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INFLUENCE OF DIETARY PUMPKIN SEED POWDER SUPPLEMENTATION ON GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY, BLOOD CONSTITUENTS AND CARCASS TRAITS OF GROWING RABBITS

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ABSTRACT: This research was performed to determine the influence of dietary addition of pumpkin seed powder (PKSP) comparable to zinc oxide (ZnO) on growth performance, nutrient digestibility, caecal bacterial count, some blood metabolites and slaughter traits of growing V-line rabbits during 35-91 days of age. A total of one hundred V-line rabbits aged 35 days were randomly divided into five homogeneous groups of five replicates with four rabbits per each (20 rabbits/group). The first group was fed a basal diet without any additives and assigned as a control group. The rabbits of second group were fed a basal diet supplied with zinc oxide (ZnO, 100 mg/kg diet), while the 3rd, 4th, and 5th groups were fed a basal diet enhanced with varying levels of PKSP (0.05, 0.1, and 0.2%), respectively. Results indicated that growing rabbits fed basal diet with 0.1% PKSP had significant improvements in final body weight, body weight gain, fed conversion ratio, performance index and economic efficiency compared with those for the rest groups. Digestibility coefficient of crude protein and crude fiber and digestible crude protein for growing rabbits fed basal diet supplied with 0.1% PKSP or ZnO were significantly improved compared with other treated groups. Moreover, rabbits fed basal diet with 0.1 and 0.2% PKSP showed a significant diminish in caecal *Escherichia coli* counts and a significant rise in *lactobacillus sp.* counts compared with the rest groups. Red blood cell count, haemoglobin, blood packed cell volume and lymphocyte percent for rabbits fed basal diet with 0.1 and 0.2% PKSP or ZnO were substantially increased compared with the control group. In addition, growing rabbits fed diets with 0.2% PKSP or ZnO had a significant diminish in serum total lipids, triglycerides and cholesterol values compared with control. Furthermore, supplied diets with studied agents significantly decreased serum levels of LDL, AST, ALT, urea, creatinine and MDA, whereas HDL and TAC levels were statistically increased compared with control. Dressing percent, hot carcass weight and total edible parts for growing rabbits fed diets with 0.1% PKSP were substantially improved compared with the rest groups. In conclusion, supplementing the diet of growing rabbits with 0.1% PKSP could be a good tool for optimizing growth performance, nutrient digestibility, caecal bacterial count and slaughtering traits, with the best record of economic efficiency.

Key words: Growing rabbits, Pumpkin, Zinc oxide, Productive performance, Digestibility

INTRODUCTION

Rabbits are considered one of the most important solutions to resolve the problem of animal protein deficiency in developing countries resulting from population growth (Nehad *et al*., 2009). Improving the performance of rabbits is essential to increasing rabbit meat production. To achieve the highest productivity, growing rabbits must be in good health, and the diet must contain their nutrient requirements (Marco Birolo, 2023). Therefore, antibiotics are usually added as growth promoters to rabbit diets (Attia *et al*., 2014). Recently, interest has increased in providing safe natural alternatives to avoid the harmful effects of antibiotics, reducing microbial resistance and producing safer animal products with minimal residues of antibiotics (Achilonu *et al*., 2018). Phytogenic feed additives, such as different parts of plants or their extracts are considered the best alternative to antibiotics due to the active substances that they contain and their ability to enhance feed flavor, palatability, voluntary feed intake, and weight gain (Elghalid *et al*., 2020). Therefore, it well be able to improve feed consumption, growth, and the immunity of the animals (Chakraborty *et al*., 2013).

Among potential phytogenic feed additives are pumpkin "*Cucurbita Moschata*" seeds (PKS) which belong to the family *"Cucurbitaceae*". The pumpkin's beneficial dietary components are associated with its secondary metabolite (Hussain *et al*., 2021). Furthermore, PKS contain an appropriate amount of vitamin A, which is essential for growth and immune response **(**Krimer-Malešević, 2020; Hussain *et al*., 2021). In addition, PKS have antioxidant properties related to their contents of vitamins, such as tocopherols, carotenoids, and ascorbic acid (Kim *et al*., 2016). Also, PKS are a good source of potassium, phosphorus, and magnesium; they contain moderately high amounts of zinc, selenium, calcium, copper, iron, and manganese, and these elements make PKS excellent for dietary supplementation for animals (Petkova and Antova, 2019). Several studies showed that PKS are a precious source of proteins that possess about 80% radical scavenging activity (Nawirska-Olszanska *et al*., 2013; Kaya and Türker, 2022). The protein isolated from PKS has a high biological value due to the essential amino acids that it contains such as methionine, lysine, tryptophan, phenylalanine, histidine, valine, threonine, leucine, and isoleucine (Nawirska-Olszanska *et al*., 2013). The seeds of pumpkin generally contain approximately 50% oil (Ozuna and León-Galván, 2017) which contains mono- and polyunsaturated fatty acids such as oleic and linoleic acids (Lestari *et al*., 2019).

The bioactivity of the seeds could offer natural alternatives for the control of pathogenic organisms and improve their health status (Brooker and Acamovic, 2005). The active compounds of PKS lower the harmful lipids in blood serum while increasing the value of beneficial lipids, as well as reducing abdominal fat (Aguilar *et al*., 2011). Achilonu *et al*. (2018) mentioned that supplementing the diet of livestock with PKS enhanced growth and production performance, besides improving carcass quality and hematological parameters. Moreover, Vlaicu *et al*. (2021) reported that laying hens supplemented with 9% PKS meal increased polyunsaturated fatty acids and antioxidants while decreased total cholesterol in the egg yolk. Furthermore, PKS has a beneficial effect on hypercholesterolemic, inflammation, and bacterial counts (Amin *et al*., 2020; Mukherjee *et al*., 2021).

Zinc (Zn) is an important element for many enzymes as a co-factor and is involved in many physiological metabolisms associated with immunity and growth, such as cell division and protein synthesis (Chasapis *et al*., 2020; Mateos *et al*., 2020). Besides, Zn has antioxidant properties that inhibit the oxidation of DNA and proteins as well as the inflammation response and reduce the production of reactive oxygen species (Prasad and Bao, 2019). Growing rabbits responded positively to 100 mg Zn/kg diets in terms of improving body weight gain and feed conversion ratio (Selim *et al*., 2012).

The goal of this study was to investigate the impact of dietary addition of pumpkin seed powder (PKSP), comparable to zinc oxide (ZnO), on growth performance, nutrient digestibility, caecal bacterial counts, some blood metabolites and carcass and meat traits of growing V-line rabbits during 35–91 days of age.

2. MATERIALS AND METHODS

This study was conducted at El-Sabahia Poultry Research Station, Animal Production Research Institute, Agriculture Research Center, Egypt.

Pumpkin seed powder (PKSP) preparation:

Dried pumpkin seeds were purchased from a local commercial market and ground into a fine powder using an electric dry mill. Subsequently, powders were stored in well-tied black plastic bags at room temperature (≈25°C). The chemical composition of PKSP used in this study is presented in Table 1. The chemical composition, total phenolic compounds (equivalent to gallic acid) and antioxidant activity (equivalent to ascorbic acid) of PKSP were determined according to AOAC (2007); Fogliano *et al*. (1999) and Viuda-Martos *et al*. (2010), respectively.

Animals, management and experimental design:

A total of one hundred V-line rabbits aged 35 days (sex ratio 1:1) were used. Rabbits were individually weighed and averaged (631.14±69.6 g), then randomly divided into five homogeneous groups considering the initial weight and sex of rabbit. Each group included 20 rabbits in five replicates with four rabbits. The rabbits were housed in galvanized wire cages battery with standard dimensions of (50×45×40 cm) until the end of the experiment (ninety-one days of age). The first group was fed the basal diet without supplementation and served as a control. The second group was fed the basal diet supplemented with zinc oxide (ZnO, 100 mg/kg diet), while the 3rd, 4th, and 5th groups were fed basal diets supplemented with different levels of PKSP (0.05, 0.1, and 0.2%), respectively. The groups were fed the same basal diet, formulated to meet growing rabbit nutrient requirements according to NRC (1977). The ingredients and nutrient composition of pelleted diets fed during the experimental period are illustrated in Table 2. Feed and water were provided *ad libitum* throughout the experimental period. The rabbits were raised under similar management (environmental temperature 23±1^{O}C and relative humidity 60±1.5%), hygienic conditions (vaccinations and health care), and a regulated photoperiod (16 h light: 8 h dark/d).

Productive performance and economic efficiency:

The rabbits were weighed at 35 and 91 days of age, then body weight gain (BWG) was calculated, while feed intake (FI) was detected in this period from the difference between the weights of the offered feed and the feed remainder. Feed conversion ratio (FCR) was computed as the ratio between feed intake and weight gain during 35-91 days of age. While, the viability percent was calculated. The price of rabbits and experimental diets was calculated according to the market price at the time of the experiment. The performance index was calculated as reported by North (1981). The economic efficiency (EE) was represented as (net revenue / total cost) × 100, while the relative economic efficiency (REE) was calculated as (economic efficiency / economic efficiency of the control) × 100 according to Zeweil (1996).

