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EFFECT OF LEAD POLLUTED DIETS ON GROWTH AND PRODUCTIVE EFFICIENCY OF JAPANESE QUAIL AND ITS ALLEVIATION BY DIETARY PECTIN SUPPLEMENTATION

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ABSTRACT: The present study was carried out to test the effect of using pectin to alleviate the toxic effect of lead on absolute growth rate, relative growth rate and productive efficiency in Japanese quail. A total number of 336 Japanese quail chicks (one week old), were randomly divided into 7 groups (48 chicks/each group), each group had 4 replicates (12 chicks/each). Quail chicks in all treatments were similar in the average initial body weight (38.7 g). A completely randomized design experiment was performed including seven groups. The first group of birds was served as control. While the 2^{nd} and 3^{rd} group of quails fed a diet supplemented with 1.0 and 3.0 g of pectin/kg diet, respectively. The 4^{th} and 5^{th} groups fed a diet supplemented with 0.5 and 1.0 g of lead/kg diet, respectively. The 6^{th} and 7^{th} groups fed a diet supplemented with 1.0 g of pectin and 0.5 g of lead/kg diet and 3.0 g of pectin and 1.0 g of lead/kg diet, respectively. Growth performance including absolute growth rate, relative growth rate and production efficiency were studied. The results of the present work could be summarized as follows: Quail birds fed the control diet and those fed diet containing pectin level of 3 g/kg diet and lead as 0.5 g/kg diet showed significantly ($P<0.01$) the highest measure in each of absolute growth rate and relative growth rate. The productive efficiency of quails treated by pectin at 1 g/kg and 0.5 lead g/kg diet showed the lowest estimates in comparison with the other groups without significant differences. In conclusion, pectin could be used in quail diets to diminish the deleterious effects of lead.

Key words: Lead, pectin, growth performance, quail.

INTRODUCTION

The contaminations of poultry diets with heavy metals remain a problem for poultry industry, food safety regulatory agencies and concerned consumers **(Abou-Kassem *et al.*, 2016)**. The contaminations of poultry rations with heavy metals cause a high reduction in growth rate, feed efficiency and egg production, which result finally great economical loss for poultry farms. Nearly, all potential food ingredients contain some kinds of heavy metals, such as lead,which are usually associated with tendency to accumulate in living organisms and are highly toxic when adsorbed into body **(Wan Ngah *et al.*, 2004; Abd El-Rahman *et al.*, 2014)**. The level of an individual trace element varies among the large diversity of foods but is generally consistent for a specific food product **(Ibrahim *et al.*, 2012)**.

Lead (Pb) is abundant in the environment from different sources include automotive gasoline piston engines, oil burners, lead pipes, incinerators, industrial effluents and smokestack fallout (**Sharma and Street 1980; Ravichandran, 2011**). The direct neurotoxic actions of Pb include apoptosis, excitotoxicity. Pb has been also associated with impaired neurobehavioral functioning in children, decrements in intelligence quotient **(Ciobanu *et al.,* 2012)**. Low concentrations of Pb can be found in tissues of clinically normal birds and animals **(Doganoc, 1996; Hamidipour *et al.*, 2016).**

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The use of new additives in the diet to eliminate heavy metals should not cause negative effects on animal performance and on cost-benefit analysis **(Silva *et al.*, 2013)**.

Pectin is a complex mixture of polysaccharides (heteropolysaccharide consisting of mainly residues of galacturonic acid) in the primary cell wall and the middle lamella of plant tissue that make up about one third of the dry matter of the cell wall in most plants **(Brouns *et al.*, 2012; Abd El-Rahman *et al.*, 2014; Hosseini *et al.*, 2016; Kuchkarova and Kudeshova, 2016)** and are extremely variable in chemical structure **(Langhout and Schutie, 1996)**. Pectin is also used in the pharmaceutical industry to decrease blood fat, soothe pain **(Liu *et al.*, 2010)**, and decrease heart disease and gallstones **(Bagherian *et al.*, 2011)**. Because of its functional and nutritional properties, the demand for pectin in the world market is in excess of 30,000 tons annually, with a growth rate of about 4–5% per annum **(Hosseini *et al.*, 2016)**.

