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THE EFFECT OF PHYTOBIOTICS SUPPLEMENTATION AND MAGNETIZED DRINKING WATER ON PRODUCTION PERFORMANCE AND EGG QUALITY OF LAYING HENS

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ABSTRACT

The experiment was conducted to evaluate the production performance and egg quality of laying hens supplemented with phytobiotics and magnetized drinking water. This experiment used 2700 gauss level in Magnetized Drinking Water (MDW). The phytobiotics had two form: the non-encapsulated phytobiotics (PTO) and encapsulated phytobiotics (EPTO). There were untreated water (control) and the treated water (MDW, PTO, PTO+MDW, EPTO, EPTO+MDW). The treatments were presented by 0.6% for each treatment. The result showed highly significant (p<0.01) improvement on feed conversion ratio (FCR) but no significant effect on other production performance variables including feed intake, hen day production (HDP), egg mass, and income over feed cost (IOFC). The results indicated a highly significant improvement (p<0.01) on egg weight and yolk cholesterol. There were no significant effects on shape index (SI), shell weight, shell thickness, Haugh unit (HU), albumen height, yolk weight, yolk index (YI), and yolk color of egg quality variables. It was concluded that the encapsulated form (EPTO and EPTO+MDW) had the best improvement on FCR and yolk cholesterol, on another hand the non-encapsulated form (PTO and PTO+MDW) increased the egg weight of laying hens.

Keywords: Drinking water quality; egg; magnet; yolk cholesterol.

INTRODUCTION

The use of Antibiotic Growth Promoters (AGPs) has been prohibited in the livestock production. Using natural growth promoters (NGPs) is one of the efforts to solve this problem. Phytobiotic is NGPs that are derived from plants. Phytobiotic has some functions such as growth-promoting effect, antimicrobial activity, anti-inflammation activity and improve the performance and egg quality of the laying hens (Ayeni *et al*., 2020; Gheisar and Kim, 2018; Hazrati *et al*., 2019). Phytobiotic optimizes the gut system and improves the performance production and egg quality of laying hens by utilizing the bioactive compounds which are contained in the plant.

There are many herb plants used for phytobiotic. Ginger and turmeric are a great combination that was studied in many previous pieces of research. Ginger used at a specific level increases egg weight, improves egg quality, reduces the percentage of yolk cholesterol content, and had a positive effect on immunomodulation, antioxidant and growth hormone (El-Hack *et al*., 2020; Kafi *et al*., 2017; Wen *et al.*, 2019). The use of turmeric as phytobiotic has benefits on parameters of production performance, egg quality, gut morphology, immunological profile, and economic efficiency (Azouz 2020; Kinati *et al*., 2021; Kosti *et al*., 2020; Mousa *et al*., 2019; Rahman *et al*., 2021).

The powder phytobiotic in feed had low homogeneity. Sinurat *et al*. (2020) reported that diet supplemented by powder phytobiotics had lower improvement than liquid phytobiotics on production performance (body weight, feed intake, and feed conversion ratio). The higher feed intake in powder phytobiotics increased the feed cost. The circumstance will decrease the profit. On the other hand, the use of liquid phytobiotic in drinking water has low durability which is effectively just held by two to four hours in drinking water. The encapsulation technology will protect phytobiotic and increase durability. The encapsulation technology protects bioactive in feed by adding encapsulant as a coating so that the bioactive protected from the damages (Lee *et al*., 2020; Natsir *et al.*, 2013).

The use of phytobiotic is affected by the quality of drinking water. The magnetized drinking water in 1850, 3000, 6500, and14500 Gs levels increases water quality also improves growth hormone, production performance, egg quality, and immune function of laying hens (Abobatta, 2019; Darsi *et al*., 2017; El-Sabrout and Hanafy, 2017; El-Sabry *et al*., 2020; Mitre, 2018). The water generally contains HCO_3-, Mg^{2+}, Na^{+}, Cl^{-}, CO_3^{2-} and Ca^{2+} (El-Sabrout and Hanafy, 2017). The CO_3^{2-} and Ca^{2+} formed the calcium carbonate ions ($CaCO_3$) which create the suspended solids and increase the growth of bacteria in drinking water. Gabrielli *et al.* (2001) stated that using magnetized water will release Ca^{2+} in water.

