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Impact of Different Levels of Crude Protein on Production Performance and Meat Quality in Broiler Selected for Slow Growth

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Abstract: The production performance and meat quality of the slow-growing hybrid Hubbard JA757 were monitored under conditions of diets differentiated by crude protein content. A total of 1200 as-hatched day-old chickens were equally and randomly allotted into two treatments (T-1 and T-2), with six replicates provided for each treatment (100 chickens/replicate). T-1 chickens received standard diets (according to Hubbard Company recommendations), and those in T-2 were fed diets supplemented with crude protein (+0.5% CP in the growing phase and +1.0% CP in the finishing phase). At the end of the investigations (age 56 days), the T-2 chickens performed better than the T-1 chickens for growth traits (+2.72% body weight; +2.77% daily growth gain; −0.34% mortality; and −4.15% feed conversion ratio); for slaughtering (+0.66% dressed yield; +1.10% breast weight; and +1.25% thigh weight); and for quality meat (+0.55% dry matter in thigh muscles and +1.52% dry matter in breast muscles) ($p > 0.05$). Statistically significant differences ($p < 0.05$) occurred between treatments for body weight, daily weight gain, and feed conversion ratio due to the 0.5% CP feed supplementation during the 15–28 day age period, justifying the usefulness of the CP increasing throughout the grower diet only and not during the finishing period.

Keywords: Hubbard; slow growth; protein level; performance; meat yield

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1. Introduction

Although the world consumption of poultry meat is following an upward trend, its production according to industrial principles has generated negative reactions from those interested in animal welfare (too-high brooding densities, lack of access to the external environment, incidence of specific diseases, etc.) [1], but also from consumers who have complained about poor meat sensory properties and the nutritional value of the meat from the current chicken broilers selected for rapid growth [2]. To respond to the new preferences of the market [3], new genetic resources are being sought to replace the industrial broiler, such as nonimproved local breeds, certified Label Rouge chickens, purebred fowl [4], and special genotypes selected for low growth speeds (slow-growing chickens), a solution increasingly accepted by both meat producers [5,6] and particularly by consumers, due to the quality of the meat, which is perceived as similar to that from traditionally reared fowl [7,8].

The biggest challenge in fowl farming is to provide proper nutrition that is perfectly adapted both to the performance potential and physiological requirements of each category of poultry [9], while ensuring the financial profitability; hence, 70–75% of production costs are generated by feeding [10]. Among the dietary ingredients, the most expensive are those providing the desired level of protein [11]. They differ greatly in terms of quality parameters and especially of purchasing price, related to a multitude of conjunctural factors and even geopolitics applied at regional levels [12]; i.e., the production cost of 1 kg of chicken meat is about 45% higher in EU countries than in Brazil, one of the world's largest soybean producers [13]. In broiler chickens, the dietary protein is extremely important because it serves as the raw matter for structural body protein neosynthesis [14]. Artificial poultry selection was conducted to increase the muscle mass in breast and leg meat, which implies a high protein intake [15]. As for the effectiveness of the use of proteins by the body of chickens, the studies carried out have shown that this is influenced by various factors, such as their content of amino acids and the bioavailability of the amino acids provided [16]; the existence of some antinutritional factors and the ratio to other nutrients [17]; and the microclimate factors and especially the ambient temperature, feeding technique, consumption level, etc. [18]. When enough protein is provided, normal productive results are obtained [19], while too-low protein levels or the use of proteins of low biological value reduce growth gains and increase feed conversion [20] and depreciate the quality of the carcasses and negatively affect fowl health [21]. The demand for meat obtained from broilers selected for slow growth has increased as well in Romania, but most of the poultry farms are experiencing productive levels below the theoretical performance of the biological material used due to climate and socioeconomic peculiarities specific to the area, but also to the lack of experience on this production system [22].

Under these conditions, we aimed to study the effect of feeding diets supplemented with crude proteins on the growth and slaughter performances, including meat quality, in a well-rated slow-growing chicken hybrid in Romania, namely the Hubbard JA757. In establishing the experimental plan, it was considered that the nutrients in the feed are mainly directed to the function of thermoregulation in the first days of life [15]; consequently, the diets supplemented with crude proteins were fed after the age of 14 days (when enzymatic equipment is fully functional and can efficiently absorb proteins and transaminate the proteins) until the moment of slaughter, in order to achieve higher quantitative and quality performances of the meat. When formulating the experimental diets, it was taken into account that the proportion of inclusion of different ingredients should not affect the nutritional features (especially the metabolizable energy content) and that their manufacturing cost should be similar to that of the standard diets, in order to avoid interferences when calculating the economic profitability applied to the experimental variant proposed by us.

2. Materials and Methods

2.1. Ethics Statement

All experimental procedures complied with the specifications of the Code of Ethics in Scientific Research of the University of Life Sciences of Iasi, Romania (statement no. 26, issued on 17 April 2022 by the Bioethics Committee of Faculty of Food and Animal Sciences, Iasi University of Life Sciences), as well as with those comprised in the Procedures Manual for slow-growth chicken broilers applied in the poultry unit where the investigations were carried out, validated by the International GC-Mark System.

2.2. Biological Material and Management Measures

Studies were carried out on 1200-day-old Hubbard JA757 hybrid chickens in their natural sex ratio (slow-growing genotype, https://www.hubbardbreeders.com/media/leaflet-premium-tradition-en-20220706-ld.pdf (accessed on 14 August 2022)) that were brooded as-hatched and studied until slaughtering (56 days). To achieve the proposed goal, 2 experimental treatments were designed: T-1 treatment = fed standard diets (according to Hubbard recommendations) and T-2 treatment = fed diets supplemented with crude proteins throughout the growing period (+0.5% CP) and the finishing period (+1.0% CP) (Table 1).

Table 1. Experimental protocol.