Due to its properties pectin swells in the gastrointestinal tract, forming a gelatinous mass that adsorbs undigested food residues, binds and removes cholesterol and other toxic substances and waste products from the body, improves blood circulation and intestinal peristalsis **(Thakur *et al.*, 1997; Zhao *et al.*, 2008; Kuchkarova and Kudeshova, 2016)**. **Saki *et al.* (2011)** concluded that a higher ratio of pectin to cellulose induces more variations in the intestinal morphology of broiler chickens, especially at 14 days of age.

Japanese quail (*Coturnix japonica*) is suitable as a model for the study of toxicity in animals for being readily available, easy to handle, maintainable under laboratory conditions, much lower feed and space requirement than the domestic fowl, disease resistance, economic viability in farming and small size which accelerates the accumulation of heavy metals in their tissues just in two weeks (**Farghly *et al.*, 2015; El-Sheikh *et al.*, 2016**). Japanese quail emerged as one of the important species of poultry in Egypt and it was gradually occupied its place in food basket.

The present study aimed to investigate the effects of lead polluted diets and its alleviation by pectin on growth performance of growing Japanese quail under Sharkia Governorate conditions, Egypt.

MATERIALS AND METHODS

This work was carried out at Poultry Research Farm, Poultry Department, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt. A total number of 336 Japanese quail chicks of one week age were randomly divided into 7 groups (48 birds/ each), each group of birds had 4 replicates (12 per each), where each replicate was housed in one cage. A completely randomized design experiment was performed including seven groups (the experimental design is presented in Table 1). The first group of birds was served as a control. The second and third groups of quails fed a diets supplemented with 1.0 g and 3.0g of pectin/kg diet, respectively. The fourth and fifth groups fed diets supplemented with 0.5 g and 1.0g of lead/kg diet, respectively. The sixth group fed a diet supplemented with 1.0 g of pectin and 0.5 g of lead/kg diet. While the seventh group fed a diet supplemented with 3.0 g of pectin and 1.0 g of lead/kg diet.

The basal experimental diet was formulated to cover the nutrient requirements of growing Japanese quails as recommended by **NRC (1994)** as shown in Table 2. The birds were fed the contaminated diets and were reared during the experimental period in cages (dimensions of 30 × 30 × 30 cm), under the same managerial, hygienic and environmental conditions.

Birds were daily exposed to continuous light during the first week then the light was decreased by one hour during the rest of the experimental period. Where the light intensity was 15-20 Lux. The quail chicks were fed *ad-libitum* and fresh water was available during the whole experimental period, where drinkers and feeding troughs were daily cleaned.

The investigated measurements were absolute growth rate, relative growth rate and production efficiency. Absolute growth was calculated according to the following equation:

Absolute growth rate = Final body weight (at 6 weeks of age) – The initial body weight (at 1 week of age).

The relative growth rate was calculated according the following equation:

Relative growth rate (%) = (the final body weight – the initial weight)×100/the initial body weight

Table 1. Experimental design

Group	Number	Ration	
		Lead	Pectin
1	48(4R)	Control	Control
2	48(4R)	0	1.0 g/kg diet
3	48(4R)	0	3.0 g/kg diet
4	48(4R)	0.5 g/kg diet	0
5	48(4R)	1.0 g/kg diet	0
6	48(4R)	0.5 g/kg diet	1.0 g/kg diet
7	48(4R)	1.0 g/kg diet	3.0 g/kg diet

Table 2. Composition and calculated analysis of the experimental diet during 1 – 6 weeks of age in Japanese quail

Ingredient	Percentage
Yellow corn	52.5
Soybean meal	38.2
Corn gluten 60%	4.30
Vegetable oil	1.60
Di-calcium phosphate	1.60
Limestone	0.90
Nacl	0.30
Premix (1)	0.30
L-lysine	0.03
DL methionine	0.07
Choline chloride	0.20
Calculated analysis (%)(2)	
CP	24.15
ME kcal/kg	2904
Ca	0.80
Avail, P (%)	0.46
Lysine	1.31
Methionine	0.50
Methionine+ Cystine	0.82

(1) Growth vitamin and Mineral premix, each 1 kg contains of: Vitam. A 12000, 000 IU; Vitam. D3, 2000, 000 IU; Vitam. E. 10g; Vitam. k3 2 g; Vitam. B1, 1000 mg ; Vitam. B2, 49g ; Vitam. B6, 105 g; Vitam. B12, 10 mg; Pantothenic acid, 10 g; Niacin, 20 g , Folic acid , 1000 mg ; Biotin, 50 g; Choline Chloride, 500 mg, Fe, 30 g; Mn, 40 g; Cu, 3 g; Co, 200 mg; Si, 100 mg and Zn, 45 g.

