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The relationship among pre and post slaughter traits of American Bronze Turkey

Abstract

This study aimed to investigate the relations among the pre- and post-slaughter traits of American bronze turkeys. Birds were raised under three different lighting regimes. Pre-slaughter traits were measured when the birds were 15-, 20-, and 30-weeks of age. Canonical correlation analysis showed that as the birds aged the relations among the pre- and post-slaughter characters became more pronounced. Coefficients of determination (R^2) were 63.6-82.8% when pre-slaughter characteristics were measured at the 15^{th} week, 84.8-94.6% at the 20^{th} week, and 91.3-99.1% at the 30^{th} week, respectively.

Key Words: American Bronze Turkey, trait relation, body weight, carcass weight, lighting program, canonical correlation

Zusammenfassung

Titel der Arbeit: **Beziehungen zwischen Merkmalen vor und nach dem Schlachten bei Amerikanischen Bronzeputen**

Ziel der Arbeit ist es, die Beziehungen einiger Merkmale breitbrüstiger Amerikanischer Bronzeputen in Abhängigkeit vom Alter vor und nach dem Schlachten zu untersuchen. Die Versuchstiere wurden bei drei unterschiedlichen Lichtregimes gehalten. Die Datenerfassung erfolgte im Alter von 15, 20 sowie 30 Wochen. Danach wurden die Tiere geschlachtet und weitere Merkmale bestimmt. Die kanonische Korrelationsanalyse ergab, dass die Merkmale vor dem Schlachten mit zunehmendem Alter der Tiere deutlichere Beziehungen zu den nach dem Schlachten erfassten Merkmalen erkennen ließen und entsprechende Voraussagen im Hinblick auf Veränderungen ermöglichten. Das Bestimmtheitsmaß (R^2) betrug 63,6-82,8 %, wenn die Merkmale vor dem Schlachten bei einem Alter der Puten von 15 Wochen, 84,8-94,6 % von 20 Wochen und 91,3-99,1 % von 30 Wochen erfasst wurden.

Schlüsselwörter: Amerikanische Bronzeputen, Merkmalsbeziehungen, Körpergewicht, Schlachtgewicht, Lichtprogramme, Kanonische Korrelation

Introduction

Meat, milk, egg and spring wool production are important characteristics of animal breeding. These traits may show some degree of correlation with each other as well as with some other growth characteristics of the animals. Investigation of these relations provide important information to researchers in practice (HAVENSTEIN et al., 1988; NESTOR and NOBLE, 1995; CHRISTENSEN et al., 2000; SWATLAND, 2001; VELLEMAN et al., 2003; ISIGÜZAR, 2003; ANDRASSY-BAKA, et al., 2003). As with all animal species, information on the correlations among the pre- and post-slaughter traits is quite important in poultry breeding since knowing which of the pre-slaughter trait(s) affect which of the post-slaughter trait(s) enables us to predict what kind of product(s) will be obtained. This kind of information is valuable as it allows early selection, as well as giving a chance to make an early evaluation of the success of the breeding program. Based on these evaluation results, the breeder will have a chance to make necessary adjustments, if needed any (NESTOR et al., 2001). Lighting

is one of the important environmental factors affecting poultry performance. Continuous or intermittent lighting in fattening affect not only growth rate and performance of poultry but also carcass quality (HERSTAD, 1992; CLARKE et al., 1993; ŞENGÜL et al., 2000; MENDEŞ et al., 2005). Therefore, the relationship among the pre- and post-slaughter traits of poultry may change depending upon lighting regime (NOLL et al., 1991; NEWBERRY, 1992; HULET et al., 1993; HAMILTON and KENNIE, 1997; AL-MAHROUS, 1997; NESTOR et al., 2000). However, there are not many studies about that. This study attempted to investigate the relations among some pre-slaughter and post-slaughter traits of American Bronze Turkeys, which were raised in three different lighting regimes via canonical correlation analysis.

There are several measures of correlation to express the relationship between two or more variables (such as the standard Pearson product moment correlation coefficient, rank correlation, Kendal Tau correlation, multiple regression, multiple correspondence analysis etc) (ZAR, 1999). Canonical correlation analysis is an additional procedure for assessing the relationship between variables. Specifically, this analysis allows researcher to investigate the relationship between two sets of variables. Canonical correlation analysis was therefore used in the present study to investigate the relationship between pre-and post-slaughter traits of American Bronze Turkey.

