The Use of Probiotic and Antioxidants to Improve Welfare and Production of Layer Duck at Commercial Farms for Global Warming Mitigation

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Abstract. Global warming affected increasing the risk of ducks to be more succeptable to heat stress which leads to decrease welfare and production. This research aimed to study duck welfare and productivity under probiotic and antioxidants administration at commercial farms. The method used was experiment with Completely Randomized Designed (CRD) based on factorial pattern. The treatment was dose of natural/homemade and commercial probiotics combined with vitamin C at 400 mg kg^{-1} and 600 mg kg^{-1} feed. Thus there were four treatment combinations. Each treatment was replicated five times, totally were 20 flocks of duck. Each flock had 50 laying females so there were 1 000 ducks. The treatment was conduced for 2 mo. The parameters observed included, i) duck welfare based on Heterophyl/Lymphocyte (H/L) ratio; ii) egg production consisted of (a) duck day production, and (b) egg weight. This study concluded that administration of combination between homemade probiotic and vitamin C at 600 mg kg^{-1} feed significantly ($p < 0.05$) increased duck welfare and egg production but did not affect egg weight.

Key words: Heat stress, increase duck welfare and egg production, local ducks, vitamin C

1 Introduction

High ambient temperature is a serious obstacle in developing poultry production in tropical areas, especially in recent climate change phenomenon. Climate change now is one of big issues concerns to the world. It is understood since climate change has severe impact not only for human being but also animal. Indonesian National Aviation and Space Agency reported that the climate in Indonesia has become warmer during the 20th century with an average annual temperature has increased by about 0.3 °C since 1900 [1]. Ducks, as a homeotermic animal, is succeptable to heat stress which leads to decreasing its welfare and productivity. Previous study reported that under dry intensive system, local ducks suffered from heat stress as indicated by rectal temperature, behaviour, and body and plumage

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condition [2]. Therefore, releasing heat stress is an essential factor to improve duck welfare. Recently it has been proven that oxidative stress is a molecular mechanism of many different stresses, including environmental stresses (e.g. heat stress), nutritional stresses (e.g. mycotoxins) and internal stresses (e.g. bacterial, viral, etc.) [3]. Manipulation on daily management is required to protect the ducks from suffering from heat stress, among others by using vitamins as functional feed.

Several studies have been conducted to investigate the use of probiotic and vitamins for alleviation of heat stress in poultry. In broiler chickens, probiotic *Lactobacillus* strains have proven to be able to restore the microbial balance and maintaine the natural stability of indigeneous bacterial microbiota following heat stress–induced changes [4]. Under heat stress conditions, chickens fed with diets containing *Lactobacillus* cultures have higher antibody production than those on control diet [5]. Supplementation of probiotic in diet significantly increases white blood cells count and decreases Heterophyl/Lymphocyte (H/L) ratio which is important in reduction of stress effect in poultry [6]. Relating to heat stress, probiotic might be useful for ameliorating the adverse influence of heat on the egg production and the gut health of laying hens [7].

The most important and well–characterised natural antioxidants in the animal body are vitamins E and C. All antioxidants are responsible for prevention of the damaging effects of free radicals and toxic products of their metabolism [8]. [9] Stated that in broiler chicks, optimal antioxidant supplementation is shown to be important to maintain growth rate, immunocompetence and meat quality. Whereas in broiler chickens, supplementation of 250 mg kg^{-1} vitamin C was the most effective in reducing heat stress [10]. Recently it has been proven that vitamin C (ascorbic acid) – an important antioxidant synthesised in chickens and its dietary supplementation is shown to be effective in stress conditions, when its requirement substantially increased. [9]. Some studies have shown that vitamin C has been reported to enhance immune response by modifying corticosteroid synthesis in adrenal glands [11]. Most previous studies, however, concerned on vitamins use for chickens. Thus, study on effect of probiotic and vitamin combination on duck welfare is lacking, especially that under commercial farm management.

Keeping this in mind, this study was conducted to examine the effect of probiotic and vitamin C combination on welfare and egg production of local ducks kept in commercial farms.

