Egyptian J. Anim. Prod., 59, Suppl. Issue, May (2022):51-55

EFFECTS OF NANO-GRAPHENE AS A WATER SUPPLEMENTATION ON PRODUCTIVE PERFORMANCE, CARCASS TRAITS AND BONE MEASUREMENTS OF BROILER CHICKENS

A.M. Tammam[1], S.A. Ibrahim[1], A.A. Hemid[1], F. Abdel-Azeem[1], A.I.El-Faham[1], Nematallah G.M. Ali[1] and W. Salem[2]

1- Faculty of Agriculture, Ain Shams University, Cairo, Egypt, 2- Faculty of Science, South Valley University, Qena, Egypt

SUMMARY

The aim of the present study was to estimate the effects of graphene nanoparticles (GNaPs) as a water supplementation on broiler chickens growth performance, carcass characteristics and bone measurements at five weeks of age. In total, 150 1 day old Cobb 500 mixed sex broiler chicks were used in 5 treatments (30 chicks each), within 3 replicates and 10 chicks per each replicate. The experimental drinking water were prepared using (0.0, 2.5, 5.0, 7.5 and 10 ppm GNaPs). At the end of the experiment 4 birds of each treatment were slaughtered to estimate carcass characteristics and bone measurements.

The results showed that:

1- Productive performance (LBW, BWG and FI) increased significantly for birds received 10 ppm GNaPs in drinking water, on the other hand, FCR didn't differ between treatments.

2- All carcass traits (carcass%, giblets% and total edible parts%) and carcass cuts (breast%, thigh%, drumstick% and wing%) were numerically higher for birds received 10 ppm GNaPs in drinking water.

3- Tibia measurements weren't affected significantly by different levels of GNaPs in drinking water except tibia breaking strength and ash%.

In conclusion, supplemented 10 ppm graphene nanoparticles in broiler drinking water can improve growth performance without negative effect on carcass characteristics or bone measurements.

Keywords: Graphene, nanoparticles, performance, broiler

INTRODUCTION

Graphene nanoparticles, graphite nanoparticles, or charcoal nanoparticles are different structural combinations for carbon nanoparticles.

Graphene is a thick atom substance consisting of carbon bound to beta-sp2 in the structure of the honeycomb. Graphene reduces cell adhesion when it enters the cytoplasm and nucleus (Wang *et al.*, 2011).

Saminathan *et al.*. (2018) studied the effect of feeding broiler chicks diets supplemented with graphene nanoparticles on performance of broilers. The experimental treatments were basal diet (broilers fed a diet with neither AF nor MGO-CTS added, T1), basal diet + 0.25% MGO-CTS (T2), basal diet+ 0.50% MGO-CTS (T3),AF diet + 0.25% MGO-CTS (T4), AF diet + 0.50% MGO-CTS (T5), and AF diet (T6). The results showed that LBW, and BWG improved significantly by using graphene nanoparticles in broiler diets.

The growth of Gram-positive, Gram-negative and *Escherichia coli* bacteria have been affected significantly by the sharp edges of the reduced graphene nanoparticles (Akhavan and Ghaderi, 2010). Park (2010) also they found that graphene is noncytotoxic to the mammalian cells.

Graphene oxide nanocomposites (MGO) have demonstrated the efficiencies in the absorption of AFs, ochratoxin A, and zearalenone (Pirouz *et al*., 2017), such as efficiencies of hydrated sodium calcium aluminosilicate (HSCAS), sodium bentonite and zeolites and modified materials Montmorillonites treated with organic cations14, chitosan polymers15 and yeast16. However, these adsorbents have been shown to be effective against one or two specific mycotoxin, and are relatively expensive unlike MGO which its cost is relatively cheap (Var *et al.,* 2008, Jaynes and Zartman 2011, and Deng 2013).

Magnetic nanoparticles have been widely used in environment remediation due to their ease of separation from aqueous mixtures (Deng 2013). The novelty of this study is the use of magnetic graphene oxide nanocomposites (MGO) as an adsorbent to remove Fusarium mycotoxins in animal feed. As noted, the adsorption of $FB^1$and FB^2 are dependent on their solubility according to polarity and other characteristics affecting toxin reduction (Boudergue 2009). Hence, more than 70% of the response variability can be explained as a reduction in Fusarium toxins by MGO.

