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Effects of Ecological Sea Buckthorn Powder Supplementation on Egg Production and Quality in Free-Range Moravia Black Hens

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Abstract: The growing demand for sustainable and healthier egg production systems, combined with the need to reduce the use of synthetic additives in poultry feed, has led to an increased interest in natural feed supplements. This study evaluated the effects of dietary supplementation with ecological sea buckthorn (*Hippophae rhamnoides*) powder on the performance and egg quality of 600 laying hens of the Moravia Black breed, raised in a free-range system. Three groups were included: one control group with standard feed and two experimental groups supplemented with 1% and 2% sea buckthorn powder. Over 11 weeks, parameters such as egg production, feed consumption, and egg quality, including egg weight, volume, shell thickness, and yolk color, were monitored. The 2% supplementation significantly improved egg production, egg weight, shell strength, and yolk carotenoid content, with stable feed consumption and negligible mortality, confirming the additive's safety. These results highlight the potential of sea buckthorn powder as a natural feed additive to enhance poultry productivity and product quality, supporting sustainable and healthier egg production.

Keywords: egg production; egg quality; laying hens; sea buckthorn powder; sustainable poultry farming

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1. Introduction

Eggs represent an important source of nutrients, ranging from high-biological-value proteins to vitamins and minerals essential for biochemical processes [1]. Some studies have shown that most consumers' daily diets include low levels of essential fatty acids, with implications for cardiovascular health [2]. As a result, solutions have been sought to modify the lipid composition of eggs, either by reducing cholesterol or altering the fatty acid profile, as well as increasing their nutritional value, specifically producing functional eggs with a higher content of bioactive substances [3]. Generally, it can be stated that the quality of eggs for consumption is dictated by numerous factors, with breed (hybrid used), rearing system, and diet being essential [4,5].

A key factor for obtaining eggs with higher biological value, analyzed in this study, is the breed or hybrid. In the poultry industry, significant progress has been made in creating laying hybrids with outstanding productive performances, the result of research in genetics and improvement. Thus, studies in this field have highlighted multiple differences between purebred hens and commercial hybrids [6]. For instance, Sussex hens demonstrated the best welfare indicators among pure breeds, while ISA Brown recorded the lowest levels among commercial lines. Comparing these two groups of birds revealed higher mortality and aggressiveness in purebred hens, indicating lower welfare levels compared to commercial hybrids, which adapt better to confined spaces [7].

The second factor considered in this study is the poultry rearing system, regulated by Directive 74/1999/EC of the European Union Council, which aims to ensure minimal comfort conditions for laying hens [8,9]. Consequently, alternative rearing solutions have been adopted that allow the productive potential of birds to be expressed while ensuring welfare conditions [10]. One widely accepted and consumer-appreciated alternative is free-range rearing [11]. This method has proven highly beneficial for bird populations used for egg production, positively impacting both the general health of the flocks and the quality of the eggs produced. Advantages include reduced mortality rates [12,13], minimization of stress-inducing factors [11] (affecting quantitative egg production [14]), and improved egg quality [15,16].

Closely related to the rearing system is egg hygiene, a parameter of interest because eggs can carry microbiological or physical contaminants. Contamination pathways stem from farm biosecurity or the quality of raw materials used in feed production [17].

The third element investigated focuses on the nutritional characteristics of the combined feeds given to laying hens and their effects on welfare and egg quality. From this perspective, direct correlations were identified between the levels of essential amino acids (methionine, cystine) and the incidence of feather pecking or losses due to cannibalism [18].

Administering diets with low protein levels (14%) resulted in reduced productive parameters and significant decreases in certain blood parameters (uric acid, triglycerides, albumin) compared to birds receiving 16% crude protein [19]. In the same context, it was observed that low-protein combined feeds decreased serum proteins and cholesterol only in birds raised on permanent litter, with these parameters unaffected in battery-housed birds [20]. Using formulas with reduced metabolizable energy and crude protein lowered feeding costs and improved serum creatine kinase activity but also reduced serum triglyceride and cholesterol levels [21]. Another study showed that a wheat-rich diet (50% vs. 25% wheat) negatively affected plumage quality, with mortality and cannibalism rates influenced by the rearing system [22,23].

Using unconventional resources (dried olive pulp at doses of 2–6%) improved egg quality (increased polyunsaturated fatty acids and reduced saturated fatty acids) and lipid health indices (lower AI and TI and higher h/H ratio), in a dose-dependent manner [24]. Studies show that the inclusion of 2% of SBM in the experimental diet led to a more than 25% increase in vitamin E and an almost 50% increase in xanthophylls compared to the control. The markers specific to the coronary risk decreased significantly in the experimental group compared to the control, showing a beneficial effect of dietary SBM on the quality of yolk lipids [25].

In conclusion, the concept of quality, as reflected in the welfare of birds and the quality of their production, is directly influenced by the careful selection of the hybrid used, aligning the rearing system with the birds' ethological characteristics, and ensuring proper nutrition [26]. The thesis of this study is that dietary supplementation with ecological sea buckthorn powder can improve performance and egg quality in Moravia Black hens, the objective of this study being to evaluate the effects of this supplementation on egg production and quality. This case study represents research conducted under production conditions, focusing on the performance of Moravia Black hens reared in one of the most valued systems (free-range) and fed a diet supplemented with a natural biostimulator (organic sea buckthorn powder). The use of ecological sea buckthorn powder in the diet of laying hens has gained attention in poultry nutrition due to its rich bioactive composition. Sea buckthorn *(Hippophae rhamnoides)* is a natural source of vitamins (A, C, E), antioxidants, polyunsaturated fatty acids, and carotenoids, all of which are essential for enhancing the overall health of birds. Scientific studies have demonstrated that supplementing the diets of laying hens with natural biostimulants like sea buckthorn can strengthen their immune systems, reduce oxidative stress, and improve resistance to diseases [27]. This is particularly beneficial in sustainable poultry farming practices, where the focus is on reducing the reliance on synthetic additives and enhancing the natural health and productivity of birds [28,29].

Incorporating sea buckthorn powder into poultry feed has been shown to significantly enhance egg quality, particularly in terms of yolk color, shell strength, and nutrient profile. Research highlights that the carotenoids and polyunsaturated fatty acids present in sea buckthorn are directly deposited in the yolk, leading to richer pigmentation and improved nutritional value. Studies also report a reduction in saturated fatty acids and an increase in beneficial omega-3 and omega-6 fatty acids in the eggs of hens fed sea buckthorn, contributing to a healthier lipid profile. Such eggs are increasingly sought after by health-conscious consumers, aligning with the growing demand for functional foods that provide additional health benefits [30–32].

Regardless of the technology used for rearing laying hens, the fundamental goal remains the provision of eggs with superior quality parameters suitable for a healthy diet [33]. This goal can be achieved through various methods, including incorporating natural preparations derived from wild or cultivated flora, or by-products of their processing, into the birds' feed.

Moreover, ecological sea buckthorn powder aligns with sustainable farming practices by utilizing renewable and organic resources. Research has shown that using natural additives like sea buckthorn can enhance the welfare of laying hens, reducing stress and promoting better productivity, especially in systems such as free-range rearing. This approach not only improves the overall quality of eggs but also contributes to environmental sustainability and animal welfare [34]. As highlighted in various scientific works, integrating ecological ingredients like sea buckthorn into poultry diets represents a step forward in producing high-quality, nutritious eggs while adhering to eco-friendly and ethical farming practices.

2. Materials and Methods

2.1. Biological Material

The Negru de Moravia breed originates from South Moravia, Czechia, where it was selected for egg production. The first chickens were black, but later, other color varieties were developed.

These birds have an elegant body, not very large but strong and compact, with a small head and a narrow comb. Their neck is of medium length, with feathers evenly distributed, and their wings are short but well proportioned.

The Negru de Moravia has a body weight of 2.0–2.2 kg and an excellent egg production rate of approximately 300 eggs per year. The eggs are beige in color and weigh about 60 g.