Treatment	Experimental Factors			
	Hybrid	Protein Level (%)		
		Starter Diet (1–14 Days)	Grower Diet (15–28 Days)	Finisher Diet (29–56 Days)
T-1	Hubbard JA757	21.5	19.0	17.0
T-2	Hubbard JA757		19.5	18.0

Broilers in both experimental treatments were reared on permanent litter, in 2 halls identical in size and technological systems, with uniformly provided microclimate at the levels recommended by the hybrid producer company. In each hall, 6 rearing pens (3 m × 2.25 m) were set up, and then 100-day-old broilers (density = 15 heads/m^2) were randomly brooded in each one, ensuring 6 replicates for each experimental treatment; the rearing pens were arranged in pairs at the front end of the hall, in the central area, and at the rear end of the hall.

Assessment of growth performance was carried out on a total of 1200 chicken broilers, equally allotted in the two experimental treatments (600 heads/treatment); for each experimental treatment, 6 replicates were organized (100 heads/replicate), corresponding to the 6 rearing pens deployed per hall.

Evaluation of the quantitative meat production was applied on a total of 120 chicken broilers (60 heads/treatment, half males and half females), slaughtered at 56 days. To achieve the number of slaughtered individuals per treatment, 5 males and 5 females were extracted from each rearing pen (replicate) (10 heads/pen × 6 pens/treatment = 60 heads/treatment) in such a way that their body weight fell within the average weight of the respective treatment.

Meat quality analyses were performed on samples taken from 24 carcasses (12 carcasses/treatment), both from the breast and thigh regions. Meat samples used in the sensory examination were taken in whole pieces of approx. 100 g each, and those for the assessment of chemical composition were mixed and chopped (breast separated from thighs) and then subjected to laboratory investigations. Ten analytical repetitions/sensory tests were carried out for each investigated trait.

The studied broilers were given combined feed, as Starter diets (1–14 days), Grower diets (15–28 days), and Finisher diets (29–56 days) made of cereals and other feedstuffs, at different inclusion rates (Table 2).

Standard diets were fed to T-1 broilers, formulated based on the Hubbard hybrid guide, following different crude protein levels: 21.5% in Starter diet; 19.0% in Grower diet; and 17.0% in Finisher diet. Supplemented crude protein diets were provided to the T-2 broilers at the beginning of the growing phase (19.5% CP) and all through the finishing phase (18.0% CP). In terms of metabolizable energy contents, there were no differences between the T-1 and T-2 treatments (Starter diet = 2952 kcal/kg; Grower diet = 2950 kcal/kg; and Finisher diet = 3000 kcal/kg). Crude protein supplementation in T-2 treatment also increased essential amino acid dietary levels by 10.38–11.21% for lysine; by 10.87–11.36% for methionine; by 11.9–12.36% for methionine + cystine; and by 13.0–13.9% for threonine.

2.3. Growth Performances

Chicken broilers were individually weighted before feeding and at the same hour in the morning of days 1, 15, 29, and 56 using an electronic scale with an error of ±5 g. Values measured outside the standard deviation of the average weight specific to the respective age were excluded from the analysis.

Weight gain was calculated as the difference between the average weight of the broilers at the beginning of the period and their weight at the end of the analyzed period.

Mortality rate was derived from daily registration of the dead chickens in each hall that accumulated for each age period and overall production series, and their number was reported to the initial flock.

Table 2. Diet composition and nutritional values.

Feedstuffs	**Standard Diets (T-1)**			**Crude Protein-Supplemented Diets (T-2)**		
	Starter (1–14 Days)	**Grower (15–28 Days)**	**Finisher (29–56 Days)**	**Starter (1–14 Days)**	**Grower (15–28 Days)**	**Finisher (29–56 Days)**
Maize %	42.84	39.59	46.95	42.84	46.46	67.04
Wheat %	20.00	30.00	20.00	20.00	20.00	7.94
Soybean meal %	25.00	11.26	9.20	25.00	23.09	12.70
Full-fat soybean %	-	15.23	-	-	-	
Sunflower meal %	-	-	8.00	-	-	
Brewer′s yeast %	3.00	-	4.00	3.00	6.00	6.00
Soybean oil %	2.06	0.49	4.80	2.06	1.20	0.51
Calcium carbonate %	1.56	0.91	1.60	1.56	1.30	1.14
Monocalcium phosphate %	1.03	0.89	1.03	1.03	0.71	0.49
Vit–min. premix %	0.68	0.69	0.43	0.68	0.59	0.58
Salt %	0.34	0.40	0.33	0.34	0.37	0.23
L-lysin %	0.26	0.31	0.40	0.26	0.14	0.20
Dl-metihonine %	0.17	0.23	0.17	0.17	0.03	
L-Threonine %	0.06	-	0.09	0.06	0.11	0.03
PL68 * %	3.00	-	3.00	3.00	-	3.00
Sodium bicarbonate %	-	-	-	-	-	0.14
Nutritional features						
ME (kcal/kg)	2952	2950	3000	2952	2950	3000
Crude protein %	21.50	19.00	17.00	21.50	19.50	18.00
Lysine %	1.28	1.16	1.06	1.28	1.16	1.06
Methionine %	0.50	0.46	0.44	0.50	0.46	0.44
Meth. and Cyst. %	0.95	0.89	0.84	0.95	0.89	0.84
Valine %	0.98	0.90	0.84	0.98	0.90	0.84
Isoleucine %	0.84	0.77	0.72	0.84	0.77	0.72
Arginine %	1.36	1.24	1.17	1.36	1.24	1.17
Tryptophan %	0.21	0.19	0.19	0.21	0.19	0.19
Threonine %	0.84	0.77	0.72	0.84	0.77	0.72
Lysine dig. %	1.15	1.03	0.95	1.15	1.03	0.95
Methionine dig. %	0.45	0.41	0.39	0.45	0.41	0.39
Meth. and Cyst. dig. %	0.85	0.78	0.74	0.85	0.78	0.74
Valine dig. %	0.86	0.78	0.73	0.86	0.78	0.73
Isoleucine dig. %	0.73	0.67	0.62	0.73	0.67	0.62
Arginine dig. %	1.19	1.08	1.02	1.19	1.08	1.02
Tryptophan dig. %	0.18	0.17	0.16	0.18	0.17	0.16
Threonine dig. %	0.73	0.67	0.62	0.73	0.67	0.62
EAA	6.01	5.49	5.14	6.01	5.49	5.14
NEAA	15.49	13.51	11.86	15.49	14.01	12.86
EAA % of CP	28.0	28.9	30.2	28.0	28.2	28.6
NEAA % of CP	72.0	71.1	69.8	72.0	71.8	71.4
EAA/NEAA ratio	0.39	0.41	0.43	0.39	0.39	0.40
Calcium %	1.03	0.84	0.99	1.03	0.95	0.75
Crude fat %	4.13	6.55	7.02	4.13	3.50	2.91
ME/CP ratio	137.30	155.26	176.47	137.30	151.28	166.66
Cost (EUR/kg)	0.66	0.43	0.64	0.66	0.44	0.63

