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COMPARATIVE EFFECTS OF NANOPARTICLES (SILVER VS. GRAPHENE) IN DRINKING WATER FOR BROILER CHICKENS

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SUMMARY

A study conducted to evaluate the use of silver nanoparticles in broiler drinking water compared to graphene nanoparticles on carcass characteristics and immune organs%. 270 unsexed one-day old of Cobb 500 broiler chicks were divided into 9 treatments, each has 3 replicates with 10 broiler chicks. The tested nanoparticles treatments were (0.0, 2.5, 5.0, 7.5 and 10.0 ppm/L) drinking water of two types of nanoparticles (silver or graphene). At the end of experiment, the carcass traits and immune organs% of four birds per treatment were determined. The results showed that: No statistical differences between treatments were found on carcass characteristics (carcass, giblets, total edible parts and abdominal fat %) or carcass parts (breast, thigh, drumstick and wings %). No significant effects, related to nanoparticles (silver vs. graphene) utilization, were observed for the weight of spleen and bursa of fabricius. The obtained results showed that the supplementation of nanoparticles (silver vs. graphene) by different levels in broiler drinking water didn't affected carcass characteristics and immune organs%.

Keywords: *Nanoparticles, broiler chicks, carcass traits, carcass parts and immune organs.*

INTRODUCTION

Several applications of nanotechnology for food and agricultural production are being developed in research and development (R&D) settings. Key international challenges are associated with animal production, including environmental sustainability, health, disease control, and feed security. Nanotechnology holds promise for animal health, veterinary medicine, and other areas of animal production (Scott, 2005).

Nanomaterials, which used in animal and poultry production for instance such as silicon dioxide, Graphene, calcium and magnesium; and silver nanoparticles for water purification or antimicrobial packaging or feed storage, zinc as a feed colorant. Titanium dioxide, a feed colorant used as a ultraviolet (UV) protection barrier in the feed packaging industry is an approved inorganic nanoparticle because it becomes transparent and also loses its ability to act as a feed colorant in its nanoform (El Sabry *et al.*, 2018).

Nanoparticles added to broilers feed not only positively affected breast and thigh muscle protein content while simultaneously lowering cholesterol, but raised the average daily gain and feed efficiency of the broilers. The implications of these results are shorter production cycles for better quality meat with less feed required to have broilers reach market weight (Zha *et al.*, 2009).

Nanosilver is one of the most commonly used nanomaterials because of its strong disinfectant properties (Chen *et al.*, 2007). Silver is a noble metal that has been known since ancient time to control microbial proliferation even against antibiotic-resistant bacteria (Wadhera and Fung, 2005).

Recent studies on use of silver in nanosize as an alternative to antibiotics and its preprobiotic properties with increasing immunity have led to use of this nanoparticle largely, especially in veterinary and dependent sciences (Sawosz *et al.*, 2007). Nanosilver was toxic to mammalian liver cells, stem cells, and even brain cells (Hussain *et al.*, 2005 and 2006).

The inhibitory effect of ionic silver is due to several biological events such as attachment to cell membranes, its adsorption to the negatively charged bacterial cell wall, changes of membrane permeability, generating reactive oxygen species (ROS) and de-activating cellular enzymes (Loghman *et al.*, 2012).

Kout Elkloub *et al.* (2015) showed significant differences in carcass percentage with silver nanoparticles supplement (67.92, 67.74, 68.53, 68.22, 67.44 and 66.33% respectively). The highest carcass percentage has recorded by the 4ppm/kg treatment (68.53%). Also, the gizzard percentage differs significantly with silver nanoparticles supplement (1.42, 1.37, 1.48, 1.42, 1.23 and 1.36% respectively). In addition to abdominal fat percentage differs significantly with silver nanoparticles supplement (1.18, 1.46, 1.47, 1.35, 1.49 and 1.68% respectively). While the percentages of liver, heart and spleen haven't differed significantly with silver nanoparticles supplement.

Grodzik and Sawosz (2006) assessed the effect of SNaPs at a concentration of 10 ppm on the bursa and growth, which showed a reduction in the size and number of follicles and hadn't major effect on the growth of the chickens compare with control.

Ahmadi (2012) found that there was a significant increase in intestine percentage with increasing Nano-silver (SNaPs) level in the diet (2.17, 2.56, 2.69 and 2.88% respectively), so the highest small intestine percentage was recorded 60 ppm treatment group (2.88%).

Felehgari *et al.* (2013) indicated that treatments had significant effected on small intestine percentage increases significantly with different levels (1.34, 1.72, 2.05, 2.34 and 2.36% respectively), where the highest small intestine was recorded by the T5 group (2.36%).

This study aimed to investigate the effect of using different types and levels of nanoparticles (graphene or silver) in broiler drinking water on Carcass characteristics, carcass cuts and immune organs%.

