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Relationship Between Production Characteristics and Proportion of Body Measurements of Holstein Cows

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ABSTRACT
The objective of this study was to determine Holstein Cattle body measurements using digital imagingDIPM methods. The ratios were calculated by dividing each measurement by another and the relationship between the ratios and the output characteristics were evaluated. For this reason, the body measurements of the 198 heads of Holstein cattle breed dairy cows were calculated by the Set Object Video System (SOVS) process. The ratios were calculated by dividing each body measurement to another then the relationship between these ratios and the characteristics including the daily average milk yield (DAMY), the number of inseminations per calving (NIPC), the age at insemination (AFI) and the age at first calving (AFC) were evaluated. The relationship between DAMY, NIPC, AFI, AFC and body measurements were; withers height (WH), back height (BH), rump height (RH), pin bone height (PBH)), chest depth (CD), body length (BL), trunk length (TL), body area (BA) and body perimeter (BP) was low, negative and not statistical significantly ($p>0.05$). The highest R^2 measured for DAMY by WH (0.389 ($p<0.01$), for NIPC by BA (0.344 ($p<0.05$)), for AFI by BP (0.266 ($p<0.05$)) and for AFC by BP (0.249 ($p<0.05$)) used in multiple regression equations. It can be stated that the use of DIPM is more convenient than TM for the body measurement of milking cows. The estimated power of regression equations for estimating milk and reproductive output, such as DAMY, NIPC, AFI and AFC, were low for Holstein cattle breeding cows.

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Siyah Alaca Süt Sığırlarında Vücut Ölçülerinin Birbirlerine Oranlarının Verim Özellikleri ile İlişkisi

ÖZET
Çalışmada, Görüntü İşleme Metotları kullanarak Siyah Alaca süt sığırlarının vücut ölçülerinin ortaya konması, elde edilen vücut ölçülerinin birbirlerine bölünerek oranlar elde edilmesi ve bu oranların verim özellikleri ile ilişkilerinin ortaya konması amaçlanmıştır. Bu amaçla 198 büyük baş Siyah Alaca süt sığırının Sabit Nesne Video Metodu yardımıyla vücut ölçüleri tespit edilmiştir. Tespit edilen vücut ölçüleri birbirlerine bölünerek oranlar elde edilmiş ve bu oranlar ile Günlük Ortalama Süt Verimi (GOSV), Gebelik Başına Tohumlama Sayısı (GBTS), İlkine Tohumlama Yaşı (İTY) ile İlkine Buzağılama Yaşı (İBY) arasındaki ilişkileri ortaya konmuştur. Araştırmada, GOSV, GBTS, İTY ve İBY ile vücut ölçülerinden cidago yüksekliği (CY), sırt yüksekliği (SY), sağrı yüksekliği (SGY), oturak yumru yüksekliği (OYY), göğüs derinliği (GD), vücut uzunluğu (VU), gövde uzunluğu (GU), vücut alanı (VA) ve vücut çevresi (VÇ) arasındaki ilişkinin tüm laktasyon guruplarında düşük, negatif yönlü ve istatistik olarak önemli olmadığı gözlenmiştir ($p>0.05$). Vücut ölçülerinden elde edilen oranlar modele dahil edilerek GOSV, GBTS, İTY ve İBY'nın tahmini için oluşturulan çoklu regresyon denklemlerine ilişkin en yüksek

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Vücut ölçüleri
Görüntü işleme
Gebelik Başına Tohumlama Sayısı
İlkine buzağılama yaşı

Determinasyon Katsayısı (R^2) değerlerinin GOSV için CY (0.389 ($p<0.01$)), GBTS için VA (0.344 ($p<0.05$)), İTY için VÇ (0.266 ($p<0.05$)) ve İBY için VÇ ile edilen oranların kullanıldığı çoklu regresyon denklemleri olduğu gözlenmiştir. Süt sığırlarında vücut ölçülerinin belirlenmesinde GİM uygulamalarının Klasik Ölçüm Metotları'na (KM) göre daha pratik olduğu söylenebilir. Siyah Alaca süt sığırlarında GOSV, GBTS, İTY ve İBY gibi süt ve döl verimlerinin tahmini için vücut ölçülerinden elde edilen oranlar kullanılarak oluşturulan regresyon denklemlerinin tahmin gücünün düşük olduğu belirlenmiştir.