Materials and Methods

In this study, 15-week old 60 wide breast American Bronze turkeys were used. The study was carried out at the Research Unit of the Çanakkale Onsekiz Mart University. The animals were raised under intensive conditions with a lighting program of 23L: 1D in the first 55 days of the study. They were then allowed to go onto the pasture. Three different artificial lighting programs in addition to day light were applied 16th week onwards. Group I (control), group II and group III were involved lighting programs as 23L: 1D, 18L: 6D and 12L: 12D, respectively. Each group had 20 turkeys. The starter and growth diets of the animals included 28% crude protein, 2900-3000 kcal/ME and 22% crude protein, 2800-2900 kcal/ME, respectively under intensive condition. Wheat and water were offered *ad libitum* to the turkeys when they returned back from the pasture under semi-intensive condition. The following pre-slaughter traits were measured when the birds were 15-, 20-and 30 weeks old: live weight (X1), length of shank (X2), length of breast (X3), depth of breast (X4) and circumference of breast (X5). The live weight gains of turkey in all groups were determined by weighting. The animals were slaughtered at 31st week of the investigation. The post-slaughter traits were: carcass weight (Y1), liver weight (Y2), full weight of gizzard (Y3), empty weight of gizzard (Y4), small intestine length (Y5), and weight of small intestine (Y6).

Statistical Method and Data Analysis

Canonical correlation analysis (CCA) was used to investigate the relationships among the pre-slaughter and post-slaughter traits. These analyses were performed with SAS PROC CANCORR (SAS, 1999). From CCA, a linear association between predictor variables (pre-slaughter traits) and dependent variables (post slaughter traits) were determined. Canonical variables are linear combinations of the original quantitative measurements that contain the highest possible multiple correlation with each group

and that summarize among-class variation. The goal of CCA is to evaluate the relative contribution of each variable to the derived canonical functions in order to explain nature of the relationship(s). Consider the following two equations:

$$U_m = a_{m1}X_1 + a_{m2}X_2 + ... + a_{mp}X_p \quad (1)$$

$$V_m = b_{m1}Y_1 + b_{m2}Y_2 + ... + b_{mp}Y_p \quad (2)$$

Equation (1) and (2) gives the new variables U_m and V_m which are a linear combination of the X (pre-slaughter) and Y (post slaughter) variables respectively. Let C_m be the correlation between U_m and V_m. The objective of canonical correlation is to estimate a_{m1}, a_{m2}... a_{mp} and b_{m1}, b_{m2}... b_{mp} such that C_m is maximum. Equation (1) and (2) are the canonical equations, U_m and V_m are the canonical variates, and C_m is the canonical correlation (SHARMA, 1996).

Results

Descriptive statistics were given in Table 1, and the canonical correlations between pre-slaughter and post-slaughter variables, their standard error, R^2, and canonical variates were given in Table 2.

Table1
Mean and standard deviation for pre-and post slaughter variables of various lighting program (Mittelwerte und Standardabweichung der Variablen vor und nach dem Schlachten bei unterschiedlichem Lichprogramm)

Lighting Program	Variables	Mean of 15th week	Mean of 20th weeks	Mean of 30th weeks
		$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$	$\bar{X} \pm S_{\bar{X}}$
23L:1D	X1	3466.3±63.5	4528.5±93.37	7654.3±210.59
	X2	14.3±0.20	15.47±0.21	14.85±0.44
	X3	12.7±0.17	14.97±0.13	16.02±0.14
	X4	5.4±0.10	5.80±0.09	5.94±0.11
	X5	54.8±0.81	65.14±0.67	71.60±0.88
	Y1	5501.1±168.5	5501.1±168.5	5501.1±168.5
	Y2	101.9±4.6	101.9±4.6	101.9±4.6
	Y3	168.2±14.58	168.2±14.58	168.2±14.58
	Y4	168.5±9.99	168.5±9.99	168.5±9.99
	Y5	218±13.8	218±13.8	218±13.8
	Y6	180.5±10.5	180.5±10.5	180.5±10.5
18L:6D	X1	3472.75±83.36	4647.75±121.78	7828±255.11
	X2	14.24±0.17	15.37±0.22	20.06±5.53
	X3	12.75±0.16	14.76±0.17	16.07±0.18
	X4	5.32±0.11	5.57±0.12	5.52±0.08
	X5	54.30±0.50	64.39±0.76	72.40±0.79
	Y1	5814.40±207.95	5814.40±207.95	5814.40±207.95
	Y2	97.98±3.82	97.98±3.82	97.98±3.82
	Y3	183.96±15.57	183.96±15.57	183.96±15.57
	Y4	175.98±9.88	175.98±9.88	175.98±9.88
	Y5	221.57±16.30	221.57±16.30	221.57±16.30
	Y6	180.11±9.81	180.11±9.81	180.11±9.81
12L:12D	X1	3359.32±865	4279.37±103.79	7547.16±219.42
	X2	13.22±0.10	13.68±0.22	13.62±0.25
	X3	12.09±0.09	14.11±0.13	15.32±0.14
	X4	5.33±0.11	5.37±0.09	5.29±0.19
	X5	53.42±0.52	59.47±0.50	65.62±0.72
	Y1	5631.24±174.45	5631.24±174.45	5631.24±174.45
	Y2	112.27±5.93	112.27±5.93	112.27±5.93
	Y3	187.69±15.98	187.69±15.98	187.69±15.98
	Y4	173.58±10.41	173.58±10.41	173.58±10.41
	Y5	194.87±15.85	194.87±15.85	194.87±15.85
	Y6	161±8.19	161±8.19	161±8.19

