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Original Article

Predictive Equations of Carcass Characteristics and Primal Cut Weights of Native Mexican Guajolotes Using Body Measurements

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ABSTRACT

This study was conducted to develop predictive equations for carcass characteristics and primal cut weights of native Mexican guajolotes using body measurements (BM). For this study, a total of 36 male guajolotes (*Meleagris gallopavogallopavo*), aged 6 to 10 months, and mean slaughter body weight (SBW) of 4543.14 ± 656.60 g, were used. The birds were kept under traditional extensive conditions. The following BMs were recorded 24 h before slaughter: thoracic perimeter (TP), body circumference (BC), body length (BL), wing length (WL), keel length (KL), shank length (SL) and shank diameter (SD). After slaughter, hot carcass weight (HCW), cold carcass weight (CCW), hot dressing percentage (HDP), cold dressing percentage (CDP), organs and viscera weight (VIS) and abdominal fat weight (AFW) were recorded. The carcasses were dissected in to five primal cut (breast, thigh, drumstick, back and wing). The SBW and BMs showed moderate to high positive correlations (*p*<0.01; 0.34≤r<0.97) with carcass characteristics and primal cut weights. In the equations generated to predict HCW, CCW, HDP, CDP, VIS and AFW, the R2 ranged from 0.40 to 0.96, and the predictor variables were SBW, KL, BC, WL and SL. Regarding the equations developed to predict the primal cut weights, R2 ranged from 0.58 to 0.91. In these models, SBW, BC, SD, WL and KL explained most of the observed variation. The prediction equations obtained in the study had moderate to high accuracy; therefore, they can be used by researchers, technicians and poultry producers to obtain information on the carcass composition of native Mexican guajolotes.

INTRODUCTION

In today's poultry production, carcass tissue composition is an economically important factor to the increasing demand for specific cuts of meat (Faridi *et al.,* 2012). The weights and proportions of meat in the carcass, which are quantified by traits such as the retail product, are indicators of the quality of the carcasses based on the quantity of product to be marketed (Silva *et al.,* 2012). Therefore, the emphasis in meat poultry production is on the quality and yield of the main parts of the carcass (Faridi *et al.,* 2012).

The most accurate standard method for determining carcass tissue composition in meat species is physical separation of the tissues or by dissection (Lorenzo *et al.,* 2018). However, it is an expensive, laborious procedure, and requires a lot of time and specialized labor (Faridi *et al.,* 2012). In addition, it promotes a significant waste of meat (Lin *et al.,* 2018; Batista *et al.,* 2021). Therefore, some indirect methods have been proposed to estimate the yield and tissue composition of the carcass of farm animals, such as digital image analysis (Bozkurt *et al.,* 2008; Lorenzo *et al.,* 2018; Batista *et al.,* 2021), X-ray computed tomography (Navajas *et al.*, 2010), and real-time ultrasonography (Melo *et al.,* 2003; Teixeira *et al.,* 2008). Although these techniques are promising for the subjective evaluation of carcass composition, their use is limited to laboratory conditions and the required equipment is expensive, which represents a challenge for developing countries. On the other hand, several authors (Bochno *et al.,* 2000; Kleczek *et al.,* 2006; Yakubu *et al.,* 2009; Tyasi *et al.,* 2018; Costa *et al.,* 2020; Gomes *et al.,* 2021) showed that the development of regression equations using somebody measurements represents an indirect, accurate and non-invasive method to predict carcass components. Additionally, this technique allows information to be collected from animals *in vivo*, without the need for sacrifice, so it can be useful for selective breeding and genetic improvement (Banerjee, 2011; Erensoy *et al.,* 2020).

