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EFFECTS OF DIETARY NUTRIENT CONCENTRATIONS ON PERFORMANCE, CARCASS AND MEAT QUALITY TRAITS OF ORGANICALLY REARED BARRED PLYMOUTH ROCK CHICKENS

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ABSTRACT

The study aimed to assess the performance, carcass traits, chemical and amino acids (AA) composition of breast and thigh meat organically reared Barred Plymouth Rock (BPR) chickens fed different nutrient concentrations. A total of 240 one-day-old BPR mixed-sex chicks (average weight 35.57±0.17 g) were allocated in a complete randomized design into 3 dietary treatments with 8 replicates of 10 chicks each, and used in an 84-d feeding trial according to organic meat technology (Regulations 834/2007 and 848/2018). Dietary treatments consisted of a basal isocaloric and isonitrogenous organic diet as a control (T0), isocaloric and low-crude protein (CP) level organic diet (T1; 1% CP lower) and isonitrogenous and low-metabolizable energy (ME) level organic diet (T2; 220 kcal/kg ME lower). Results showed that dietary treatments did not influence the overall weight gain of BPR chicks, but feed conversion ratio was poorer in experimental (T1 and T2) diets than in control. There were no effects of dietary treatments on carcass traits and digestive organs. Proximate composition (dry matter, fat, protein, ash) and energy value of meat were not altered by treatments, except the protein content of thigh muscle significantly decreased in T1 compared to the other treatments. Certain individual AA, which included phenylalanine in breast muscle, as well as lysine and phenylalanine in the thigh muscle, decreased by fed T1 diet, leading to a significant decrease in both breast and thigh muscles of total AA (TAA) and essential AA (EAA) in T1 than the other treatments. The non-essential AA (NEAA) and the ratios of EAA/TAA or EAA/NEAA did not differ among treatments. Our results show that irrespective of dietary treatments or muscle type, the meat of BPR chicks has a balanced AA profile with more than 40% EAA/TAA ratio and more than 60% EAA/NEAA ratio. In conclusion, these findings indicate that fed low-energy diet (2770 kcal/kg ME and 21.4% CP in starter-grower phase, respectively 2880 kcal/kg ME and 18.6% CP in finisher phase) in BPR chicks represents an alternative with no adverse effect on productive performance, carcass traits, and meat protein quality.

Keywords: organic, carcass, growth performance, nutrient concentrations, meat composition.

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INTRODUCTION

Poultry meat production is estimated to grow at an average rate of 1.8% globally and 2.4% in developing countries by 2050 (Mottet and Tempio, 2017) due to the ever-increasing consumer demand (Dalle Zotte *et al.*, 2020), and for this reason, the outlook for poultry seems very good. Once meat supply meets or exceeds demand, consumers prefer fresh, high-quality products due to concerns about health, environmental protection and animal welfare impacts (Jez *et al.*, 2011). In this context, organic poultry and free-range alternative systems are also expected to grow (Brockotter, 2017). In addition, modern consumers are willing to pay a higher price for organically or environment friendly poultry meat produced from farms with higher nutritional and animal welfare standards (Lusk, 2018; Del Bosque *et al.*, 2021). The increase in organic food consumption among EU countries, including in Romania, has been due to its direct impact on consumer health, lifestyle, and social convenience, as well as on the environment and sustainable development (Oroian *et al*., 2017; Petrescu *et al*., 2017; Fortea *et al*., 2022).

Organic poultry meat production, regulated by the European Commission (EC) Regulations 834/2007, 543/2008, 889/2008 and 848/2018, is defined as the production from slow- or fast-growing chicken breeds reared for minimum 81 d of age. These regulations state that in the choice of breeds, account should be taken for their adaptability to local conditions, vitality and disease resistance, helping to maintain biodiversity and sustainable agricultural production (Gálvez *et al.*, 2020).