They are active birds with a gentle temperament, efficiently utilizing food resources for egg production. They also exhibit a good reproduction rate and excellent adaptability to a wide range of environmental conditions.

The biological material studied consisted of 600 laying hens of the Moravia Black breed, raised in a free-range system. Their diet was supplemented with ecological sea buckthorn powder, and a series of parameters related to egg production and quality were subsequently monitored. The tested product was “Ecological Sea Buckthorn Powder”, produced by S.C. Eco Catena S.R.L., Vulturești-Bacău, Romania, with the following characteristics: energy value = 374 kcal/100 g; protein = 18.21%; lipids = 3.38%; total carbohydrates = 67.76%.

The birds (600 individuals) were divided into three groups: one control group (200 birds) and two experimental groups (200 birds each). The control group (coded M-m) was fed a standard combined feed without sea buckthorn powder. In the experimental group M-1, 1% sea buckthorn powder was added to the standard feed, while in the experimental group M-2, the feed was supplemented with 2% sea buckthorn powder.

The experiment was conducted over a period of 11 weeks, spanning from early September to late November 2023, which corresponds to the peak laying period of the hens, raised in a free-range system.

The birds were monitored over 11 weeks (from the 30th week of life to the 40th week), during which the main production indicators were recorded, including body weight, flock losses, egg production, laying intensity, feed consumption, and the structure of egg production. The second objective involved determining specific egg quality indicators, assessed weekly (egg weight, egg volume, shape index, specific gravity, egg structure, shell thickness and strength, yolk color, and carotenoid content).

2.2. Description of the Experimental Unit

The poultry farm where the research was conducted was established in 2018, with its main activity being the raising of laying hens and the commercialization of table eggs (Figure 1). The farm is located on a plateau in the southwest of Târgu Frumos town, Iași County, and covers an area of 9000 m^2, enclosed by a steel wire mesh fence mounted on concrete poles. To the south, it borders the E583 road (Iași-Bacău), to the north, it is surrounded by a forest strip, and to the east and west by two agricultural fields.

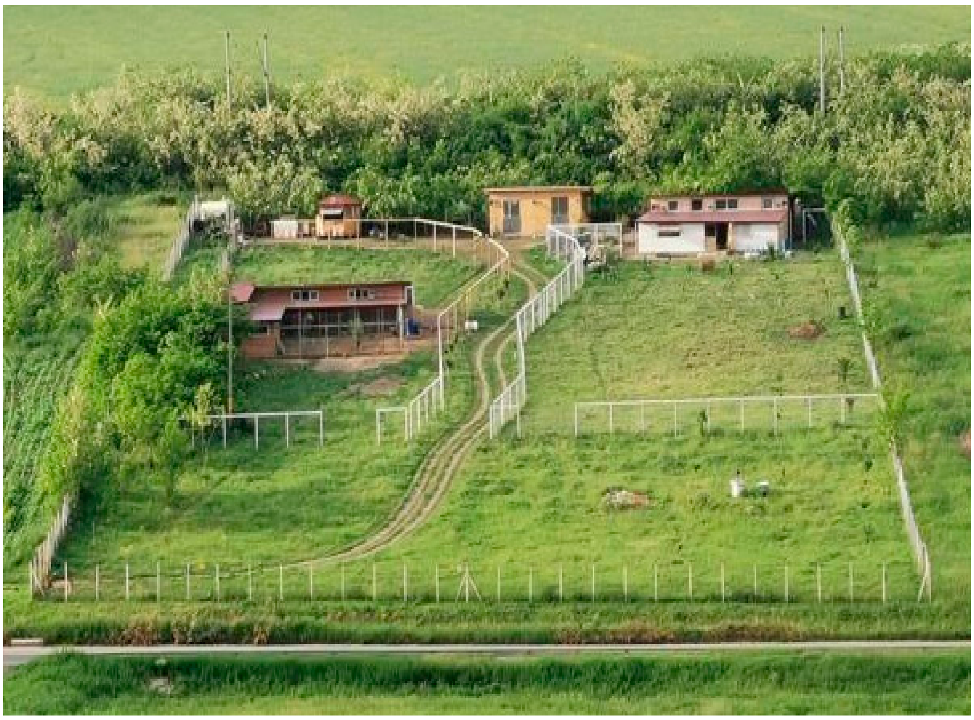

Figure 1. Overview of the poultry farm where the research was carried out (original photo).

The area where the farm is located is characterized by a temperate climate, which in recent years has undergone a series of changes predominantly marked by temperature fluctuations and shifts in seasonal patterns. For instance, temperatures ranged between 15 and 26 °C in September (night and day), between 12 and 18 °C in October, and between 6 and 10 °C in November. However, as previously mentioned, there were fluctuations, with some days in September seeing temperatures rise to 31 °C, while in November, they dropped to 0–5 °C.

The rearing halls are constructed of wood, thermally insulated, and equipped with windows for natural lighting. They are also fitted with solar panels to provide artificial lighting. Regarding infrastructure, the shelters feature reinforced concrete block foundations beneath the structural pillars and interrupted reinforced concrete foundations for the non-structural pillars on the facades and gables. The flooring consists of lightly reinforced concrete, 15 cm thick, placed on a 15 cm compacted ballast fill.

The superstructure of the halls is made of wooden frames (pillars and beams) to which double panels of pressed wood are attached, with basalt wool inserted between them for insulation. Additionally, there are non-structural pillars for gables and window and door frames. To comply with welfare standards and ensure bird comfort, the halls are equipped with slatted floors, perches for resting, and an appropriate number of drinkers, feeders, and nesting boxes to accommodate the housed population.

2.3. The Technological Flow Applied in the Experimental Unit

The facility operates a complete production flow, which includes raising replacement pullets as well as adult hens. The halls are equipped with paddocks enclosed by metal mesh fences, where fruit trees have been planted to provide shade and reduce wind speed. Access to the paddocks is through sliding doors in the walls of the halls, allowing the hens to explore the natural environment and forage on grass and insects.

The farm carries out a range of activities common to both sectors, such as preparing the halls for population, populating the halls, supplying feed, and daily care (feeding, watering, cleaning the halls and paddocks, ensuring the microclimate, and monitoring general health).

Replacement pullets are purchased at one day old and introduced into the youth hall, which is cleaned and disinfected beforehand. Antibiotics are not used in the facility, and only the two mandatory PPA vaccines (administered on days 9 and 21) are applied. The farm is serviced by a local veterinarian who regularly monitors the health of the flock. During the research, no parasites were observed, as this parameter is controlled by maintaining proper hygiene.

Adult hen halls are populated when the pullets reach 14 weeks of age. At this point, the birds undergo a 2-week acclimation period to the new environment (Figure 2). The laying period begins when the hens are 19 weeks old and typically lasts until they are 80–85 weeks old. The average laying rate is 25% at 22 weeks of age, peaks at 93% during weeks 28–33, and then gradually declines to 65% by the time the hens are 80 weeks old.

At the end of the production period, the adult hen hall is depopulated (hens are sold as culls), followed by a 42-day cycle for cleaning and sanitary rest. During this time, the hall is washed, disinfected, and sealed.

The eggs are collected manually and transferred to a dedicated room where they are sorted and packed into cartons of 10 or 30 eggs (Figure 3). These cartons are wrapped and delivered according to orders. Non-conforming eggs (cracked or deformed) are considered waste and are temporarily stored in a refrigerated container.

Figure 2. House for laying hens.

Figure 3. Unsorted eggs produced by Moravia Black hens.

2.4. The Structure of the Fodder Recipe

The birds forming the three groups were fed a combined feed with similar nutritional characteristics, with the main differences being the inclusion of sea buckthorn powder in the diets of groups M-1 and M-2 (Table 1).

Table 1. The structure of the combined feed administered to the studied birds.

