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Muntaha Yousief
University of Basrah

Falih Hamad
University of Basrah

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Body and Udder Measurements and Heritability and their Relationship to the Production of Milk in the Iraqi Buffalo

T.A. Jaayid, M.Y. Yousief, F.H. Hamed and J.M. Owaid

Animal Production, College of Agriculture,
Basrah University, Basrah, Iraq.
E-mail: taleb1968@yahoo.com

Abstract

A total of 500 buffalo aged 3-6 years from three provinces in southern Iraq were included in current study. They were distributed as follows 200 animals from the province of Basrah (186 females and 14 males) and 150 animal from the province of Dhi Qar (135 females and 15 males) and 150 animal from the province of Missan (140 females and 10 males). Milk yield was measured and some of the standards body and udder measurements were recorded. Body measurements included body length, heart girth, paunch girth, wither height and chest depth. Those of udder were udder hight, front and rear teat length, front and rear diameter and teat distance. Regression coefficients (linear, quadratic, cubic and exponential) among body and udder measurements and milk yield were calculated. Animal from Missan province showed significantly superiority of body measurements in comparison with those from Basrah and Dhi Qar. The male showed higher values in comparison with females in major body measurements except the body length and chest depth where females were superior than males. While Basrah showed significantly higher milk yield followed by Missan and Dhi Qar. Heritability was between moderate (0.27 paunch girth) to high for body length (0.88). Regression between body measurements and milk yield was positive and significant ($p \leq 0.05$) that between wither height and chest depth, where the regression was positive or negative but non significant. All types of regression for milk production upon body measurements were significant with values ranged 0.742-0.86by for linear regression. Correlation and regression coefficients (Linear, quadratic, cubic and exponential) for milk yield on udder measurement were positive and highly significant ($p \leq 0.01$) with udder depth (0.492) and rear teat length (0.521). Strong positive significant relationship ($p \leq 0.01$)between milk yield and relative indices with accuracy rate equal to 84% for vacuum-sternum index and 92.5% for anamorphosis index.

Introduction

Cattle body measurements are phenotypic markers to the production ability for milk yield. In addition, the assessment of body measurements has direct economical effect on selection index and life time production. It has been sought to obtain phenotypic indices that clarify the activity of the genes that are responsible to that indices as a primary step to understand the relationship among the features of the single species and the inheriting elements that are in charge of physiology or productivity features that assisting in selection and genetic improvement (Ashweel *et al.,* 1998).

Body measurements have economical and vital benefits among dairy cattle, thus, it is very important to measure relationship between the appearance of the animal and its ability to production (Dehss *et al*., 2007). There are more than 17 measurements, which were assessed in the dairy cattle in USA and some other countries (Misztal *et al*., 1993), all these measurements are distributed normally and their inheritance is achieved by polygene. For setting an genetic improvement programs for any population required to be measuring heritability to be able to prepare a strategy for genetic and production progress. Bourdon (1997) noted that knowing heritability is among the indicators that can be sought for assistance to predict the breeding values and productive ability that will lead to genetic improvement. Many studies assessed the heritability for body measurements were characterized with high heritability except udder measurements which characterized with moderate. Donald (1960) noted the high productivity cows tend to have big udders, beside that the relationship between the udders measurements and milk yield can be used as a selection criteria in dairy cattle (Chongkasikit, 2002). The objectives at this study was to measure buffalo body and udder measurements, milk yield and the relationship between measurements was milk yield.

Materials and methods

A total of 500 buffalo aged 3-6 years from three provinces in southern Iraq were used. This were distributed as 200 animal from the province of Basra (186 females and 14 males), 150 animals from the province of Dhi Qar (135 females and 15 males) and 150 animal from the province of Missan (140 females and 10 males). Milk yield and some of the standards body and udder measurements were recorded. Body measurements includes body length, heart girth, paunch girth, wither height and chest depth. They were measured as cm by ruler (Hardjosubroto and Astuti, 1993). Udder measurements included udder high, front and rear teat length, front and rear diameter and teat distance (Magid, 1983). All measurements were taken before milking. From these data regression coefficients (linear and exponential and square and cube) were calculated between body or udder measurements and total milk yield (SPSS, 2009). Heritability was determined after estimating variance component through General Linear Models (GLM) with in the statistical program as fallow SPSS (2009).