Several studies recommend medium- or slow-growing birds for organic production (Fanatico *et al.*, 2006; Fanatico *et al*., 2009; Sirri *et al.*, 2011; Mikulski *et al.*, 2011; Yamak *et al.*, 2014; Englmaierová *et al*., 2020) due to their better adaptation to growing conditions, while others (Castellini *et al.*, 2002; Epp, 2018) recommend fast-growing poultry for economic reasons, as higher welfare standards usually imply higher production costs (Vissers *et al.*, 2019).

A suitable option for raising organic production is Barred Plymouth Rock, known as a dual-purpose breed that can be slaughtered between 8 to 12 weeks for meat production.

Productive performance and carcass quality are mainly influenced by genotype, sex and age (Castellini *et al.*, 2008; Cömert *et al.*, 2016; Kuźniacka *et al.*, 2017; Rajkumar *et al.*, 2021), as well as by production system and nutrition (Pavlovski *et al.*, 2009; Bancos, 2010; Kuźniacka *et al.*, 2014; Attia *et al.*, 2021).

Several studies investigated the effects of reduced dietary energy (Sakomura *et al.*, 2004; Schneiders *et al.*, 2016; Infante-Rodríguez *et al.*, 2016; Copat *et al.*, 2020) and protein (Quentin *et al.*, 2005; Dairo *et al.*, 2010; Alqazzaz *et al.*, 2019; Infante-Rodríguez *et al.*, 2020) contents in slow- or fast- growing broilers. Due to the importance of feeds in organic meat production, feed compounds should be optimized from both economic and biological performance perspectives to ensure a balance between welfare, sustainability and productivity (Cobanoglu *et al.*, 2014; Edwards, 2019). However, Attia *et al.* (2021) stated that reducing the dietary crude protein and energy levels, improving sustainability, and lowering production costs are some issues in poultry production. To our knowledge, there are no data regarding the productive performance and meat quality traits of BPR chicks raised in an organic system. Thus, we hypothesized that feeding different nutrient concentrations in BPR chickens could affect meat quality trait responses without altering productivity.

In this respect, the study aimed to assess the growth performance, carcass traits, chemical and amino acids composition of breast and thigh meat of organically reared BPR chickens fed low-protein and low-energy diets.

MATERIALS AND METHODS

Location, birds and experimental design: The birds in this experiment were cared for in accordance with Law 43/2014 for the handling and protection of animals used for experimental purposes and EU Council Directive 98/58/EC on the protection of farm animals, approved by the University of Agronomic Sciences and Veterinary Medicine Bucharest (UASVM-Bucharest), approval no. 1832/2021.

A total of 240 one-day-old mixed-sex BPR chicks (average weight 35.57±0.17 g) obtained from an authorized hatchery were used in a 84 d feeding trial. The experiment was carried out at the bio-lab of the UASVM-Bucharest, under standard organic meat technology (Regulations 834/2007 and 848/2018) with the same management conditions. Chicks were distributed in a complete randomized design into three dietary treatments with eight replicates of ten chicks each (1:1 sex ratio). Chickens were grown in 24 indoor floor pens with wood shaving litter material at stocking density of 10 chicks per m^2; each pen was equipped with manual feeder (4 cm/head feeding front) and drinker. The lighting program used was 23L:1D for the first 3 d, and the rest of the experimental period was decreased to 16L:8D. After 28 days, the chicks from each replicate pen had outdoor access, through a 50x70 cm opening doorway, and an available outdoor surface of ≥ 4 m^2 per chicken. Chickens had access to the outdoor area from 8.00 to 18.00. Figure 1 shows the weekly average temperature and relative humidity trend during 4 to 12 weeks when chickens had access to the outdoor area. The composition of the outdoor vegetation contained about 70% gramineae (*Lolium perenne* and *Bromus tectorum*) and 30% leguminous (*Medicago* sp).