This novel adsorbent involves the transformation of surface properties by exchanging structural charge-balance cations with high-molecular weight quaternary amines and increasing the amount of carbon, resulting in an increased adsorption capacity for removing multi–mycotoxins. Nano-composite magnetic graphene oxide with chitosan MGO-CTS can primarily act as an adsorbent to bind AFs and to reduce mycotoxin effects on broilers (Saminathan *et al.*, 2018).

Graphene nanoparticles are the latest nanomaterials used in the field of animal production. Therefore, there might be a scanty of researches on this substance in poultry feed or drinking water.

The aim of the present experiment was to test the effect of graphene nanoparticles as a water supplementation on productive performance, carcass traits and bone measurements in broiler chicks.

MATERIALS AND METHODS

The present study was conducted in the poultry nutrition laboratory, Faculty of Agriculture, Ain Shams University, Shalakan, Kaliobia Governorate. A total of hundred and fifty unsexed broiler chicks (Cobb 500), one-day old, were randomly divided into 5 treatments of 30 chicks each and divided into 3 replicates of 10 bird each in a completely randomized design. Chicks were kept under similar conditions of managements throughout the experimental period (1-35 days of age). The 5 treatments were prepared using 0.0, 2.5, 5.0, 7.5 and 10.0 ppm Graphene nanoparticles supplemented to drinking water. Diets were formulated to meet requirements based on the manual guide of Cobb 500 broiler chicks strain and composition of basal diets according to NRC (1994) were presented in Table (1). Chicks were weighted and feed intake was recorded weekly. Body weight (BW), body weight gain (BWG) and feed conversion ratio (FCR) were obtained. At the end of the experiment (35 days of age), four chicks were randomly taken from each treatments and slaughtered to determine the percentage of carcass, liver, heart, gizzard, abdominal fat, spleen, bursa, and carcass cuts. Bone quality measurements were evaluated using wet and dry tibia weight, tibia length, tibia width, seeder index and tibia breaking strength.

Data were analyzed statistically using general linear model (GLM) procedure of SAS (SAS, 2004) and Duncan's Multiple range test (Duncan, 1955).

Table 1. Composition and calculated chemical analysis of starter, grower and finisher diets

	Diets		
Ingredients	**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 was done according to NRC (1994).

RESULTS AND DISCUSSION

Growth performance:

Table (2) presents the mean ± SE of body weight, body weight gain, feed intake, feed conversion ratio and European production efficiency factor of broiler chicks consumed water supplemented with different levels of graphene nanoparticles (GNaPs). At 28 days of age the average of body weight and body weight gain were insignificantly increased with (10.0 ppm), GNaPs supplementation. The same trend was more pronounced at 35 days of age. In general, at 35 days of age, chicks with (10.0 ppm, GNaPs) supplementation had the heaviest body weight (1949.48 g/ chick) and the best body weight gain (1905.95 g/ chick) in comparison with the control group (1829.15 and 1784.99 g), respectively.

At 35 days of age there were significant differences in feed intake throughout the entire experimental period (0-35 days of age) compared to the control group except (T_3, 7.5 ppm, GNaPs). Also, chicks received water containing 10.0 ppm GNaPs gave the highest feed intake (2901.32 vs. 2751.38 g) compared with the control group. On the other hand, feed conversion ratio at 35 days wasn't significantly different between treatments. Also, chicks received water containing (2.5 or 7.5 ppm) GNaPs gave the best figures (1.51) compared with other treatments, however, differences among treatments were insignificant. These results agreed with those of Odunsi *et al.* (2007), Abu Bakr (2008), Majewska *et al.* (2011), Khadem *et al.* (2012), and Saminathan *et al.* (2018).

Table 2. Effect of different levels of graphene nanoparticles in broiler drinking water on productive performance