Specification	**Experimental Batches**		
	M-m	**M-1 (1%)**	**M-2 (2%)**
Corn kernels	23.5	23.5	23.5
Soybean meal (46% protein)	5	5	5
Granulated alfalfa	3	3	3
Peas	3	3	3
Wheat bran	1	1	1
Shell grit	1	1	1
Calcium	2.2	2.2	2.2
Premix	0.8	0.8	0.8
Unfiltered sunflower oil	0.5	0.5	0.5
Organic sea buckthorn powder	-	0.4	0.8

Table 1. *Cont.*

Specification	Experimental Batches		
	M-m	**M-1 (1%)**	**M-2 (2%)**
	Characteristics		
Protein (%)	12.10	12.54	13.16
Fat (%)	3.71	3.77	3.84
Fiber (%)	4.26	4.38	4.58
Ash (%)	11.51	12.13	13.89
Starch (%)	39.45	37.88	36.02

The primary ingredient was corn grain (23.5%), supplemented with soybean meal (46% crude protein—5%), pelleted alfalfa (3%), peas (3%), wheat bran (1%), shell grit (1%), calcium (2.2%), a vitamin–mineral premix (0.8%), unfiltered sunflower oil (0.5%), and sea buckthorn powder (1–0.4% for M-1 and 2–0.8% for M-2).

As a result, for the control group (M-m), the protein level was 12.1%, the fat content was 3.71%, the fiber content was 4.26%, the ash level was 11.51%, and the starch content was 39.54%.

The control batches recorded higher values of protein, specifically 12.54% for M-1 and 13.16% for M-2, compared to 12.1% observed in the control sample M-m. Regarding the fat content, slight differences were identified, with an increase of 0.07% (in M-1) and 0.13% (in M-2) compared to the value identified for the control batch (M-m).

The fiber percentage ranged from a minimum value of 4.26% in M-m to a maximum of 4.58% in M-2, with the M-1 batch being intermediate at 4.38%.

For the ash content, the control batch (M-m) showed a percentage of 11.51%, while increases of 0.62% (for M-1) and 2.38% (for M-2) were observed in the other batches.

Starch was present at a percentage of 39.45% in the control batch (M-m), which was lower by 1.57 percentage points in M-1 and by 3.43 points in M-2.

2.5. Methods

The indicators tracked were determined using the following methods:

- Weight growth dynamics: In each group, 20 individual birds were selected and weighed at the start of each control week.
- Flock losses: Mortality cases were calculated relative to the flock size at the beginning of the respective week.
- Laying intensity: Calculated as the ratio between the weekly egg production and the average flock size of the respective group.
- Egg production structure: Each control week, the eggs obtained were categorized into four size classes: XL (over 73 g), L (63–72.9 g), M (53–62.9 g), and S (under 53 g). The distribution was then reported relative to the weekly egg production.
- Feed consumption: Recorded as total weekly feed consumption per group (kg feed/week) and average daily consumption (g feed/bird/day).
- Egg weight: Determined as the average weekly weight of the eggs.
- Shape index: Calculated as the percentage ratio of the large diameter to the small diameter of the eggs.
- Egg volume: Computed using the formula $V(cm^3) = 0.519 \times D \times d^2$, where D is the large diameter (cm) and d is the small diameter (cm).
- Egg structure: The three egg components (albumen, yolk, and shell) were weighed and expressed as percentages of the total egg weight.
- Shell thickness: Measured as the average of three readings (sharp end, rounded end, and equatorial zone) using a gauge with a comparator dial.

- Shell strength: Calculated using the formula R(gf/cm^2) = shell thickness × 230.
- Yolk color: Assessed by comparison with the La Roche color scale.
- Carotenoid content: Expressed as double the La Roche score plus one.

Data Processing

The experimental data were processed using calculation algorithms in Microsoft Excel. The comparison of variability between groups and within groups was performed using the One-Way ANOVA (Analysis of Variance) test.

3. Results

3.1. Productive Performances of the Herds Studied

3.1.1. Body Weight of Birds

The first productive parameter observed was the body weight of the studied birds. At the beginning of the research, during the 30th week of life, the body weight recorded values that were nearly equal across the three groups (M-m = 2412.4 g, M-1 = 2412.0 g, M-2 = 2412.2 g). This similarity was due to the rigorous selection process conducted when forming the study groups. The average body weights were within the limits defined by the breed standard, specifically ranging from 2346 g to 2478 g.

Analyzing the dynamics of this parameter, it was observed that for all groups, there was an increase in the average weight achieved. Thus, at the midpoint of the period (week 35), maximum values of 2526.8 g were recorded for M-m, while for M-1 and M-2, these values were 0.13% and 0.25% lower, respectively. Although there were some differences, they did not exceed the breed standard (2471–2531 g) (Table 2).

Table 2. The evolution of weekly and total body weight of birds based on the percentage of sea buckthorn powder administered.

Age (Weeks)	Standard Weight (g)	Realized Weight (g)		
		M-m	M-1	M-2
30	2346–2478	2412.4	2412.0	2412.2
31	2360–2483	2439.2	2438.1	2437.4
32	2372–2492	2470.7	2469.5	2467.0
33	2402–2510	2494.3	2492.1	2490.4
34	2450–2518	2509.8	2507.3	2503.8
35	2471–2531	2526.8	2523.4	2520.5
36	2478–2539	2540.5	2535.8	2532.2
37	2482–2544	2565.4	2560.9	2557.1
38	2486–2565	2588.4	2583.7	2579.5
39	2491–2573	2611.9	2606.6	2602.1
40	2496–2584	2640.4	2635.8	2631.3
The evolution of body weight during the 30–40-week period				
	M-m	M-1		M-2
$\overline{X} \pm s_{\overline{X}}$	2527.25 ± 71.32	2524.11 ± 69.69		2521.23 ± 68.24
V%	2.50	2.45		2.41
L1 vs. L2 = n.s. [F(1, 20) = 0.010, *p* = 0.842]. L1 vs. L3 = n.s. [F(1, 20) = 0.041, *p* = 0.842]. L2 vs. L3 = n.s. [F(1, 20) = 0.009, *p* = 0.842].				

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant.

By the end of the study, in week 40, the body weights continued to rise. Over the five weeks, the body weight surpassed the standard for the Negru de Moravia breed (2496–2584 g). As a result, in the final week of the study, the average weight of the birds in

M-m was 2640.4 g, in M-1 it was 2635.8 g, and in M-2 it was 2631.3 g. Specifically, compared to the average weight suggested by the standard (2540 g), the values obtained were higher by 3.95% in M-m, 3.77% in M-1, and 3.6% in M-2.

3.1.2. The Situation of Exits from the Workforce

Another major aspect of poultry growth is the situation of exits from the flock, which impacts quantitative production on one hand, but also aligns with the applied raising system. In this case, the age of the birds at the start of the study (30 weeks) and the health benefits provided by the free-range system were two key elements that led to the identification of a minimal loss percentage. Over the course of the 11 weeks of the study, the losses represented 1% for the M-m group and 0.5% for the M-1 and M-2 groups (Table 3). Within the three groups, the exits from the flock were accidental, caused by mechanical injuries.

Table 3. The situation of exits from the workforce.

Age (Weeks)	M-m			M-1			M-2		
	Effective Weekly		Death Rate (%)	Effective Weekly		Death Rate (%)	Effective Weekly		Death Rate (%)
	Beginning (Heads)	End (Heads)		Beginning (Heads)	End (Heads)		Beginning (Heads)	End (Heads)	
30	200	200	-	200	200	-	200	200	
31	200	200	-	200	199	0.50	200	200	-
32	200	199	0.50	199	199	-	200	200	-
33	199	199	-	199	199	-	200	200	-
34	199	199	-	199	199	-	200	200	-
35	199	199	-	199	199	-	200	200	-
36	199	198	0.50	199	199		200	200	-
37	198	198	-	199	199	-	200	199	0.5
38	198	198	-	199	199	-	199	199	-
39	198	198	-	199	199	-	199	199	-
40	198	198	-	199	199	-	199	199	-
30–40	-	-	1.0	-	-	0.50	-	-	0.50

3.1.3. Numerical Egg Production and Laying Intensity

The numerical egg production for the M-m group amounted to 13,719 eggs for the period from 30 to 40 weeks. In the first week of control, the laying intensity was calculated at 86.29%, while the peak laying intensity occurred in week 33, reaching 93.18%. A similar situation was observed for the control groups M-1 and M-2, where the peak laying occurred in week 33 as well, but with higher values: 93.32% (M-1) and 93.79% (M-2). In the first week of control, the laying intensity for M-1 was calculated at 89.07% and for M-2 at 90.00% (Table 4).

