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College of Agriculture, University of Basrah

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# Effect of Supplementing Different Levels of Okra Seed (*Abelmoschus esculentus* L.) Powder on Growth Performance, Carcass Characteristics, Blood Parameters and Gut Microbial Populations in Broiler Chickens

**Rabia J. Abbas**

Animal Production Department, Collage of Agriculture, University of Basrah, Iraq

***Corresponding author**: rj.abbas@yahoo.com
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**Abstract:** A study was conducted to determine the effect of different levels of okra (*Abelmoschus esculentus* L.) seed powder (OSP) in diets on performance, carcass characteristics, some blood parameters, and gut microbial populations in broiler chickens. For the present experiment, 216 day old chicks were randomly divided into four groups, each group consisting three replicates of 18 chicks in a completely randomized design. Four diets were formulated with diet 1 as the basal diet (control), while 2, 3, and 4 were supplemented with OSP at 1, 2 and 4 %, respectively. The results revealed that the highest final live body weight, accumulative weight gain, and better feed conversion ratio was achieved in birds fed with 1 or 2 % of OSP. Feed intake and carcass characteristics were similar among groups. The highest relative weight of the spleen and cecum was observed in the control group, while the lowest value was observed in birds fed with 4% and 2% OSP, respectively. The longest length of the gastrointestinal tract was seen in 2% OSP compared to other groups. Serum cholesterol and ALT activity were decreased as compared to control diets. The group fed with 2 % OSP showed higher albumin levels compared to those fed with 1% of OSP. The population of total bacteria and *Escherichia coli* in jejunum digesta of OSP supplemented broiler chickens was reduced, meanwhile, there was an increased in lactic acid bacteria counts as compared to control. Therefore, 1 and 2 % okra seed powder in the diet of broiler chickens was able to improve the growth performance.

**Keywords:** Broiler, Okra seed powder, Productive performance, Biochemical traits.

## Introduction

Okra, *Abelmoschus esculentus* L. (Moench) commonly known as ladies finger, besides in several other vernacular names. It was cultivated as an important vegetable crop in tropical, subtropical and warm temperate regions around the world (Roy *et al*., 2014). It has been called "a perfect villager's vegetable" because of its robust nature, dietary fibers and distinct seed protein balanced in both lysine and tryptophan amino acids (Kumar *et al.*, 2010). *A. esculentus* L. seeds were founded to contain high levels of crude protein 24.85% (Ndangui *et al*., 2010). Previous studies revealed that seed protein is rich in tryptophan

(94 $mg.g^{-1}$ nitrogen) and as well contains suitable amounts of sulfur-containing amino seeds exceptionally useful in reducing human malnutrition (NAP, 2006). Besides that, the composition of okra seed protein from amino acids is comparable to that of soybean, and the protein efficiency ratio (PER) is higher than that of soybean, as well as the pattern of amino acids in the protein, renders it an adequate supplement to legume or cereal basic diets according to Gemede *et al*. (2015). On the other hands, okra seed protein with good PER and net protein utilization (NPU) values is comparable to many cereals (excepting wheat) and its oil yield is similar to the most oil seed crops except oil palm and soybean oil (Kumar, *et al*., 2010). Also, a recent study confirmed that the great of essential amino acids of okra seeds powder were leucine (6.71%) followed by lysine (5.22%) (Abouel-Yazeed, 2019).

In terms of biomolecular characters in okra seeds, Dhruve *et al*. (2020) indicated that the highest amount of free amino acid, reducing sugars and calcium was recorded in genotype AOL 13-75 whereas, lysine was higher present in Pusasawani and methionine the highest in genotype AOL 13-90. According to studies by Benchasri (2012) and MEF (2013).