The Guajolote (*Meleagris gallopavogallopavo*) is a poultry native to Mexico that has an acceptable productive yield, high rusticity and resistance to diseases, as well as a good capacity for adaptation that allows it to thrive in various adverse climatic conditions (Portillo-Salgado *et al.,* 2022). Male guajolotes are characterized by their ability to produce meat as they have good muscle development and produce little fat in the carcass (Juárez-Caratachea, 2004). Instead, female guajolotes are used only for the incubation of eggs, their own or those of Creole hens, due to their excellent maternal ability in protecting their chicks in outdoor conditions (Portillo-Salgado *et al.,* 2020). The Guajolote production is an important poultry activity in suburban and rural communities because it contributes to the nutritional and economic sustenance of families. The birds are raised in semi-technified, extensive or backyard conditions (Portillo-Salgado *et al.,* 2022). The consumption of Guajolote meat has a long tradition in Mexico and in other Central American countries. Although this meat is mostly consumed during in december, through out the year it is used in the preparation of typical regional dishes that are offered in social and family festivities because it has a desirable flavor and aroma (Ramírez-Rivera *et al.,* 2012). In native guajolotes, the most important primal carcass cuts are the breast, drumsticks and thighs, and represent approximately 30% of the total muscle mass of the bird (Juárez-Caratachea, 2004). However, other components of the carcass are also used, such as the back and wings.

Therefore, the hypothesis of this study was that body measurements taken *in vivo* could be used to predict carcass characteristics and primal cut weights in native Mexican guajolotes. Since there is littles cientific literature on the use of body measurements to estimate carcass composition of native Mexican guajolotes, the objective of this study was to develop predictive equations for carcass characteristics and primal cut weights using body measurements of native Mexican guajolotes.

MATERIAL AND METHODS

Experimental site and animals

The animals included in this study were handled in accordance with the guidelines and ethical standards for the use and care of animals intended for research established by the Animal Welfare Committee (Comité de Bienestar Animal (COBIAN)) of the Colegio de Postgraduados (Approvalnumber: 002/21). The experiment was carried out in an experimental poultry unit (19° 29′ N, 90° 32′ W; 24 masl), located in the locality of Sihochac, Campeche, Mexico.

In the experiment, a total of 36 male guajolotes, aged 6 to 10 months, and mean slaughter body weight (SBW) of 4543.14 ± 656.60 g, were used. The birds were randomly collected in different poultry production units from rural communities in the municipality of Champotón, Campeche, where they were traditionally raised in extensive conditions (Portillo-Salgado *et al.*, 2018).-They had access to the outside during the day (7:00 to 18:00 h), while at night they were confined in a roofed pen, with concrete walls and floor, the latter was covered with 10 cm thickwood chip bed. Feeders and drinkers were provided in the pen. The feed, provided in mashform, consisted of a mixed diet that included: 60% corn, 20% wheat bran, and 20% soybean meal, and had 17% crude protein (CP) and 11.90 MJ metabolizable energy (ME/kg) (NRC,1994). The grazing areas were covered with the grasses *Cynodondactylon*, *Urochloabrizanthacv. Marandu,* and *Pennisetumpurpureum*. Feed and water were available *ad libitum*.

Body measurements

Body measurements (BM) were taken *in vivo* on each guajolote 24 h before slaughter using a plastic measuring tape graduated in cm and a millimeter digital vernier (TRUPER®). Birds were placed upright on a flat surface. BMs were taken as previously described by Cigarroa-Vázquez *et al.* (2013), these were: thoracic perimeter (TP), body circumference (BC), body length (BL), wing length (WL), keel length (KL), shank length

(SL) and shank diameter (SD). All measurements were made by the same person for consistency purposes and to avoid undesirable measurement errors.

Slaughter of animals

All birds were sacrificed on the same day after a 12 h fasting period, during which they received only cleanwater. The slaughter was carried out in accordance with the Official Mexican Standards (NOM-008-ZOO-1994, NOM-009-ZOO-1994 and NOM-033-ZOO-1995) established for the humane slaughter of animals intended for meat production. Before slaughter, the body weight (SBW) of the birds was recorded using a precision digital scale(±1 g). The birds were humanely killed by exsanguination, and the carcasses were then scalded in hot water (60-65 °C) for 2 min to facilitate manual plucking. The head and legs were cut off, and the viscera and internal organs (VIS), comprising blood, liver, empty gizzard, heart, kidneys, lungs, intestines, gall bladder, and spleen, were collected and weighed. Likewise, the weight of abdominal fat (AFW) attached to the carcass was recorded. Subsequently, the carcasses were weighed to obtain the hot carcass weight (HCW), and they were stored at +4 °C for 24 h to obtain the cold carcass weight (CCW). The percentages (%) of hot (HDP) and cold (CDP) dressing were determined in relation to the SBW. Carcass dissection was performed as described by Hahn & Spindler (2002). The primal cuts selected were the breast, thigh, drumstick, back and wing.