Items	Treatments					MSE	Sig.
	0	2.5	5	7.5	10		
Live body weight (g)							
0 day-old	44.16	45.03	44.33	43.56	43.83	0.75	**NS**
14 day-old	470.20	486.50	461.80	466.97	463.43	16.18	**NS**
28 day-old	1227.03	1276.39	1245.78	1233.36	1256.78	49.30	**NS**
35 day-old	1829.15[b]	1871.62[ab]	1876.94[ab]	1811.36[b]	1949.78[a]	32.17	**
body weight gain (g)							
0-14 day-old	426.03	441.46	417.46	423.40	419.60	16.24	**NS**
14-28 day-old	756.83	789.89	783.98	766.38	793.34	43.02	**NS**
28-35 day-old	602.12	603.08	631.15	584.00	685.95	58.81	**NS**
0-35 day-old	1784.99[b]	1826.58[ab]	1832.61[ab]	1774.80[b]	1905.95[a]	31.90	**
Feed intake (g)							
0-14 day-old	536.37	541.13	552.03	526.94	544.73	25.24	**NS**
14-28 day-old	993.36	996.03	996.30	997.56	997.76	3.91	**NS**
28-35 day-old	1221.64[bc]	1231.59[bc]	1280.79[b]	1177.99[c]	1358.82[a]	26.12	**
0-35 day-old	2751.38[bc]	2768.75[bc]	2829.12[b]	2702.50[c]	2901.32[a]	42.27	**
Feed conversion ratio (g .feed/g .gain)							
0-14 day-old	1.26	1.23	1.32	1.24	1.29	0.06	**NS**
14-28 day-old	1.31	1.26	1.27	1.30	1.26	0.06	**NS**
28-35 day-old	2.03	2.05	2.03	2.01	1.98	0.14	**NS**
0-35 day-old	1.54	1.51	1.54	1.51	1.52	0.01	**NS**
Performance index							
0-35 day-old	120.54	120.71	123.30	122.74	123.27	4.48	**NS**
European production efficiency factor							
0-35 day-old	330.86[b]	347.38[ab]	339.64[ab]	333.57[ab]	355.72[a]	8.58	*

a,b: Means in the same row with the same letters are not significantly different. MSE: Mean standard error NS: Non-significant *: (P≤ 0.05), **: (P≤ 0.01).

Table (2) showed a significant improvement on EPEF in treated groups compared with control. These results might be related to that LBW, BW and feed intake were affected significantly by treatments. However, chicks received water containing (10.0 ppm GNaPs) gave the highest figures (123.27 and 355.72) compared with other treatments, whereas the control group gave the lowest figures being (120.54 and 330.86), respectively.

Carcass characteristics:

Data for carcass characteristics and parts of slaughtered broiler from different treatments are presented in Table (3). No significant differences in all studied traits were observed due to the experimental treatments ,but there were an increase in carcass, giblets and total edible parts percentages by supplementing 2.5 and 10.0 ppm GNaPs compared with those fed control diets, the corresponding figures were (72,84 and 70.83 vs. 68.84 for carcass%), (4.49 and 4.80 vs. 4.13 for giblets%) and (77.34 and 75.64 vs. 73.00 for total edible parts%), respectively. Moreover, there was a little increase in breast% and figures being (31.02 and 32.16 vs. 28.69%), respectively, without any significant differences.

These findings are in contrast with those of Odunsi *et al.* (2007), and, Khadem *et al.* (2012) who reported that there were significant effects of different levels of charcoal on percentage of carcass and abdominal fat. On the other hand, Majewska *et al.* (2011), Jila *et al.* (2014), and Saminathan *et al.* (2018) found that carbon; charcoal or graphene nanoparticles did not significantly affect carcass traits of broiler chickens.

Table 3. Effect of graphene nanoparticles in broiler drinking water on some carcass characteristics

Items	Treatments					MSE	Sig.
	0	2.5	5	7.5	10		
<u>Carcass characteristics %</u>							
Carcass	68.84	72.84	69.12	70.10	70.83	4.66	**NS**
Liver	2.30	2.40	2.33	2.41	2.62	0.19	**NS**
Gizzard	1.29	1.58	1.70	1.56	1.65	0.26	**NS**
Heart	0.53	0.50	0.46	0.46	0.52	0.09	**NS**
Giblets	4.13	4.49	4.50	4.43	4.80	0.40	**NS**
Total edible parts	73.00	77.34	73.59	74.44	75.64	4.70	**NS**
Abdominal fat	1.07	0.98	0.98	0.91	1.14	0.13	**NS**
spleen	0.13	0.12	0.10	0.12	0.10	0.03	**NS**
Bursa of Fabricius	0.05	0.05	0.07	0.05	0.05	0.01	**NS**
<u>Carcass cuts %</u>							
Breast	28.69	31.02	30.13	26.06	32.16	1.67	**NS**
Thigh	17.52	18.12	19.29	15.23	20.41	1.42	**NS**
Drumstick	8.91	8.39	9.96	8.79	9.99	1.38	**NS**
Wing	6.57	6.95	6.77	5.93	7.31	0.79	**NS**
Nick	4.63	4.07	4.53	3.47	4.58	0.44	**NS**

a,b: Means in the same row with the same letters are not significantly different. MSE: Mean standard error NS: Non-significant.

