Effects of slaughter age and gender on carcase characteristics and meat quality of native Mexican Turkey (M. g. gallopavo) reared under an extensive production system

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ABSTRACT

The study aimed to investigate the effects of slaughter age and gender on carcase characteristics and meat quality of native Mexican turkeys raised under an extensive production system. Forty-five native turkeys (36 males and 9 females) were used. They were sacrificed at 24, 32, and 40 weeks of age. Slaughter age significantly affected slaughter weight (SW), hot carcase weight (HCW) and cold carcase weight (CCW). Also, dressing percentages, non-carcase components, internal organs, abdominal fat, and most carcase parts and proportions were affected. Gender significantly affected SW, HCW and CCW, non-carcase components, internal organs, and carcase parts weights. Regarding the physical properties of breast and leg meat, pH values and colour parameters taken at 45 min and 24 h post-mortem, as well as the water-holding capacity (WHC), cooking (CL), and drip loss (DL), were significantly affected by slaughter age, except CL in leg meat. Meanwhile, gender influenced L*\textsubscript{45min}, b*\textsubscript{24h}, the pH\textsubscript{24h} values, and CL in breast meat. Concerning the chemical composition of the meat, slaughter age had a significant effect on the ether extract (EE) content of breast meat and on dry matter (DM), crude protein (CP), EE, ash, and energy contents of leg meat. Gender significantly affected the DM, CP, and energy contents of breast meat and DM, EE, and energy contents of leg meat. These results indicate that the carcase weight and yield, and its components, as well as meat quality, were better in older male turkeys than in adult females.

HIGHLIGHTS

- Slaughter age and gender significantly influence carcase yield and composition and as well as meat quality in native Mexican turkeys raised under extensive traditional conditions.
- It is recommended that native turkeys be slaughtered at around 40 weeks to obtain more acceptable carcase yields and meat of better nutritional value.
- The native Mexican turkey is a viable poultry resource for ecological production systems.

Introduction

Currently, poultry meat is one of the most consumed foods of animal origin worldwide since it provides proteins, vitamins, and minerals of high biological value, essential nutrients in the human diet (Marangoni et al. 2015). Thus, poultry meat contributes to the nutrition and food security of the population, especially in developing countries (Mottet and Tempio 2017). In recent years, a trend has been observed in the consumption of poultry meat produced from ecological or organic production systems, as they provide a good image for the product and environmental sustainability, improved animal welfare and meat quality (Aksoy et al. 2021; Cobanoglu et al. 2014; Dal Bosco et al. 2021; Özbek et al. 2020; Uhlírová et al. 2018). In these production systems, poultry must have access to an abundance of fresh air, daylight, and outdoor space. Specifically, every effort has to be made to allow chickens to live as natural a life as possible (Dal Bosco et al. 2021). Likewise, greater use of local and native...
poultry genotypes has also been promoted as an alternative to commercial genotypes because they produce meat with high nutritional value with more protein and less fat (Dalle Zotte et al. 2019). In addition, its production is cheap since it requires fewer inputs and less labour than intensively farmed poultry (Boz et al. 2019; Kokoszyński et al. 2020; Onk et al. 2019; Uhlírová et al. 2018).

Turkeys (Meleagris gallopavo gallopavo) are poultry native to Mexico with interesting biological and productive characteristics for ecological or organic poultry production systems (Portillo-Salgado et al. 2022). They show slow growth because they have been kept unselected over the years; however, they are characterised by their excellent muscle development and little carcass fat (Juárez-Caratachea 2004). In addition, native turkeys are incredibly resilient. They have good adaptability and natural resistance against some common poultry diseases due to their ability to develop antibodies, allowing them to thrive under various climatic conditions (Camacho-Escobar et al. 2008).

The raising of native turkeys has a long tradition in Mexico and other Central American countries (Ramírez-Rivera et al. 2012). It is a crucial poultry activity for small and medium producers since it allows them to obtain meat for self-consumption and sale, contributing to families’ food and economic sustenance (García-Flores and Guzmán-Gómez 2016). This poultry is traditionally bred in extensive conditions and grazed in open spaces, cultivated areas, or backyards to diversify and complement their diet through herbs, grasses, fruits, seeds, worms, and insects (Portillo-Salgado et al. 2018). At the same time, this production system generates an environment of wellbeing and improves the birds’ physical condition (Cigarroa et al. 2017).

