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RESEARCH ARTICLE

Response of broiler chickens to jojoba oil and silver nanoparticles dietary supplementation

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Abstract

This study aimed to evaluate the effect of Jojoba Oil and nanoparticles of Silver supplementation on growth performance, viability and economics in broiler chickens. A total of 192 Ross 308 broiler chicks (1-day-old) were allocated to 4 experimental treatments: CONT (control diet), JO (CONT diet with 150 mg/kg of Jojoba oil), Nano-Ag (CONT diet with 4 mg/kg nanoparticles of Silver), and JO+Nano-Ag (CONT diet plus Jojoba Oil and nanoparticles of Silver). Each treatment had 6 replicates of 8 birds. The experiments lasted for 35 days. Starter and grower diets, based on corn and soybean meal, and water were available *ad libitum*. Body weight and feed intake were measured from 0 to 35 days. Body weight gain and feed conversion ratio were calculated. Survivability rate and cost economics were calculated. Statistical comparisons were performed using a One-way ANOVA. Supplementation of JO and Nano-Ag separately as well as in the form of combined usage, increased ($P<0.05$) body weight and body weight gain compared to CONT. Supplementation of broiler diets with JO, Nano-Ag or their combination improved feed conversion ratio, without any significant effect on feed intake. Interestingly, a lower mortality rate was recorded in the supplementation groups and, therefore, a higher net return was observed. Hence, the present study demonstrates that supplementation of JO and Nano-Ag separately as well as in the form of combined usage, improved growth performance and economic return of broiler chickens.

Keywords: Jojoba oil, Silver nanoparticles, productive performance, economics, broiler chicken

1. Introduction

A common nutritional strategy to increase food safety and total income as well as to reduce livestock mortality is to use in-feed-antibiotics as growth promoters. However, on the one hand, the use of in-feed antibiotics has recently been viewed critically and their usage is banned completely in the EU since 2006 (Regulation (EC) No. 1831/2003). On the other hand, it is still common practice in in Middle East particularly in Egypt to add antibiotics as growth promoter to poultry diets to improve their production, health and meat quality. However, it is generally accepted that the use of antibiotics may potentially affect human health, animal and environment due to their cross and multiple resistance of bacterial infections in humans. In some studies the ability of phytogenic and minerals in the form of nanoparticles is used as alternative growth promoters have already been proven and thus started to play a decisive role in nutrition of poultry (Abdel-Wareth *et al.*, 2012; 2018; 2019; 2020;2021 Abdel-Wareth and Lohkare, 2014; Abdel-Wareth, 2016). Scientific *in vitro* and *in vivo* studies have variously

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claimed that phytogenics have antioxidant, antimicrobial, hypocholesterolemic, and immune stimulating properties (Lee *et al.*, 2004; Brenes and Roura, 2010) that may be beneficial to enhance poultry production. The impact of phytogenic on the intestinal microbiota is considered essential for the biological effects; however, the exact mode of action is still not clear (Hafeez *et al.*, 2016). Essential oils are a common phytogenic known for its antimicrobial properties, strong antioxidant properties, enhance appetite and gastro protective and mucus enhancing activities, mainly due to phenolic contents (Marrufo *et al.*, 2013). Jojoba (*Simmondsia chinensis* L) is a perennial woody shrub native to semi-arid regions and cultivated in Egypt and the jojoba extract has antioxidant effects and can protect against mycotoxins induced hepatotoxicity (Abdel-Wahhab *et al.*, 2016). However, it is very difficult to directly compare different studies using different phytogenic applications because the efficacy of these applications will additionally depend on factors such as species, composition, administration dose, method and frequency of application, bird age, and environmental stress factors (Hippenstiel *et al.*, 2011). *Hippophae rhamnoides* extract as a phytogenic supplement for broilers diet reduced the mortality rate, leading a subsequently higher profitability (Kalia *et al.*, 2018).