*Abelmoschus esculentus* L. seeds are a potential sources of oil, with levels varying from 20- 40 (%), which consists of linoleic acid up to 47.4%. Okra seed oil seed was found to contain high levels of unsaturated fatty acids, mainly oleic (up to 24.89%) and linoleic (up to 42.78%), for that, the oil can be classified in the oleic-linoleic acid group, whereas, dominant saturated acid was palmitic (up to 25.79%) (Ndangui *et al*., 2010). Furthermore, okra seed oil has potential hypocholesterolemic effect (Hassan & Ali, 2015). As well, it can be considered the oil of okra seeds for the prevention and treatment of human diseases and its complication as a potent antioxidant (Al-Kanani *et al*, 2019). Seed mucilage, of okra is may be responsible for washing away toxic substances and bad cholesterol, which loads the liver (Dhruve *et al*., 2015). Kumar *et al*. (2013) have revealed that okra contains special fiber, which takes sugar levels in blood under control, providing sugar quantity, acceptable for the bowels. According to Gemede *et al*. (2015), okra vegetable crop is a powerhouse of valuable nutrients, about half of which is soluble fiber in the form of gums and pectin's which help to hypocholesterolemic, lowering the risk of heart diseases.

Arapitsas (2008) reported that the main component of okra seeds was oligomeric catechins (2.5 $mg.g^{-1}$ of seeds) and flavonol derivative (3.4 $mg.g^{-1}$ of seeds), however the pod skin mostly a component of hydroxycinnamic, and quercetin derivatives (0.2 and 0.3 $mg.g^{-1}$ of skins), also, the author pointed out that okra seeds and pods are rich in phenolic compounds with important biological properties like quartering derivatives, catechin oligomers and hydroxycinnamic derivatives. Some studies have indicated that different parts of okra plant (flower, fruit, leaf, and seed) had high antioxidant activity (Shui & Peng, 2004; Atawodi *et al*., 2009; Liao *et al*., 2012). Hassan & Ali (2015) mentioned that the intake of okra seeds will provide the necessary energy to body, and important phenolics and flavonoids that could support immune body system and prevention of diseases. Additionally**,** okra fruit extracts showed antimicrobial activity against seven pathogenic strains that belong to *Bacillus subtilis*, *Streptococcus pyogens*, *Klebsiella*

*pneumoniae, Staphylococcus aureus, Escherichia coli, Proteus mirabillis* and *Pseudomonas aeruginosa* (Chaudhari *et al*., 2011). Olorunnipa *et al*. (2013) showed that the methanol extracts of *Abelmoschus esculentus* L. Moench (Okra) dried fruit had bactericidal activity against *Helicobacter* strains (*H. pylori* strains coded BAA009 and *H. pylori* BAA026) *in vitro* study.

Kalarani *et al*. (2017) stated that acetonic extract of various parts of okra plant (peel, seed, the combinations of peel and seeds) has been shown antibacterial activity that was higher than the activity of the positive control (Ofloxacin). Many studies have focused to describe the medicinal characteristics of okra (Amin, 2011; Nwachukwu, *et al*., 2014; Roy *et al*., 2014; Singha *et al*., 2014; Gemede *et al*., 2015). There is limited research available on the effect of okra seeds on poultry performance. supplementation of okra meal in broiler diets was not changed among groups on daily gains and feed conversion ratio, whereas there was a significant improvement in broiler skin pigmentation and belly fat considering that xanthophyll's - rich okra meal may be used as a natural coloring source in poultry feed (Liu *et al*., 2008). Machebe *et al*. (2013) reported that feeding okra seeds extracts (50 $ml.l^{-1}$) breeder Turkey hens significantly improved the number of eggs laid, fertility and hatchability of the eggs. Given this background, the objective of this study was to determine the effect of dietary supplementation with okra seeds meal on the productive performance in broiler chickens. As well as, to examine whether okra seeds supplementation affected carcass characteristics, internal organ properties and blood parameters.

## Materials & Methods

### Preparation of okra seed powder

Okra seeds were obtained from a local market of Basrah city, Iraq. The seeds were grinded to a fine powder in an electrical mixer and then mixed manually with the basal broiler diet (starter or grower diets) at the levels 1, 2 and 4 %.

