# EVALUATION OF CARCASS PARAMETERS AND MEAT CHOLESTEROL OF EXOTIC TURKEY BIRDS FED DIETS OF VARYING ENERGY AND PROTEIN LEVELS

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**ABSTRACT**
*A study to evaluate the carcass yield, organ yield, and meat cholesterol concentration of exotic turkey bird meat was carried out at the Turkey Unit of the Teaching and Research Farm located at Obafemi Awolowo University in Ile-Ife. One hundred and fourty-four 16-week-old exotic turkeys previously raised on phase feeding patterns from day-old to 16 weeks of age were randomly selected and assigned to six different diets in a 2 x 3 factorial arrangement. Diets formulated with 19%, 17%, and 15% crude protein levels were distributed to energy levels of 2900 kcal/kg and 3000 kcal/kg with six energy/protein (E/P) ratios of 152:1, 171:1, 193:1, 158:1, 176:1, and 200:1. Each treatment diet was replicated twice with twelve (12) birds per replicate. Body weight changes were recorded. Carcass and meat cholesterol evaluation was done at the 24th week of the trial. Live weight, dressed weight, dressing percentage, and drumstick were significantly (P > 0.05) influenced by diets. Energy*protein interaction (p<0.005) affected the dressed weight and drumstick percentage. Lungs and dressed gizzard expressed as percent of dressed weight were significantly (p<0.005) influenced by the dietary protein and energy, respectively. There were significant (P<0.05) effects of energy, protein, energy/protein ratio, and energy × protein interaction on the breast meat cholesterol (mg/100g). The study concludes that birds fed diets with a higher energy/protein ratio tend to have a higher rate of weight gain, while a low energy/protein ratio can limit weight gain and lead to higher cholesterol levels in turkey meat.*
**Keywords: turkey, carcass, meat, organs, cholesterol, energy, protein, ratio**

## INTRODUCTION

Turkey belongs to the largest poultry that produces high-quality meat (Ljubica *et al*., 2021). Turkeys (*Meleagris gallopavo*) are reared all over the world for their tasty and high quality meat. According to Oso *et al.* (2013), a major goal of the modern turkey industry was the production of nutritious breast meat. The protein requirements of turkey poults are higher than those of broiler chicks at the same age (NRC, 1994). Rations deficient in protein, even if not clearly reflected in the growth performance, will impact negatively on the carcass meat percentage. The metabolizable energy (ME) of a turkey's diet can significantly influence both cholesterol levels in the meat and carcass weight. Dietary energy in excess of that required for protein deposition usually results in increased carcass fat content. This is because ME provides the energy necessary for growth and muscle development. It has been asserted that the specific ratio between dietary energy and crude protein are important factors for faster growth rate and carcass composition (Matanmi *et al.,* 2014). A higher E/P ratio, meaning more energy relative to protein, is generally associated with faster weight gain in turkeys and generally leads to lower cholesterol levels in turkey meat. This is because excess energy is efficiently converted into muscle mass, stored as fat, and fat synthesis can compete with cholesterol synthesis. The offered interpretation was that high energy to protein ratios caused overconsumption of dietary energy, as birds eat to meet dietary protein/amino acid requirements. Turkey has a high dressing percentage that could amount to 87% of slaughter weight (Turkey management guide, 2012). The efficiency of dietary protein utilization by growing turkey is influenced by the dietary energy/protein ratio (Gous *et al.,* 2022). Breast meat was the most valuable part of the turkey carcass in most countries. Lestari *et al.* (2020) investigated the use of alternative forages in adult turkey diets and concluded that breast meat cholesterol levels were affected by diets. Several studies had demonstrated the importance of optimizing dietary energy and protein levels to enhance turkey growth performance and meat quality. In a study, Saleh *et al.* (2021) observed that dressing percentages were not significantly affected by reducing dietary protein levels of diets.

## MATERIALS AND METHODS

### Experimental Diets and Turkey Birds

The experiment took place at the Turkey Unit of the Teaching and Research Farm located at Obafemi Awolowo University in Ile-Ife. One hundred and fifty exotic turkeys of the Nicholas strain were used for the study. The birds were raised on phase feeding patterns from day-old to 16 weeks of age, following recommended energy and protein levels for turkeys. One hundred and fifty 16-week-old exotic turkeys were randomly selected and assigned to six different diets in a 2 x 3 factorial arrangement. Turkeys were fed diets 1-3 containing 2900 (Kcal/kg) ME at 19%,

17%, and 15% levels and diets 4-6 containing 3000 (Kcal/kg) ME at similar CP levels of 19%, 17%, and 15% from 16 to 24 weeks of age (Table 1). The corresponding energy to protein (E/P) ratios of diets 1-6 were 152:1, 171:1, 193:1, 158:1, 176:1, and 200:1, respectively.