Digestibility trial:

At the end of the experimental period (91 days of age), a digestibility trial was conducted using 25 male rabbits (five from each treatment) to determine the apparent digestibility of nutrients for the experimental diets. Animals were individually housed in metabolic cages equipped with a system for separation feces and urine. The quantitative collection of feces started 24 hours after offering the daily feed. The feces of each rabbit were collected once a day at 9:00 am and feed intake was recorded every day in the morning for five days as the collection period. The collected samples of feces and feeds were pooled and stored at -18 ºC until analysis. Fecal samples were dried at 60 ºC for 72 h and ground through a 1 mm screen on a Wiley grinder. Digestibility coefficients were determined and expressed on DM basis using the ((Nutrient intake - Nutrient voided = Retained)/Intake) *100. Feed and feces samples were analysed for moisture, ash, crude protein (CP), ether extract (EE) and crude fiber (CF) according to AOAC (2007). Nitrogen free extract (NFE) was calculated from the difference between dry matter and other components. Total Digestible Nutrients (TDN) and digestible crude protein (DCP) were calculated. Digestible energy (DE, Kcal/kg diet) was calculated as follows: TDN x 44.3 (Perez *et al*., 2010).

Caecal bacterial count:

During slaughter time, ten samples of caecum content from rabbits of each treatment were collected for enumeration of total bacterial count (TBC), *Escherichia coli*, proteus, and *Lactobacillus spp.* as a colony-forming unit (CFU) using modified methods described by Baurhoo *et al*. (2007).

Blood collection and hematobiochemical analyses:

At the end of the trial, blood samples were taken from the marginal ear vein (n = 10, for each group). The blood samples were collected in the morning before providing the ration. The blood samples were collected in clean tubes with or without heparin. Blood samples with heparin were used to measure hematological variables. The hematological variables were assessed according to Schalm *et al*. (1975). The phagocyte activity (PA) and phagocytic index (PI) were determined according to Kawahara *et al*. (1991). Blood serum was obtained by centrifugation at 860x g for 20 min at 4 ^{O}C and stored at -20 ^{O}C until the analysis was performed. The blood serum concentrations of total protein, albumin, total lipids, triglycerides, total cholesterol, high-density lipoprotein (HDL), aspartate aminotransferase (AST), alanine aminotransferase (ALT), urea and creatinine values were spectrophotometrically analyzed using commercial diagnostic kits from Diamond Diagnostics (23 EL-Montazah St. Heliopolis, Cairo, Egypt, http://www. diamonddiagnostics.com) according to the procedure described by the manufacturer. The difference between total protein and albumin was used to compute the serum globulin level. Serum low-density lipoprotein (LDL) and very low density lipoprotein (VLDL) were estimated by Friedewald *et al*. (1972). Total antioxidant capacity (TAC) was measured according to Erel (2004). The lipid peroxidation biomarker such as malondialdehyde (MDA) was assayed in the blood serum (Conti *et al*., 1990).

Slaughter traits and chemical meat analysis:

At the end of the experimental period (91 days of age), ten rabbits from each group (2 per replicate, one male and one female) were randomly selected, fasted for 12 hours, then individually weighed and immediately slaughtered and exsanguinated. Slaughter procedure and carcass analysis were adopted as described by Blasco and Ouhayoun (1996). After complete bleeding, skinning and removing of viscera, the weight of the hot carcass was determined then the carcass and giblets (liver, heart, and kidney) were weighed. The dressing percentage included the relative weights of the carcass and giblets were estimated. Samples of meat were individually taken from each rabbit leg.

The chemical composition of meat was assayed according to AOAC (2007).

Statistical analysis:

Data were statistically analyzed in a completely randomized design using the General Linear Model (GLM) procedure of SAS program 9.4 (SAS, 2001 Inst. Inc. Cary, NC, USA). The mean difference at $P \leq 0.05$ was tested using the Student-Newman-Keuls test. Percentage data of the studied traits were transformed to square root or arc sine, while bacterial counts were converted using Log transformation before statistical analysis. The statistical model used was: $Y_{ij} = \mu + T_i + e_{ij}$

Where; Y_{ij} = is each dependent an observation under study, μ = overall mean, T_i = is the effect of treatments (i=1,2, ….5) and e_{ij} = is the experimental random residue error. The least square mean (LSM) + standard errors were calculated and tested for significance using the "t" test (Steel and Torrie, 1980).

RESULTS

Growth performance traits and economic efficiency:

Growth performance, performance index and economic efficiency of growing rabbits fed basal diet supplied with varied levels of PKSP comparable to ZnO during 35- 91 days of age are shown in Table 3. The data of this table indicated that initial body weight at 35^{th} day of age did not declare any statistical change between the experimental groups. Results of Table 3 recorded that growing rabbits fed basal diet enhanced with PKSP at different levels or ZnO substantially ($P \leq 0.05$) improved FBW, BWG, FCR, performance index and economic efficiency compared with those for control group. Furthermore, animals fed basal diet supplied with 0.1% PKSP significantly realized perfect values of the aforementioned parameters contrasted with those for other treated groups. Furthermore, feed intake and viability percent for all supplemented groups did not reveal any statistical difference compared with those for the control. In addition, economic efficiency for growing rabbits fed basal diet supplemented with 0.1% PKSP significantly rose compared with other treated groups.

Apparent nutrient digestibility, nutritive values and caecal bacterial count:

Results presented in Table 4 showed that apparent digestibility coefficient values of DM, OM and NFE for growing rabbits fed basal diet supplied with 0.05 and 0.1% PKSP or ZnO were significantly ($P \leq 0.05$) improved compared with those fed basal diet with 0.2% PKSP and control groups. In addition, the apparent digestibility coefficient values of CP and CF for animals fed basal diet enriched with 0.1% PKSP or ZnO were significantly ($P \leq 0.05$) improved compared with the other treated groups. Moreover, the apparent digestibility coefficient values of EE did not show any statistical changes between the experimental groups. Regarding nutritive values, TDN and DE for rabbits fed basal diet with 0.05 and 0.1% PKSP or ZnO were significantly increased compared with those supplemented with 0.2% PKSP and control groups. Likewise, rabbits fed basal diet plus 0.1% PKSP or ZnO had a significant improvement in DCP percent in comparison with the rest groups.

Also, results of Table 4 indicated that growing rabbits fed basal diet supplemented with 0.1 and 0.2% PKSP represented significant ($P \leq 0.05$) decline in *E. coli* count compared with the other rest groups. The opposite trend was demonstrated for *lactobacillus sp.* count which the same mentioned groups represented a significant ($P \leq 0.05$) improvement. Moreover, the total bacterial count and proteus counts did not reveal any significant differences among the experimental groups.

Hematological parameters and immunological indices:

Results presented in Table 5 showed that red blood cells count (RBCs) and haemoglobin (Hgb) for rabbits fed basal diet plus 0.1 and 0.2% PKSP or ZnO were significantly ($P \leq 0.05$) increased compared with those for control group. In the same line, growing rabbits fed basal diet with PKSP levels or ZnO showed a significant increase in packed cell volume (PCV), mean corpuscular volume (MCV) and lymphocyte percent compared to control group. Moreover, mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) for growing rabbits fed basal diet with 0.1% PKSP were significantly ($P \leq 0.05$) improved in comparison with those for the rest groups. In addition, groups fed basal diet with 0.1% PKSP or ZnO had a significant increase in white blood cell counts (WBC's) compared with those fed 0.05% PKSP or control groups. Otherwise, PA and PI did not show any significant change among the experimental groups.

Blood biochemical constituents:

Data in Table 6 show that growing rabbits fed 0.2% PKSP had a significant ($P \leq 0.05$) increase in serum albumin value and a significant decrease in globulin value compared with the others. Moreover, feeding rabbits on basal diet supplied with 0.1 and 0.2% PKSP or ZnO significantly decreased total lipids, triglyceride and VLDL values compared with control. Whereas, these experimental groups did not reveal any statistical change between each other with respect to the previous mentioned parameters. Furthermore, serum cholesterol and LDL values for groups fed basal diet supplied with PKSP at different levels or ZnO were significantly ($P \leq 0.05$) lowered in comparison with those for the control group. The opposite trend was observed for HDL in the same mentioned groups which represented significant increase. Likewise, rabbits fed basal diet plus 0.1 and 0.2% PKSP significantly realized perfect values of LDL. On the other hand, values of total protein did not declare any statistical effects among the experimental groups. In addition, growing rabbits fed basal diet with ZnO or PKSP levels had significant ($P \leq 0.05$) decrease in AST, ALT, urea and creatinine concentrations compared with those for control group. Moreover, these experimental groups did not represent any statistical change between each other referring to the previous mentioned parameters. Furthermore, TAC for animals fed basal diet with ZnO or PKSP levels was significantly ($P \leq 0.05$) improved compared with those for control and the adverse trend was noticed for MDA which significantly ($P \leq 0.05$) reduced.