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

Live weight average (LW), livability (LA), slaughter age (SA) and feed conversion ratio (FCR) were accepted such as technical indicators of production, and production efficiency (PEF) was calculated with the following formula (**Tandoğan and Cicek, 2016**):

$$PEF = \frac{LW\ (kg) \times LA\ (\%)}{SA\ (days) \times FCR\ (kg)} \times 100$$

Where:

LW (kg) = Live weight average at the end of the rearing period, LA (%) = Livability (number of birds alive at the end of the rearing period relative to the number of chicks placed), SA (days) = Slaughter age of chicks, FCR (kg) = Cumulative feed intake (kg)/total weight gain (kg).

Data were statistically analyzed on a completely randomized design using the SAS General Liner Models Procedure **(SAS, 2002)** basis according to **Snedecor and Cochran (1982)** using the following model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where:

Y_{ij} = an observation, μ = the overall mean, T_i = effect of treatment level (i = 1 to7), and e_{ij} = random error. Differences among means were tested using Duncan's New Multiple Rang test **(Duncan, 1955)**.

RESULTS AND DISCUSSION

Results related to growth performance (absolute growth rate, relative growth rate and productive efficiency percentage) are shown in Table 3 and Figs. 1, 2 and 3.

Quail birds fed the control diet and those fed diet containing pectin level as 3 g/kg diet and those fed diet containing lead as 0.5 g/kg diet showed significantly ($P<0.01$) the highest measures in relative growth rate and absolute growth rate. The productive efficiency of quails treated by pectin at 1 g/kg feed and 0.5 lead g/kg diet showed the lowest estimates in comparison with the other groups without significant differences (Table 2 and Fig. 3). These results clearly indicate that lead cause a remarkable decreases in the absolute growth and the productive efficiency. The obtained results completely confirmed the possibility of using pectin as a food supplementation for alleviating the diverse effects of lead poisoning.

Prolonged toxicity of lead metal is associated with the fact that the lead is able to be accumulated in the body **(Kuchkarova and Kudeshova, 2016)**. Quails have the ability to accumulate lead in their tissues, especially in liver than muscles **(Hamidipour *et al*., 2016)**. For that reason, group of quails had access to a diet containing 0.5 g of lead/ kg diet had similar growth rate as those of the control group.

In the present work, the quail birds fed diets supplemented with pectin did not show greater growth in comparison with the control group. The explanation for this may be due to that gel-forming carbohydrates such as pectin probably delay gastric emptying by increasing gastric viscosity **(Sandhu *et al*., 1987)**. This in turn would increase satiety and reduce the capacity or the desire of the animal to consume more feed **(Razdan *et al*., 1997)**.

Reduction of the body weight in quails exposed to lead intoxication has been also observed in other researches **(Ibrahim *et al*., 2012; Metwally *et al*., 2015; Kuchkarova and Kudeshova, 2016)**. The reduction in growth rate in quails might be related to metabolic disorders associated with transfer of zinc dependent enzyme activity **(Kuchkarova and Kudeshova, 2016)**. The latter authors added that an important part in decreasing growth rate in lead treated quails can play a reduction in the activity of brush border carbohydrases of the small intestine.

The effect of dietary pectin on the performance of broiler chicks is strongly influenced by the degree of esterification or the origin of the pectin product, and the amounts that are added to the diet **(Langhout and Schutie, 1996)**. Pectin levels in the broiler`s diet affect intestinal transit time, excreta moisture content and feed digestibility according to the developmental phase of the broiler **(Silva *et al*., 2013)**. The latter authors indicated that intestinal viscosity increases as pectin ingestion increases. Intestinal transit time and intestinal viscosity have a higher influence on feed digestibility at growth stage. Therefore, the addition of pectin to the feed improved growth performance of broilers at the starter phase.