MATERIALS AND METHODS

The present study was carried out at the Poultry Nutrition Farm, Poultry Production Department, Faculty of Agriculture, Ain Shams University, Shalakan, Kaliobia, Egypt.

This experiment conducted to evaluate the effect of using nanoparticles (silver or graphene nanoparticles) as a supplementation in broiler drinking water on broiler carcass traits, carcass parts and immune organs%. 270 unsexed one-day-old of Cobb 500 broiler chicks were used in this study; obtained from a commercial hatchery divided into 9 treatments, each treatment comprised of 30 chicks divided into 3 replicates of ten chicks. The tested nanoparticles treatments were (0 nanoparticles) as a control treatment, 2.5, 5.0, 7.5, and 10.0 ppm/L drinking water of two types of nanoparticle (silver or graphene nanoparticles).

Chicks were fed on the experimental corn – soybean diets in which the composition and calculated analysis shown in Table (1).

At the end of experiment (35 days of age) four chicks from each treatment were randomly selected and fasted for about 10 hours then slaughtered. After complete bleeding, followed by plucking the feathers and removed of head, viscera, shanks, spleen, gizzard, liver, heart, and abdominal fat, the rest of the body was weighted to determine dressed weight. Weight of different parts of carcass, wing, breast, thigh, and drumstick were recorded to the nearest gm. Immune organs (spleen and bursa) were weighted using a digital electric balance and recorded to the nearest milligrams.

Data were statistically analyzed by SAS, 2004). Factors test using two ways ANOVA. Means were compared using Duncan´s range test (Duncan, 1955) where the level of significance was set at minimum ($P \leq 0.05$).

Treatments were assigned as the main factor, the statistical model performed as follow:

$$Yij = \mu + Ti + Lj + (T*L)\,ij + Eijk$$

Where

Yij= is the effect of the observation

μ = overall mean.

Ti = the effect of ith levels of nanoparticles.

Lj= the effect of the jth type of nanoparticles.

(T*L) ij= interaction between types and levels of nanoparticles.

Eijk = random error

Table (1): Composition and calculated analysis of starter grower and finisher diets

Ingredients	Diets		
	Starter*	**Grower***	**Finisher***
Yellow corn	55.76	59. 70	63.70
Soybean meal 48%	37.84	33.10	28.22
Soy oil	2.44	3.40	4.42
Bone meal	2.91	2.60	2.26
Limestone	0.24	0.35	0.50
HCL Lysine	0.00	0.04	0.08
DL Methionine (99%)	0.21	0.21	0.22
Salt	0.30	0.30	0.30
Premix**(Vit+Min)	0.30	0.30	0.30
Total	**100.00**	**100.00**	**100.00**
Calculated analysis* **			
Crude protein (%)	23.01	21.04	18.99
M E (kcal / kg)	3003	3102	3204
C \P ratio	130	147	168
Calcium (%)	1.00	0.95	0.90
Available phosphorus (%)	0.50	0.45	0.40
Methionine (%)	0.63	0.60	0.58
Methionine + Cysteine (%)	0.95	0.90	0.85
Lysine (%)	1.35	1.25	1.15

** Starter (1-14 day old), Grower (15-28 days- old) and finisher (29-35 day old).*

*** Each 3 kg contains: Vit A 12 000 000 IU, Vit D3 2 000 000 IU, Vit E 1g, Vit K3 2 g, Vit B1 1 g, Vit B2 5 g, Vit B6 1.5 g, Vit B12 10 mg, Nicotinic acid 30 g, Pantothenic acid 10 g, Folic acid 1 g, Biotin 50 mg Choline chloride 250 g, Iron 30 g, Copper 10 g, Zinc 50 g, Manganese 60 g, Iodine1 g, Selenium 0.1 g, Cobalt 0.1 g and carrier (CaCO3) to 3 kg.*

**** Calculated analysis according to NRC (1994).*

RESULTS AND DISCUSSION

Carcass and total edible parts percentages:

Table (2) was summarized carcass characteristics % at 35 days of the age of broiler chickens received different types (SNaPs & GNaPs) or levels of nanoparticles

As shown in Table (2) no significant differences have observed in percentages of carcass and total edible parts (TEP) between different types (SNaPs and GNaPs) of nanoparticles. The corresponding values for carcass % ranged between (68.82 and 70.35%), while, TEP % ranged between (73.20 and 74.80%) and abdominal fat % ranged between (1.17 and 1.18%). The significant differences among different types (SNaPs and GNaPs) of nanoparticles there weren't.

