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Study on the conversion of energy and protein in fattening of Guinea-fowls up to 16 weeks of age by introducing "Clarc of distribution/ transformation"

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Abstract

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The energy and crude protein distribution from fodder to the breast and thigh muscles was calculated. New indexes "Clarc of energy distribution (CED)" and "Clarc of protein transformation (CPT)" were introduced. Fodder consumption was calculated as the difference between the offered fodder and the collected residues, in total for the group. The growth rate for each period (week) was calculated as the difference between final and the initial live weight. In order to equalize to a conventional unit (A), a recalculation of the weight of the breast and thigh muscles on a basis of 1 kg of weight gain was made. The "Clarc's" were calculated by using the following formula: CED = Total energy content in A/Total metabolizable energy intake for 1 kg growth; CPT = Total (crude) protein content in A/Total (crude) protein intake for 1 kg growth. The following average values for both sexes were established: CDE to the breast muscle – 0.0255; to the thigh muscle – 0.0215; CPT to the breast muscle – 0.0514; to the thigh muscle – 0.0398.

Keywords: Clarc of energy distribution; Clarc of protein transformation; guinea-fowls

Introduction

The reasons for domesticating guinea-fowl and its rearing under intensive farming in a number of countries are the good culinary and dietary qualities of the meat, the bird unpretentiousness to the living conditions and the high resistance to all the diseases typical of other farm birds (Batty, 1992). The species utilizes feed effectively and practically it is not susceptible to any disease (Tye & Gyawu, 2001; Moreki, 2009; Adeyeye, 2011). The interest in rearing guinea-fowl has significantly increased over the past few decades in some European countries, particularly in France, Belgium and the Scandinavian countries (Baeza et al., 2001).

During the last 30 years, a large part of Europe has estimated guinea-fowl as a source of dietary meat having a wild gameflavour, attractive to the luxury food markets. In addition, the increased consumer demand for healthy foods that are produced on small farms and the search for new sources of income by the farmers have stimulated researchon that avian species in the recent years (Bernacki et al., 2012). However, in Europe itself, there is an impressive niche for the production and marketing of that type of meat (Baeza et al., 2001; Sharma & Singh, 2006; Santiago et al., 2007).

In available literature there is an abundance of data on feed conversion in guinea-fowls (Avornyo et al., 2013; Mareko et al., 2006; Adeyemo & Oyejola, 2004; Nobo et al., 1992) but there are no studies on the biological effectiveness of energy and protein of feed after separating the muscle.

At the same time as the most accurate indicator of energeticnutritional level of the fodders is determined the net energy (Pirgosliev & Rose, 1999).

The term 'Clarc of transformation/distribution' has been known in theecology of chemical elements for a long time (Dobrovolskiy, 1998; Baykov, 1994), but it could also be introduced as anobjective indicator when studying the production efficiency of livestockfarming – both in breeding and technological aspects (Penkov & Genchev, 2018). The authors also present a methodology for developing itin the meat-type poultry farming.

The aim of the present study was to establish the energy and protein transformation in guinea-fowls fattened to different ages by introducingof the "Clarcs of the energy transformation/protein distribution".

Material and Methods

The experimental work was carried out on the poultry farm in the Training-and-Experimental Fields of the Agricultural University of Plovdiv. A local population of guinea-fowls with a pearl-colored plumage was used. For the purpose of the experiment, 60 guinea-fowls were studied in 2 consecutive production years, originating from the same hatchery in the respective year, in an equal number from both sexes. The poultry reared on the floor in a solid building under controlled microclimate at a density of 20–22 birds/m^2 from one-day to four weeks of age. After four weeks of age, the poultry were reared in a free-range, in a light type of polymer building with grassy yards for free walking, with a gradual decrease of the density to 4 birds/m^2. They were fed *ad libitum*, in a two-phase regime. The feed composition is presented in Table 1.

Throughout the growing period, weight gain was controlled every week by weighing using OHAUS balance with a precision of 0.01 g. Exactly 16 weeks after hatching, four male and four female birds were selected from each group, their live weight being close to the average for the group, and prepared for slaughter analysis.

Fodder consumption was calculated as the difference between the offered fodder and the collected residues, in total for the group. The growth rate for each period (week) was calculated as the difference between final and the initial live weight.

The feed conversion rate (FCR) was calculated on the basis of the results obtained for the feed intake and the live weight gain for the given period (Mwale et al., 2008).

