



Optimizing Egg Production and Gut Health in Ac Chickens through Functional Product Supplementation

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Abstract | This study was conducted from March to May 2024 at a farm in Binh Minh district, Vinh Long province, Vietnam. It aimed to determine the effects of supplementing functional foods in the diet of laying hens to evaluate the performance, egg quality, and intestinal health of laying hens. The experiment was designed in a completely randomized design, including 250 hens aged 30–40 weeks, divided into five treatment groups with five replications for each group (10 hens per replication). The treatments were as follows: Control (BD): Basal diet, C250: BD + 250 mg product/kg feed, C500: BD + 500 mg product/kg feed, C750: BD + 750 mg product/kg feed and C1000: BD + 1000 mg product/kg feed. The results showed that the highest laying rate was observed in the C1000 group (41.1%; $P < 0.05$), while the lowest feed conversion ratio (FCR) was found in the C750 group (3.72 g feed/g egg; $P < 0.05$). Furthermore, some egg quality parameters were improved, among which C750 and C1000 showed the highest egg weight (35.4 g/egg and 35.0 g/egg) and Haugh unit (82.5 and 82.8) compared to the other treatments, ($P < 0.05$). The C1000 treatment had the highest yolk index (0.44), albumen index (0.09) and yolk color score (7.65) compared to the other treatments, ($P < 0.05$). In conclusion, supplementing the functional product at levels of 750 mg to 1,000 mg/kg of feed into the diet of Ac Chickens increased egg productivity and reduced FCR. Additionally, the product improved some egg quality indicators, such as egg weight, yolk index, albumen index, HU, and increased the number of beneficial microorganisms (*Lactobacillus*) while reducing harmful microorganisms (*Salmonella spp.*, *E. coli*, *Clostridium perfringens*) in Ac Chicken manure.

Keywords | Ac chicken, Egg quality, Reproductive, Intestinal health

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INTRODUCTION

The Ac Chicken (*Gallus gallus domesticus* Brisson) is one of the native chicken breeds that has long been raised in the Mekong Delta. According to Kojima *et al.* (2014), Ac Chicken has a significantly higher carnosine content

(798.3 mg/100 g breast meat) than White chicken (417.2 mg/100 g breast meat). Carnosine is a protein abundant in the meat and brain of vertebrates, playing an important role in physiological functions such as anti-aging, anti-oxidation, anti-fatigue, and neurotransmission (Caruso *et al.*, 2019). Carnosine has been used in medical applications to

treat diseases such as diabetes, Alzheimer's, aging, cancer, and other chronic diseases (Derave *et al.*, 2019).

Additionally, Ac Chicken eggs are favored by consumers for their lack of fishy odor, rich and fragrant taste, high-protein whites, elevated yolk ratio, and highly appealing dark color. Ac Chickens reach sexual maturity early (Le *et al.*, 2023), at 119–123 days old. Their eggs weigh 31.3–36.2 g/egg, and the laying rate is 52.3–58.1% at 23–37 weeks old. Ac Chickens are raised industrially for egg production in Tien Giang and Long An provinces on a large scale (Le *et al.*, 2023). Research in this field is limited; instead, most studies focus on nutrition (Truong *et al.*, 2019) and gene polymorphism (Le *et al.*, 2023).

Probiotics are live microorganisms that offer health benefits when consumed, typically by enhancing or restoring the balance of intestinal flora. They are generally regarded as safe, as the beneficial microorganisms promote health while suppressing the growth of harmful ones. Additionally, they help reduce unpleasant odors and moisture in Ac Chicken manure, maintaining a clean environment. Several studies have shown that probiotics improve egg productivity and quality in native chickens (Phan and Pham, 2023). Research by Nguyen *et al.* (2022) also demonstrates that adding probiotics to feed increases productivity and meat quality in Tre chickens. Vitamin E is known to be a vitamin that improves egg productivity and quality. Many studies have shown that adding vitamin E to the diet or drinking water increases egg productivity in Isa Brown chickens (Nguyen and Pham, 2018). The combination of probiotics and vitamin E added to chicken feed is expected to improve egg productivity and quality in Ac Chicken (Table 2).

