animal to know and estimate the live weight (LW) and growth of the animals if they are unable to weigh them. For this purpose, there are various LW estimation equations proposed in camels (Boué, 1949; Graber, 1966; Wilson, 1978; Field, 1979; Bucci et al., 1984; Abouheif et al., 1986; Yagil, 1994; Patel et al., 2007; Ihuthia, 2010; Koç et al., 2022). Kadim and Mahgoub (2013) stated that some body measurements (BM) such as shoulder height (SH), heart girth (HG) and abdominal girth (AG) are used to estimate the live weight of camels. Although equations for LW estimation in camels of different ages have been developed, Schwartz et al. (1983), Simpkin (1983), Bissa et al. (1998), Kamoun (2004), Kuria et al. (2007) and Ihuthia (2010) have developed LW estimation equations for young camels. In addition, without touching or disturbing the animal some morphological measurements of camels with three dimensional modelling method were also determined (Çağlı and Yılmaz, 2021), but a suggested formula to estimate LW for *Tülü*'s was not found among these studies.

The present stud aimed to determine the growth performances of *Tülü* calves up to 6 months of age, by weighing live weights and taking various BMs monthly. At the same time, correlation coefficients between LW, monthly weight gain (MWG), daily weight gain (DWG), and BMs were determined, and the equations for the estimation of LW from BMs were derived.

Material and Methods

This study was conducted on a camel farm in İncirliova/Aydın, Türkiye. Twenty-one *Tülü* calves, 14 of them male and 7 of them female, born from 2017 to 2021, were weighed and measured monthly until the 6th month of age between 10:00-12:00 before milking to determine LW, MWG, and DWG. The birth weight (BW) of calves and their BMs were taken within 24 hours after birth. A 2000 kg digital scale with 0.5 kg precision and a measuring meter and a 30 cm ruler were used for weighing and taking their BMs. BMs on calves were taken as described in Koç et al. (2022). The measurements taken are wither height (WH), rump height (RH), abdominal height (AH), body length (BL), hearth girth (HG), abdominal girth (AG), arm length (AL), neck length (NL), tail length (TL), rump width (RW) and shoulder width (SW).

The mothers of all calves were dromedary, sired with Bactrian bulls. In this camel farm, natural service was used, the Bactrian male being left in the group compartment with the non-pregnant camels, where he mates several times with the females showing heat. Mating season is prolonged from December to May.

Pregnant camels were kept in a pasture owned by the farmer between April and December, and when the weather got cooler, the animals were moved to the shelter and fed intensively. Pregnant camels, whose parturition approached, were moved to the individual birth pen, and after giving birth, they were housed with their calves in this pen until they reached approximately 2-3 months old. *Tülü* calves are accustomed to suckling their mothers after birth, so that they received colostrum and are fed accordingly.

Tülü calves were separated from their mothers at night after they were 2-3 months old, and they were kept apart until milking at 12:00-13:00 on the next day. With the start of milking time, the calf is provided to reach its mother to pre-stimulate her before milking. Then, the camel is milked by preventing the calf from suckling. Camels were milked with a mobile milking machine in the barn, but the residual milk was not collected and left to the calf. The calf, which remains with its mother for a while, is then separated and housed in a separate group compartment until milking the next day. The camel whose offspring died continued to be milked, so that it did not dry off, oxytocin being used for a week to stimulate milking.

Since their mothers will be used for milk production, when the calves reach the age of 2-3 months, calf starters produced for dairy cattle calves are given to them. They also consumed dry alfalfa grass that was constantly in front of them as roughage. The water requirements of the calves were met in the trough in front of them.

Statistical Analysis

The SAS (9.4) package program was used to analyze the data. The subgroups were compared according to Tukey test ($P<0.05$). Since the number of calves born in 2017, 2018, and 2019 was low, the data for these years have been combined. The statistical model used in the analysis of weight and BMs was as follows:

$$Y_{ijkl} = \mu + a_i + b_j + c_k + e_{ijkl}$$

Where

Y_{ijkl} : the observation value of the traits,
μ : the overall mean of the traits,
a_i : the effect of the year (I= ≤2019, 2020, 2021),
b_j : the effect of sex (j= male, female),
c_k : the effect of age as month (k= birth, 1, 2, 3, 4, 5 and 6 mo),
e_{ijkl} : the error term.

