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Original Article

Economic Efficiency of Producing Meat Products of Male Layer-Type Chickens Raised in Bulgaria

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ABSTRACT

The research aimed to investigate the economic aspects of rearing male layer-type chickens to produce meat, so as to determine the production cost and propose a selling price for the products obtained. The experiment was conducted at the Institute of Animal Science – Kostinbrod, Bulgaria, using Lohmann Brown Classic cockerels. A total of 800 chickens were initially involved. The birds were slaughtered at 5 and 9 weeks of age. The costs incurred for the rearing were classified as fixed and variable, and calculated cumulatively for each week of the experiment (Option 1). Subsequently, we tested the second option of the experiment - rearing all the cockerels until 9 weeks of age (Option 2). In this scenario, the chickens were slaughtered at a random moment after 5 weeks and up to 9 weeks of age. Mathematical modelling was applied to compare the economic indicators of Option 1 and Option 2. The economic efficiency was determined for both rearing options, and was higher in the second one. The optimum age of slaughter in terms of profitability was found to be 9 weeks of age. Thus, based on the economic analysis, we propose an alternative to the currently applied practice of culling the 1 day-old layer cockerels. Furthermore, a minimum selling price of 9.85 EUR/kg has been suggested for the sale of the derived meat product.

INTRODUCTION

Historically, meat and meat products have played an important role in human diet. Chicken is currently the most consumed type fo meat worldwide. This is probably due to the lack of cultural prejudices associated with its consumption, its mild taste, fine texture, and favourable nutritional profile, including low fat content. Until the 1920s, chickens were used for both meat and eggs. Over the past 50 years, the development of the poultry industry has divided chicken breeding into two main directions - broiler lines with massive chest muscles for meat and laying hens capable of high egg production (Flock & Preisinger, 2007; Tixier-Boichard *et al.*, 2012).

Rearing male layer-type chickens has been considered unprofitable, and hence these birds are usually culled immediately after hatching (Damme & Ristic, 2003; Krautwald-Junghanns, 2018). Due to ethical and welfare concerns, this practice is no longer accepted by society. This is the reason for numerous discussions and studies that aim to find alternatives to the culling of day-old layer cockerels. Legislation changes in this direction have been adopted or are in the process of being adopted in European countries. As of January 2022, Germany banned the culling of male layer-type chickens, followed by France. Other countries such as Austria, Ireland, and Luxembourg support the ban on culling male cockerels, but are still waiting for scientific evidence on alternative methods to avoid this practice (Dahm & Pistorius, 2021). We have every reason to expect that in the near future new practices using male layer chicks will grow within the EU and reach Bulgaria as well. The alternative methods to avoid culling of the day-old layer cockerels include in-ovo sexing, development of dual purpose lines, and rearing male layer–type chickens for meat (Weissmann *et al.*, 2013; Krautwald-Junghanns *et al.*, 2018). Male layer-type chickens are slow-growing and have lower breast and thigh yield compared to the fast-growing broilers, butthey are more resistant to diseases (Mikulski *et al.*, 2011). Several studies have shown that the meat of these birds has a more favourable dietetic profile, with lower fat content and higher protein (Fanatico *et al.*, 2008; Lichovníková *et al.*, 2009). Data from AVEC (2022) showed that in 2021, the consumption of broiler meat in EU amounted to 11,171 thousand tons. At the same time, the production of layers was of 300 million per year (Eurostat, 2022). This is approximately the number of the male layer-type chickens that were hatched and culled at 1 day of age. Even when fully realized as a meat product, their market share does not exceed 5% of the total poultry meat consumption in EU. We consider that there is a sufficient number of consumers that would be willing to pay higher price for a product with more nutritional and health benefits. Hence, the aim of our study was to investigate the economic aspects of rearing male layer-type chickens raised for meat production, in order to determine production costs and propose a market price for such a product based on economic analysis.

MATERIALS AND METHODS

Location and time of the experiment

The trial was carried out in the experimental poultry farm of the Institute of Animal Science - Kostinbrod, Bulgaria, from June 06 till August 08, 2022.