$$h^2 = \frac{4\sigma^2 s}{\sigma^2 s + \sigma^2 p}$$

Were $h^{2:}$ heritability
σ^2s: sire variance
σ^2P: phenotypic variance

Relative indices were calculated the method used by Terzano *et al.* (2007)

1. Body Length-Chest Index = $\frac{\text{body length}\times 100}{\text{heart girth}}$
2. Vacuum-Sternum Index = $\frac{\text{wither height}-\text{chest depth}\times 100}{\text{wither height}}$
3. Anamorphosis Index = $\frac{\text{heart girth}^2}{\text{wither height}}$
4. Compactness Index = $\frac{\text{weight}}{\text{wither height}}$

Body weight was estimated as described by Khare and Baghel (2010)

1. Live body Weight (in pounds) = $\frac{\text{body length}\times\text{heart girth}^2}{300}$
2. Live body Weight (Kg) = $\frac{\text{body length}\times\text{heart girth}^2}{300}\times 0.4536$

Picture 1: Iraqi buffalo from Basrah province.

Picture 2: Iraqi buffalo from Dhi Qar Province.

Results and Discussions

Table (1) described the effects of gender and area on body measurements of Iraqi buffalos. Missan province showed significant superiority ($p \leq 0.05$) in most body measurements in comparison with Basrah and Dhi Qar. Male buffalos showed higher values ($p \leq 0.05$) in comparison with females in majority of body measurements except the chest length and depth where females got higher ($p \leq 0.05$) values. Interaction between gender and area had no significant effect on body measurements.

Table (1): Mean of body measurements and milk yield of Iraqi buffalo in different regions.

Body measurement (cm)	Sex	Basrah	Dhi Qar	Maysan	Mean
Body length	male	164.15±1.76	164.26±1.65	165.74±1.86	164.68^{b}±1.75
	female	168.65±0.44	175.62±0.57	176.31±0.55	172.35^{a}±0.88
	mean	164.69^{b}±0.93	165.40^{ab}±0.77	166.44^{a}±0.89	
Heart girth	male	201.67±2.50	202.27±1.99	205.58±2.33	203.06^{a}±2.67
	female	193.33±0.79	196.91±0.87	195.45±0.69	194.86^{b}±0.68
	mean	200.66^{c}±0.65	201.74^{b}±0.98	204.91^{a}±0.78	
Paunch girth	male	242.87±1.53	246.07±1.43	245.08±1.61	244.52^{a}±1.11
	female	234.09±0.88	233.62±0.70	236.53±0.77	234.44^{b}±0.99
	mean	241.82^{b}±0.22	244.84^{a}±0.61	244.50^{a}±0.21	
Wither height	male	147.13±2.87	148.11±2.60	148.20±1.89	147.75^{a}±1.88
	female	143.27±1.98	143.045±1.66	145.04±1.21	143.56^{b}±0.71
	mean	146.66^{b}±0.82	147.60^{ab}±0.76	147.99^{a}±0.77	
Chest depth	male	78.70±0.79	79.05±0.79	78.92±0.91	78.88b±0.88
	female	80.99±0.55	85.28±0.45	86.97±077	83.52a±0.60
	mean	79.00b±032	79.66a±0.57	79.46ab±0.21	
Total milk yield) kg (		2186.34^{a}	2005.62^{c}	2109.60^{b}	2108.95
		±	±	±	±
		70.49	28.3	95.46	102.7

Basrah buffalos showed significantly higher ($p \leq 0.05$) milk yield than those of Missan and Dhi Qar. Missan buffalo showed significantly higher udder measurements values (table, 2) except the front teat length as Basrah buffalo got higher values.

Table (3) showed common mean and heritability of body and udder measurements. The heritability was between the moderate value (0.27 paunch girth) to the high for body length (0.88). These results showed that the traits linked with high heritability such as body length, however heritability of the paunch girth is low due to that paunch girth is affected by the rumen size and feed consumption.

Table 2: Mean of buffalo udder measurements of Iraqi in different regions.