Furthermore, silver (Ag) has been valued throughout history because many of its properties are useful to humans and animals. Silver can be supplemented in the different form of inorganic, organic complexes, and nanoparticles (Saleh and El-Magd, 2018); however, nanoparticles of Silver possess comparable efficiency, high bioavailability, strong adsorbing ability, and low toxicity compared with other Ag sources. Nanoparticles of silver (Nano-Ag) are fine particles of metallic Ag that have at least one dimension smaller than100nm. Nano-Ag is an emerging alternative feed additives for poultry. As a result of Nano-Ag has ability as antimicrobial and antioxidant as well as becoming increasingly important because of its wide range of applications (Furno *et al.*, 2004; Nadworny *et al.*, 2010; Mahmoud, 2012; Poynton *et al.*, 2012). Despite the widespread use of Nano-Ag, relatively little research has been undertaken to determine its biological effects exposure. Moreover, the most beneficial response of Nano-Ag is as a potent antimicrobial because they are toxic to viruses, fungi, bacteria, and algae (Cho *et al.*, 2005; Percivaletal.2007). Saleh and El-Magd (2018) reported that broiler chicks fed Nano-Ag showed improved body weight gain and feed efficiency and increased ash digestibility. Also, Andi *et al.* (2011) reported supplementation of Nano-Ag significantly improved in growth performance of broilers. However, many researchers did not find any significant changes due to Nano-Ag feeding of chickens (Sawosz *et al.*, 2007; Ahmadi and Kurdestani 2010; Ahmadi and Rahimi, 2011; Pineda *et al.*, 2012; Ognik *et al.*, 2016). These contradictory founding may be related to variations in the Nano-Ag size, level, duration, preparation method and bird's age.

More studies are needed to justify the effects of Nano-Ag, JO and their combination on productive performance of broiler chickens. Therefore, the objective of this study was to assess and compare the effects of either Nano-Ag, JO or their combination on on growth performance, viability and economics in broiler chickens.

2. Materials and methods

2.1. Experimental design and dietary treatments

The experiment was used to evaluate the effect of Jojoba oil and nanoparticles of Silver supplementation on growth performance, viability and economics in broiler chickens. A total of 192 Ross 308 broiler chicks (1-day-old)

were allocated to 4 experimental treatments: CONT (control diet), JO (CONT diet with 150 mg/kg of Jojoba oil), Nano-Ag (CONT diet with 4 mg/kg nanoparticles of Silver), and JO+Nano-Ag (CONT diet plus Jojoba Oil and nanoparticles of Silver). Each treatment had 6 replicates of 8 birds. The experiments lasted for 35 days.

Birds were fed commercial diets according to Ross 308 recommendation. Silver nanoparticles were essentially synthesized at Botany & Microbiology Department, Faculty of Science, South Valley University as previously described by Azizi *et al.*, 2013.

2.2. Experimental Conditions

Animal housing and handling procedures during experimentation were in accordance with guidelines of the Institutional Animal Care Committee of the South Valley University.

Chicks were reared in a three-tier wire floor battery in a closed house. The chicks of each replicate were allocated in cages with slatted floor of iron. The diameters of the cages were 120 × 70 × 50 cm in length, width and height, respectively. Chicks had full access to feed and water during the experimental period. The chicks were housed in galvanized metal battery cages during the experimental period from 0 to 35 days of age. The temperature was 34°C at the first week and decreased gradually up to 24°c at the fourth week, all chicks were kept under the same managerial conditions.

2.3. Broiler Performance Parameters

The body weight was recorded per pen on a weekly basis from the initial day to the final day of the experiment. In addition, the feed consumption for each pen between weighing was determined by measuring feed residue on the same d as the birds were weighed. Feed conversion ratio was calculated as feed per gain based on the weight of feed consumed divided by body weight gain per pen. The magnitude of production variables such as feed intake and body weight were adjusted for bird mortalities.

2.4. Survivability Rate and Cost Economics

Mortality was recorded daily and with the obtained data the percentage of viability was calculated. The European performance efficiency factor (EPEF), as suggested by Huff *et al.* (2013), was calculated using the following formula: body weight (kg) × % viability × 100/feed conversion ratio × trial duration in day.

