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Effects Of The Feed And Phytoveterinary Additive BIO MULTI+ As An Alternative To Antibiotics On The Persistence Of Egg Laying After The Peak Of Novogen Brown Layers.

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ABSTRACT

The fight against antimicrobial resistance has generated growing interest in reducing, or even eliminating, the use of antibiotics in livestock farming. The overuse of these substances in animal production, particularly in poultry farming, raises concerns regarding public health and environmental sustainability. In this context, biological alternatives are being explored to maintain zootechnical performance without resorting to chemical antibiotics. The main objective of this research was to evaluate the effectiveness of the BIO-MULTI+ phytoveterinary feed additive on the production parameters of Novogen Brown laying hens, as an alternative to conventional zootechnical standards. The trial was carried out on a flock of 1,616 laying hens aged between 36 and 45 weeks, housed in a 220 m^2 building. The results obtained indicate that the daily feed intake in the group treated with BIO-MULTI+ evolved in the same proportions as the standard group, with no significant difference. The laying rate, although slightly lower (overall difference of 4.69%), did not show a statistically significant difference compared to the standard group ($p > 0.05$). However, the average egg weight was higher in the treated group, with an overall difference of 3.24 g, though also not statistically significant. Feed conversion ratios showed a similar trend in both groups, with the treated group exhibiting a more linear variation. Finally, cumulative mortality was significantly lower in the experimental group (0.99%), which is 2.73 times lower than that of the zootechnical standard group. These results suggest that the use of the BIO-MULTI+ biological additive is a promising alternative to chemical antibiotics, allowing for the maintenance of good zootechnical performance while reducing health risks associated with drug residues and antimicrobial resistance.

Keywords: Poultry farming, BIO-MULTI+, Biological alternative, Commercial layer, Zootechnical performance.

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INTRODUCTION

Poultry farming, particularly the production of laying hens, constitutes a key sector of the agricultural economy, both in Africa and globally. It provides an essential source of animal protein in the form of eggs, while actively participating in food security and the fight against poverty [1]. In Côte d'Ivoire, the egg is a valuable source of animal protein of high biological value, easily accessible and inexpensive for the majority of households [2]. Compared to other meat products such as beef or fish, which are often unaffordable for low-income populations, the egg represents a nutritional alternative of choice [3]. However, the technical-economic performance of layer farms often remain compromised by the prevalence of diseases, the drop in productivity and the high costs linked to the use of chemical antibiotics to prevent or treat infections [4]. The excessive and sometimes inappropriate use of these antibiotics has led to major public health concerns, including antimicrobial resistance, as well as negative impacts on the environment and the quality of poultry products [5]. Between 2009 and 2010, 270 cases of human infections with resistant *Salmonella kentucky* were confirmed in France, caused in particular by poultry imported from East and North Africa [6]. A study carried out in 2021 on farms in Abidjan and Agnibilékrou isolated 2012 strains of *E. coli* and 36 strains of Salmonella. Resistance reached 98% for doxycycline, 84% for sulfamides, 80% for trimethoprim-sulfamethoxazole, 71% for streptomycin, as well as moderate resistance to ampicillin, colistin, gentamicin, flumequine, amoxicillin and chloramphenicol [7]. In this context, biological inputs appear to be promising alternatives. These inputs, in addition to strengthening poultry immunity, improve digestive health, reduce mortality and contribute to better feed conversion [8]. Therefore, it becomes crucial to assess to what extent the integration of these biological inputs can not only maintain the health of consumers but above all improve the technical and economic balance sheet of poultry farms.

This requires a rigorous analysis of their effectiveness on zootechnical performance, notably laying rate, feed consumption, animal viability and on economic indicators including production cost, the profit margin but above all profitability. The objective of this work is therefore to explore this alternative and measure their effects during the production phase of laying hens through the use of a biological solution called MULTI-BIO+ as a replacement for synthetic antibiotics. Specifically, it will involve evaluating the effect of the feed additive MULTI-BIO+ on production parameters in a flock of Novogen Brown laying hens. Then, its effect will be evaluated on the qualitative parameters of eggs in these laying hens.