Dietary treatments consisted of a basal isocaloric and isonitrogenous organic diet as a control (T0), isocaloric and low-crude protein (CP) level organic diet (T1; 1% CP lower) and isonitrogenous and low-metabolizable energy (ME) level organic diet (T2; 220 kcal/kg ME lower). Two-phase feeding technology was used: starter-grower (1-28 d) and finisher (29-84 d). The diets (Table 1) were formulated based on organic raw materials (corn, wheat, barley, pea, soya cakes, sunflower cakes and oil, corn gluten) procured from locally organic registered and certified producers from the Romanian south-east (Călărași county) and eastern (Covasna county) regions. Feed and water were provided *ad libitum*.

During the study, the chicks were individually weighed at 1 d, when chicks were wing-banded, and at 84 d, to calculate the overall period body weight gain. Feed intake (FI) and livability were monitored daily, and the feed conversion ratio (FCR) was calculated.

Slaughter traits and sample collection: At 84 d of age, 24 chicks (n=8/treatment; 4 male and 4 female) were selected for slaughter traits evaluation and muscle collection. After slaughter, using the cervical dislocation technique, the chicks were defeathered. Carcasses dissection was done following the EC Regulation no. 543/2008 and determined the weight of the carcass, breast, legs, wings, internal organs and the rest of the carcass. Breast (n=8/treatment) and thigh (n=8/treatment) muscles (deboned and skinless) were sampled, minced, homogenized, packed and kept at –20°C until chemical analyses.

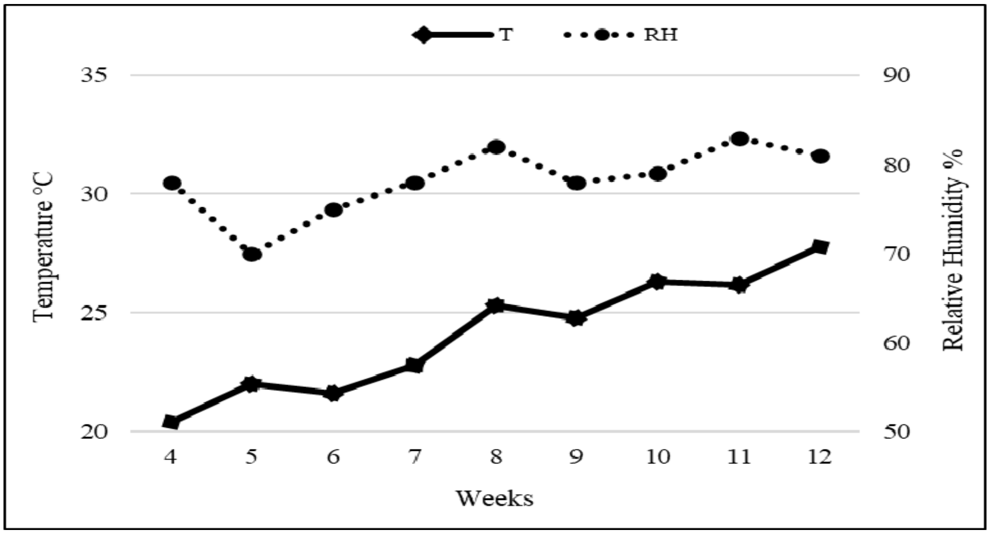

Figure 1. Trend of weekly average temperature (°C) and relative humidity (%) during trial