In addition, the correlation coefficients (Pearson correlation) between the traits were calculated and by using MINITAB 13.0 stepwise regression procedure, five equations to estimate LW from BMs were developed.

Results and Discussion

Birth weight (BW) did not vary significantly between years (Table 1). While the effect of age was found to be statistically significant ($P<0.01$) for all traits except MWG and DWG, the effect of sex was significant ($P<0.05$) only for NL and HG, while the effect of year was significant for LW ($P<0.05$), AH ($P<0.01$), NL ($P<0.01$), SW ($P<0.05$) and TL ($P<0.05$).

Tülü calves with a BW of 34.7±1.80 kg achieved an average of 23.38±0.87 kg per month and an average of 0.768±0.03 kg per day, reaching a weight of 114.5±3.18 kg at the age of third month and a weight of 175.3±3.38 kg at the age of sixth month (Table 1).

The first six-month, DWG average of those born in or before 2019 (0.831±0.06 kg) was found to be higher than those born in 2020 (0.748±0.04 kg) and 2021 (0.691±0.08 kg). In addition to the difference between the years, the fathers of the calves born in 2017-2018 on the farm was differed from those of calves born in 2019 and following years. Indeed, the Bactrian bull used for mating is generally changed every 5 years.

Table 1. Live weight (LW), monthly weight gain (MWG), daily weight gain (DWG), and body measurements of *Tülü* calves up to six months of age

Factor	n	LW	MWG	DWG	WH	RH	AH	AG
Year		*	NS	NS	NS	NS	**	NS
≤2019	23	114.0±1.77[a]	25.2±1.60	0.831±0.06	126.0±0.96	122.6±0.77	137.0±1.12[ab]	135.2±1.48
2020	32	108.8±1.54[b]	22.8±1.28	0.748±0.04	126.5±0.84	124.0±0.67	140.2±0.97[a]	139.1±1.29
2021	18	107.6±2.41[b]	20.3±2.25	0.691±0.08	124.9±1.32	123.0±1.05	134.9±1.53[b]	135.7±2.02
Sex		NS	NS	NS	NS	NS	NS	NS
Male	52	112.1±1.30	22.2±1.16	0.742±0.04	125.8±0.71	123.0±0.57	137.3±0.83	136.0±1.09
Female	21	108.2±1.95	23.3±1.76	0.771±0.06	125.8±1.06	123.3±0.85	137.5±1.24	137.3±1.64
Age, mo		**	NS	NS	**	**	**	**
Birth	21	34.7±1.80[a]	-	-	105.0±0.98[a]	102.5±0.78[a]	107.2±1.14[a]	78.9±1.51[a]
1	16	60.6±2.05[b]	24.4±1.56	0.788±0.05	114.8±1.12[b]	112.7±0.90[b]	123.3±1.30[b]	107.9±1.72[b]
2	11	88.7±2.48[c]	27.7±1.95	0.893±0.07	122.8±1.35[c]	120.8±1.08[c]	132.9±1.57[c]	126.9±2.08[c]
3	7	114.5±3.18[d]	21.7±2.44	0.738±0.08	128.7±1.73[cd]	126.1±1.09[d]	142.1±2.02[d]	142.7±2.66[d]
4	6	139.1±3.38[e]	24.3±2.58	0.796±0.09	131.8±1.84[de]	128.7±1.48[de]	147.1±2.14[de]	158.1±2.84[e]
5	6	158.0±3.38[f]	18.3±2.58	0.641±0.09	137.1±1.84[ef]	133.4±1.48[ef]	152.3±2.14[ef]	166.3±2.84[ef]
6	6	175.3±3.38[g]	20.3±2.58	0.686±0.09	140.5±1.84[f]	138.0±1.48[f]	156.8±2.14[f]	175.9±2.84[f]
Overall	73		23.38±0.87	0.768±0.03	119.99±1.55	117.42±1.49	129.49±2.22	120.36±4.10