Table 4. The effect of administering organic sea buckthorn powder on the numerical egg production and laying intensity in the studied birds.

Experimental Batch	M-m		M-1		M-2	
Total numerical egg production (11 weeks)	13,719		13,793		13,907	
Statistical indicator/studied parameter	$\overline{X} \pm s_{\overline{x}}$	V%	$\overline{X} \pm s_{\overline{x}}$	V%	$\overline{X} \pm s_{\overline{x}}$	V%
Effective average—reported over the 11 weeks of research (head)	198.82 ± 0.78	0.36	199.68 ± 0.46	0.28	199.68 ± 0.46	0.28
Average egg production per week—reported over the 11 weeks of research (eggs/week)	1247.18 ± 42.36	3.11	1253.91 ± 37.26	3.12	1264.27 ± 37.79	3.14

Table 4. *Cont.*

Experimental Batch	**M-m**		**M-1**		**M-2**	
Average laying intensity—reported over the 11 weeks of research (%)	89.61 ± 2.87	3.39	89.95 ± 2.67	3.10	90.44 ± 2.52	2.93
Numerical egg production						
M-m vs. M-1 = n.s. ($F(1, 20) = 0.1564$, $p = 0.6967$) M-m vs. M-2 = n.s. ($F(1, 20) = 0.9971$, $p = 0.3300$) M-1 vs. M-2 = n.s. ($F(1, 20) = 0.4194$, $p = 0.5246$)						
Laying intensity						
M-m vs. M-1 = n.s. ($F(1, 20) = 0.0839$, $p = 0.7750$) M-m vs. M-2 = n.s. ($F(1, 20) = 0.5244$, $p = 0.4774$) M-1 vs. M-2 = n.s. ($F(1, 20) = 0.1972$, $p = 0.6617$)						

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant.

The higher values of laying intensity were based on higher total egg production, with 13,793 eggs for M-1 and 13,907 eggs for M-2.

The overall situation regarding laying intensity shows that the best average results were identified in the M-2 group (90.45%), followed by M-1 (89.95%) in second place, and M-m in last place (89.61%).

3.1.4. The Structure of Egg Production

An interesting element is the structure of egg production by weight categories, as this parameter is directly related to the price of the eggs. In the case of the control group M-m, the largest share was held by eggs classified in the L and M categories, accounting for 51.77% and 45.32%, respectively. Very large eggs (XL) were found at a percentage of 2.24%, while eggs in the S category made up only 0.67% (Table 5).

Table 5. The influence of organic sea buckthorn powder on the structure of egg production according to European commercial standards.

Eggs Category	**M-n**		**M-1**		**M-2**	
	$\overline{X} \pm s_{\overline{X}}$	**V%**	$\overline{X} \pm s_{\overline{X}}$	**V%**	$\overline{X} \pm s_{\overline{X}}$	**V%**
XL	2.24 ± 0.41	16.39	2.32 ± 0.42	15.20	2.38 ± 0.43	14.86
L	51.77 ± 5.15	6.10	51.96 ± 5.34	6.53	52.29 ± 5.53	6.83
M	45.32 ± 4.36	7.33	45.06 ± 4.59	7.97	44.70 ± 4.81	8.49
S	0.67 ± 1.39	207.18	0.66 ± 1.38	203.28	0.63 ± 1.37	214.44
Category XL						
M-m vs. M-1 = n.s. ($F(1, 20) = 0.2115$, $p = 0.6506$) M-m vs. M-2 = n.s. ($F(1, 20) = 0.6461$, $p = 0.4310$) M-1 vs. M-2 = n.s. ($F(1, 20) = 0.1226$, $p = 0.7299$)						
Category L						
M-m vs. M-1 = n.s. ($F(1, 20) = 0.0073$, $p = 0.9329$) M-m vs. M-2 = n.s. ($F(1, 20) = 0.0517$, $p = 0.8225$) M-1 vs. M-2 = n.s. ($F(1, 20) = 0.0199$, $p = 0.8892$)						
Category M						
M-m vs. M-1 = n.s. ($F(1, 20) = 0.0190$, $p = 0.8917$) M-m vs. M-2 = n.s. ($F(1, 20) = 0.0312$, $p = 0.8616$) M-1 vs. M-2 = n.s. ($F(1, 20) = 0.0996$, $p = 0.7556$)						

Table 5. *Cont.*

Eggs Category	M-n	M-1	M-2
Category S			
M-m vs. M-1 = n.s. (F(1, 20) = 0.0002, p = 0.9879) M-m vs. M-2 = n.s. (F(1, 20) = 0.0059, p = 0.393) M-1 vs. M-2 = n.s. (F(1, 20) = 0.0038, p = 0.9513)			

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; European standards (XL—extra large; L—large; M—medium; S—small); $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant.

For the M-1 group, the results were similar, with the highest proportion of eggs being in the L (51.96%) and M (45.06%) categories. Only 2.32% were XL eggs, while the S category accounted for 0.66%.

The M-2 group stood out by producing more eggs in the L and M categories (specifically 52.29% for L and 44.70% for M). In this group, a higher percentage of XL eggs was observed (2.38%), while the S category had a lower proportion (0.63%).

3.1.5. Consumption of Combined Feeds

The feed consumption was expressed weekly (kg per group per week), and based on this, the average daily consumption (grams per bird per day) was determined. Finally, the average values for both parameters were calculated for all 11 weeks of the study.

Thus, the control group M-m recorded a total consumption of 2145.6 kg over the period, with very similar values identified for M-1 (2145.2 kg) and M-2 (2146.1 kg).

The average daily consumption per group varied from 139.6 g per bird per day for M-2 to 140.2 g per bird per day for M-m, with M-1 being intermediate at 139.9 g per bird per day (Table 6).

Table 6. The comparative evolution of compound feed consumption relative to the percentage of organic sea buckthorn powder administered.

Experimental Batch	M-m		M-1		M-2	
Studied Parameter/Statistical Indicator	$\overline{X} \pm s_{\overline{X}}$	**V%**	$\overline{X} \pm s_{\overline{X}}$	**V%**	$\overline{X} \pm s_{\overline{X}}$	**V%**
Total (kg/batch)	195.05 ± 0.26	0.13	195.02 ± 0.397034	0.21354	195.10 ± 0.28	0.12
Daily average (g/head)	140.16 ± 0.43	0.27	139.90 ± 0.40	0.249883	139.58 ± 0.32	0.19
Total combined feed consumption (kg/batch)						
M-m vs. M-1 = n.s. (F(1, 20) = 0.0648, p = 0.8016) M-m vs. M-2 = n.s. (F(1, 20) = 0.1508, p = 0.7019) M-1 vs. M-2 = n.s. (F(1, 20) = 0.3047, p = 0.5870)						
Daily average combined feed consumption (g/head)						
M-m vs. M-1 = n.s. (F(1, 20) = 2.1935, p = 0.1542) M-m vs. M-2 = * p = 0.0548 (F(1, 20) = 4.1610) M-1 vs. M-2 = ** p < 0.05 (F(1, 20) = 12.9211, p = 0.0018)						

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant; *—significant differences; **—distinct significant differences.