Slaughter traits and chemical meat analysis:

Results of Table 7 revealed that hot carcass weight (g) besides percentages of dressing, total edible parts and spleen for group fed basal diet with 0.1% of PKSP were significantly ($p \leq 0.05$) improved in comparison with other experimental groups. Whereas, nonedible parts percent for the same mentioned group was significantly ($P \leq 0.05$) decreased. Moreover, pre-slaughter weight (g), liver, heart, kidney and edible giblets percentages have not shown any apparent significant change among the experimental groups. Also, the results of Table 7 demonstrated that growing rabbits fed a basal diet supplied with varied levels of PKSP represented a significant ($P \leq 0.05$) decrease in ether extract of rabbit meat compared with the control. Meanwhile, other meat chemical compositions of rabbits did not reveal any statistical influence among the experimental groups.

DISCUSSION

Growth performance traits and economic efficiency:

The current results regarding the significant enhancement of BWG and FCR for growing rabbits fed a basal diet supplied with different levels of PKSP are in accordance with the findings of Nworgu *et al*. (2007a) who established that addition of pumpkin leaf extracts improved BWG of broiler chickens. Furthermore, Nworgu *et al*. (2007b) and Omenka and Anyasor

(2010) observed that addition of pumpkin leaf meal to broiler diet improved BWG and FCR. Additionally, Martínez *et al*. (2010) reported that the 10% implication of PKS meal in broiler chicken rations served as an appropriate replacement for soyabean meal as it improved production performance. Likewise, Aguilar *et al.* (2011) showed that the inclusion of dietary PKS meal by 3.3, 6.6 and 10% partly displacing soyabean meal and vegetable oil for improving the productive performance of broiler chickens. Moreover, Wafar *et al.* (2017) reported that substitution of pumpkin instead for soybean meal in the diet by different levels 0, 5, 15, and 20% significantly improved BW and BWG of broiler chickens. Besides, Ragab *et al.* (2013) noted that growing rabbits fed a diet enriched with a complex of pumpkin and *Nigella sativa* oils (2.5 g/kg diet per each) represented the perfect results of productive performance and economic efficiency. Finally, Abdelnour *et al.* (2023) stated that addition of different doses of PKS oils (0.5,1 and 2 ml/kg diet) significantly increased BWG and FCR of growing rabbits exposed to heat stress. The explanation of improvements in rabbits growth rate and feed utilization under high ambient temperature may be related to active substances present in PKS oils such as eugenol (Hong *et al*., 2012). This eugenol substance found in PKS has antioxidant properties which improve the ability of digestive system enzymes and consequently improve productive performance (Kulaitiene *et al*., 2018). Moreover, Nkosi *et al*. (2006) mentioned that the improvement of animal performance may be related to the active compounds in PKS such as minerals, vitamins as well as phenolic compounds which have protective effect on liver and intestinal cells to improve the nutrient absorption.

The significant increase of BWG and FCR herein for growing rabbits fed basal diet supplemented with ZnO is in agreement with those of Abdel-Wareth *et al*.(2022) who revealed that addition of ZnO to the diet in the form of Nano improved BWG for growing rabbits at different doses and revealed that ZnO had the ability to react with free radicals in body cells so plays an important role in the immune system as well as improve the enzymes function. Similar results were obtained by Selim *et al*. (2012) in growing rabbits at dose 100 mg/kg diet which improved the final body weight. The improvement of FCR in rabbits due to Zn supplementation may be due to the beneficial effect of Zn on energy and protein metabolism (Zaghari *et al*., 2015).

The non-significant effect of PKSP levels on FI in this study was previously documented by Wafar *et al*. (2017) who indicated that PKS did not affect feed consumption in broiler chickens. Contrary to our results, Nworgu *et al*. (2007a) demonstrated that FI of broiler chicken fed extracts of pumpkin leaves was increased. On the other hand, Bashar and Abubakar (2001) stated a reduction in FI of broiler chickens fed a high dietary implication level of PKS meal (30%). Referring to the non-effect of FI due to the addition of ZnO Selim *et al*. (2012) and Chrastinová *et al*. (2015) have drawn the same conclusion. Whereas, Jahanian and Rasouli (2015) mentioned contradicted results.

In conclusion, using all experimental levels of PKSP or ZnO in this study realized best significant records of performance index. The improvement results in performance index could be explained on the light of increase in BWG and FCR improvement for the experimental growing rabbits.

Nutrient digestibility coefficients and caecal bacterial count:

The current results of significant increase of digestibility coefficients values of DM, OM, CF, NFE and CP for growing rabbits fed 0.05 and 0.1% PKSP or ZnO are in compatible with the information reported by Ragab *et al*. (2013) who mentioned that growing rabbits fed a diet enriched with a complex of pumpkin and *Nigella sativa* oils

(2.5 g/kg diet per each) represented higher digestibility coefficients and improved caecal fermentation. This improvement in digestibility was revealed by Herkel *et al.* (2014) who stated that PKS contains active ingredients such as phytogens that enhance the integrity of the intestinal mucosa and motivate the release of digestive juices in chickens.

Concerning Zn effects on nutrient's digestibility the results herein are in agreement with those presented by Gad Alla (2001**)** who observed that the apparent digestibility of DM and OM was substantially improved. Similarly, Hafez *et al*. (2002) showed that rabbit's diets supplied with Zn had higher nutrient digestibility coefficients. Previously, Banerjee (1988**)** mentioned that digestibility improvement and nutritive values due to Zn addition could be directly associated with the higher absorptive capability of the mucous membranes. The same author reported that improving the digestive capacity of rabbit by Zn addition might be linked with increased activity of Zn-dependent enzymes which connected with the digestion of carbohydrates, fat, and protein. Besides, Suttle (2010**)** stated that zinc addition has an impact on the metabolism of proteins and carbohydrates due to its involvement of purified enzymes.

Our results of the significant decrease of *E. coli* and increase of *lactobacillus sp.* counts due to supplementing the diet with 0.1 and 0.2% PKSP in growing rabbits were interpreted by Nkukwana *et al*. (2014) who referred that phytogens in PKS have activity sites in the digestive system through modulation of gut microorganisms, maximizing both nutrient digestibility and productive performance. Nonetheless, their complication and extent of bioactivity give alternative prospects for synthetic control of harmful organisms, promotion of nutrition, or improved defense against disease infections. (Brooker and Acamovic, 2005).

The significant decrease of *E. coli* and increase of *lactobacillus sp.* in the gut of rabbits fed PKSP could be the reason of productive performance improvement such as BWG and FCR. This conclusion is in line with those reported by Simone and Paci (2021) who mentioned that the gastrointestinal tract microbiota of rabbits is essential for their ability to digest feed, produce vitamins, share in fermentative activity that produces volatile fatty acids, stimulate their immune systems and enhance resistance to disease infections.

Hematological parameters and immunological indices:

The significant improvements of hematological parameters for growing rabbits due to supplementation the diet with 0.1 and 0.2% PKSP in this study were previously drawn by different researchers. Adedapo *et al*. (2002) observed that enhancing the diet by PKS and *Sorghum* significantly improved haematological parameters in rabbits. This notion concurs with the examinations of Nworgu *et al*. (2007a) who detected elevated PCV, Hgb, red blood corpuscles of broiler chickens fed extracts of pumpkin leaves. Moreover, Abdelnour *et al*.(2023) reported that PKS oils (2 ml/kg diet) for growing rabbits improved all hematological which related to the antioxidant properties of PKS that protect RBC from lysis by free radicals and decreased WBC count compared to control. Otherwise, Ragab *et al*.(2013) found that PKS oil had no effect on the differential WBC counts of growing rabbits.

Results of the previous mentioned hematological parameters improvement due to using dietary ZnO are in agreement with the results of Konomi and Yokoi (2005) who mentioned that zinc plays a critical role in RBC maturation which effect in erythroid and erythropoietin found in bone marrow and plasma respectively. Also, Elgayed *et al*. (2022) showed that zinc oxide increased RBC count and Hgb concentration without significant increase in monocyte or eosinophils comparing to control group. Finally, Mahmood *et al*. (2023) found that different sources of dietary zinc significantly increased WBC in group treated with small amount of nano ZnO compared to control and interpreted this result is due to the immunomodulatory effect of Zn which improve the function of immune response and increase interferon production. On the other hand, El Hendy *et al*. (2001) found that zinc had no effect on WBC count, differentiation and immune indices but is important for the immune system preservation which proliferate the immune cell as lymphocyte.