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INTRODUCTION

Morpohological characteristics of domestic animals are one of the main subjects of animal breeding and one of the most explored by animal scientists. Phenotypic characteristics are utilized as important selection criteria in animal breeding. Various measurement, such as body height, BH, WH, BL, and CD are important morphological features of the animal body that are utilized to evaluate the individual identity, structural capacities, the relationship to the fertility levels, morphological type assessment and in particular, the identification of breeds and breeds of characters.

Tien and Tripathi (1990) stated that body measurement heritability is categorized as moderate and high. The body weight and body type or shape of the animals are formed and changed according to particular breeding objectives. Dairy genotypes, particularly Holstein cattle, are known to have improved over several years in terms of udder or dairy characteristics and to demonstrate morphological differences as compared to other yield-oriented genotypes. Differences in the shape and morphological characteristics of livestock genotypes that were systematically improved over many years in milk or meat yield were observed. Morphological traits of dairy cattle were used as direct selection criteria for predicting type characteristics and longevity and indirect selection criteria as early herd life (Yavuz and Kaygisiz, 2015; Mimaryan and Yener, 2000). A prerequisite for the efficient production of dairy cattle is the production of a genotype of high yield. However, it is possible to obtain productivity from the individual for several years ahead. Body structures play an important role in the longevity of the individual.

In addition to the yield characteristics, the morphological properties of individual animals should be considered as selection criteria in the cattle breeding program. The main aim of the morphological assessment of the animal is to decide if in addition to their milk yield, they have an acceptable body structure. It is assumed that the only way where the optimal yield levels can be achieved through the detection of healthy and well-visible cows (Alıç, 2007). The studies investigating the relationship between body measurements and individual productivity levels in cattle are generally focused on estimating live weight (LW) from body measurement. Body measurements such as BH, WH, BL, TL, CD and CW were also determined using standard body measurement tools. Regression equations were calculated using the body measurements obtained to estimate the production yields of the animals. Researchers reported that image processing is a simple and practical method for assessing body measurements of different animal species (Dogaroglu,2006; Onal, 2011, Hyslop et al., 2008; Tazser et al., 2000; Negretti and Bianconi 2005).

The Holstein Cattle body measurements were calculated by the digital image processing methods and the proportions were obtained by dividing the body measurements taken by the digital image processing methods. The relation between the obtained proportions and the yield characteristics has been revealed.

MATERIALS and METHODS

Material

198 head Holstein cows of different ages and their production records and images formed the study material. The milking cows evaluated in the study were from the private dairy farm.

Method

The measurement points reported by Kok (1996), Dogaroglu (2006) and Onal (2011) were evaluated in this analysis. Seven body measurement points were evaluated: withers height (WH), back height (BH), rump height (RH), pin bone height (PBH), chest depth (CD), body length (BL), trunk length (TL), body area (BA) and body perimeter (BP).

Image Processing

Set Object Video System (SOVS) was used as an image processing method for the determination of body measurement points (Onal, 2011). During the

transition (walking) of the animals from the platform that was installed, the video recording was taken from the digital camera and via the digital platform. Digital photos captured in .jpeg format from a video record (Canon 600D; Canon, Tokyo, Japan). The digital images were measured on a PC with the assistance of Image ProPlus software (Figure 1) (Figure 2) (Onal, 2011).

Daily average milk yield was used as milk production parameters and the number of insemination per calving, age at first insemination, and age at first calving as fertility parameters in the study.

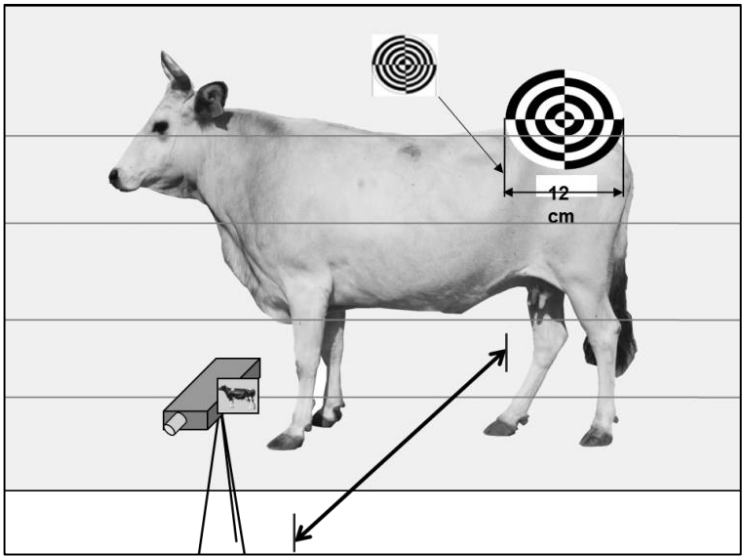

Figure 1.Image recording (Onal, 2011)
Şekil 1. Görüntülerin alınması (Onal, 2011)