This study aimed to determine the most appropriate level of dietary supplementation of functional foods in laying hen diets to evaluate performance, egg quality and intestinal health of laying hens.

MATERIALS AND METHODS

EXPERIMENTAL ANIMAL

The study was conducted from March to May 2024 at a farm in Binh Minh district, Vinh Long province, Vietnam. Ac Chickens for the research were sourced from this farm and were vaccinated against hepatitis, cholera, and H5N1. The experiment involved 250 Ac hens, aged 30 to 40 weeks.

Tools used in the study included an electronic scale for weighing chickens and feed, and a notebook and pen for data recording. Five hens were randomly placed in each cage (dimensions: 0.5 m length, 1.2 m width, 0.45 m height), with a stocking density of 0.12 m² per bird (area = 0.5 m × 1.2 m = 0.6 m²). The cage floor was lined with

coconut fiber (Figure 1). Chickens had free access to water via automatic drinking nipples.



Figure 1: Ac hens in cages at 35 weeks old.

Table 1: Ingredients and chemical composition of basal diets.

Variables		30–40 weeks age
Ingredients, %	Maize meal	39.3
	Broken rice	21.1
	Rice bran	12.1
	Fish meal	6.50
	Soya meal	16.0
	Lysine	0.05
	Methionine	0.15
	Bone meal	2.5
	Seashell meal	1.5
	Premix	0.8
Chemical composition and Metabolisable energy, %	ME, kcal/kg feed	2860
	ME, MJ/kg DM	12.1
	EE	3.85
	Crude protein (%)	17.1
	Crude fiber (Max) (%)	7.0
	Calcium (%)	4.1
	Phosphorus (Min-Max) (%)	0.9–2.0
	Lysine (Min) (%)	0.9
	Methionine and Cystein (Min) (%)	0.8
	Moisture (Max) (%)	14.0

Animal Husbandry Laboratory.

EXPERIMENTAL DESIGN

From weeks 30 to 40, the Ac Chickens were housed in pens and fed a standard diet containing 17% crude protein and 2,860 kcal/kg of metabolizable energy (as detailed in Table 1). They had unrestricted access to both food and water throughout the study period.

Table 2: The product composition in this study.

Ingredient	Content
Betaglucan (Min) (mg)	50.0
<i>Lactobacillus</i> spp. (Min) (CFU)	10 ⁹
<i>Bacillus</i> spp. (Min) (CFU)	10 ⁹
<i>Sacharomymyces cerevisiae</i> (Min) (CFU)	10 ⁴
<i>Bacillus megaterium</i> (Min) (CFU)	10 ⁴
<i>Aspergillus oryzae</i> (Min) (IU)	10 ⁴
Vitamin A (Min) (IU)	5,000
Vitamin D3 (Min) (IU)	150
Vitamin E (Min) (IU)	500
Lysine (mg)	2.1
Methionine (mg)	0.5
Glucose (g)	1,000
Moisture (Max) (%)	12.0

Source: Khang Phat Loc Trading Joint Stock Company, Vietnam.

EXPERIMENTAL DESIGN

The experiment was arranged in a completely randomized design with 5 treatments, each treatment had 5 replications, (two hundred and fifty hens were numbered from 1 to 250.

They were then written with numbers from 1 to 250 on paper and randomly drawn to assign the treatments). There were 25 experimental units in total, 10 hens/unit.

- Control (C0): basic diet (BD).
- C250: BD + 250 mg of product/kg of feed.
- C500: BD + 500 mg of product/kg of feed.
- C750: BD + 750 mg of product/kg of feed.
- C1000: BD + 1,000 mg of product/kg of feed.

*Care: Hens were fed twice daily, at 7 A.M. and 14: 00, while water was provided ad libitum through automatic nipple drinkers. The lighting system ensures 16 hours of lighting per day, using LED bulbs and rated power of 3 W/ m². All treatments were managed and administered in accordance with the protocols established by Asia Nutrition Technologies Company Limited (Vietnam).