2.5. Statistical analysis

All data were subjected to one-way ANOVA and were the general linear model (GLM) procedure of Statistical Analysis System (SAS Institute, Inc., Cary, NC, USA) software (SAS, 2005). Duncan's multiple range test was used to compare means. Significance was declared at $P<0.05$.

3. Results

3.1. Growth Performance and Feed Intake

The effects of JO, Nano-Ag and their combination on growth performance of broiler chickens is summarized in Figures 1, 2, 3, 4, 5 and 6. The results showed that supplementation of JO and Nano-Ag separately as well as in the form of combined usage, increased ($P<0.05$) body weight and body weight gain compared to CONT at 21 and 42 days of age. Supplementation of broiler diets with JO, Nano-Ag or their combination improved feed conversion ratio throughout the experimental period (1-21, 22-42 and 1-42 days). However, Feed intake was not significantly affected by treatments.

3.2. Economics and Viability Rates

Figures 7 and 8 show the results of viability rate and EPEF in relation to JO and Nano-Ag

separately as well as in the form of combined in the broiler diets. The dietary peppermint levels improved viability rate (P=0.003) throughout the experimental period (Figure 7). Overall EPEF was significantly increased by JO and Nano-Ag supplementations (Figure 8). Interestingly, a lower mortality rate was recorded in the supplementation groups and, therefore, a higher net return was observed.

4. Discussion

The objectives of the current study were to evaluate the growth performance and economic response of broiler chickens to dietary Nano-Ag and JO and to explore the underlying mechanism. Our study showed a significant improvement in weight gain, feed conversion ratio, viability and economic efficiency when Jo, Nano-Ag and their combination were included in the broiler diet.

In the current study, supplementation of jojoba oil significantly increased growth performance, and economic and reduce mortality rate compared to control group. It is very difficult to directly compare different studies using different herbal ingredients because the efficacy of these investigations may be depended on different factors such as herbal composition, dose, application method and bird age (Hippenstiel *et al.,* 2011; Abdel-Wareth *et al.,* 2012; 2016; 2020; 2021). Due to lack of JO study conducted on broiler chickens other phytogenic were used to explain the finding. Interestingly, a lower mortality rate was recorded in the supplementation groups compared to the control group and, therefore, a higher net return was observed in this study. *Hippophae rhamnoides* extract as a phytogenic supplement for broilers diet reduced the mortality rate, leading a subsequently higher profitability (Kalia *et al.,* 2018). Also, broiler chickens fed essential oils showed an improved feed conversion ratio and these effects can result in higher profitability in production of broilers. Furthermore, the improvement in feed conversion ratio and this could be related to improved feed utilization efficiency (Akbari *et al.,* 2016). Furthermore, the increase in growth performance of broiler chicks fed JO due to this medicinal plant could be attributed to its content of active components.

In the current study, supplementation of Nano-Ag significantly improved growth performance and profitability of broilers compared to control group. This improvements in growth performance and profitability may be due to Nano-Ag is an emerging alternative feed additives for poultry. As a result of Nano-Ag has ability as antimicrobial and antioxidant as well as becoming increasingly important because of its wide range of applications (Furno *et al.,* 2004; Nadworny et al., 2010; Mahmoud, 2012; Poynton *et al.,* 2012). Despite the widespread use of Nano-Ag, relatively few researches has been undertaken to determine its biological effects exposure. Moreover, the most beneficial response of Nano-Ag is as a potent antimicrobial because they are toxic to viruses, fungi, bacteria, and algae (Cho *et al.,* 2005; Percival *et al.,* 2007). Saleh and El-Magd (2018) reported that broiler chicks fed Nano-Ag showed improved body weight gain and feed efficiency and increased ash digestibility. Also, Andi *et al.* (2011) reported supplementation of Nano-Ag significantly improved in growth performance of broilers. However, many researchers did not find any significant changes due to Nano-Ag feeding of chickens (Sawosz *et al.,* 2007; Ahmadi and Kurdestani 2010; Ahmadi and Rahimi, 2011; Pineda *et al.,* 2012; Ognik *et al.,* 2016). These contradictory founding may be related to variations in the Nano-Ag size, level, duration, preparation method and bird's age.