Birds and housing

A total of 800 male layer-type chickens of the Lohmann Brown Classic hybrid were used in this experiment. The chickens were reared conventionally until 9 weeks of age at an initial stocking density of 22 birds/m². When the chickens reached 5 weeks of age, fragmentation of the stocking density was applied until reaching 7 birds/m². The density fragmentation method (DFM) applied in this experiment was modified in the Institute of Animal Science-Kostinbrod. Based on previous practical experience, we applied higher stocking density at an earlier age. The male layer-type chickens were raised in separate pens in deep litter and controlled microclimate. The lighting regime alternated between 3 h of light and 3 h of dark, repeated during the 24 h cycle.

Rent (depreciation of the buildings)

The birds were housed in the experimental poultry farm of the Institute. Since the depreciation of the buildings is more difficult to determine for cost calculation, we have used the price at which the Institute rents a building of the same size as the one used for housing the chickens.

Feeding

The chickens were fed *ad libitum* with standard broiler feed containing maize, wheat, sunflower meal, and soybean meal (crude protein 20%, fat 4.60%, crude fibers 5.00%, Ca 0.90%, P 0.65%, Lys 1.10%, Met 0.50%, ME 3000 kcal/kg). The water was provided through gravity drinkers.

Medicines and decontamination

The vaccination program applied followed to the recommendations of Lohmann Tierzucht for layers of the Lohmann Brown Classic hybrid. Decontamination of the building was done using $Ca(OH)_2$.

Transportation and slaughtering

At the age of 5 weeks, fragmentation of the stocking density (DFM) was applied, and birds were separated according to their live weight. The chickens weighing less than 360 g (approximately ¾ of the total number of birds in the trial) were slaughtered. The rest of the chickens were left at the same pens with a decreased stocking density until reaching 9 weeks of age, and then were slaughtered. The chickens selected for slaughter were transported to the abattoir in cages that contained 8 chickens each.

Methodology of calculation of the costs and the production cost

The total costs for rearing and slaughter of the male layer-type chickens were calculated according to the following equations:

$$TC = \sum_{i=1}^{n} F_i + \sum_{j=1}^{m} V1_j + \sum_{k=1}^{l} V2_k \quad (1),$$

$$GC = \sum_{i=1}^{n} F_i + \sum_{j=1}^{m} V1_j \quad (2),$$

Where TC are the total costs (EUR - all the following costs are in the same currency);

GC are the costs for rearing the layer cockerels before slaughter;

Fi are the fixed costs comprising:

1. Rent (depreciation) of the building where the birds were reared;
2. Preparation of the premises, including covering and preliminary heating before housing the one-day-old chickens.

   V1j are a group of variable costs that were used to calculate the production cost per kg of live weight at farm level, including:
3. Labour costs;
4. The price of a day-old chick;
5. Cost of vaccines and decontamination of the building;
6. Electricity costs;
7. Feed costs.

   V2k are a group of variable costs that help to calculate the production cost of the ready-to-purchase product. They include:
8. Costs of transportation;
9. Costs of slaughter;
10. Costs of packaging and freezing.

When dividing the costs into these groups, we considered the extent to which each respective cost was directly linked to the object of the study. We considered that the fixed costs were not directly connected to the object of our research, contrary to the variable costs. The second group of variable costs were separated from the rest, since they might be incurred in each moment during the trial, and they helped us to calculate the production cost of the product for each period. The production cost per kg of live weight was calculated as follows:

Slw = GC/LW (3),

Where Slw is the production cost/kg live weight (EUR/kg), GC are the total costs before slaughter (EUR), and LW is the total live weight of the all the chickens involved (kg).

After slaughtering the cockerels, the dressing percentage was calculated for the product that is ready to be purchased (carcass with removed feet, head and viscera). Its production cost was calculated according to the following equation:

Scw = TC/CW (4),

Where Scw is the production cost of the ready-to-purchase product (EUR/kg), TC are the total costs (EUR), and CW is the weight of the ready-to-purchase product (kg).

We have determined the ratio between the revenue and the costs at a fixed price for the product using the equation below:

Rat = TR/TC (5),

Where TR is the total revenue, and TC are the total costs.