FCR = feed intake (g)/ live weight gain (g)

The results were processed by using the "Biostatistics" program.

Table 1. Composition and nutritional value of compound fodder for guinea-fowl'sfattening

Compounds, %	Starter (0–5 weeks of age)	Grower (6-16 weeks of age)
Maize	26.00	30.00
Wheat	22.20	25.65
Soybean meal 44% CP	35.00	33.00
Sunflower meal 34% CP	3.00	4.00
Fish meal 72 % CP	7.00	–
L-lysine HCL	0.12	0.17
DL-methionine	0.16	0.18
Chalk	1.42	1.15
Calcium phosphate	2.15	1.90
Salt	0.10	0.10
Sodium bicarbonate	0.35	0.35
Vitamin-mineral premix	0.50	0.50
Sunflower oil	2.00	3.00
Content in fodder:		
ME, MJ/kg	12.10	12.41
Crude protein, %	26.21	21.82
Lysine, %	16.30	12.96
Methionine+cysteine, %	0.98	0.87
Treonine, %	1.09	0.95
Tryptophan, %	0.27	0.21
Ca, %	1.27	1.00
Avail. P, %	0.50	0.42
Na, %	0.18	0.18

The metabolizable energy and crude protein intake were calculated as the average product of the fodder consumed (by weeks) and the content of metabolizable energy and crude protein in 1 kg of feed.

Birds were slaughtered according to Decree No 22 of 14 December 2005 to minimize animal suffering during slaughter.

Processed carcasses were packed in folio and placed for cooling and storage at a temperature of 0–4°C for 24 hours. Then the breasts and thighs were separated from the carcass and only the muscle tissue was dissected and weighed.

In order to equalize to a conventional unit (A), a recalculation of the weight of the breast and thigh muscles on a basis of 1 kg of weight gain by the formula was used:

A = muscle weight (in g)/total growth (in g)*1000

The "Clarc of energy distribution" (CED) and the "Clarc of protein transformation" (CPT) were calculated by the formula (Penkov & Genchev, 2018):

CED = Total energy content in A/Total metabolizable energy intake for 1 kg growth

CPT = Total (crude) protein content in A/Total (crude) protein intake for 1 kg growth.

Results and Discussion

Table 2 presents the feed conversion, gross energy and crude protein in birds fattened up to 16 weeks of age.

Table 2. Fodder, metabolizable energy (ME) and crude protein (CP) in fattened Guinea fowls – mean from 2 replications

Indexes	X mean	Stand. Dev.
Fodder conversion ratio (FCR), kg/kg growth	3.82	0.67
ME conversion , MJ/kg growth	47.04	7.21
CP conversion, g/kg growth	885.93	155.40

In available literature, it's mentioned that FCR varies from 3.48 to 4.77 kg in Guinea fowls fed up to 16 weeks of age (Avornyo et al., 2013; Mareko et al., 2006; Adeyemo & Oyejola, 2004; Nobo et al., 1992; Angelov, 2019). The results of those characteristics, obtained in the present study, were consistent with those reported by the authors cited.

Table 3 presents the total growth for the studied period, the mean weights of the breast and thigh muscles of one bird, and their weights per unit of growth. The total growth was higher in the male birds and similar results were also obtained by Angelov (2019).

In both, breast and thigh muscles, the advantage of the females were significant. Similar differences were found by Angelov (2019) in fattening guinea-fowls and by Genchev et al. (2005) in fattening Japanese quails for different production purposes.

Differences in the recalculated weights of both muscle types to 1 kg growth were in favor of the female birds again.

Differences between the exchangeable energy and raw protein content in the breast and thigh muscles were low and insignificant by sex, especially when calculated to 1 kg of growth (Table 4). In available literature there are no data on energy and protein recalculation to weight gain, but that is understandable, since they are only needed for recalculations of CED and CPT.

Table 4 presents the values of Clarce of energy distribution (CED) and Clarce of protein transformation (CPT) for both types of muscles and both sexes of Guinea-fowls.