Blood biochemical constituents:

The significant influence of reducing serum harmful lipid levels of rabbits such as triglycerides, cholesterol, LDL and VLDL besides increasing the beneficial lipid levels due to dietary addition of 0.1 and 0.2% of PKSP are keeping with the previous researches. Omenka and Anyasor (2010) showed a decrease in total serum cholesterol when pumpkin vegetables were fed to broilers. Moreover, Hajati *et al*. (2011) found that dietary PKS oil significantly decreased cholesterol and triglyceride values in blood plasma of broiler chickens. It has also been demonstrated that the chemical composition of feeds supplemented with PKS oil highly impacts blood levels of triglycerides, total cholesterol, phospholipids, LDL and HDL in poultry (Martínez *et al*., 2010; Martínez, 2012). Also, Aguilar *et al.* (2011) found that the inclusion of dietary PKS meal by 3.3, 6.6 and 10% partly displacing soyabean meal and vegetable oil reduced serum levels of harmful lipids, while the serum levels of beneficial lipids improved in broiler chicken. The explanation of lipid profile improvement due to PKS supplementation may be related to active substances found in pumpkin which decrease intestine absorption of cholesterol (Abed and Alkalby 2018). The same significant influence of PKS on serum lipid profile was observed for ZnO supplementation as Abd El-Hack *et al*. (2018) who observed that zinc methionine significantly decreased LDL in laying hens. The opposite results regarding the decrease of serum total cholesterol in this study was reported by Al-Daraji and Amen (2011) who found that total cholesterol for broiler breeders had been significantly increased due to the zinc addition.

The parameters of liver and kidney functions had been improved in this study due to addition of different levels of PKSP and ZnO and these results are combatable with those reported by Nwanna and Oboh (2007) who mentioned that PKS oils are able to improve liver function due to the anti-oxidant properties of total phenols and β-carotene content which had been demonstrated to be a strong antioxidant and protective activities against cell injury. This explanation confirms with our results tabulated in Table1 which demonstrated that PKSP had high amount of total polyphenols (0.387%) which acts as free radical scavengers so prevent damage of cells. Also Abdelnour *et al*. (2023) showed that under high ambient temperature groups treated with 2 ml/kg diet of PKS oil decreased AST and ALT compared to control group. Sharma *et al.* (2013) reported that alcoholic extract of PKS caused significant reduction of AST and ALT to normal levels and related that due to the active component found in the extract which has the protective effect on hepatic cells. Abdel-Wareth *et al*. (2022) found that dietary nano ZnO decreased AST and ALT of growing rabbits exposed to high ambient temperature and interpreted these results to the anti-oxidant properties which maintain the body cells and plays an essential role in regenerate the cells and division.

The improvement of blood urea value due to supplementing the diet with PKSP or ZnO are in accordance with those reported by Ramadan *et al*. (2016) who explained that PKS contain high amount of potassium and phosphorus which may improve the kidney function. Abdelnour *et al*. (2023) showed that under high ambient temperature groups treated with 2 ml/kg diet of PKS oil significantly reduced urea and creatinine. Also, Abdel-Wareth *et al*. (2022) mentioned that nano ZnO significantly decreased creatinine and urea of growing rabbits exposed to heat stress.

The substantial increase of serum TAC and MDA decrease due to supplementation the diet with PKSP and ZnO are in agreement with those previously reported by Bakeer (2021) who mentioned that supplemented PKS oil in rabbit diet showed a significant increase in serum antioxidant enzymes and MDA decrease. These results were cleared by Kulaitiene *et al.* (2018) and Nkosi *et al*. (2006) who reported that PKS contain active compounds such as zinc, vitamin E and phenolic compounds which have antioxidant properties against free radicals and protect the organ from damage through reducing accumulation of fat in liver tissues. Meanwhile, Ma *et al*.(2011) reported that zinc improved body anti-oxidants status at 120 mg/kg in the diet of the broiler which increased plasma TAC and decreased MDA compared to control group.

Slaughter traits and chemical meat analysis:

Current evidence of significant increase for hot carcass weight (g) besides percentages of dressing, total edible parts, spleen and meat ether extract for growing rabbits fed 0.1% PKSP are partially compatible with the previous researches. Martínez *et al*. (2010) reported that the implication of 10% PKS in broiler chicken rations resulted in significant reduction in abdominal fat, and no statistical changes were noted in the sensorial quality of the chicken breast and thigh portions. Similarly, Omenka and Anyasor (2010) found a reduction in mean fat content of heart, gizzard and muscles when pumpkin vegetables were fed to broiler chickens. Also, Aguilar *et al.* (2011) showed that the implication of dietary PKS meal by 3.3, 6.6 and 10% partly displacing soyabean meal and vegetable oil improved edible portions yield and reduced abdominal fat. Furthermore, Ragab *et al.* (2013) noted that growing rabbits fed a diet enriched with a complex of pumpkin and *Nigella sativa* oils (2.5 g/kg diet per each) represented perfect results concerning carcass quality. Selim *et al*. (2012) and Elsisi *et al*. (2017) confirmed our results regarding the non-effect of ZnO supplementation on carcass and meat traits.

IN CONCLUSION,

supplementing the diet of growing rabbits with 0.1% PKSP could be a good tool for optimizing growth performance, nutrient digestibility, caecal bacterial count and slaughtering traits, with the best record of economic efficiency.

Table (1): Chemical composition of pumpkin seeds powder (PKSP)

Component	**%**
Dry matter	95.02
Crude protein	28.37
Crude fiber	11.49
Ether extract	34.56
Nitrogen free extract	14.38
Crude ash	6.22
Antioxidant activity	0.698
Total polyphenols	0.387

Table (2): Feed ingredients and chemical composition of rabbit basal diet

Feed Ingredient	%	Nutrient Composition (%DM Basis)	
Soybean meal (44%CP)	19.30	Dry matter (DM)	89.30
Yellow corn	7.00	Organic matter (OM)	90.72
Barley	17.10	Crude protein (CP)	17.58
Wheat bran	24.88	Crude fiber (CF)	13.11
Clover hay	25.00	Ether extract (EE)	2.03
Molasses	3.00	Nitrogen-free extract (NFE)	58.00
Dicalcium phosphate	1.71	Ash	9.28
Limestone	1.08	NDF[2]	29.85
Sodium chloride	0.35	ADF[2]	17.01
Vitamin and minerals mixture[1]	0.30	Digestible energy (Kcal/Kg DM) [3]	2599
DL-methionine	0.28	Zn (mg/kg)[4]	62.7
Total	100		

[(1)]Provides per kg of diet: Vit.A,1200 IU; Vit.D3, 2500 IU; Vit. E, 10 mg; Vit. K3, 3mg; Vit.B1, 1mg; Vit.B2, 4mg; Pantothenic acid, 10 mg; Nicotinic acid, 20 mg; Folic acid, 1 mg; Biotin, 0.05mg; Niacin, 40 mg; Vit.B6, 3 mg; Vit. B12, 20 mcg; Choline Chloride, 400 mg; Mn, 62 mg; Fe,44 mg; Zn, 56 mg; I, 1 mg; Cu, 5 mg and Se, 0.01mg.[(2)]Determined using the procedures of Van Soset *et al* (1991). [(3)]Digestible energy (DE) was calculated according to Lebas (2013). [(4)] Calculated on the basis of the ingredients composition. NDF: Neutral detergent fiber; ADF: Acid detergent fiber.

Table (3): Influence of dietary pumpkin seeds powder (PKSP) comparable to Zinc oxide (ZnO) on growth performance and economic efficiency of V-line growing rabbit during 35-91 days of age

Items	Control	ZnO 100 mg /kg	Pumpkin seeds powder levels %			SEM	P value
			0.05	0.10	0.20		
Initial body weight, g	628.7	632.3	631.0	626.7	637.0	28.9	0.8914
Final body weight, g	2081[c]	2140[b]	2154[b]	2227[a]	2125[b]	52.6	0.0001
Body weight gain, g	1447[c]	1522[b]	1509[b]	1600[a]	1488[b]	52.1	0.0001
Feed intake, g	5331	5330	5352	5379	5311	161.0	0.8192
Feed conversion ratio	3.68[a]	3.50[b]	3.55[b]	3.36[c]	3.58[b]	0.105	0.0001
Performance index,%	56.51[c]	61.54[b]	60.34[b]	66.27[a]	59.61[b]	2.66	0.0001
Viability,%	80	95	90	95	90	11.83	0.2900
Economic efficiency							
Total feed cost (L.E.)	53.33	53.42	53.65	54.01	53.54	1.61	0.8023
Feed cost(L.E.)/kg weight gain	36.86[b]	35.08[c]	35.59[bc]	33.74[d]	36.03[b]	1.06	0.0001
Price of total weight gain(L.E.)	72.39[c]	76.13[b]	75.45[b]	80.05[a]	74.44[b]	2.60	0.0001
Net revenue (L.E.)	19.05[d]	22.69[b]	21.77[bc]	26.01[a]	20.89[c]	2.06	0.0001
Relative economic efficiency	100	119.0	114.0	134.9	109. 1	ND	ND
Economic efficiency (EE)	35.74[d]	42.52[b]	40.71[bc]	48.21[a]	39.01[c]	4.07	0.0001

[a,b,c] means having different superscripts in the same row are significantly different ($P \leq 0.05$). SEM: standard error of means; P value: probability level. ND: not done. Price of one kg of each commercial rabbit diet: 10 LE; pumpkin seeds: 40 LE; Zinc oxide: 200 LE and live body weight: 50 LE.