RESULTS AND DISCUSSION

During the trial period, the live weight and the feed intake of the birds were controlled weekly and the weight gain was calculated. The initial live weight of the day-old chickens involved in the trial was 34.97±0.25 g. The live weight of the birds at 5 weeks of age was 329.00 ± 5.58 g, and at 9 weeks of age it reached 1096.01±9.23 g. The birds gained 294.03±6.28 g to reach the weight at 5 weeks old, and 1061.04±9.06 g to reach the final body weight for the experiment. The cumulative feed intake until 5 weeks was 872.27±4.73 g/bird, whereas until the end of the trial, the birds consumed 3089.40±100.73 g/bird. The dynamics of the growth performance traits of the male layer-type chickens for each week of the experiment was presented and analysed in details elsewhere (Popova *et al.*, 2023).

The determination of the production cost per kg of live weight and kg of ready-to-purchase product was conducted for the two rearing options. Option 1 is the real experiment with application of density fragmentation. In Option 2, we applied mathematical modelling of the experimental parameters assuming that all the chickens were reared at the same conditions as in Option 1, and were slaughtered at a random age after 5 weeks and up to 9 weeks. The aim was to calculate the production costs for both options and to compare their economic efficiency.

Option 1 (real experiment)

Table 1 presents the cumulative costs for the 9 week period of rearing of the layer cockerels.

From the 800 male layer-type chickens initially involved in the trial, 15 died by the age of 5 weeks. Until 9 weeks of age, this number increased to 17 chickens. This number represents a relatively low mortality of just over 2% for the entire trial period. Such result is similar to a study by Malchow *et al.* (2019), who registered a mortality rate of 1.7 % for the same period and at similar rearing conditions for male chickens.

The male layer-type chickens were put into 5 pens with an area of 36.5 m^2. The pens occupied exactly ¼ of the total efficient area of 146 m^2 for rearing of

Table 1 – Cumulative costs and production cost (EUR/kg) per kg of live weight and ready-to-purchase product derived from male layer-type chickens (Option 1).

Cost	Cumulative costs (EUR) for the trial period									
	1 d	1 wk	2 wk	3 wk	4 wk	5 wk	6 wk	7 wk	8 wk	9 wk
Chickens	800	793	789	788	786	785	208	206	206	206
Mortality, birds	0	7	11	12	14	15	15	17	17	17
I.Fixed costs (1+2)	29.41	44.08	58.74	73.41	88.07	102.73	117.40	132.06	146.72	161.39
1. Rent	14.66	29.33	43.99	58.66	73.32	87.98	102.65	117.31	131.97	146.64
2. Building preparation	14.75	14.75	14.75	14.75	14.75	14.75	14.75	14.75	14.75	14.75
II. First group of variable costs (3+4+5+6+7)	319.87	444.69	582.83	771.56	951.58	1191.58	1280.38	1380.48	1501.12	1624.13
3. Labour costs	36.86	73.35	109.66	149.95	190.13	230.27	269.35	308.32	347.30	386.27
4. Price of a day old chicken	122.86	122.86	122.86	122.86	122.86	122.86	122.86	122.86	122.86	122.86
5. Medicines	102.81	106.00	108.99	112.39	115.59	118.78	121.98	125.17	128.37	131.57
6. Energy	57.34	118.15	186.73	247.17	275.30	303.40	308.71	313.98	320.30	328.72
7. Feed	0.00	24.33	54.59	139.19	247.70	416.27	457.48	510.15	582.29	654.71
III. Second group of variable costs (8+9+10)	533.00						647.25			
8. Transportation	172.59						255.35			
9. Slaughter	320.27						320.27			
10. Packaging and freezing	40.14						71.63			
IV. Total costs before slaughter (I+II)	349.28	488.77	641.77	844.97	1039.65	1294.31	1397.78	1512.54	1647.84	1785.52
V. Total costs (I+II+III)	882.28	1021.77	1174.77	1377.97	1572.65	1827.31	2045.03	2159.79	2295.09	2432.77
VI. Live weight (kg)	28.011	39.476	71.693	126.966	179.919	258.145	284.970	318.525	359.565	403.820
VII. Product weight (kg)	17.776	25.051	45.496	80.573	114.177	165.188	185.780	213.944	251.599	296.340
VIII. Production cost of kg of live weight (EUR/kg) (IV/VI)	12.47	12.38	8.95	6.66	5.78	5.02	4.90	4.75	4.58	4.42
IX. Production cost of the ready product (EUR/kg) (V/VII)	49.63	40.79	25.82	17.10	13.77	11.06	11.01	10.09	9.12	8.21