In poultry, carcass characteristics and meat quality properties are affected by numerous factors, including age at slaughter, gender, genotype, diet, production system, environment, and procedures before and after slaughter (Baéza et al. 2022). Therefore, it is crucial to evaluate these factors to regulate and optimise their production and allocate added value based on the quality of the product (Onk et al. 2019). In particular, the meat of native turkeys is considered one of the healthiest meats since it contains low cholesterol and fat levels (Gallardo-Nieto et al. 2007). In addition, it has a good flavour and aroma, which are attractive sensory attributes for consumers (Ramírez-Rivera et al. 2012). These qualities contribute to the acceptance of native turkeys’ meat, which facilitates its adoption. However, there is not enough scientific data on the characteristics of the carcase and the technological and nutritional value of native turkey meat (López et al. 2011). The influence of age at slaughter and gender on these parameters has not been evaluated.

Therefore, the purpose of this study was to evaluate the effects of slaughter age and gender on carcass characteristics, physical properties, and chemical composition of breast and leg meat from native Mexican turkey raised under a system of extensive production. This information is essential for the sustainable use of this native poultry resource raised under a production model that represents a potential source in the supply of organic products to meet the demands of the current poultry market.

Materials and methods

Ethics statement

All the experimental procedures used in this study were approved by the Animal Welfare Committee (COBIAN) of the Colegio de Postgraduados. They complied with the standards for regulating the use and care of animals used for research (Approval number: COBIAN 002/21).

Birds and design of the experiment

The experiment was carried out in a poultry production unit in Sihochac, Champotón, Campeche, Mexico (19.49° 21’ N, 90.58° 20’ W; 24 m.a.s.l.). The area is characterised by a warm sub-humid climate with summer rainfall A(w), temperatures that oscillate between 18 and 30 °C, and total annual precipitation of 1600 mm (INEGI 2009).

The study period was from June to December 2021. The experimental material consisted of a total of 45 native turkeys, comprising 36 males and 9 females, with an age of 12 weeks and a mean initial body weight of 2238.13 ± 485.45 g and 1825.00 ± 268.48 g, respectively. The birds were randomly collected in different poultry production units from rural communities in Champotón, Campeche, where they are traditionally raised under extensive production systems (Portillo-Salgado et al. 2018). All birds were dewormed and vaccinated upon arrival, and an adaptation period of 15 d was given. Animals had outdoor access during the day (7:00 to 18:00 h) and were kept at night in a poultry house with walls and floor made of concrete. The floor was covered with a 10 cm thick wood chip bed. Feeders and drinkers were installed.

The feeding of the birds consisted of domestic organic waste, such as tortillas, bread, and vegetables;
tomato (Solanum lycopersicum), lettuce (Lactuca sativa L.), potato (Solanum tuberosum), cabbage (Brassica oleracea), and onion (Allium cepa). They also had access to fruits such as papaya (Carica papaya), avocado (Persea americana), sapote (Manilkara zapota), maney (Pouteria sapota), mango (Mangifera indica), and carambola (Averrhoa carambola). The grazing areas were covered with the grass(es) Cynodon dactylon, Urochloa brizantha cv. Marandu, and Pennisetum purpureum. Additionally, the birds received a mixed diet that included: 60% corn, 20% wheat bran, and 20% soybean meal that contained 17% crude protein (CP) and 11.90 MJ of metabolisable energy (ME/kg) (National Research Council (NRC) 1994). Feed and water were available ad libitum.

**Slaughter and carcase characteristics**

Fifteen turkeys (12 males and 3 females) were humanely killed at different slaughter ages (24, 32, and 40 weeks). Slaughter weight (SW) was recorded after 10 h of fasting with free access to clean water. The birds were humanely slaughtered by exsanguination following 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. Later, the carcases were scalded in hot water (60–65 °C) for 2 min to facilitate manual plucking. Head, feet, internal organs (edible and non-edible), and abdominal fat were removed and weighed. Subsequently, the carcases were weighed to obtain the hot carcase weight (HCW), and they were stored at +4 °C for 24 h to obtain the cold carcase weight (CCW). The percentages of hot and cold dressing were determined relative to the SW. Carcase dissection was performed as described by Hahn and Spindler (2002). Carcase parts weights and their percentages relative to the CCW were determined (Yamak et al. 2018).

**Evaluation of meat physical properties**

The physical properties of the breast (Pectoralis major) and leg (thigh and drumstick) meat without skin were analysed. Meat colour was measured at 45 min and 24 h post-mortem using a colorimeter (Model CR-400, Konica Minolta®, Tokyo, Japan), recording the lightness (L*), redness (a*), and yellowness (b*) values recommended by the manufacturer (CIE 1986). Three replicate measurements were made of these variables and their average was recorded for each sample. The pH values were taken at the same sampling points using a portable pH metre (Model HI 99161, Hanna Instruments®, USA) equipped with a glass electrode, which was introduced to a depth of one cm in the cross-section of the muscle (Uhlířová et al. 2018). The pH metre was previously calibrated using two calibration buffers (pH 4.0 and 7.0).