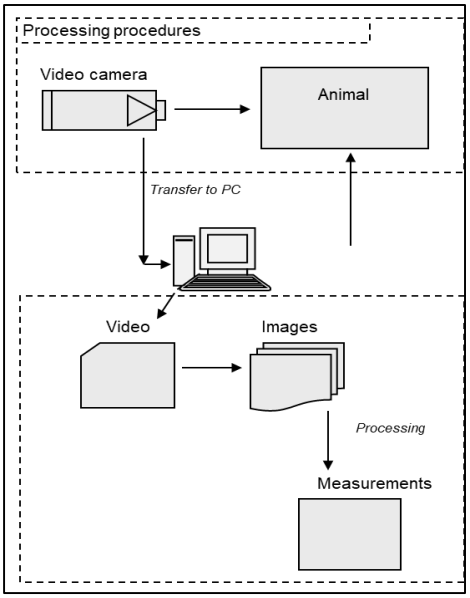

Figure 2.Image processing procedures
Şekil 1. Görüntülerin işlenmesi aşamaları

Statistical analysis

Statistical analyzes were performed using the SPSS program Ver. 15.0 (IBM, Armonk, NY, USA) for the evaluation of the data. Duncan's multiple comparison test was performed as a comparison test between categories. Basic statistics for body measurements and mean traits were obtained using the univariate. The technique was also used to evaluate Pearson correlations between body measurements and traits. The best regression equation estimating milk and fertility parameters was determined by Stepwise Linear Regression Analysis.

RESULTS and DISCUSSION

According to lactation numbers, descriptive statistics for milk and fertility yields of Holstein milking cows were given in Table 1. The statistical difference between the daily average milk yield and the number of insemination per pregnancy were calculated in terms of lactation number ($p<0.01$). No statistical difference was observed between the first age of insemination and the first age of calving ($p> 0.05$).

The relationship between body measurements and production yields

During the first lactation between yield and body measurements, and r values for milking cows; there was usually a low negative association between yield and body measurements.

In this study, the r values between the daily average milk yield (kg), and the pin bone height (PBH) were low and negative -0.267 ($p>0.05$). While, r values between the daily average milk yield (kg) and the chest depth were 0.031 ($p>0.05$) (Table 2). The weak r values for the number of inseminations per pregnancy were between 0.334 ($p<0.05$) in chest depth and -0.061 ($p>0.05$) in body length. There was a weak but statistically significant age at first insemination and chest depth -0.335 ($p<0.05$) and a strong but not statistically significant age relationship at first insemination trunk length -0.093 ($p>0.05$). The weak r between the back height and trunk length r=-0.041 ($p>0.05$) and the strong r between the body length and trunk length r=0.975 ($p<0.01$) was determined when the body measurements were calculated between each other.

This study was conducted to determine the relationship between body measurement and milk yield, it was shown that the r values between milk production and body measurements as well as body height, body length and chest depth were -0.19, -0.19 and-0.19 respectively for milking cows in the first lactation (Akbulut et al. 1998). Mimanyar and Yener (2000) stated that the r values between milk yield and milk height -0.09. Orhan (2007) reported that r value calculated between 305 days milking yield and rump height -0.49. It was indicated that the results

obtained in this research were generally consistent with the results published in the literature (Mimaryan and Yener, 2000; Orhan, 2007).

Table 1. Descriptive statistics of milk and fertility yields
Çizelge 1. Süt ve döl verimine ilişkin tanımlayıcı istatistikler