Table 1. Ingredients and chemical analysis of the organic diets

Ingredients (%)	**Starter-grower (1-28 d)**			**Finisher (29-84 d)**		
	T0	**T1**	**T2**	**T0**	**T1**	**T2**
Corn[1]	27.05	29.75	20.95	25.35	16.00	7.25
Wheat[1]	24.60	15.00	25.20	9.00	15.00	17.30
Barley[1]	-	9.80	10.00	20.30	24.75	32.00
Pea[1]	11.00	11.00	11.00	17.00	17.00	17.00
Soya cakes[1]	14.80	11.80	14.60	14.00	5.30	7.00
Sunflower cakes[1]	8.00	8.00	6.50	-	7.00	7.00
Corn gluten[1]	7.50	7.50	7.50	5.50	5.50	5.50
Sunflower oil[1]	2.80	2.90	-	5.00	5.60	3.10
Monocalcium phosphate	1.40	1.40	1.40	1.15	1.15	1.15
Calcium carbonate	1.55	1.55	1.55	1.40	1.40	1.40
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin-mineral premix[2,3]	1.00[1]	1.00[1]	1.00[1]	1.00[2]	1.00[2]	1.00[2]
Nutrient composition (%)						
Dry matter	89.95	89.90	89.88	89.92	89.98	89.94
Crude protein	21.40	20.40	21.40	18.60	17.60	18.60
Lysine	0.92	0.86	0.92	0.90	0.76	0.89
Methionine	0.38	0.37	0.37	0.30	0.30	0.31
Methionine + cystine	0.76	0.73	0.76	0.64	0.63	0.65
Crude fat	5.12	5.28	2.30	7.22	7.62	5.01
Crude fibre	4.83	4.97	4.86	3.96	5.07	5.43
Calcium	0.88	0.88	0.88	0.77	0.78	0.79
Available phosphorus[c]	0.43	0.43	0.44	0.38	0.39	0.40
Metabolizable energy[c], kcal/kg	2990	2990	2770	3100	3100	2880

T0, control diet; T1, low-protein diet; T2, low-energy diet.

[1]Raw materials organically produced.

[2]Per kg feed: 900,000 UI vit. A; 330,000 UI vit. D_3; 3,000 mg vit. E; 220 mg vit. K_3; 220 mg vit. B_1; 800 mg vit. B_2; 440 mg vit. B_6; 2.2 mg vit. B_{12}; 6600 mg vit. B_3; 1,500 mg vit. B_5; 100 mg vit. B_9; 10,000 mg vit. C; 55,000 mg choline chloride; 10,000 mg Mn; 7,500 mg Zn; 8,000 mg Fe; 800 mg Cu; 25 mg Co; 45 mg I; 30 mg Se.

[3]Per kg feed: 900,000 UI vit. A; 250,000 UI vit. D_3; 3,000 mg vit. E; 165 mg vit. K_3; 165 mg vit. B_1; 600 mg vit. B_2; 300 mg vit. B_6; 1.5 mg vit. B_{12}; 5,000 mg vit. B_3; 1,000 mg vit. B_5; 75 mg vit. B_9; 10,000 mg vit. C; 44,000 mg choline chloride; 10,000 mg Mn; 7,500 mg Zn; 8,000 mg Fe; 800 mg Cu; 25 mg Co; 45 mg I; 30 mg Se. [c]calculated values.

Chemical analyses: Chemical composition of ingredients and feeds samples were analyzed as per standardized methods of OJEU (2009): dry matter (6496:2001), crude protein (5983-2:2009), crude fat (6492:2001), crude fibre (6865:2002), crude ash (2171:2010), calcium (6490-2:1983) and phosphorus (spectrophotometry method).

The muscle samples (breast and thigh) proximate composition was determined by standardized techniques of OJEU (2009): dry matter (1442:2010), crude fat (1444:2008), crude protein (937:2007) and crude ash (936:2009). The energy value of meat was calculated based on the fat and protein contents and their physical equivalents of caloric amounts (9.45 kcal/g for fat and 5.65 kcal/g for protein).