The Ca^{2+} is used as an antibacterial compound to decrease population of the pathogenic bacteria in drinking water. Using magnetized drinking water increases body weight and feed conversion ratio (FCR) in poultry also effects for improving heart functions, performance production, egg quality, reproduction hormones (estrogen and progesterone), antioxidants in the blood, also all biochemical and physiological

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properties (Al-Hilali, 2018; El-Hanoun *et al.*, 2017). This study aims to evaluate the effect of phytobiotics supplementation and magnetized drinking water on production performance and egg quality of laying hens.

MATERIALS AND METHODS

Materials

This study used the phytobiotic containing *Zingiber officinale var. amarum* and *Curcuma longa Linn.* The 2700 gauss level of magnet was counted by gaussmeter in Electro Engineering Laboratory of the Faculty of Engineering Universitas Brawijaya. The encapsulated phytobiotic used 2 coating process. Chitosan was used for the first coating process and the second coating process used a combination of whey protein and Arabic gum as encapsulants. The encapsulation was conducted in the Animal Feed Industry Laboratory of the Faculty of Animal Science Universitas Brawijaya. The self-mix feed used in this research was analyzed in the Animal Nutrition and Feed Laboratory of the Faculty of Animal Science Universitas Brawijaya (Table 1).

The experiment used 288 57-week-old ISA Brown laying hens that were raised in a single battery cage (30 cm x 35 cm x 40 cm). The egg weight was counted by digital scales precision 0.01. The micrometer screw, digital calipers, and tripod micrometer were used for counting the other egg quality variables. The yolk color was counted by the yolk color fan. The yolk cholesterol was analyzed at the Animal Science Laboratory of Universitas Padjajaran.

Table 1. Ingredients and Nutrient Contents of Feed

Ingredients	Value (%)	Nutrient Content	Value (%)
Corn	52.7	Dry Matter	90.28
Rice brain	13.95	Metabolism Energy	2959
Soybean meal	24.5	(kcal/Kg)	19.44
Meat bone meal	4.7	Crude Protein	2.95
Grit	3.1	Crude Fiber	4.93
Lysine	0.1	Crude Fat	7.99
Methionine	0.15	Ash	
Premix [a]	0.2		
Salt	0.2		
Monocalcium Phosphate	0.4		
Total	100		

a) Premix from PT. MITRAVET (Composition/1kg: vitamin A = 2.000.000 IU, vitamin D3 = 400.000 IU, vitamin E = 3.000 mg, vitamin K = 400 mg, vitamin B12 = 4 mcg, thiamin HCI/B1 = 400 mg, riboflavin HCI/B2 = 1.200 mg, pyridoxin HCI/B6 = 800 mg, Ca-d-pantothenate = 2.160 mg, niacinamide = 8.000 mg, folic acid = 200 mg, biotin = 4 mg, L-Carnitine = 10.000 mg, copper sulphate = 4.000 mg, cobalt sulphate = 300 mg, ferro sulphate = 10.000 mg, Mn oxide = 20.000 mg, sodium selenite = 150 mg, carrier ad = 1.000 mg.

Methods

The method used was *in vivo* experiment with a completely randomized design. This study applied the magnetized drinking water (MDW) and two forms of phytobiotics (non-encapsulated phytobiotics (PTO) and encapsulated phytobiotics (EPTO)). The experiments consisted of the untreated water (control) and the treated water with five formulas (MDW, PTO, PTO+MDW, EPTO, and EPTO+MDW). There were six groups divided randomly with four replicates that containing twelve laying hens for each replicate. PTO and EPTO were presented by 0.6% of drinking water with *ad libitum* method for six weeks

(forty-two days). The feed was presented by the *restricted feeding* method once a day with 120 g/head/day. Variables of production performance were feed intake, hen day production (HDP), egg mass, feed conversion ratio (FCR), and income over feed cost (IOFC). The feed intake was counted once a week by calculating the leftover feed. Collected eggs were counted twice a day for HDP. Egg mass was a result from HDP multiplied by egg weight. FCR was calculated by feed intake divided egg mass. Calculating IOFC used the following formula.