The water-holding capacity (WHC) of the meat was determined by placing ground meat samples (20 g) on absorbent gauze inside sealed plastic bags and cooking in a water bath at 85 °C for 10 min (Kokoszyński et al. 2020). Cooked meat samples were chilled at +4 °C for 30 min and dried with paper towels. The CL was expressed as the ratio between the weight before and after cooking. Drip loss (DL) was determined by placing ground meat samples (20 g) in two sealable bags (one of the bags was perforated to allow dripping) and storing them at +4 °C for 24 h (Kokoszyński et al. 2020). The LD was expressed as the percentage of weight loss of the sample concerning its weight recorded before the refrigeration period. WHC, DL, and CL measurements were performed in triplicate and the average was calculated.

**Chemical composition of meat**

The chemical composition analysis of breast (Pectoralis major) and leg (thigh and drumstick) meat without skin was carried out according to the methods approved by the AOAC (1990). Dry matter (DM) content (%) was calculated by freeze-drying the sample using a freeze-dryer (LABCONCO®). Crude protein (CP) (%) was determined by combustion according to the Dumas method (AOAC 2005; method 990.03). The ether extract content (%) was determined with diethyl ether using the Soxtec method or immersion method (Thiex et al. 2003), approved by the AOAC (2000; method 991.36). Ash content (%) was determined by incineration at 600 °C for 2 h (AOAC 1995; method 942.05), whereas gross energy content by combustion using calorimetric equipment (IKA® C200 BASIC).

**Statistical analysis**

Data analysis was performed using the SAS ver. 9.4 statistical package (SAS Institute Inc., Cary, NC 2016). A
Shapiro–Wilks test was performed to evaluate the normality of data. The results of the carcase characteristics, physical properties and chemical composition of meat were analysed by a two-way ANOVA that considered slaughter age (A) and gender (G) as fixed effects (PROC GLM). A × G interaction was also analysed. The model used was:

\[ Y_{ijk} = \mu + A_i + G_j + (A \times G)_{ij} + e_{ijk} \]

where: \( Y_{ijk} \) is the response variable (carcase characteristics, physical properties, and chemical composition of meat); \( \mu \) is the overall mean common to all observations; \( A_i \) is the effect of the age (24, 32, and 40 weeks); \( G_j \) is the effect of the gender (male and female); \( (A \times G)_{ij} \) is an interaction of age with gender; \( e_{ijk} \) is the random error with mean 0 and variance \( \sigma^2 \). Bonferroni’s test assessed significant differences among means. Differences were considered significant at \( p < 0.05 \). For statistical analyses, the individual bird was the experimental unit.

**Results and discussion**

**Slaughter weight and carcase characteristics**

Until now, this is the first study to explore the effects of age at slaughter and gender on carcase characteristics and meat quality of native Mexican turkeys raised under an extensive production system. The SW and carcase characteristics of native Mexican turkeys are under an extensive production system. The SW and carcase characteristics of native Mexican turkeys are presented in Table 1. SW, HCW, and CCW were affected by slaughter age (<0.001); however, the mean values of these traits were significantly different (<0.05) only in males, they were higher at 32 and 40 weeks of age. Old males had 33% more SW and 40% more HCW and CCW than young males. In females, SW, HCW and CCW increased with age, only 23%, 10% and 10%, respectively. Gender had a significant effect (<0.001) on SW, HC, and CCW, with higher values in males than females, except at 24 weeks, where HCW and CCW did not vary significantly (<0.05) between genders.

