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The relation of both body dimentional and body condition score with milk yield in lactating Egyptian buffaloes

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ABSTRAT:

Twenty Egyptian buffaloes were divided into two groups at the end of the first lactation season according to their lactation period (LP). The first group (G1) was lactated more than seven months (225 days on average) and the second group (G2) was lactated less than seven months (175 days on average). Body measurements were measured three times, at the beginning of the lactation period, after three months of onset lactation and at the beginning of the dry period for each buffalo cow. The body condition score (BCS) was measured during lactating season. BCS system was developed using ultrasonographic measurements of body fat reserves. The average of total milk yield (TMY) was significantly higher in G1 than that in G2 by 36.22%. The higher shoulder height was recorded in mid lactation period in G1. There were significant differences between groups in all skeletal check points. There was a negative correlation between milk yield and chest circle but there was a positive correlation between milk yield and ultra-sonographic fat thickness in lumbar vertebrae and chest.

KEYWORDS: Egyptian buffaloes, milk yield, body measurements, new body condition score system.

1. INTRODUCTION:

Anitha et al. (2011) reported that the concept of (BCS) of dairy animals has gained widespread acceptance as managemental aid in dairy production. A new BCS system was developed for Murrah buffaloes. Edmonson et al. (1989) evaluated the body locations only visually. BCS was assigned using the developed chart and the new BCS system was found to be precise and consistent. Baghdasar (1990) found positive correlation between dimensional body measurements and milk yield. Antanaitis et al. (2021) reported that changes in (BCS) during perpartum have an effect on health and fertility of cattle. Cattle that lose more body mass are more prone to develop diseases during lactation.

The new BCS chart with a 1 to 5 scale having 0.5 increments examining eight skeletal check points was developed to score Murrah buffaloes. For beef cattle, a 9-point scale is commonly used (Wagner et al., 1988) concerning dairy cows, 8 and 10 point scales are used in Australia and New Zealand (Roche et al 2004). The prevailing scoring systems in the United States and Ireland use a 5-point scale (Ferguson et al 1994) where Edmonson et al. (1989) evaluated the body locations only visually. BCS was assigned using the developed chart and the new BCS system was found to be precise and consistent. Thus, the present study was designed to suggest anatomical measurements, amount of fat reserves and the assessment of scores which helped in the development of a valid BCS system for buffaloes.

The aim of the current study was to estimate the relation among body dimensional measurements, body condition score with milk yield and using these relationships to predict milk production in lactating Egyptian buffaloes.

2. MATERIALS AND METHODS:

The experimental work of this study was carried out at the Experimental Station of Animal Production, Faculty of Agriculture, Fayoum University, Fayoum, Egypt.

Experimental animals:

Twenty Egyptian buffaloes were divided into two groups at the end of the first lactation season according to their lactation period (LP). The first group (G1) was lactated more than seven months (225 days on average) and the second group (G2) was lactated less than seven months (175 days on average). Buffaloes were housed in shaded open yards and maintained under the same managerial and environmental conditions. They were fed individually according to NRC (2001). The nutrient requirements were adjusted according to the buffalo`s live body weight (BW), and subsequent milk production of each buffalo. Buffaloes were milked manually twice daily at 6:00 AM and 6:00 PM. The experimental work lasted until the buffaloes stop lactation. Total milk yield (TMY, Kg), daily milk yield (DMY, Kg), weekly milk yield (WMY) and lactation period (LP/day) were recorded for each buffalo alongside.Lactating period was divided to three stages early, mid and late lactation according to Metry et al. (1994).