Table 3. Means ($\overline{X}$ ± SE) of absolute growth rate, relative growth rate and productive efficiency of Japanese quail as affected by pectin and lead treatments

Item	Absolute growth rate (g, 1-6 weeks)	Relative growth rate (%, 1-6 weeks)	Productive efficiency
Control	189.98±2.08[a]	142.14±0.49[a]	179.77±8.32
Pectin 1 g/kg	180.27±2.74[b]	139.94±0.74[ab]	169.87±8.33
Pectin 3 g/kg	189.59±2.81[a]	142.00±0.54[a]	193.92±5.11
Lead 0.5 g/kg	189.62±2.20[a]	142.06±0.46[a]	187.54±9.64
Lead 1 g/kg	175.35±4.16[b]	138.65±1.07[b]	173.94±10.22
Pectin 1 g + lead 0.5 g	181.75±3.08[ab]	140.28±0.77[ab]	163.36±5.10
Pectin 3 g + lead 1 g	176.14±1.57[b]	139.00±0.41[b]	184.66±8.54
Significance	**	**	**NS**

** P<0.01 and NS = Not significant.
Means in the same column within each classification with different letters differ significantly (P<0.05).

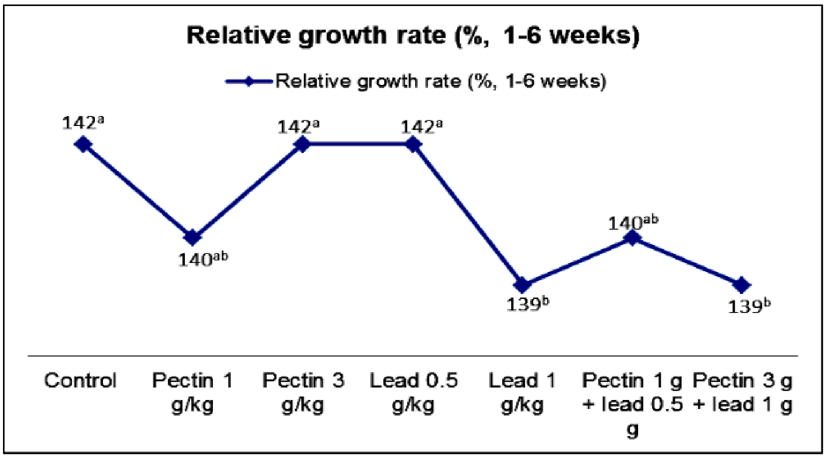

Fig. 1. Relative growth rate of Japanese quail as affected by pectin and lead levels

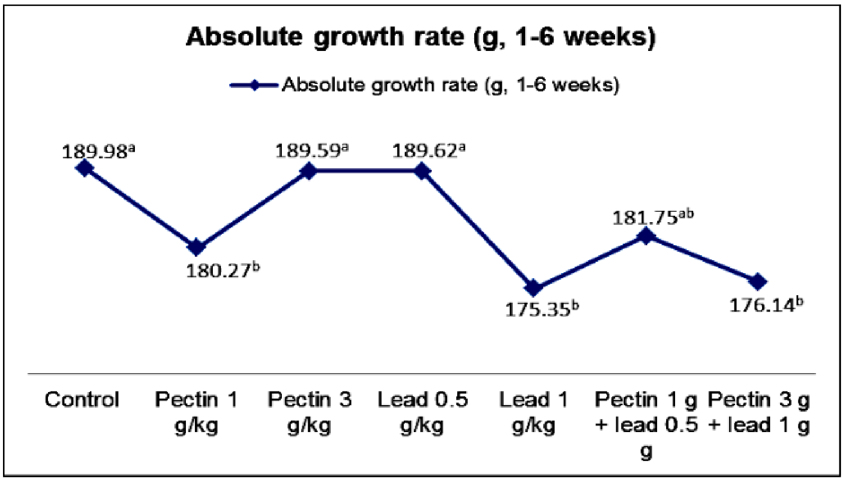

Fig. 2. Absolute growth rate of Japanese quail as affected by pectin and lead levels