* Non-GMO bacterial SCP concentrate based on microbial fermentation of vegetal raw materials from crop origin (Intraco Ltd., Antwerp, Belgium). Composition: protein—68%; fat—3.25%; crude fiber—1%; ash—10%; and moisture—10%. Amino acid profile: lysine—2.35%; methionine + cysteine—1.15%; isoleucine—2.45%; tryptophan—0.60%; threonine—3.0%; arginine—2.95%; valine—3.25%; alanine—5.02%; and glutamic acid—18.1%.

Feed intake was calculated based on the feed quantity supplied to each hall and the existing average flock. The individual average daily feed intake (g feed/head/day) and the total individual consumption (g feed/head/period) were calculated for the three stages of feeding (starter, grower, and finisher diets) as well as for the total studied period (1–56 days). The feed conversion ratio (FCR) was calculated by dividing the individual total feed intake to the individual weight gain.

The European Production Efficiency Factor (EPEF) was calculated as the percentage ratio between livability (L, %) and body weight at slaughter (LW, kg) and slaughter age (SA, days) and FCR (kg feed/kg weight gain), according to Equation (1):

$$\text{EPEF} = \frac{\text{L} \times \text{BW}}{\text{SA} \times \text{FCR}} \times 100 \quad (1)$$

Using the unitary cost to manufacture 1 kg of feed (Table 2) from each type of formulation, the data related to total weight gain, to total feed intake per technological period (starter, grower, and finisher), to flock size per period, and to production costs generated by feeding were calculated and were considered as expenses (Es). Total produced body weight at slaughter, multiplied by the unitary selling price per kg meat (EUR 1.67) resulted in the income (I) values. Revenue (R) was calculated using Equation (2), while the profitability rate (PR), as % revenue generated by each EUR 100 invested expenses, was calculated using Equation (3).

$$\text{R (EUR)} = \text{I (EUR)} - \text{E (EUR)} \tag{2}$$

$$\text{PR (\%)} = \text{R (EUR)} \times 100/\text{E (EUR)} \tag{3}$$

2.4. Performances at Slaughter

From each experimental group, 60 broilers (30 males + 30 females), whose weight fell within the average of the respective group, were selected and were slaughtered (after prior electrical stunning) in accordance with the technological stages specific to the poultry slaughterhouse of the farm where the research was conducted.

At the end of the slaughter, the resulting carcasses (with head and claws) were chilled for 24 h, at a temperature of +3 °C, and then the dressed yield was calculated based on the individual body weight of the broilers prior to slaughter (LW, kg), and the weight of the corresponding individual refrigerated carcasses (CW) was calculated according to Equation (4):

$$\text{Dressed yield } (\%) = \frac{\text{CW}}{\text{LW}} \times 100 \tag{4}$$

Each obtained carcass was manually cut by a single operator into four anatomical pieces that included the related musculature, bone base, and skin (breast, legs, wings, and remnants); each cut portion was weighed using a precision electronic scale, and the values obtained were calculated as a percentage of the originating carcasses.

2.5. Assessment of Meat Quality

Meat sensorial exams were carried out by 5 trained evaluators, using a hedonic scale with 5 graduations: (1 = very disagreeable; 2 = moderately disagreeable; 3 = slightly disagreeable; 4 = agreeable; and 5 = very agreeable). Each evaluator received whole meat samples (taken from the pectoral and thigh muscles), precooked in an oven until +80 °C was achieved in the thermal center and then brought to an acceptable temperature for tasting (ISO 11136:2014, updated 2020 [23]).

Meat chemical composition was investigated by standard protocols, in accordance with the Romanian standards in force applicable for meat and meat preparations: the content in dry matter by the oven-drying method at +105 °C (ISO 1442:1997, updated 2018) [24]; crude protein by the Kjeldahl method (SR ISO 937:1978, updated 2018) [25]; crude fat by the Soxhlet method (SR ISO 1443:1973, updated 2018) [26]; and crude ash by the calcination method at +550 °C (SR ISO 936:1998, updated 2018) [27]. Nine analytical repetitions were carried out for each sample (breast and thighs).

2.6. Data Treatment

Obtained data were input into a database grouped by columns with individual values, and then they were statistically treated to compute the main statistical descriptors (mean, standard error of mean) and to analyze the variance in one-to-one comparisons via the unpaired *t*-test with Welch correction, assuming not equal standard deviations, using the GraphPad Prism 9 software (GraphPad Inc., San Diego, CA, USA).

3. Results

3.1. Productive Performances

Body weight dynamics. The day-old chicks came from a specialized hatchery and were homogenous in terms of body weight (41.38 g for broilers in T-1 treatment and 41.39 g for those in T-2 treatment). At 14 days old, the average weight of the T-1 broilers was 312.86 g, while T-2 reached 315.69 g, with no statistical differences. At 28 days, significant differences ($p < 0.05$) were found between the broilers fed the 0.5%-supplemented CP diet (T-2986.52 g) and those fed the standard diet (T-1935.39 g). At the slaughter moment (day 56), the body weight reached 2359.27 g (standard diet) and 2425.36 g (diet supplemented with CP), with no statistical difference (Table 3).

Table 3. Dynamics of body weight, daily weight gain, and mortality.