Factor	n	BL	NL	HG	SW	AL	RW	TL
Year		NS	**	NS	*	NS	NS	*
≤2019	23	88.1±1.12	54.1±1.02[a]	118.1±1.18	17.6±0.57[a]	101.2±1.20	14.1±0.34	42.9±0.66[ab]
2020	32	87.4±0.97	55.4±0.89[a]	120.1±1.03	19.5±0.50[b]	104.2±1.04	14.1±0.30	42.9±0.58[a]
2021	18	85.7±1.52	59.9±1.39[b]	118.0±1.61	19.2±0.78[ab]	103.6±1.64	13.8±0.46	45.2±0.90[b]
Sex		NS	*	*	NS	NS	NS	NS
Male	52	87.7±0.82	57.7±0.75[a]	120.3±0.87[a]	19.0±0.42	102.8±0.88	13.7±0.25	43.5±0.49
Female	21	86.5±1.23	55.2±1.13[b]	117.2±1.30[b]	18.5±0.63	103.2±1.33	13.7±0.38	43.8±0.73
Age, m		**	**	**	**	**	**	**
Birth	21	60.6±1.13[a]	41.9±1.03[a]	80.6±1.20[a]	13.4±0.58[a]	88.0±1.22[a]	9.8±0.35[a]	32.7±0.67[a]
1	16	74.3±1.30[b]	47.4±1.18[b]	100.8±1.37[b]	16.5±0.67[b]	97.0±1.39[b]	12.3±0.40[b]	38.0±0.78[b]
2	11	88.7±1.57[c]	50.3±1.43[b]	113.8±1.66[c]	19.0±0.81[bc]	99.9±1.69[bc]	14.1±0.48[bc]	40.4±0.93[bc]
3	7	88.9±2.01[cd]	60.5±1.83[c]	124.9±2.12[d]	19.4±1.03[bc]	105.3±2.16[cd]	13.7±0.61[bc]	44.7±1.19[cd]
4	6	96.4±2.14[de]	61.8±1.95[c]	132.4±2.26[de]	19.8±1.10[bc]	106.9±2.30[cd]	13.8±0.65[bc]	48.5±1.27[de]
5	6	102.6±2.14[e]	65.6±1.95[c]	137.8±2.26[e]	21.2±1.10[c]	111.7±2.30[d]	14.9±0.65[cd]	49.5±1.27[e]
6	6	104.2±2.14[e]	67.8±1.95[c]	140.9±2.26[e]	22.0±1.10[c]	112.2±2.30[d]	17.1±0.65[d]	51.8±1.27[e]
Overall	73	80.01±1.92	52.03±1.16	109.10±2.67	17.55±0.47	98.93±1.19	12.63±0.30	40.15±0.81

WH: wither height, RH: rump height, AH: abdominal height, AG: abdominal girth, BL: Body length, NL: neck length, HG: hearth girth, SW: shoulder width, AL: arm length, RW: rump width, TL: tail length, LW: live weight, MWG: monthly weight gain, DWG: daily weight gain.