Udder measurement	Basrah	Dhi Qar	Maysan
Udder height	68.36[c]±0.03	70.98[b]±0.06	72.29[a]±0.09
Front teat length	6.87[a] ±0.01	6.49[c] ±0.02	6.76[b] ±0.04
Rear teat length	6.03[c] ±0.011	6.11[b] ±0.05	6.29[a] ±0.02
Front teat diameter	4.06[c] ±0.009	4.32[b] ±0.03	4.57[a]± 0.029
Rear teat diameter	4.24[b] ±0.011	4.28[b]± 0.078	4.64[a]± 0.071
Teat distance	10.50[c] ±0.02	11.13[b] ±0.017	11.45[a] ±0.062

Table 3: Mean, standard deviation and heritability of body and udder measurements.

Body measurement	$\bar{X}$	SD	h^2
Body length	165.43	5.73	0.88
Heart girth	202.26	5.12	0.68
Paunch girth	243.53	6.03	0.27
Wither height	147.34	5.43	0.29
Chest depth	79.33	4.11	0.77
Udder measurements			
Udder height	70.33	4.589	0.72
Front teat length	6.73	0.789	0.09
Rear teat length	6.14	0.713	0.63
Front teat diameter	4.29	0.446	0.11
Rear teat diameter	4.38	0.453	0.17
Teat distance	10.98	2.267	0.44

Whereas, the heritability of udder measurements were between low(0.09 for the length of the front teat) to high (0.72 for udders depth). It is so apparent that the dimensions of the teats have heritability in Scandinavian cattle from 0.98 for the length of the teat and about 0.50 for the distance between the right and the left teats and 0.38 for the teat diameter (Johansson & Rendel, 1972). It is clear from the values of the heritability of the udders measurements that the length of the teats and the depth of the udders are controlled mostly by genotypes, which helped in the possibility to make selection on these traits as far as their measurements on the animal is easy and able to predict the breeding values more accurately.

Correlations and different types of regression of milk yield and body measurement were shown in table (4). Correlations were positive and significant ($p \leq 0.05$) between milk yield and either body length (0.320), heart girth (0.365) and punch girth (0.295). It was known that big animals measured by their body length, chest and punch girth produce high milk yield. Larger buffalos produce high quality of milk due to their capability to consume larger quantities and store more fat in their body. These results agreed with that of Sieber *et al*. (1988).

Table (4) showed that all types of regression at milk yield on body measurements (body's length, chest area, abdomen area, front height and chest depth) were significant. Increase in body dimensions encountered by increase in absolute milk yield agreed with the results of Sieber et al. (1988).

Table 4: Correlation coefficients and linear quadratic, cubic and exponential regression and square between milk and body measurements.

Body measurement	Correlation Coefficient (r)	Equation	Accuracy rate R^2%	Constant (a)	Parameter estimates		
					b1	b2	b3
Body length	0.320*	Linear**	79.5	-531.9	15.96		
		Quadratic**	82.5	-8960	116.6	.300-	
		Cubic**	82.7	-6276	67.41	0	0
		Exponential**	79.2	605.7	0.008		
Heart girth	0.365*	Linear**	74.2	-1383	17.26		
		Quadratic**	85.6	26321	-260.4	0.695	
		Cubic**	85.5	17186	-122.3	0	0.001
		Exponential**	74.4	402.8	0.008		
Paunch girth	0.295*	Linear**	76.8	-1521	14.91		
		Quadratic**	82.4	19353	-157.9	0.357	
		Cubic**	82.2	12229	-70.44	0	0
		Exponential**	76.9	378.1	0.007		
Wither height	0.03	Linear**	84.8	-448	17.35		
		Quadratic**	86.2	5455	-63.06	0.274	
		Cubic**	86	3312	-21.07	0	0.001
		Exponential**	84.8	628.6	0.008		
Chest depth	-0.014	Linear**	81	327.8	22.45		
		Quadratic**	81.2	1476	-6.49	0.18	
		Cubic**	81.2	1476	-6.49	0.18	0
		Exponential**	80.8	908.1	0.011		