$$IOFC = (egg\ mass \times egg\ cost) - (feed\ intake \times feed\ cost)$$
$$SI = \big(egg\ width\ (mm) \div egg\ length\ (mm)\big) \times 100$$
$$HU = 100\ log_{10}\ (albumin\ height\ (mm) - 1.7 \times egg\ weight(g)^{0.37} + 7.6)$$
$$YI = \big(yolk\ height\ (mm) \div yolk\ diameter\ (mm)\big) \times 100$$

Egg quality variables were egg weight, shape index (SI), shell weight, shell thickness, haugh unit (HU), albumen height, yolk weight, yolk index (YI), yolk color, and yolk cholesterol. The formulas of SI, HU, and YI were presented above (Alasahan and Copur, 2016; Roberts, 2004). Digital caliper was used for counting egg width and egg length. Egg weight was calculated on daily egg recording. Shell weight was counted by scale with precision 0.001. Shell thickness used micrometer screw. Albumen height was calculated by micrometer tripod. Yolk color was known by using yolk color fan with eight color level. The yolk cholesterol used kits with CHOD-PAP (enzymatic photometric test) method (Diasys Diagnostic Systems GmbH 2005).

Statistical Analysis

The data obtained was analyzed by analysis of variance (ANOVA) followed with Duncan's multiple tests on significant results. The statistical analysis used the SPSS software (version 26) from IBM, USA.

RESULT AND DISCUSSION

The Effect of Phytobiotics Supplementation and Magnetized Drinking Water on Production Performance of Laying Hens

This study had evaluated the production performance of phytobiotics supplementation ((non-encapsulated phytobiotics (PTO) and encapsulated phytobiotics (EPTO)) and magnetized drinking water (MDW) on feed intake, hen day production (HDP), egg mass, feed conversion ratio (FCR), and income over feed cost (IOFC) (Table 2).

The result showed highly significant effect (p<0.01) on FCR and there was no effect on other variables of performance production. The lowest result was shown by PTO (109.13 g/head/day). HDP results showed that EPTO+MDW had the highest result (90.87 %). The lowest result of HDP was PTO (82.92 %). Generally, using MDW improved HDP than treatments without MDW. The highest result of egg mass in this research was shown by EPTO+MDW (57.12 g/head/day). Control (52.33 g/head/day) had the lowest result in this variable. EPTO (1.94) had the best result shown on FCR. IOFC showed that EPTO (464.45 IDR/head/day) had the best result while the lowest result was shown in control (359.36 IDR/head/day).

The use of MDW improved the water quality. The better water quality increased the absorption nutrient of feed. The results of present study are in line with previous (El-Sabrout and El-Hanoun, 2019; Gholizadeh *et al*., 2008). The improvement of feed efficiency is affected by better nutrient absorption in the gastrointestinal by phytobiotic. Phytobiotic had been proven improving gastrointestinal function and nutrient digestibility, gut microflora, and immune function (Grashorn, 2010; Mousa *et al*., 2019). Encapsulation technology used chitosan, whey protein, and Arabic gum as

encapsulants. The encapsulant protects phytobiotic so that it can optimize the digestion and absoprtion. Arabic gum and whey protein as encapsulants affected digestibility and metabolism in the gut system. This circumstance improves poultry immunity, egg production and egg quality (Chen and Chen, 2004; Pineda-Quiroga *et al.*, 2017).

There was no significant effect on egg mass, wherease the use of phytobiotic treatments numerically increased egg mass of laying hens. Sunder *et al*. (2013) reported that addition phytobiotic increases egg weight. The research had a similar effect to treatment by phytobiotic. The lower the FCR is, the better the performance production of laying hens. The EPTO that contains encapsulated phytobiotic without magnetized drinking water. The result in this study agrees with El-Katcha *et al*. (2017) that showed the uses of a magnetic system in drinking water of poultry improved the feed conversion. Turmeric content of phytobiotic affected better performance on the feed conversion ratio variable (Kinati *et al*., 2021). Improving FCR would decrease feed intake and increase egg production. EPTO had higher result than others on IOFC even though there is no statistically effect. The encapsulated phytobiotic optimized the absorption nutrient in laying hens.