### Animal husbandry and treatments

Two hundred and sixteen day-old broiler chicks (Ross 308) were distributed randomly into four groups, each including three replicate battery cages (18 birds. $cage^{-1}$). Four diets were formulated with diet 1 as the control diet, while 2, 3, and 4 were supplemented with okra seed powder (OSP) at 1, 2, and 4 %, respectively. All the birds under the experiment were provided standard feeding that formulated to meet the nutrient requirements. The parts composition of broiler starter and grower diets has been presented in table (1). Nutrient analysis of OSP was determined as described in AOAC methods (2016) (Table 2).

### Carcass traits

Six birds from each treatment (two birds per replicate) were selected based on the average weight of the group and sacrificed for carcass study at the end of $4^{th}$ week, after the birds were manually eviscerated and dressed. Internal organs were carefully removed, weighed and expressed as a percentage of the live weights. The weight of carcass cuts (thigh, breast, back, wings and neck) was calculated. Dressing percent was calculated according to the equation of Al-Fayadh *et al*. (2011):

$$\text{Dressing percentag} = \frac{\text{Dressed weight (gm)}}{\text{Live weight (gm)}} \times 100$$

**Table (1): The composition and nutrient content of experimental rations.**

| Ingredients (%) | Starter (1-20 days) | Grower (21-28 days) |
|---|---|---|
| Maize | 29.80 | 33.80 |
| Wheat | 15.00 | 15.00 |
| Broken rice | 14.00 | 14.00 |
| Soybean meal | 34.00 | 29.00 |
| Vegetable oil | 1.00 | 2.00 |
| [1]Broiler protein Concentrate | 5.00 | 5.00 |
| Calcium carbonate ($CaCo_3$) | 0.70 | 0.70 |
| [2]Mineral mixture | 0.30 | 0.30 |
| Common salt | 0.20 | 0.20 |
| **Total** | **100** | **100** |
| [3]Calculated chemical analysis | | |
| Energy ME (Kcal. $Kg^{-1}$) | 3004 | 3106 |
| Crude protein (%) | 23.07 | 21.23 |
| Calorie: protein ratio | 130.21 | 146.30 |
| Ether extract (%) | 2.30 | 3.35 |
| Crude fiber (%) | 3.90 | 3.65 |
| Calcium (%) | 0.81 | 0.81 |
| Available P (%) | 0.34 | 0.33 |
| Lys (%) | 1.25 | 1.13 |
| Met + Cys (%) | 0.74 | 0.69 |

[1]Protein concentrate used from Al-Hayat Company , Jordanian Origin, provided per kilogram of diet: 44% Protein, 2800 kcal/kg ME, 12% Fat, 25% Ash, 5% Calcium, 2.9% Phosphorus, 2.55% Methionine + cysteine , 2.8% Lysine. [2]Content/kg: Manganese 80 g; Iron 80 g; Zinc 50 g; Copper 10 g; Cobalt 2 g; Iodine 1 g; Excipient Q.S. - 1,000 g. [3]Was calculated according to the feed composition Tables given in NRC (1994).

**Table (2): Chemical composition (% on a dry weight basis) of the of okra seed powder.**

| Nutrients (%) | Okra seed powder |
|---|---|
| Moisture | 9.73 |
| Crude protein | 22.01 |
| Ether Extract | 14.99 |
| Total ash | 5.21 |
| Crude fiber | 17.63 |
| Nitrogen free extract | 30.43 |
| Organic matter | 94.79 |
| [1]Metabolized Energy (Kcal.$Kg^{-1}$) | 2810 |

[1]ME was calculated by the equation described by Lodhi *et al*. (1976).

## Blood parameters

At the end of the experiment, six chicks per treatment were slaughtered, and blood samples were collected in tubes without heparin for biochemical assays. The blood sample was drawn in the early morning from the wing vein of birds and allowed to clot at room temperature (25°C) for one hour prior to serum collection. The blood sample was collected in heparinized test tubes and centrifuged at 3000 rpm, 15 min, and 25$^{o}$C to obtain serum. The serum preserved at -20 $^{0}$C until the time of analysis. The following variables were

measured: Total proteins and albumin by a Colorimetric method using available Commercial Kits (Biolab SAS, France); sera globulin was calculated as the difference between total protein and albumin; cholesterol, triglycerides, and glucose were measured according to the methods described by Tietz (1999) by using available Commercial kits (Biolabo SAS); aspartate aminotransferase (AST) and alanine aminotransferase (ALT), were measured by using diagnostic kits (QCA, Amposta, Spain). AST: ALT ratio was calculated.

