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Relationships between different live animal physical measurements and carcass parameters of crossbred pigs of three different weight groups#

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Abstract

The present study was carried out to find the correlation between different live animal physical measurements and some economically important carcass parameters and to predict these carcass parameters using multiple linear regression models. Heart girth and flank girth showed a highly significant (p<0.01) correlation with carcass weight in all three weight groups. Angle showed significant correlation with carcass weight in group I and highly significant correlation in group II. Heart girth also showed a highly significant (p<0.01) correlation with the total meat yield of pigs in groups I and II. Dressing per cent was not significantly correlated with any of the live animal physical measurements in groups I and III. But the correlation was highly significant with heart girth in group II. Multiple linear regression analysis revealed that live animal physical measurements played a minor role on the majority of carcass characteristics, while the heart girth was critical in several instances. Physical measures of the live animals predicted carcass weight better than other carcass parameters. (R^2=0.623 – 0.924)

Keywords: *Physical body measurements, carcass weight, dressing per cent, total meat yield*

Pig farming serves as an important source of income to many farmers. This class of livestock are efficient converters of food wastes to valuable meat. Due to its high prolificacy rate,

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growth rate and shorter generation intervals, pig farming is substantially more profitable than other livestock farming. At present, the market value of pigs are determined based on their live weight. Pricing based on a visual appraisal of the body condition of pigs is also found in practice. The body condition scoring system based on the visual appraisal, on the other hand, is less precise, less reproducible and there have been reports of person-to-person variations (Li *et al*., 2021). Recently, an angle measuring equipment called 'sow caliper' was developed and is being used in the pork industry to assess body condition scores (Knauer and Baitinger, 2015). Several works on prediction of live weight of pigs from body measurements are reported earlier (Narayananikutty *et al*., 2004, Leena *et* al., 2004 and Mutua *et al*., 2011). However, the market value of pigs for meat production depends on the expected yield of some economically important carcass parameters. Prediction of economically important carcass parameters from inexpensive live animal measurements itself will help to select and segregate pigs into different classes of grades based on expected carcass yield for which the farmer can sell his pigs at a premium price. Hence this study was carried out to determine the relationship between various live animal physical measurements and various carcass parameters and to predict these economically significant carcass parameters from live animal body measurements.

Materials and methods

The study was conducted at Meat Technology Unit, Mannuthy. A total of 102 crossbred pigs of either sex was procured from local farmers. The slaughter weight was recorded using an electronic weighing balance. The animals were divided into three weight groups viz. group I comprising pigs with body weight less than 80 kg, group II comprising pigs with body weight between 81 to 120 kg and group III with body weight more than 121 kg. Different live animal physical measurements such as body length, heart girth, flank girth, body condition score and angle were taken on live animals. Pigs were slaughtered as per scientific slaughter procedure and different economically important carcass parameters were determined.

Live animal physical measurements

Body length was measured from the midpoint between the ears to the base of the tail according to the procedure described by Mutua *et al*. (2011). The heart girth was measured as the circumference of the animal body immediately posterior to the forelimbs as per guidelines of Adeola *et al*. (2013). The flank girth was measured as the circumference of the animal body immediately anterior to the hind limb, based on the procedure described by Ochoa Zaragoza (2009). Body condition score chart developed by Michaela (2019) ranging from 1 to 5 was used to score pigs. Measured the angle at the midline at the lumbar region posterior to the last rib with an angle measuring instrument as per guidelines given by Knauer and Baitinger (2015).

Carcass measurements

Carcass length was measured from the cranial edge of the first rib to the cranial tip of aitch bone using a flexible textile tape. The weight of dressed carcass after removal of head and shanks were recorded. The dressing per cent was calculated as per cent of slaughter weight. Total meat yield was calculated as a per cent of live weight. Abdominal fat depots including kidney fat, pelvic fat, and peritoneal fat were removed and weighed and were expressed as per cent on carcass basis. The intramuscular fat content of *Longissimus dorsi* muscle was quantified according to the method described by AOAC 2006.

Statistical analysis

Data was analysed using IBM SPSS statistics software, version 24.00. Pearson correlation (2 tailed) and multiple linear regression analysis was carried out to interpret data.

Results and Discussion

Coefficients of correlation between different live animal physical measurements and carcass parameters of pigs from weight group I

Coefficient of correlation between different live animals and economically important carcass parameters of pigs from weight group I are shown in Table 1. Carcass length was significantly (p<0.01) correlated with body length. The results are in accordance with the findings of Lewis (1957). Carcass weight was significantly correlated with heart girth followed by flank girth and body length (p<0.01). The result was in accordance with the findings of Yazama and Tomoda (1986) and Muthukumar (2018). Angle was significantly (p<0.05) correlated with carcass weight.