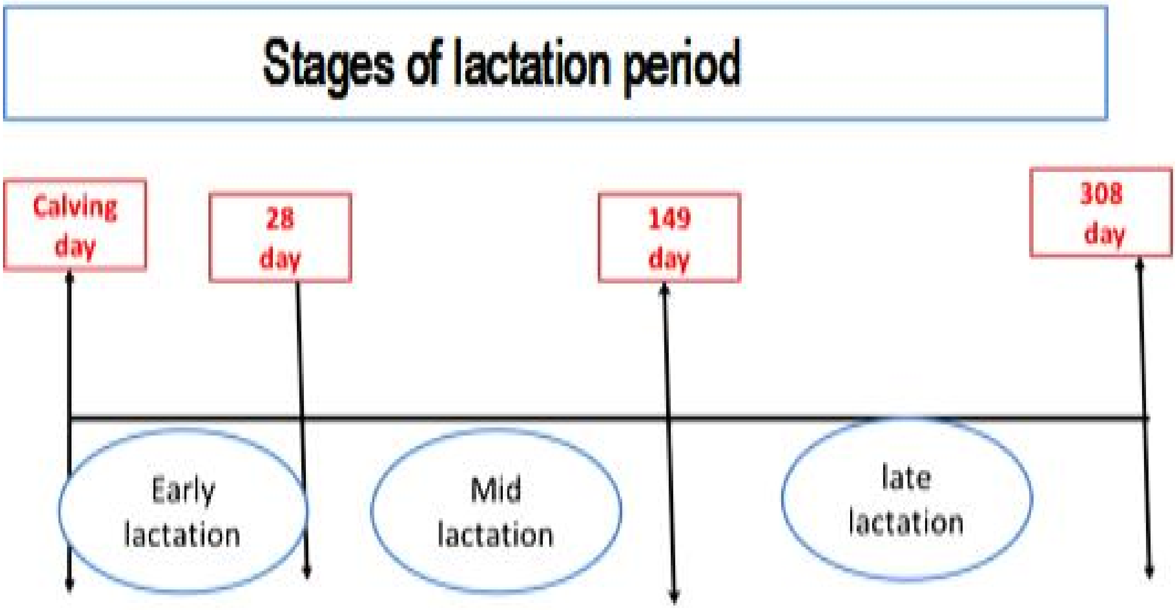

Fig. 1. Stage of lactation in Egyptian lactating buffaloes

Body measurements:
Body measurements were measured three times, at the beginning of the lactation period, after three months of lactation and at the beginning of dry period. The measurements of body (cm) were:-

- Shoulder height (SH): distance from the surface of the soil/platform to the dorsal point of the withers, measured with a stick-rule.
- Height at hip bone (HH)
- Chest circle(CC)):plastic tape drawn around behind the front legs, measured from a point slightly behind the shoulder blade, down the fore ribs.
- Neck length (NL).
- Rump length (RL).
- Shoulder width (SW).
- Ischial tuberosity width (ITW).
- Thigh circumference (TC).

Body measurements were proposed by Abeygunawardena et al. (1999) as shown in Fig (2).

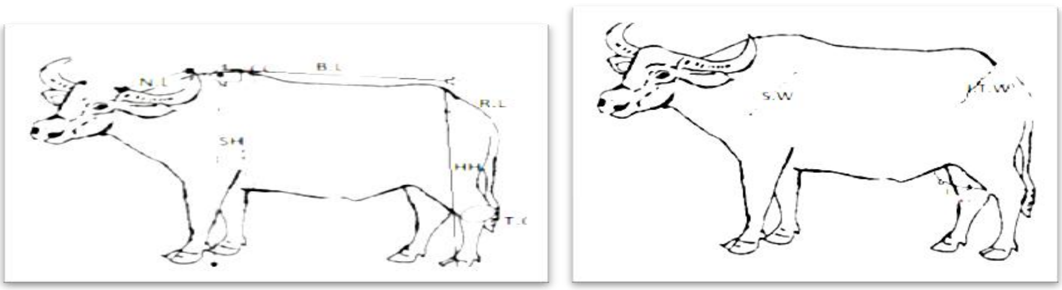

Fig. 2. Linear parameters measuring on body surface of buffaloes used for estimating of body condition score (BCS) and body surface area (BSA). neck length (NL), rump length (RL), shoulder width (SW), ischial tuberosity width (ITW), thigh circumference (TC)

Ultrasonographic assessment of the precision of new body condition score (BCS) system:

The BCS developed system was subjected to test its precision in twenty buffaloes for each point (1, 2, 3, 4, 5 and 6) of the scale by ultrasonographic measurements of body fat reserves. A Body condition score (BCS) was measured at the beginning of lactating season. The BCS and ultrasonographic measurements were obtained independently for the same buffaloes on the same day (Sonoscope A6 vet 2013) with a 5.5 MHz convex transducer that used to determine the amount of subcutaneous fat at six body locations through a coupling gel on each buffalo according to Bruckmaier and Blum, (1992).