Statistical analysis

Initially, the descriptive statistics of the variables were obtained using the MEANS procedure of the SAS statistical program, ver. 9.4 (SAS Inst. Inc., Cary, NC). For exploratory analysis of relationships between dependent (carcass characteristics and primal cut weights) independent variables (body measurements), Pearson correlation coefficients (r) were obtained using the CORR procedure of SAS. Simple and multiple linear regressions were developed to estimate functional relationships between variables using the REG procedure of SAS. The STEPWISE and Mallow's Cp options were used in the REG procedure to determine the significant variables ($p<0.05$) that were included in the statistical models. The STEPWISE process added and removed explanatory variables in the models to strike a balance between model simplicity (*parsimony*) and predictive performance. The goodness of fit of the models was determined using the determination coefficient (R^2), root mean square error (RMSE), Akaikés Information Criterion (AIC) and Bayesian Information Criterion (BIC). Models with the lowest RMSE, AIC and BIC, and highest R^2 were defined as the best models (Rivera-Alegría*et al.,* 2022).

RESULTS AND DISCUSSION

To date, this is the first study conducted to evaluate the use of body measurements as an indirect, practical, and non-invasive method to predict carcass characteristics and primal cut weights of native Mexican guajolotes. The mathematical models developed in this type of study, in addition to estimating the tissue composition of the carcass in poultry of different breeds and sexes, also contribute to establishing the optimal marketage (Faridi *et al.,* 2012).

The results of the descriptive analysis of the variables are shown in Table 1. The mean SBW was 4543.14 ± 656.60 g, with a CV of 14.45% among birds. The observed variability is related to the susceptibility of this variable to external influences such as climatic conditions (Silva *et al.*, 2019); however, a diversified database is desirable for better accuracy (Gomes *et al.,*2021). Regarding HCW and CCW, they showed mean values of 2781.43 ± 496.91 g and 2747.57 ± 487.51 g, respectively, both with a CV > 17%. The high variation observed in HCW and CCW may be due to the values of SBW of the birds. Based on these results, the HDP and CDP were estimated, which in turn had values of around 60%, with a CV of 4.70% for both parameters. Previously, Juárez-Caratachea (2004) reported higher percentages of hot and cold dressing (78.94 and 75.91%, respectively), which were related to the higher slaughter body weigh to the native guajolotes used in that study (7.93 ± 0.69 kg). In poultry production, the dressing percentage is an important criterion for the evaluation of slaughter value of the carcass (Mueller *et al.,* 2018; Nematbakhsh *et al.,* 2021). Overall, carcass characteristics showed moderate variability (<25%), except AFW which had a CV of 92.11% among birds. In this regard, Nematbakhsh *et al.* (2021) found that the variation in body fat content in broilers can be explained by breed, slaughter age and maturity stage of the birds. Internal fat is considered to be the most variable body component in farm animals (Bautista-Díaz *et al.,* 2020). On the other hand, the primal cut weights extracted from the carcass showed moderate variability (10.59-33.39%). The greatest variation was observed in back and breast weights, which showed a CV of 33.39% and 28.30%, respectively. This variability may be associated with the lack of genetic improvement practices due to the fact that these native poultry have remained unselected over the years since they are raised in extensive or backyard conditions (Juárez-Caratachea *et al.,* 2019). However, Juárez-Caratachea (2004) suggests that variability among native guajolotes with respectto a particular trait represents an advantage in the systematic selection of the best individuals for the purpose of improving this characteristic. Finally, the BMs showed low variability (4.20-10.15%), which is consistent with the results in other studies (Ríos *et al.,* 2016; Portillo-Salgado *et al.,* 2020), which reported moderate or low morphological variability in the populations of native guajolotes reared in rural regions of Mexico.