Quadratic, cubic and exponential regression of milk yield on measurements did not show great change with significant accuracy. Great increase in milk yield as body length started increase from 165 cm to 170 cm then started to be increased slightly after that until reaching the last scale (Figure 1). Yet, the linear relationship between milk yield and body length showed significant relationship ($p \leq 0.05$) with accurate rate (R^2) reached 79.5%. The average increase in milk yield when there is a unit increase in body length (1 cm) equal to 15.96 gm (Figure 4). The relationship of milk production and chest girth (Figure. 2) showed that the highest associated with a girth 200-210 cm. This relationship was linear and positive ($p \leq 0.05$) and the increase of the chest girth by 1 cm encountered by increase of 17.26 gm in milk yield with accuracy (R^2) reached %74 (Fig., 4). Maximum milk yield was shown when punch girth was 240 cm, wither height was 145cm and chest depth was 80cm (Figures., 3, 4 and 5).

These relations were linear and positive (p≤0.01). One unit increase in punch girth or wither height or chest depth caused an increase of 14.90, 17.35, and 22.45gm in milk yield respectively.

Association between milk yield and udder measurements were shown in table (5) and figures 6-10. All kinds of regression were significant (p≤0.01). Correlation between milk yield and each of udder depth, rear teat length, front teat diameter, rear teat diameter were significant and their values ranged from 0.209 to 0.521. Results agreed with those of Lin *et al.* (1987).The relationship of milk yield with udder measurements was characterize by a linear positive relation (p≤0.01) except that of distance between teats. Accuracy was 72% for front teat diameter to 87% for udder depth and milk yield. An increase of 1 cm in front teat diameter encountered an increase in milk yield reached 151.478 gm due to the reasons behind that was the increase in teats leads to an increase in milk flow speed. Figures (5 and11) showed that there were no relationship between milk yield and distance between the teat with very low accuracy (4%). Tilki *et al.* (2005) found a non significant negative relation between milk yield and distances between teats. It can be concluded from heritability value (table 3) and relationships between milk yield and udder depth or rear teat length that we could improve the production of milk of Iraqi buffalos through selection with increase udder depth or teat length specially these two measurements can be conducted easily in fields.

Table (6) showed that there was strong positive significant (p≤0.01) relationship between milk yield and relative indices with accuracy rate between 84% for Vacuum-Sternum Index and 92.5% for anamorphosis Index. Chang in one unit in indices of body length-chest, vacuum-sternum, anamorphosis and compactness caused an increase of 22.709, 10.668, 4.449 and 241.63 gm in milk yield respectively. Sieber *et al.* (1988) noted that bones are the first tissues that are completed in growth in early ages, and the front height measurements and body length reflect the bone Skeleton that is seemed to be important sign for calculating the basic food needs and predicting early productivity.

