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Effects of curcumin supplementation in aflatoxin B1-contaminated diet on the performance and egg quality of laying duck

Effects of curcumin supplementation in aflatoxin B1-contaminated diet on the performance and egg quality of laying duck

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Abstract. The objective of this study was to asses the effects of curcumin supplementation in AFB1-contaminated diet on the performance and external egg quality of laying duck. Fourty eight seven-months female Alabio ducks (*Anas platyrinchos Borneo*) were randomly allocated into 3 groups with 4 replicates of 4 ducks per pen: (1) Control (commercial feed); (2) AFB1 100 ppb diet (Control + AFB1-contaminated diet} and (3) CUR diet (AFB1 100 ppb diet + 0.05% Curcumin). Dietary trial was conducted for 42 days. Ducks were weighed on day 21 and 42 to calculate the body weights changes. The percentage of egg production was calculated since 21st day. Egg weight, shell thickness, and yolk weight percentage were determined in egg samples collected on the last three days of the experiment. Data were subjected to analysis of variance (IBM SPSS 21). Results showed live weight and weight gain were signifcantly lower in AFB1 diet ($P < 0.05$), and curcumin supplementation could diminish the negative effect of AFB1. However, treatments had no significant effects ($P > 0.05$) on egg production and egg external qualities. It was concluded that curcumin supplementation has positive effects on the laying duck performance which ingest AFB1-contaminated diet.

1. Introduction

Mycotoxins are secondary toxic metabolites produced by filamentous fungi, in which, aflatoxin B1 (AFB1) is the most studied mycotoxin because of its toxicity and prevalences [1]. Factors of climate, the composition of the commodity, agronomic practices, harvesting, handling, and storage contribute on fungi to grow and produce mycotoxin [2]. Previous studies indicated a high occurrence of AFB1 in feed and feedstuffs collected in Indonesia [3-5].

In poultry industry, AFB1 contamination in feed not only resulting huge economic losses because of decreases in poutry performance, but also public health hazard since AFB1 residues may present in the poultry products [6]. Duck is one of the sensitive animals to aflatoxin exposure that related to its liver biotransformation capacity [7]. Therefore, consumption of AFB1 contaminated diet will not only lead to a decrease in duck performance but potentially present aflatoxin residues in duck's tissues and egg [8-9].

Many ways have been developed to counteract the toxic effect of aflatoxin, those methods grouped as physical, chemical and biological method. AFB1 causes cell damage, free radical production, and lipid peroxidation. Thus several potential antioxidants and food additives have been evaluated in

diminishing the adverse effects of AFB1 exposure including free radical scavenging, reduced lipid peroxidation, and general inhibition of the mutagenic process [6, 10].

Curcumin is a polyphenolic carotenoid isolated from the rhizome of turmeric (*Curcuma longa*) that has antioxidant, anti-inflammatory, antimicrobial, antiviral, and antifungal properties [11]. Previous studies indicated that curcumin is initiating the transcription of genes encoding detoxifying enzymes and cytoprotective proteins [12]. Therefore, curcumin supplementation has potential to alleviate the negative effects of aflatoxin exposure. The objectives of this study are to determine the effects of curcumin supplementation in aflatoxin B1-contaminated diet on the performance and egg quality of laying duck.

2. Material and methods

2.1. Material

AFB1-contaminated feed (CF) was produced by inoculation of *Aspergillus flavus* FNCC in a commercial complete feed for laying duck (IP333, PT. Wonokoyo, Surabaya). CF sample was analyzed to determine the AFB1 levels. Then, CF was mixed into commercial feed to obtain AFB1 level at 100 ppb. AFB1 levels was determined by ELISA test using ELISA kits for AFB1 (AgraQuant® Aflatoxin B1, Romer Labs. Singapore). Curcumin used in the experiment was curcuminoid produced by PT. Sidomuncul, Semarang.

2.2. Methods

Fourty eight seven-months female Alabio ducks (*Anas platyrinchos Borneo*) were randomly allocated into 3 groups with 4 replicates of 4 ducks per pen. The treatments were: (1) Control diet (commercial feed); (2) AFB1 diet 100 ppb (commercial feed + AFC); and (3) CUR diet (AFB1 diet 100 ppb + 0.05% Curcumin). Experimental diet was provided restricted (150 g/d/bird) to ensure the amount AFB1 intake, whereas drinking water was provided ad libitum. The experiment was started when the ducks day average more than 60%. The experimental was conducted for 42 dayss. Body weights were determined individually at 0, 21, and 42 days of experiment. Egg production and duck day averages were recorded per pen since 21 to 42 days of experiment. Egg samples for external egg quality examination were collected from last three days of experiment. Observed variables for external quality were egg weight, shell thickness, and the weight percentage of yolk. Data were analyzed using analysis of variance according to completely randomized design. All statistical analysis was performed using software package SPSS version 21.0 (IBM, USA).