In the present study, poor weight gain was observed in males and females between 32 and 40 weeks of age. This result could be due to puberty, which in this poultry species is reached between 6 and 9 months of age (Portillo-Salgado et al. 2022). During puberty, male turkeys display aggressive behaviour to demonstrate dominance within the flock, while female turkeys begin laying, which affects feed intake, reducing weight gain rates (Uicab-Sonda 2019). Similar findings were reported by Zawacka et al. (2017) in Green-legged Partridge chickens because during sexual maturity; cockerels show an aversive behaviour to establish hierarchies within the flock, which negatively influences their productive parameters. In hens, the growth curve flattens when they start laying eggs. On the other hand, the differences between male and female turkeys regarding slaughter weight and hot and cold carcase weights could be attributed to the variation in growth patterns due to the effect of sexual dimorphism that characterises the species (Pérez-Lara et al. 2013).

| Slaughter age (weeks) | Gender | Slaughter weight (g) | Hot carcase weight (g) | Cold carcase weight (g) | Hot dressing percentage (%) | Cold dressing percentage (%) |
|-----------------------|--------|---------------------|-----------------------|------------------------|----------------------------|----------------------------|
| 24                    | ♂      | 3802.1<sup>b</sup>  | 2245.4<sup>b</sup>    | 2225.8<sup>b</sup>    | 58.9<sup>b</sup>           | 58.5<sup>b</sup>           |
|                       | ♂      | 2816.7<sup>c</sup>  | 1683.4<sup>b</sup>    | 1675.0<sup>b</sup>    | 59.8<sup>b</sup>           | 59.5<sup>b</sup>           |
| 32                    | ♂      | 4806.7<sup>a</sup>  | 2957.5<sup>a</sup>    | 2900.0<sup>a</sup>    | 61.4<sup>a</sup>           | 60.2<sup>a</sup>           |
|                       | ♂      | 3401.7<sup>c</sup>  | 2141.7<sup>b</sup>    | 2120.0<sup>b</sup>    | 62.9<sup>b</sup>           | 62.2<sup>b</sup>           |
| 40                    | ♂      | 5064.1<sup>c</sup>  | 3174.1<sup>c</sup>    | 3150.4<sup>c</sup>    | 62.6<sup>c</sup>           | 61.1<sup>c</sup>           |
|                       | ♂      | 3440.0<sup>c</sup>  | 1893.4<sup>c</sup>    | 1878.3<sup>c</sup>    | 55.1<sup>c</sup>           | 54.6<sup>c</sup>           |
| RMSE                  |        | 342.12              | 281.19                | 274.71                 | 2.41                       | 2.37                       |

RMSE: root mean square error.
<sup>a-b</sup>Means within columns with no common superscript letter differ significantly (<0.05).
lower carcase yield than those raised under controlled conditions. These results could be related to physical activity and higher energy expenditure of birds raised outdoors, as well as to the inherently variable factors (temperature, photoperiod and light intensity) that characterise production systems with outdoor access (Sarica et al. 2009). The effect of slaughter age × gender interaction was significant for HCW and CCW, as well as for dressing percentages (p < .05, p < .01).

The effects of slaughter age and gender on the non-carcase components, internal organs, and abdominal fat weights of native Mexican turkeys are given in Table 2. Head and foot weights were significantly affected by the factors studied (p < .01, p < .001). Thirty-two and 40-week-old males had heavy heads. The weight of their feet was similar to that of 24-week-old males and 32-week-old females. These results indicate a more significant growth of the head and feet until week 32, after which the weight of these non-carcase components decreases with age. In the study by Musundire et al. (2018), the weight of the head and feet of chickens and guinea fowl decreased with age; in this case, the authors suggest that it is due to the allometric growth of the birds during maturity.

In the present study, the effect of slaughter age was significant (p < .05, p < .001) for liver, heart, spleen, intestines, and abdominal fat weights. The mean values of these variables increased with age, except for total intestinal weight, which did not vary significantly (p > .05) among age groups. In contrast, Sarica et al. (2009) showed that the weights and proportions of edible and inedible internal organs of Big-6 turkeys decreased with age. In poultry, internal organs develop at different rates depending on their functions (Murawska 2013). For example, the development of the heart, liver, gizzard and intestines are completed in the first stages of life, so the proportion of these organs with regard to body weight decreases with age (Sarica et al. 2019; Yamak et al. 2016). Gender had a significant effect (p < .05, p < .001) on the weight of internal organs and abdominal fat, except for the weight of the liver and intestines (p > .05). Male turkeys had heavier internal organs than females due to its larger size and high body weight. Abdominal fat weight was significantly higher (p < .05) in females of all ages. Male turkeys had less abdominal fat in their carcasses than female turkeys, and probably because of differences in metabolic rate and fat accumulation capabilities (Nikolova et al. 2007). Murawska (2013) found that female commercial turkeys develop belly fat at 8 weeks and males at 10 weeks of age, respectively; however, at the time of slaughter, male and female turkeys showed a fat proportion of 2.3 and 1.5%, respectively. Several authors (Boz et al. 2019; Sarica et al. 2009; Uhlířová et al. 2018. Musundire et al. 2018; Yamak et al. 2016) reported that gender has a significant effect on abdominal fat in poultry. The slaughter age × gender interaction had a significant effect (p < .001) on abdominal fat weight.