2 Materials and methods

2.1 Methods

This study used experimental method that conducted in collaboration with '*Berkah Abadi'* duck farmer group and ducks reared under dry system intensively. Under intensive system, the ducks are mostly kept in sheds with rice straw bedding and solid floor ranch infront of the sheds [12]. The study was located at Tegal City, Central Java, Indonesia which is located in the northern coastal area of Java Island. The City and its surrounding areas is one of the most important duck centers in Indonesia with its very famous local layer duck namely *Tegal Duck*. It is believed that the duck belongs to *Indian Runner* family.

2.2 Materials and methods

The materials used was local layer ducks which the age of 13.4 mo ± 1.3 mo. Intensive system refers to the conventional reraing by the farmers in which ducks were confined around the farmer's village by closed fence. Hence ducks had no access to the outside area, and the amount of feed provided could be controlled and measured. Drinking water was provided *ad libitum* three times a day i.e. in the morning, noon, afternoon, while feed was given twice a day i.e. in the morning and in the afternoon. The feedstuffs were locally available which mainly consisted of rice bran, dried rice, and fresh fish (*Leiognathidae* T. N. Gill, 1893) with proportion of 39.65 %, 25.11 % and 35.24 % respectively. The nutrient content were 26.38 % crude protein, 2.923 kcal kg^{-1} metabolic energy, 2.29 % Calcium and 0.78 % Phosphorus.

This study used Factorial method with treatments consisted of combinations between three doses of home–made (H) and commercial probiotics (C) with vitamin C 400 (C1) and 600 (C2) mg kg feed. There were four treatments units were replicated five times. Thus, totally were 20 flocks. Each flock had 50 female ducks; therefore this study involved 1 000 ducks. The treatments were applied each morning, mixed thoroughly in duck ration.

2.2.1 Data collected:

i. Heterophils to lymphocyte (H/L) ratio as a welfare status
   Blood samples were taken from two ducks per flock for determination of H/L ratio on 60^{th} d of the study.
ii. Daily ambient air temperature and humidity as indicators of environmental condition were measured at 6 am, noon, and 3 pm.
iii. Laying percentage/duck day production (expressed as average number of eggs laid per day in relation to number of female ducks $flock^{-1}$), and average egg weight (g) $flock^{-1}$ as indicators of egg production.

2.2.2 Data analysis:

Data collected were analyzed using Analysis of Variance (ANOVA) and followed by Honestly Significant Different (HSD) test if any different effects.

3 Results and discussions

Blood H/L ratio, duck day production (DDP), and egg weight during this study were summarized in Table 1 below.

Table 1. H/L ratio, DDP, and egg weight during the study

Parameters	Treatments			
	HC1	HC2	CC1	CC2
H/L Ratio	0.56a	0.55a	0.75b	0.61b
DDP (%)	72.04a	68.75b	64.40b	66.39b
Egg weight (g)	67.28a	68.98a	69.35a	70.61a

Note: numbers at the same row with different alphabet indicate significant differences ($p < 0.05$).

3.2 Duck welfare

H/L ratio in this study ranges from 0.32. to 1.14 with an average of 0.62 ± 0.09. Statistical analyses indicated that H/L ratio in HC1 was significantly ($p < 0.05$) lower than that in other treatments. It indicated that combination of home–made probiotic and vitamin C supplementation has improved duck welfare. Figure 1 presents the average of H/L ratio of each group of treatment.

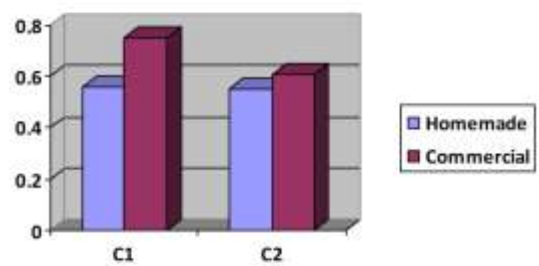

Fig. 1. The average of H/L ratio of each group of treatment

Results of this study indicate that ducks supplemented with combination of home–made probiotic and vitamin C had lower H/L ratio which means that the ducks were more welfare. [13] Stated that ducks in welfare condition has lower H/L ratio than those in stress condition.

3.2 Egg production

Average egg production was 66.99 % ± 3.29 % ranging from 47.86 % to 87.14 %. This finding confirms that previous results of [2, 14]. Egg production of control and treatment groups presented in Figure 2.