MATERIALS AND METHODS

MATERIALS

Biological material of animal origin

The study involved 1616 laying hens of Novogen Brown strain of 36 weeks of age with an average weight of 1825 ± 85 g. The pullets were placed at one day of age and kept until 36 weeks, start of the experiment.

Biological material of plant origin

BIO-MULTI+ organic input

As part of improving health and zootechnical performance of laying hens, a biological input called BIO-MULTI+ was used. It is a feed and phytoveterinary additive from the Ivorian Society for Development and Valorization of Organic Poultry, capable of filling dietary deficiencies and strengthening the immune system of farm animals. This product stands out for its ability to improve production performance and effectively combat various illnesses of viral, bacterial, parasitic and fungal origin. One of the notable advantages of BIO-MULTI+ is the absence of waiting times. This allows use without risk of residues in animal products intended for human consumption. BIO-MULTI+ should be stored at a temperature not exceeding 25°C and away from sunlight and any heat source. Table I presents the chemical composition of the BIO-MULTI+ product.

Table I: Chemical composition of BIO-MULTI+

Inputs	Composition
Minerals	K, Ca, Mg, Fe, Zn, Cu, Mn etc
Vitamins	A, B1, B2, B3, B6, B9, B12, C, E, K
Macronutrients	Carbohydrates, Dietary fiber, Proteins, Lipids
Other components	Cholesterol, Monounsaturated fatty acid
Pigments and antioxidants	Beta-carotene, Tocopherols, Phenol acid etc.
Specific acid	Essential amino acids, acetic acid

Feed used during the experiment

The feed used during this experiment is laying feed 1 from the Dutch company KOUDIJS de Heus. Table II presents the bromatological composition of the feed.

Table II: Bromatological composition of KOUDIJS feed

Composition	Indicative value
Raw protein	16.0 (%)
Crude fat	5.30 (%)
Lysine	0.70 (%)
Methionine	0.40 (%)
Calcium	3.60 (%)
Phosphorus	0.40 (%)
Metabolizable energy	2800 kcal

Technical equipment

Livestock equipment

The equipment used in this study includes automatic second-age drinkers for watering subjects, as well as second-age feeders designed for feed distribution. Nesting boxes were also installed to allow hens to lay eggs.

Other materials

The technical equipment used during this study is essentially composed of scales for weighing feed and eggs, a sprayer and disinfectant for disinfection. A electronic caliper, with a precision of 1 mm, was used to measure the external and internal parameters of the eggs. Petri boxes were used to collect the content of eggs for the measurements of egg internal parameters.

METHODS

Study site and experimental building

This research work was carried out in the Grands-Ponts region, more precisely in the department of Dabou, a locality located in the south of Côte d'Ivoire, approximately 50 km west of Abidjan, the economic capital. The study site is the experimental farm of the Ivorian Society of Development and Valorization of Organic Poultry farming, abbreviated SIDeVAB. The site is located between the town of Dabou and the village of Pkass, 300 m from the coastal highway, linking Dabou to Grand-Lahou. The site has an area of 400 m² and contains the experimental building with an area of 220 m² with the following dimensions: length x width x side height (20 m x 11 m x 4 m). The trial was carried out from April to June 2025 over a period of 10 weeks. The figure 1 shows the location of the study site.