Body locations were selected based on the skeletal checkpoints used for body condition scoring and ease of obtaining and reading ultrasonographic measurements Fig (3).

- The first location was the area between the tail head and pin bones;
- The second location was the lumbar area. The transducer was oriented parallel to the midline, midway between the spinous and transverse processes.
- The third location was the area between 12^{th} and 13^{th} ribs.
- The fourth location was the area between the sacral crest and tuber coxae.
- The fifth area was located midway between hooks and pins above the greater trochanter of the femur.
- The sixth area was located in chest area.

Measurements were obtained by freezing the image on the screen of the ultrasound machine and then measuring the layer of subcutaneous fat in the center of the screen (Domecq et al., 1995).

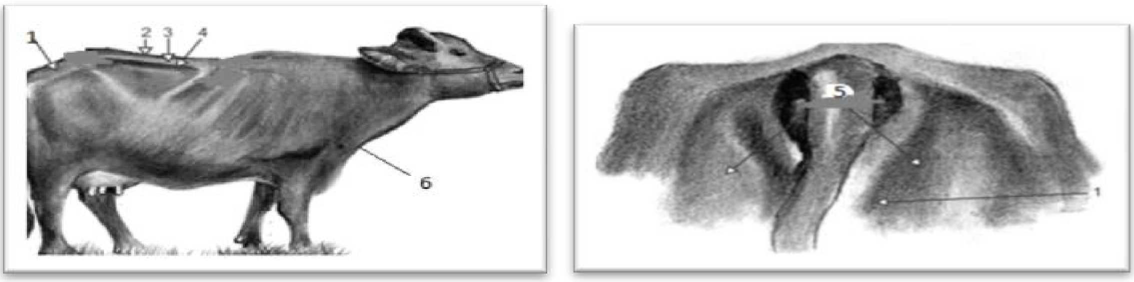

Fig. 3. Picture showing the skeletal check points for body condition score in Egyptian buffalo

Statistical analysis:

General linear model procedure according to SPSS 21 (2012) was used for the statistical analysis of milk yield, body measurements and new body condition score (BCS) system during the experimental period using the following model:

$Y_{ijk} = \mu + P_i + A(P)_{ik} + G_j + (P*G)_{ij} + e_{ijk}$

Where ,

Y_{ijk}= Any observation of k^{th} animals within j^{th} group within i^{th} experimental period.

μ = Overall mean

P_i = Effect of i^{th} period (I = lactation stage)

$A(P)_{ik}$= the repeated of k^{th} animals within i^{th} experimental period.

G_j = Effect of j^{th} group (j = 1-2, 1 = G1 and 2= G2)

$(P*G)ij$= The interaction between experimental periods and groups.

e_{ijk} = Experimental error.

Duncan's multiple range tests were used to compare the differences among means (Duncan's, 1955). Phenotypic correlations were estimated using SPSS (2012) program.

3. RESULTS AND DISCUSSION:

Milk yield:

The average of DMY of lactating Egyptian buffaloes in the present study was higher in G1than that recorded by Abou Zeina et al. (2009) who found that the average of DMY in buffaloes was 3.97 kg but it was lower than that recorded by Farouk (2012) who reported that the average of DMY in buffaloes was 4.5 liters. These results were higher than that reported by Siddiquee et al (2010) who found that the average of daily milk yields were 2.11 and 2.5 liters, respectively for Trishal and Companiganj whereas the peak daily milk yields were 5.03±0.678 and 9.06±1.297 liters, respectively for Trishal and Companiganj and the lowest daily milk yields were 0.75±0.391 and 1.50±0.717 liters, respectively for that regions.