Broilers Age (Days)	Statistics	Body Weight (g)		Daily Weight Gain (g/day)		Mortality (%)	
		T-1	T-2	T-1	T-2	T-1	T-2
1	Mean ± SEM	41.38 ± 0.09	41.39 ± 0.11	-	-		
	t test *p* values	0.9916		-		-	
14	Mean ± SEM	312.86 ± 1.07	315.69 ± 1.25	19.39 ± 0.04	19.59 ± 0.05	1.00 ± 0.01	1.00 ± 0.01
	t test *p* values	0.6973		0.6650		0.9899	
28	Mean ± SEM	935.39 ± 3.51	986.52 ± 3.94	44.47 ± 0.29	47.92 ± 0.17	0.84 ± 0.02	0.67 ± 0.01
	t test *p* values	0.0464 *		0.0146 *		0.0024 **	
56	Mean ± SEM	2359.27 ± 9.52	2425.36 ± 10.19	50.85 ± 0.15	51.39 ± 0.20	1.70 ± 0.05	1.53 ± 0.04
	t test *p* values	0.2518		0.6502		0.0191 *	
1–56	Mean ± SEM			41.39 ± 0.15	42.57 ± 0.18	3.54 ± 0.12	3.20 ± 0.10
	t test *p* values	-		0.2461		0.0171 *	

SEM—standard error of mean. * significant differences for $p < 0.05$. ** significant differences for $p < 0.01$.

Weight gain dynamics. From the analysis of the data related to the growth rate of the studied chickens, it emerged that it was influenced by the nutritional characteristics of the provided feed, according to the data presented in Table 3. For example, in the first period (1–14 days), the chickens in both treatments were fed diets with identical protein levels (Starter), and their growth rate varied similarly (19.39 g/head/day in T-1 and 19.59 g/head/day in T-2). Throughout the next age period (15–28 days), significant differences ($p < 0.05$) occurred between the treatments (47.92 g/head/day in T-2 vs. 44.47 g/head/day in T-1). In the last studied period (29–56 days), chickens from T-2 (+1.0% CP diet) achieved a daily weight gain of 51.39 g/head, compared to 50.85 g/head in T-1 (standard diet). Throughout the whole series, the dynamics of weight gain was at an average level of 41.39 g/head/day in chickens fed the standard diet (T-1) and 42.57 g/head/day in chickens fed the diet supplemented with CP (T-2).

Mortality dynamics. In the first 14 days, the mortality was similar in the two treatments at 1.0% of the initial flock (Table 3). In the next age period (15–28 days), the mortality rate decreased to 0.84% in T-1 and to 0.67% in T-2, and then it increased to 1.70% and 1.53%, respectively, throughout the last period (29–56 days). Over the total period studied (1–56 days), the broilers fed standard diets (T-1 treatment) reached a mortality of 3.54%, while those fed CP-supplemented diets (T-2 treatment) reached 3.20%.

Feed intake and conversion. Table 4 shows the data related to the average daily feed intake and to the feed conversion ratio for the three dietary stages (starter, grower, and finisher) and for the entire growth period as well (1–56 days).

Table 4. Feed intake and feed conversion rates.

Broilers' Age and Dietary Periods (Days)	Statistics	Average Feed Intake (g feed/head/day)		Feed Conversion Ratio (kg feed/kg Gain)	
		T-1	T-2	T-1	T-2
1–14 (starter)	Mean ± SEM	40.68 ± 0.70	40.56 ± 0.63	2.098 ± 0.07	2.070 ± 0.07
	t test *p* values	0.8853		0.5914	
15–28 (grower)	Mean ± SEM	56.88 ± 1.37	56.35 ± 1.27	1.279 ± 0.05	1.176 ± 0.05
	t test *p* values	0.6707		0.0125 *	
29–56 (finisher)	Mean ± SEM	118.39 ± 3.48	116.57 ± 3.33	2.245 ± 0.11	2.187 ± 0.09
	t test *p* values	0.5124		0.3677	
1–56 (overall)	Mean ± SEM	83.21 ± 2.99	82.16 ± 2.85	2.010 ± 0.11	1.930 ± 0.10
	t test *p* values	0.6157		0.2061	

SEM—standard error of mean. * significant differences for $p < 0.05$.

The obtained data show that chickens fed CP-supplemented diets (T-2) consumed slightly less feed, leading to better feed conversion rates than chickens fed standard diets (T-1), both by diet type and by the total studied period.

European Production Efficiency Factor and Economic Profitability. Based on the data obtained during the growth of the studied chickens, the European Performance Efficiency Factor values were calculated and are presented in Table 5.

Table 5. European Production Efficiency Factor.

Traits	Statistics	Treatments	
		T-1	T-2
Survival rate (%)		96.46 ± 3.27	96.80 ± 3.08
Body weight (kg)		2.36 ± 0.009	2.43 ± 0.010
Age at slaughter (days)		56	56
FCR (kg feed/kg gain)		2.01 ± 0.11	1.93 ± 0.10
EPEF (European Production Efficiency Factor)	Mean ± SEM	202.25 ± 0.44	217.63 ± 0.59
	t test *p* values	0.0038 *	

SEM—standard error of mean. * significant differences for $p < 0.01$.

The European Production Efficiency Factor had a lower value in the T-1 treatment (202.25 points), compared to that calculated for the T-2 broilers (217.63 points) ($p < 0.05$).

A lower income was obtained by the end of the experiment in the standard-fed broilers (EUR 615.02) compared to those fed the CP-supplemented diet (719.76), hence the difference in the profitability rate (36.92% in T-1 and 44.07% in T-2).

Table 6 depicts the economic results of each tested diet (standard or supplemented for crude protein level).

3.2. Meat Yield

Dressed yield. At the end of the production series, the chickens were slaughtered in order to establish the yield at slaughter (Table 7).

The body weight at slaughter in the chickens fed the standard diet (T-1) was 2365.18 g and that of the carcasses reached 1712.63 g, resulting in a dressed weight of 72.41%. In the chickens fed diets supplemented with CP, the body weight at slaughter was 2428.19 g, and the carcass weight reached 1774.28 g; therefore, the dressed weight was 73.07%. No statistical differences occurred between treatments.

Proportion of cut parts. The meat production was also evaluated through the proportion of the four main anatomical regions (breast, thighs, wings, and remnants) in the structure of the carcasses (Table 8).