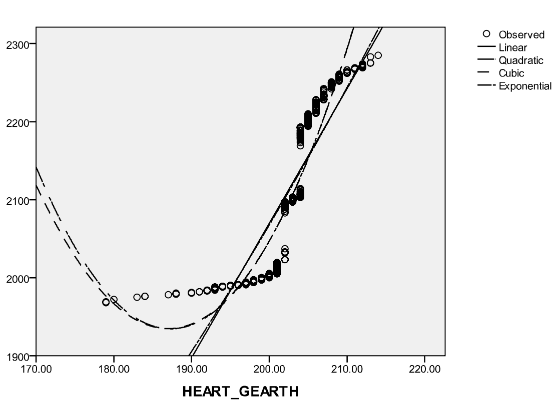

Figure 2

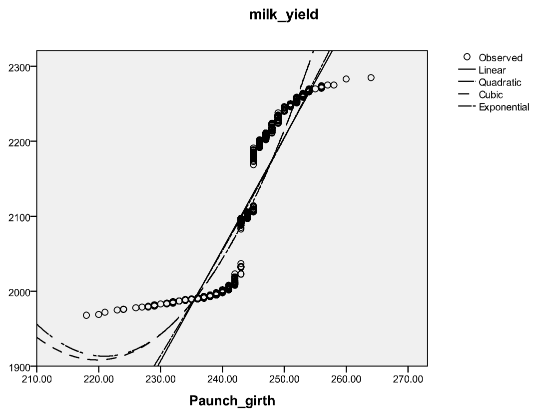

Figure 3

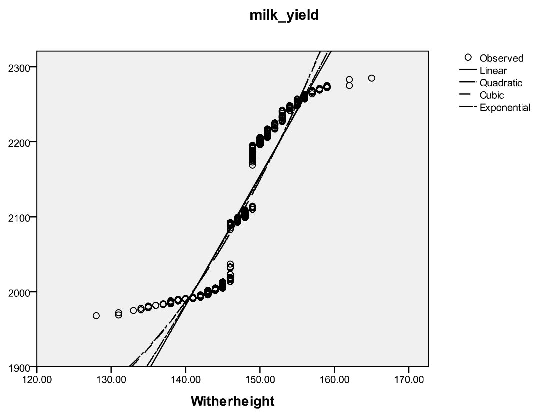

Figure 4

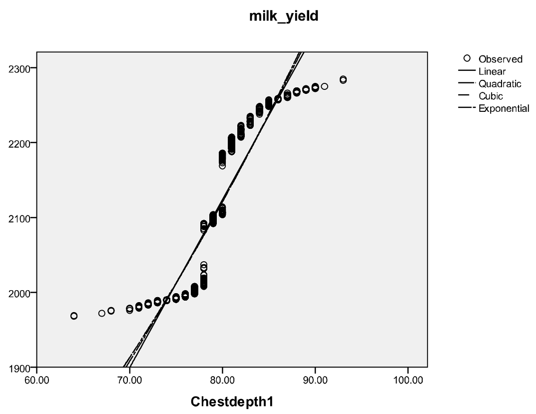

Figure 5

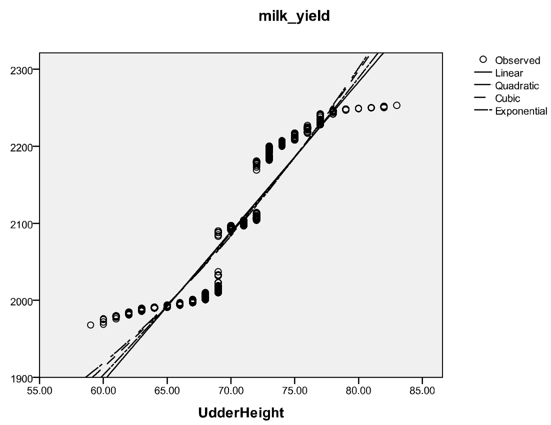

Figure 6

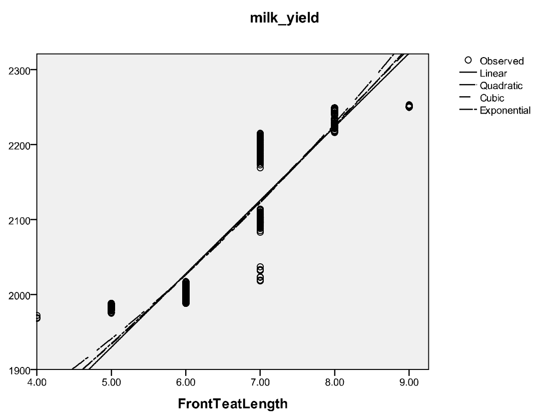

Figure 7

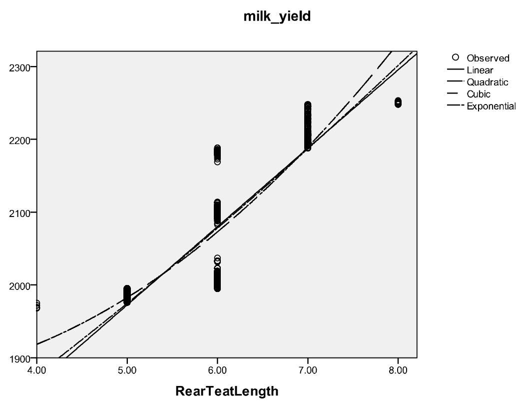

Figure 8

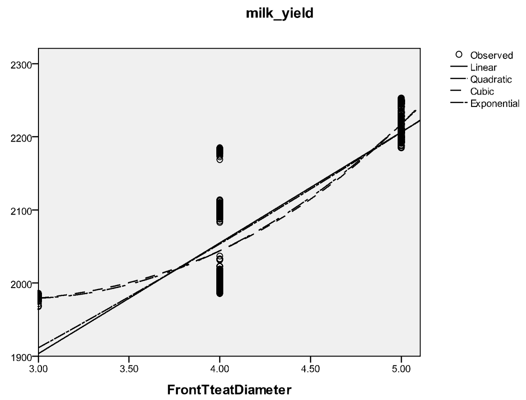

Figure 9

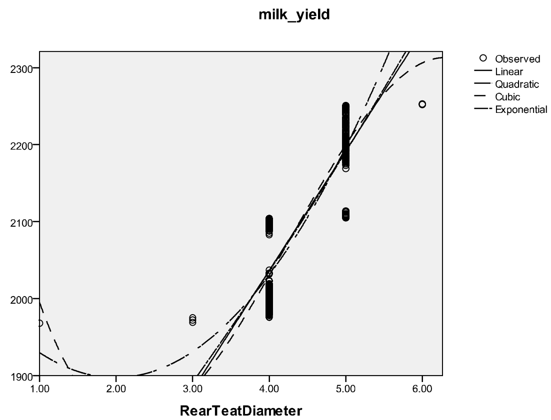

Figure 10

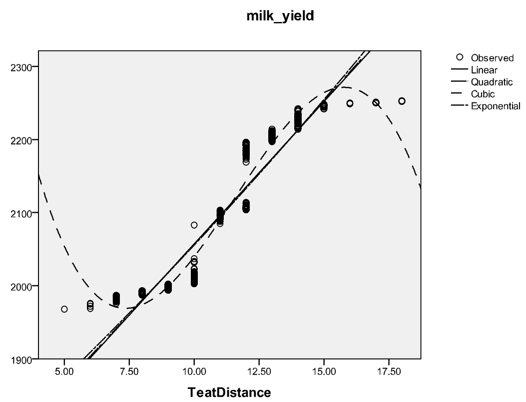

Figure 11

Table 5: Correlation coefficients linear regression quadratic, cubic and exponential of milk yield and udder measurements.

Udder measurement	Correlation Coefficient (r)	Equation	Accuracy rate R^2 %	Constant (a)	Parameter Estimates		
					b1	b2	b3
Udder height	0.492**	Linear**	87	730.096	19.414		
		Quadratic**	87.5	2038.84	-17.85	0.264	
		Cubic**	87.4	1527.93	0	0.067	0.001
		Exponential**	87	1094.37	0.009		
Front teat length	0.074	Linear**	76.4	1439.32	98.05		
		Quadratic**	76.8	1670.51	27.946	5.229	
		Cubic**	77.1	1678.37	0	12.947	-0.548