The lowest DMY was observed to be 1 liter and the highest DMY was 5 liters with an average DMY of 2.32±0.63 liters. Mudgal (1987) found that Murrah herds yielded on an average of 1975 liters in a lactation period of 338 days and Nil-Ravi yielded up to 4500 liters or about 10 liters per day. Guglielmetti (2007) reported that in the Chursdorf herd over a 305-day lactation period, milk yield was 2232 kg on average in the first lactation and of2577 kg in the second lactation.

The average DMY of both groups during different lactation stages are presented in Table (1). In this study, the maximum DMY was recorded during the mid-lactation period. It was higher by 32.26% and 30.85% in G1 and by 62.76% and 105.72% in G2 than those in early and late lactation period respectively. Regardless of groups the highly significant DMY was recorded in mid lactation period and it was higher than early and late lactation periods by 43.45% and 55.48%, respectively.

Table 1. Means and standard error of daily milk yield during the three different stages of lactation in Egyptian buffaloes

Groups	Stages of lactation		
	Early	Mid	Late
G1	$3.72^{NS} \pm 0.43$	$4.92^{NS} \pm 0.42$	$3.76^{NS} \pm 0.52$
G2	$2.90^{NS} \pm 0.34$	$4.72^{NS} \pm 0.14$	$2.3^{NS} \pm 0.23$
Average	$3.36^{b}\pm0.29$B	$4.82^{a}\pm0.21$	$3.10^{b}\pm0.37$

Means with different letters in the same row are significantly different, (P<0.05),
NS = not significant, G1 = Group that milked more than 7 months and G2= Group that milked less than 7 months.

Body measurements:

Data in Table (2) showed that SH average was significantly higher in G1 than that in G2 by 5.11%and shoulder height average increased significantly in mid lactation period than that in early and late lactation periods in each group. The higher shoulder height was recorded in mid lactation period in G1. The same trend was recorded in HH. There was a significant increase in G1 thane that in G2 by 5.13% and the highest HH was recorded in the late period in G1. There were not significant difference in CC between groups and the highest CC was recorded in early lactation period in G1concerning NL, there were a significant difference between G1 and G2 by7.4% and the highest NL was recorded in mid lactation period in G1. On the other hand, RL was higher in G2 than that in G1 by 8.57%but among the stages of lactation there was non-significant (P≤0.01) deference among groups. Value of SW was higher in G1 than that in G2 by 17.62% and the higher S.W was recorded in mid and late lactation periods in G1.The ITW was higher in G1 than that G2 by 4.71%.Among the stages of lactation there was non-significant (P≤0.01) deference among groups. Value of TC was higher in G1than that in G2 by 3.19% and their was a significant difference among stages average in TC. The mobilization of reserves is indispensable for maintaining high milk yield following parturition. With advancing lactation, BCS of cattle changes probably responding to changes in their energy balance (Coffey et al2003). This process is correlated to the daily milk yield curve, which is quite precisely opposite to the BCS curves (Coffey et al., 2002 and 2003). These results also supported the present results of body condition mobilization and deposition with increase and decrease in milk production. Our results agree with these of Deshpande et al. (2020) who reported that there were insignificant change in body measurements that might be due to post-natal allometric growth during pre-pubertal period and different growth rate in different body parts.

Table 2. Means and standard error of body measurements (cm) in different groups during the three different stages lactation in Egyptian buffaloes