Figure 1 Location of the study site

Conduct of the experiment

Animal management

The experiment was carried out using subjects aged 36 weeks. The starting number for the experiment was 1616 Novogen Brown pullets. The animals were watered freely using automatic drinkers throughout the trial period, ~~starting~~ from the farm's borehole. The feed used during the experimental phase is laying feed 1 from the company KOUDIJS, as recommended on the company's technical sheet. During the day, 190 kg of feed are served according to the following distribution:

- 5h00 : 55 Kg of feed
- 8h00 : 50 Kg of feed
- 10h30 : 30 Kg of feed
- 15h00 : 55 Kg of feed

A lighting program was implemented due to 15 hours of light over the entire study period. In fact, artificial light, combined with natural light from switching on the bulbs from 5 a.m. to 7 a.m. and from 5 p.m. to 8 p.m., allows for 15 hours of continuous light.

Egg management

While driving, eggs were collected six times a day to reduce the risk of brooding, soiling, cracking and breakage. This frequency of collection facilitated the assessment of egg quality. Furthermore, the litter in the nests was regularly renewed to guarantee the cleanliness of the eggs and contributed to reducing the breakage rate.

Traitement biologique à base de BIO-MULTI+

The organic feed and phytoveterinary input BIO-MULTI+ was used as a feed additive and as an alternative to any chemical antibiotic treatment. Table III gives the dosage of BIO-MULTI+.

Table III: Prophylactic program based on BIO-MULTI+

Target: Commercial layers in production phase: 18 - 80 weeks

Age (weeks)	Objective	Recommended dose of MULTI-BIO+	Duration of administration	Remarks
18 – 20	Transition to egg laying, stabilization of the flora	2 ml/L of water	5 days	Promotes stable egg laying
24 – 26	Digestive and immune support	1.5 ml/L of water	4 days	Control of digestive disorders

32 – 34	Prevention of common infections	2 ml/L of water	3 days	Period susceptible to infections
40 – 42	Maintenance of laying performance	1.5 ml/L of water	5 days	Production optimization
50 – 52	Prevention of metabolic fatigue	2 ml/L of water	5 days	Liver and immune support
60 – 62	Performance Stabilization	1.5 ml/L of water	4 days	End of intensive production phase
70 – 72	Preparation for the end of the cycle	2 ml/L of water	3 days	Reduction of metabolic stress

NB: Systematic treatment in the event of illness or suspicion of illness

Zootechnical parameters

Daily feed consumption

Daily feed consumption per hen (DFC) is an essential parameter in the management of a laying hen farm. It makes it possible to meet the real nutritional needs of animals, monitor their state of health and optimize production performance. It is determined by formula (1):

$$\text{DFC(g)} = \frac{\text{Quantity of feed distributed (g)} - \text{Quantity of feed remaining (g)}}{\text{Total number of hens}} \quad (1)$$

Daily laying rate

The laying rate is an essential indicator for evaluating the performance, health and profitability of a laying hen farm. It allows breeders to make informed decisions to optimize production and guarantee the success of their activity. It is determined by the formula (2):

$$\text{Laying rate (\%)} = \frac{\text{Number of eggs per day}}{\text{Total number of laying hens present}} \text{ x } 100 \quad (2)$$

Average egg weight

Knowledge of the average weight of eggs is crucial to assess the quality of production and the body condition of the animals. The average egg weight influences the total mass of eggs produced. The body weight of hens with which it is correlated. An inadequate body weight can affect egg production. In addition, the proportion of egg components (white, yolk, shell) is linked to the total weight of the egg. The formula (3) allows us to determine this.

$$\text{AEW}(g) = \frac{\text{Sum of weights of weighed eggs}}{\text{Number of total eggs weighed}} \quad (3)$$

Conversion index

The conversion index (CI) in laying hen farming measures the efficiency with which hens convert feed into egg production. A lower CI indicates better feed efficiency, because the less feed is needed to produce the same amount of meat or eggs, the higher the profitability. It is determined by formula (4).

$$\text{CI} = \frac{\text{Quantity of feed consumed during a period}}{\text{The weight gained during the same period}} \quad (4)$$

Mortality rate

The livestock mortality rate is a key indicator of herd health and performance. It makes it possible to assess the impact of various diseases, environmental conditions and management practices on bird survival.Its expression is given by formula (5).