Carcase parts weights and proportions of native Mexican turkeys are presented in Table 3. Slaughter age showed a significant effect (p < .001) on breast, drumstick, back, neck, and wing weights, with mean values increasing with age. Also, the back and neck proportions increased with age (p < .01, p < .001); on the contrary, the proportion of the thigh decreased. Musundire et al. (2018) reported that the decrease in weights and proportions of some carcase parts with increasing age is due to the allometric growth of poultry. In this study, gender had a significant effect (p < .05, p < .001) on carcase parts weights and proportions, except for thigh and wing proportions (p > .05). Males had significantly higher (p < .05) carcase parts weights than females. That might be due to the variation in the metabolic processes of each gender. Also, the growth rates of the tissue particles lead to changes in the distribution of the tissue components in the carcase parts (Bochno et al. 2005). The breast was the component with the highest weight and proportion in the carcase. In male turkeys between 24 and 40-week-old, breast weight increased from 615.0 to 1073.6 g, while its percentage increased from 27.5 to 34.1%. In female turkeys, breast weight increased from 493.3 to 546.7 g, but breast proportion decreased from 29.4 to 29.1%. Case et al. (2010) mention that the breast increment is due to an accelerated increase in the depth of the muscle. That might be due to the length and width of the breast that remains constant, increasing the bird’s body size. The breast ratios observed in this study were higher than those reported by Safiyu et al. (2019) in local Nigerian turkeys (17.6–18.92%) but lower than those reported by Werner et al. (2008), Damaziak et al. (2013) and Murawska et al. (2015) in different lines of commercial turkeys (28.5–38.8%). Such differences are explained by the greater muscle deposition of commercial turkeys in the breast compared to local genotypes, such as native turkeys, which have not been subjected to selective breeding programs. The effect of the slaughter age × gender interaction was significant (p < .05, p < .01) for weight and proportion of the breast and the proportion of wings.
Table 3. Effects of slaughter age and gender on carcase part weights and ratios of native Mexican turkeys.

| Slaughter age (weeks) | Gender | Breast weight (g) | Breast ratio (%) | Thigh weight (g) | Thigh ratio (%) | Drumstick weight (g) | Drumstick ratio (%) | Back weight (g) | Back ratio (%) | Neck weight (g) | Neck ratio (%) | Wing weight (g) | Wing ratio (%) |
|-----------------------|--------|-------------------|------------------|-----------------|----------------|---------------------|-------------------|----------------|----------------|----------------|---------------|----------------|---------------|
| 24                    | ♀      | 615.0b            | 27.5b            | 449.6b          | 20.2a          | 248.3c              | 18.0a             | 232.1c         | 10.4c          | 210.0bc        | 11.2c         | 280.0bc        | 13.4b         |
| 32                    | ♀      | 493.3b            | 29.4b            | 335.0b          | 20.1a          | 400.0b              | 14.8b             | 190.0b         | 11.2c          | 116.6b         | 7.0b          | 250.0b         | 14.3b         |
| 40                    | ♀      | 600.0b            | 28.2b            | 323.3b          | 15.2b          | 305.0c              | 14.4b             | 355.0b         | 16.8bc         | 131.6b         | 6.3b          | 293.3bc        | 13.9bc        |
| RMSE                  |        | 144.28            | 3.05             | 41.57           | 1.21           | 40.73               | 1.04              | 54.28          | 1.42           | 60.96          | 2.12          | 27.65          | 1.08          |

RMSE: root mean square error.

a>bMeans within columns with no common superscript letter differ significantly (p < 0.05).
The effects of slaughter age and gender on colour parameters and pH values of breast and leg meat from native Mexican turkeys are shown in Table 4. Slaughter age had a significant effect ($p < .001$) on breast and leg meat colour parameters. Damaziak et al. (2013) found higher values of $a^*$ parameter and lower values of the $b^*$ and $L^*$ parameters in the breast and leg meat of male Big-6 turkeys compared to females.