Throughout the experimental period, the number of eggs produced was recorded daily to calculate egg production as the laying rate, expressed as the percentage of eggs produced per hen. A list of reproductive and egg quality indicators was also documented, with data collection methods detailed in Table 3. Eggs were collected daily at 17: 00,

Table 3: Methodology for characterization.

Indicators	Items	Data collection methods	References
Egg productivity	Hens weight at the beginning (kg)	Record the weight of each hen before starting the experiment.	
	Eggs number (EN) (eggs/10 hens)	Record the total number of eggs everyday from 40 to 50 weeks old. EN = Total eggs number /hens number x 10	Le <i>et al.</i> (2023)
	Laying rate (LR) (%)	LR = (Eggs number per week/hens number present) x 100	Le <i>et al.</i> (2023)
	Feed intake (FI) (g of feed/hen/day)	Weigh the amount of feed provided each day and the amount of feed remaining at the end of the day. FI = (Amount feed provide per day - amount feed remain per day)/10 hens	Nguyen and Nguyen (2022)
	Feed intake/10 eggs (g of feed)	Total feed intake (g)/Total eggs number x 10	Nguyen and Nguyen (2022)
	Feed conversion ratio (FCR) (g of feed/g of egg)	Monitor the average daily feed intake and then calculate the total feed consumption per week. Weigh the total egg weight daily, then calculate the weekly total egg weight. FCR = (Total feed intake per week/Total egg weight per week)	Nguyen and Nguyen (2022)
Egg quality	Egg weight (g)	Collecte eggs at 5 P.M and weigh egg with the electronic scale.	Le <i>et al.</i> (2023)
	Egg shape index (SI) (%)	Use the digital caliper to measure the small diameter and large diameter of eggs. SI = (Small diameter/large diameter) x 100	Sandi <i>et al.</i> (2013)
	Egg yolk and albumen index	Brake eggs and separate the albumen, yolk and shell to calculate: - Yolk index = Yolk height (cm)/Yolk diameter (cm) - Albumen index = Albumen height (cm)/ Albumen diameter	Englmaierová <i>et al.</i> (2014)
	Shell thickness (mm)	Separate the eggshell membrane and measure with a specialised ruler based on 3 points: large, equator, small of egg.	
	Haugh unit (HU)	HU = 100 x log (T - 1,7 x W ^{0,37} + 7,57) T (mm): albumen thickness; W (g): egg weight.	Haugh (1937)
	Yolk color score	Determine with Roche colorimeter.	

numbered, and monitored to assess treatment yields. Additionally, egg weight and egg shape index were measured daily throughout the entire experiment.

MEASUREMENTS AND DATA COLLECTION

At the end of the 40-week study, fecal samples were collected to assess the presence of *Lactobacillus*, *Salmonella* spp., *E. coli*, and *Clostridium perfringens*. These bacteria were quantified using the colony counting method. For each treatment group, around 100 grams of feces were collected directly from the barn, with samples obtained from 10 Ac Chickens per group. The samples were promptly stored in cold conditions to maintain their integrity, then homogenized and sent to the Biology Laboratory at the Center for Analytical Services in Can Tho City, where the colony counting method was employed to measure the levels of the target microorganisms.

CHEMICAL ANALYSES

The chemical composition of the feed samples was analyzed to determine the content of DM, OM, CP, EE, CF, and ash, following the established AOAC (1990) procedures. Neutral detergent fiber was measured using the method developed by Van Soest *et al.* (1991), and metabolizable energy was calculated based on Janssen's (1989) formula.

STATISTICAL ANALYSES

Data analysis was performed using the General Linear Model (GLM) in Minitab version 18.1.0 (Minitab, 2018), with treatment differences evaluated through the Tukey method in the same software.

RESULTS AND DISCUSSION

Table 4 indicated that the egg productivity indicators in the treatments were statistically different ($P < 0.05$). At the start of the study, the hens' weights across all five treatments were not significantly different, suggesting that the Ac hens used in the study were comparable.