Figure captions

Figure 1. Daily body weight gain, g (DBWG, g) of broilers in response to Jo, Nano-Ag and their

combination supplementation during the period of 1-21 days of age.

Figure 2. Daily body weight gain, g (DBWG, g) of broilers in response to Jo, Nano-Ag and their combination supplementation during the period of 22-42 days of age.

Figure 3. Daily body weight gain, g (DBWG, g) of broilers in response to Jo, Nano-Ag and their combination supplementation during the period of 1-42 days of age.

Figure 4. Feed conversion ratio (FCR) of broilers in response to Jo, Nano-Ag and their combination supplementation during the period of 1-21 days of age.

Figure 5. Feed conversion ratio (FCR) of broilers in response to Jo, Nano-Ag and their combination supplementation during the period of 22-42 days of age.

Figure 6. Feed conversion ratio (FCR) of broilers in response to Jo, Nano-Ag and their combination supplementation during the period of 1-42 days of age.

Figure 7. Viability (%) of broilers in response to Jo, Nano-Ag and their combination supplementation during the 42 days of age.

Figure 8. European production efficiency factor [EPEF, calculated as % viability × body weight (kg) × 100/feed conversion ratio × trial duration in day] of broilers in response to Jo, Nano-Ag and their combination supplementation during the period of 42 days of age.