The correlation of total meat yield with heart girth was highly significant (0.685**) and with that of angle measurements was significant (0.45*). Body condition score was a poor indicator to predict carcass composition.

Coefficients of correlation between different live animal physical measurements and carcass parameters of pigs from weight group II

The coefficient of correlation between different live animals and economically important carcass parameters of pigs from weight group II are shown in Table 2.

Among live animal physical measurements, heart girth showed a significantly higher coefficient of correlation with carcass weight and total meat yield followed by angle and flank girth measurements (p<0.05). The results were in accordance with the findings of Yazama and Tomoda (1986) and Muthukumar (2018). Dressing percent was also highly significantly correlated with heart girth and angle measurements (0.512 and 0.482 respectively p<0.01). The result was in agreement with the findings of Muthukumar (2018).

Total meat yield also showed a highly significant correlation with heart girth (0.388, p<0.01). The results are in congruence with the findings of Duran *et al*. (1995) who found that heart girth had a significant correlation with lean per cent. Separable fat showed highly significant correlation with heart girth and body condition score (0.351 and 0.420 respectively p<0.01). From these results, it could be concluded that there exists a strong relationship between heart girth and different carcass parameters.

Coefficients of correlation between different live animal physical measurements and carcass parameters of pigs from weight group III

Coefficients of correlation between different live animal and carcass parameters

Table 1. Coefficients of correlation between different live animal and carcass parameters of pigs from weight group I

Parameter	Carcass length	Carcass weight	Total meat yield	Dressing percent	Separable fat	Intramuscular fat
Body length	0.493**	0.540**	0.405*	0.028	0.237	0.560**
Heart girth	0.508**	0.806**	0.685**	0.306	0.274	0.508**
Flank girth	0.410*	0.698**	0.154	0.257	0.146	0.266
Body condition score	0.048	0.097	0.179	-0.010	-0.060	0.185
Angle	0.052	0.474*	0.455*	0.327	0.234	0.231

** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2-tailed)

Table 2. Coefficients of correlation between different live animal and carcass parameters of pigs from weight group II

Parameter	Carcass length	Carcass weight	Total meat yield	Dressing per cent	Separable fat	Intramuscular fat
Body length	0.419**	0.220	-0.035	-0.087	-0.282*	0.263
Heart girth	0.067	0.734**	0.388**	0.512**	0.351**	0.297*
Flank girth	-0.058	0.457**	0.173	0.150	0.208	0.155
Body condition score	-0.388**	0.334*	0.275*	0.334*	0.420**	-0.177
Angle	-0.301*	0.553**	0.257	0.482**	0.316*	0.186

** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2-tailed)

Table 3. Coefficients of correlation between different live animal and carcass parameters of pigs from weight group III

Parameter	Carcass length	Carcass weight	Total meat yield	Dressing per cent	Separable fat	Intramuscular fat
Body length	0.369	0.586	0.168	-0.419	-0.163	0.217
Heart girth	0.497	0.960**	-0.143	0.023	0.227	0.149
Flank girth	0.374	0.876**	-0.233	0.145	0.196	0.108
Body condition score	-0.138	0.047	-0.282	-0.246	-0.202	0.349
Angle	-0.945	0.996	-0.117	0.819	-0.947	-0.424

** Correlation is significant at the 0.01 level (2-tailed) *Correlation is significant at the 0.05 level (2-tailed)

of pigs from weight group III are represented in Table 3. Carcass weight showed highly significant correlation with heart girth and flank girth (0.960 and 0.876 respectively, $p<0.01$). The result was in accordance with the findings of Yazama and Tomoda (1986). Lack of significance between different live animal physical measurements and different carcass parameters evaluated in this group may be due to a lower sample size.

Multiple linear regression analysis for developing prediction equation for carcass weight using live animal physical body measurements in different weight groups

Multiple linear regression analysis was carried out to find out the carcass weight of pigs from three different weight groups using live animal physical body measurements and the results are represented in Table 4.

The adjusted coefficient of multiple determination (adjusted R^2) was 0.634, 0.623 and 0.924 for groups I, II, and III respectively. The F statistics were found to be highly significant for groups I and II at 1 per cent level of significance, whereas for group III, F statistics was non-significant. This may be due to the lower sample size. In the multiple linear regression analysis for group I, coefficient of body length was found to be significant at 5 per cent significance level, whereas in group II coefficient of heart girth was highly significant at 1 per cent significance level.

Multiple linear regression analysis for developing prediction equation for dressing per cent using live animal physical body measurements in different weight groups

Multiple linear regression analysis was carried out to find out the dressing per cent of pigs from three different weight groups using live animal physical body measurements and the results are represented in Table 5.