The total number of eggs was highest in the C1000 treatment (417 eggs) and lowest in the C0 treatment (392 eggs; $P < 0.05$). Similarly, the laying rate was highest in the C1000 treatment (41.1%) and lowest in the C0 treatment (38.2%; $P < 0.05$). In general, the total egg count and laying rate in the diets supplemented with the product were higher than in the control group. This improvement is likely due to the presence of beneficial microorganisms in the product, which enhanced digestive health and nutrient absorption, thereby positively impacting reproductive performance. Additionally, the product contained vitamin E, which is known to support reproductive health in animals.

The beneficial effect of probiotics on egg production was also highlighted in the study by, who worked with Saki-

ni and Giriraja chickens (native to Nepal). Their research suggested that probiotics containing *Bacillus subtilis* and *Lactobacillus acidophilus* helped chickens improve feed absorption and metabolism, ultimately contributing to increased egg production. In a similar vein, Jiang *et al.* (2013) reported that supplementing vitamin E at 200 mg/kg of feed increased the laying rate of Hyline Brown laying hens (82.7%) compared to the control group (80.7%). Zhao *et al.* (2021) found that a 100 mg/kg dose of vitamin E also improved the laying rate (89.0%) compared to the control (83.5%). In the present study, the product containing *Bacillus* spp., *Lactobacillus* spp., and vitamin E exhibited similar effects to those found by Neupane *et al.* (2019) and Zhao *et al.* (2021). The laying rate of Ac hens was lower than that reported in some other studies, such as 54.6% at 28–39 weeks of age (Nguyen *et al.*, 2022) and 52.3–58.1% at 23–37 weeks of age (Nguyen *et al.*, 2022). These differences may be attributed to variations in survey periods, care, and rearing conditions.

Table 4: Effect of treatments on reproductive performance of Ac Chickens at 30–40 weeks old.

Items	C0	C250	C500	C750	C1000	SE	P
Hens weight at the beginning (g/hen)	894	892	893	897	898	1.88	0.187
Eggs number (eggs/10 hens)	392 ^b	404 ^{ab}	409 ^a	415 ^a	417 ^a	3.22	0.012
Laying rate	38.2 ^d	39.6 ^c	40.3 ^b	41.0 ^a	41.1 ^a	0.13	0.011
Feed intake (g of feed/hen/day)	51.3 ^{ab}	51.9 ^{ab}	50.9 ^b	51.3 ^{ab}	52.5 ^a	0.31	0.010
Feed intake/10 eggs (g of feed)	1,420 ^a	1,363 ^b	1,315 ^c	1,318 ^c	1,330 ^{bc}	7.11	0.013
FCR (g of feed/g of egg)	4.15 ^a	3.93 ^{ab}	3.76 ^b	3.72 ^b	3.80 ^{ab}	0.07	0.007

^{a,b,c}: Means with different letters in the same row differ significantly ($p < 0.05$).

Feed intake was highest in the C1000 treatment (52.3 g/hen) and lowest in the C500 treatment (50.9 g/hen). Overall, feed intake in the diets supplemented with the product was higher than in the control group. Xiang *et al.* (2019) found that supplementing the probiotic *Clostridium butyricum* in the feed of Lohmann laying hens positively affected several egg productivity and quality indicators. Their experiment, which supplemented *Clostridium butyricum* at 0.5 g/kg of feed, resulted in increased feed intake, reduced FCR, improved laying rate, survival rate, eggshell hardness, and albumen content. The beneficial bacteria in probiotics are crucial for enhancing digestive health in laying hens

and broilers by stimulating the microvilli in the small intestine, thereby improving nutrient absorption from the feed.

Additionally, feed intake per 10 eggs was lowest in the C500 treatment (1,315 g) and highest in the C0 treatment (1,420 g). The feed intake per 10 eggs in the diets supplemented with the product was lower than in the control group, indicating more efficient conversion of nutrients and energy into eggs. The C500 treatment stands out due to its lower feed intake per 10 eggs, contributing to improved economic efficiency in egg production.