		Exponential**	76.6	1532.11	0.047		
Rear teat length	0.521**	Linear**	73.3	1434.17	107.65		
		Quadratic**	74.5	1924.18	-53.85	13.104	
		Cubic**	74.5	1924.18	-53.85	13.104	0
		Exponential**	73.1	1529.73	0.051		
Front teat diameter	0.209*	Linear**	72	1449.06	151.478		
		Quadratic**	76.1	2435.3	-314.61	54.208	
		Cubic**	76.1	2033.67	0	-26.11	6.694
		Exponential**	71.5	1541.63	0.072		
Rear teat diameter	0.218*	Linear**	74.5	1415.72	155.188		
		Quadratic**	78.4	2028.29	-131.59	33.055	
		Cubic**	79.4	2425.53	-598.13	181.693	-14.22
		Exponential**	74.2	1516.77	0.074		
Teat distance	-0.065	Linear ns	4	15.345	-0.002		
		Quadratic ns	5	-32.047	0.038	-0.0001	
		Cubic ns	5	-2.596	0	0.00008	-0.0001
		Exponential ns	4	15.759	0		

Table 6: Linear regression coefficients of milk yield and body index of Iraqi buffalo.

Index	accuracy rate R^2 %	Constant (a)	Parameter Estimates (b)
Body Length-Chest Index	91	126.09	22.709
Vacuum-Sternum Index	84	1167.56	10.668
Anamorphosis Index	92.5	864.35	4.449
compactness Index	90	1018.45	241.63

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