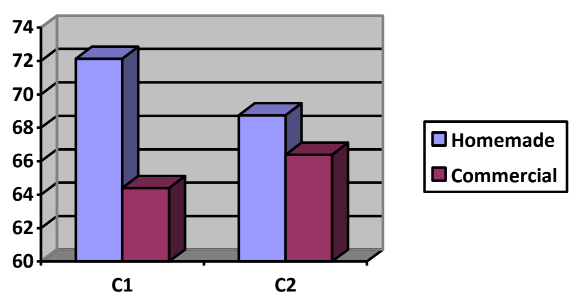

Fig. 2. Egg production of control and treatment groups

Statistical analysis showed that combination of home–made probiotic and vitamin C supplementation significantly ($p < 0.05$) increased duck day production. It seems that that the dose was the most effective quantity for supplementation. High requirement of vitamin occurs when poultry under stress condition since it has vital roles in metabolic reactions. One of the most crucial factor of vitamin C is in amino acid metabolism which affect egg production.

3.3 Egg weight

Egg weight ranges from 61.80 g to 75.20 g with an average of 69.05 g ± 1.37 g. This finding was confirmed the results of previous research which found that egg weight was 71.14 g ± 6.08 g [14]. The lowest egg weight was found at control ducks although it us not significant ($p > 0.05$). Figure 3 presents the average of egg weight during the study.

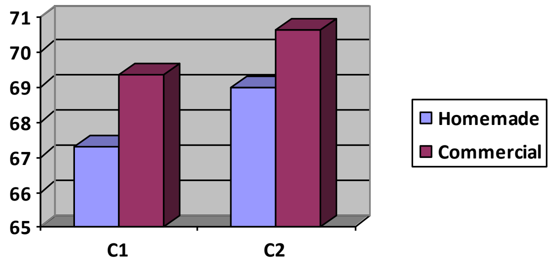

Fig. 3. The average of egg weight during the study

3.4 Environmental condition

Environmental condition at study site is presented in Table 2.

Table 2. Average ambient temperature and humidity at location study

Environmental condition	Morning	Noon	Afternoon	Average
Temperature (ºC)	27.06 ± 0.64	31.91 ± 0.89	31.35 ± 0.85	29.35 ± 2.65
Humidity (%)	88.94 ± 3.81	79.43 ± 5.76	82.32 ± 3.50	83.56 ± 4.88

Table 2 indicates that environmental temperature of the study site was 29.35 ºC ± 2.65 ºC on average which was higher than the maximum temperature needed by poultry. Study site which was coastal region of Tegal City, Central Java, Indonesia is considerably suffer from climate change. At the same time relative humidity was also high with average of 83.56 % ± 4.88 %. It seems that environmental condition in the area was higher than the thermo–neutral zone required by ducks. Thermo–neutral zone for poultry is between 18 ºC to 25 ºC, and the most efficient temperature for ducks ranges between 23 ºC to 25 ºC [15]. Figure 4 presents the variation of average daily ambient temperature and humidity during the study.

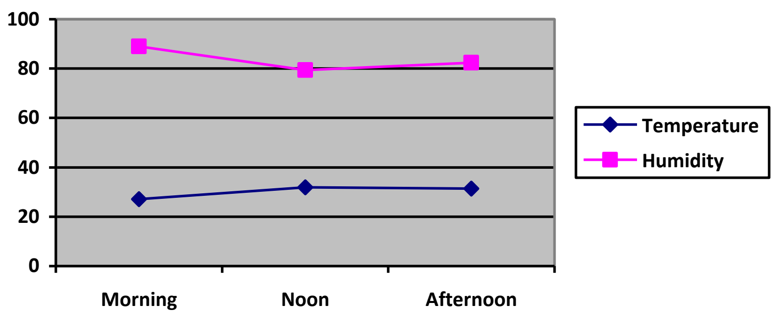

Fig. 4. Variation of average daily ambient temperature and humidity during the study

Controlling the ducks' environment, particularly temperature, humidity, litter moisture and ammonia is crucial to duck welfare [16]. If the ambient temperature is higher than the thermoneutral zone, panting will increase ten times which decreases productivity [17]. Qualitative observation along the study showed that ducks with treatments had more comfort condition indicated by less drinking and panting activities.

4 Conclusions

On commercial level, that administration of three doses of home–made probiotic and 600 mg kg^{-1} vitamin C has improved duck welfare and egg production, but did not increase the egg weight.

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