*Source: own calculation

** The second group of variable costs (8+9+10) are constant for both periods 1-5 weeks and 6-9 weeks of age

the birds. The monthly rent of the whole building was 255.65 EUR. These data were used to calculate the rent for rearing of the chickens that was fixed at 14.664 EUR per week for the whole trial period. The cost of medicine amounted to 102.81 EUR, incurred once for the vaccination of the chicks, and the remaining were used for decontamination of the premises for the whole trial period. Labour costs were calculated based on the hourly employment of the staff on this task. The costs of slaughtering the chickens were fixed and amounted to 0.41 EUR per chicken. The transportation costs and the costs for packaging and freezing depended on the size of the chickens. For the chickens slaughtered at 5 weeks of age, they were respectively 0.22 EUR and 0.05 EUR per bird, while for those slaughtered at the end of the trial (9-week-old), they were respectively 0.62 EUR and 0.205 EUR per chicken.

Some of the data shown in Table 1 need additional comments. The total live weight of all 785 chickens that lived to 5 weeks of age was 258.145 kg. A total of 577 from these (with a total weight of 178.135 kg) were slaughtered at this age, and the remaining 208 (with a total weight of 80.010 kg) were left for rearing until 9 weeks of age. The calculation of the production cost per kg of live weight for each week until 9 weeks includes the assumption that all the chickens would be sacrificed in the respective week, i. e. all the costs before slaughter (1-7) were comprised. When calculating the production cost of the ready-to-purchase product, the second group of variable costs (8-10) was included. The dressing percentage of the birds was first determined for the 5-week-old chicks. From the average live weight of 308.73 g per chick, we had 195.93 g ready-to-purchase product, which was 63.46% of the live weight. For the aim of the experiment, we accepted that this percentage is constant for the rearing period until 5 weeks of age. The weight of the ready-to-purchase product derived from the 9-week-old chickens was also determined. At an average live weight of 1.09556 kg, the ready-to-purchase product had an average weight of 0.88983 kg, that is 81.22 %. Similar results in slow-growing chickens were also shown by other studies. Galobart & Moran (2004) reported 70.2%, while Laudadio & Tufareli (2010) recorded 70%-71%. The latter, however, stated that this trait might vary widely (67 % to 78%). Data showed that with an increase in the weight of the cockerels, the dressing percentage also grew (approximately 18% for the period from 5 till 9 weeks of age). When calculating the dressing percentage of the chickens for this period with a good enough approximation, we might assume a linear relationship, which is given by the equation:

$y = 0.2257x + 0.5649$ (6),

where x is the live weight (kg) for the week when we applied the approximation, while y is the dressing percentage for the respective week. After these explanations and the application of equations (1), (2), (3), (4) and (6), we calculated the total costs for the period of rearing of the chickens before and after slaughter, the production cost per kg of live weight, and kg of ready-to-purchase product, which are shown in the last two lines of Table 1. The costs of feed, labour, and electricity play the most significant part in the formation of the production cost per kg of live weight, and the costs of slaughter and transport are important for the production cost of the ready-to-purchase product. Hence, possibilities to optimize these costs should be explored in order to reduce production costs.

Option 2 (mathematical modelling)

To calculate the production cost per kg of live weight and kg of ready-to-purchase product at Option 2, we applied a mathematical model. In this option we assumed that the slaughter of the birds would be carried out at a random moment in the period between 6 and 9 weeks of age, at the same rearing conditions as in the real experiment. This included registering the same mortality, and the same stocking density which as a direct consequence means a 4-fold increase in rental costs (4 times more pens would be needed). Accordingly, the costs for labour, decontamination of the building and electricity also increased 4 times. When calculating the live weight, the coefficient of increase of the weight of chickens slaughtered at 9 weeks of age compared to their weight at 5 weeks was used, which amounted to 2.821. The same considerations were used to calculate feed costs. Equation (6) was used to calculate the weight of the ready-to-purchase product. The cumulative costs and the production cost per kg of live weight and ready-to-purchase product thorugh the applied mathematical modelling are shown in Table 2.