The results of the Pearson correlation coefficients (r) are shown in Table 2. The SBW and BMs showed moderate to high positive correlations (p<0.01; 0.34≤r<0.97) with carcass characteristics and primal cut weights, except for WL, which had a positive correlation (p<0.01) onlywith BRW (r = 0.35). These high correlations indicate elevated meat production capacity, and these measurements can thus be used as selection tools (Silva *et al.*, 2019). However, SL presented a negative correlation (p<0.01) with AFW (r = -0.56) and BAW (r = -0.33). This means that birds with shorter shanks have a greater weight of abdominal fat and back, and vice versa. Juárez-Caratachea (2004) reported, in native male guajolotes, that SBW presented moderate to high positive correlations (0.38≤r<0.90) with carcass characteristics and breast, leg and thigh weights. The strong relationship between bodyweight and the breast and thigh weights is due to the fact that in these parts of the carcass there is greater deposition of muscle tissue (Ogah, 2011). Other studies in chickens (Melo *et al.,* 2003; Yang *et al.,* 2006; Mendeş & Akkartal, 2009; Yakubu *et al.,* 2009; Erensoy *et al.,* 2020), ducks (Bochno *et al.,* 2000; Kleczek *et al.,* 2006; Kokoszyňski *et al.,* 2019), and guinea fowl (Ogah, 2011) also reported high and significant correlations between bodyweight and body measurements with carcass characteristics and primal cut weights. This suggests that bodyweight and body measurements could be used as reliable predictors of carcass composition.

The regression equations developed to predict carcass characteristics and primal cut weights are presented in Tables 3 and 4. For HCW, two equations explained (p<0.001) between 95 [Eq.1] and 96% [Eq. 2] of the observed variation. Of these, Equation [2], which included SBW and KL as predictors, was the best model to predict HCW because it had lower values of RMSE (98.84), AIC (324.41), and BIC (326.95). Instead, for CCW, the SBW explained (p<0.001) by itself a 95% of the variation observed in the model [Eq. 3], with RMSE, AIC and BIC values of 104.40, 327.32 and 329.55,

Table 1 – Descriptive analysis of the body measurements, carcass characteristics and primal cut weights in native Mexican guajolotes (n = 36).

Variable	Description	Mean ± SD	Minimum	Maximum	CV (%)
Body measurements					
SBW	Slaughter body weight (g)	4543.14 ± 656.60	3465.00	5655.00	14.45
TP	Thoracic perimeter (cm)	47.04 ± 4.45	37.80	55.60	9.47
BC	Body circumference (cm)	46.04 ± 3.27	39.40	51.50	7.11
BL	Body length (cm)	40.33 ± 4.09	31.80	48.30	10.15
WL	Wing length (cm)	33.28 ± 1.40	30.40	39.60	4.20
KL	Keel length (cm)	16.29 ± 0.90	14.80	18.50	5.52
SL	Shank length (cm)	13.21 ± 0.65	11.80	14.30	4.92
SD	Shank diameter (cm)	1.86 ± 0.12	1.70	2.20	6.52
Carcass characteristics and primal cut weights					
HCW	Hot carcass weight (g)	2781.43 ± 496.91	1960.00	3675.00	17.86
CCW	Cold carcass weight (g)	2747.57 ± 487.51	1940.00	3640.00	17.74
HDP	Hot dressing percentage (%)	60.94 ± 2.86	55.60	67.43	4.70
CDP	Cold dressing percentage (%)	60.22 ± 2.83	54.72	66.79	4.70
VIS	Organs and viscera weight (g)	589.05 ± 126.05	378.20	819.40	21.39
AFW	Abdominal fat weight (g)	12.74 ± 11.73	6.50	36.00	92.11
BRW	Breast weight (g)	872.57 ± 246.96	510.00	1300.00	28.30
THW	Thigh weight (g)	480.85 ± 50.92	355.00	570.00	10.59
DRW	Drumstick weight (g)	457.57 ± 61.83	360.00	595.00	13.51
BAW	Back weight (g)	373.28 ± 125.04	190.00	585.00	33.39
WIW	Wing weight (g)	376.42 ± 42.90	295.00	460.00	11.39

SD = Standard deviation; CV = Coefficient of variation.

