RELATIONSHIP OF UDDER AND BODY MEASUREMENTS WITH MILK IELD IN HOLSTEIN COWS REARED IN EGYPT

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ABCTRACT

The aim of the present study was to study the relationship of udder and body measurements with milk yield in Holstein cows in Egypt. Milk yield, udder and body measurements were recorded using 10 Holstein cows in first and second parity. Highly positive correlations were found between each of udder measurements and total milk yield of both 1st and 2nd parity. Phenotypic correlation coefficients among different udder measurements were positive and highly significant in both 1st and 2nd parity. All correlation coefficients between body measurements and total milk yield were positive. The accuracy values of using body measurements as predictors to total milk yield ranged generally from 3.10% to 71.90 %, this means that body measurements could be used as predictors to total milk yield.

Key words: Holstein cows, body measurements, udder measurements, total milk yield, parity.

INTRODUCTION

Interrelationships between body conformation and milk yield are of special importance to the dairy industry because dairy farmers usually judge the merit of dairy cows at least partially on the basis of type or conformation. Body dimensions such as heart girth, withers height, and body length are related to milk production (Lin et al., 1987 in Holstein heifers, Bardakcioglu et al., 2004 in Holstein cows and Mingoas et al., 2017 in Zebu cows). Productivity of front and rear quarters in cows, highly suitable for machine milking, should constitute 42% and 58% of the total amount of milk produced, respectively (Kuczaj, 2010).

Tancin *et al.* (2007) investigated differences in the milk yield of individual mammary quarters, and showed that the right front quarters produced 22.04%, left front quarters 22.23%, right rear quarters 28.24% and left rear quarters 27.49% of the cow's total milk output.

The udder plays the most important role in dairy cows. It is also important to connect to the body strongly, and deeper and larger udders with lobes in balance are demanded. Thin and soft skin on the udder make the milk characteristics of a cow better. Udder and teat measurements show variation between breeds and individuals in the same herd according to age and lactation stages. Different levels of coefficient correlation between udder-teat measurements and milk yield have been reported. Phenotypic correlation coefficients were found between 0.11 and 0.30 for 305-day milk yield with teat length and diameter in Gir cows (Qureshi *et al.,* 1984 and Coban, 2005).

Many studies results have recorded positive correlations between udder traits and milk production in Tunisia [Moufeda, 2014] and in India [Patel et al., 2016 in crossbred cows and Upadhyay et al., 2014 in native goats]. In Chile, [Angeles, 2014] noted positive correlations of 0.77 ($p<0.0001$) between udder depth and milk production and 0.60 ($p<0.0001$) between udder height and milk production in local cows. Furthermore, various correlations between udder measurements and milk production were stated in Pakistan Sahiwal cows Khan and Khan [2016] and Zwertvaegher *et al.2012* in Holstein cows. The relationships between udder characteristics and milk yield can be useful tools in selecting animals in dairy production systems especially in Zibu cows (Mingoas et al., 2017). Rump length is the most important trait among all body measurements studied for prediction of first lactation performance, while Udder height was more closely related, genetically and phenotypically, to first lactation yield traits than teat lengths, teat diameters, or teat distance. Lin et al., 1987.

The aim of the present study was to study the relationship of some udder and body measurements with milk yield in Holstein cows.

MATERIALS AND METHODS

Animals:

A total number of 10 lactating Holstein cows in the first and second parity were chosen from El-Tobge farm, Fayoum, Egypt. The average of body weight was 482 kg for the animals in the first parity and 498 kg for second parity.

Management and feeding:

The cows were kept under shad. The total daily requirements were calculated for each animal by the knowledge of average live body weight (BW), and subsequent milk production **t**hey were fed according to NRC (2001). Cows were machines milked twice daily at 6:00 am and 6:00 pm.

Study parameters:

Milk yield:

Total milk yield was recorded for each cow.

Body measurements:

Body measurements were taken on each cow according to Sawanon *et al*. (2011). These measurements were taken by measuring tape. The cows were weighed and body measurements of each cow for 25 weeks were taken weekly during first and second parity. The cow was fasting before weighing and during the process of body measurements for 12 hours. Each cow was allowed to stand on horizontal concrete floor and was positioned into an even stand before taken body measurements.

Measurements were recorded as the following:

1- Chest circumference (heart girth), the circumference of the body just behind the fore legs.
2- Thigh circumference, the circumference of the thigh was measured from the medium of thigh.

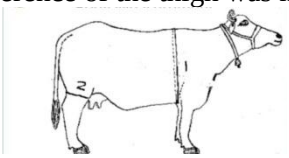

Fig. 1: body measurements 1- Chest circumference (heart girth), 2- Thigh circumference Sawanon *et al.* (2011).