The comparison between Option 1 and Option 2 showed that the total costs in the second option increased by 62.4%. The fixed costs increased by 109.0% (due to higher rental costs). The first group of variable costs increased by 66.8% (mostly due to increased feed and labour costs). The second group of variable costs increased by 42.2%. Despite the higher costs, we found lower a production cost in

Table 2 – Cumulative costs and production cost (EUR/kg) per kg of live weight and ready-to-purchase product derived from male layer-type after mathematical modelling (Option 2).

Cost	Cumulative costs (EUR) for the period from 6 to 9 weeks				
	5 wk	6 wk	7 wk	8 wk	9 wk
Chickens	785	777	777	777	777
Mortality, birds	0	8	8	8	8
I.Fixed costs (1+2)	102.73	161.39	220.04	278.70	337.35
1. Rent	87.98	146.64	205.29	263.95	322.60
2. Building preparation	14.75	14.75	14.75	14.75	14.75
II. First group of variable costs (3+4+5+6+7)	1191.58	1475.13	1829.06	2256.96	2692.78
3. Labour costs	230.27	386.60	542.49	698.37	854.25
4. Price of a day-old chicken	122.86	122.86	122.86	122.86	122.86
5. Medicines	118.78	131.57	144.35	157.13	169.91
6. Energy	303.40	324.67	345.73	371.01	404.71
7. Feed	416.27	509.43	673.60	907.59	1141.05
III. Second group of variable costs (8+9+10)	533.00	920.50			
8. Transportation	172.59	484.67			
9. Slaughter	320.27	317.82			
10. Packaging and freezing	40.14	118.01			
IV. Total costs before slaughter (I+II)	1294.31	1636.52	2049.10	2535.66	3030.13
V. Total costs (I+II+III)	1827.31	2557.02	2969.60	3456.16	3950.63
VI. Live weight (kg)	258.145	344.645	453.017	585.440	728.150
VII. Product weight (kg)	165.188	229.549	316.136	431.298	566.931
VIII. Production cost of kg live weight (EUR/kg) (IV/VI)	5.02	4.75	4.52	4.33	4.16
IX. Production cost of the ready product (EUR/kg) = V/VII	11.06	11.14	9.39	8.01	6.97

*Source: own calculation.

** The second group of variable costs (8+9+10) are constant for the period between 6-9 weeks of age.

Option 2. While the production cost per kg of live weight decreased relatively little, from 4.42 EUR to 4.16 EUR (-5.9%), the cost of the ready to purchase product in the second option decreased significantly - from 8.21 EUR to 6.97 EUR (- 15.10%). These results give us reason to believe that slaughtering a part of the chickens at an earlier age than 9 weeks is not economically justified. The detailed breakdown of the costs by items per kg of ready-to-purchase product (Table 3) showed increases only in the rental and labour costs (by 14% and 16% respectively), while all the remaining costs decreased.

Table 3 – Costs by items for kg of ready to purchase product in the different options of rearing and slaughter.

Cost	Cost by item, EUR/kg ready-to-purchase-product					
	Option 1		Option 2		Option 2 - Option 1	
	EUR	%*	EUR	%*	EUR	%**
Rent	0.50	6.03	0.57	8.17	0.07	14.00
Preparation of the building	0.05	0.61	0.03	0.37	-0.02	-40.00
Labour	1.30	15.88	1.51	21.62	0.21	16.15
Price of a day-old chick	0.41	5.05	0.21	3.11	-0.20	-48.78
Medicines	0.44	5.39	0.30	4.30	-0.14	-31.82
Electricity	1.11	13.52	0.72	10.24	-0.39	-20.08
Feed	2.21	26.92	2.01	28.88	-0.20	-9.05
Transportation	0.86	10.50	0.85	12.27	-0.01	-48.15
Slaughter	1.08	13.17	0.56	8.04	-0.52	-1.16
Packaging and freezing	0.24	2.95	0.21	2.99	-0.03	-12.50
Production cost of the ready-to- purchase product	8.21	100	6.97	100	-1.24	-15.10

Source: own calculation

*Percentage of the respective cost from the production cost of the ready-to-purchase product.