**Table 1: Composition of the Experimental Diets of Turkeys with Varying Energy and Protein Levels (16 - 24 Weeks)**

| Metabolisable Energy (kcal/kg) | 2900 | 2900 | 2900 | 3000 | 3000 | 3000 |
|---|---|---|---|---|---|---|
| Crude Protein Level (%) | 19 | 17 | 15 | 19 | 17 | 15 |
| Experimental diets | 1 | 2 | 3 | 4 | 5 | 6 |
| Energy/Protein (E/P) ratio | 152:1 | 171:1 | 193:1 | 158:1 | 176:1 | 200:1 |
| Ingredients (%): | | | | | | |
| Maize | 57.05 | 60.70 | 64.70 | 59.00 | 61.94 | 65.70 |
| Soy Bean Meal | 21.65 | 14.10 | 7.80 | 23.00 | 18.20 | 9.00 |
| Wheat Offal | 16.10 | 19.90 | 22.18 | 12.00 | 14.60 | 19.00 |
| Fish Meal | 2.20 | 2.30 | 2.10 | 2.00 | 1.00 | 2.00 |
| Palm Oil | - | - | - | 1.00 | 1.00 | 1.00 |
| Bone Meal | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Premix | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Salt | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Methionine | - | - | 0.04 | - | 0.03 | 0.04 |
| Lysine | - | - | 0.18 | - | 0.23 | 0.26 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Each treatment diet was replicated twice, with twelve (12) birds per replicate. Diets used were produced at the Obafemi Awolowo University Teaching and Research Farm Feed Mill and were free of feed additives. The proximate composition analysis of the experimental diets was conducted following the methods outlined in AOAC (2002). Birds were allowed unlimited access to clean drinking water and feed. Body weight changes were recorded weekly, while feed consumption was recorded daily.

**Carcass Analysis**

Evaluation of the carcass parameters was done at the 24th week of the trial. One bird per replicate (a total of 12 birds) with a weight indicative of each treatment was chosen and killed. The 12 birds were fasted overnight to cleanse the gut of digesta to an acceptable amount. Each turkey was weighed and the head severed. Slaughtered turkeys were thoroughly bled, de-feathered, and eviscerated. The dressing percentage, which is the ratio of dressed carcass weight to live bird weight, was determined using the eviscerated weight. The weight of the major internal organs, namely, the dressed gizzard, heart, liver, lungs, kidney, and spleen, as well as the weight of the cut portions: the wings, thighs, drumsticks, breast, and back of the entire carcass, were expressed as a percentage of the dressed weight.

**Determination of Cholesterol Concentration of Turkey Meat**

Meat samples were taken from the breast and thigh of turkeys for cholesterol determination. The cholesterol levels were determined as described by the Liebermann-Burchard system (Damiati and Khoja, 2011).

**Data Analysis**

Data generated were subjected to factorial analysis of variance (ANOVA) using the General Linear Model of SAS (2008) package for Windows. Significant differences between means were separated using the Duncan Multiple Range Test.

**RESULTS AND DISCUSSION**

Calculated and approximate compositions of experimental diets are presented in Table 2. Proximate values of metabolic energy (kcal/kg) and crude protein (%) obtained were in consonance with the calculated values obtained (Table 2). The determined crude fibre and nitrogen-free extract of the diets were, however, higher than the calculated values, while the calculated values of the diet's ether extract were higher than the proximate values. These could be attributed to the different ingredient sources.

**Table 2: Calculated and Proximate Composition of Turkey Diets with Varying Energy and Protein Levels at 16-24 Weeks of Age**

| Experimental diets | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| **Calculated Values** | | | | | | |
| Metabolisable Energy (kcal/kg) | 2907.64 | 2903.05 | 2907.22 | 3008.16 | 3000.04 | 3005.54 |
| Crude Protein (%) | 19.12 | 17.03 | 15.03 | 19.04 | 17.04 | 15.00 |
| Ether Extract (%) | 3.70 | 3.72 | 3.73 | 3.67 | 3.67 | 3.69 |
| NFE (%) | 50.77 | 46.13 | 41.78 | 51.98 | 47.29 | 42.74 |
| Crude fibre (%) | 3.94 | 3.85 | 3.71 | 3.71 | 3.67 | 3.53 |
| **Proximate Composition** | | | | | | |
| Metabolisable Energy (kcal/kg) | 2897.31 | 2913.89 | 2919.72 | 3005.66 | 3011.36 | 3009.02 |
| Crude Protein (%) | 19.18 | 17.04 | 14.98 | 19.31 | 17.16 | 15.07 |
| Ether Extract (%) | 1.54 | 1.78 | 1.82 | 3.80 | 3.77 | 3.92 |
| Crude fibre (%) | 5.23 | 5.30 | 4.63 | 4.45 | 3.24 | 3.60 |
| Nitrogen free extract (%) | 58.11 | 60.26 | 62.48 | 55.87 | 58.34 | 60.11 |