$$\text{Mortality rate (\%)} = \frac{\text{Total dead animals}}{\text{Total effective departure}} \times 100 \quad (5)$$

Apparent density

Egg bulk density is a measurement used to assess the quality of an egg, in particularly its freshness and buoyancy. It is a criterion commonly used in poultry farming, quality control and incubation. The apparent density of the egg is an indicator of freshness according to the following standards:

- Fresh egg: density > 1.08 g/cm^3
- Less fresh egg: density between 1.05 – 1.08
- Old egg (air has increased): density < 1.03

This is why eggs float in water when they are old. Also, selecting eggs with a normal density avoids porous or too light eggs. The formula (7) allows you to determine the apparent density of an egg.

Relative egg weight

$$\text{Apparent density} = \frac{\text{Weight}}{\text{Length (cm)X width}^2\text{ (cm)}} \text{ X } 100 \quad (7)$$

The relative weight of the egg components makes it possible to determine the balance between the parts (yolk, white and shell). A good yolk/white ratio is sought for direct consumption of the egg, industrial processing (pastry, sauces) and nutrition in particular, protein and lipid intake.The formula (8) gives its expression :

$$\text{Relative weight} = \frac{\text{weight of white or yellow}}{\text{Egg weight}} \text{ X } 100 \quad (8)$$

Statistical analyzes

The data collected during this study were subject to statistical analyzes in order to evaluate the level of significance between the values obtained and the reference values. The software used is XLSTAT version 2025. Thus, the Tukey HSD test was used to compare the means and a Chi-square test was used to compare the proportions. Comparisons were made at the 5% significance level.

RESULTS AND DISCUSSION

RESULTS

Zootechnical parameters

Daily feed consumption of the Novogen Brown layer subjected to BIO-MULTI+

The figure 2 shows the weekly evolution of the daily consumption of Novogen Brown layers having received the BIO-MULTI+ treatment compared to the zootechnical standard over a 10-week trial period. Over the entire period of the trial, particularly 36 to 45 weeks, the actual ration evolved in the same proportions as the zootechnical standard. Indeed, no significant difference was observed between the intake values of the experimental batch compared to the standard. The standard ration increased from 104 g at the start of the experiment to reach 115 g at the end of the test. These values increase to 105 g and 115 g respectively in the experimental batch for the same period.

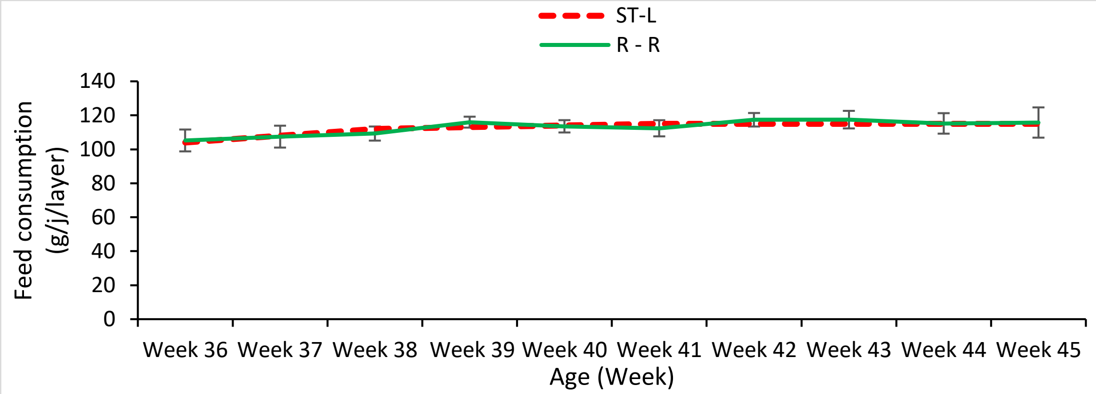

Figure 2 Weekly evolution of the daily consumption of Novogen Brown layers compared to the standard