Udder measurements:

The following udder measurements were taken on each cow according to Sid and El Barbary (2000) which were taken weekly from the third week (3^{rd}) to avoid excessive udder edema after calving and consequently till the 27^{th} weeks of lactation. The diameter 1 to 2 is the udder circumference, line 1 to 3 is the udder length, line 4 to 5 is the udder depth fore quarter, and line 6 to 7 is the udder depth rear quarter

Udder size was calculated as the following formula:-

Udder size (cm^3) = (udder depth fore quarter + udder depth rear quarter /2) × udder circumference.

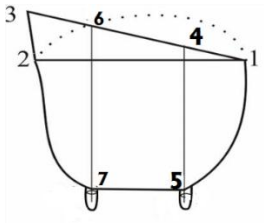

Fig. 2: Udder dimensions measurements (Sid and El Barbary 2000) Statistical analysis:

Data were subjected to a one-way analysis of variance with parity order as a fixed main effect using SPSS (2012) program. The following model was used:

$$Y_{ij} = \mu + P_i + e_{ij}$$

Where, Y_{ij} the individual observation; μ=The overall mean; P_i=The parity effect (P=1-2) and e_{ij}=random error term.

Linear regression equations and phenotypic correlations were estimated using SPSS (2012) program according to Becker (1985).

RESULTS AND DISCUSSION

The effect of parity on milk yield and both some body and udder measurements is presented in Table 1. It could be observed that the parity had highly significant ($P \leq 0.01$) effect on all of the studied traits where milk yield and body measurements increased from the first to the second parity. Milk yield was significantly increased by 30.68% from the first to the second parity and body measurements (Chest circumference and Thigh circumference) were increased from the first to the second parity by 3.77% and 10.72% respectively. Furthermore, the same trend was recorded in all udder measurements (Udder circumference, Udder length, Udder depth fore quarter, Udder depth rear quarter and Udder size) since they were increased by 14.74%, 10.16%, 31.38%, 7.39% and 31.53% respectively. These findings are confirmed the results obtained by Baghdasar *et al.* (2011 and 2012) for their studies on buffaloes at Baghdad and Mosul governorate. Moreover, the current results were agreed with Modh *et al.* (2017) who reported that there was a significant ($P < 0.05$) increasing trend in length and width of the udder from 1st to 2nd parity at the rate of 24.3 and 9.7 %, respectively, which afterwards became static for length and width of udder up to 4th parity. These results were agreed with that of Zwertvaegher, et al., 2012 and Mingoas et al., 2017. Moreover, Sindhi results indicated that multiparous cows had a significant larger volume of udder than the primiparous cows (Prasad *et al*. 2010). Many previous reports supported the present findings (Singh *et al.*, 2010 and Patel, 2014). Finally, the observed increases in milk production and udder traits may be due to progressive udder hypertrophy with respect to cow's age and parity Abdou et al., 2012. Moreover, these increases in all udder traits were affected by lactations number since udder tissues might be continued to develop up to 6th parity, and then they began to regress as cow's age advanced Tilki *et al.* (2005).

Table (1): Milk yield and some body and udder measurements during 1st and 2nd parity in Holstein cows (Means ± SE).

Body and udder traits	Parity	
	First	Second
Milk yield, kg	3461 ± 139.32	4523 ± 149.63 **
Chest circumference, cm	192.12 ± 0.88	199.37 ± 0.42 *
Thigh circumference, cm	64.27 ± 0.18	71.16 ± 0.41 **
Udder circumference, cm	46.55 ± 0.25	53.41 ± 0.35 **
Udder length, cm	40.46 ± 0.23	44.57 ± 0.28 *
Udder depth fore quarter, cm	21.29 ± 0.17	27.97 ± 0.25 **
Udder depth rear quarter, cm	26.26 ± 0.17	28.20 ± 0.22*
Udder size, cm^3	912.12 ± 14.99	1199.72 ± 15.53**

* $P \leq 0.05$ and ** $P \leq 0.01$.