Figure 1

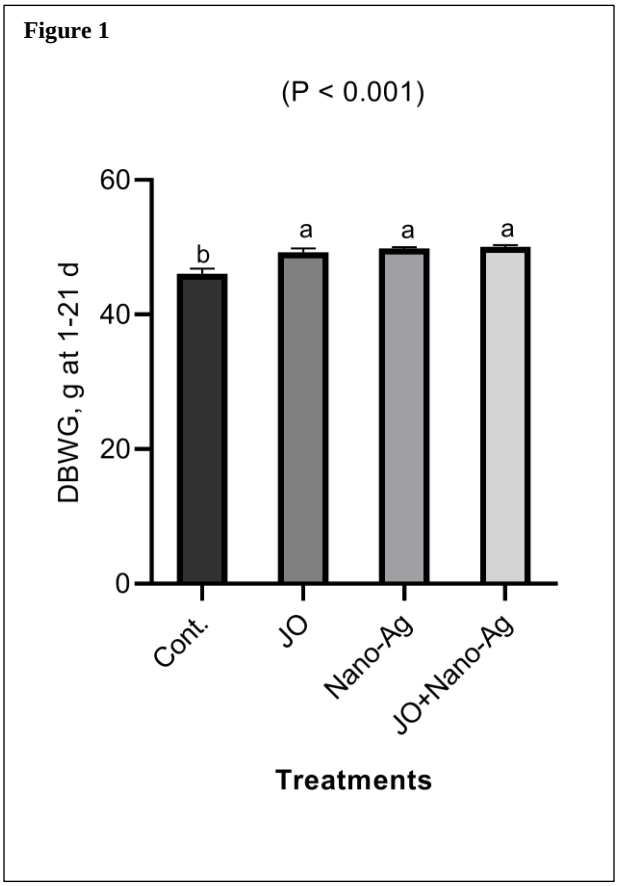


Figure 2

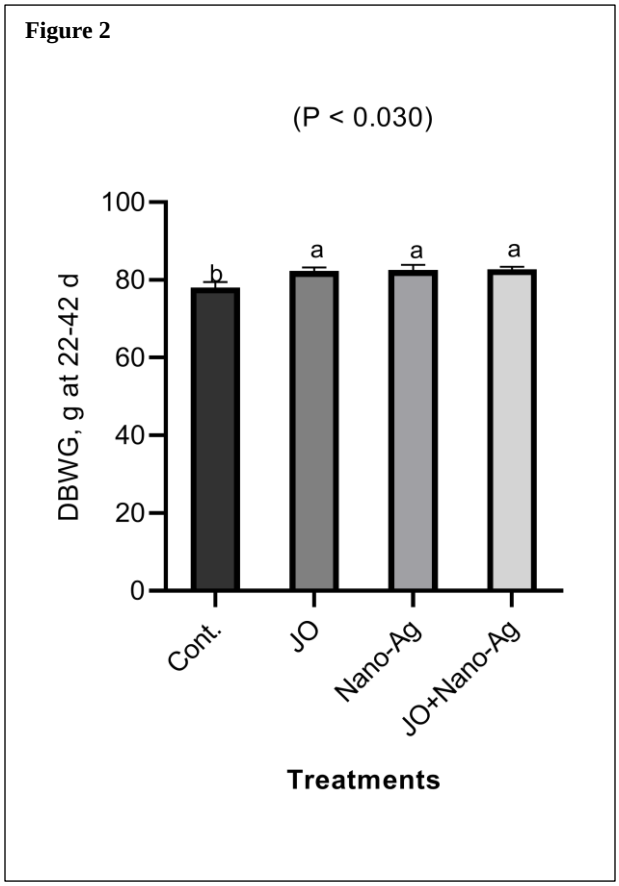


Figure 3

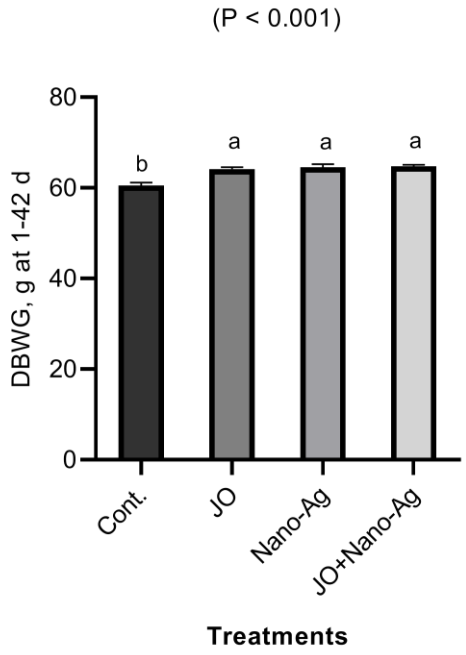


Figure 4

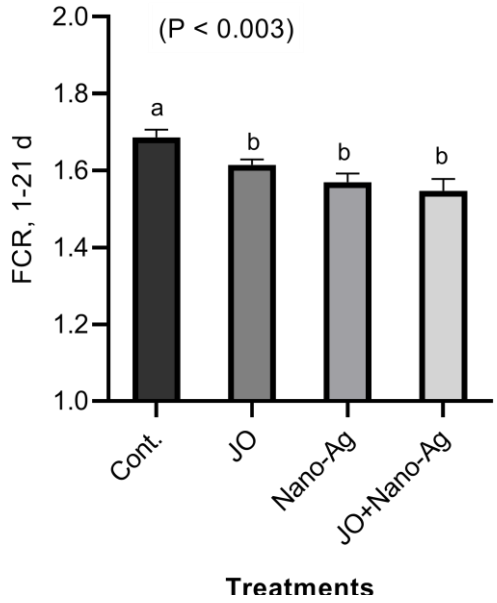


Figure 5

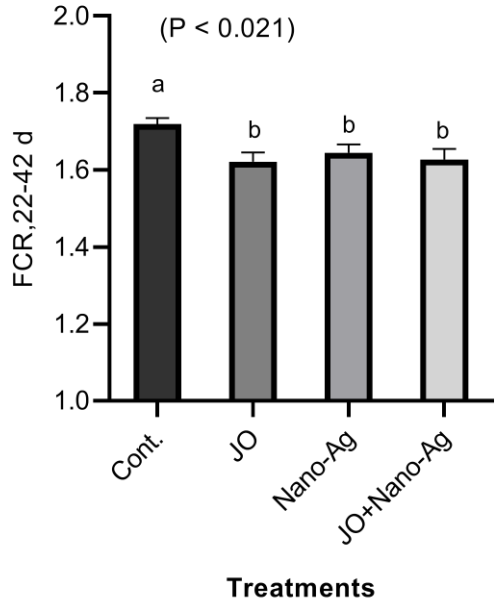


Figure 6

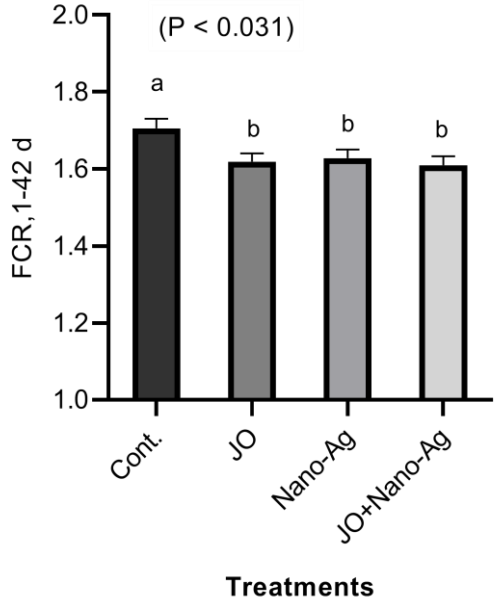


Figure 7