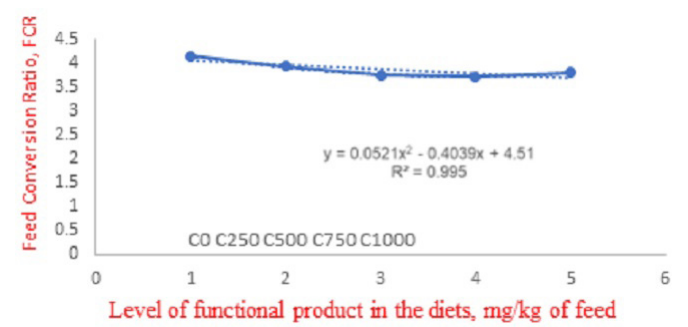


Figure 2: Effect of treatments on FCR of ac chickens at 30-40 weeks old.

As shown in Figure 2, the regression equation was an $R^2 = 0.995$, indicating that the data fits the experimental design well. Furthermore, the FCR was lowest in the C750 treatment (3.72) and highest in the C0 treatment (4.15; $P < 0.05$). In general, FCR values were lower in the treatments supplemented with the product compared to the control, ($P < 0.05$). The reduced FCR in these treatments can be attributed to the beneficial bacteria supporting the digestive system, which helped the chickens absorb nutrients more effectively and convert them into eggs more efficiently. This suggests that the C750 treatment is particularly notable for its low FCR, which enhances the economic efficiency of egg production. Similarly, Nguyen *et al.* (2022) reported FCR values of 2.94 and 2.98 in Ac Chickens fed diets containing Moringa leaf powder and Turmeric powder, respectively, at 23-29 weeks old.

EFFECT OF TREATMENTS ON EGG QUALITY

Table 5 presented the egg quality indicators in the treatments, which were all statistically significant ($P < 0.05$). The egg weight were highest in the C750 treatment and C1000 treatment (35.4 g/egg and 35.0 g/egg) and lowest in the C0 treatment (34.2 g/egg; $P < 0.05$). In general, the egg weight in the treatments with the product was higher than in the control treatment. This proved that the product had an effect on increasing the egg weight of Ac hens. The effect of probiotics and vitamin E on egg weight has been published by previous studies worldwide. Bodhi *et al.* (2023) used probiotics containing beneficial bacteria (*L. acidophilus*, *L. plantarum*, and *Bifidobacterium* spp. with a density

of 1.2×10^9 CFU/ml) supplemented into the diets of ISA Brown laying hens, and the results showed the highest egg weight in the treatment supplemented with 3 ml of probiotic/kg of feed (53.5 g/egg) and the lowest in the control (50.0 g/egg). Abdelqader *et al.* (2013) found that supplementing *Bacillus subtilis* inoculants increased egg weight in White chickens. In addition, the present study also showed that the Ac Chicken had lower egg weight than the native chickens in Southern Ethiopia (46.6 g/egg raised in the lowland; 48.6 g/egg in the midlands; and 45.4 g/egg in the highland) (Berhanu *et al.*, 2022). The differences in results of the above studies were due to differences in care and nutritional conditions.

Table 5: Effect of treatments on egg quality of Ac Chickens at 30-40 week old.

Items	C0	C250	C500	C750	C1000	SE	P
Egg weight (g/egg)	34.2 ^c	34.7 ^{bc}	35.0 ^{ab}	35.4 ^a	35.0 ^{ab}	0.13	0.012
Egg shape index (%)	74.2	74.5	74.5	74.4	74.6	0.18	0.06
Egg shell thickness (cm)	0.35	0.36	0.37	0.37	0.38	0.02	0.775
Egg albumen height (mm)	8.08 ^c	8.17 ^{bc}	8.91 ^b	9.08 ^a	9.15 ^a	0.06	0.012
Egg albumen index	0.07 ^c	0.08 ^b	0.08 ^b	0.09 ^a	0.09 ^a	0.01	0.011
Egg yolk height (mm)	15.0 ^c	15.4 ^b	15.4 ^{ab}	15.6 ^a	15.6 ^a	0.14	0.010
Egg yolk index	0.41 ^b	0.41 ^b	0.41 ^b	0.43 ^a	0.44 ^a	0.01	0.010
Egg yolk color score	7.29 ^c	7.49 ^b	7.52 ^{ab}	7.55 ^{ab}	7.65 ^a	0.24	0.044
Haugh unit	79.1 ^c	81.5 ^b	82.1 ^{ab}	82.5 ^a	82.8 ^a	0.44	0.011

a,b,c; Means with different letters in the same row differ significantly ($p < 0.05$).