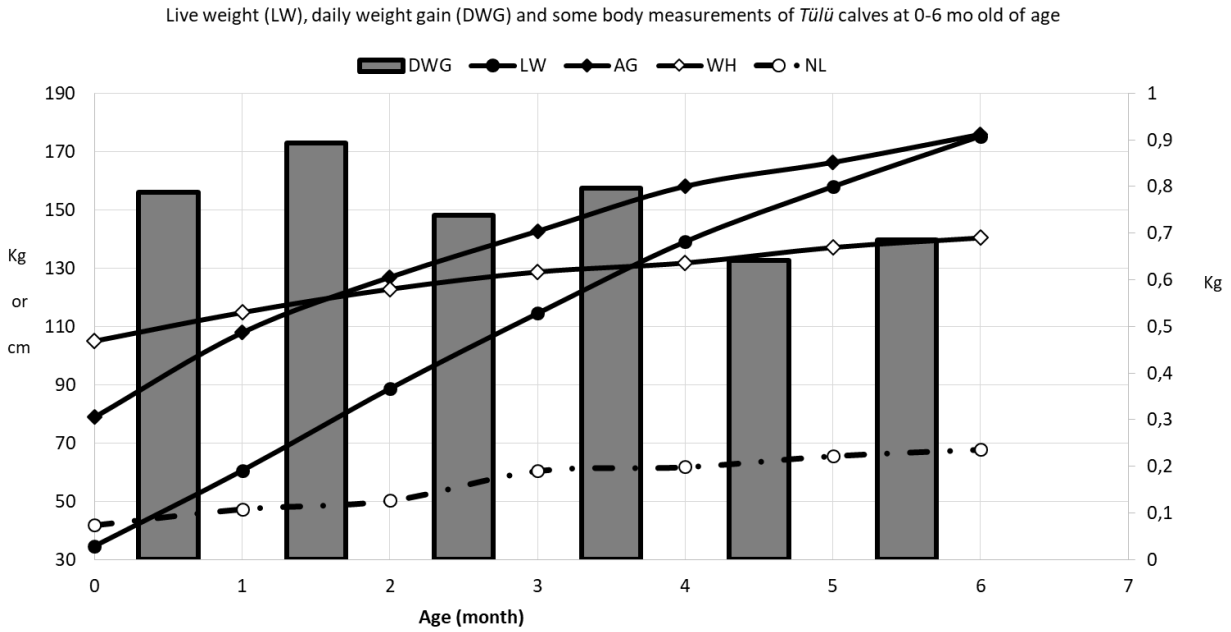

Figure 1. Changes of live weight (LW), daily weight gain (DWG), wither height (WH), abdominal girth (AG) and neck length (NL) in Tülü calves from birth to 6 months of age.

The monthly changes of LW, DWG, WH, AG, and NL in *Tülü* calves from birth to 6 months of age, reported in Figure 1, show that although DWG was high in the first two months, a fluctuating course occurred in the later months, then a decrease was observed due to the restriction of milk feeding, the calves being used only for stimulating their mothers for milking by their presence. Although the differences between the months were statistically not significant, DWG, which was 788 g in the first month, increased to 893 g in the second month, then decreased below 800 g in the third and fourth months, and below 700 g in the fifth and sixth months (Figure 1).

Unlike other farm animals, apart from hump, camels also have a long neck. Their NL, which was 41.9±1.03 cm at birth, reached 67.8±1.95 cm at the age of six months. On the other hand, front leg lengths increased from 88.0±1.22 cm at birth to 112.2±2.30 cm in the 6th month of age.

Weights at Different Age

Birth weight (BW): Season (i.e. photoperiod), which has a significant effect on reproductive traits, also affects fetal development in camels (Nagy and Juhasz, 2019). These researchers stated that the mother camel is the factor with the greatest influence on birth weight, followed by parity, year, and month of birth, but the share of mother breed, gender, sire, gestation length and maternal age is lower. Kadim and Mahgoub (2013), suggested that the heritability of BW in camels was higher than in other meat species, and that high BW, which is affected by the sum of the factors contributing to the nutrition of the fetus in the uterus, results in higher calf viability and higher growth rate.

In the present study, BW obtained for *Tülü* calves (34.7±1.80 kg) was determined to be higher than the values reported for dromedary calves in some previous studies (Harmas et al., 1990; Hammadi et al., 2001; Bakheit et al., 2009). The BW mean obtained in our study was close to the means reported for dromedary calves in UAE: Nagy and Juhasz (2019) reported 34.5±0.09 kg, and Bene et al. (2020) reported 34.75 ± 5.67 kg. Koç et al. (2022) stated that the birth weight of F1 *Tülü* calves ranged from 26 kg to 51 kg and calculated the BW in *Tülü* calves in Türkiye as 35.99±1.25 kg on average, slightly higher than the average BW obtained in the present study. Nagy and Juhasz (2019), stated that the birth weight of dromedary camel ranged between 10 and 64 kg from 3909 data belonging to 6 different genotypes from the records kept for 10 years in a farm in Dubai.

The average BW in Indian camels was 39 kg (Bissa, 1996) and Sabahat et al. (2021) stated that BW in dromedary camels showed significant variation according to the regions, breed and within breed, and reported an average of 35 kg. According to Hammadi et al. (2001) BW in camels was affected by the level of feeding and reported that females receiving supplement feeding in Tunisian dromedary camels had 8 kg higher BW in their calves (31±4 kg) than those having no supplement (23±2 kg).

The BW average obtained for *Tülü* calves in the present study was lower than the average reported by Dioli (2020) for hybrid F1 camels (45.4 kg) which was higher than the average for dromedary and Bactrian calves. He also stated that hybrid F1 camels had higher growth rates. Fatih et al. (2021) reported BW of eight different Pakistani camel breeds (Bravhi, Kachi, Kharani, Kohi, Lassi, Makrani, Pishin and Rodbari) ranged from 37.24 kg to 47.29 kg in females and 40.08 to 50.27 kg in males. These authors determined that BW means of these breeds were higher than the average obtained for *Tülü* calves in the present study.