Impact of the feed additive and phytoveterinary BIO-MULTI+ on laying intensity in Novogen Brown

The figure 3 shows the weekly evolution of the laying intensity of the experimental batch compared to the zootechnical standard over the 10 weeks of the trial. Over the entire trial period, the experimental batch recorded egg laying below the zootechnical standard with a weekly deviation of 0.47%, an overall deviation of 4.69% over the entire study period. No significant difference was observed statistically between the laying rates of the two batches ($p > 0.05$). Furthermore, the actual laying curve has three periods. The first period starts from weeks 36 to 38. During this period, the experimental batch experienced an increase in egg laying which increased from 94.60% to 94.70%. Then, at 39 to 40 weeks, there was a big gap in the laying rate between the experimental batch and the standard batch. Finally, from the 41 week period until the end of the trial at 45 weeks, the experimental batch experienced an increase in laying, considerably reducing the gap with the zootechnical standard.

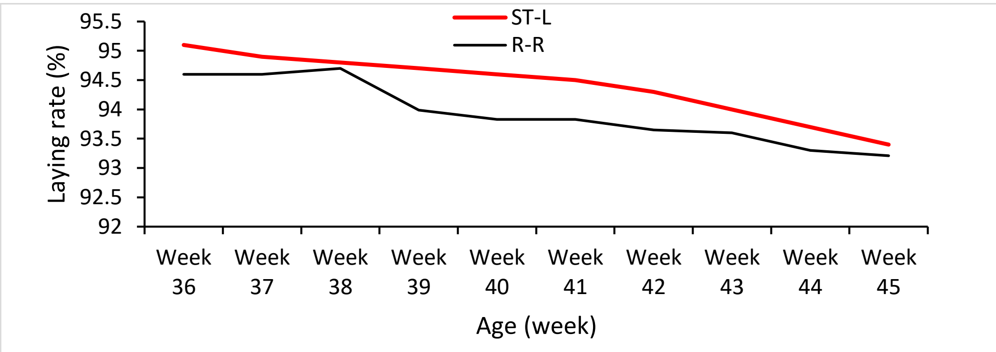

Figure 3: Weekly evolution of the laying of Novogen Brown layers compared to the standard

Effect of the feed and phytoveterinary additive BIO-MULTI+ on the average egg weight of the commercial layer Novogen Brown

In this study, the experimental batch recorded an average egg weight greater than the zootechnical standard over the entire trial period. However, no statistical difference was observed (Figure 4). In the experimental batch, the weight evolved from 63.30 g to 64.30 g compared to 63.00 g to 64.00 g of the zootechnical standard. Indeed, the average weekly difference in egg weight between the two (2) batches was 0.32 g with an overall difference of 3.24 g.