Table (4): Influence of dietary pumpkin seeds powder (PKSP) comparable to Zinc oxide (ZnO) on apparent nutrient digestibility, nutritive value and intestinal bacterial count of V-line growing rabbit during 35-91 days of age

Items	Control	ZnO 100 mg /kg	Pumpkin seeds powder levels %			SEM	P value
			0.05	0.10	0.20		
Apparent nutrient digestibility (%)							
Dry matter	69.1^{c}	70.3^{a}	70.1^{a}	70.4^{a}	69.6^{b}	0.330	0.0001
Crud protein	75.4^{c}	76.3^{a}	75.8^{b}	76.4^{a}	75.5^{bc}	0.290	0.0001
Ether extract	70.9	71.4	71.4	71.2	71.3	0.621	0.7246
Crud fiber	37.2^{c}	38.1^{a}	37.8^{b}	38.2^{a}	37.5^{bc}	0.460	0.0067
Nitrogen free extract	73.8^{c}	75.3^{a}	75.2^{a}	75.4^{a}	74.5^{b}	0.482	0.0001
Organic matter	69.1^{b}	70.1^{a}	70.0^{a}	70.2^{a}	69.4^{b}	0.387	0.0001
Nutritive values							
Total digestible of nutrients (%)	62.33^{c}	63.39^{a}	63.2^{a}	63.44^{a}	62.73^{b}	0.287	0.0001
Digestible energy (kcal/kg)	2762^{c}	2808^{a}	2801^{a}	2810^{a}	2779^{b}	12.70	0.0001
Digestible crud protein (%)	12.21^{c}	12.35^{a}	12.27^{b}	12.37^{a}	12.23^{bc}	0.045	0.0001
Intestinal bacterial count							
TBC (cfu x10^{6})	4.53	4.58	4.53	4.56	4.53	0.112	0.9134
E. Coli (cfu x10^{3})	1.24^{a}	1.26^{a}	1.23^{a}	1.09^{b}	1.08^{b}	0.050	0.0001
Proteus (cfu x10^{3})	0.866	0.856	0.860	0.876	0.856	0.041	0.9044
Lactobacillus spp. (cfu x10^{3})	2.25^{bc}	2.24^{bc}	2.19^{c}	2.44^{a}	2.38^{a}	0.132	0.0201

^{a,b,c} Means in the same row followed by different letters are significantly different at ($p \leq 0.05$), SEM: Standard error of mean, TBC: Total bacterial count; *E. Coli*: *Escherichia coli*

Table (5): Influence of dietary pumpkin seeds powder (PKSP) comparable to Zinc oxide (ZnO) on haematological parameters and some immunological indices of V-line growing rabbit during 35-91 days of age

Items	Control	ZnO 100 mg /kg	Pumpkin seeds powder levels %			SEM	P value
			0.05	0.10	0.20		
RBCs (10^{6}/mm^{3})	6.340^{c}	6.580^{a}	6.390^{bc}	6.490^{ab}	6.520^{a}	0.1311	0.0010
Hgb (g/100 ml)	10.10^{c}	10.90^{b}	10.30^{bc}	11.70^{a}	10.90^{b}	0.7440	0.0002
PCV (%)	41.10^{c}	44.20^{a}	42.50^{b}	42.90^{b}	43.90^{a}	1.083	0.0001
MCH (pg)	15.92^{b}	16.54^{b}	16.12^{b}	18.04^{a}	16.70^{b}	0.9771	0.0001
MCHC (g/dL)	24.54^{b}	24.63^{b}	24.25^{b}	27.30^{a}	24.81^{b}	1.442	0.0001
MCV (fL)	64.82^{c}	67.18^{a}	66.50^{b}	66.10^{b}	67.33^{a}	0.7580	0.0001
WBC (10^{3}/mm^{3})	5.290^{c}	5.420^{ab}	5.280^{c}	5.490^{a}	5.360^{bc}	0.1411	0.0077
Neutrophils (N), (%)	31.60^{a}	26.50^{b}	27.50^{ab}	25.10^{b}	27.40^{ab}	4.683	0.0435
Lymphocytes (L), (%)	36.50^{b}	39.50^{a}	40.10^{a}	39.10^{a}	39.30^{a}	1.374	0.0001
N/L ratio	0.873^{a}	0.676^{b}	0.689^{b}	0.646^{b}	0.702^{b}	0.1427	0.0081
PA (%)	23.00	23.50	23.60	23.10	23.20	1.345	0.8285
PI (%)	1.190	1.270	1.210	1.200	1.160	0.0970	0.1591

^{a,b,c} Means in the same row followed by different letters are significantly different at ($p \leq 0.05$), SEM: Standard error of mean, RBCs: red blood cells count, Hgb: haemoglobin, PCV: packed cell volume, MCH: mean corpuscular haemoglobin; MCHC: mean corpuscular haemoglobin concentration, MCV: mean corpuscular volume; WBCs: white blood cell count, PA: phagocytic activity, PI: phagocytic index

Table (6): Influence of dietary pumpkin seeds powder (PKSP) comparable to Zinc oxide (ZnO) on biochemical blood constituents of V-line growing rabbit during 35-91 days of age

Items	Control	ZnO 100 mg /kg	Pumpkin seeds powder levels %			SEM	P value
			0.05	0.10	0.20		
Total protein, g/dl	5.715	5.600	5.640	5.595	5.673	0.1793	0.1687
Albumin, g/dl	3.035[b]	3.099[b]	2.965[b]	3.053[b]	3.386[a]	0.2350	0.0026
Globulin, g/dl	2.680[a]	2.501[b]	2.675[a]	2.542[b]	2.287[c]	0.1421	0.0001
Total Lipids, mg/dl	413.5[a]	396.5[b]	403.0[ab]	393.5[b]	390.0[b]	15.44	0.0222
Triglycerides, mg/dl	120.0[a]	101.0[bc]	111.5[ab]	102.0[bc]	100.0[c]	11.74	0.0012
Cholesterol, mg/dl	171.0[a]	166.5[c]	169.2[b]	166.2[c]	164.4[d]	1.334	0.0001
LDL, mg/dl	93.60[a]	87.60[b]	88.00[b]	82.60[c]	84.70[c]	3.167	0.0001
HDL, mg/dl	53.40[c]	58.70[b]	58.90[b]	63.20[a]	59.70[b]	3.581	0.0001
VLDL, mg/dl	24.00[a]	20.20[bc]	22.30[ab]	20.40[bc]	20.00[c]	2.348	0.0012
AST, U/L	135.0[a]	119.0[b]	122.5[b]	119.0[b]	119.5[b]	11.20	0.0133
ALT, U/L	74.00[a]	65.00[b]	66.00[b]	66.50[b]	64.50[b]	5.066	0.0007
Urea, mg/dl	23.00[a]	19.90[b]	19.40[b]	20.50[b]	19.80[b]	1.545	0.0001
Creatinine, mg/dl	0.693[a]	0.601[b]	0.594[b]	0.599[b]	0.585[b]	0.0336	0.0001
TAC, mmol/l	1.185[c]	1.402[a]	1.349[b]	1.396[a]	1.388[a]	0.0307	0.0001
MDA, mmol/dl	13.99[a]	13.27[b]	13.19[bc]	12.81[c]	13.13[bc]	0.4961	0.0001

[a,b,c] Means in the same row followed by different letters are significantly different at ($p \leq 0.05$), SEM: Standard error of mean; LDL: low-density lipoprotein; HDL: high-density lipoprotein; VLDL: very low-density lipoprotein; AST: aspartate aminotransferase; ALT: alanine aminotransferase; TAC: total antioxidant capacity, MDA: Malondialdehyde.