The amino acids (AA) composition was analysed according to OJEU (2009) by high-performance liquid chromatography (HPLC) after acid hydrolysis in 6 N HCl at 110°C for 24 hours, using an HPLC Surveyor Plus Thermo Electron and HyperSil BDS C18 column (250mm x 4.6mm x 5m; Thermo Electron, Massachusetts, USA) as described by Vărzaru *et al.* (2013). The following AAs were identified and expressed as g/100 g dry matter: lysine, leucine, isoleucine, cysteine, methionine, phenylalanine, histidine, aspartic acid, proline, glycine, serine, and alanine. The sum of total AA (TAA), essential AA (EAA), non-essential AA (NEAA), and the ratios of EAA/TAA and EAA/NEAA were calculated.

Statistical analysis: SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA) was used for data analysis. Shapiro-Wilk's test was used to analyze the data normal distribution. The pen (replicate) served as the experimental unit for the performance, while for the carcass traits and meat analyses, each sample of birds was used. The effect of dietary treatments on performance and meat quality traits was determined using one-way ANOVA, where these traits were set as dependent variables and diet as fixed effect. Tukey test was used to determine the differences among means considered statistically significant at $P \leq 0.05$. The results were presented as means and standard error of the mean (SEM).

RESULTS AND DISCUSSION

Growth performance: As shown in Table 2, the mean values of body weight and weight gain during the overall period were similar, with no significant differences between dietary treatments ($P \geq 0.05$), indicating that all diets used support the growth of BPR chicks. At 84 days, BPR chicks reached similar slaughter weights that aligned with the weight of slow-growing genotypes reared in organic production systems between 2 and 2.5 kg (Yamak *et al*., 2014). Attia *et al*. (2021) found no significant effect on body weight when fed reduced protein level or protein and energy levels in slow-growing broilers. Infante-Rodríguez *et al*. (2016) reported that dietary energy levels in broilers did not affect the body weight gain but decreased feed intake. Our results are consistent with those reported previously for slow-growing genotypes (Mikulski *et al.*, 2011; Sirri *et al*., 2011; Kuźniacka *et al*., 2014; Cömert *et al*., 2016; Gálvez *et al*., 2020), demonstrating that growth rates may be genotype related (Yamak *et al*., 2014).

Regarding the feed consumption and conversion, the results showed an insignificant increased FI in both experimental groups T1 and T2 ($P \geq 0.05$), which leads to a significant increase in FCR by T2 (+4.45%) and T1 (+2.1%) than control T0 ($P \leq 0.05$). It is well-known that feed consumption represents the main cost of poultry production; thus, improving feed efficiency is a key objective of breeding strategies, although little research focuses on slow-growing genotypes (Wen *et al*., 2018). Some studies have shown that FCR is related to production traits, and the selection for lower FCR leads to higher body weight gain and average daily gain, but it may also result in higher feed intake and decreased meat quality (Wen *et al*., 2018; Yi *et al*., 2018). According to Sinpru *et al.* (2021), it is crucial to understand the molecular basis mechanisms (i.e. intestinal gene expression that regulates immune response, glutathione metabolism, vitamins and lipids metabolism) for FCR to improve feed efficiency in slow-growing chicks. Thus, a possible explanation of poorer FCR in our study could be attributed to the genes that can affect body control and thermoregulation, which reduces their potential for adaptation to changes in feed intake or environmental temperature (Sinpru *et al*. 2021). Fanatico *et al*. (2008) have shown that fed low-nutrient levels in slow-growing chicks with outdoor access increased feed intake and poorer feed conversion, which could be attributed to higher maintenance requirements of chicks, environmental temperatures and the movement for foraging and exercise activities. Several studies (Castellini *et al*., 2002; Wang *et al*., 2008) reported poorer growth rates and feed efficiencies in slow-growing chickens raised in organic systems with outdoor access. In general, it has been noticed that slow-growing chicks are inefficient in terms of feed conversion (Yamak *et al*., 2014; Wen *et al*., 2018; Sarica *et al*., 2019).