Table 2 – Pearson correlationcoefficients(r) amongthe variables used in thedevelopmentoftheequations.

	SBW	TP	BC	BL	WL	KL	SL	SD
HCW	0.97^{***}	0.69^{***}	0.84^{***}	0.61^{***}	0.24^{ns}	0.55^{***}	-0.22^{ns}	0.37^{**}
CCW	0.97^{***}	0.70^{***}	0.85^{***}	0.61^{***}	0.25^{ns}	0.55^{***}	-0.24^{ns}	0.38^{**}
HDP	0.67^{***}	0.49^{***}	0.57^{***}	0.40^{**}	0.15^{ns}	0.26^{ns}	-0.12^{ns}	0.29^{ns}
CDP	0.64^{***}	0.51^{***}	0.58^{***}	0.40^{**}	0.15^{ns}	0.24^{ns}	-0.19^{ns}	0.30^{ns}
VIS	0.79^{***}	0.40^{**}	0.53^{***}	0.41^{**}	-0.00^{ns}	0.30^{ns}	-0.08^{ns}	0.24^{ns}
AFW	0.66^{***}	0.50^{***}	0.61^{***}	0.47^{***}	-0.00^{ns}	0.46^{***}	-0.56^{***}	0.15^{ns}
BRW	0.93^{***}	0.75^{***}	0.87^{***}	0.68^{***}	0.35^{**}	0.58^{***}	-0.33^{ns}	0.26^{ns}
THW	0.76^{***}	0.49^{***}	0.59^{***}	0.40^{**}	0.09^{ns}	0.43^{***}	-0.24^{ns}	0.34^{**}
DRW	0.88^{***}	0.62^{***}	0.75^{***}	0.52^{***}	0.16^{ns}	0.45^{***}	-0.18^{ns}	0.49^{***}
BAW	0.89^{***}	0.53^{***}	0.70^{***}	0.53^{***}	0.09^{ns}	0.58^{***}	-0.33^{**}	0.23^{ns}
WIW	0.80^{***}	0.47^{***}	0.68^{***}	0.31^{ns}	0.18^{ns}	0.24^{ns}	0.03^{ns}	0.47^{***}

HCW = Hot carcassweight; CCW = Coldcarcassweight; HDP = Hot dressingpercentage; CDP = Colddressingpercentage; VIS = Organs and visceraweight; AFW = Abdominal fatweight; BRW = Breastweight; THW = Thighweight; DRW = Drumstickweight; BAW = Back weight; WIW = Wingweight; SBW = Slaughterbodyweight; TP = Thoracicperimeter; BC = Bodycircumference; BL = Bodylength; WL = Winglength; KL = Keellength; SL = Shanklength; SD = Shankdiameter;

$^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<.001$; ^{ns} non-significant.