Table 3. Total growth (0-16 weeks of age) and weight of native breast and thigh muscles of male and female Guinea fowls (mean)

Indexes	Male		Female		Both of the sexes	
	X mean	SD	X mean	SD	X mean	SD
Total growth 0-16 weeks, g	1208	11.46	1144	8.63	1176	10.05
Weigh of breast 1muscle, g	191.00a	6.76	200.55a	5.87	196.1	6.32
Weight of thigh muscle, g	168.59a	2.25	171.54a	5.52	170.07	3.99
Recalculated weight to 1 kg growth – breast muscle, g	158.59a	5.59	175.27a	5.20	166.68	5.38
Recalculated weight to 1 kg growth – thigh muscle, g	139.48a	1.86	149.90a	5.00	144.69	3.43

Note: a-a by roads – Statistical significance ($P < 0.05$)

Table 4. Gross energy (GE) and crude protein (CP) content in the breast and thigh muscles of the experimental birds and Clarc's of energy distribution (CED) and protein transformation (CPT)

Indexes	Male		Female		Mean	
	X mean	SD	X mean	SD	X mean	SD
GE in 1 kg breast muscle (in native substance), MJ	6.17	0.06	6.09	0.14	6.13	0.08
CP in 1 kg breast muscle (in native substance), g	233.5	2.5	230.4	4.9	231.95	3.7
GE in 1 kg thigh muscle (in native substance), MJ	5.1	0.02	6.00	0.01	5.91	0.06
CP in 1 kg thigh muscle (in native substance), g	203.8	2.5	208.5	2.6	206.5	2.4
GE in a unit of breast muscle (native subst.) recalculated to 1 kg growth, MJ	1.18	0.01	1.22	0.01	1.20	0.01
CP in one unit breast muscle (native subst.) recalculated to 1 kg growth, g	44.60	0.5	46.21	0.98	45.49	0.85
GE in a unit of thigh muscle (native subst.) recalculated to 1 kg growth, MJ	0.98	0.01	1.03	0.01	1.01	0.01
CP in a unit of thigh muscle (native subst.) recalculated to 1 kg growth, g	34.36	0.5	35.77	0.4	35.06	0.4
Clarc of energy distribution – breast musc.	0.0251 (2.51%)		0.0259 (2.59%)		0.0255 (2.55%)	
Clarc of energy distribution – thigh musc.	0.0208 (2.08%)		0.0219 (2.19%)		0.0215 (2.15%)	
Clarc of protein transformation – breast musc.	0.0503 (5.03%)		0.0522 (5.22%)		0.0514 (5.14%)	
Clarc of protein transformation – thigh musc.	0.0388 (3.88%)		0.0404 (4.04%)		0.0398 (3.98%)	

The average CED value for the breast muscle is 0.0255, and for the thigh muscle – 0.0215, i.e. 2.55% of the metabolizable energy intake per 1 kg of weight gain was accumulated in the breast muscle and 2.15% – in the thigh muscle. The total amount of metabolizable energy transferred to the two edible muscle types is 4.70% (0.0470 as a coefficient). CPT data are 0.0514 or 5.14% for the breast muscle and 0.0398 or 3.98% for the thigh muscle, respectively, and in total to both muscle types – 0.0912 or 9.12%.

Data show that female birds have a lower live weight until 16 weeks of age but higher values of energy and protein distribution both for the breast and thigh muscles. Similar dependencies were also established in fattening Japanese quails (Penkov & Genchev, 2018).

Conclusions

The following conversion rates per one kilogram of growth were established: forage – 3.82 kg, metabolizable energy – 47.04 MJ, crude protein – 885.93 g.

The following weights of breast and thigh muscles were found:

Breast muscle:

– Based on the total growthover the entire period (16 weeks) – from 191.00 g (in males) to 200.55 g (in females).

– Based on a 1kg of weight gain, from 158.59 g (in males) to 175.27 g (in females) guinea-fowls.

Thigh muscle:

– Based on total growth over the entire period (16 weeks) – from 168.59 g (in males) to 171.54 g (in females).

– Based on 1kg of weight gain– from 139.48 g (in male) to 149.90 g (in female) guinea-fowls.

The following values of "Clarcs"were calculated:

– Clarc of energy distribution (CED): for the breast muscle – 0.0255 (in average); 0.0251 (in males) and 0.0259 (in females); for the thigh muscle– 0.0215 (in average); 0.0208 (in males) and 0.0219 (in females).

– Clarc of protein transformation (CPT): for the breast muscle – 0.0514 (in average); 0.0503 (in males) and 0.0522 (in females); for the thigh muscle– 0.0398 (in average); 0.0388 (in males) and 0.0404 (in females).

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