Bone measurements:

Tibia measurements of slaughtered birds from different treatments are presented in Table (4). The results showed that, there were no significant differences between treatments in physical measurements (wet and dry tibia weight (g), tibia length and widths (mm) or seedor index) or chemical measurements (organic matter, calcium and phosphorus percentages).

On the other hand, tibia breaking strength (Kg/ cm^2) and ash% indicated significant difference between treatments and the highest breaking strength was detected for the chicks in 7.5 ppm GNaPs being (39.58 Kg/ cm^2), while the highest ash % was detected for the chicks in all GNaPs treatments except 7.5 ppm being (45.15m 44.20 and 43.62 vs. 40.54% for control group) and the difference between treatments were significant.

Table 4. Effect of graphene nanoparticles in broiler drinking water on some bone parameters

Items	Treatments					MSE	Sig.
	0	2.5	5	7.5	10		
Wet Tibia Weight(g)	13.75	14.50	13.25	16.00	15.00	3.74	**NS**
Dry Tibia Weight (g)	6.69	6.93	6.62	7.92	7.24	1.86	**NS**
Tibia length (mm)	84.72	88.91	89.44	87.37	88.34	3.14	**NS**
Tibia Width (mm)	7.25	7.25	6.38	6.59	7.09	0.80	**NS**
Seedor index	0.80	0.78	0.84	0.91	0.82	0.19	**NS**
Tibia Breaking Strength(Kg/cm^2)	37.58^{ab}	28.49^{c}	29.75^{c}	39.58^{a}	35.84^{b}	1.29	**
Ash %	40.54^{b}	45.15^{a}	44.20^{ab}	40.32^{b}	43.62^{ab}	2.47	*
Organic matter %	58.88	57.54	55.50	60.76	56.56	1.83	**NS**
Calcium %	15.89	15.89	15.24	14.80	16.00	1.66	**NS**
Phosphorus %	9.49	9.07	9.86	9.32	9.57	0.47	**NS**

a,b: Means in the same row with the same letters are not significantly different. MSE: Mean standard error NS: Non-significant *: ($P\leq 0.05$),**: ($P\leq 0.01$).

CONCLUSION

Findings of this study indicated that broilers chicks consuming drinking water supplemented with 10.0 ppm GNaPs can achieve maximum productive performance without any side effects.

REFERENCES

Abu Bakr B.E., 2008. The effect of using citrus wood charcoal in broiler rations on the performance of broilers. An - Najah Univ. J. Res. (N. Sc.), 22:19-24.

Akhavan, O. and E. Ghaderi, 2010. Toxicity of graphene and grapheneoxide nano walls against bacteria. American Chem. Soci.Nano,4:10: 5731-5736.

Aly, S. E., M. M.Abdel-Galiland M. A. Abdel-Wahhab, 2004. Application of adsorbent agents technology in the removal of aflatoxin B (1) and fumonisin B (1) from malt extract. Food and chem. Toxi.: an int. J. published for the British Industrial Bio. Res. Asso, 42:1825–1831.

Boudergue, C. (2009). Review of mycotoxin-detoxifying agents used as feed additives: mode of action, efficacy and feed/food safety. **https://doi.org/10.2903/sp.efsa.2009.EN-22**

Duncan, D.B., 1955. Multiple range and multiple F test. Biometrics 11: 1-42.

Deng, J.H., 2013. Simultaneous removal of Cd (II) and ionic dyes from aqueous solution using magnetic graphene oxide nanocomposite as an adsorbent. Chem. Eng. J. 226, 189–200.

Jaynes, W. F. and R.E. Zartman, 2011. Aflatoxin toxicity reduction in feed by enhanced binding to surface-modified clay additives. Toxi. 3, 6, 551–565, https://doi.org/10.3390/toxins3060551

Khadem A.A., D.Sharifi, M.Barati and. M. Borji, 2012. Evaluation of the effectiveness of yeast, zeolite and active charcoal as aflatoxin absorbents in broiler diets. Glo. Veter. J. 8, 4: 426-432

Majewska. T., K.Pudyszak and K.kozłowski, 2011. The effect of charcoal addition to diets for broilers on performance and carcass parameters. Veter. IRzootechn. (vet med zoot). 55, 77: 30-32.

NRC., 1994. Nutrient Requirements of Poultry. 9th rev. ed. Natl. Acad. Press, Washington, DC.