Another trait of importance to consumers and meat processors is pH, as it determines the shelf life of meat. The decreased pH causes less bacterial growth in the meat; therefore, the shelf life of meats with a high pH is shorter (Boz et al. 2019). In the current study, slaughter age had a significant effect ($p < .001$) on breast and leg meat pH values recorded at 24 h post-mortem, which decreased with age (Table 4). Likewise, slaughter age influenced significantly ($p < .001$) the pH value of leg meat taken at 45 min post-mortem, with higher mean values for old turkeys. In this regard, the glycogen content in muscle is predominantly affected by the proportional changes in muscle fibres where the patterns of muscle metabolism may differ. For instance, the breast and legs of older birds tended to have increased glycogen storage, thereby reducing the post-mortem pH (Panpipat et al. 2022). The effect of gender was significant ($p < .05$) only for the pH value of the breast recorded at 24 h post-mortem. In general, the pH values obtained in the present study were not in the intervals which would cause an adverse effect such as pale, soft, exudative meat (Onk et al. 2019). Slaughter age $\times$ gender interaction was not significant ($p > .05$) for pH values. In the study by Sarica et al. (2011), the pH values of breast and thigh meat from Bronze and Hybrid turkeys, and their crosses, were affected by slaughter age, with old turkeys having a lower pH than young turkeys. In another study, Gálvez et al. (2018) found that gender did not significantly influence the pH values of commercial turkeys’ breast and thigh muscles.

| Slaughter age (weeks) | Gender | Colour45min | Colour24h | pH45min | Colour45min | Colour24h | pH24h |
|-----------------------|--------|-------------|-----------|---------|-------------|-----------|-------|
|                       |        | $L^*$   $a^*$  $b^*$  | $L^*$   $a^*$  $b^*$  | $L^*$   $a^*$  $b^*$  | $L^*$   $a^*$  $b^*$  |
| 24                    | ♀      | 5.8b  47.6ab  1.1b  3.7b  | 5.9a  46.2ab  1.5a  3.2b  | 5.8a  44.6abc  2.3b  4.3a  | 5.9a  45.9ab  3.2a  4.9a  |
|                       | ♂      | 5.8a  45.9ab  1.2ab  2.1ab  | 5.9a  45.1ab  1.1a  1.5b  | 5.8a  45.3abc  2.2b  3.8a  | 5.8a  45.4abc  2.2a  4.8a  |
| 32                    | ♀      | 5.7a  54.5a  2.2a  1.1b  | 5.4a  49.5ab  2.6a  1.1b  | 5.9a  49.1ab  4.5b  2.3a  | 5.6b  45.0ab  6.4a  1.8a  |
|                       | ♂      | 5.6a  47.3ab  2.3ab  0.4b  | 5.6b  46.2ab  2.9b  1.3b  | 6.1ab  47.5ab  4.6b  1.6a  | 5.7b  39.9abc  8.7ab  3.9ab  |
| 40                    | ♀      | 5.8a  38.8a  2.7a  2.7ab  | 5.5b  41.7ab  1.1a  0.7b  | 6.2ab  36.7a  9.3a  3.4a  | 5.6b  34.7a  8.8a  1.4ab  |
|                       | ♂      | 5.8a  40.2a  2.6a  2.2ab  | 5.6b  40.7a  1.4a  0.9b  | 6.3a  36.7a  9.3a  3.4a  | 5.6b  34.7a  8.8a  1.4ab  |
| RMSE                  |        | 0.178 4.152 0.755 1.142  | 0.102 3.613 0.881 0.756  | 0.153 4.929 1.774 1.754  | 0.119 4.008 1.632 1.392  |

RMSE: root mean square error.

$\text{ab}$Means within columns with no common superscript letter differ significantly ($p < 0.05$).
The cited authors also reported that breast muscle had lower pH values than thigh muscle. Similarly, in our study, the pH in breast meat was lower than in leg meat; this is because, usually, breast meat consists of type IIB fibres which has high glycogen content. This characteristic of breast meat is related to higher lactic acid accumulation post-mortem than thigh meat (Panpipat et al. 2022).