The average BW observed here was also lower than the mean reported by Sahani et al. (1998) for Indian (indigenous) and semi-intensive reared Bikaneri (38.20±0.47 kg), Jaisalmeri (36.46±0.61 kg) and Kachchhi (35.13±0.64 kg) breeds. In a study of Bactrian camels in China, Zhao et al. (2000) reported slightly lower BW (34.55±7.17 kg) than the value found for *Tülü*s in our present study.

Three-month LW (114.5±3.18 kg) and six-month LW (175.3±3.38 kg) averages of *Tülü* calves determined in the present study were higher than the averages reported by Sahani et al. (1998) for Indian Bikaneri (89.095±1.57 kg and 150.27±1.45 kg), Jaisalmeri (87.172±1.81 kg and 146.22±1.69) and Kachchhi (89.085±2.92 kg and 144.43±1.63 kg) breeds at the same age. It was also higher than Chinese Bactrian camels reported by Zhao et al. (2000): three- and six-month LW in Bactrian camels were 91.83±10.48 kg and 140.6±19.63 kg, respectively.

The mean LW obtained for three-month-old *Tülü* calves observed in our study was also higher than Tunisian dromedary calves reported by Hammadi et al. (2001) who found 79 kg. However, it was slightly lower than Indian dromedary calves (119 kg) at the same age according to Bissa et al. (1998). Besides, the average 6-months LW in our study was slightly higher than the value (171 kg) reported by the same author.

In traditional camel farming systems worldwide calves suckle their mothers after birth, and weaning usually occurred between 3 months and 12 months (Faye et al., 2021) or even more. In our monitored farm, the weaning age reached over12 months and the lactating camels were milked depending on the demand for milk. Thus, the milking was not complete. Important residual milk was left to the calf. The milk yield of the mother is consequently underestimated, and the amount of residual milk suckled by the camel calf could significantly effect on its growth performance. Thus, if globally, the birth weight of *Tülü* camel calf was not exceptional, the growth appeared interesting at least until 6 months of age. The results regarding daily weight gain confirm this.

Daily Weight Gain

As with other livestock species, the nutritional status or dietary energy and protein content of camels have a significant impact on their growth performance. In camels, the growth curve is sigmoidal (Kadim and Mahgoub, 2013) and they have an inflection point at the age of 7-8 years (Kadim et al., 2008).

DWG mean found in this study was 0.768±0.03 kg and varied between 0.641±0.09 kg and 0.893±0.07 for *Tülü* calves in the first six months and these values were detected to be higher than the overall means of Bikaneri, Jaisalmeri, and Kachchhi camels in India reported by Sahani et al. (1998): 0.605 ± 186 kg/day from birth to 3 mo of age and, 0.627 ± 0.014 kg from 3 to 6 mo of age. Such difference could be due to the heterosis effect mentioned above and to the more intensive feeding conditions.

Table 2. Correlation coefficients between live weight, monthly weight gain, daily weight gain, and body measurements of *Tülü* calves from birth to six months of age

	RH	AH	AG	BL	NL	HG
WH	0.973**	0.972**	0.947**	0.910**	0.853**	0.937**
RH		0.972**	0.957**	0.916**	0.839**	0.942**
AH			0.972**	0.924**	0.832**	0.959**
AG				0.951**	0.852**	0.977**
BL					0.807**	0.929**
NL						0.867*
HG						
SW						
AL						
RW						
TL						
LW						
MWG						

	SW	AL	RW	TL	LW	MWG	DWG
WH	0.765**	0.900**	0.774**	0.873**	0.949**	-0.075	-0.044
RH	0.759**	0.900**	0.775**	0.867**	0.948**	-0.160	-0.124
AH	0.781**	0.900**	0.768**	0.889**	0.955**	-0.128	-0.100
AG	0.753**	0.860**	0.744**	0.915**	0.976**	-0.099	-0.063
BL	0.695**	0.804**	0.689**	0.883**	0.942**	-0.141	-0.107
NL	0.630**	0.818**	0.695**	0.875**	0.862**	-0.236	-0.121
HG	0.775**	0.840**	0.737**	0.905**	0.959**	-0.167	-0.111
SW		0.772**	0.577**	0.638**	0.717**	-0.101	-0.062
AL			0.736**	0.815**	0.838**	-0.134	-0.120
RW				0.718**	0.757**	-0.046	-0.019
TL					0.911**	-0.169	-0.105
LW						-0.121	-0.072
MWG							0.938**