On other hand, the laying hens will decrease their feed intake because phytobiotics optimize the absorption of nutrients and energy and affect the faster fulfill in the gut of laying hens. This circumstance was affected by the increasing non-pathogenic bacteria population in the digestibility of laying hens. Presented the encapsulated feed increased the population of non-pathogenic bacteria compared to non-encapsulated feed (Natsir *et al*., 2013; Natsir *et al.*, 2010).

Table 2. The effect of phytobiotics supplementation and magnetized drinking water on production performance of laying hens

	Control	MDW	PTO	PTO+MDW	EPTO	EPTO+MDW	SEM	*p-value*
Feed Intake (g/head/day)	115.64	111.01	109.13	113.11	109.63	113.60	0.75	0.068
Hen Day Production (%)	85.61	87.50	82.92	87.23	88.81	90.87	0.91	0.177
Egg Mass (g/head/day)	52.33	53.85	53.12	55.92	56.54	57.12	0.61	0.104
Feed Conversion Ratio (head)	2.25[b]	2.04[a]	2.06[a]	2.03[a]	1.94[a]	1.99[a]	0.02	<0.01
Income Over Feed Cost (IDR/head/day)	359.36	413.42	406.11	437.28	464.45	453.24	11.83	0.104

MDW : Magnetized Drinking Water, PTO: Phytobiotics, EPTO: Encapsulated Phytobiotics, SEM : Standard Error of Means.

[a-b] Different letter indicates highly significant differences between the means (p<0.01).

The Effect of Phytobiotics Supplementation and Magnetized Drinking Water on Egg Quality of Laying Hens

This study had evaluated the egg quality of phytobiotics supplementation ((non-encapsulated phytobiotics (PTO) and encapsulated phytobiotics (EPTO)) and magnetized drinking water (MDW) on egg weight, shape index (SI), shell weight, shell thickness, Haugh unit (HU), albumen height, yolk weight, yolk index (YI), yolk color, and yolk cholesterol. Table 3 showed the egg quality of phytobiotics supplementation and magnetized drinking water in the laying hens.

The result showed a highly significant effect (p<0.01) on egg weight and yolk cholesterol of egg quality variables. There was no significant effect on other variables of egg quality. PTO (64.07 g) and PTO+MDW (64.12 g) are the highest result on egg weight. Phytobiotic in this research contains ginger (*Zingiber officinale var.*

amarum) and turmeric (*Curcuma longa Linn).* Using phytobiotic (ginger) on the feed will increase the average egg weight of laying hens (Zhao *et al*., 2011; Wen *et al*., 2019).

Ginger has been demonstrated to have various bioactive such as antioxidant and antimicrobial (Zhang *et al*., 2009; Dedov *et al*., 2002; Kafi *et al*., 2017). These favorable effects have contributed to the increase in egg weight of laying hens. The use of turmeric has increased the egg weight of laying hens (Gumus *et al*., 2018). The additional MDW on the treatments generally decreases SI, shell weight and shell thickness compared to treatments without MDW. SI is classified into 3 groups that are round egg (SI > 76), standard egg (SI = 72-76), and sharp egg (SI < 72) (Duman *et al*., 2016). Roberts (2004) reported that the eggshell of eggs contains up to 3 g of calcium.