**Percentage change of the costs between Option1 and Option 2.

The relative share of the incurred costs for each of the items for Option 1 and Option 2 was calculated. Feed costs amounted to the highest share in both scenarios (26.92 and 28.88%, respectively). In contrast to the rearing of fast-growing broilers, where the feed costs vary between 60 and 70% (Popescu & Criste, 2003; Parvutoiu *et al.*, 2010; Heidari *et al.*, 2011), in our experiment this indicator was more than twice lower. Hence, the use of more expensive feed or feed with better profile would not excessively affect the production cost, but would significantly improve the quality of the meat. The labour costs formed 15.88% and 21.62% of the production cost of the ready-to-purchase product. These costs were relatively high and might not be compared to the costs of broiler rearing, mainly due to the higher weight gain and the much shorter growth period of the latter. One of the significant indicators affecting this cost is the size of the farm. Afzal & Khan (2017) showed that large farms spent up to 40% less for labour in comparison to small farms. The other costs with considerable shares were electricity and transportation costs. The electricity costs depend to the greatest extent on the outside temperature. With year-round chicken rearing, it is clear that the values of this cost will vary widely. The only thing that can be done in this case is the maintenance of high thermal insulation, combined with good ventilation of the premises. Transport costs depend to a large extent on the distance to the slaughterhouse. It is also one of the stress factors that affect the quality of the meat, as noted by Feddes *et al.* (2002). It is therefore important to minimize the transport time of the birds whenever possible.

Rental costs are respectively 6.03% and 8.17% for the two options. We believe that the method of fragmentation of the stocking density at a certain age is appropriate, because at high stocking densities, high levels of heat and ammonia are produced, leading to a decrease in the immunity of birds (An *et al.*, 2012). Furthermore, greater density is correlated with a negative coefficient on live weight. Feddes *et al.* (2002) found an increase in the live weight of chickens of up to 5% at lower stocking densities. In the same study, lower feed and water intake was found in chickens reared at a lower density.

Another option to reduce the cost of rearing chickens is the use of raised platforms, which can increase the efficient area. In their study, Malchow *et al.* (2019) found that Lohmann Brown Classic chickens willingly used these structures. The number of chickens also increased with increasing ages, reaching up to

26% during the light period of the day and up to 36% during the dark period.

The results of the production costs presented in this study are considerably higher than those obtained for fast-growing broilers. Van Horne (2020) reported that the production costs for conventional broilers were 0.83 EUR/kg of live weight at farm level, and 1.46 EUR/kg of carcass after slaughter. According to Chibanda *et al.* (2022), the production costs of broilers were within the range of 140-180 EUR/100 kg of live weight. In our experiments with slow growing broilers and dual purpose chickens, we found that the production costs were lower for the former (2.62 EUR/kg live weight and 3.61 EUR/kg ready product) and significantly higher for the latter (9.59 EUR/kg live weight and 15.32 kg/ready product) when compared to the costs for male layer-type chickens (unpublished data).

Based on the data obtained from this experiment, we can suggest a minimum selling price for the ready- to-purchase product produced by the male Lohmann Brown Classic chickens. We believe that the gross profit margin should be at least 20% of the cost of the product in Option 1. In this case, we obtained a minimum price of 9.85 EUR/kg. The price we recommend is several times higher than that of conventionally raised broilers, but it is within the usual prices for this type of product, which ranges from 7 to 11 EUR/kg in the EU (Grashorn & Serini, 2006).

Figure 1 and Figure 2 show the ratio between the revenue (curve C-D) and the costs incurred (curve A-B) for the 9-week period of rearing of the layer cockerels in both options, i.e. the return for a unit of invested capital. Point E on these graphs is the point where revenue equaled costs. The area enclosed between points A, C, and E is an area of economic loss, and the area between points E, B, and D is an area of economic efficiency, where revenue exceeds costs.