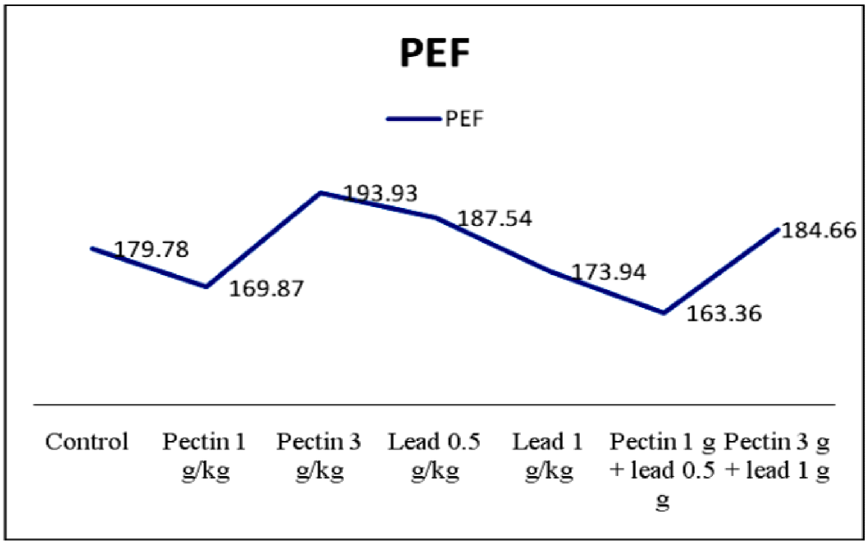

Fig. 3. Productive efficiency of Japanese quail as affected by pectin and lead levels

Several investigators suggested that the viscous property of pectin is the major factor responsible for its anti-nutritive effect **(Langhout and Schutie, 1996; Razdan *et al.*, 1997)**. **Wils-Plotz (2012)** showed that dietary inclusion of pectin at 7% inclusion level in broiler diets, during the 14 days post-hatch, reduced weight gain by 32% when compared to the control group.

Weight loss and impaired reproduction **(Hoshiari and Pourkhabbaz, 2012)**, poisoning, poor performance and death are other consequences of lead poisoning **(Mehrotra *et al.*, 2008)**.The present results are in line with those of **Razdan *et al.* (1997)** who indicated that diets containing pectin gave similar effects on growth performance as the control diet. As well as **Langhout and Schutie (1996)** reported that addition levels of 1.5 and 3% of pectin to the diet decreased weight gain by approximately 30% as compared to the control group.

Ibrahim *et al.* (2012) found that gain in body weight was lowered in lead treated groups (1/20, 1/40 and 1/160 of the oral LD_{50} of lead acetate) relative to the control.

Based on the current findings, it can be concluded that pectin could help in alleviation of the adverse lead effects on growth performance of quail chicks. However more studies are required to detect the appropriate levels according to many factors like pectin source and level.

REFERENCES

Abd El-Rahman, S.A., N.A.A. Hashem and A.A. Bakr (2014). Adsorption studies on lead (II) ions by low; high esterified pectin and pectin extracted from water hyacinth leaves. J. Soil Sci. and Agric. Eng., Mansoura Univ., 5 (5): 617-630.

Abou-Kassem, D.E., Kh.M. Mahrose and M. Alagawany (2016). The role of vitamin E or clay in growing Japanese quail fed diets polluted by cadmium at various levels. Anim., 10 (3): 508-519.

Bagherian, H., F.Z. Ashtiani, A. Fouladitajar and M. Mohtashamy (2011). Comparisons between conventional, microwave-and ultrasound-assisted methods for extraction of pectin from grapefruit. Chem. Eng. and Proc., 50: 1237–1243.

Brouns, F., E. Theuwissen, A. Adam, M. Bell, A. Berger and R.P. Mensink (2012). Cholesterol-lowering properties of different pectin types in mildly hyper-cholesterolemic men and women. Europ. J. Clin. Nutr., 66: 591–599.

Ciobanu, C., B.G. Slencu and R. Cuciureanu (2012). Estimation of dietary intake of cadmium and lead through food consumption. Revista Medico-Chirurgicala a Societatii De Medici Si Naturalisti Din Iasi, 116: 617-623.