3.2. Quality Indicators of Laid Eggs

3.2.1. Egg Weight

The weight of the eggs did not experience major fluctuations between the groups under study, with the general trend being an increase in the value of the indicator from one week of control to another. Analyzing the results as a whole, it can be observed that the largest egg weights were recorded in the M-2 group, at 63.80 g, while the smallest were in the M-m group, at 63.46 g. The average value determined for the M-1 group was 63.53 g (Table 7).

Table 7. The evolution of egg weight based on the percentage of organic sea buckthorn powder administered.

Age (Weeks)	M-m (N = 30)		M-1 (N = 30)		M-2 (N = 30)	
	$\overline{X} \pm s_{\overline{x}}$ (g)	V%	$\overline{X} \pm s_{\overline{x}}$ (g)	V%	$\overline{X} \pm s_{\overline{x}}$ (g)	V%
30	62.89 ± 0.55	4.82	62.90 ± 0.47	4.11	62.89 ± 0.45	3.92
31	63.00 ± 0.93	8.05	63.10 ± 0.51	4.44	63.15 ± 0.46	4.01
32	63.11 ± 0.92	7.98	63.20 ± 0.54	4.72	63.32 ± 0.50	4.29
33	63.24 ± 0.89	7.68	63.31 ± 0.57	4.98	63.50 ± 0.53	4.58
34	63.37 ± 0.86	7.48	63.40 ± 0.58	5.03	63.68 ± 0.53	4.58
35	63.46 ± 0.91	7.86	63.58 ± 0.61	5.29	63.84 ± 0.55	4.69
36	63.57 ± 0.94	8.13	63.62 ± 0.67	5.80	63.91 ± 0.58	5.01
37	63.66 ± 0.99	8.55	63.74 ± 0.68	5.87	64.08 ± 0.61	5.23
38	63.78 ± 1.01	8.69	63.85 ± 0.70	6.02	64.11 ± 0.63	5.55
39	63.89 ± 1.04	8.95	63.94 ± 0.71	6.10	64.54 ± 0.66	5.63
40	64.04 ± 1.06	9.07	64.20 ± 0.72	6.13	64.77 ± 0.67	5.68
The average egg weight during the 30–40-week period						
30–40	63.46 ± 0.37	8.53	63.53 ± 0.39	5.55	63.80 ± 0.57	4.80
M-m vs. M-1 = n.s. ($F(1, 20) = 0.2144$, $p = 0.6483$) M-m vs. M-2 = n.s. ($F(1, 20) = 2.7915$, $p = 0.1103$) M-1 vs. M-2 = n.s. ($F(1, 20) = 1.6509$, $p = 0.2135$)						

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; N—number of eggs for which the determination was made; $\overline{X} \pm s_{\overline{X}}$ —mean ± standard deviation; V%—coefficient of variation; n.s.—not significant.

3.2.2. Egg Format Index

The determination of the format index revealed normal values for this indicator across all three groups. Specifically, for M-m, a value of 73.25% was determined, for M-1 it was 73.30%, and for M-2 it was 73.38% (Table 8).

Table 8. The influence of the addition of organic sea buckthorn powder in the birds' diet on the size index.

Age (Weeks)	M-m (N = 30)		M-1 (N = 30)		M-2 (N = 30)	
	$\overline{X} \pm s_{\overline{x}}$ (%)	V%	$\overline{X} \pm s_{\overline{x}}$ (%)	V%	$\overline{X} \pm s_{\overline{x}}$ (%)	V%
30	71.85 ± 1.00	7.59	71.85 ± 0.86	6.55	71.86 ± 0.85	6.48
31	72.15 ± 1.40	10.62	72.19 ± 0.99	7.52	72.23 ± 0.87	6.58
32	72.44 ± 1.43	10.78	72.48 ± 1.02	7.68	72.52 ± 0.92	6.96
33	72.46 ± 1.43	11.11	72.50 ± 1.02	7.70	72.58 ± 0.93	6.99
34	72.50 ± 1.53	11.57	72.56 ± 1.06	7.98	72.62 ± 0.93	7.04
35	73.04 ± 1.59	11.95	73.10 ± 1.07	8.02	73.18 ± 0.96	7.16
36	73.56 ± 1.64	12.23	73.61 ± 1.09	8.13	73.70 ± 0.98	7.28
37	73.97 ± 1.69	12.56	74.02 ± 1.28	9.45	74.11 ± 1.07	7.91
38	74.11 ± 1.74	12.87	74.20 ± 1.29	9.56	74.31 ± 1.08	7.97
39	74.69 ± 1.78	13.04	74.73 ± 1.31	9.60	74.84 ± 1.11	8.11
40	75.03 ± 1.99	14.56	75.11 ± 1.37	9.98	75.25 ± 1.12	8.13
The size index analyzed for the 30–40-week period.						

Table 8. *Cont.*

Age (Weeks)	**M-m (N = 30)**		**M-1 (N = 30)**		**M-2 (N = 30)**	
	$\overline{X} \pm s_{\overline{x}}$ (%)	**V%**	**$\overline{X} \pm s_{\overline{x}}$ (%)**	**V%**	**$\overline{X} \pm s_{\overline{x}}$ (%)**	**V%**
30–40	73.25 ± 1.07	1.39	73.30 ± 1.09	1.41	73.38 ± 1.13	1.44
M-m vs. M-1 = n.s. (F(1, 20) = 0.0116, p = 0.9152) M-m vs. M-2 = n.s. (F(1, 20) = 0.073, p = 0.7898) M-1 vs. M-2 = n.s. (F(1, 20) = 0.027, p = 0.8722)						

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; N—number of eggs for which the determination was made; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant.

3.2.3. Specific Gravity of Eggs

The determination of the specific weight was carried out on a sample of 30 eggs from each group, with the analyses repeated weekly. The highest value of the indicator was found in the M-2 group (1.100), while the lowest was in the M-m group, at 1.087. The M-1 group had an intermediate value, with a determined specific weight of 1.093 (Table 9).

Table 9. Changes in the specific weight of eggs relative to the addition of organic sea buckthorn powder used.

Age (Weeks)	**M-m (N = 30)**		**M-1 (N = 30)**		**M-2 (N = 30)**	
	$\overline{X} \pm s_{\overline{x}}$ (g/cm^3)	**V%**	**$\overline{X} \pm s_{\overline{x}}$ (g/cm^3)**	**V%**	**$\overline{X} \pm s_{\overline{x}}$ (g/cm^3)**	**V%**
30	1.061 ± 0.014	7.16	1.062 ± 0.014	7.03	1.062 ± 0.009	6.22
31	1.068 ± 0.017	8.64	1.070 ± 0.011	5.86	1.073 ± 0.010	4.99
32	1.074 ± 0.017	8.88	1.078 ± 0.012	5.93	1.082 ± 0.010	5.03
33	1.079 ± 0.018	8.92	1.083 ± 0.012	6.12	1.088 ± 0.010	5.28
34	1.082 ± 0.018	8.97	1.089 ± 0.012	6.18	1.094 ± 0.011	5.47
35	1.088 ± 0.019	9.14	1.096 ± 0.014	6.87	1.100 ± 0.012	5.66
36	1.091 ± 0.019	9.58	1.099 ± 0.014	6.93	1.107 ± 0.012	5.81
37	1.095 ± 0.019	9.26	1.104 ± 0.013	6.45	1.115 ± 0.013	6.11
38	1.098 ± 0.020	9.94	1.109 ± 0.014	7.04	1.120 ± 0.014 (10-R1)	6.23
39	1.104 ± 0.020	10.11	1.115 ± 0.014	7.18	1.126 ± 0.014	6.78
40	1.118 ± 0.021	11.20	1.122 ± 0.015	7.97	1.130 ± 0.014	6.80
The average specific weight during the 30–40-week period						
30–40	1.087 ± 0.016	8.36	1.093 ± 0.018	6.51	1.100 ± 0.022	5.75
M-m vs. M-1 = n.s. (F(1, 20) = 0.684, p = 0.418) M-m vs. M-2 = n.s. (F(1, 20) = 2.289, p = 0.146) M-1 vs. M-2 = n.s. (F(1, 20) = 0.524, p = 0.478)						

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; N—number of eggs for which the determination was made; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant.