Table 3. The effect of phytobiotics supplementation and magnetized drinking water on egg quality of laying hens

	Control	MDW	PTO	PTO+MDW	EPTO	EPTO+MDW	SEM	*p-value*
Egg Weight (g)	61.13^{a}	61.57^{a}	64.07^{c}	64.12^{c}	63.67^{bc}	62.84^{b}	0.26	<0.01
Shape Index	76.01	75.46	78.23	77.37	77.66	78.23	0.34	0.060
Shell Weight (g)	7.60	7.24	7.58	7.58	7.38	7.63	0.07	0.500
Shell Thickness (mm)	0.58	0.56	0.57	0.59	0.55	0.57	0.00	0.179
Haugh Unit	73.98	76.74	84.00	79.47	78.54	78.86	1.04	0.117
Albumin Height (mm)	5.85	6.37	7.47	6.75	6.56	6.53	0.16	0.072
Yolk Weight	16.38	16.75	17.50	16.75	17.92	17.00	0.16	0.037
Yolk Index	41.31	43.16	43.14	43.10	42.79	42.61	0.22	0.118
Yolk Color	8.06	7.62	7.67	7.83	7.29	7.88	0.11	0.515
Yolk Cholesterol (mg/100g)	225.34^{b}	225.39^{b}	224.75^{b}	225.28^{b}	218.10^{a}	218.12^{b}	0.73	<0.01

MDW : Magnetized Drinking Water, PTO: Phytobiotics, EPTO: Encapsulated Phytobiotics, SEM : Standard Error of Means.

$^{a-c}$ Different letter indicates highly significant differences between the means (p<0.01).

These indicate that using MDW decrease the calcium for laying hens. The magnetized water reduces Ca in drinking water required for eggs. It agrees with previous research reported that observation on Ca^{2+} concentration in water by magnetization showed a reduction in the concentration of Ca and $CaCO_3$ in water (Gabrielli *et al.*, 2001; Jiang *et al*., 2013). Using MDW and phytobiotics generally improved the HU and albumen height on the egg of laying hens. EPTO is the highest result on HU and albumen height variables. The encapsulation technology helps to protect the phytobiotic from the damages on the way to the gut system (Natsir *et al.,* 2013). This circumstance will optimize the bioactive contained in phytobiotic in the gut system. Phytobiotics contain turmeric which stimulates the growth of tubular gland cells and epithelial cells in magnum to secrete and synthesize albumen, and increasing the albumen weight (Kinati *et al*., 2021; Saraswati *et al*., 2013). Adding MDW and phytobiotics in general increase the yolk weight and YI but affect the decreasing yolk color compared to control treatment.

These similar to previous research which reported that the addition of phytobiotic (ginger) enhanced the YI of laying hens (Incharoen and Yamauchi, 2009; Mousa *et al*., 2019). Adding 0.5% phytobiotic (ginger root) has increased the yolk weight in the egg of laying hens (Akbarian *et al.,* 2011). The yolk color highly depends on carotenoid which is the source of red and yellow (xanthophylls) pigments (Englmaierova *et al*., 2014). Yildirim *et al*. (2013) reported that xanthophyll is attached to fat-soluble

pigments in the feed. There is no effect on yolk color in this research may be indicated by the same feed to all treatments. It disagrees to other studies which reported that the addition of phytobiotic (turmeric) increases the results of yolk colors (Kinati *et al*., 2021; Riasi *et al*., 2012).

This difference may be affected by the level of percentage the use of phytobiotic, the high results on that research are indicated by more than ≥ 1% level of used phytobiotic. The best results on yolk cholesterol are EPTO (218.10 mg/100g) and EPTO+MDW (218.12 mg/100g). The encapsulation technology optimizes the absorption of phytobiotic in the gut system by protecting the phytobiotic from the damages with using encapsulants. The result indicated that EPTO has had better durability and effectivity than PTO. This circumstance pushed the phytobiotic on the nutrient absorption process optimally. It agrees with previous research which reported that the addition of phytobiotic (ginger) effectively decreases the yolk cholesterol in the egg of laying hens (Akbarian *et al*., 2011; Gurbuz and Salih, 2017; Wen *et al*., 2019).

CONCLUSION

This study suggests that the inclusion of phytobiotics supplementation and magnetized drinking water showed better feed conversion ratio, egg weight, and yolk cholesterol. Two types of encapsulated phytobiotics (EPTO and EPTO+MDW) were the best treatment on FCR and yolk cholesterol of laying hens. Phytobiotics treatments (PTO and PTO+MDW) had the highest result on egg weight of laying hens.

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