Numerically, the chicks received drinking water supplemented with 10.0 ppm nanoparticles had the highest percentages of carcass, TEP and abdominal fat% which recorded values (70.34, 75.03 and 1.35%) respectively compared with other treatments. These results agree with Ibrahim *et al.* (2015), Ognik *et al.* (2016), and El-Faham *et al.* (2017) who showed that the percentages of Dressing percentage and adipose fat hadn't affected significantly with treatments.

These results disagree with Vadalasetty *et al.* (2018) who showed that the percentage of dressing has affected significantly in the treated group compering with the control group.

The results shown that experimental treatments hadn't significant effect between the different levels of nanoparticles on most studied parameters. The corresponding values for values for liver % ranged between 2.33 and 2.51%, gizzard% ranged between 1.29 and 1.64%, heart % ranged between 0.41 and 0.53 %, also total giblets %ranged between 4.16 and 4.69 %. The differences failed to be significant compare to different dietary treatments. These results agree with Ahmedi and Rahimi (2011), Ognik *et* *al.* (2016) and Vadalasetty *et al.* (2018) who showed that the percentages of heart and liver weren't affected by treatments. However, these results differed with Mohammadi *et al.* (2015) and Felehgari *et al.* (2013) who indicated that treatments had significantly affected some carcass characteristics where the liver percentage increase significantly with different levels.

Immune organs percentages:

Results in Table (3) were comparing the different types and levels of nanoparticles on percentages of the immune organ.

It was revealed from obtained data that values of the immune organs (spleen and bursa) weight % showed no significant difference between types or levels of nanoparticles.

The corresponding values for spleen weight % ranged between 0.10 and 0.13 %, while bursa weight % ranged between 0.04 and 0.06 %, but the differences among treatments were insignificant. These results agree with Ibrahim *et al.* (2017) and Ibrahim *et al.* (2015) and Vadalasetty*et al.* (2018) who showed that the percentage of bursa wasn't affected by treatment. These results disagree with Ahmadi and Kurdestany (2010) showed that bursa percentage had decreased significantly with increasing in silver nanoparticles (SNaPs) levels.

Carcass parts percentages:

As shown in table 4 no significant differences have observed in percentages of carcass parts (breast, thigh, drumstick and wing %) between different types (SNaPs and GNaPs) or levels of nanoparticles.

Numerically, the chickens received drinking water supplemented with (GNaPs) had higher percentages of the breast (28.69 vs. 27.29%), thigh (18.11 vs. 17.97%) and wing (6.70 vs. 6.19%) compared with chickens received drinking water supplemented with (SNaPs).

On the other hand, chicks received drinking water supplemented with (10.0 ppm/l) had the highest percentages which recorded (29.99%) of breast and (19.52%) of thigh and chickens received drinking water supplemented with (5.0 ppm/l) had the highest percentages of drumstick and wing being (10.0 and 6.91%), respectively. The differences between treatments weren't significant. These results agree with Odunsi *et al.* (2007) and Ognik *et al.* (2016) who showed that the percentages of breast muscles and thigh muscles hadn't affected significantly with treatments.

CONCLUSION

All carcass traits, carcass cuts and immune organs% haven't affected by nether types or levels of nanoparticles (Graphene nanoparticles or silver nanoparticles).

Table (2): Supplementation of nanoparticles (SNaPs & GNaPs) in broiler drinking water on carcass characteristics

Items%	Type	Control	Levels				overall	Sig.			
			T1	T2	T3	T4		MSE	T	L	T*L
Carcass	SNaPs	68.84	67.58	68.90	68.93	69.84	68.82	4.38	NS	NS	NS
	GNaPs	68.84	72.84	69.12	70.10	70.83	70.35				
	Overall	68.84	70.21	69.01	69.52	70.34					
Liver	SNaPs	2.33	2.54	2.35	2.51	2.40	2.43	0.28	NS	NS	NS
	GNaPs	2.33	2.40	2.30	2.41	2.62	2.41				
	Overall	2.33	2.47	2.32	2.46	2.51					
Gizzard	SNaPs	1.29	1.37	1.46	1.47	1.64	1.44	0.24	NS	NS	NS
	GNaPs	1.29	1.58	1.70	1.56	1.64	1.55				
	Overall	1.29	1.47	1.58	1.51	1.64					
Heart	SNaPs	0.53	0.47	0.50	0.46	0.53	0.50	0.08	NS	NS	NS
	GNaPs	0.53	0.50	0.46	0.36	0.52	0.47				
	Overall	0.53	0.48	0.48	0.41	0.53					
Total Edible parts	SNaPs	73.00	71.97	73.23	73.38	74.42	73.20	0.53	NS	NS	NS
	GNaPs	73.00	77.33	73.59	74.44	75.63	74.80				
	Overall	73.00	74.65	73.41	73.91	75.03					
Abdominal fat	SNaPs	1.22	1.37	0.99	1.13	1.17	1.18	0.23	NS	NS	NS
	GNaPs	1.22	0.98	1.17	0.93	1.53	1.17				
	Overall	1.22	1.17	1.08	1.03	1.35					

*a,b: Means in the same row or column with the same letters are not significantly different. MSE: Mean standard error NS: Non-significant **: (P≤ 0.01) SNaPs= silver nanoparticles, GNaPs = graphene nanoparticles, T*L= the interaction between types and levels of nanoparticles.*

Table (3): Supplementation of nanoparticles (SNaPs & GNaPs) in broiler drinking water on immune organs.