Doganoc, D.Z. (1996). Distribution of lead, cadmium, and zinc in tissues of hens and chickens from Slovenia. Bulletin of Environ. Contamination and Toxicol., 57: 932-937.

Duncan, D.B. (1955). Multiple Range and Multiple F-Test. Biomet., 11: 1-42.

El-Sheikh, T.M., N.M. Essa, A.A. Abdel-Kareem and M.A. Elsagheer (2016). Evaluation of productive and reproductive performance of Japanese quails in floor pens and conventional cages with different stocking densities. Egypt. Poult. Sci. J., 36 (3): 669 – 683.

Farghly, M.F., Kh.M. Mahrose and D.E. Abou-Kassem (2015). Pre and post hatch performance of different Japanese quail egg colors incubated under photostimulation. Asian J. Poult. Sci., 9 (1): 19-30.

Hamidipour, F., H.R. Pourkhabbaz, M. Banaee and S. Javanmardi (2016). Bioaccumulation of lead in the tissues of Japanese quails and its effects on blood biochemical factors. Iranian J. Toxicol., 10 (2): 13-21.

Hosseini, S.S., F. Khodaiyan and M.S. Yarmand (2016). Aqueous extraction of pectin from sour orange peel and its preliminary physicochemical properties. Int. J. Biol. Macro., 82: 920-926.

Hoshiari, E. and A.R. Pourkhabbaz (2012). A study of heavy metal (Pb, Zn, Cd) accumulation in different tissues of Sebria Gull (*Larus heuglini*) from Hara Biosphere Reserve. Env. Sci., 9 (2): 89-100.

Ibrahim, N.M., E.A. Eweis, H.S. El-Beltagi and Y.E. Abdel-Mobdy (2012). Effect of lead acetate toxicity on experimental male albino rat. Asian Pacific J. Tropical Biomed., 2(1): 41-46.

Kuchkarova, L.S. and G.T. Kudeshova (2016). Effect of pectin on the activity of pancreatic α-Amylase in growing rats with lead intoxication. Ame. J. Biomed. and Life Sci., 4(5): 69-74.

Langhout, D.J. and J.B. Schutie (1996). Nutritional implications of pectins in chicks in relation to esterification and origin of pectins. Poult. Sci., 75: 1236 - 1242.

Liu, L., J. Cao, J. Huang, Y. Cai and J. Yao (2010). Extraction of pectins with different degrees of esterification from mulberry branch bark, Bioresource Technol., 101 : 3268–3273.

Mehrotra, V., V.L. Saxena and A.K. Saxena (2008). Impact of different doses of lead on internal organs of quails. J. Env. Biol., 29 (2): 147-149.

Metwally, E.A.M., F.A. Negm, R.A. El-Din and A.M. Nabil (2015). Anatomical and histological study of the effect of lead on hepatocytes of albino rats. Int. J. Biomed. Mat. Res., 3(4): 34-45.

NRC, (1994). Nutrient Requirements of Poultry. 9th Ed. Nat. Acad. Press, Washington, DC.

Ravichandran, S. (2011). Possible Natural ways to eliminate Toxic Heavy Metals. Int. J. Chem. Tech. Res., 3 (4): 1886-1890.

Razdan, A., D. Pettersson and J. Pettersson (1997). Broiler chicken body weights, feed intakes, plasma lipid and small-intestinal bile acid concentrations in response to feeding of chitosan and pectin. British J. Nutr., 78 : 283-291.

Saki, A.A., H.R. Matin, P. Zamani, M.M. Tabatabai and M. Vatanchian (2011). Various ratios of pectin to cellulose affect intestinal morphology, DNA quantitation, and performance of broiler chickens. Livestock Sci.139: 237-244.

SAS (2002). SAS Institute Inc., Cary, NC, USA. SAS Proprietary Software Version 9.00 (TS M0).

Sandhu, K.S., M.M. El-Samahi, I. Mena, C.P. Dooley and J.E. Valenzuela (1987). Effect of pectin on gastric emptying and gastroduodenal motility in normal subjects. Gastroenterol., 92: 486-492.