Carcass traits: Results of carcass traits of BPR chicks at 84 d are presented in Table 3. There were no effects of dietary treatments on carcass yield, carcass cut-up yields and digestive organs ($P \geq 0.05$). The lack of differences between dietary treatments obtained in our study could be related to better intestinal absorption and conversion of energy and nutrients from diets into tissue (Molnar and Gair, 2015; Sinpru *et al*., 2021), an explanation also supported by growth performance results even though the feed efficiency was slightly lower. These data are consistent with other research which reported that lowers dietary energy (Sakomura *et al.*, 2004; Infante-Rodríguez *et al.*, 2016; Copat *et al.*, 2020) or protein levels (Infante-Rodríguez *et al.* 2020) did not compromise carcass slaughter traits. As expected, organically reared BPR chicks have lower breast yield but higher legs yield, also reported by other authors for slow-growing birds (Mikulscki *et al.*, 2011; Sirri *et al.*, 2011; Cömert *et al.*, 2016).

Table 2. Effect of dietary nutrients concentrations on overall growth performance (1 to 84 d) of BPR chicks

Items	T0	T1	T2	SEM	*P*-value
Initial body weight (g)	35.7	35.5	35.6	0.551	0.0967
Final body weight (g)	2456	2496	2440	88.24	0.809
Weight gain (g)	2421	2461	2404	88.17	0.806
Feed intake (g)	8185	8454	8483	313	0.418
Feed conversion ratio (g: g)	3.38[c]	3.44[b]	3.52[a]	0.0074	0.0001

Means of 8 replicates/treatment. T0, control diet; T1, low-protein diet; T2, low-energy diet; SEM – standard error of the mean. [a,b,c]Means within a row without a common superscript differ significantly (P≤0.05).

Table 3. Effect of dietary nutrients concentrations on carcass traits of BPR chicks at 84 d[1]

Traits (% of live weight)	T0	T1	T2	SEM	*P*-value
Carcass yield	79.7	80.0	81.2	4.773	0.943
Breast yield	16.9	16.7	17.2	1.065	0.864
Legs yield	22.3	22.2	22.6	1.703	0.976
Wings yield	7.90	8.20	8.60	0.813	0.732
Back yield	21.9	22.6	21.6	1.930	0.864
Head yield	3.60	3.10	4.00	0.312	0.0634
Shanks yield	3.20	3.20	3.40	0.299	0.608
Heart yield	0.40	0.50	0.50	0.0558	0.0710
Gizzard yield	1.60	1.50	1.50	0.230	0.777
Liver yield	1.90	2.00	1.80	0.263	0.824

[1]Means of 8 chicks/treatment. T0, control diet; T1, low-protein diet; T2, low-energy diet; SEM – standard error of the mean. Differences between means are not statistically significant (P≥0.05).

Meat quality: Table 4 shows the proximate composition and energy value of meat of BPR chicks at 84 d. No significant changes among dietary treatments were noticed for the dry matter, fat, protein, ash content as well as energy value of breast muscle (P≥0.05). Regarding the proximate composition of thigh muscle, the results showed no differences except for protein content that significantly decreased in T1 compared to the other treatments (P=0.0251). A possible reason for these decreases could be related to an imbalance in essential amino acids and lipid metabolism or the higher fibres muscle activities due to exercise in the outdoor areas.

Table 4. Effect of dietary nutrients concentrations on chemical composition and energy value of meat of BPR chicks at 84 d[1]

Traits (g/100 g)	Muscle	T0	T1	T2	SEM	*P*-value
Dry matter (DM)	Breast	28.1	28.6	28.7	0.757	0.733
	Thigh	29.9	32.6	30.1	2.048	0.459
Crude fat	Breast	3.10	3.71	3.52	0.481	0.483
	Thigh	6.48	8.89	8.80	0.780	0.0888
Crude protein	Breast	22.2	21.9	22.2	0.886	0.900
	Thigh	19.8[a]	17.8[b]	18.8[ab]	0.360	0.0251
Crude ash	Breast	1.15	1.12	1.13	0.0385	0.960
	Thigh	0.93	0.89	0.84	0.0276	0.0990
Energy value (Kcal/100 g)	Breast	155	159	159	5.850	0.736
	Thigh	168	171	178	6.162	0.346

[1]Means of 8 breast and 8 thigh samples/treatment. T0, control diet; T1, low-protein diet; T2, low-energy diet; SEM – standard error of the mean. [a,b]Means within a row without a common superscript differ significantly (P≤0.05).