Relationship of milk yield with body and udder measurements:

Table (2) shows the relationship between body measurements, udder traits and total milk yield of the first and the second lactation. All phenotypic correlations among body measurements and total milk yield in general were positive but not for Thigh

circumference in 2nd parity. Current results represent a positive correlation of 0.62 between milk yield and heart girth and 0.19 between milk yield and Thigh circumference in Holstein cows in general. The obtained high correlation values (over 0.5) in most cases as illustrated in Table 2 (except those of thigh circumference in general cows and in second parity) might indicate to the suitability of using such body indices and equations for predicting total milk yield of the cow. The current results for Holstein cows in Egypt confirmed the previous works of Lin et al., (1987), Sieber *et al.* (1988) Bardakcioglu et al., (2004), Hans *et al*. 2008, Bayram *et al.* (2006) in Holstein cows and Mingoas et al., 2017 in Zibu cows who stated that all body measurements especially Chest circumference were positively correlated with milk yield suggesting that future production might predictable through these body traits and reliable. The high correlations between each of chest circumferences and total milk yield indicated that the higher milk yield was associated with heavier cows as well as largest chest. In addition, the accuracy values of using body measurements as predictors to total milk yield ranged generally from 3.61 % to 67.24% may support the idea of using body measurements as predictors to milk production.

Highly correlations were found between each of the udder measurement and total milk yield in both two parities of lactation and in general (Table 2). All of the obtained correlation values were high positive. Results showed that high correlations among milk yield and different morphological udder traits (udder circumference, udder length, fore udder depth, hind udder depth and udder size) were ranged from 0.74 to 0.97 either in general or between parities as shown in Table (2). Similar results were reported by Deng *et al.* (2012) who reported that the previous mentioned udder traits before and after milking were affected significantly ($P<0.05$) by parity order. In the same trend, Tilki *et al.* (2005) reported that all the udder measurements were affected by lactations number. Moreover, relatively strong relationship between milk yield and udder length was recorded by Deng *et al.* (2012) and between milk yield and udder length, depth and size Zwertvaegher, et al., 2012 in Holstein cows and Mingoas et al., 2017 in Zebu cows.

It could be seen from the regression equations listed in Table 2 that most of udder measurements regressed to milk yield with higher accuracy of prediction where the general coefficients of determinations% for the regression of milk yield on udder circumference, udder length, udder depth fore quarter, udder depth rear qurter, udder size were 65.61, 88.36, 75.69, 77.44 and 65.61 respectively as reported by Singh *et al.* (2010). It is obvious that for example, The regression of milk yield on udder length indicated that each 1 cm change in udder length represent a change of 156.44 and 131.15 kg in total milk yield for both 1st and 2nd parity. In the same way, if udder depth of fore quarter increases I cm total milk yield will increase 94.82 kg and 191.31 kg, while 1 cm increase in udder depth of the rear quarter, the total milk yield increases by 171.63 kg and 208.16 kg in the 1st and 2nd parity, respectively. Thus, considering the correlation values and simple regression equations together with udder length and depth of fore and rear quarters may lead to accuracy for predicting milk yield of the examined cows. These results are in close agreement with the finding of Deng *et al.* (2012).

Udder size (hight and weidth) were grown progressively from 1st to 2nd parity and highly positively correlated to milk yield might be due to progressive udder hypertrophy and the continuing of udder tissues development with respect to cow's age and parity (Tilki *et al.* 2005; Abdou et al., 2012; Zwertvaegher et al., 2012 and Mingoas et al., 2017) . the high positive correlation among all udder characteristics and milk production suggests that

larger and higher udder depth are useful for milk production selection criteria in improving programs or predicting the latter production.

Additionaly, The proportional higher accuracy of prediction equation obtained suggested that regression equation was sufficient to use in predicting milk yield from linear body measurements as previously recorded by Musa et al., 2011 in Kenana cattle breed.

Table 2: Relationship between total milk yield (Y) in kg, body and udder measurement (X) in cm and phenotypic correlations (r)

Body and udder measurement	Parity	Simple regression equation	$R^2 \times 100$	(r)
Chest circumference	G	Y= -3142.34 + 33.87 X	38.44	0.62**
	1	Y= 155.88 + 15.99 X	40.96	0.64**
	2	Y= -11561.66 + 77.67 X	59.29	0.77**
Thigh circumference	G	Y= 1887.71 + 23.62 X	3.61	0.19*
	1	Y= - 3220.14 + 111.76 X	67.24	0.82**
	2	Y = 5360.49 – 32.26X	7.84	-0.28*
Udder circumference	G	Y = -572.30 +76.17 **X**	65.61	0.81*
	1	Y = 94.44 + 67.73 **X**	94.09	0.97**
	2	Y = -2673+ 124.44 **X**	54.76	0.74
Udder length	G	Y= - 2667.90 + 139.06 **X**	88.36	0.94**
	1	Y= - 3357.33 + 156.44 **X**	72.25	0.85
	2	Y= - 2333.43 + 131.15 **X**	86.49	0.93
Udder depth fore quarter	G	Y= 256.49 + 132.07 **X**	75.69	0.87*
	1	Y= 1045.43 + 94.82 **X**	70.56	0.84
	2	Y= -1195.67 + 191.31 **X**	88.36	0.94**
Udder depth rear quarter	G	Y= -407.24 + 142.25 **X**	77.44	0.88
	1	Y= -1048.78 + 171.63 X	88.36	0.94**
	2	Y= -2208.09 + 208.16 **X**	84.64	0.92*
Udder size	G	Y= 1330.74 + 1.72 **X**	65.61	0.81*
	1	Y= 1430.22 + 1.60 **X**	84.64	0.92**
	2	Y= 181. 82 + 2.48 **X**	60.84	0.78