3.2.4. Egg Volume

Another quality indicator was the egg volume, where the highest values were recorded in the M-2 group at 56.41 cm^3, and the lowest in the M-m group at 56.02 cm^3. The values for the M-1 group were intermediate, but without significant differences, with a value of 56.25 cm^3 (Table 10).

Table 10. The influence of the addition of organic sea buckthorn powder on the volume of eggs laid.

Age (Weeks)	M-m (N = 30)		M-1 (N = 30)		M-2 (N = 30)	
	$\overline{X} \pm s_{\overline{x}}$ (cm^3)	V%	$\overline{X} \pm s_{\overline{x}}$ (cm^3)	V%	$\overline{X} \pm s_{\overline{x}}$ (cm^3)	V%
30	54.74 ± 0.99	5.71	54.78 ± 0.57	3.28	54.76 ± 0.62	3.58
31	54.89 ± 1.07	6.15	55.07 ± 0.64	3.69	55.12 ± 0.46	2.64
32	55.08 ± 1.04	5.98	55.21 ± 0.68	3.89	55.44 ± 0.53	3.02
33	55.29 ± 1.10	6.27	55.65 ± 0.78	4.45	55.82 ± 0.61	3.45
34	55.71 ± 1.11	6.97	55.92 ± 0.86	4.86	56.03 ± 0.59	3.33
35	56.12 ± 1.27	7.14	56.38 ± 0.81	4.52	56.61 ± 0.64	3.58
36	56.47 ± 1.36	7.59	56.74 ± 0.74	4.13	56.92 ± 0.74	4.11
37	56.69 ± 1.47	8.17	56.93 ± 0.89	4.97	57.04 ± 0.77	4.25
38	56.90 ± 1.62	8.99	57.09 ± 0.92	5.11	57.21 ± 0.85	4.69
39	57.11 ± 1.71	9.45	57.28 ± 0.95	5.23	57.54 ± 0.86	4.73
40	57.27 ± 1.80	9.93	57.65 ± 1.04	5.69	57.99 ± 0.89	4.88
The volume of eggs determined for the 30–40-week period						
30–40	56.02 ± 0.92	7.54	56.25 ± 0.97	4.58	56.41 ± 1.04	3.66
M-m vs. M-1 = n.s. ($F(1, 20) = 0.296$, $p = 0.593$) M-m vs. M-2 = n.s. ($F(1, 20) = 0.824$, $p = 0.375$) M-1 vs. M-2 = n.s. ($F(1, 20) = 0.141$, $p = 0.712$)						

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; N—number of eggs for which the determination was made; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant.

3.2.5. Weight of Egg Components

Since egg consumption in Romania primarily focuses on shell eggs, it was deemed appropriate to determine the proportion of their components. Although the results obtained were similar, the overall analysis allowed us to rank the M-m and M-2 groups first in terms of yolk proportion, with a value of 32.11% for both. The M-1 group was ranked second, with a value of 32.10%.

The proportion of egg white was 59.25% for M-2, 59.37% for M-1, and 59.43% for M-m. Regarding the total egg structure, the mineral content of the shell ranged from 8.46% for M-m to 8.64% for M-2 (Table 11).

Table 11. The proportion of the main components of eggs based on the percentage of organic sea buckthorn powder used.

Experimental Batch	M-m (N = 30)		M-1 (N = 30)		M-2 (N = 30)	
Indicator	$\overline{X} \pm s_{\overline{x}}$	V%	$\overline{X} \pm s_{\overline{x}}$	V%	$\overline{X} \pm s_{\overline{x}}$	V%
Yolk (%)	32.18 ± 0.13	0.39	32.11 ± 0.10	0.31	32.12 ± 0.17	0.53
Egg white (%)	59.38 ± 0.03	0.05	59.37 ± 0.03	0.04	59.24 ± 0.09	0.15
Shell (%)	8.44 ± 0.15	1.68	8.52 ± 0.13	1.49	8.64 ± 0.08	0.95
Yolk (%)						
effectM-m vs. M-1 = n.s. ($F(1, 20) = 1.60$, $p = 0.221$) M-m vs. M-2 = n.s. ($F(1, 20) = 0.0051$, $p = 0.944$) M-1 vs. M-2 = n.s. ($F(1, 20) = 0.0051$, $p = 0.944$)						
Egg white (%)						
M-m vs. M-1 = n.s. ($F(1, 20) = 0.4697$, $p = 0.5010$) M-m vs. M-2 = ** $p < 0.05$ ($F(1, 20) = 15.6774$, $p = 0.0008$) M-1 vs. M-2 = ** $p < 0.05$ ($F(1, 20) = 13.1192$, $p = 0.0017$)						

Table 11. *Cont.*

Experimental Batch	**M-m (N = 30)**	**M-1 (N = 30)**	**M-2 (N = 30)**
Shell (%)			
M-m vs. M-1 = n.s. (F(1, 20) = 1.2145, p = 0.2835) M-m vs. M-2 = ** $p < 0.05$ (F(1, 20) = 10.3560, p = 0.0043) M-1 vs. M-2 = * $p < 0.05$ (F(1, 20) = 4.6823, p = 0.0428)			

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant; *—significant differences; **—distinct significant differences.

3.2.6. The Thickness of the Mineral Shell of Eggs

The integrity of eggs during handling is directly influenced by the thickness of the mineral shell. Analyzing this indicator, a reduction in shell thickness was observed from one week of control to the next, a trend that was consistent across all three groups.

The results showed that the thickest mineral shell was found in the M-2 group (with a value of 0.787 mm), while the thinnest was in the M-m group (with a value of 0.728 mm). The M-1 group had an intermediate value, with a determined thickness of 0.776 mm (Table 12).

Table 12. The impact of using different percentages of organic sea buckthorn powder on the mineral shell thickness of the eggs studied.

Age (Weeks)	**M-m (N = 30)**		**M-1 (N = 30)**		**M-2 (N = 30)**	
	$\overline{X} \pm s_{\overline{x}}$ (mm)	**V%**	**$\overline{X} \pm s_{\overline{x}}$ (mm)**	**V%**	**$\overline{X} \pm s_{\overline{x}}$ (mm)**	**V%**
30	0.792 ± 0.021	14.25	0.793 ± 0.015	10.41	0.792 ± 0.014	10.02
31	0.790 ± 0.021	14.87	0.793 ± 0.015	10.59	0.794 ± 0.014	10.23
32	0.787 ± 0.021	14.28	0.791 ± 0.016	10.97	0.795 ± 0.014	10.45
33	0.783 ± 0.021	15.01	0.788 ± 0.016	11.11	0.795 ± 0.015	10.56
34	0.780 ± 0.022	15.69	0.786 ± 0.016	11.25	0.793 ± 0.015	10.69
35	0.775 ± 0.023	15.97	0.780 ± 0.016	11.69	0.790 ± 0.016	10.71
36	0.774 ± 0.023	16.28	0.778 ± 0.017	12.13	0.787 ± 0.016	11.38
37	0.768 ± 0.024	16.83	0.773 ± 0.017	12.58	0.784 ± 0.017	11.69
38	0.763 ± 0.024	17.11	0.770 ± 0.018	12.61	0.781 ± 0.017	11.87
39	0.744 ± 0.023	17.09	0.766 ± 0.018	12.87	0.777 ± 0.017	12.12
40	0.702 ± 0.023	17.86	0.751 ± 0.018	13.45	0.774 ± 0.017	12.38
The mineral shell thickness determined for the 30–40-week period						
Average	0.769 ± 0.026	15.43	0.779 ± 0.013	11.67	0.787 ± 0.007	10.98
M-m vs. M-1 = n.s. (F(1, 20) = 1.3084, p = 0.2662) M-m vs. M-2 = * $p < 0.05$ (F(1, 20) = 5.1252, p = 0.0349) M-1 vs. M-2 = n.s. (F(1, 20) = 3.4234, p = 0.0791)						

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant; *—significant differences.