Table (7): Influence of dietary pumpkin seeds powder (PKSP) comparable to Zinc oxide (ZnO) on carcass characteristics and meat chemical composition of V-line growing rabbit at 91 days of age

Items	Control	ZnO 100 mg /kg	Pumpkin seeds powder levels %			SEM	P value
			0.05	0.10	0.20		
Pre-slaughter weight, g	2073	2103	2108	2114	2083	50.36	0.3263
Hot carcass weight, g	1049^{c}	1075^{bc}	1085^{bc}	1148^{a}	1095^{b}	47.32	0.0006
Dressing, %	50.53^{b}	51.15^{b}	51.50^{b}	54.30^{a}	52.07^{b}	1.867	0.0006
Heart weight, %	0.340	0.333	0.348	0.337	0.350	0.0519	0.9441
Kidney weight, %	0.725	0.714	0.743	0.725	0.720	0.0562	0.806
Liver, %	4.272	4.286	4.275	4.257	4.241	0.2384	0.9942
Spleen, %	0.048^{bc}	0.046^{c}	0.049^{bc}	0.055^{a}	0.049^{bc}	0.0033	0.0001
Edible Giblets, %	5.336	5.351	5.353	5.330	5.299	0.2809	0.9931
Total edible parts, %	55.86^{b}	56.50^{b}	56.85^{b}	59.63^{a}	57.36^{b}	1.980	0.0013
Non-edible parts, %	44.14^{a}	43.50^{a}	43.15^{a}	40.37^{b}	42.64^{a}	1.979	0.0013
Meat chemical composition, %							
Dry matter	31.28	31.33	31.22	31.38	31.33	0.643	0.987
Crude protein	24.61	24.79	24.88	25.06	24.80	0.686	0.674
Ether extract	4.61^{a}	4.49^{ab}	4.21^{c}	4.28^{bc}	4.26^{c}	0.240	0.0017
Ash	1.66	1.64	1.65	1.65	1.65	0.094	0.981

^{a,b,c} Means in the same row followed by different letters are significantly different at (p≤0.05); SEM, Standard error of mean.

REFERENCES

Abd El-Hack, M.E.; Alagawany, M.; Salah, A.S.; Abdel-Latif, M.A; and Farghly, M.FA., 2018. Effects of dietary supplementation of zinc oxide and zinc methionine on layer performance, egg quality, and blood serum indices. Bio Tra Ele Res 184, 456-462.

Abdelnour, S.A.; Metwally, M.G.E.; Bahgat, L.B.; and Naiel, M.A. E., 2023. Pumpkin seed oil–supplemented diets promoted the growth productivity, antioxidative capacity, and immune response in heat-stressed growing rabbits. *Tropcal Animal Health and Production*, 55 (1), 1–11. https://doi.org/10.1007/s11250-023-03460-3

Abdel-Wareth, A.A.A.; Amer, S.A.; Mobashar, M.; and El-Sayed, H.G. M., 2022. Use of zinc oxide nanoparticles in the growing rabbit diets to mitigate hot environmental conditions for sustainable production and improved meat quality. *BMC Veterinary Research*, 18 (1), 1–10. https://doi.org/10.1186/s12917-022-03451-w.

Abed, N.; and Alkalby, J., 2018. Ameliorative effect of pumpkin seed oil on alterations in thyroid gland functions induced by chlorpyrifos in adult male rats. Basrah Journal of Veterinary Research, 17(3): 307- 318.

Achilonu, M.C.; Nwafor, I.C.; Umesiobi, D.O.; and Sedibe, M.M., 2018. Biochemical proximates of pumpkin (*Cucurbitaeae spp*.) and their beneficial effects on the general well-being of poultry species. J. Anim. Physiol. Anim. Nutr., 102, 5–16.

Adedapo, A.; Dina, O.; Saba, A.; and Oladipo,O., 2002. Evaluation of Telfaria occiden talis and Sorghum bicolor extracts aspotent haematinics in domestic rabbits.Nigerian Journal of Animal Production 29,88–93.

Aguilar Y.M.; Yero, O.M.; Navarro, M.I.V.; Hurtado, C.A.B.; López, J.A.C.; and Mejía, L.B.G., 2011. Effect of squash seed meal (*Cucurbita moschata*) on broiler performance, sensory meat quality, and blood lipid profile. Rev Bras Cienc Avic 2011;13:219-26. https://doi.org/10.1590/S1516-635X2011000400001

Al-Daraji, H.J.; and Amen, M.H.M., 2011. Effect of dietary zinc on certain blood traits of broiler breeder. Int J Poult Sci 10:807-813.

Al-Khalifa, K.H., 2006. The effect of zinc on growth performance of meat rabbit. *Saudi J.Biol. Sci.*, 13: 71-78.

Amin, M.Z.; Rity, T.I.; Uddin, M.R.; Rahman, M.M.; and Uddin, M.J., 2020. A comparative assessment of anti-inflammatory, antioxidant and antibacterial activities of hybrid and indigenous varieties of pumpkin (*Cucurbita maxima Linn*.) seed oil. Biocatalysis and Agricultural Biotechnology, 28:101767.

Association of Official Analytical Chemists (AOAC), 2007. Official Methods of Analysis: (19th edition).Washington, DC, USA.

Attia Y.A.; El-Hanoun, A.M.; Bovera, F.; Monastra, G.; El-Tahawy, W.S.; and Habiba, H.I., 2014. Growth performance, carcass quality, biochemical and haematological traits and immune response of growing rabbits as affected by different growth promotersJ. Anim. Physiol. Anim. Nutr., 98, pp. 128-139

Bakeer, M. R., 2021. Focus on The Effect of Dietary Pumpkin (*Cucurbita moschata*) Seed Oil Supplementation on Productive Performance of Growing Rabbits. Journal of Applied Veterinary Sciences, 6 (2): 22 – 26.

Banerjee, G.C., 1988. Feeds and principles of animal nutrition. Rev. Oxford and IBH Publishing Co. PVT Ltd. New Delhi.

Bashar, Y. and Abubakar, A., 2001. Performance of broiler birds fed pumpkin (*Cucubita maxima*) seed meal. In: A. E. O.Malau-Aduli (ed.), Proceeding of the 26th Annual Conference of Nigerian Society of Animal Production Vol. 26. National Animal Production Research Institute, Zaria,pp. 283–285.

Baurhoo , B.; Phillip, L.; and Ruiz-Feria, C.A., 2007. Effects of purified lignin and mannao oligosaccharides on intestinal integrity and microbial populations in the ceca and litter of broiler chickens. Poultry Science, 86, 1070–1078. https://doi.org/10.1093/ps/86.6.1070.

Blasco, A.; and Ouhayoun, J., 1996. Harmonization of criteria and terminology in rabbit meat research World Rabbit Sci., 4 (1996), pp. 93-99.

Brooker, J. D.; and Acamovic, T., 2005. Phytochemicals in livestock production systems. Animal Feed Science and Technology 121, 1–4.

Chakraborty, S. B.; Horn, P.; and Hancz, C., 2013. Application of phytochemicals as growth-promoters and endocrine modulators in fish culture. Reviews in Aquaculture 5, 1–19.

Chasapis, C.T.; Ntoupa, P.A.; Spiliopoulou, C.A.; and Stefanidou, M.E., 2020. Recent aspects of the effects of zinc on human health. Arch. Toxicol. **2020**, 94, 1443–1460.

Chrastinová, L.; Cobanova, K.; Chrenkova, M.; Polacikova, M.; Formelova, Z.; Laukova, A.; Ondruska, L.; Poganysimonova, M.; Strompfova, V.; Bucko, O.; Mlynekova, Z.; Mlynar, R.; and Gresacova, L., 2015. High Dietary Levels of Zinc for Young Rbbits. Slovak Journal of Animal Science, 48: (2): 57–63.

Conti, M.; Morand, C.; Levillain, P.; and Lemmonnier, A., 1991. Improved fluorometric determination of malondialdehyde. Clin. Chem., 37: 1273-1275.

El Hendy, H.A.;Yousef, M.I.; and Abo El-Naga, N.I., 2001. Effect of dietary zinc deficiency on hematological and biochemical parameters and concentrations of zinc, copper, and iron in growing rats. Toxicology, 167, 2, 163-170.

Elgayed, A.; Sami, H.; El Moghazy, G.; Saba, F.; Ghanem, M.; and Abdel-Raoof, Y., 2022. Effect of zinc oxide nanoparticles and zinc oxide on clinical, hemato-biochemical, body weight, trace elements and wool zinc changes in lambs. Benha Veterinary Medical Journal, 42(2), 147-152. https://doi.org/10.21608/bvmj.2022.138119.1521.

Elghalid, O. A.; Kholif, A. E.; El-Ashry, G. M.; Matloup, O. H.; Olafadehan, O. A.; El-Raffa, A. M.; and Abd El-Hady, A. M., 2020. Oral supplementation of the diet of growing rabbits with a newly developed mixture of herbal plants and spices enriched with special extracts and essential oils affects their productive performance and immune status. *Livestock Science*, *238*, 104082.

Elsisi, G.F.; Ayyat, M.S.; Gabr, H.A.; and Abd El-Rahman, G.A., 2017. Effect of dietary protein levels and zinc supplementation on growth performance, digestibility, blood constituents and carcass traits of growing rabbits. Zagazig J. Agric. Res., Vol. 44 No. (4). 1369-1378.

Erel, O., 2004. A novel automated method to measure total antioxidant response against potent free radical reactions. Clin. Biochem., 37: 112-119. doi:10.1016/j.clinbiochem.2003.10.014.