respectively. It was observed that the SBW contributed a high percentage of the variation for HCW and CCW. These findings are consistent with previous studies in poultry (Bochno *et al.,*2000; Raji *et al.,* 2010; Banerjee, 2011), which reported that body weight accounted for a high proportion of the variation in carcass weight. However, the inclusion of body measurements in the models, such as chest circumference, breast width, body length, wing length and keel length, improves their accuracy (Yakubu *et al.,* 2009; Ogah, 2011; Behiry *et al.,* 2019). In the same way, the models to predict HDP [Eqs. 4 and 5] were fitted using the SBW and KL as predictor variables. However, Equation [5], compared toEquation [4], had the best goodness of fit due to its lower values of RMSE (2.09 *vs* 2.14), AIC (54.75 *vs* 55.28) and BIC (57.39 *vs* 57.32), as well as the highest prediction capacity (R^2 = 0.49). For the prediction of CDP, a single Equation [6] was fitted, with R^2 = 0.40; in this case, only SBW was included as a predictor. The equations developed to predict VIS [7-10] showed an R^2 that ranged between 0.62 and 0.79. In these models, SBW, BC, WL and KL were included as predictor variables, with Equation [10] having the best goodness of fit (RMSE = 60.96, AIC = 292.33 and BIC = 295.94), and explained 79% of the variation observed in the model. Regarding the prediction of AFW, the variables that were included in the models [Eqs. 11 and 12] were SBW and SL, providing an increase in R^2 from 0.44 to 0.61. However, Equation [12] which included both variables presented lower RMSE (7.50), AIC (143.98) and BIC (146.52) values. In broilers, Melo *et al.* (2003) reported that abdominal fat weight can be predicted with good accuracy (R^2 = 0.74) using a regression equation that included live weight and abdominal fat surface. In another study (Raji *et al.,* 2010), using the same type of poultry, a prediction model was developed for fat weight that presented an R^2 of 0.86, using the chest girth, chest depth, chest width, live weight and wing length, as predictor variables. Similarly, Kleczek *et al.* (2006) reported that carcass fat weight of male Muscovy ducks can be estimated from a regression model that included bodyweight, humerus length and chest depth. The high precision of the model developed in the study was confirmed with the coefficients of multiple correlation (r = 0.87) and determination (R^2 = 0.75). Recently, Lin *et al.* (2018) fitted an equation to predict abdominal fat weight in Pekinducks using live weight, skin fat thickness, chest width and neck length, showing a r = 0.58 and R^2 = 34.65%.

In the prediction of BRW, in addition to the SBW, two body measurements (BC and SD) were added to the models [Eqs. 13-15] (Table 4). Equation [13], using SBW as the only predictor, explained 87% of the variation observed in the model. However, the inclusion of body measurements provided a light increase in R^2 of 4%, reaching a precision of 91% and lower values of RMSE (77.51), AIC (308.28) and BIC (311.28). Previously, Rymkiewicz & Bochno (1998) suggested the use of live weight and thickness of breast muscles, in a practical and accurate model (R^2 = 0.972) for the prediction of breast meat weight in broilers. Similarly, Melo *et al.* (2003) reported that the best model for the prediction of breast weight in broilers was the simple regression of live weight because it had an R^2 of 0.85, with a residual standard error of 32.34 g. In male Muscovyducks, Kleczek *et al.* (2006) proposed a regression equation that included bodyweight, breast-bone crest length and chest girth to estimate breast muscle weight. The model showed a multiple correlation coefficient between the dependent

Table 3 – Regressions equations to predict the carcass characteristics using body measurements in native Mexican guajolotes (*n* = 36).