WH: wither height, RH: rump height, AH: abdominal height, AG: abdominal girth, BL: Body length, NL: neck length, HG: hearth girth, SW: shoulder width, AL: arm length, RW: rump width, TL: tail length, LW: live weight, MWG: monthly weight gain, DWG: daily weight gain

Table 3. Equations developed by using body measurements for predicting live weight of *Tülü* calves up to six months of age

	Equations	R^2	Std. Deviation
1	LW = -76.59 + 1.36 AG	95.31	10.6
2	LW = -145.28 + 1.04 AG + 0.89 WH	95.91	10.0
3	LW= -133.89 + 1.05 AG + 1.28 WH -0.59 AL	96.20	9.73
4	LW = -130.17 + 1.00 AG + 1.19 WH - 0.72 AL + 0.50 NL	96.45	9.47
5	LW= -134.76 + 1.02 AG + 1.27 WH -0.66 AL +0.45 NL- 0.70 SW	96.58	9.36

LW: live weight, AG: abdominal girth, WH: wither height, AL: arm length, NL: neck length, SW: shoulder width.

DWG average in our study for the first six months was higher also than the results (between 0.500 and 0.605 kg/day) reported by Field (1979), Wilson (1992), Hammadi et al. (2001), Musavaya (2003), Ihuthia (2010), but comparable (0.733-0.760 kg) to the observations of Kamoun (1993), Bissa (1996), El-Badawi (1996), Khanna et al. (2004) and Iqbal et al. (2001) in dromedary calves. It was also higher than Chinese Bactrian calves (Zhao et al., 2000). For example, the 6-month DWG was 0.500 kg/day only for Zarrin et al. (2020).

Similar to DWG obtained in *Tülü* calves in the first months of the present study, Hammadi et al. (2001) found an average DWG of 0.806 kg/day in camel calves issued from females supplemented from parturition to 90 days' post-partum, *vs* 0.376 kg only in non-supplemented.

In another study, Khanna et al. (2004) reported that DWG of Indian Jaisalmeri and Bikaneri breeds between 0-3 months of age was 0.700 and 0.770 kg, respectively, which was close to DWG of *Tülü* calves in the first and third months and but lower than the mean observed in the second month in our study. Musavaya (2003) determined that DWG in Kenya dromedary calves was 0.411 kg and 0.380 kg in males and females, respectively, much lower than our results. Under appropriate feeding conditions in Kenya dromedary calves, Wilson (1992) reported 0.870 kg DWG in the first month that is higher than the value (0.795±0.052 kg) obtained in our study for the same time, but in the same investigation, DWG up to 6 months was 0.570 kg only that was lower than our results. In Egyptian dromedary camels, El-Badawi (1996) reported higher weight gain from birth to six months of age, except for the weight gain found in the second month of our study, as 0.830-0.970 kg per day.

Although six-months DWG mean obtained in this study was similar to the mean obtained by Iqbal et al. (2001) in Pakistani dromedary camels in the same period, our second-month value (0.893 kg) was higher, but our values for the 4, 5 and 6 months were lower than their values for the same months.

Considerably lower values were reported in Kenyan pastoral system (Ihuthia, 2010) with 8-month DWG of 0.212 kg. Such low performance was attributed to the low milk availability of the mother in relationship with the abundance and quality of pastoral resources. Thus, Field (1979) reported that DWG was 0.222 kg and 0.655 kg during the dry and rainy years, respectively.

Hammadi et al. (2001) stated that small amount of milk is sufficient to provide moderate growth in calves due to the low requirements for nutrients in the first month and added that the milk yield of the mother will have a significant effect on the growth rate in the following months. Kamoun (2004) stated that DWG of camel calves from birth to one-year-old age could reach 1000 g under appropriate management and feeding conditions.

DWG of calves was higher in the period when the mother's milk yield was high, but DWG could be negative in the period when the milk yield decreased (Zhao et al., 2000). For Chinese Bactrian calves, DWG in the third (0.782±0.349 kg) and fifth (0.667±0.17 kg) months was reported by Zhao et al. (2000) to be slightly higher than the averages obtained for *Tülü* calves at the same months in this study, but lower than DWG obtained in the other months.

Correlations

Correlations between LW of *Tülü* calves and BMs were all positive and highly significant (r=0.717-0.976; P<0.01), while there were no significant relationships between LW and MWG and between LW and DWG (Table 2). There were no significant correlations between DWG and MWG with BMs. Correlations between BMs were obviously all positive and highly significant, too.