Fogliano, V.; Verde, V.; Randazzo, G.; and Ritieni, A., 1999. Method for Measuring Antioxidant Activity and Its Application to Monitoring the Antioxidant Capacity of Wines. Journal of Agricultural and Food Chemistry, 47(3), 1035–1040. https://doi.org/10.1021/jf980496s

Friedewald, W. T.; Levy, R. I.; and Fredrickson, D. S., 1972. Estimation of the Concentration of Low-Density Lipoprotein Cholesterol in Plasma, Without Use of the Preparative Ultracentrifuge. Clinical Chemistry, 18(6), 499–502. https://doi.org/10.1093/clinchem/18.6.499

Gad Alla, S.A.Z., 2001. Effect of dietary zinc and iodine supplementation on growth performance, apparent digestibility, blood metabolites and reproductive efficiency in Bauscat rabbits. In: the proceeding of 2nd Sci Con on Animal Production and Health in Semi Arid Area, 4-6 Sep, El Arish, Egypt, p. 363-373.

Hafez, S.I.; El-Awady, N.; Deraz, T.A.A.; and Yacout, M.H.M., 2002. Response of supplemental some mineral elements in rabbits diets on digestibility nutritional balances and feed efficiency. J. Agric. Sci. Mansoura Univ., 27(3):1393-1403.

Hajati, H.; Hassanabadi, A.; and Waldroup, P.W., 2011. Effects of dietary supplementation with pumpkin oil (*Cucurbita pepo*) on performance and blood fat of broiler chickens during finisher period. American Journal of Animal and Veterinary Sciences. 6.

Herkel, R.; Galik, B.; Bıro, D.; Rolinec, M.; Simko, M.; Juracek, M.; Majlat, M.; and Arpasova, H., 2014. The effect of pumpkin and flaxseed oils on selected parameters of laying hens performance. Acta Fytotechnica et Zootechnica 17, 96–99.

Hong, J.C.; Steiner, T.; Aufy, A.; and Lien, T.F., 2012. Effects of supplemental essential oil on growth performance, lipid metabolites and immunity, intestinal characteristics, microbiota and carcass traits in broilers. Livestock science. 144: 253-262.

Hussain, A,; Kausar, T.; Din, A.; Murtaza, M.A.; Jamil, M.A.; Noreen, S.; Rehman, H.U.; Shabbir, H.; and Ramzan, M.A., 2021. Determination of total phenolic, flavonoid, carotenoid, and mineral contents in peel, flesh, and seeds of pumpkin (*Cucurbita maxima*). Journal of Food Processing and Preservation, 45(6): e15542.

Jahanian, R.; and Rasouli, E., 2015. Effects of dietary substitution of zinc-methionine for inorganic zinc sources on growth performance, tissue zinc accumulation and some blood parameters in broiler chicks. *Journal of Animal Physiology and Animal Nutrition*, *99*(1), 50–58. https://doi.org/10.1111/jpn.12213.

Kawahara, E.; Ueda, T.; and Nomura, S., 1991. In vitro Phagocytic activity of white-spotted shark cells after injection with Aer-monas salmonicida extra cellular products. 26, 213–214.

Kaya, S.; and Türke, P.F., 2022. Current health benefits of pumpkin seeds (*Cucurbita spp.*) as a nutraceutical: a detailed literature review. World Journal of Advance Health Care Research, Volume: 6.Issue: 8 Page N. 54-64.

Kim, N.R.; Kim, H.Y.; Kim, M.H.; and Jeong, H.J., 2016. Improvement of depressive behavior by Sweetme Sweet Pumpkin™ and its active compound, β-carotene. Life Sciences.147:39–45. doi: 10.1016/j.lfs.2016.01.036

Konomi, A.; and Yokoi, K., 2005. Zinc deficiency decreases plasma erthropoitin concentration in rats. *Biol Trace Elem Res* 107:289-92.

Krimer-Malesevic, V., 2020. Pumpkin seeds: Phenolic acids in pumpkin seeds (*Cucurbita pepo L.*). In V. R. Preedy & R. R. Watson (Eds.), Nuts and seeds in health and disease prevention (pp. 533-542). Academic Press.https://doi.org/10.1016/b978-0-12-818553-7.00037-1

Kulaitiene, J.; Černiauskiene, J.; Jariene, E.; Danilčenko, H.; and Levickiene, D., 2018. Antioxidant activity and other quality parameters of cold pressing pumpkin seed oil. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, *46*(1), 161–166.

Lebas, F., 2013. Feeding strategy for small and medium scale rabbit. In Proceedings of the 3rd Conference of Asian Rabbit Production Association, Bali, Indonesia, 27–29 August 2013; pp. 1–15.

Lestari, B.; Walidah, Z.; Utomo, R.Y.; Murwanti, R.Y.; and Meiyanto, E., 2019. Supplementation with extract of pumpkin seeds exerts estrogenic effects upon the uterine, serum lipids, mammary glands, and bone density in ovariectomized rats. Phytotherapy Research, 33(4): 891-900.

Ma, W.; Niu, H.; Feng, J.; Wang, Y.; and Feng, J., 2011. Effects of zinc glycine chelate on oxidative stress, contents of trace elements, and intestinal morphology in broilers. *Biological Trace Element Research*, 142(3), 546–556. https://doi.org/10.1007/s12011-010-8824-9.

Mahmood, S.F.; Al-Farha, A.A.B.; and Hameed, H.M., 2023. Infuence of Nano zinc sulfate on some hematological values and liver function in broiler under high ambient temperature. Egyptian Journal of Veterinary Sci.,54(3),491-501.

Marco Birolo., 2023. Feeding, Nutrition and Rearing Systems of the Rabbit. Animals Apr; 13(8): 1305. doi: 10.3390/ani13081305.

Martínez, Y., 2012. Chemical characterization of pumpkin seed flour and its use in feeding laying hens and broilers [Doctoral thesis]. Habana, Cuba: Instituto de Ciencias Animal; 2012.

Martínez, Y.; Valdivie, M.; Martínez, O.; Estarrón, M.; and Córdova, J., 2010. Utilization of pumpkin (Cucurbita moschata) seed in broiler chicken diets.

Cuban Journal of Agricultural Science, *44*(4), 387–392.

Mateos, G.G.; Garia-Rebollar, P.; and de Blas, C., 2020. Minerals, vitamins and additives. In Nutrition of the Rabbits, 3rd ed.; De Blas, C., Wiseman, J., Eds.; CABI Publishing: Wallingford, UK, 2020; pp. 126–133.

Mukherjee, P.K.; Singha, S.; Kar, A.; Chanda, J.; Banerjee, S.; Dasgupta, B.; Haldar, P.K.; and Sharma, N., 2021. Therapeutic importance of Cucurbitaceae: A medicinally important family. Journal of Ethnopharmacology, 10(282): 114599. Available at: https://pubmed.ncbi.nlm.nih.gov/34487849/

Nawirska-Olszanska, A.; Kita, A.; Biesiada, A.; Sokol-Leztowska, A.; and Kucharska, A. Z., 2013. Characteristics of antioxidant activity and composition of pumpkin seed oils in 12 cultivars. Food Chemistry 139, 155–161

Nehad, AR.; Sedki, A.A.; and El-neney, A.M., 2009. New trend in rabbit's growth in relation to energy and protein requirements. Egypt J Rabbit Sci 19: 87-106

Nkosi, C.Z.; Opoku, A.R.; and Terblanche, S.E., 2006. In vitro antioxidative activity of pumpkin seed (*Cucurbita pepo*) protein isolate and its in vivo effect on alanine transaminase and aspartate transaminase in acetaminophen-induced liver injury in low protein fed rats. Phytother Res 20:780–783. https://doi.org/10.1002/ptr.1958

Nkukwana, T.T.; Muchenje, V.; Pieterse, E.; Masika, P.P.; Mabusela, T.P.; Hoffman, L.C.; and Dzama, K., 2014. Effect of Moringa oleifera leaf meal on growth performance, apparent digestibility, digestive organ size and carcass yield in broiler chickens. Livestock Science 161, 139–146.

North, M.O., 1981 Second ed. AVI Publishing Company Inc; USA: 1981. Commercial Chicken Production and Manual; pp. 95–101.

NRC, 1977. National Research Council, Nutrient Requirements of Rabbits 2^{nd} (Eds). National Academy Press, Washington, DC.

Nwanna, E.E.; and Oboh, G., 2007. Antioxidant and Hepatoprotective Properties of Polyphenol Extracts from Telfairia occidentalis (Fluted Pumpkin) Leaves on Acetaminophen Induced Liver Damage. Pakistan Journal of Biological Sciences Volume: 10 | Issue: 16 , Page No.: 2682-2687 DOI: 10.3923/pjbs.2007.2682.2687.

Nworgu, F.C.; Ogungbenro, S.A.; and Solesi, K.S., 2007a . Performance and some blood chemistry indices of broiler chicken served fluted pumpkin (Telfaria occidentalis) leaves extract supplement. American-Eurasian Journal of Agriculture and Environmental Science, 2(1), 90-98.

Nworgu, F.C.; Ekemezie, A.A.O.; Ladele, A.O.; and Akinrolabu, B.M., 2007b. Performance of broiler chickens served heat-treatedfluted pumpkin (Telfaria occidentalis) leaves extractsupplement. African Journal of Biotechnology Vol. 6 (6), pp. 818-825.