Items%	Type	Control	Levels				overall	MSE	Sig.		
			T1	T2	T3	T4			T	L	T*L
	SNaPs	0.13	0.11	0.11	0.13	0.09	0.11				
Spleen	GNaPs	0.13	0.12	0.10	0.12	0.10	0.11	0.03	NS	NS	NS
	Overall	0.13	0.11	0.10	0.12	0.10					
	SNaPs	0.05	0.05	0.05	0.05	0.04	0.05				
Bursa	GNaPs	0.05	0.04	0.07	0.05	0.05	0.05	0.01	NS	NS	NS
	Overall	0.05	0.04	0.06	0.05	0.04					

*a,b: Means in the same row or column with the same letters are not significantly different. MSE: Mean standard error NS: Non-significant **: (P≤ 0.01) SNaPs= silver nanoparticles, GNaPs = graphene nanoparticles, T*L= the interaction between types and levels of nanoparticles.*

Table (4): Supplementation of nanoparticles (SNaPs & GNaPs) to broiler drinking water on carcass cuts.

Items%	Type	Control	Levels				Overall	MSE	Sig.		
			T1	T2	T3	T4			T	L	T*L
	SNaPs	27.00	20.95	31.40	29.28	27.83	27.29				
Breast	GNaPs	27.00	32.82	28.36	23.13	32.16	28.69	4.94	NS	NS	NS
	overall	27.00	26.88	26.88	26.20	29.99					
	SNaPs	17.51	17.43	18.21	18.06	18.62	17.97				
Thigh	GNaPs	17.51	18.11	19.29	15.23	20.41	18.11	1.68	NS	NS	NS
	overall	17.51	17.77	18.75	16.64	19.52					
	SNaPs	8.91	9.47	10.05	9.04	8.96	9.26				
Drum	GNaPs	8.91	8.39	9.96	8.79	8.79	9.21	1.21	NS	NS	NS
	overall	8.91	8.93	10.00	8.91	9.48					
	SNaPs	6.56	6.10	7.06	5.54	5.70	6.19				
Wing	GNaPs	6.56	6.95	6.77	5.93	7.31	6.70	0.90	NS	NS	NS
	overall	6.56	6.52	6.91	5.73	6.51					

*a,b: Means in the same row or column with the same letters are not significantly different. MSE: Mean standard error NS: Non-significant **: (P≤ 0.01) SNaPs= silver nanoparticles, GNaPs = graphene nanoparticles, T*L= the interaction between types and levels of nanoparticles*

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مقارنة تاثيرات اضافة جزيئات النانو (الفضة والجرافين) لمياه شرب دجاج اللحم

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اجريت الدراسة لتقييم تأثير جزيئات النانو فضة لماء شرب دجاج اللحم بالمقارنة بجزيئات النانو جرافين على صفات الذبيحة وطول والقناة الهضمية. استخدم في التجربة مائتين وسبعون كتكوت عمر يوم من هجين (Cobb 500) قسمت عشوائيا على 9 معاملات كل معاملة بها 3 مكررات و10 كتاكيت بكل مكرر. المعاملات الغذائية كالتالي (0.0 و2.5 و5.0 و 7.5 و10.0) جزء في المليون/ لتر ماء شرب من كلا النوعين من جزيئات النانو (فضة او الجرافين) (بالإضافة لمجموعة الكنترول

فى نهاية التجربة (٣٥يوم) اختير ٤ فرخات من كل معاملة لدراسة صفات الذبيحة والقطعيات نسبة الاعضاء المناعية

تتلخص النتائج فيما يلي:

1. صفات الذبيحة لم تتأثر بالمعاملات المختلفة (٪ للذبيحة٪للحوائج٪للاجزاء الكلية الماكولة٪دهن البطن) وكذلك ٪للقطعيات (صدر/فخد/دبوس/جناح)
2. لم يتأثر الوزن النسبى للبرسا والطحال بالانواع أو المستويات المختلفة من جسيمات النانو

أوضحت النتائج أن إضافة جزيئات النانو (الفضة أو الجرافين) لماء شرب دجاج اللحم بالمستويات المختلفة لم يؤثر على صفات الذبيحة أو النسبة المئوية للاعضاء لمناعية.