The adjusted R^2 values for the dependent variable dressing per cent of pigs was higher for group II (0.315) than the other two groups. Only group II pigs showed a highly significant F statistics. In the multiple linear regression analysis for group II coefficient of heart girth was found to be highly significant at 1 per cent significance level.

Multiple linear regression analysis for developing prediction equation for total meat yield using live animal physical body measurements in different weight groups

Multiple linear regression analysis was carried out to find out the total meat yield of pigs from three different weight groups using live animal physical body measurements and the results are represented in Table 6.

The adjusted coefficients of multiple determination (adjusted R^2) were less than 0.3 for groups I and II which indicated that less than 30 per cent variation in the dependent variable is explained by independent variables such as body length, heart girth, flank girth, body condition score and angle. Adjusted R^2 was negative for group III which indicated that the model is inappropriate to predict meat yield.

Multiple linear regression analysis for developing prediction equation for separable fat using live animal physical body measurements in different weight groups

Multiple linear regression analysis was carried out to find out per cent separable fat of pigs from three different weight groups using live animal physical body measurements and the results are given in Table 7.

The adjusted R^2 values were negative for group I and group III and were very low for group II. The F statistic was found to be non-significant for all three groups studied. In the multiple linear regression analysis coefficients of all independent variables were found to be non-significant.

Multiple linear regression analysis for developing prediction equation for intramuscular fat using live animal physical body measurements in different weight groups

Multiple linear regression analysis was carried out to find out the intramuscular fat content of pigs from three different weight groups using live animal physical body measurements and the results are given in Table 8.

The adjusted coefficients of multiple determination as for group II animals was 0.315 which indicated that 31.5 per cent variation in the dependent variable is explained by independent variables. The F statistics was found to be highly significant for group II pigs at 1 per cent significance level and significant for group I pigs at 5 per cent level.

Table 4. Regression analysis for developing prediction equation for carcass weight using live animal physical body measurements in three different weight groups

Sl. No	Xi	Variables	Group I			Group II			Group III		
			coefficient	t statistics	p value	coefficient	t statistics	p value	coefficient	t statistics	p value
	A	Constant	-100.01**	-3.377	0.003	-115.66**	-3.788	0.000	-175.099ns	-0.26	0.807
1	X1	Body length	0.8348*	2.52	0.020	0.072ns	0.812	0.421	0.47ns	1.484	0.212
2	X2	Heart girth	0.083ns	0.471	0.643	1.014**	5.419	0.000	1.753ns	1.897	0.131
3	X3	Flank girth	0.363ns	1.347	0.192	0.093ns	0.812	0.421	0.458ns	0.745	0.498
4	X4	body condition score	0.006ns	2.046	0.551	-2.54ns	-0.932	0.356	-13.649ns	-1.991	0.117
5	X5	Angle	0.167ns	0.873	0.393	0.377ns	1.69	0.098	-0.085ns	-0.023	0.983
Dependent variable = Carcass weight											
Adjusted R2			0.634			0.623			0.924		
F statistics			11.843**			18.196**			12.823ns		
N			28			61			13		

** Highly Significant (p<0.01) * Significant (p<0.05) ns – Non significant

Table 5. Regression analysis for developing prediction equation for dressing per cent using live animal physical body measurements in three different weight groups

Sl. No	Xi	Variables	Group I			Group II			Group III		
			coefficient	t statistics	p value	coefficient	t statistics	p value	coefficient	t statistics	p value
	A	Constant	0.154ns	0.003	0.998	-13.02ns	-0.447	0.657	86.86ns	0.169	0.874
1	X1	Body length	-0.251ns	-0.838	0.412	-0.102ns	-1.199	0.237	-0.109ns	-0.451	0.675
2	X2	Heart girth	0.493ns	0.881	0.388	0.597**	3.347	0.002	-0.006ns	-0.009	0.993
3	X3	Flank girth	0.13ns	0.285	0.778	-0.117ns	-1.073	0.289	0.099ns	0.21	0.844
4	X4	body condition score	0.014ns	0.546	0.251	-1.70ns	-0.654	0.516	-0.023ns	-0.004	0.997
5	X5	Angle	0.241ns	0.745	0.464	0.299ns	1.406	0.166	-0.057ns	-0.02	0.985
Dependent variable= Dressing per cent											
Adjusted R^2			0.007			0.315			-1.001		
F statistics			1.045ns			5.776**			0.099ns		
N			28			61			13		

** Highly Significant (p<0.01) * Significant (p<0.05) ns – Non significant

Table 6. Regression analysis for developing prediction equation for total meat yield using live animal physical body measurements in three different weight groups