***Values are means of duplicate samples (air dried basis)***

**Carcass Evaluation**

Carcass, organ yield, and meat cholesterol levels of turkeys are shown in Tables 3a and b. The dressing percentage was obtained as a percent of live weight. There were significant *(P < 0.05)* differences in the live weight, dressed weight, dressing percentage, and drumstick of turkey carcass yields in this study. A significant energy*protein interaction was observed on the dressed weight and drumstick expressed as percentage of dressed weight. The dressing percentage was influenced by the energy level of diets, while the final live weight was affected by the ratio of energy to protein. This result, however, agreed with Saleh *et al.* (2021) that dressing percentages were not significantly affected by reducing dietary protein levels of diets. Average dressing percentage (83.19%) of exotic turkeys in this study was lower than 87% dressing percentage reported for large white turkeys (Turkey management guide, 2012) but was higher than the 76.60% and 75.90% average carcass yield reported for turkey at 16 and 18 weeks of age by Roberson *et al.* (2003), respectively.

The average breast meat yield (30.65%) recorded in this study was higher than the 26-28% range reported for turkey by Aviagen (2010) and 28.00% and 28.60% reported for turkeys at 16 and 18 weeks of age, respectively, by Roberson *et al.* (2003). The findings in this study showed that the relationship between live weight and dressed weight and dressed weight and dressing percentage were not linear.

That turkeys in this study with higher dressed weights had a higher yield of breast meat showed that heavier body weight turkeys had more breast meat. This is an indication of better efficiency of utilization of protein and well-balanced low-CP diets. Dressed carcass weight on diet 1 had the highest percentage of dressed gizzard (2.36%), and diet 3 had the highest spleen (0.1945%) values. The lungs and dressed gizzard weight expressed as percent of dressed weight were significantly ($p<0.005$) influenced by the dietary protein and energy, respectively.

**Cholesterol Content of Exotic Turkeys Meat**

There were significant *(P<0.05)* effects of energy, protein, energy/protein ratio, and energy × protein interaction on the breast meat cholesterol (mg/100g). However, the thigh meat cholesterol (mg/100 g) is not affected by any of the factors. Breast meat cholesterol was significantly *(P<0.05)* higher on diet 1 (2900 kcal/kg ME, 19% CP, E/P ratio 152:1). This supports the assertion that a lower E/P ratio, meaning more protein relative to energy, can lead to higher cholesterol levels in turkey meat. This is because protein synthesis can stimulate cholesterol synthesis.

Thus, on average, breast meat cholesterol (mg/100g) was significantly *(P<0.05)* higher on energy level 2900 kcal/kg ME and on 17% CP. Thigh and breast meat fat (%) were significantly *(P < 0.05)* higher on the 19% CP. The 55.28–64.90 (mg/100g) thigh meat cholesterol and 54.00–67.13 (mg/100g) breast meat cholesterol reported in this trial was within 27 to 90 mg cholesterol/100 reported for raw poultry meat (Bragagnolo, 2009).

**Table 3a: Carcass parameters of exotic turkey expressed as percentage of dressed weight and meat Cholesterol Concentration**