Eq. No.	Equations	R^2	RMSE	AIC	BIC	*p*-value
Hot carcassweight (g)						
[1]	HCW = –587.08 (±121.11***) + 0.74 (±0.02***) × SBW	0.95	101.04	325.03	327.26	<0.0001
[2]	HCW = –118.14 (±319.97ns) + 0.77 (±0.03***) × SBW – 37.60 (±23.83^{ns}) × KL	0.96	98.84	324.41	326.95	<0.0001
Coldcarcassweight (g)						
[3]	CCW = –549.65 (±125.14***) + 0.72 (±0.02***) × SBW	0.95	104.40	327.32	329.55	<0.0001
Hot dressingpercentage (%)						
[4]	HDP = 47.50 (±2.56***) + 0.002 (±0.000***) × SBW	0.45	2.14	55.28	57.32	<0.0001
[5]	HDP = 57.28 (±6.79***) + 0.003 (±0.000***) × SBW – 0.78 (±0.50^{ns}) × KL	0.49	2.09	54.75	57.29	<0.0001
Colddressingpercentage (%)						
[6]	CDP = 47.66 (±2.64***) + 0.002 (±0.000***) × SBW	0.40	2.20	57.44	59.68	<0.0001
Organs and visceraweight (g)						
[7]	VIS = –100.22 (±93.96^{ns}) + 0.15 (±0.02***) × SBW	0.62	78.39	307.26	307.57	<0.0001
[8]	VIS = 473.30 (±211.43*) + 0.24 (±0.03***) × SBW – 21.65 (±7.31**) × BC	0.70	70.53	300.79	301.63	<0.0001
[9]	VIS = 954.39 (±273.20**) + 0.27 (±0.03***) × SBW – 21.11 (±6.77**) × BC – 39.73 (±15.74*) × KL	0.75	65.27	296.25	298.13	<0.0001
[10]	VIS = 1515.53 (±349.27***) + 0.27 (±0.03***) × SBW – 18.26 (±6.44**) × BC – 18.65 (±7.92*) × WL – 44.66 (±14.85**) × KL	0.79	60.96	292.33	295.94	<0.0001
Abdominal fatweight (g)						
[11]	AFW = –41.23 (±10.66**) + 0.01 (±0.002***) × SBW	0.44	8.89	154.95	155.85	<0.0001
[12]	AFW = 69.66 (±30.61*) + 0.009 (±0.002***) × SBW – 7.73 (±2.04**) × SL	0.61	7.50	143.98	146.52	<0.0001

R^2 =Determinationcoefficient; RMSE = Root mean square error; AIC =AkaikésInformationCriterion; BIC =BayesianInformationCriterion; SBW = Slaughterbodyweight; TP = Thoracicperimeter; BC = Bodycircumference; BL = Bodylength; WL = Winglength; KL = Keellength; SL = Shanklength; SD = Shankdiameter.

$^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<.001$; ^{ns}: non-significant.

variable and the set of independent variables of 0.77, while the R^2 was 59.29%. For female ducks, the cited authors suggested an equation that included bodyweight, breast-bonecrest length, and breast muscle thickness. The developed model presented higher values of the multiple correlation coefficient (0.80) and of R^2 (64.16%), than the equation based on data for males. For the estimation of THW, SBW was the only independent variable that was included in the prediction model [Eq. 16], which had an R^2 of 0.58. Raji *et al.* (2010) found that thigh weight of male broilers was predicted with high accuracy (r = 0.91; R^2 = 0.83) based on live weight, chest width and chest girth, while for females the independent variables were chest girth, chest width, live weight and chest depth (r = 0.94; R^2 = 0.88). Regarding the DRW prediction, the variables that were included in the models were SBW and SD [Eqs. 17 and 18]. It was observed that the SBW alone can explain 78% of the variation of the dependent variable, but with the inclusion of SD in Equation [18], the precision had a light increase (R^2 = 0.81) and the model showed a best fit (RMSE = 27.41, AIC = 234.64, BIC = 237.18). Three equations were generated to predict BAW [Eqs. 19-21], which showed an R^2 ranging between 0.79 and 0.83. In this case, SBW associated with WL and SD were selected as predictor variables. Finally, the models developed to predict WIW [Eqs. 22-25] explained from 64 to 80% of its variation, being the model of Equation [25] the one that had a slightly better goodness of fit (RMSE = 20.16, AIC = 214.88 and BIC = 218.49). Although both back and wings are considered low-value carcasscuts, it is known that in poultry up to 32% of total lean meat is found in these body parts, as well as in the neck (Bochno *et al.*, 2003; 2005).

CONCLUSION

In conclusion, our results suggest that slaughter body weight can be used together with the body measurements as predictive variables of carcass characteristics and primal cut weight of native Mexican guajolotes. The prediction equations obtained in the study had moderate to high accuracy ($R^2 > 0.40 \leq$ and ≤ 0.96); therefore, they can be used by researchers, technicians and poultry producers to obtain information on the carcass composition of native guajolotes. Further studies should evaluate the use of these equations under different production conditions.

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Table 4 – Regressions equations to predict the primal cuts weights using body measurements in native Mexican guajolotes (*n* = 36).