Moreover, the eggshell was thickest in the C1000 treatment (0.38 cm), followed by the C750 and C500 treatments (0.37 cm), and thinnest in the C0 treatment (0.35 cm). The study of Bodhi *et al.* (2023) on ISA Brown laying hens showed that supplementing probiotics (*L. acidophilus*, *Bifidobacterium* spp., and *L. plantarum*) in the diet at a dose of 5 ml probiotic/kg of feed made the eggshell (0.36 cm) thicker than the control (0.33 cm). The good absorption of nutrients from feed helped the eggshell formation process to be better, thereby leading to an increase in eggshell thickness. The improvement in eggshell quality was observed when supplementing vitamin D3 in the diet of Brown chickens in the study by Hatairat *et al.* (2015). Eggshell thickness (0.37 cm) was improved by supplementing 6,000 IU of vitamin D3 in a diet containing 3.5% calcium compared to a control diet without vitamin D3 (0.34 cm). This finding suggested that dietary vitamin D3 supplementation may offset the adverse effects of low calcium levels

(3.5% in feed) on eggshell quality. Increased vitamin D3 levels may improve eggshell quality by increasing the active form of vitamin D3 (1,25(OH)₂ produced in the kidney). This active ingredient stimulated the synthesis of a calcium-binding protein required for calcium transport across the intestinal membrane and eggshell formation. The present study used a vitamin D3-supplemented formulation, which also resulted in an increase in eggshell thickness compared to the control.

Similarly, the HU tended to increase gradually according to the supplemented treatment. The highest HU was in the C1000 treatment (82.8), and the lowest was in the C0 treatment (79.1). The study by Bodhi *et al.* (2023) supplemented probiotics in diets to improve the HU of ISA Brown eggs. The treatment of supplementing a mixture of probiotics (*L. acidophilus*, *Bifidobacterium* spp., and *L. plantarum* with a density of 1.2×10^9 CFU/ml) at a dose of 3 ml/kg of feed helped the eggs achieve HU (106.8), much higher than the control (97.3).

Besides, the yolk color score was highest in the C1000 treatment (7.65) and lowest in the C0 treatment (7.29). This result was similar to the findings of Bodhi *et al.* (2023) when supplementing probiotics in the diets improved the yolk color score of ISA Brown eggs. Specifically, the probiotic-supplemented treatments had higher yolk color scores (6.75-8.82) than the control (6.70). Neijat *et al.* (2015) observed an increase in yolk color score, HU, yolk index, and albumen index in laying hens treated with a product containing *Bacillus subtilis* DSM29784 strain. Sjoftan *et al.* (2021) suggested that the intestinal environment promoted improvement in both internal and external egg quality by enhancing the absorption of minerals and nutrients necessary for egg production.

INTESTINAL MICROFLORA

Table 6 reveals that after 40 weeks, *Salmonella* bacteria were nearly undetectable in the Ac Chicken manure, especially in the C500, C750, and C1000 treatment groups. On the other hand, the levels of *Lactobacillus* increased. The C1000 group was notable for having the highest concentration of beneficial *Lactobacillus* bacteria and the lowest amounts of harmful *E. coli* and *Clostridium perfringens*. This is beneficial for the Ac Chickens' well-being, as *Lactobacillus* supports gut health, whereas the other two bacteria are linked to disease.

In contrast, adding the functional product to the Ac Chickens' food significantly lowered the harmful bacteria *E. coli* and *Clostridium* in their digestive system after 10 weeks. This improvement is likely due to the functional product boosting the beneficial bacteria *Lactobacillus*, which helped control the harmful ones. The group receiving the highest dose of C1000 showed the best results, with the

least amount of *E. coli* and *Clostridium*. These findings are consistent with previous research showing that fermented food can enhance beneficial gut bacteria and reduce harmful bacteria in ducks.

Table 6: Bacteria density in Ac Chicken at 40th weeks age of the experimental.