| Parameters | Diets (E/P) ratio | | | | | | Mean Separation (Energy Levels) | |
|---|---|---|---|---|---|---|---|---|
| | 152:1 | 171:1 | 193:1 | 158:1 | 176:1 | 200:1 | Energy 1 | Energy 2 |
| Live Wt. (g) | 10200.00[a] | 11350.00[a] | 9900.00[a] | 10900.00[a] | 10950.00[a] | 11100.00[a] | 10483.33 | 10983.33 |
| Dressed Wt.(g) | 8610.00[a] | 9190.00[a] | 7745.00[a] | 9150.00[a] | 9400.00[a] | 9500.00[a] | 8515 | 9350 |
| Dressed Wt. (%) | 84.41[a] | 81.11[ab] | 78.23[b] | 83.94[ab] | 85.97[a] | 85.48[a] | 81.25[b] | 85.13[a] |
| Wing (%) | 11.98 | 12.27 | 11.63 | 11.42 | 9.84 | 11.25 | 11.96 | 10.84 |
| Thigh (%) | 13.30 | 15.27 | 14.85 | 13.66 | 13.25 | 14.12 | 14.47 | 13.68 |
| Drumstick (%) | 13.65[ab] | 12.30[ab] | 13.19[ab] | 13.23[ab] | 11.13[b] | 14.56[a] | 13.07 | 12.98 |
| Breast meat (%) | 27.15 | 31.43 | 30.10 | 29.26 | 35.67 | 30.27 | 29.56 | 31.73 |
| Heart (%) | 0.41 | 0.49 | 0.58 | 0.44 | 0.53 | 0.42 | 0.49 | 0.46 |
| Lungs (%) | 0.52[a] | 0.38[b] | 0.52[a] | 0.44[ab] | 0.37[ab] | 0.47[b] | 0.47 | 0.43 |
| Liver (%) | 1.05 | 1.14 | 1.36 | 1.20 | 1.22 | 1.22 | 1.18 | 1.22 |
| Dressed .Gizzard (%) | 2.21[a] | 2.36[a] | 2.13[a] | 1.97[ab] | 1.44[b] | 1.76[ab] | 2.23[a] | 1.72[b] |
| Spleen (%) | 0.09 | 0.11 | 0.20 | 0.12 | 0.11 | 0.11 | 0.13 | 0.11 |
| TMC (mg/100g) | 58.38 | 61.2 | 56.8 | 55.28 | 59.15 | 64.90 | 58.79 | 59.78 |
| BMC (mg/100g) | 67.13[a] | 61.42[c] | 57.43[d] | 54.00[e] | 63.93[b] | 64.03[b] | 61.99[a] | 60.66[b] |

Means within rows with different superscripts are significantly different ($P < 0.05$).

**Table 3b: Mean Separations and p-values of turkey meat cholesterol and carcass parameters**

| Parameter | Mean Separation (Protein Levels) | | | | p-values | | | |
|---|---|---|---|---|---|---|---|---|
| | P1 | P2 | P3 | SEM | Energy | Protein | E/P | E×P |
| Live Wt. (g) | 10550 | 11150 | 10500 | 408.59 | 0.3177 | 0.4811 | 0.0431 | 0.4032 |
| Dressed Wt.(g) | 8880 | 9295 | 8622 | 225.26 | 0.0606 | 0.3723 | 0.182 | 0.0263 |
| Dressed Wt. (%) | 84.18 | 83.54 | 81.85 | 0.9495 | 0.0255 | 0.3876 | 0.0843 | 0.1240 |
| Wing (%) | 11.70 | 11.06 | 11.44 | 0.3344 | 0.1336 | 0.7304 | 0.4296 | 0.4136 |
| Thigh (%) | 13.48 | 14.26 | 14.48 | 0.259 | 0.0504 | 0.0979 | 0.0499 | 0.0643 |
| Drumstick (%) | 13.44 | 11.72 | 13.88 | 0.4283 | 0.9257 | 0.1227 | 0.2866 | 0.0429 |
| Breast meat (%) | 28.2 | 33.55 | 30.19 | 1.0529 | 0.2977 | 0.1471 | 0.3195 | 0.6989 |
| Heart (%) | 0.42 | 0.51 | 0.50 | 0.0219 | 0.39905 | 0.1053 | 0.0651 | 0.0898 |
| Lungs (%) | 0.48[a] | 0.38[b] | 0.50[a] | 0.0208 | 0.1669 | 0.0285 | 0.5557 | 0.0830 |
| Liver (%) | 1.13 | 1.18 | 1.29 | 0.0395 | 0.6530 | 0.2624 | 0.3178 | 0.3819 |
| Dressed .Gizzard (%) | 2.09 | 1.90 | 1.95 | 0.1065 | 0.0118 | 0.5660 | 0.2016 | 0.0732 |
| Spleen (%) | 0.10 | 0.11 | 0.15 | 0.0132 | 0.4281 | 0.2264 | 0.1378 | 0.2060 |
| TMC (mg/100g) | 56.83 | 60.18 | 60.85 | 1.1779 | 0.6277 | 0.2661 | 0.1010 | 0.1972 |
| BMC (mg/100g) | 60.57[b] | 62.68[a] | 60.73[b] | 1.3399 | 0.0246 | 0.0153 | <.0001 | <.0001 |

Means within rows with different superscripts are significantly different ($P < 0.05$). E/P – Energy/Protein ratio, P 1, 2, 3- Protein Levels 1, 2 and 3, SEM – Standard error of Means, × - Interaction. E/P – Energy/Protein ratio, TMC- Thigh Meat Cholesterol, BMC – Breast

## CONCLUSION

The dressing percentage was influenced by the energy level of diets, while the final live weight was affected by the ratio of energy to protein. Birds fed diets with a higher energy/protein ratio tend to have a higher rate of weight gain, while a low energy/protein ratio can limit weight gain due to insufficient energy intake, leading to higher cholesterol levels in turkey meat.

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