* $P \leq 0.05$ and ** $P \leq 0.01$. G= General

Relationship between different body and udder measurements:

Phenotypic correlation coefficients among different body and udder measurements of Holstein cows in Egypt are presented in Table (3). Body characteristics values such as Chest circumference (r=0.09) was moderately correlated to thigh circumference in cows. These results were supported by Cerqueira *et al.* (2013). Furthermore, both heart girth and thigh circumference have all positive but moderate correlation with udder measurements. Phenotypic correlation between body measurements and various udder traits indicates to some extent that cows with greater heart girth and thigh circumference tended to have greater udder traits. This result was in line with that of Lin et al., 1987 who reported that Holstein heifers with greater heart girth or withers height tend to have higher udders, or with Singhal et al., 2013 who found that body length and heart girth were significant with regard to different shapes of udder in Gir cows.

Udder measurements had very strong and significant correlations with each other's where they were ranged from 0.53 for udder length with Udder depth rear quarter to 0.92 for Udder depth rear quarter with Udder depth fore quarter. Udder size has higher

phenotypic associations with the rest of udder traits under study. Positive and highly significant (p<0. 01) correlations were recorded between udder circumference and other udder traits such as udder depth fore quarter (0.79), udder depth rear quarter (0.76), udder length (0.73) and udder size 0.89) while udder depth fore quarter was strongly correlated to udder depth rear quarter (0.92), udder length (0.54) and udder size (0.91). Moreover, udder depth rear quarter was highly associated with udder length (0.53) and udder size (0.91) while udder length has a higher phenotypic correlation of (0.66) with udder size (Table-4).

The obtained results of high correlations make udder traits are expectable, since increasing of udder size is accompanied by an increase in udder measurements which supported by the outcomes of Patel *et al*. (2019).

Table 3: Correlation coefficients among different body and udder measurements.

Body/ udder measurement	Chest circumference (heart girth)	Thigh circumference	Udder circumference	Udder depth fore quarter	Udder depth rear quarter	Udder length	Udder size
Chest circumference	1	0.09					
Thigh circumference	0.09	1					
Udder circumference	0.04	0.06	1				
Udder depth fore quarter	0.01	0.02	0.79**	1			
Udder depth rear quarter	0.03	0.05	0.76**	0.92**	1		
Udder length	0.02	0.07	0.73**	0.54**	0.53**	1	
Udder size	0.05	0.04	0.89**	0.91**	0.91**	0.66**	1

**** significant at 0.01**

CONCLUSION

This study stated that body and udder morphological traits values, especially heart girth and udder length, were strongly correlated to milk yield in Holstein cows reared under Egyptian condition. It could be concluded that body morphology and udder dimensions can be used precisely to predict future total milk production in Holstein cows in Egypt.

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علاقة قياسات الضرع والجسم بإنتاج اللبن في أبقار هوليشتاين

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اجريت الدراسة الحالية باستخدام ١٠ راس من ابقار الهولشتين فى موسم الحليب الاول والثانى. تم تسجيل انتاج اللبن ومقاييس الجسم ومقاييس الضرع لكل بقرة. وجد ان هناك ارتباط موجب قوى بين كل من مقاييس الضرع وانتاج اللبن الكلى فى كل من الموسم الاول والثانى. كما ان هناك توافق إيجابى عالى المعنوية بين مقاييس الضرع المختلفة فى كل من الموسم الاول والثانى. كما وجد ان معامل الارتباط بين مقاييس الجسم وانتاج اللبن الكلى كان ايجابى. وجد ان درجة الدقة لاستخدام مقاييس الجسم والضرع كمؤشر لإنتاج اللبن يتراوح بين ٣.١ % الى ٧١.٩% وهذا يعنى أمكانية استخدام مقاييس الجسم والضرع كمؤشر لإنتاج اللبن.

الكلمات الدالة:- إنتاج اللبن الكلى – مقاييس الجسم – مقاييس الضرع.