Sharma, R.P. and J.C. Street (1980). Public health aspects of toxic heavy metals in animal feeds. J. Ame. Vet. Med. Ass., 177: 149-153.

Silva, V.K., V.S. Morita and I.C. Boleli (2013). Effect of pectin extracted from citrus pulp on digesta characteristics and nutrient digestibility in broilers chickens. Revista Brasileira de Zootecnia, 42 (8): 575-583.

Snedecor, G.W. and W.G. Cochran (1982). Statistical Methods. 6th Ed. Iowa State Univ. Press, Ame, USA.

Tandoğan, M. and H. Cicek (2016). Technical performance and cost analysis of broiler production in Turkey. Revista Brasileira de Ciência Avícola, 18 (1): 169-174.

Thakur, B.R., R.K. Singh and A.K. Handa (1997). Chemistry and uses of pectin-a review. Critical Rev. in Food Sci. and Nutr., 37 (1): 47-73.

Wan Ngah, W.S., A. Kamari and Y.J. Koay (2004). Equilibrium and kinetics studies of adsorption of coppor (II) on chitosan and chitosan/ PVA beads. Int. J. Biol. Macr., 34: 151-155.

Wils-Plotz, E.L. (2012). The combined effects of purified fiber and dietary threonine on chick growth, and gut health, when infected with coccidiosis. M. Sc. Thesis, University of Illinois at Urbana-Champign, Urbana, Illinois, USA.

Zhao, Z.Y., L. Liang, X. Fan, Z. Yu, A.T. Hotchkiss, B.A. Wilk and I. Eliaz (2008). The role of modified citrus pectin as an effective chelator of lead in children hospitalized with toxic lead levels. Alternative Therapies, 14 (4): 34-38.

تأثير التلوث بالرصاص على النمو وكفاءة الإنتاج في السمان الياباني وتقليل آثاره باستخدام البكتين في العليقة

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أجريت هذه الدراسة لاختبار تأثير استخدام البكتين للتخفيف من التأثير السمي للرصاص على معدل النمو النسبي ومعدل النمو والكفاءة الإنتاجية في السمان الياباني، تم تقسيم ٣٣٦ طائر سمان ياباني (عمر أسبوع) إلى ٧ مجموعات (٤٨ طائر/ كل مجموعة)، وكانت طيور السمان في جميع المعاملات مماثلة في متوسط وزن الجسم (٣٨,٧جم)، وقد أجريت تجربة تصميم عشوائية تماما بما في ذلك سبع مجموعات، وكانت المجموعة الأولى من الطيور بمثابة الكنترول، المجموعة الثانية من السمان تم تغذيتها على ١جرام من البكتين/كجم علف، المجموعة الثالثة تم تغذيتها على ٣ جرام من البكتين/كجم علف، المجموعة الرابعة تم تغذيتها على ٠,٥ جرام من الرصاص/كجم علف، المجموعة الخامسة تم تغذيتها على ١ جرام من الرصاص/كجم علف، المجموعة السادسة تم تغذيتها على ١ جرام من البكتين و ٠,٥ جرام من الرصاص/كجم علف، في حين أن المجموعة السابعة تم تغذيتها على ٣ جرام من البكتين و ١ جرام من الرصاص/كجم علف، تم دراسة أداء النمو بما في ذلك معدل النمو المطلق ومعدل النمو النسبي وكفاءة الإنتاج، ويمكن تلخيص نتائج هذا العمل على النحو التالي: طيور السمان التى تم تغذيتها عليقة الكنترول والطيور التى تم تغذيتها على عليقة تحتوي على مستوى البكتين ٣ جرام/ كجم علف والرصاص ٠,٥ جرام / كجم علف اظهرت معنويا ($P < 0.01$) أعلى المقاييس في معدل النمو النسبي ومعدل النمو المطلق، وكانت الكفاءة الإنتاجية للسمان المعامل بالبكتين بمعدل ١ جرام/ كجم مع الرصاص عند مستوي ٠,٥ جرام/كجم علف هي الأدنى بالمقارنة مع المجموعات الأخرى دون اختلافات معنوية، نستخلص من هذه الدراسة أنه يمكن استخدام البكتين في علائق السمان لتقليل اثار التلوث بالرصاص.

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