Variables	Treatments					SE	p
	C0	C250	C500	C750	C1000		
<i>Lactobacillus</i> (10 ⁸ CFU/g)	1.09 ^c	3.81 ^{bc}	3.98 ^{bc}	4.88 ^b	5.33 ^a	0.33	0.01
<i>Salmonella</i> spp. (25g (+/-))	Positive	Positive	Non detected	Non detected	Non detected	-	-
<i>E. coli</i> (10 ⁵ CFU/g)	4.99 ^a	4.05 ^{ab}	3.23 ^b	2.21 ^c	2.01 ^c	0.06	0.01
<i>Clostridium perfringens</i> (10 ⁴ CFU/g)	4.06 ^a	3.81 ^{ab}	3.01 ^b	2.35 ^c	2.02 ^d	0.04	0.02

a, b, c: Means within a row with different superscripts are significantly different (P<0.05).

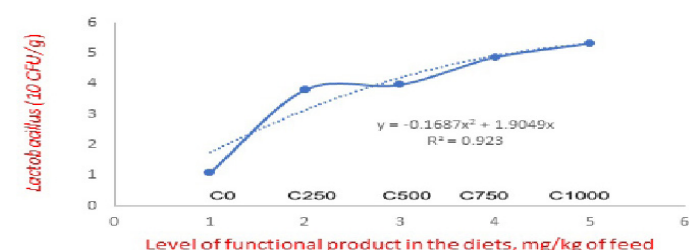


Figure 3: Effect of treatments on *Lactobacillus* in the ac chicken manure.

As shown in Figure 3, as the level of the functional product in the chickens' diet increased, the number of beneficial microorganisms (*Lactobacillus*) also increased. The regression equation was $R^2 = 0.9153$, $R^2 = 0.9153$, indicating that the data were consistent with the experimental design.

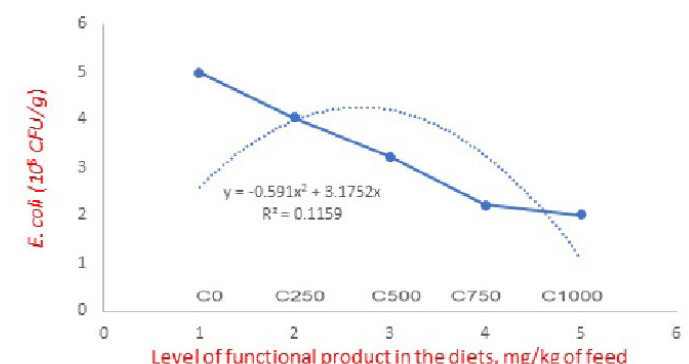


Figure 4: Effect of treatments on *E. coli* in the ac chicken manure.

Meanwhile, in Figure 4, harmful microorganisms (*E. coli*) decreased. This can be explained by the increase in benefi-

cial microorganisms (*Lactobacillus*), which compete for nutrients and inhibit the growth of harmful microorganisms (*E. coli*).

CONCLUSIONS AND RECOMMENDATIONS

- Supplementing the functional product at levels of 750 mg to 1,000 mg/kg of feed into the diet of Ac Chickens increased egg productivity and reduced FCR.
- In addition, the product improved some egg quality indicators, such as egg weight, yolk index, albumen index, HU, and increased the number of beneficial microorganisms (*Lactobacillus*) while reducing harmful microorganisms (*Salmonella spp.*, *E. coli*, *Clostridium perfringens*) in Ac Chicken manure.
- Further research will be needed on the duration of the final weeks.
- Further research will be needed on other egg-laying breeds to provide results for other egg-laying breeds.

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NOVELTY STATEMENTS

Functional Product Supplementation (combination of probiotics and vitamins) appropriately contributes to improving productivity, egg quality and intestinal health of Ac Chickens.

AUTHOR'S CONTRIBUTIONS

Pham Tan Nha: Investigation, methodology, formal analysis, manuscript preparation, editing and finalization.

Nguyen Vu Thuy Hong Loan and Ho Trung Thong: Conceptualization and design of the experiment.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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