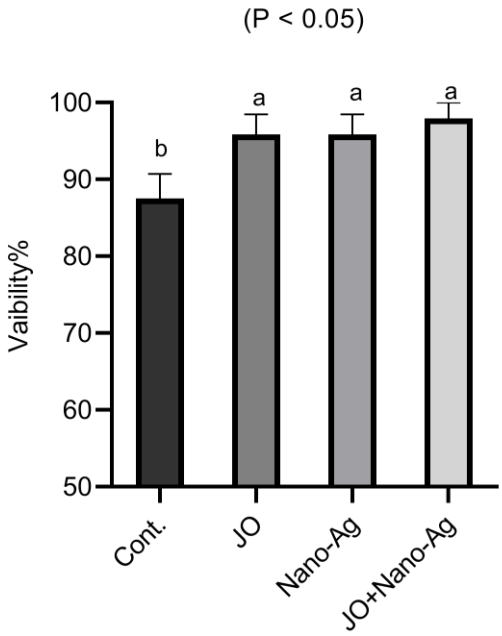
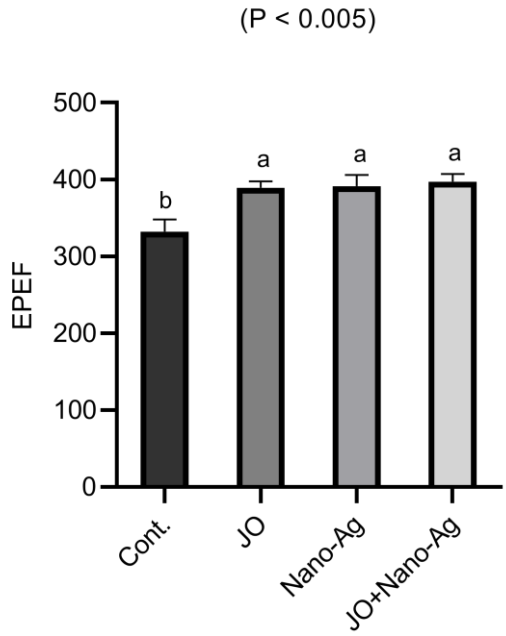


Figure 8



5. Conclusion

It can be concluded that supplementation of JO and Nano-Ag separately as well as in the form of combined usage, improved growth performance and profitability of broiler chickens.

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