3. Results and discussion

3.1. Body weight changes and egg production

Table 1 shows the treatment diet had siginificant effect on final body weight and body weight changes ($P<0.05$). Exposures of AFB1 100 ppb for 6 weeks in AFB1 diet and CUR diet resulted in lower body weight change compare to the commercial feed. High standard deviatian values were found in body weight change of AFB1 diet, that indicated many birds suffered from AFB1 exposure and lossing their body weight.

The impact of AFB1 exposure on duck body weight is consistent with previous studies. Study of [13] showed that duck is more sensititive to AFB1 exposure compare to chicken, in which starting at 50 ppb, AFB1 would caused a decrease in duck weight. Others studies showed that AFB1 exposure causes a decrease in feed efficiency in ducks [14]. This might resulted in decrease in productivity and this detrimental response depends on doses of AFB1 [15].

However, research on the effects of AFB1 exposure on the performance of laying ducks is still very rare. In 1-day-old ducklings who received feed with levels of AFB1 0 to 100 ppb for 21 days, AFB1 levels caused a decrease in weight gain [15]. Research on broiler showed a weight loss from 1,999 g to 1,853 g of chickens fed 200 ppb AFB1 for 8 weeks [16]. Study of [17] concluded that in chickens,

consumption of aflatoxin causes weight loss, decreased feed consumption, and increased feed conversion. The percentage of weight loss reported varies depending on the dose and duration of exposure, such as 5% weight loss at a dose of 500 ppb; 10% weight loss at a dose of 800 ppb for 28 days; and 15% weight loss at a dose of 1,000 ppb for 21 days.

Table 1. Effects of experiment diet on body weight changes and egg production of laying duck

Treatments	Final body weight (kg)	Body weight changes (g)	Duck Days Average (%)[ns]
Control[1]	1615±131[b]	80.6±52.2[b]	70±20
AFB1 diet 100 ppb[2]	1557±102[ab]	1.2±70.5[a]	73±19
CUR[3]	1497±94[a]	6.7±73.2[a]	74±18

[a, b] Means in the same colum with different superscript is significantly different (P<0.05)
[ns] Means in the same colum is not significantly diferent (P>0.05)
[1] Commercial feed for laying duck (IP333, PT. Wonokoyo, Surabaya)
[2] Commercial feed+Aflatoxin B1 contaminated diet resulted AFB1 level of 100 ppb
[3] AFB1 diet 100 ppb + 0.5% Curcumin

Supplementation of curcumin in CUR diet appears to reduce the impact of AFB1 exposure by reducing weight loss, eventhough the body weight changes was not different to AFB1 diet. This result is similar to previous study of [6] that showed curcumin addition in a diet containing 2000 ppb AFB1 could diminish the negative effect of AFB1 on body weight gain.

Dietary treatment had no significant effect on egg production of laying duck (duck days average) (P>0.05). In laying hens, study of [18] showed egg production decrease from 85% to 40% after treatment of AFB1 1.0 mg/kg of body weight per day for 6 weeks. At lower doses, the study of [19] showed the production and egg weight of white leghorn were not affected by aflatoxin at levels of 100 ppb for 60 days, although feeding aflatoxin caused a decrease in feed consumption.

3.2. External egg quality

Egg weight, egg shell thickness and the percentage of yolk weight were not affected by treatment (P>0.05) (Table 2). The egg shell thickness and the percentage of yolk weight were slightly lower in duck received AFB1 diet and curcumin supplementation had tendency to improve shell thickness and yolk weight, however these were not significantly different (P>0.05).

Table 2. Effects of experiment diet on external egg quality of laying duck[ns]

Treatments	Egg weight (g)	Shell thickness (mm)	Yolk weight (%)
Control[1]	65.7±2.26	0.48±0.07	31.9±1.15
AFB1 diet 100 ppb[2]	66.3±1.85	0.46±0.07	31.5±1.68
CUR[3]	65.0±2.68	0.48±0.07	32.7±1.18

[ns] Means in the same colum is not significantly diferent (P>0.05)
[1] Commercial feed for laying duck (IP333, PT. Wonokoyo, Surabaya)
[2] Commercial feed+Aflatoxin B1 contaminated diet resulted AFB1 level of 100 ppb
[3] AFB1 diet 100 ppb + 0.5% Curcumin

Study of [20] showed a decrease in egg weight of laying hens which received AFB1 2500 ppb for 4 weeks. AFB1 negatively influenced on shell thickness and could affect on egg weight. AFB1 interferes lipid metabolism and deposition in yolk [21] and resulting a lower percentage of yolk weight [20, 22].

This study failed to determine the effect of curcumin supplementation in AFB1-contaminated on egg quality of laying duck. However, many studies had suggested the beneficial effects of curcumin supplementation in rate of 0.5-1% ind diet for laying hens including improved weight gain, egg production and egg weight [23]. It was also reported that curcumin has a potential to control carcinogenesis by decreasing the activities of enzymes related to AFB1 bioactivation in the liver [24].

4. Conclusion

Curcumin supplementation could diminish the adverse effects of AFB1 on laying duck, especially on body weight change. Further research, including higher AFB1 levels and longer duration of exposure, is needed to determine the effects on egg production and quality.

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