**Micro-bacterial count**

The number of bacteria was estimated according to pour plate method mentioned by Harrigan & McCance (1976). Samples of the contents from the jejunum were immediately collected per chick (six chicks per treatment) into glass containers, later it was transferred to the microbial population laboratory. One gram of the jejunum contents were mixed and placed in sterile glass containing 9 ml of sterile peptone solution. The dilution process was then carried out to dilute the decomposition to $10^{-2}$ dilution, then 1 ml of the dilute was added to 9 ml of peptone solution to reached dilution $10^{-3}$. This process was re-reduced to $10^{-5}$. $10^{-8}$ dilution. In the microbial cultivation, transfer 1 ml of each dilution to two sterile plates and add 20 ml of sterilized agar culture to estimate total bacterial, MRS (De Man, Rogosa, and Sharpe agar) agar (facultative anaerobes Lactobacillus spp.) and McConkey agar to estimate colonic bacteria (*Escherichia coli*). For bacterial growing, all the plates were incubated at 37°C, MRS agar plates were incubated anaerobically for 48 hours and other plates were incubated aerobically for 24 hours. The bacteria counts were estimated by multiplying the total number of bacterial colonies at each incubation period in a dilution inverted.

**Statistical analysis**

The data were subjected to analysis of variance (One –way ANOVA) in accordance to Completely Randomized Design (CRD) using SPSS software (2015) to analyze the results. Least Significant Difference (L.S.D.) test was applied to the separated means at significant level of 0.05 (SPSS, 2015).

## Results

**Effect of OSP supplementation on productive performance of broilers**

The effect of dietary supplementation with okra (*Abelmoschus esculentus)* seed powder (OSP) on the productive performance of broiler chickens is presented in Table 3. The result revealed that the groups supplemented with 1 and 2 % OSP caused significantly ($P \leq 0.05$) higher body weight and weight gain when compared with 4% treated and control group at 28 days of age, meanwhile all OSP supplementations did not show any effect on total feed intake. As table (3) shows, there were a significant improvement for feed conversion ratio (FCR) at levels 1 and 2% during experimental period as compared with control and higher levels of OSP (4%).

**Carcass and internal organ characteristics**

No significant differences were found with regard to the carcass characteristics measurements (Table 4). Table (5) shows that, with the exception of the relative weight of the spleen, gastrointestinal tract length and caecum weight, all other organs measured were not significantly influenced by the dietary treatments.

**Table (3): Effect of okra seeds powder on the overall (0-28 d) performance of broiler chicks.**

| Parameters | Treatment of okra seeds powder (%) | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 4 |
| Initial live weight (g) | $35.4^{a} \pm 0.23$ | $35.5^{a} \pm 0.70$ | $34.2^{a} \pm 0.23$ | $35.0^{a} \pm 0.62$ |
| Final body weight (g) | $1473^{bc} \pm 17.89$ | $1540^{a} \pm 0.88$ | $1524^{ab} \pm 23.09$ | $1468^{c} \pm 3.28$ |
| Total weight gain(g) | $1437.6^{b} \pm 17.67$ | $1504.5^{a} \pm 1.63$ | $1489.8^{a} \pm 22.86$ | $1433.0^{b} \pm 12.82$ |
| Total feed intake ($g.bird^{-1}$) | $2351^{a} \pm 33.26$ | $2366^{a} \pm 25.58$ | $2311^{a} \pm 0.87$ | $2303^{a} \pm 4.30$ |
| Feed conversion ratio(g:g) | $1.64^{b} \pm 0.014$ | $1.57^{a} \pm 0.019$ | $1.55^{a} \pm 0.008$ | $1.61^{ab} \pm 0.017$ |

[a-c] Means within main effects with no common superscripts are different significantly p≤0.05)

Result for relative spleen weight showed that birds fed the control and 1 and 2 % okra seed diets had the highest significant values that were similar (P≤0.05) but higher than the value recorded by those fed the 4% okra seed diet. Birds fed a 2% okra seed diet had the longest length of the gastrointestinal tract as compared to other groups. Caecum relative weight was higher (P≤0.05) in control (1.004%) as compared to 2% okra seed group.