L: light, D: dark

It was shown that the 0.861 calculated canonical correlation between 15th week traits (variables) of bronze turkey grown at 23L: 1D program and the traits of the post-

slaughter were not significant (P=0.168). The pre-slaughter traits of the turkeys at 20th week of age were expressed by the following equation; U1=-0.0001X1+1.1557X2+0.2146X3-0.3661X4-0.0851X5, the post slaughter traits of the turkeys were expressed via V1=0.0009Y1+0.0349Y2+0.0003Y3-0.0030Y4-0.0133Y5-0.0032Y6. The pre-slaughter traits of the turkeys at 30th week were expressed by the following equation; U1=0.0011X1-0.0579X2+0.4262X3-0.0047X4-0.0849X5.

Table 2
Canonical correlations, Standard error, R^2, P-value, and Canonical variates (Kanonische Korrelationen, Standardfehler, R^2, P-Wert und kanonische Variable)

Lighting Program	Age (Week)	Canonical Correlation	SE	R^2	P	Canonical variates
23l: 1D	15	0.861	0.059	0.742	0.168	U1=0.0021X1+0.918X2-0.4795X3-0.6489X4-0.1004X5
						V1=0.0009Y1+0.0349Y2+0.0003Y3-0.0030Y4-0.0133Y5-0.0032Y6
	20	0.935	0.029	0.874	0.029*	U1=-0.0001X1+1.1557X2+0.2146X3-0.3661X4-0.0851X5
						V1=0.0009Y1+0.0349Y2+0.0003Y3-0.0030Y4-0.0133Y5-0.0032Y6
	30	0.994	0.002	0.988	0.001**	U1=0.0011X1-0.0579X2+0.4262X3-0.0047X4-0.0849X5
						V1=0.0012Y1+0.0039Y2+0.0037Y3+0.0029Y4+0.0064Y5-0.0006Y6
18L:6D	15	0.797	0.084	0.636	0.608	U1=0.0006X1-0.0621X2-1.3844X3+1.2275X4+0.4825X5
						V1=0.0011Y1-0.0071Y2+0.0216Y3+0.0002Y4+0.0059Y5-0.0222Y6
	20	0.921	0.035	0.848	0.069	U1=0.0004X1+0.6154X2-0.3705X3+0.0765X4+0.1502X5
						V1=0.0012Y1-0.0001Y2-0.0047Y3+0.0021Y4-0.0045Y5-0.0014Y6
	30	0.956	0.019	0.913	0.026**	U1=0.0001X1+0.0056X2+0.5138X3+1.62657X4+0.0945X5
						V1=0.0004Y1+0.0164Y2-0.0008Y3+0.0195Y4+0.0113Y5-0.0196Y6
12L:12D	15	0.910	0.041	0.828	0.050**	U1=-0.0007X1-2.4640X2+1.2272X3+0.6198X4+0.2449X5
						V1=0.0013Y1+0.0075Y2+0.0038Y3+0.0133Y4+0.0147Y5-0.0196Y6
	20	0.972	0.012	0.946	0.010**	U1=0.0021X1+0.4669X2-0.3187X3-0.4277X4+0.0005X5
						V1=0.0011Y1-0.0142Y2+0.0072Y3+0.0013Y4+0.0048Y5+0.0002Y6
	30	0.996	0.002	0.991	0.001**	U1=0.0010X1-0.0249X2-0.0809X3+0.0461X4+0.0169X5
						V1=0.0012Y1-0.0015Y2+0.0025Y3-0.0001Y4+0.0010Y5+0.0027Y6

U1: Canonical variates pre slaughter *P<0.05, **P<0.01
V1: Canonical variates post slaughter

The post slaughter traits of turkeys were expressed via V1=0.0012Y1+0.0039Y2+0.0037Y3+0.0029Y4+0.0064Y5-0.0006Y6. Calculated canonical coefficients were 0.797 and 0.921, which were not significant at 15th and 20th week (P=0.608 and P= 0.069) under 18L: 6D lighting program. However, the calculated canonical correlation coefficient which is 0.956 between the traits determined at 30th week and the post slaughter traits were significant (P=0.026). The pre-slaughter traits of the turkeys at 20th week were expressed by the following equation; U1=0.0004X1+0.6154X2-0.3705X3+0.0765X4+0.1502X5. The post slaughter traits of the turkeys were expressed via V1=0.0012Y1-0.0001Y2-0.0047Y3+0.0021Y4-0.0045Y5-0.0014Y6. Likewise, the pre- slaughter traits at 20th week were expressed by the following equation; U1=0.0001X1+0.0056X2+0.5138X3+1.62657X4+0.0945X5, while the post slaughter traits were expressed by V1=0.0004Y1+0.0164Y2-0.0008Y3+0.0195Y4+0.0113Y5-0.0196Y6.