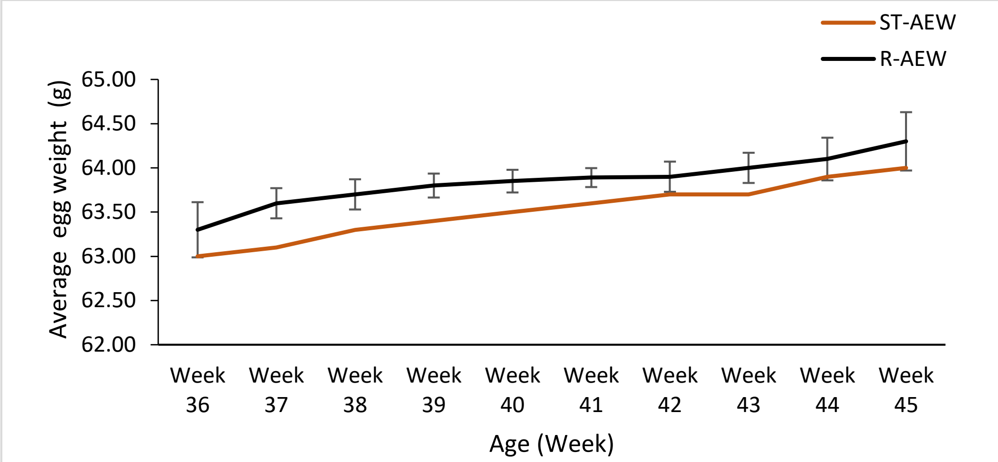

Figure 4 : Weekly evolution of the weight of eggs from the actual batch compared to the standard

Weekly evolution of the conversion index achieved compared to the standard

The table IV presents the weekly conversion indices (CI) of the actual batch compared to the zootechnical standard over a period of 10 weeks. Quantitatively, the CI of the treated batch and the zootechnical standard evolved in a statistically similar way ($p > 0.05$). The CI values oscillated between 1.66 and 1.84 compared to 1.65 and 1.81 in the zootechnical standard.However, unlike the CI of the standard which evolved, that of the experimental batch experienced a sawtooth evolution.

Table IV: Comparison of the conversion index of the standard and the experimental batch of Novogen Brown laying hens

Age	CI Standard	CI Real	*p-value*
Week 36	1,65	1,66	*0,67*
Week 37	1,71	1,69	*0,08*
Week 38	1,77	1,72	*0,73*
Week 39	1,78	1,82	*0,17*
Week 40	1,80	1,78	*0,35*
Week 41	1,81	1,76	*0,08*
Week 42	1,81	1,84	*0,11*
Week 43	1,81	1,84	*0,08*
Week 44	1,80	1,80	*1*
Week 45	1,80	1,80	*1*

Cumulative mortality in Novogen Brown layers subjected to BIO-MULTI+ compared to the zootechnical standard

The figure 5 compares the cumulative mortality of the actual batch to zootechnical standard. The mortality in the treated group was significantly lower than that observed in the zootechnical standard over the trial period. The cumulative mortality of the treated batch was 0.99%, or 2.73 times lower than that of the zootechnical standard.

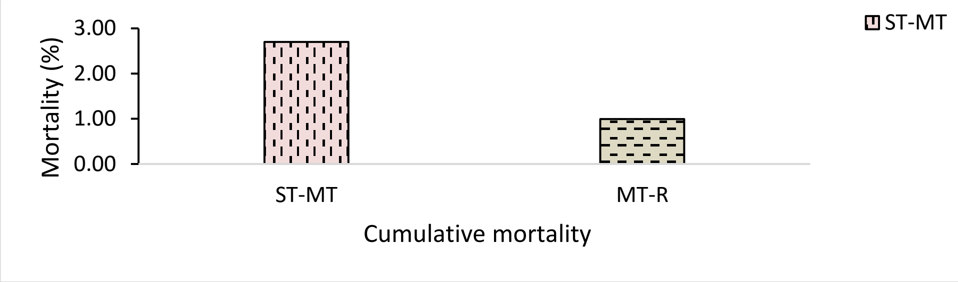

Figure 5: Cumulative mortality of the real batch and the standard batch

Egg quality parameters

The table V highlights the main qualitative parameters of eggs from the experimental batch and their comparison with the standardized values. Overall, all parameters meet standard standards.The relative weights of white and yellow are 60.71% and 29.26% respectively. These values are included in the reference values.