**Table (4): Effect of okra seeds powder on carcass traits in broiler chicks.**

| Parameters | Okra seeds (%) | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 4 |
| Carcass weight (g) | $1191^{a} \pm 40.90$ | $1224^{a} \pm 34.05$ | $1110^{a} \pm 44.97$ | $1145^{a} \pm 53.24$ |
| Carcass yield (%) | $71.03^{a} \pm 0.84$ | $71.66^{a} \pm 0.48$ | $71.28^{a} \pm 0.56$ | $71.49^{a} \pm 0.29$ |
| Breast yield (%) | $37.74^{a} \pm 0.86$ | $38.56^{a} \pm 2.07$ | $38.85^{a} \pm 2.08$ | $36.35^{a} \pm 0.67$ |
| Thigh yield (%) | $27.41^{a} \pm 0.61$ | $27.84^{a} \pm 1.69$ | $30.28^{a} \pm 3.20$ | $28.33^{a} \pm 1.14$ |
| Back yield (%) | $17.66^{a} \pm 0.80$ | $18.18^{a} \pm 1.05$ | $17.26^{a} \pm 0.96$ | $18.30^{a} \pm 0.19$ |
| Wing yield (%) | $10.19^{a} \pm 0.42$ | $9.53^{a} \pm 0.33$ | $10.46^{a} \pm 0.36$ | $9.69^{a} \pm 0.39$ |
| Neck yield (%) | $4.18^{a} \pm 0.38$ | $4.07^{a} \pm 0.35$ | $4.35^{a} \pm 0.20$ | $4.86^{a} \pm 0.47$ |
| Total giblets (%) | $6.04^{a} \pm 0.23$ | $5.96^{a} \pm 0.16$ | $6.14^{a} \pm 0.13$ | $5.88^{a} \pm 0.21$ |
| Liver yield (%) | $2.83^{a} \pm 0.07$ | $2.56^{a} \pm 0.14$ | $2.78^{a} \pm 0.13$ | $2.56^{a} \pm 0.09$ |
| Heart yield (%) | $0.52^{a} \pm 0.03$ | $0.61^{a} \pm 0.01$ | $0.56^{a} \pm 0.02$ | $0.56^{a} \pm 0.03$ |
| Gizzard yield (%) | $2.64^{a} \pm 0.24$ | $2.79^{a} \pm 0.12$ | $2.80^{a} \pm 0.22$ | $2.76^{a} \pm 0.16$ |

[a]Means in the same row with a common superscript are insignificant differences (P≥0.05).

**Serum parameters**

Table (6) presents the serum metabolites to the dietary groups. Total serum protein, globulins, Albumin to globulins ratio, glucose, triglyceride, AST activity, and AST to ALT ratio did not vary significantly due to dietary groups. A significant difference (P≤ 0.05) was recorded on serum albumin, cholesterol and ALT activity of broilers fed various diets. Serum cholesterol and ALT activity were declined (P≤ 0.05) in all experimental groups as compared with the control one, on other hands, the group of 2 % okra seed powder showed higher (P≤ 0.05) albumin levels than those fed 1% okra seed powder.

**Micro-bacterial count**

The results in table (7) showed that there was a significant (p≤0.05) reduction in total bacterial and *E. coli*, whereas the *Lactobacilli* population