Unlike this study where the highest correlation was between LW and AG (r=0.976; P<0.05), Koç et al. (2022) calculated the highest correlation between BW and HG (r= 0.782 P<0.05) in *Tülü* calves.

At birth, HG and AG measurements were very close to each other in *Tülü* calves (Table 1). A similar finding was also observed in Koç et al. (2022). In their study on *Tülü* calves, HG was only 0.64 cm longer than AG, while in this study HG was also 1.7 cm longer than AG. When the *Tülü* calves reached the age of 6 months, the AG had a length of 35 cm longer than the HG. It is clear that a large part of this difference is due to the growth of the hump and its filling with fat.

On the other hand, compared to the values at birth, at 6 months of age, as LW increased 5.05 times, AG, HG, RW, BL, SW and NL increased 2.23, 1.75, 1.75, 1.72, 1.64 and 1.62 times, respectively. This shows that the development of tissues and internal organs of *Tülü* calves is different after birth and their share in LW is not the same as at birth.

Live Weight Estimation

Breeders want to know the animals' developmental status and weights at different ages. Knowing LW plays an important role in determining the price of the animal at selling or buying. However, there is no scale for weighing animals in field conditions and in every farms. For this purpose, estimating LW from BMs with various equations is possible.

Five equations developed by stepwise regression to estimate LW of *Tülü* calves from BMs were proposed (Table 3). In the first one, LW was estimated by using AG (R^2=95.31, Std. Dev.=10.6). If WH, AL, NL and SW are used in addition to AG to estimate LW, R^2=96.58 and Std. Dev.=9.36.

Unlike the equation derived in this study, Kuria et al. (2007) stated that HG gave the best estimate in suckling calves. Like this study, Ihuthia (2010) stated that the best single estimator of LW was AG. In a recent comparative study on the accuracy of published equations for estimating LW from BMs in camels, Field (1979) proposed LW estimation equation was reported to be the best option (Boujenane, 2019). Field (1979) proposed an equation estimating LW from WH, HG and AG measurements.

Although Koç et al. (2022) suggested the use of HG alone to predict BW (R^2=61.16) in *Tülü* calves, in this study it was found that HG would be insufficient to predict LW in the following months, and using AG, including hump, would be a more accurate predictor of LW (R^2=95.31).

The equations obtained in our study are valid for *Tülü* calves with a LW ranging between 26 kg and 195.5 kg, and it should be emphasized that the error will be much higher in the estimations to be made using these equations for weights other than these values. Such a situation was described by Devore and Pack (1993) as “danger of extrapolation”.

Conclusion

As well as camels’ wrestling abilities, their body structure also provides important advantages to apply their wrestling style during wrestling and to gain superiority over their opponents. Considering that a wrestling camel starts wrestling at the age of 7 years, deciding whether the animal is a good wrestler by looking at BMs and body weight after birth requires a long-term study involving many animals. By paying attention to the developments and changes in LW and BMs of *Tülü’*s at birth and after, it may be possible to make some inferences about which wrestling styles the wrestling camels can do better in the future. Starting from this point, under intensive conditions, DWG of *Tülü* calves in the first six months of their life has been varied between 641-893 g. Using only AG in estimation of body weight in *Tülü* calves, which considers the hump, and which shows significant improvement after birth and has a significant share in body weight, will increase the accuracy of LW estimation.

Declarations

Conflict of Interest

The authors declare that they have no conflict of interest.

Authors’ Contributions

Atakan Koç: Concept and design of the study, data collection and analysis and writing of the manuscript.

Alkan Çağlı: data collection. All authors read and approved the final manuscript.

Ethical Approval

With the decision of Aydın Adnan Menderes University Animal Experiments Local Ethics Committee (Aydın ADU-HADYEK) numbered 64583101/2022/101, it was stated that "there is no ethical objection to conducting the research".

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Data Availability

The datasets created and/or analyzed during the current studies were obtained within the scope of Scientific Research Projects Commission, Aydın Adnan Menderes University, Türkiye (Project code: ZRF-18013), and the PRIMA program under grant agreement No: 1832 CAMELMILK projects. It is not appropriate to be publicly available until any publication based on it is made, but is available from the corresponding author upon reasonable request.

Consent for Publication

Not applicable.

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