Sl No	Xi	Variables	Group I			Group II			Group III		
			coefficient	t statistics	p value	coefficient	t statistics	p value	coefficient	t statistics	p value
	A	Constant	16.99^{ns}	1.682	0.107	-2.102^{ns}	-0.088	0.93	-117.85^{ns}	-0.245	0.819
1	X1	Body length	0.029^{ns}	0.48	0.636	-0.09^{ns}	-1.307	0.198	0.21^{ns}	0.929	0.405
2	X2	Heart girth	0.592**	5.248	0.000	0.499**	3.424	0.001	-0.109^{ns}	-0.165	0.877
3	X3	Flank girth	-0.401**	-4.36	0.000	-0.069^{ns}	-0.775	0.442	-0.096^{ns}	-0.219	0.837
4	X4	body condition score	0.004^{ns}	2.846	0.371	-1.326^{ns}	-0.624	0.535	-1.758^{ns}	-0.359	0.738
5	X5	Angle	0.112^{ns}	1.716	0.101	0.176^{ns}	1.012	0.317	1.014^{ns}	0.376	0.726
Dependent variable=Meat yield											
Adjusted R2			0.283			0.289			-0.639		
F statistics			14.45**			5.229**			0.298 ns		
N			28			61			13		

** Highly Significant (p<0.01) * Significant (p<0.05) ns – Non significant

Table 7. Regression analysis for developing prediction equation for per cent separable fat using live animal physical body measurements in three different weight groups

Sl No	Xi	Variables	Group I			Group II			Group III		
			coefficient	t statistics	p value	coefficient	t statistics	p value	coefficient	t statistics	p value
	A	Constant	-1.595^{ns}	-0.651	0.522	-1.064^{ns}	-0.242	0.81	3.275^{ns}	0.047	0.965
1	X1	Body length	0.009^{ns}	0.625	0.538	-0.022^{ns}	-1.717	0.093	-0.025^{ns}	-0.772	0.483
2	X2	Heart girth	0.013^{ns}	0.475	0.640	0.037^{ns}	1.356	0.182	0.069^{ns}	0.719	0.512
3	X3	Flank girth	0.000^{ns}	0.486	0.596	0.008^{ns}	0.495	0.623	-0.025^{ns}	-0.399	0.71
4	X4	body condition score	-0.01^{ns}	-0.441	0.664	0.208^{ns}	0.53	0.599	0.052^{ns}	0.073	0.945
5	X5	Angle	0.012^{ns}	0.756	0.458	0.001^{ns}	0.034	0.973	-0.019^{ns}	-0.049	0.963
Dependent variable=Separable fat											
Adjusted R2			-0.057			0.114			-0.776		
F statistics			0.66^{ns}			2.342^{ns}			0.214^{ns}		
N			28			61			13		

** Highly Significant (p<0.01) * Significant (p<0.05) ns – Non significant

Table 8. Regression analysis for developing prediction equation for intramuscular fat using live animal physical body measurements in three different weight groups

Sl No	Xi	Variables	Group I			Group II			Group III		
			coefficient	t statistics	p value	coefficient	t statistics	p value	coefficient	t statistics	p value
	A	Constant	-14.92^{ns}	-1.451	0.161	-49.424**	-3.665	0.001	-369.177^{ns}	-0.818	0.459
1	X1	Body length	0.120^{ns}	1.953	0.064	0.025^{ns}	0.639	0.526	-0.02906^{ns}	-0.137	0.898
2	X2	Heart girth	0.132^{ns}	1.152	0.262	0.156^{ns}	1.892	0.065	0.184^{ns}	0.297	0.781
3	X3	Flank girth	-0.091^{ns}	-0.978	0.339	-0.011^{ns}	-0.218	0.829	-0.179^{ns}	-0.434	0.687
4	X4	body condition score	0.009^{ns}	1.154	0.421	-5.10**	-4.238	0.000	3.301^{ns}	0.718	0.513
5	X5	Angle	0.036^{ns}	0.547	0.59	0.332**	3.373	0.001	2.064^{ns}	0.816	0.460
Dependent variable= Intramuscular fat											
Adjusted R^2			0.271			0.315			-.814		
F statistics			3.323*			5.776**			0.192^{ns}		
N			28			61			13		

** Highly Significant (p<0.01) * Significant (p<0.05) ns – Non significant

Conclusion

The present study concluded that there exists a strong relation between different live animal physical measurements and different economically important carcass traits. Heart girth showed significant correlation with carcass weight in all the three weight groups ($p<0.01$). Angle also showed significant correlation with carcass weight except for group III. Heart girth also showed significant correlation with meat yield in group I and II. Dressing per cent was not significantly correlated with any of the live animal physical measurements in groups I and III. Results of multiple linear regression analysis revealed that live animal physical measurements played a minor role for the majority of carcass attributes while the heart girth was of major importance in several situations. The live animal physical measurements better predicted the carcass weight than other carcass parameters

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Conflict of interest

The authors declare that they have no conflict of interest.

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