3.2.7. Crack Resistance of the Mineral Shell

For the reasons mentioned earlier, we were also interested in determining the breakage resistance of the mineral shell. In terms of this parameter, greater differences were observed between the experimental groups. Thus, the lowest resistance was observed in the M-m group, with a value of 176.90 g f/cm^2, followed by the M-1 group with a value of 179.17 g f/cm^2, and the M-2 group, where a value of 181.11 g f/cm^2 was determined (Table 13)

Table 13. The changes in breakage resistance of the mineral shell relative to the percentage of organic sea buckthorn powder used in the diet of Moravia Black hens.

Age (Weeks)	M-m (n = 30)		M-1 (n = 30)		M-2 (n = 30)	
	$\overline{X} \pm s_{\overline{x}}$ (g f/cm^2)	V%	$\overline{X} \pm s_{\overline{x}}$ (g f/cm^2)	V%	$\overline{X} \pm s_{\overline{x}}$ (g f/cm^2)	V%
30	182.16 ± 5.50	16.55	182.39 ± 4.39	13.18	182.16 ± 3.87	11.63
31	181.70 ± 5.58	16.83	182.39 ± 4.66	14.01	182.62 ± 4.00	12.01
32	181.61 ± 5.57	16.80	181.93 ± 4.46	13.44	182.85 ± 4.14	12.42
33	180.09 ± 5.52	16.79	181.24 ± 4.72	14.28	182.85 ± 4.20	12.59
34	179.40 ± 5.56	16.98	180.78 ± 4.82	14.61	182.39 ± 4.32	12.98
35	178.25 ± 5.71	17.56	179.40 ± 4.87	14.89	181.70 ± 4.20	12.67
36	178.02 ± 5.73	17.63	178.94 ± 4.87	14.91	181.01 ± 4.33	13.12
37	176.64 ± 5.96	18.49	177.79 ± 4.89	15.07	180.32 ± 4.28	13.01
38	175.49 ± 6.14	19.19	177.10 ± 4.88	15.11	179.63 ± 4.23	12.89
39	171.12 ± 6.30	20.16	176.18 ± 4.87	15.15	178.71 ± 4.30	13.20
40	161.46 ± 5.97	20.27	172.73 ± 4.79	15.20	178.02 ± 4.34	13.35
The breakage resistance of the mineral shell for the 30–40-week period						
30–40	176.90 ± 6.05	16.46	179.17 ± 3.03	14.67	181.11 ± 1.71	12.98
M-m vs. M-1 = n.s. (F(1, 20) = 1.2331, p = 0.2800) M-m vs. M-2 = * $p < 0.05$ (F(1, 20) = 4.9279, p = 0.0381) M-1 vs. M-2 = n.s. (F(1, 20) = 3.4234, p = 0.0791)						

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant; *—significant differences.

3.2.8. The Color of the Yolk

A parameter that influences the purchasing decision of consumers, the color of the yolk was determined on a sample of 30 eggs from each group, each week of the experiment, using the La Roche scale.

At the end of the study, the average values obtained were calculated, highlighting a more intense orange color in the M-2 group (with a determined value of 12.12 points), a less intense color in M-1 (with a value of 10.22 points), and a paler shade in the M-m group (with a value of 8.33 points) (Table 14).

Table 14. The impact of adding organic sea buckthorn powder on the modification of yolk color in eggs produced by Moravia Black hens.

Age (Weeks)	M-m (N = 30)		M-1 (N = 30)		M-2 (N = 30)	
	$\overline{X} \pm s_{\overline{x}}$ (Points)	V%	$\overline{X} \pm s_{\overline{x}}$ (Points)	V%	$\overline{X} \pm s_{\overline{x}}$ (Points)	V%
30	8.37 ± 0.08	5.62	8.38 ± 0.06	4.21	8.37 ± 0.06	3.78
31	8.35 ± 0.09	5.89	9.72 ± 0.08	4.57	11.15 ± 0.07	3.56
32	8.35 ± 0.08	5.44	10.25 ± 0.09	4.63	12.04 ± 0.07	3.12
33	8.34 ± 0.09	6.19	10.44 ± 0.09	4.89	12.59 ± 0.07	3.09
34	8.34 ± 0.09	5.97	10.44 ± 0.07	3.75	12.62 ± 0.09	4.11
35	8.33 ± 0.09	6.28	10.48 ± 0.08	3.98	12.65 ± 0.09	4.07
36	8.32 ± 0.09	6.01	10.50 ± 0.08	4.10	12.70 ± 0.10	4.27
37	8.31 ± 0.08	5.55	10.50 ± 0.09	4.63	12.78 ± 0.09	3.92
38	8.31 ± 0.08	5.67	10.52 ± 0.09	4.57	12.78 ± 0.09	3.85
39	8.30 ± 0.10	6.45	10.55 ± 0.08	4.22	12.81 ± 0.10	4.37
40	8.29 ± 0.11	7.03	10.61 ± 0.10	4.99	12.86 ± 0.10	4.14
The yolk color determined during the 30–40-week period						

Table 14. *Cont.*

Age (Weeks)	M-m (N = 30)		M-1 (N = 30)		M-2 (N = 30)	
	$\overline{X} \pm s_{\overline{x}}$ (Points)	V%	$\overline{X} \pm s_{\overline{x}}$ (Points)	V%	$\overline{X} \pm s_{\overline{x}}$ (Points)	V%
30–40	8.33 ± 0.02	5.25	10.22 ± 0.66	4.12	12.12 ± 1.34	4.22
M-m vs. M-1 = *** $p < 0.001$ (F(1, 20) = 90.983, $p < 0.0001$) M-m vs. M-2 = *** $p < 0.001$ (F(1, 20) = 87.997, $p < 0.0001$) M-1 vs. M-2 = ** $p < 0.001$ (F(1, 20) = 17.908, $p = 0.0004$)						

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; n.s.—not significant; **—very significant differences; ***—extremely significant differences.

3.2.9. The Carotenoid Content of the Yolk

The carotenoid quantities, which ultimately determine the color of the yolk, were also determined for 30 eggs from each group, each week of the experiment, and then the average values were calculated. Higher values were identified for the M-2 group, where the quantity was 25.25 mg/g, followed by the M-1 group (with a quantity of 19.43 mg/g) and the M-m group, with only 17.66 mg/g (Table 15).

Table 15. Determining the carotenoid content in the yolk based on the percentage of organic sea buckthorn powder administered to Moravia Black hens.

Age (Weeks)	M-m (N = 30)		M-1 (N = 30)		M-2 (N = 30)	
	$\overline{X} \pm s_{\overline{x}}$ (mg/g)	V%	$\overline{X} \pm s_{\overline{x}}$ (mg/g)	V%	$\overline{X} \pm s_{\overline{x}}$ (mg/g)	V%
30	17.74 ± 0.072	2.22	17.76 ± 0.038	1.17	17.74 ± 0.033	1.02
31	17.70 ± 0.092	2.86	20.44 ± 0.048	1.28	23.30 ± 0.042	0.98
32	17.70 ± 0.083	2.57	21.50 ± 0.053	1.36	25.08 ± 0.034	0.75
33	17.68 ± 0.087	2.69	21.88 ± 0.050	1.25	26.18 ± 0.053	1.11
34	17.68 ± 0.097	3.01	21.88 ± 0.043	1.08	26.24 ± 0.049	1.03
35	17.66 ± 0.088	2.74	21.96 ± 0.060	1.49	26.30 ± 0.047	0.97
36	17.64 ± 0.100	3.11	22.00 ± 0.063	1.58	26.40 ± 0.062	1.29
37	17.62 ± 0.095	2.96	22.00 ± 0.052	1.29	26.56 ± 0.095	1.97
38	17.62 ± 0.097	3.02	22.04 ± 0.065	1.61	26.56 ± 0.077	1.58
39	17.60 ± 0.100	3.11	22.10 ± 0.069	1.70	26.62 ± 0.055	1.13
40	17.58 ± 0.115	3.57	22.22 ± 0.052	1.29	26.72 ± 0.048	0.98
The carotenoid content determined for the 30–40-week period						
30–40	17.66 ± 0.04	2.40	21.43 ± 1.31	1.35	25.24 ± 2.68	1.05
M-m vs. M-1 = *** $p < 0.001$ (F(1, 20) = 90.983, $p < 0.0001$) M-m vs. M-2 = *** $p < 0.001$ (F(1, 20) = 17.908, $p = 0.0004$) M-1 vs. M-2 = *** $p < 0.001$ (F(1, 20) = 87.997, $p = 9.17 \times 10^{-9}$)						