Table 6. Economic efficacy indices (Expense, Incomes, Revenue, and Rate of Profitability).

Dietary Periods	Traits	Treatments	
		T-1	T-2
Starter	Total feed intake (kg)	340	339
	Unitary diet cost (EUR/kg)	0.66	0.66
	Feeding expenses (EUR)	224.40	223.74
Grower	Total feed intake (kg)	471	467
	Unitary diet cost (EUR/kg)	0.43	0.44
	Feeding expenses (EUR)	202.53	205.48
Finisher	Total feed intake (kg)	1936	1911
	Unitary diet cost (EUR/kg)	0.64	0.63
	Feeding expenses (EUR)	1239.04	1203.93
Overall (1–56 days) feeding expenses (E) (EUR)		1665.97	1633.15
Flock size sent to slaughterhouse (heads)		579	581
Average individual weight (kg)		2.359	2.425
Total body weight at slaughter/group (kg)		1365.86	1408.93
Meat unitary selling price (EUR/kg)		1.67	1.67
Income (I) (EUR)		2280.99	2352.91
Revenue (R) (EUR)		615.02	719.76
Profitability rate (PR) (%)		36.92	44.07

Table 7. Dressed yield.

Traits	Statistics	Treatments	
		T-1	T-2
Body weight (g)	Mean ± SEM	2365.18 ± 24.12	2428.19 ± 21.63
	t test *p* values	0.2735	
Carcass weight (g)	Mean ± SEM	1712.63 ± 18.35	1774.28 ± 14.66
	t test *p* values	0.1525	
Dressed yield (%)	Mean ± SEM	72.41 ± 0.76	73.07 ± 0.64
	t test *p* values	0.6960	

SEM—standard error of mean.

Table 8. Proportions of cut parts in carcasses.

Cut Parts	Statistics	Treatments	
		T-1	T-2
Breast (%)	Mean ± SEM	34.23 ± 0.39	34.61 ± 0.39
	t test *p* values	0.6370	
Thighs + drumsticks (%)	Mean ± SEM	33.95 ± 0.32	34.38 ± 0.33
	t test *p* values	0.5914	
Wings (%)	Mean ± SEM	12.26 ± 0.13	12.39 ± 0.14
	t test *p* values	0.6656	
Remnants (%)	Mean ± SEM	19.56 ± 0.17	18.62 ± 0.19
	t test *p* values	0.0633	

SEM—standard error of mean.

When cutting the carcasses, we found that those from chickens fed CP-supplemented diets (T-2) had a higher proportion of breast (34.61% vs. 34.23% in T-1), thighs (34.38% vs. 33.95% in T-1), and wings (12.39% vs. 12.26% in T-1). A higher proportion of remnants was found (19.56% vs. 18.62%) in T-1 carcasses (standard diets). No statistically significant differences occurred between the treatments in any of the compared regions.

3.3. Meat Quality

This was evaluated through the lens of sensory properties and chemical composition on samples taken both from the leg and breast muscles.

Sensory assessment of meat. There were certain differences between the experimental treatments in favor of the meat obtained from chickens that received diets supplemented with crude protein (T-2). In thigh muscles, it was found that the most appreciated attribute was flavor + savoriness (T-1 = 4.84 points and T-2 = 4.90 points), followed by tenderness (T-1 = 4.65 points and T-2 = 4.72 points) and consistency (T-1 = 4.62 points and T-2 = 4.70 points); the least-valued trait in thigh meat was juiciness, for which only 3.84 points (T-1) and 3.89 points (T-2) were awarded (Table 9).

Table 9. Sensory scores of thigh and breast meat.

Traits	Statistics	Thigh Meat		Breast Meat	
		T-1	T-2	T-1	T-2
Tenderness	Mean ± SEM	4.65 ± 0.12	4.72 ± 0.13	4.80 ± 0.14	4.85 ± 0.15
	t test *p* values	0.2582		0.7305	
Juiciness	Mean ± SEM	3.84 ± 0.13	3.89 ± 0.13	3.52 ± 0.11	3.61 ± 0.11
	t test *p* values	0.6982		0.4741	
Flavor and savoriness	Mean ± SEM	4.84 ± 0.16	4.90 ± 0.14	4.25 ± 0.14	4.32 ± 0.13
	t test *p* values	0.6815		0.6078	
Firmness	Mean ± SEM	4.62 ± 0.14	4.70 ± 0.14	4.74 ± 0.14	4.82 ± 0.13
	t test *p* values	0.5764		0.5817	

SEM—standard error of mean.

In the case of the pectoral muscles, the sensory examination revealed that the best-rated quality was tenderness (4.80 points for the T-1 treatment and 4.85 points for the T-2 treatment), and the lowest-rated was juiciness (3.52 points for T-1 and 3.61 points at T-2); intermediate scores were recorded for consistency (4.74 points for T-1 and 4.82 points for T-2) and for flavor + savoriness (4.25 points for T-1 and 4.32 points for T-2) (Table 9).

Chemical composition of meat. A higher proportion of dry matter (29.33% vs. 29.17%) and crude protein (19.58% vs. 19.26%), but lower crude fat (6.34% vs. 6.46%) and crude ash (3.28% vs. 3.30%) were achieved in the T-2 treatment vs. the T-1 treatment (Table 10).

Table 10. Proximate composition of thigh and breast meat.

Traits	Statistics	Thigh Meat		Breast Meat	
		T-1	T-2	T-1	T-2
Dry matter (%)	Mean ± SEM	29.17 ± 0.38	29.33 ± 0.32	28.53 ± 0.35	28.97 ± 0.40
	t test *p* values	0.8146		0.5167	
Crude protein (%)	Mean ± SEM	19.26 ± 0.32	19.58 ± 0.29	22.85 ± 0.25	23.32 ± 0.35
	t test *p* values	0.4910		0.3959	
Crude fat (%)	Mean ± SEM	6.46 ± 0.20	6.34 ± 0.19	2.81 ± 0.11	2.74 ± 0.11
	t test *p* values	0.4972		0.5382	
Crude ash (%)	Mean ± SEM	3.30 ± 0.11	3.28 ± 0.14	2.73 ± 0.12	2.80 ± 0.10
	t test *p* values	0.5298		0.5377	

SEM—standard error of mean.