Eq. No.	Equations	R^2	RMSE	AIC	BIC	*p*-value
Breastweight (g)						
[13]	$BRW = -723.72\ (\pm 107.20^{**}) + 0.35\ (\pm 0.02^{***}) \times SBW$	0.87	89.44	316.49	317.58	<0.0001
[14]	$BRW = -1278.50\ (\pm 250.36^{***}) + 0.26\ (\pm 0.04^{***}) \times SBW + 20.94\ (\pm 8.66^{*}) \times BC$	0.89	83.52	312.62	314.26	<0.0001
[15]	$BRW = -960.94\ (\pm 265.25^{**}) + 0.25\ (\pm 0.04^{***}) \times SBW + 26.80\ (\pm 8.37^{**}) \times BC - 305.03\ (\pm 122.92^{*}) \times SD$	0.91	77.51	308.28	311.28	<0.0001
Thighweight (g)						
[16]	$THW = 210.39\ (\pm 39.71^{**}) + 0.05\ (\pm 0.008^{***}) \times SBW$	0.58	33.13	246.97	249.20	<0.0001
Drumstickweight (g)						
[17]	$DRW = 78.40\ (\pm 34.86^{*}) + 0.08\ (\pm 0.007^{***}) \times SBW$	0.78	29.08	237.85	239.61	<0.0001
[18]	$DRW = -68.09\ (\pm 72.50^{ns}) + 0.07\ (\pm 0.007^{***}) \times SBW + 94.57\ (\pm 0.41.72^{*}) \times SD$	0.81	27.41	234.64	237.18	<0.0001
Back weight (g)						
[19]	$BAW = -399.22\ (\pm 68.51^{***}) + 0.17\ (\pm 0.01^{***}) \times SBW$	0.79	57.15	285.14	287.38	<0.0001
[20]	$BAW = 2.38\ (\pm 224.99^{ns}) + 0.17\ (\pm 0.01^{***}) \times SBW - 13.03\ (\pm 6.97^{ns}) \times WL$	0.81	55.11	283.52	286.07	<0.0001
[21]	$BAW = 410.24\ (\pm 289.08^{ns}) + 0.19\ (\pm 0.01^{***}) \times SBW - 17.44\ (\pm 6.96^{*}) \times WL - 175.49\ (\pm 83.66^{*}) \times SD$	0.83	52.40	280.88	283.88	<0.0001
Wingsweight (g)						
[22]	$WIW = 138.37\ (\pm 31.17^{***}) + 0.05\ (\pm 0.006^{***}) \times SBW$	0.64	26.01	230.04	232.27	<0.0001
[23]	$WIW = 368.97\ (\pm 73.39^{***}) + 0.06\ (\pm 0.007^{***}) \times SBW - 18.49\ (\pm 5.46^{**}) \times KL$	0.73	22.67	221.34	223.89	<0.0001
[24]	$WIW = 398.78\ (\pm 70.24^{***}) + 0.07\ (\pm 0.008^{***}) \times SBW - 2.69\ (\pm 1.18^{*}) \times BL - 16.06\ (\pm 5.24^{**}) \times KL$	0.77	21.31	217.92	220.92	<0.0001
[25]	$WIW = 291.01\ (\pm 83.14^{**}) + 0.07\ (\pm 0.007^{***}) \times SBW - 2.54\ (\pm 1.12^{*}) \times BL - 15.93\ (\pm 4.96^{**}) \times KL + 66.32\ (\pm 30.76^{*}) \times SD$	0.80	20.16	214.88	218.49	<0.0001

R^2 =Determinationcoefficient; RMSE = Root mean square error; AIC =AkaikésInformationCriterion; BIC =BayesianInformationCriterion; SBW = Slaughterbodyweight; TP = Thoracicperimeter; BC = Bodycircumference; BL = Bodylength; WL = Winglength; KL = Keellength; SL = Shanklength; SD = Shankdiameter.

$^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<.001$; ^{ns}: non-significant.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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