	Lactation Number *Laktasyon Sırası*	n	Mean *Ortalama*	S.D. *S.S.*	S.E. *S.H.*	Min.	Max.	P
Daily average milk yield (kg)	1	39	35.32 a	3.03	0.48	29.37	43.45	0.001
Günlük Ortalama Süt Verimi (kg)	2	104	40.33 c	5.64	0.55	24.06	54.39	
	3	29	39.99 bc	4.67	0.87	30.37	46.98	
	4	26	37.89 b	5.34	1.05	29.28	49.30	
	Total	198	38.97	5.39	0.38	24.06	54.39	
Number of Insemination Per Pregnancy	1	38	1.39 a	0.89	0.14	1.00	4.00	0.001
	2	103	2.82 b	1.86	0.18	1.00	9.00	
Gebelik Başına Tohumlama Sayısı	3	29	3.93 c	2.43	0.45	1.00	8.00	
	4	26	2.54 b	1.65	0.32	1.00	7.00	
	Total	196	2.67	1.93	0.14	1.00	9.00	
Age at first insemination (Day)	1	35	486.94	81.20	13.73	400.00	666.00	0.107
İlkine Tohumlama Yaşı (Gün)	2	91	497.12	81.17	8.51	401.00	760.00	
	3	29	519.45	69.51	12.91	439.00	736.00	
	4	26	527.27	48.73	9.56	445.00	629.00	
	Total	181	503.06	76.27	5.67	400.00	760.00	
Age at first calving (Day)	1	30	768.43	79.25	14.47	682.00	938.00	0.133
İlkine Buzağılama Yaşı (Gün)	2	90	773.04	76.55	8.07	680.00	992.00	
	3	28	790.04	56.29	10.64	717.00	983.00	
	4	26	805.62	47.30	9.28	723.00	912.00	
	Total	174	779.85	71.05	5.39	680.00	992.00	

Means with different letters are significantly different ($P < 0.05$). SD: Standard Deviation, SE: Standard Error

Table 2. The correlation coefficient (r) values between body measurements and production yields
Çizelge 2. Vücut ölçüleri ile verim özellikleri arasındaki korelasyon katsayıları (r)

	Daily average milk yield (kg) *Günlük Ortalama Süt Verimi (kg)*				Number of Insemination Per Pregnancy *Gebelik Başına Tohumlama Sayısı*			
Lactation Number	1	2	3	4	1	2	3	4
WH/*CY*	-0.047	0.165	0.042	0.141	-0.104	-0.024	-0.207	-0.151
BH/*SY*	-0.014	0.117	0.223	0.165	-0.078	-0.025	-0.343	-0.087
RH/*SGY*	-0.168	0.044	0.000	0.053	-0.099	0.032	-0.107	-0.222
PBH/*OYY*	-0.267	0.017	0.069	0.035	-0.114	0.061	-0.231	-0.258
CD/*GD*	0.031	0.012	-0.244	-0.184	-0.334*	-0.043	0.128	-0.190
BL/*VU*	-0.171	-0.058	-0.023	-0.251	-0.061	0.110	-0.004	-0.062
BA/*VA*	-0.023	0.064	-0.234	0.056	-0.163	0.078	0.206	0.050
BP/*VÇ*	-0.112	0.135	-0.053	0.127	-0.237	0.034	0.201	0.086
	Age at first insemination (Day) *İlkine Tohumlama Yaşı (Gün)*				Age at first calving (Day) *İlkine Buzağılama Yaşı (Gün)*			
Lactation Number	1	2	3	4	1	2	3	4
WH/*CY*	-0.224	0.084	0.179	0.112	-0.262	-0.001	-0.115	0.008
BH/*SY*	-0.155	0.053	0.154	0.260	-0.250	-0.079	-0.082	0.156
RH/*SGY*	-0.305	0.025	-0.105	0.096	-0.292	-0.110	-0.281	0.054
PBH/*OYY*	-0.256	0.018	-0.139	0.093	-0.247	-0.075	-0.075	0.047
CD/*GD*	-0.335*	0.205	-0.049	-0.031	-0.346	0.066	-0.250	-0.084
BL/*VU*	-0.186	0.146	0.196	-0.064	-0.121	0.078	-0.033	-0.138
BA/*VA*	-0.182	0.132	0.028	-0.194	-0.205	0.036	-0.137	-0.230
BP/*VÇ*	-0.327	0.139	-0.006	-0.248	-0.387*	0.055	-0.131	-0.326

*P<0.05

Relationship between the proportions and the output of production:

The R^2 values for multiple regression equations generated by lactation number to estimate the average daily milk yield, the number of inseminations per pregnancy, the first insemination age and the first calving age utilizing body proportion values were shown in Table 3. Lactation numbers were evaluated in four groups (1st, 2nd, 3th and 4th). Multiple regression equations for estimating the daily average milk yield, the number of inseminations per pregnancy, the first insemination age, and the first calving age were generated by including all proportion values obtained by dividing each body size to other body measurements.