Calculated canonical correlation coefficient as 0.910 between the traits of the turkeys grown under 12L: 12D lighting program at 15th week and the post slaughtering traits were found statistically significant (P=0.05). The determined traits at 30th week were expressed as U1=0.0010X1-0.0249X2-0.0809X3+0.0461X4+0.0169X5, the post slaughter traits were expressed by V1=0.0012Y1-0.0015Y2+0.0025Y3-0.0001Y4+0.0010Y5+0.0027Y6.

Generally, the values of R^2 (coefficient of determination) of all the three lighting programs were considerably high. It was shown that there were high harmonies among canonical varieties to calculate relationship between the pre and post slaughtering traits. The coefficients of determination (R^2) were 63.6-82.8% when pre-

slaughter traits were measured at the 15th week, were 84.8-94.6% at the 20th week, and were 91.3-99.1% at the 30th week, respectively.

Discussion

Canonical correlation analysis technique was used to demonstrate the relations between pre- and post slaughtering traits in American bronze turkeys. The results of the analysis have shown that the traits measured pre-slaughter can be used to predict the changes in the post slaughtering traits.

The results of the present study demonstrated that as the age of the birds increased, relationships among the traits were much apparent between pre- slaughter and post slaughter in the same breeding system. For example, when the turkeys were at 15th week, the canonical correlation coefficient of the traits between the pre- and post slaughtering was 0.861 (P=0.168) under 23L:1D lighting program. When these birds were at 20th week and 30th week, the canonical correlation coefficient of these traits were found to be 0.935 (P=0.029) and 0.994 (P=0.000), respectively. It is important to point out that while the age of the turkeys increased, the canonical correlation coefficient of the traits between pre- and post slaughtering also increased.

In the equation related to the 20th week of age, as the length of shank (X2) and breast (X3) increased, the weight of liver increased in the same way. In another case, the higher the live weight (X1) and width of breast (X4), and the circumference of breast (X5) is lower the weight of empty gizzard (Y4), the length of small intestine (Y5) and the weight of small intestine (Y6). Most determinative trait was the width of breast (X4). High determinations in the traits of the length of breast (X3) and the weight of liver (X1) at 30th week led to the increase in other traits (Y1, Y2, Y3, Y4, and Y5) except for the weight of small intestine (Y6).

Late determination of the pre-slaughtering traits of the turkeys grown under 18L: 6D lighting program provided a much clearer relationship between those traits and the post slaughter traits. The importance level of the calculated canonical correlation coefficient was an indicator. While the post slaughtering Y1, Y2, Y4 and Y5 traits were affected positively from pre-slaughtering, Y3 and Y6 were negatively affected. The most determinative trait of pre-slaughtering was the width of breast (X4) with a coefficient of 1.62657.

While the length of shank (X2=2.4640) provided the most important contribution for U1 formation under 12L: 12D lighting program at 15th week, the live weight (X1) with a coefficient of 0.0007 provided the least contribution. While Y6 (0.0196) provided the highest contribution for V1 formation, Y1 (0.0013) provided the lowest contribution. The higher the live weight (X1) and the length of shank (X2) of the turkeys is the lower the weight of small intestine (Y6). On the other hand, the length (X3) and width (X4) of breast, and the circumference of breast (X5) led to the increase in other traits except for small intestine weight (Y6).

When the coefficient of the equations which were constructed for 12L: 12D lighting program at 30th week were evaluated, X3 (0.0809) provided the highest contribution and X1 (0.0010) provided the lowest contribution for the formation of the U1 canonical variate. While Y6 (0.0027) and Y3 (0.0015) provided the highest contribution, Y4 (0.0010) provided the lowest contribution for the formation of the V1 canonical variate. The turkeys with high X1, X4 and X5 traits grown under this

lighting program also had high post-slaughtering traits except for Y2 and Y4. It means that the increase of X2 and X3 traits resulted in a decrease in Y2 and Y4.

Implication

Canonical correlation analysis technique can be a useful way of demonstrating the relation between two variable sets in animal based studies as well as in other areas of research.

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