Table 5. Effect of dietary nutrients concentrations on amino acids profile of meat of BPR chicks at 84 d[1]

Traits (g/100 g DM)	**Muscle**	**T0**	**T1**	**T2**	**SEM**	***P*-value**
Lysine	Breast	5.59	5.79	5.91	0.433	0.769
	Thigh	5.83^a	4.64^b	5.29^a	0.595	0.0341
Leucine	Breast	1.59	1.20	1.62	0.435	0.613
	Thigh	2.11	1.62	1.85	0.174	0.271
Isoleucine	Breast	1.00	0.89	0.99	0.210	0.835
	Thigh	1.23	1.17	0.72	0.351	0.494
Cystine	Breast	7.31	7.38	7.54	0.491	0.894
	Thigh	7.63	6.11	7.34	1.344	0.724
Methionine	Breast	2.89	2.31	2.24	0.559	0.529
	Thigh	2.46	2.26	2.38	0.174	0.750
Phenylalanine	Breast	3.58^a	2.31^b	2.97^a	0.255	0.0350
	Thigh	2.20^a	1.35^b	3.07^a	0.616	0.0423
Histidine	Breast	4.02	3.78	3.45	0.584	0.664
	Thigh	3.24	2.44	3.12	1.921	0.951
Proline	Breast	1.18	1.00	1.44	0.421	0.620
	Thigh	1.14	1.40	1.62	0.368	0.687
Aspartic acid	Breast	5.31	5.13	5.43	0.224	0.484
	Thigh	5.17	5.80	5.54	0.259	0.351
Glycine	Breast	10.09	10.19	10.42	0.683	0.889
	Thigh	3.44	3.30	3.60	0.258	0.730
Serine	Breast	5.11	5.16	4.52	1.113	0.823
	Thigh	2.98	2.80	2.81	0.680	0.978
Alanine	Breast	7.59	7.58	7.39	0.167	0.508
	Thigh	10.40	9.06	9.89	1.109	0.717
Total AA (TAA)	Breast	55.27^a	52.71^b	53.95^a	0.491	0.0316
	Thigh	47.82^a	41.93^b	47.14^a	0.427	0.0485
Essential AA (EAA)	Breast	25.98^a	23.65^b	24.74^a	0.370	0.0187
	Thigh	24.70^a	19.57^b	23.68^a	0.600	0.0440
Non-essential AA (NEAA)	Breast	29.29	29.06	29.21	0.616	0.932
	Thigh	23.11	22.35	23.45	2.078	0.931
EAA/TAA ratio	Breast	0.470	0.450	0.460	0.0276	0.164
	Thigh	0.520	0.470	0.500	0.103	0.491
EAA/NEAA ratio	Breast	0.890	0.810	0.850	0.0079	0.159
	Thigh	1.06	0.880	1.01	0.0252	0.476

[1]Means of 8 breast and 8 thigh samples/treatment; T0, control diet; T1, low-protein diet; T2, low-energy diet; SEM – standard error of the mean; EAA included lysine, leucine, isoleucine, cysteine, methionine, phenylalanine, and histidine; NEAA included aspartic acid, proline, glycine, serine, and alanine; [a,b]Means within a row without a common superscript differ significantly (P≤0.05).