OdunsiA.A., T.O.Oladele, A.O.Olaiya and O.S. Onifade, 2007. Response of broiler chickens to wood charcoal and vegetable oil based diets. Worl. J. of Agri. Sci.3, 5: 572-575.

Papaioannou, D., P. D.Katsoulos, N. Panousis and H.Karatzias, 2005.The role of natural and synthetic zeolites as feed additives on the prevention and/or the treatment of certain farm animal diseases: A review. Micro. and Meso. Mater. 84, 1-3, 161–170.

Park, S., 2010. Biocompatible, robust free-standing paper composed of a TWEEN/graphene composite. Adv. Mater. 22, 15: 1736–1740

Pirouz A. A., J. Selamat, S. Z. Iqbal, H. Mirhosseini, R. AbediKarjiban and F. Abu Bakar, 2017. The use of innovative and efficient nanocomposite (magnetic graphene oxide) for the reduction on of Fusarium mycotoxins in palm kernel cake.Sci. Reports , 7,1: 134–158.

Saminathan, M., J. Selamat, A.A. Pirouz, N. Abdullah and I. Zulkifli, 2018. Effects of nano-composite adsorbents on the growth performance, serum biochemistry, and organweights of broilers fed with aflatoxin-contaminated feed. Toxins 10, 345: 1-15.

SAS., 2004. SAS procedure Guide, Version 6.12 th. SAS Institute, Cary, NC., USA.

Var, I., B. Kabak and Z. Erginkaya, 2008. Reduction in ochratoxin A levels in white wine, following treatment with activated carbon and sodium bentonite. Food Control 19, 592–598

Wang JT, C. Chen, E. Wang and Y. Kawazoe, 2011. A new carbon allotrope with six-fold helical chains in all-sp2 bonding networks. Sci Rep. 4: 4339.

تأثيراضافة نانو الجرافين لماء الشرب على الأداء الإنتاجي وخصائص الذبيحة وقياسات عظام دجاج التسمين

احمد محمد تمام [1]، سيد عبد الرحمن ابراهيم [1]، علاء الدين عبد السلام حميد [1] ، فتحي عبد العظيم [1]، احمد ابراهيم سليمان الفحام [1] ، نعمت الله جمال الدين علي [1] ووسام محمد على سالم [2]

1- كلية الزراعة، جامعة عين شمس، القاهرة، مصر، 2- كلية العلوم، جامعة جنوب الوادى، قنا، مصر

الهدف من هذه الدراسة هو تقدير تأثير جزيئات النانو الجرافين (GNaPs) كاضافة لماء الشرب على الأداء الانتاجي لدجاج التسمين وخصائص الذبيحة وقياسات العظام عند عمر خمسة أسابيع. تم استخدام 150 كتكوت تسمين غيرمجنس Cobb 500 بعمر يوم وقسمت الي 5 معاملات (30 كتكوت لكل منهما) ، في 3 مكررات و 10 كتكوت لكل مكرر. تم اضافة النانو جرافين لماء الشرب بمعدل (0.0 ، 2.5 ، 5.0 ، 7.5 ، 10 جزء في المليون من GNaPs). في نهاية التجربة تم ذبح 4 طيور من كل معاملة لتقدير خصائص الذبيحة وقياسات العظام.

أظهرت النتائج ما يلي:

1- زاد الأداء الإنتاجي (LBW و BWG و FI) بشكل ملحوظ للطيور التي حصلت على 10 جزء في المليون من النانو جرافين في مياه الشرب ، من ناحية أخرى لم يختلف معدل التحويل الغذائي (FCR) بين المعاملات.

2- جميع صفات الذبيحة (الذبيحة٪ ، الحوصلة٪ وإجمالي الأجزاء الصالحة للأكل٪) وقطع الذبيحة (الصدر٪ ، الأفخاذ ، أفخاذ٪ والأجنحة) ارتفعت بصورة غير معنوية للمعاملة التي حصلت على 10 جزء في المليون من النانو جرافين في مياه الشرب.

3- لم تتأثر قياسات الساق بشكل معنوي بمستويات مختلفة من GNaPs في مياه الشرب باستثناء قوة كسر الساق ونسبة الرماد.

الإستنتاج:

إضافة 10 جزء في المليون من الجرافين النانوي في مياه الشرب لدجاج التسمين يمكن أن يؤدي إلى تحسين معدلات النمو دون التأثير السلبي على خصائص الذبيحة أو قياسات العظام.