As for the breast muscles, the dry matter content was lower than that in the thighs in both experimental treatments (28.53% in T-1 and 28.97% in T-2). Higher levels were found for crude protein (22.85% in T-1 and 23.32% in T-2) and much lower for crude fat (2.81% for

T-1 and 2.74% for T-2). The crude ash in the meat was lower than in the thighs, within the range of 2.73–2.80% (Table 10).

4. Discussion

Producing poultry meat in farming systems that is different from the conventional industrial type has become a necessity at the present time, given the orientation of consumer preferences toward a meat with better-accentuated sensory features, characteristics resembling to wild or traditionally farmed fowl, and with less moisture content. To respond to this demand, farmers began to rear various slow-growth hybrids (broilers) or to limit the weight gain up to a maximum of 45 g/day, by reducing the crude protein level of the fed diets.

4.1. Productive Performances

Body weight dynamics. Body weight was directly influenced by the nutritional characteristics of the diets. After the first 14 days of life, the body weight was close in the chickens from the two experimental treatments (312.86 g in the T-1 treatment and 315.69 g in the T-2 treatment), because both groups received an identical diet of protein content, and the weight differences at the age of one day were insignificant (41.38 g vs. 41.39 g). During the period of 15–28 days, a diet supplemented with 0.5% CP was used in the T-2 treatment, so in the end, the chickens had a body weight that was higher by 5.18% compared to the chickens fed the standard diet (T-1) ($p < 0.05$). Although the highest CP supplementation was provided in the age period 29–56 days (+1.0% CP), the difference in body weight between the experimental treatments was only 2.74% in favor of the chickens in the T-2 group. The body weight at 56 days (2359.27 g in T-1 and 2425.36 g in T-2) can be considered as normal for a slow-growing hybrid, comparable to those obtained under similar experimental conditions. In the Hubbard broiler line JA957 (slow-growing), Mikulski et al., 2011 [28] reported a body weight of 1.94 kg (42 days) and of 3.64 kg (65 days), while in the F15 Hubbard line (rapid-growing), the average body weights reached at the same ages of slaughter were 2.39 kg and 4.40 kg. In addition, in the Hubbard ISA Red JA chicken broiler that reared free-range chickens (access to a grassy paddock since 14 days old until slaughtering at 84 days), there were reached body weights of 2.99 kg in the group fed the protein- and energy-rich diet, compared to a 2.27 kg body weight in the control group fed a diet restricted in energy and protein levels [29]. Other studies carried out on slow-growth hybrids (ISA J 457 and ISA J 257), fed differentially in the starter period (standard organic feed vs. feed supplemented with fish meal) and slaughtered at different ages (56 and 77 days), showed that the genetic variant ISA J 257 fed higher protein levels achieved a better growth performance and a higher quality of the carcass and of the yielded meat [30].

Weight gain. The average daily weight gain was correlated with the body weight dynamics, with certain differences given by the experimental factor. For example, in the age period 15–28 days, the weight gain rate of chickens in the T-2 treatment was higher by 7.20% than that of chickens in the T-1 treatment, while in the period 29–56 days, the difference between the treatments was only 1.05%. The data indicate that the tested hybrid (Hubbard JA757) utilizes the dietary proteins more efficiently during the growth period than during the finishing period. This statement is supported by the significant statistical differences ($p < 0.05$) between the two experimental treatments, but also by the specifications in the literature that show that the formation of muscle mass in chickens intensifies after the age of 14 days when their digestive enzymatic equipment becomes fully functional [15]. During the entire studied period (1–56 days), the average daily weight gain was 41.39 g/head/day in T-1 chickens and 42.57 g/head/day in T-2 chickens, attesting the fact that the Hubbard JA757 is a well-selected hybrid for slow growth, in both cases not exceeding the maximum threshold of 45 g/head/day as is specific for this category of broilers. For this trait, other studies conducted on slow-growth broilers did not underline the differences due to the dietary levels of energy and protein (low vs. high), but did underline the changes in feeding behavior of the fowl based on the feeding technique (ad libitum vs. restricted feeding) [30]. Weight gains of 50.48–53.20 g/head/day were obtained in the ROSS-308 conventionally reared broilers, slaughtered at 42 days, due to the protein profile optimization of the diet, through supplementing different levels of lysine, methionine, and L-carnisine [31]. Weight gain could also be influenced by lighting schedule adjustments, such as reported for Beijing-You in a slow-growing chicken broiler, where the daily gain was 20.28–21.09 g/head, within the 1–90 day interval [32].

Mortality. A higher mortality rate occurred in the first 14 days (1.0% for each treatment) when mostly the low-viable chickens died, but also in the last 28 days of the study (1.70% in T-1 treatment and 1.53% in T-2 treatment) due to cardiovascular issues that occurred in specimens with a high body weight; the other mortality cases were mostly due to mechanical incidents (fracture, dislocation, suffocation, etc.), and no metabolic–nutritional morbidity was observed. Overall, the mortality levels throughout the whole period (1–56 days) fell within the normal limits (3.54% in T-1 and 3.20% in T-2) specific to slow-growing chickens designed to be reared in closed sheds, with no access to the outer environment. Significant differences between treatments occurred both in the grower diet phase (15–28 days, $p < 0.01$) and the finisher diet period (29–56 days), as well as in the total studied period (1–56 days) ($p < 0.05$), showing that crude protein supplementation ensured a better growth pace and a better immune response and therefore better resilience to morbidities. In other similar studies, feeding a high-energy, protein-rich diet to Hubbard ISA Red JA chickens significantly improved growth and feed intake compared to a low-energy, protein-poor diet, but with no differences between groups in the mortality rate [33]. Other studies reported that using high dietary energy levels (3000–3300 kcal ME/kg feed) in “Lingnan” slow-growing chickens induced a 4.17–6.67% mortality, compared to just a 3.33% flock loss in chickens fed 2900 kcal ME/kg feed, despite all groups receiving the same dietary crude protein content (16%) [34]. In addition, rearing different fowl genotypes (fast-growing, slow-growing, and Rhode Island chickens) in different systems (intensive and free-range) resulted in differences in body weight, growth rate, and feed conversion efficiency, but not in the rate of survival ($p > 0.05$) [35].