Body Measurement (cm)	SH	HH	CC	NL	RL	SW	ITW	TC
Early	139.2^{bc}± 0.80	142.2^{ab} ± 0.58	192.20^{a}± 4.45	59.80^{ab}± 2.31	35 ± 2.58	24.80^{ab}± 0.66	51.80± 0.97	70.60^{a}± 1.24
Mid	150.4^{a}± 4.08	142.0^{ab}± 4.5	172.00^{c}± 4.32	62.40^{a}± 2.69	35 ± 2.58	25.80^{a}± 0.73	51.80± 0.97	61.60^{b}± 3.14
late	146.6^{ab}± 2.56	150.4^{a}± 1.8	176.40^{bc} ± 4.31	54.60^{ab}± 1.96	35 ± 2.58	27.60^{a}± 1.81	52.60± 1.43	68.80^{a}± 1.39
G1	145.4^{A}± 1.95	144.87^{A}± 1.83	180.20± 3.29	58.93^{A}± 1.52	35.0^{B}± 1.38	26.07^{A}± 0.70	52.07^{A}± 0.62	67.00^{A}± 1.53
Early	134.6^{c}± 2.71	134.8^{b}± 4.44	188.00^{ab} ± 3.74	58.00^{ab}± 4.08	38 ± 2.98	22.200^{bc}± 0.58	49.40± 1.43	66.00^{ab}± 2.02
Mid	140.8^{abc}± 5.07	140.6^{ab}± 6.34	171.40^{c}± 4.38	54.60^{ab}± 2.44	38 ± 2.98	22.20^{bc}± 0.58	49.40± 1.43	68.80^{a}± 2.66
late	139.6^{bc}± 2.74	138.0^{ab}± 5.09	186.20^{ab} ± 3.91	52.00^{b}± 3.73	38 ± 2.98	21.80^{c}± 0.37	50.40± 1.72	60.00^{b}± 1.2
G2	138.33^{B}± 2.09	137.80^{B}± 2.93	181.87± 2.93	54.87^{B}± 1.97	38.0^{A}± 1.59	22.07^{B}± 0.28	49.73^{B}± 0.83	64.93^{B}± 1.47

G1 = Group that milked more than 7 months, G2= Group that milked less than 7 months, Means with different latters in the stage aresignificantly different, ($P<0.01$).SH = Shoulder height, HH= Height at hip bone, CC= Chest circle, NL= Neck length, RL= Rump length, SW= Shoulder width, ITW= Ischial Tuberosity Width, TC= Thigh circumference.

Body condition score and ultrasonographic fat thickness:

Results in Table (3) show the BCS ultrasonographic fat thickness during the lactation season among groups. There were significant differences among groups in skeletal check points. Between the 12th and 13th ribs fat thickness was significantly higher ($P\leq0.01$) in G1 than that in G2 by 24%. However, lumbar vertebra was significantly higher ($P \leq 0.01$) in G1 than that in G2 by 32%.On the other hand, there was insignificant difference ($P \leq 0.01$) among groups in SC from tail head to pins was significant difference ($P \leq 0.01$).SC from tail head to pins was significantly higher in G1 than that in G2 by 40%.On the other hand there was insignificant different among groups in depression between hooks and pins. Chest was significantly differenced ($P \leq 0.01$) among groups. It was significantly higher ($P \leq 0.01$) in G1 than that G2 by 36%, and mean of all check points (BCS) was significantly higher ($P \leq 0.01$) in G1 than that in G2 by 22%.The present results agree with those of Anitha et al. (2011) who reported that the concept of body condition scoring of dairy animals has gained widespread acceptance as a manage mental aid in dairy production. In the present research study a new BCS system was developed for Murrah buffaloes. The skeletal check points were identified by selecting the anatomical features which made it possible to assess the fat reserves easily and by measuring the amount of fat reserves in slaughtered animals. As the BCS increased, the amount of fat reserves increased significantly ($P \leq 0.01$) indicating that BCS adequately reflected the amount of actual fat reserves. Antanaitis et al. (2021) reported that changes in BCS during per partum have an effect on health and fertility of cows. Cows that lose more body mass are more prone to develop diseases during lactation.