Omenka, R.O.; and Anyasor, N.G., 2010. Vegetable-based feed formulation on poultry meat quality. African Journal of Food Agriculture Nutrition and Development · February 2010; 2001–2011.. DOI: 10.4314/ajfand.v10i1.51474.

Ozuna, C.; and León-Galván, M., 2017. Cucurbitaceae seed protein hydrolysates as a potential source of bioactive peptides with functional properties. BioMed Research International 2017: 2121878.

Perez, J.M.; Lebas, F.; Gidenne, T.; Maertens, L.; Xiccato, G.; Parigi-Bini, R.; and Bengala Freire, J., 1995. European reference method for in vivo determination of diet digestibility in rabbits. World Rabbit Science, 3(1).

Petkova, Z.Y.; and Antova, G.A., 2019. A comparative study on quality parameters of pumpkin, melon and sunflower oils during thermal treatment. Oilseeds and Fats, Crops and Lipids, 26:32.

Prasad, A.S.; and Bao, B., 2019. Review, Molecular Mechanisms of Zinc as a Pro-Antioxidant Mediator: Clinical Therapeutic Implications. Antioxidants 2019, 8, 164.

Ragab, A.A., El-Reidy, K.F.A. and Gaafar, H.M., 2013. Effect of diet supplemented with pumpkin (Cucurbita moschata) and black seed (Nigella sativa) oils on performance of rabbits: 1- Growth performance, blood hematology and carcass traits of growing rabbits. Journal of Animal and Poultry Production, 4(7), pp.381-393.)

Ramadan, B.K.; Mohammad, S.A.; Mahmoud, E.S.; and Ouda, E.A., 2016. Role of pumpkin seed oil on some cardiovascular and renal aspects in adult male albino rats. Al-Azhar Medical Journal. 45: 931-956.

SAS Institute, 2001. SAS/STAT User's Guide. Statistics, version 8. SAS Institute, Cary, NC.

Schalm, O.W.; Jain, N.C.; and Qureshi, M.Q., 1975. Veterinary Hematology third ed. Lea and Fibinger, Philadilphia, PA, US. 1975.

Selim, N.; Abdel-Khalek, A.M.; and Gad, S.M., 2012. Effect of supplementation zinc, magnesium or iron on performance and some physiological traits of growing rabbits. Asia J. Poult. Sci. **2012**, 6, 23–30.

Sharma, A.; Sharma, A.K.; Chand, T.; Khardiya, M.; and Yadav, K.C., 2013. Antidiabetic and antihyperlipidemic activity of Cucurbita maxima Duchense (pumpkin) seeds on streptozotocin induced diabetic rats. J. Pharmacogn. Phytochem. 1, 108–116.

Simone, M.; and Paci, G., 2021. Probiotics in Rabbit Farming: Growth Performance, Health Status, and Meat Quality. Animals 2021, 11, 3388. https://doi.org/10.3390/ani11123388

Suttle, N.F., 2010. Minerals in livestock production. Asian Austral J Anim. 13:1-9.

Van Soest, P.J.; Robertson, J.D.; and Lewis, B.A., 1991. Methods for dietary fiber. Neutral detergent fiber and non-starch polysaccharide in relation to animal nutrition. J. Dairy Sci. 74:3583-3597.

Viuda-Martos, M.; Ruiz Navajas, Y.; SÃ¡nchez Zapata, E.; FernÃ¡ndez-LÃ3pez, J.; and Pérez -Ãlvarez, J. A., 2010. Antioxidant activity of essential oils of five spice plants widely used in a Mediterranean diet. Flavour and Fragrance Journal, 25(1), 13–19.

Vlaicu, P.A.; Panaite, T.D.; and Turcu, R.P., 2021. Enriching laying hens eggs by feeding diets with different fatty acid composition and antioxidants. Scientific Reports 2021:11:1:1-12.

Wafar, R.; Hannison, M.; Abdullahi, U.; and Makinta, A., 2017. Effect of Pumpkin (*Cucurbita pepo L.*) Seed Meal on the Performance and Carcass Characteristics of Broiler Chickens. *Asian Journal of Advances in Agricultural Research*, *2*(3), 1–7.

Zaghari, M.; Avazkhanllo, M.; and Ganjkhanlou, M., 2105. Reevaluation of male broiler zinc requirement by dose-response trial using practical diet with added exogenous phytase. J. Agric. Sci. Technol. 17, 333-343.

Zeweil, H.S., 1996. Enzyme supplements to diets growing Japanese quails. Egypt Poult. Sci. J. 16, 535–557.

الملخص العربي

تأثيرإضافة مسحوق بذور اليقطين للعلائق علي أداء النمو ومعاملات الهضم ومكونات الدم وخصائص الذبيحة في الارانب النامية

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تم اجراء هذة التجربة لدراسة تاثيرإضافة مسحوق بذور اليقطين للعلائق علي أداء النمو ومعاملات هضم العناصر الغذائية والعد البكتيري بالاعور وبعض مكونات الدم ، وصفات الذبيحة مقارنة باكسيد الزنك علي أرانب الفي لاين اثناء فترة النمو من عمر 35 وحتي 91 يوم. حيث تم وزن الارانب فرديا ووزعت عشوائيا علي 5 مجموعات تجريبية ؛ كل مجموعة تحتوي علي 5 مكررات كلا منها يحتوي علي أربعة أرنب وكانت المجموعات التجريبية كالاتي المجموعة الاولي: تم تغذيتها علي العليقة الأساسية بدون اي إضافات واستخدمت كمجموعة مقارنة أما المجموعة الثانية: تم تغذيتها علي العليقة الأساسية مضافا اليها اكسيد الزنك بمعدل (100 مليجرام/كجم علف) أما المجاميع من الثالثة حتي الخامسة: تم تغذيتها علي العليقة الأساسية مضافا اليها مسحوق بذور اليقطين بمعدل (0,05 ، 0,1 ، 0,2%) علي الترتيب. ويمكن ايجاز النتائج المتحصل عليها كما يلي: ادي اضافة مسحوق بذور اليقطين بمعدل 0,1% الي علائق الارانب النامية الي تحسن معنوي في وزن الجسم النهائي ، وزن الجسم المكتسب ، والكفاءة التحويلية للغذاء ومؤشر الاداء الانتاجي وكذلك الكفاءة الاقتصادية مقارنة بباقي المجموعات التجريبية. كذلك ادى تغذية الارانب النامية علي العليقة الاساسية مضافا اليها مسحوق بذور اليقطين بمعدل 0,1% او اكسيد الزنك الي تحسن معنوي في معامل هضم البروتين الخام والالياف الخام وكذلك البروتين المهضوم مقارنة بباقي المجموعات التجريبية. أوضحت النتائج ان تغذية الارانب النامية علي العليقة الاساسية مضافا اليها مسحوق بذور اليقطين بمعدل 0,1 ، 0,2 % أدي الي انخفاض معنوي في محتوي الاعور من بكتريا الايشريشيا كولاي وزيادة معنوية من بكتريا اللالاكتوباسلس. كذلك حدث تحسن معنوي في عدد خلايا الدم الحمراء والهيموجلوبين وحجم خلايا الدم المعبأة ونسبة الخلايا الليمفاوية في الأرانب النامية التي تم تغذيتها على العليقة الأساسية مضافا اليها مسحوق بذوراليقطين بمعدل 0,1 ، 0,2 % او اكسيد الزنك مقارنة بالمجموعة الضابطة. بالإضافة إلى ذلك، فإن تغذية الأرانب النامية على العليقة الاساسية مضافا اليها مسحوق بذوراليقطين بمعدل 0,2 % او اكسيد الزنك ادى الي انخفاض معنوي في محتوي سيرم الدم من الدهون الكلية والدهون الثلاثية والكوليسترول مقارنة بالمجموعة الضابطة. بصفة عامة أدت الاضافات الغذائية المختلفة الى تحسن معنوى فى محتوى السيرم من إنزيمات وظائف الكبد والكلي ومضادات الاكسدة الكلية وكذلك مستوى دليل أكسدة الدهون (المالونالدهيد) مقارنة بالمجموعة الضابطة. اضافة الي ذلك ادي تغذية الارانب النامية علي العليقة الاساسية مضافا اليها مسحوق بذور اليقطين بمعدل 0,1% الي تحسن معنوي في نسبة تصافى الذبيحة وكذلك مجموع الاجزاء الماكولة مقارنة بباقى المجموعات التجريبية.

وقد خلصت الدراسة الى ان إضافة مسحوق بذور اليقطين للعلائق بمعدل 0,1% يودى الي تحسن معنوي في الاداء الانتاجي والكفاءة الاقتصادية ومعاملات الهضم وكذلك العد الميكروبي بالاعور وبعض قياسات الدم وصفات الذبيحة فى الارانب النامية.