Feed intake and conversion. In all analyzed situations, the chickens from T-2 (diets supplemented with CP) had a lower average intake than those from T-1 (standard diets). In the age period 1–14 days, the difference between treatments was only 0.30% (40.68 g feed/head/day in T-1 and 40.56 g feed/head/day in T-2); in the period 15–28 days, the difference increased to 0.94% (56.88 g feed/head/day vs. 56.35 g feed/head/day); in the period 29–56 days, the difference increased to 1.56% (118.39 g feed/head/day vs. 116.57 g feed/head/day). Throughout the entire period (1–56 days), chickens fed diets supplemented with CP (T-2) had a more convenient average daily intake, lower by 1.28% than chickens fed standard diets (T-1). The results on feed intake reveal that the Hubbard JA757 is a hybrid that responds to dietary crude protein supplementation, well proven by the better values of the feed conversion ratio (FCR) that were 1.35% lower throughout the 1–14 day period, 8.76% lower throughout the 15–28 day period, and 2.65% lower throughout the 29–56 day period. For the entire period (1–56 days), a 4.15% lower FCR value occurred (1.93 kg feed/kg gain vs. 2.01 kg feed/kg gain) due to the better T-2 chicken performance throughout the 15–28 day period ($p < 0.05$). Other studies run on slow-growth chicken broilers, reared in similar conditions with rapid-growth ones, revealed an FCR of 2.54 in slow-growing fowl, compared to conventional ones (FCR of 2.47) [36]. In addition, regarding the thermal conditions provided, the “i657” slow-growing chicken hybrid achieved a daily feed intake of 57–73 g and an FCR of 2.15–2.49, while the ROSS-308 conventional broiler consumed 142–150 g feed/day to achieve eventually an FCR of 2.02–2.34 [37]. Providing access to slow-growth chicken broilers to feed resources in an outer hall environment (free-range rearing) allowed the FCR to decrease to 2.96, compared to the FCR 3.38 achieved by chickens exclusively maintained and fed indoors on deep litter [38]. In certain genetic strains with slow growth, different FCRs were gender-specific, reaching a 2.46–2.63 kg feed/kg gain in females and a 2.09–2.16 kg feed/kg gain in males [39].

European Production Efficiency Factor and Economic Profitability. The calculated values for the EPEF were related to the experimental variable applied in our study (different levels of CP) that influenced the performance of the Hubbard hybrid. The EPEF was 217.63 points in T-2 and only 202.25 points in T-1 ($p < 0.05$). Expressed as a percentage, the difference reached 7.07% due to the higher body weight (+2.74%), better livability (+0.35%), and lower FCR (−4.15%) values in the T-2 chickens fed CP-supplemented diets. In other studies, providing low-protein feed caused a more severe decrease in the production performance in the fast-growth genotypes (Ross 308) and in medium-growth ones (JA757) compared to slow-growth ones (ISA Dual) and negatively impacted the European Production Efficiency Factor ($p < 0.001$) in fast-growth (−10%) and medium-growth (−6%) fowl, but not in slow-growth fowl [40]. Other authors reported that in slow-growing chickens obtained through Hubbard × Yellowleg Partridge crossings slaughtered at 56 days the EPEF reached a value of 111.9 due to a body weight of 1217 g, an FCR of 1.896, and a casualty rate of 2.92% [41].

Economic efficiency. The total revenues obtained at the end of the series were at a level of EUR 615.02 in T-1 and EUR 719.76 in T-2, corresponding to revenues of EUR 1.06 and EUR 1.24 for each chicken delivered to the slaughterhouse. The rate of profitability calculated for each EUR 100 invested was higher by 7.16% in the T-2 than in the T-1 group (44.07% vs. 36.92%). Of course, if we had conducted a total expense/income analysis, the profitability rates would be much lower, knowing that feeding costs usually account for up to 70–75% of the total production expenses. In other studies, in the case of chickens raised in closed shelters for 21 days and then in the free-range system until slaughter (56 days), in the fast-growing genetic variants, a profit of USD 3.54/head was obtained, and in the slow-growing hybrids, there was a profit of only USD 0.37/head [35]. With regard to the net income achieved from the sale of the carcasses of the broilers that received diets differentiated in terms of the energy and protein provided (high, medium, low, and very low levels), the best results were obtained in the males provided an average level of nutrients (EUR 1.68/carcass) and in females (EUR 1.32/carcass) where a low level was ensured [42].

4.2. Meat Yield

Dressed yield. Although the differences in body weight at slaughter were only 2.59% in favor of chickens fed CP-supplemented diets (T-2), the experimental factor influenced meat deposition during growth, so that the weight of the carcasses was higher by 3.47% than in the chickens fed standard diets (T-1). Under these conditions, the dressed yield was better with 0.66% in the T-2 chickens than those in the T-1 chickens (73.07% vs. 72.41%), despite the fact that no statistical significance was obtained. In other studies with slow-growth broilers receiving the same diet but reared in closed halls versus free-range, better results were obtained in free-range fowl (69.88% vs. 69.80% dressed yield; 20.17% vs. 18.20% breast fillet proportion; and 27.65% vs. 27.23% thigh proportion) [43]. Other authors [44] also reported that crude protein supplementation in the Hubbard JA757 chickens generated a 74.89% dressed yield, compared to 74.66% (same genotype fed standard diet). In "Lingnan" slow-growing chickens, providing 16% crude protein and 2900 kcal ME led to a 68.99% dressed yield or a 0.25–1.36% better value than those achieved by groups fed with 16% crude protein and higher ME values (3000–3300 kcal/kg feed) [45]. Other authors reported dressed yield levels at 69.90% (Gushi local Chinese chicken) [46], 68.63% (Indbro slow-growth experimental broiler obtained from White Plymouth Rock × Cornish strain crosses) [34], or slightly above 72% (novel Slow-Growing Broiler, Australia) [47]. Increasing the level of crude protein from 15% to 23% in Hubbard broiler diets during the 22–42 day period caused a linear increase in the values of dressed yield from 66.2% to 67.87% [14].