Table 3. Means and standard error of body condition score ultrasonographic fat thickness (mm) for body condition postcalving in Egyptian buffaloes

Skeletal check points for ultrasonographic fat thickness (mm)	Groups	
	G1	**G2**
Point between 12th and 13th ribs	$3.1^{a} \pm 0.21$	$2.5^{b} \pm 0.24$
Lumbar vertebrae	$3.3^{a} \pm 0.23$	$2.5^{b} \pm 0.25$
Sacral crest	$3.1^{NS} \pm 0.32$	$2.5^{NS} \pm 0.25$
Tail head to pins	$3.5^{a} \pm 0.41$	$2.5^{b} \pm 0.25$
Depression between hooks and pins.	$3.61^{NS} \pm 0.25$	$2.72^{NS} \pm 0.36$
Chest	$3.5^{a} \pm 0.23$	$2.6^{b} \pm 0.36$
Mean of all check points (BCS)	$3.3^{a} \pm 0.32$	$2.7^{b} \pm 0.26$

G1 = group that milked more than 7 months, G2= group that milked less than 7 months.
Means with different superscipts in the same row are significantly different ($P \leq 0.01$), NS = not significant

The correlation between milk yield and body measurements:

Results in Table (4). illustrated the correlation between milk yield and body measurements. These results show that there were negative ($P \leq 0.01$) correlations among MY, CC, RL and TC. On the other hand, there were positive correlation among MY, SH, HH, NL and ITW and positive significant correlation between MY and SW. There was high positive correlation between SH and HH. In spite of there was negative ($P \leq 0.01$) correlation between SH and CC. Results also show that there was a positive correlation among SH, NL, RL, SW and ITW. Same trend was recorded between HH and CC, RL, SW, ITW and TC but there was a negative correlation among HH and NL. The same trend was recorded among CC and NL, RL and SW. On the other hand, there was a positive correlation between CC and ITW. Results also showed that there was a high positive significant correlation between CC and TC. There was positive correlation among NL, RL, SW, and ITW. Meanwhile the correlation between NL and TC was negative. In addition our results showed that there was positive correlation among RL, SW, ITW, and TC. Same trend was recorded between SW and TC and high positive significant correlation between SW and ITW. Result also showed that there was positive correlation between ITW and TC. The differences in body dimensions could be attributed to many factors, regions, management and environment conditions. These results agreed with these of Avadesian et al. (2017) who concluded that the low dimensional traits that obtained from his study with poor milk production which reflected the poor management practices Furthermore, the positive correlation among most dimensional traits and milk production could enhance smallholder buffalo farmers to improve their productivity via improving feeding practice and veterinary care. This result was consistent with the previous results that obtained by Baghdasar et al. (2012) who reported that, the reason of differences in body dimensions in different locations may be due to the management practices. Baghdasar (1990) found positive correlation between dimensional body measurements and milk yield.

Table 4. The correlation coefficient between milk yield and body measurements in the Egyptian buffaloes

	MY	S H	HH	CC	NL	RL	SW	ITW	TC
MY	1								
SH	0.188	1							
HH	0.096	0.636**	1						
CC	-0.407 *	-0.415 *	0.043	1					
NL	0.153	0.136	-0.143	-0.036	1				
RL	-0.245	0.236	0.012	-0.018	0.08	1			
SW	0.383*	0.274	0.301	-.026	0.165	0.27	1		
ITW	0.14	0.35	0.2	0.04	0.22	0.16	0.37*	1	
TC	-0.308	-0.264	0.082	0.49**	-0.207	0.20	0.054	0.17	1

* Correlation is significant at the 0.05 level,** Correlation is significant at the 0.01 level, SH = Shoulder Height, HH= Height at Hip bone, CC= Chest circle, NL= Neck length, RL= Rump length, SW= Shoulder width, ITW= Ischial tuberosity width, TC= Thigh circumference.

The correlation between milk yield and body condition score.

Results in Table (5). Showed the correlation between milk yield and body condition score. These results showed that there was a positive correlation among MY and between 12th and13th, sacral crest, tail head pins, depression between hooks and pins and BCS. Results also showed that there was a positive correlation (P≤0.05) between milk yield and Lumbar vertebrae. There were positive correlations among all body condition score. These results agree with Jílek et al. (2008) who reported that cows with moderate BCS in the first month of lactation showed the highest milk yield during the first 5 months of lactation. Roche et al. (2007) reported that optimum calving BCS for milk production was approximately 3.5 in the 5-point scale. However, there was little increase in milk yield beyond a BCS of 3.0. Jílek et al (2008) found that the lowest values were recorded in the 2nd month of lactation and the cows with higher BCS around the time of calving were found to maintain this high BCS for the next 5 months at least. Higher BCS after calving indicated lower amount of its loss and this tendency was also evident in subsequent months of lactation. Roche et al. (2007) stated that the BCS was positively correlated with BCS at calving. Therefore, cows with higher BCS after calving showed the lowest