Water-holding capacity (WHC) is an essential technological attribute of meat quality that determines its ability to retain juice when applying external forces, such as cutting, heating, grinding or pressing, and can be assessed through water loss, cooking or dripping (Sarica et al. 2011). If WHC is low, more water could be released during raw meat storage, processing and storing after meat processing resulting in weight losses in the final product as well as economic losses (Onk et al. 2019). The effects of slaughter age and gender on WHC, CL, and DL of breast and leg meat from native Mexican turkeys are given in Table 5. Slaughter age had a significant effect (p < 0.001) on WHC, CL, and DL of breast meat, as well as on WHC and DL of leg meat, with mean values that increased with age. In contrast, Sarica et al. (2011) reported that thigh meat from commercial turkeys of 21-week-olds had a lower WHC than thigh meat from turkeys of 17-week-old (40% vs. 47%). In the same experiment, no significant effect of slaughter age was observed on the WHC of breast meat. Higher WHC values might be attributed to slaughter age influence as well as higher pH values. Also, muscle proteins might be denatured at higher pH values and so WHC is decreased (Onk et al. 2019). In our study, the effect of gender was significant (p < 0.05) for CL in breast meat, with males showing significantly higher values than females. Damaziak et al. (2013) reported that breast and leg meat from hybrid and local male turkeys had higher WHC and CL values than meat from female turkeys. For their part, Sarica et al. (2011) reported that the breast meat of female commercial turkeys had a higher WHC than that of males. These authors also observed a significant effect of the genotype × gender interaction on the WHC of thigh meat. Differences in cooking losses with respect to slaughter age and gender might be attributed to different proteins solubility (especially collagen) and to different fat content. Cooking temperature and ultimate pH could also play a role (Uhlírová et al. 2018). The variation in the experimental methodologies used in each study could also influence the results obtained. There was no effect of slaughter age × gender interaction on WHC, CL, and DL of breast and leg meat.

### Chemical composition of meat

The effects of slaughter age and gender on the chemical composition of the breast and leg meat of native Mexican turkeys are shown in Table 6. The slaughter age had a significant effect (p < 0.05) on the content of ether extract of the breast meat, as well as the contents of dry matter, crude protein, ether extract, ash, and energy of the leg meat (p < 0.001). Young turkeys had a higher percentage of ether extract (2.4–2.2%) in the breast meat; in contrast, old turkeys had high percentages of dry matter (28.9–25.1%), crude protein (20.6–20.2%), ether extract (6.0–2.3%) and energy (1692.5–1231.3 cal g⁻¹), but low percentages of ash content (1.1–0.9%) in leg meat. On the other hand, the dry matter, crude protein, and energy content of breast meat and the dry matter, ether extract and energy content of leg meat were significantly (p < 0.05, p < 0.001) affected by gender (Table 6). The breast meat of the females had higher contents of dry matter (28.0–26.8% vs. 26.5–25.7%), crude protein (23.2–22.9% vs. 22.9–21.5%), and energy (1406.9–1314.4 cal g⁻¹ vs. 1322.6–1241.6 cal g⁻¹) than those observed in males.

### Table 5. Effects of slaughter age and gender on water-holding capacity, cooking loss and drip loss in breast and leg meat.

| Slaughter age (weeks) | Gender | Breast meat | Leg meat |
|-----------------------|--------|-------------|----------|
|                       |        | Water-holding capacity (%) | Cooking loss (%) | Drip loss (%) | Water-holding capacity (%) | Cooking loss (%) | Drip loss (%) |
|                       |        |              |           |              |              |           |              |
| 24                    | ♂      | 47.5<sup>b</sup> | 21.1<sup>b</sup> | 1.6<sup>b</sup> | 33.3<sup>bc</sup> | 23.6<sup>bc</sup> | 2.3<sup>b</sup> |
|                       | ♀      | 43.3<sup>b</sup> | 19.1<sup>b</sup> | 2.3<sup>ab</sup> | 20.0<sup>bc</sup> | 26.5<sup>b</sup> | 3.3<sup>ab</sup> |
| 32                    | ♂      | 76.0<sup>a</sup> | 30.4<sup>a</sup> | 4.2<sup>a</sup> | 50.0<sup>a</sup> | 32.2<sup>a</sup> | 3.4<sup>a</sup> |
|                       | ♀      | 63.3<sup>a</sup> | 26.3<sup>a</sup> | 4.0<sup>a</sup> | 46.6<sup>a</sup> | 26.3<sup>a</sup> | 4.6<sup>a</sup> |
| 40                    | ♂      | 70.0<sup>ab</sup> | 24.8<sup>ab</sup> | 3.8<sup>a</sup> | 50.0<sup>a</sup> | 25.2<sup>a</sup> | 4.2<sup>a</sup> |
|                       | ♀      | 73.3<sup>ab</sup> | 19.6<sup>ab</sup> | 3.0<sup>a</sup> | 46.6<sup>ab</sup> | 22.3<sup>a</sup> | 3.6<sup>ab</sup> |
| RMSE Effects          |        | 13.183       | 3.704      | 1.011        | 9.380       | 5.335      | 1.053       |