Proportion of cut parts. Carcasses with higher proportions of breast and legs are preferred in chicken broilers, because such anatomic parts could be better capitalized when marketed as separate products. The biological material used in our experiment (Hubbard JA757) came from genetic strains selected for the purpose of increasing the proportion of anatomical regions of commercial interest (breast and thighs). In our study, they reached together 68.18–68.99% of the carcass weight. However, the experimental factor led to certain differences in favor of the group fed CP-supplemented diets (T-2), where a higher weight was recorded for breast (+0.38%), thighs (+0.43%), and wings (+0.13%). Even if these differences were not statistically significant, it is most likely that they will be maintained in industrial production conditions, and their cumulative effect would lead to the addition of the annual revenues to the respective farms. In similar studies, the proportion of thighs and drumsticks in the carcass structure was calculated at 29.69% in novel Slow-Growing Broiler, Australia [47], at 31% in the Hubbard commercial slow-growth broilers [48], and at 32.70% in the Hubbard S757 strain [49]. In other studies, the Hubbard slow-growth broilers aged 8 weeks at slaughter had a 30% breast proportion in the carcass structure, while wings had a 12% proportion [48], and up to 31.5% breast and 12.8% wings were obtained in the Hubbard S757 carcasses slaughtered at 9.5 weeks [49]. Other research reported a 45.26% thigh and shank proportion as well as a 36.45% breast proportion in slow-growing broilers reared free-range and slaughtered at 56 days, while in those reared on deep litter exclusively indoors the proportion quota reached 46.04% for legs and 34.78% for breast [50]. Almost at the same body weight at slaughter (2 kg), Vencobb fast-growing broilers reached 37.97% for breast, 33.52% for thighs and shanks, and 12.47% for wings, while Indbro slow-growing chickens achieved carcass proportion quotas of 29.95% for breast, 30.93% for thighs and shanks, and 11.17% for wings [34]. In COBB-500 broilers, conventionally reared and slaughtered at 42 days, the breast proportion in the carcass reached 33.5–35.2%, and that of the legs was reported at 27.9–28.7% in relation to the proportion of organic selenium added in diet the [51].

4.3. Meat Quality

Sensory assessment. Meat from chickens fed CP-supplemented diets was better sensory-wise, achieving average scores of 4.40 points (breast muscle) and 4.55 points (leg muscle), compared to only 4.33 points and 4.49 points, respectively, in chickens fed standard diets. In the case of the leg muscles, the scores were higher by 1.22–1.70% in chickens fed CP-supplemented diets than in chickens fed standard diets. The highest scores were awarded for flavor and savoriness and the lowest ones for juiciness. A similar situation was found in the case of the breast muscles, with differences between the two treatments reaching 1.03–2.49%. The most appreciated was tenderness, and the least appreciated was juiciness. In the meat of Hubbard Hi-Y chickens slaughtered at the age of 42 days, tenderness was appreciated with 4.4 points (breast muscles) and 4.55 points (leg muscles), juiciness with 4.3 points and 4.13 points, respectively, and aroma and taste with 4.22 points and 4.18 points, respectively [51]. The taste, flavor, juiciness, and overall acceptability of the breast meat were higher in day 21 open-air-reared broilers, but tenderness was higher in non-free-air broilers [52].

Chemical composition. Increasing the dietary crude protein influenced the chemical composition of the meat in the sense that it favored a better accumulation of proteins and a decrease in lipids. Muscles in the legs of the T-2 broilers (CP-supplemented diets) had a higher level of dry matter (+0.55%) and CP (+1.63%); meanwhile, they were lower in crude fat (−1.89%) compared to chickens in the T-1 (standard diets). The effect was more accentuated in the breast, where the DM was higher by 1.52% and CP by 2.02% than those found in standard diet-fed chicken; in the latter samples, the meat contained 2.55% more crude fat. The achieved data are similar to those in the literature, with certain differences given by the experimental factors and especially by the age at slaughter. For example, the addition of *Scutellaria baicalensis* radix (0.5%, 1.0%, and 1.5%) in the diet fed to Hubbard Hi-Y chickens determined the following values for the chemical composition of the meat (leg muscles/breast muscles): DM = 26.71%/26.82%; CP = 19.81%/22.94%; CF = 5.72%/2.37%; and crude ash = 0.96%/1.22% [53]. Pectoral muscles taken from Hubbard JA757 chickens slaughtered at 42 days (average body weight of 2.0 kg) contained 25.69% DM; 22.90% CP; 4.64% crude fat, and 1.17% crude ash [54]. In another study performed on two Hubbard strains slaughtered at 56 days, the leg muscles contained 31.78% DM, 20.14% CP, and 11.22% crude fat (Hubbard Classic) and 29.93% DM, 20.01% CP, and 9.44% crude fat (Hubbard Yield Color) [22]. In the meat of Hubbard JA 957 chickens slaughtered at the age of 63 days, the meat DM content was 25.57% (breast) and 27.37 (thighs); CP was 23.17% and 19.10%; crude fat was 0.88% and 6.91%, crude ash reached 1.18% and 1.04% [55].

5. Conclusions

Feeding crude protein-supplemented diets to the Hubbard JA757 hybrid led to a better performance compared to the nonsupplemented chickens. Most of the differences did not cross the statistical significance threshold, except for body weight, weight gain rate, and feed conversion ratio ($p < 0.05$) throughout the grower diet period (15–28 days, +0.5 CP supplementation). The obtained data suggest that dietary crude protein supplementation provides a good response when the chicken broiler has the most intense growth rate (after 14 days, after dressing in plumage), but on the condition of keeping it within normal limits, related to the other quality parameters of the combined feed, especially without increasing its price. However, considering that the price and quality of the ingredients used to ensure a certain protein level in broilers are extremely variable, it is necessary to continue investigations in this direction to establish to what extent crude protein could be increased without affecting economic profitability to ensure better meat yield and good quality.

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