Table V: Qualitative parameters of eggs from the experimental batch compared to the zootechnical standard

Qualitative parameters of the egg	Actual batch	Standard
Shape index %	79,20	72 à 76
Apparent Density (g/m^3)	0,58	0,50 à 0,60
Relative weight of white %	60,71	55 à 62
Poids relatif du jaune %	25,26	28 à 33

DISCUSSION

The main objective of this study was to evaluate the effect of the feed additive and phytoveterinary BIO-MULTI+ on the zootechnical performance of the commercial layer Novogen Brown, through several parameters: feed consumption, laying intensity, average egg weight, conversion index, cumulative mortality and egg quality. The results obtained are generally in the dynamics described in the literature on the use of natural additives in poultry farming, in particular phytogenics, probiotics and plant extracts [9,10]. The weekly evolution of feed consumption showed that layers treated with BIO-MULTI+ did not significantly modify their feeding behavior compared to the zootechnical standard.This result is consistent with those of Mountzouris et al. [8], who observed that the incorporation of phytogenics into the diet of layers does not modify the ration ingested, provided that the additive does not compromise the palatability. The stability of consumption would indicate that BIO-MULTI+ did not act as a negative appetitive factor. This is fundamental to maintaining a constant energy intake, essential to the productivity of layers, as demonstrated by Leeson and Summers (2005) [11] in a similar study. Despite a slight drop in the laying intensity observed in the experimental batch, no statistical difference was revealed. This would mean that the feed additive and phytoveterinary does not have a degrading effect on animal productivity. Moreover, this observation corroborates the work of [12], which shows that phytogenic additives can cause non-significant fluctuations in egg-laying performance, due to their indirect mode of action by modulation of the intestinal microbiota or immunostimulating effect. In addition, the catch-up dynamic observed at the end of the experiment (weeks 41 to 45) could reflect a delayed effect of the additive. Such a hypothesis had already been put forward by [13] in similar trials.

The egg weight was slightly higher in the treated group, but without significant difference. Indeed, BIO-MULTI+ appears as a nutritious feed supplement promoting the well-being of layers. Its contribution would also be favorable to egg production because it is well assimilated and metabolized by animals, thus promoting good egg growth. This observation is consistent with the results of the work of [14]. According to these authors, certain plant extracts, rich in antioxidants and essential oils, can improve the assimilation parameters of nutrients, notably calcium and proteins, which results in an improvement in egg quality. These results are particularly important for the egg processing industry, where size has a direct impact on profitability. The evolution of the feed conversion index, although statistically similar between the two batches, revealed a linearity in the treated group, in opposition to the fluctuations observed in the standard group. This metabolic constancy is a zootechnical asset which would translate into good digestibility of nutrients thanks to the additive. The work of authors such as [15] and [16] resulted in similar results. These authors attributed these results to the actions of plant bioactives which contributed to a better digestive balance linked to an optimization of enzymatic digestion. Indeed, a more stable CI allows increased predictability in ration management and better economic efficiency. The most convincing result concerns the cumulative mortality, which was significantly lower in the treated batch, 2.73 times lower than the standard. This improvement can be attributed to the known antimicrobial and immunomodulatory properties of phytoveterinarians [17], particularly when they contain compounds such as flavonoids, tannins or saponins in reasonable proportions. A reduction in mortality is also an indirect indicator of better intestinal health and less oxidative stress, two key dimensions of performance in intensive livestock farming [18]. Finally, all the qualitative parameters measured in particular, the shape index, the apparent density, the relative weight of white and yellow showed values consistent with the standards of the species. Therefore, the use of BIO-MULTI+ does not affect the structure or composition of eggs. Moreover, the use of BIO-MULTI+ could contribute to the stabilization of internal parameters, in connection with the protective role of antioxidants on the integrity of membranes as observed by Goliomytis et al. [19]. The quality of the egg being an essential criterion for the market, this positive neutrality is an additional argument in favor of the use of this type of additive.

CONCLUSION AND OUTLOOK

The feed and phytoveterinary additive BIO-MULTI+ showed a positive zootechnical effectiveness, without disturbing feed intake, while maintaining and improving certain parameters such as mortality, egg weight and consumption index. Indeed, it thus constitutes a promising alternative to traditional growth promoters, from a sustainable breeding perspective, in line with expectations of reducing antibiotics and improving animal welfare.

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