All of the traits were positively correlated with milk and fertility yields. The coefficient of determination (R^2) of the multiple regressions of milk and fertility yields on body proportion measurements varied. According to the results, the highest R^2 value measured for multiple regression was 0.389 ($p<0.01$) for daily average milk yield at wither height, 0.344 ($p<0.05$) for body area for insemination number per pregnancy, 0.266 ($p<0.05$) for age at first insemination and 0.249 ($p<0.05$) for age at first calving (AFC) at body perimeter.

Table 3. The R^2 values of the multiple regression equation determined by the proportions of body measurements.
Çizelge 3. Vücut ölçülerine ilişkin oranlar kullanılarak elde edilen çoklu regresyon denklemlerine ait R^2 değerleri

	Lactation Number *Laktasyon Sırası*	WH *CY*	BH *SY*	RH *SGY*	PBH *OYY*	CD *GD*	BL *VU*	BA *VA*	BP *VÇ*
Daily average milk yield (kg) *Günlük Ortalama Süt Verimi (kg)*	1	0.389**	0.381	0.361**	0.372**	0.217*	0.143*	0.371*	0.378*
	2	0.036	0.032	0.026	0.024	0.023	0.014	0.075	0.070
	3	0.339	0.269	0.075	0.073	0.052	0.020	0.433	0.426
	4	0.272	0.263	0.180	0.114	0.046	0.029	0.312	0.310
Number of Insemination Per Pregnancy *Gebelik Başına Tohumlama Sayısı*	1	0.187	0.188	0.179	0.117	0.093	0.004	0.213	0.164
	2	0.049	0.047	0.038	0.039	0.035	0.008	0.063	0.069
	3	0.285	0.246	0.127	0.124	0.076	0.072	0.344	0.335
	4	0.171	0.127	0.117	0.108	0.103	0.063	0.294	0.246
Age at first insemination (Day) *İlkine Tohumlama Yaşı (Gün)*	1	0.068	0.061	0.033	0.031	0.029	0.004	0.072	0.074
	2	0.059	0.054	0.049	0.043	0.003	0.001	0.069	0.053
	3	0.239	0.240	0.133	0.106	0.086	0.002	0.243	0.192
	4	0.168	0.089	0.034	0.028	0.002	0.001	0.259	0.266
Age at first calving (Day) *İlkine Buzağılama Yaşı (Gün)*	1	0.090	0.086	0.082	0.080	0.076	0.018	0.137	0.136
	2	0.086	0.057	0.050	0.034	0.001	0.001	0.100	0.067
	3	0.208	0.207	0.165	0.054	0.048	0.021	0.211	0.076
	4	0.137	0.075	0.042	0.034	0.040	0.001	0.242	0.248

WH </> $Y_i = ß + b_{WH/BH} + b_{WH/SGY} + b_{WH/PBH} + b_{WH/CD} + b_{WH/BL} + b_{WH/TL}$
BH </> $Y_i = ß + b_{BH/SGY} + b_{BH/PBH} + b_{BH/CD} + b_{BH/BL} + b_{BH/TL}$
RH </> $Y_i = ß + b_{RH/PBH} + b_{RH/CD} + b_{RH/BL} + b_{RH/TL}$
PBH </> $Y_i = ß + b_{PBH/CD} + b_{PBH/BL} + b_{PBH/TL}$
CD</> $Y_i = ß + b_{CD/BL} + b_{CD/TL}$
BL</> $Y_i = ß + b_{BL/TL}$
BA </> $Y_i = ß + b_{BA/WH} + b_{BA/BH} + b_{BA/RH} + b_{BA/PBH} + b_{BA/CD} + b_{BA/BL} + b_{BA/TL} + b_{BA/BP}$
BP </> $Y_i = ß + b_{BP/WH} + b_{BP/BH} + b_{BP/WH} + b_{BP/BPH} + b_{BP/CD} + b_{BP/BL} + b_{BP/TL} + b_{BP/BA}$

*($p<0.05$), **($p<0.01$)

CONCLUSION AND RECOMMENDATIONS

The objective of this study was to demonstrate the relationships among body proportions and production yields in different lactation numbers of holsteins fresian milking cows. The study indicated that the predictive power of multiple regression equations produced by the use of the proportion values obtained from body measurements for the estimate of the daily average milk yield, the number of inseminations per pregnancy, the first insemination age were low in general, and similar studies would be useful for the research.

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Author's Contributions

The contribution of the authors is equal.

Statement of Conflict of Interest

The Authors have declared no conflict of interest.

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