Infante-Rodríguez *et al.* (2016) reported that fed diets with different energy concentrations in broilers did not affect the breast muscle crude protein content but higher fat content by increasing the diet energy level, whereas the proximate composition of thigh meat was similar between treatments. Infante-Rodríguez *et al.* (2020) studied different protein concentrations in broilers and found that the use of CP levels of 21.4% in the starter and 18.5% CP in finisher diets did not affect broiler performance, carcass traits or meat chemical composition. According to previous studies (Kuźniacka *et al.*, 2014; Cömert *et al.*, 2016; Rajkumar *et al.*, 2021), the main factors affecting the poultry meat chemical composition are genotype, nutrition, rearing system, sex, slaughter age, and anatomical region. Generally, proximate composition of poultry meat contains water (60 to 80%), proteins (15 to 25%), minerals (0.2 to 1.8%), and fats (1.5 to 5.3%), which is the most variable with a higher value in legs than in breast muscles (Castellini *et al.*, 2002; Culioli *et al.*, 2003).

Our results regarding the meat muscles protein content were similar to the values reported by Kuźniacka *et al.* (2017) in the breast (23%) and leg (20.2%) muscles of 18-week-old Plymouth Rock cockerels and Adamski *et al.* (2016) in breast (22.5%) and leg (20.1%) muscles of 18-week-old Sussex cockerels who analyses the meat quality traits of Plymouth Rock or Sussex cockerels compared to capons at different ages (16, 18 and 20 weeks). On the other hand, the fat percentage of meat muscles obtained in the present study was higher than was found by Kuźniacka *et al.* (2017) in breast (1.4%) and leg (4.1%) muscles of 18-week-old Plymouth Rock cockerels and Adamski *et al*. (2016) in breast (1.7%) and leg (4.9%) muscles of 18-week-old Sussex cockerels. Previous reports stated that fat content affects poultry meat's functionality, sensory quality and nutritive value (Aronal *et al.*, 2012) and is mainly influenced by feed (Guan *et al.*, 2013).

The AA profile is the most important nutritional parameter that reflects the protein quality of meat (Korish and Attia, 2019). Considering the WHO/FAO (2013) human requirements of AA, poultry meat is a valuable source of dietary EAA, representing around 40% of the total protein content (Pereira and Vicente, 2013; Kim *et al*., 2017).

The meat AA composition of BPR chicks as an effect of dietary nutrient concentrations is given in Table 5. The mean values of some individual EAA in the meat of BPR chicks, which included phenylalanine (P=0.0350) in breast muscle, as well as lysine (P=0.0341) and phenylalanine (P=0.0423) in the thigh muscle, decreased as an effect of fed low-protein diet (T1) compared to the other treatments. These led to a significant decrease in TAA's breast and thigh muscles (P=0.0316, and P=0.0485, respectively) and EAA (P=0.0187, and P=0.0440, respectively) in chicks fed T1 than the other treatments. The NEAA and the ratios of EAA/TAA or EAA/NEAA were not significantly different among treatments (P≥0.05).

It is stated that factors such as age affect protein digestibility and deposition, and the AA profile of meat could be influenced by dietary manipulation and rearing system (Wu *et al*., 2014; Korish and Attia, 2019; Gálvez *et al.*, 2020). To the authors' knowledge, no previous studies reported the AA profile of BPR chicks. However, our results shown that regardless of dietary treatments or muscle type, the meat of BPR chicks has a balanced AA profile with more than 40% EAA/TAA ratio and more than 60% EAA/NEAA ratio, which are in line with the previous reports (Kim *et al.*, 2017; Gheorghe *et al.*, 2021; Gheorghe *et al.*, 2022).

Conclusion: In conclusion, these findings indicate that fed low-energy diet (2770 kcal/kg ME and 21.4% CP in starter-grower phase, respectively 2880 kcal/kg ME and 18.6% CP in finisher phase) in BPR chicks represents an alternative with no negative effect on body weight, weight gain, carcass traits, and meat protein quality. Moreover, using BPR chicks in organic production systems could increase the diversity and attractiveness of niche market poultry products.

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