BCS loss. Identically, Kim and Suh (2003) reported that the recovery of BCS in cows with a marked condition loss was more delayed. Aeberhard et al. (2001) stated that lower BCS loss and body condition returned by week 40 to the values that were not significantly lower than those before parturition in lower-yielding Swiss Brown cows than in Holsteins. The condition score obtained in the first month of lactation only affected the peak daily milk yield produced 35.3 kg of milk on test day and for the highest scores (BCS > 3.75 points) the amount of milk obtained in test day was 25.1 kg. Rao and Anitha (2013) studied the influence of BCS at calving on the reproductive and productive performance in buffaloes and reported that milk production traits like total milk yield up to 18 weeks of lactation (1658.67 kg), 305 days predicted lactation yield (3187.3 kg), peak milk yield (16.5 kg) were higher in BCS group of 3.5-3.99 followed by the BCS groups of 4.0-4.49, 3.0-3.49 and 2.5-2.99, respectively.

Table 5. The correlation coefficients between milk yield and body condition score

	Milk yield	Between 12^{th} and13^{th}	Lumbar vertebrae	Sacral crest	Tail head pins	Depression between hook sand pins	Chest	BCS
Milk yield	1							
Between 12^{th} and13^{th}	0.224	1						
Lumbar vertebrae	0.391^{*}	0.881^{**}	1					
Sacral crest	0.309	0.867^{**}	0.791^{**}	1				
Tail head pins	0.354	0.822^{**}	0.904^{**}	0.762^{**}	1			
Depression between hooks and pins	0.336	0.825^{**}	0.892^{**}	0.776^{**}	0.977^{**}	1		
Chest	0.362^{*}	0.776^{**}	0.872^{**}	0.736^{**}	0.980^{**}	0.951^{**}	1	
BCS	0.354	0.912^{**}	0.949^{**}	0.870^{**}	0.973^{**}	0.968^{**}	0.950^{**}	1

* Correlation is significant at the 0.05 level, ** Correlation is significant at the 0.01 level.

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الملخص العربي

العلاقة بين، مقاييس الجسم، مقياس حالة الجسم وإنتاج اللبن فى الجاموس المصرى الحلاب

اجريت الدراسة باستخدام عدد عشرون من رؤوس الجاموس الحلاب فى الموسم الاول وفى نهاية موسم الحليب تم تقسيمهم الى مجموعتين تبعأ الى مدة موسم الحلابة حيث كانت المجموعة الاولى هى التى تجاوز طول موسم الحلابة 7 أشهر بينما الاخرى لم يتجاوز طول موسم الحلابة بها 7 أشهر. كان متوسط طول موسم الحلابة فى المجموعة الاولى (225 يوم) اعلى منه فى المجموعة الثانية (175). تم تسجيل قياسات الجسم المختلفة ثلاث مرات اثناء موسم الحليب حيث تم تسجيلها فى بداية وبعد ثلاثة شهور من بداية موسم الحليب ونهاية موسم الحليب. تم تطوير نظام مقاييس الجسم عن طريق قياس سمك طبقة الدهن تحت الجلدوالذى تم قياسه اثناء موسم الحليب. كان متوسط انتاج اللبن الكلى اعلى فى المجموعة الاولى عنه فى المجموعة الثانية بمقدار 36.2%. سجل اعلى معدل لارتفاع الكتف فى المجموعة الاولى فى منتصف موسم الحليب. كان هناك اختلافات معنوية بين المجموعتين فى كل نقاط قياس قياسات الجسم. كان هناك ارتباط سالب بين انتاج اللبن ومحيط الصدر بينما كان هناك ارتباط موجب بين أنتاج اللبن وسمك طبقة الدهن تحت الجلد فى منطقة الصدر.