M-m—control group (no organic sea buckthorn powder was used); M-1—group where 1% organic sea buckthorn powder was used; M-2—group where 2% organic sea buckthorn powder was used; $\overline{X} \pm s_{\overline{X}}$—mean ± standard deviation; V%—coefficient of variation; ***—extremely significant differences.

4. Discussion

The results of this study demonstrate the positive impact of sea buckthorn powder on the productive and qualitative characteristics of hens. At the outset of the experiment (30 weeks), the body weight of the birds was nearly identical across all three groups, with slight variations (M-m: 2412.4 g, M-1: 2412.0 g, M-2: 2412.2 g). By 40 weeks, the birds in all groups showed similar weight trends, consistent with the standard growth pattern for the breed. However, the slightly lower weights in the experimental groups, especially M-1 and M-2, could be attributed to the increased laying intensity observed in these groups. In comparison, a study on ISA Brown hens fed with black soldier fly larvae reported minor weight differences between control and experimental groups, reinforcing the notion that dietary supplements often have minimal effects on overall body weight [35]. Similarly, research on dietary blackberry supplementation found that egg weights steadily increase throughout the laying period, aligning with the positive effects of natural feed additives like sea buckthorn [36].

The mortality rate among the hens was very low in all groups, reflecting the breed's inherent resilience and the beneficial conditions provided by free-range housing. In the control group, two birds were lost, while only one bird was lost per experimental group, a finding that is consistent with the relatively low mortality rates observed in other studies on free-range poultry [35]. This suggests that both the breed's robustness and the environmental conditions contributed to the positive outcomes of the study.

Egg production was another area where significant results were observed. Hens in all three groups exhibited high laying intensity, peaking at 33 weeks. The experimental groups showed a slight increase in egg production, with group M-2 (2% sea buckthorn powder) yielding the highest total egg production (13,907 eggs) and individual production per hen (69.65 eggs). These results align with studies on the supplementation of feed with natural additives such as humic substances and essential oils, which have been shown to improve egg production parameters, including laying rate and feed conversion efficiency [37,38]. Meta-analyses on essential oils also report improvements in egg production, feed efficiency, and eggshell quality, attributed to the antioxidant properties of such supplements, which are likely present in sea buckthorn as well.

Egg production structure also improved with sea buckthorn supplementation, particularly in the M-2 group, where the proportion of larger eggs (L and XL) was higher compared to the control group. This result is in line with findings by Panaite et al. (2020), who reported that dietary additives like sea buckthorn could increase egg yolk weight and improve egg quality [39]. This suggests that sea buckthorn may positively influence the size and quality of eggs, potentially through its nutritional content and bioactive compounds.

Regarding feed consumption, all three groups showed similar patterns, with minimal differences in the average daily feed intake. This consistency suggests that sea buckthorn supplementation had a negligible effect on the overall feed consumption, which aligns with other studies that have found minimal impacts of natural additives on feed intake while still improving production efficiency [40–42]. The results further indicate that while feed consumption remained stable, supplementation with sea buckthorn led to better egg production and quality, thus enhancing overall productivity.

In terms of egg quality, the supplementation of sea buckthorn showed clear benefits. The average egg weight for the control group was 63.46 g, with the M-1 and M-2 groups showing slight increases, reaching 63.53 g and 63.80 g, respectively. These findings support other studies that suggest dietary supplementation, such as with sea buckthorn, can enhance egg weight and overall quality [43]. Furthermore, the shape index of the eggs remained within the optimal range, with only slight variations between groups. Notably, the eggs from the M-1 and M-2 groups showed better uniformity in shape, a characteristic often associated with the use of natural additives that help improve egg quality and consistency [44].

The specific gravity of eggs, which is an important indicator of egg quality, also improved with sea buckthorn supplementation. The M-2 group showed the highest specific gravity values, consistent with studies that have demonstrated the positive effects of sea buckthorn on egg characteristics, including shell quality and yolk weight [45,46]. This suggests that the bioactive compounds in sea buckthorn may enhance the nutritional quality of the eggs, particularly in terms of yolk and shell quality.

Egg volume, another quality indicator, was also positively influenced by sea buckthorn supplementation. The eggs from the M-1 and M-2 groups had higher average volumes compared to the control group, with the M-2 group showing the highest volume, indicating that the addition of sea buckthorn might contribute to larger eggs without significantly altering feed consumption. These findings are consistent with those of other studies that have observed improvements in egg size and volume with the use of dietary supplements [47,48].

When examining the composition of the eggs, particularly the proportion of yolk, albumen, and mineral shell, the results were consistent with known patterns of egg composition changes as hens age. The yolk proportion increased over time, while the mineral shell proportion decreased, which is typical for laying hens. Sea buckthorn supplementation did not drastically alter these trends but slightly improved the homogeneity of the egg components, particularly in the M-1 and M-2 groups. This could be a reflection of the bioactive compounds in sea buckthorn that may support overall egg quality and nutritional balance.

The thickness of the eggshells in all groups decreased over the experimental period, a typical result due to the increased size of the eggs. However, eggs from the experimental groups, particularly those receiving 2% sea buckthorn powder, had slightly thicker shells compared to the control group, aligning with the findings of studies that suggest dietary supplementation can have positive effects on calcium metabolism and eggshell quality [41,49,50]. The increased resistance to cracking in the eggs from the M-1 and M-2 groups further supports the hypothesis that sea buckthorn may improve eggshell strength and overall quality.

Finally, yolk color, an important factor for consumer preference, was more intense in the experimental groups, particularly in the M-2 group, which showed the highest La Roche points. This finding is in line with studies that have demonstrated the ability of dietary supplements like sea buckthorn to enhance yolk color consistency, making eggs more appealing to consumers [51–53].

The supplementation of sea buckthorn powder in the diet of hens led to improved productive and qualitative characteristics, including increased egg production, better egg quality, and enhanced uniformity in egg traits. These results align with previous studies on natural feed additives, supporting the potential of sea buckthorn as a valuable supplement for poultry production. Further studies could explore the underlying mechanisms of these effects and their long-term impact on poultry health and productivity.

Future research should address the limitations of this study by extending the trial duration, increasing the sample size, and controlling for external variables to better assess the long-term impact of sea buckthorn supplementation on egg production and quality.

5. Conclusions

This study evaluated the impact of sea buckthorn powder supplementation (0%, 1%, and 2%) on the performance, egg quality, and feed consumption of laying hens from 30 to 40 weeks of age. Results showed that hens receiving 2% sea buckthorn powder had the highest egg production (69.65 eggs/hen) and improved egg weight, specific gravity, and shell thickness compared to the control group. The shape index and egg volume were also enhanced, indicating better overall quality. Feed consumption varied slightly but was not significantly affected by the supplementation. Mortality rates were low, demonstrating the robustness of the hens and the suitability of the feeding conditions.

Based on the results, it is recommended that poultry producers incorporate 2% ecological sea buckthorn powder into the diets of laying hens. This supplementation can improve egg production, quality, and overall performance, while also supporting more sustainable and health-conscious poultry farming practices.

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