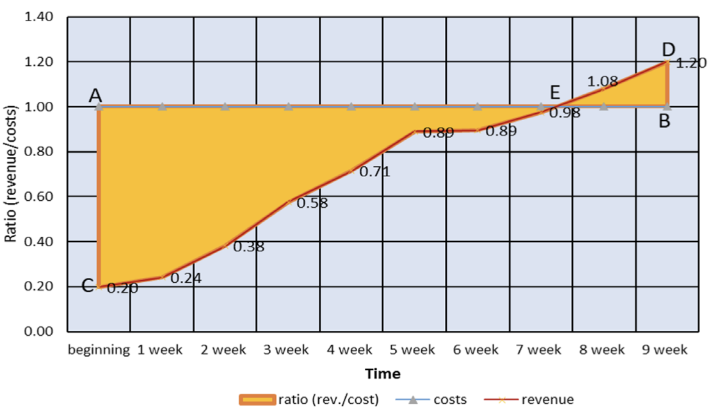

Figure 1 – Ratio revenue/costs in Option 1.

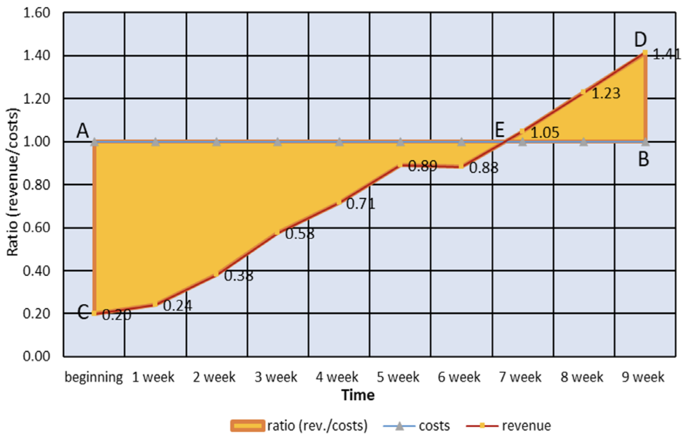

Figure 2 – Ratio revenue/costs in Option 2.

The comparison between Option 1 and Option 2 showed that the revenue/cost ratio at our fixed minimum selling price of 9.85 EUR/kg at the end of the trial period was higher for the second option (1.41 to 1.20). Also, in this option, point E, where revenue equaled costs, occurred a few days earlier.

CONCLUSIONS

The study aimed to evaluate the production cost per kg of live weight and ready-to-purchase product derived from male layer-type chickens reared until 9 weeks of age. Two options of rearing and slaughtering were compared. Option 1 included fragmentation of the stocking density of the chickens at 5 weeks of age. Option 2 was based on mathematical extrapolation, in which the production costs were estimated assuming all the birds were slaughtered at a later age (between 6 and 9 weeks) and reared at the same conditions as in Option 1. The results showed that the lowest production cost per kg of live weight and ready-to-purchase product was obtained if all the chickens were slaughtered at 9 weeks of age (Option 2). We could assume that optimal results can be obtained at slaughter at a later age, but not more than 12 weeks, since it has been found that after this age the growth rates for this breed decrease significantly, and the costs are unjustified. Based on the results of this study, we can offer an indicative selling price of 9.85 EUR/kg of ready-to-purchase product. There are too many factors that influence the indicator we studied, and further research is needed for their optimization. Last but not least, in order to obtain lower prices, the alternative of government grants could be sought. We believe that our study is a good starting point in the search for an alternative solution of the problem of culling male layer-type chickens, and the results obtained may be useful for interested producers.

Author contributions

Conceptualization, E.P and K.D; methodology, K.D.; formal analysis, E.P, K.G., T.P.; investigation,T.P., E.P., M. I.; resources, T.P., E.P.; data curation, K.D; writing—original draft preparation, K.D.; writing—review and editing, T.P., M.I.; supervision, M.I.; project administration, T.P; funding acquisition, T.P.. All authors have read and agreed to the published version of the manuscript.

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Data availability statement

Data are available upon request from the corresponding author.

Conflicts of interest

The authors declare no conflicts of interest.

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