**Note:** RMSE: root mean square error.
<sup>a,b</sup>Means within columns with no common superscript letter differ significantly (p < 0.05).
the lipid metabolism in indigenous poultry occurring lower fat content in native turkeys might be caused by turkeys. Another study (Damaziak et al. 2013) found water, protein, and fat content in commercial hybrid cant effect of gender on breast and thigh muscle meat. However, Galvez et al. (2018) found no signifi-

breast meat and the protein and fat content of thigh affected the dry matter, protein and fat content of authors also found that the gender of the birds ter, protein, and ash contents of thigh meat. These

improved lines may be due to the genotype and the type of feeding, which are factors that affect the qual-

Lower water and fat contents, while leg meat had

higher water, protein, and fat contents than females; fat content compared to that of their female counterparts. The differences observed regarding the chemical composition of the meat between Mexican native turkeys and turkeys from improved lines may be due to the genotype and the type of feeding, which are factors that affect the quality of the meat (López et al. 2011). For example, the lower fat content in native turkeys might be caused by the lipid metabolism in indigenous poultry occurring to a greater extent than that in commercial turkeys. Slaughter age × gender interaction was significant (p > .001) on leg muscle’s dry matter, ether extract, and energy contents.

Conclusions

In conclusion, native Mexican turkeys raised traditionally under extensive conditions can achieve relatively high carcase weights and yields, particularly in adult males, making them preferable for meat production. Although females present acceptable carcase yields and meat of better nutritional quality in terms of crude protein and energy, they tend to deposit higher fat content in the carcase and the meat, even more so in the leg muscle. It is recommended that native male turkeys be slaughtered at 40 weeks of age for better carcase yields and more edible, high-nutritional value meat. In the future, it is essential to manage genetic improvement programs for the native turkeys through genetic selection oriented towards the betterment of carcase and meat quality traits to take advantage of its production potential and guarantee better quality meat products.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Table 6. Effects of slaughter age and gender on chemical composition of breast and leg meat.

| Slaughter age (weeks) | Gender | Dry matter (g/100g) | Crude protein (g/100g) | Ether extract (g/100g) | Energy content (cal/g) |
|-----------------------|--------|--------------------|------------------------|------------------------|-----------------------|
| 24                    | ♂      | 26.5ab             | 21.5a                  | 2.4b                   | 132.2ab               |
|                       | ♀      | 28.0a              | 23.0a                  | 2.2a                   | 140.6a                |
| 32                    | ♂      | 25.7b              | 22.9b                  | 0.5b                   | 124.1a                |
|                       | ♀      | 27.2ab             | 22.9b                  | 2.1b                   | 134.6a                |
| 40                    | ♂      | 26.3ab             | 22.7a                  | 1.5b                   | 130.9a                |
|                       | ♀      | 26.8ab             | 23.2a                  | 1.6b                   | 131.4a                |

RMSE: root mean square error.

| Effects | Age | Gender | Age × gender | Gender  | RMSE |
|---------|-----|--------|--------------|---------|------|
|         | 0.335 | 0.129 | 0.025 | 0.292 | 0.138 | 0.001 | 0.002 | 0.001 | 0.001 |
|         | 0.001 | 0.004 | 0.001 | 0.001 | 0.001 | 0.001 |

DM: dry matter; CP: crude protein; EE: ether extract; CA: crude ash; EV: energy content.

López et al. (2011), who found that the breast, thigh, and leg meat of female native turkeys were characterised by higher contents of dry matter (25.5–21.9%) and crude protein (22.7–18.7%). On the other hand, the breast, thigh, and leg meat of male turkeys had a higher ash content (0.65–0.64%). In Bronze and Hybrid turkeys, and their crosses, Sarica et al. (2011) reported that slaughter age affected breast meat’s protein and fat contents, as well as the dry matter, protein, and ash contents of thigh meat. These authors also found that the gender of the birds affected the dry matter, protein and fat content of breast meat and the protein and fat content of thigh meat. However, Galvez et al. (2018) found no signifi-


to a greater extent than that in commercial turkeys. Slaughter age × gender interaction was significant (p > .001) on leg muscle’s dry matter, ether extract, and energy contents.

Conclusions

In conclusion, native Mexican turkeys raised traditionally under extensive conditions can achieve relatively high carcase weights and yields, particularly in adult males, making them preferable for meat production. Although females present acceptable carcase yields and meat of better nutritional quality in terms of crude protein and energy, they tend to deposit higher fat content in the carcase and the meat, even more so in the leg muscle. It is recommended that native male turkeys be slaughtered at 40 weeks of age for better carcase yields and more edible, high-nutritional value meat. In the future, it is essential to manage genetic improvement programs for the native turkeys through genetic selection oriented towards the betterment of carcase and meat quality traits to take advantage of its production potential and guarantee better quality meat products.

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