**Table (5): Effect of okra seeds powder on some gut measurements and relative organ weights in broiler chicks.**

| Characteristics | Treatment of okra seeds powder (%) | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 4 |
| Spleen weight (%) | $0.16^{a}\pm0.007$ | $0.13^{ab}\pm0.005$ | $0.15^{a}\pm0.02$ | $0.11^{b}\pm0.008$ |
| Pancreatic weight (%) | $0.32^{a}\pm0.05$ | $0.32^{a}\pm0.03$ | $0.36^{a}\pm0.02$ | $0.31^{a}\pm0.03$ |
| Proventirculas weight (%) | $0.51^{a}\pm0.02$ | $0.51^{a}\pm0.07$ | $0.54^{a}\pm0.08$ | $0.59^{a}\pm0.06$ |
| Gastrointestinal tract weight % | $4.87^{a}\pm0.18$ | $5.43^{a}\pm0.49$ | $5.32^{a}\pm0.24$ | $5.23^{a}\pm0.43$ |
| Gastrointestinal tract length (%) | $11.70^{b}\pm0.47$ | $12.02^{b}\pm0.75$ | $13.97^{a}\pm0.34$ | $12.13^{b}\pm0.44$ |
| Bursa of Fabricius weight % | $0.21^{a}\pm0.14$ | $0.22^{a}\pm0.02$ | $0.24^{a}\pm0.03$ | $0.23^{a}\pm0.01$ |
| Bursa Index | $1.00^{a}\pm0.00$ | $1.07^{a}\pm0.16$ | $1.16^{a}\pm0.15$ | $1.14^{a}\pm0.10$ |
| Caecum weight % | $1.00^{a}\pm0.23$ | $0.69^{ab}\pm0.07$ | $0.56^{b}\pm0.05$ | $0.64^{ab}\pm0.10$ |
| Caecum Length (%) | $1.46^{a}\pm0.12$ | $1.47^{a}\pm0.15$ | $1.31^{a}\pm0.13$ | $1.19^{a}\pm0.15$ |

[a-b]Means in the same row with a common superscript are insignificant differences (P≥0.05).

**Table (6): Some blood parameters at 28 days of age of chick fed okra seeds powder.**

| Parameters | Treatment of okra seeds powder (%) | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 4 |
| Total Protein ($g.dl^{-1}$) | $3.63^{a}\pm0.14$ | $3.66^{a}\pm0.23$ | $4.28^{a}\pm0.33$ | $4.16^{a}\pm0.51$ |
| Albumin ($g.dl^{-1}$) | $2.46^{ab}\pm0.13$ | $2.22^{b}\pm0.07$ | $2.52^{a}\pm0.05$ | $2.43^{ab}\pm0.08$ |
| Globin ($g.dl^{-1}$) | $1.17^{a}\pm0.12$ | $1.44^{a}\pm0.21$ | $1.76^{a}\pm0.28$ | $1.73^{a}\pm0.46$ |
| Albumin to Globulin ratio | $2.19^{a}\pm0.35$ | $1.63^{a}\pm0.22$ | $1.52^{a}\pm0.17$ | $1.64^{a}\pm0.29$ |
| Glucose (mg/dl) | $229.18^{a}\pm10.81$ | $317.25^{a}\pm51.54$ | $250.35^{a}\pm10.88$ | $298.47^{a}\pm60.83$ |
| Cholesterol ($mg.dl^{-1}$) | $120.08^{a}\pm9.26$ | $105.91^{b}\pm4.56$ | $87.79^{b}\pm2.49$ | $104.76^{b}\pm2.06$ |
| Triglyceride ($mg.dl^{-1}$) | $86.25^{a}\pm9.57$ | $125.87^{a}\pm10.34$ | $119.07^{a}\pm9.99$ | $126.75^{a}\pm24.42$ |
| [1]AST ($U.l^{-1}$) | $392.0^{a}\pm16.56$ | $379.12^{a}\pm13.81$ | $395.42^{a}\pm8.14$ | $367.81^{a}\pm13.49$ |
| [2]ALT (($U.l^{-1}$) | $254.41^{a}\pm2.24$ | $242.86^{b}\pm1.09$ | $247.09^{b}\pm3.03$ | $242.55^{b}\pm1.24$ |
| AST to ALT ratio | $1.54^{a}\pm0.05$ | $1.56^{a}\pm0.06$ | $1.60^{a}\pm0.02$ | $1.52^{a}\pm0.05$ |

[a,b]Means bearing different superscripts within a row differ significantly (P≤0.05)
[1]AST = Aspartate aminotransferase; [2]ALT= Alanine aminotransferase.

**Table (7): Micro-bacterial a count (log $cfu.g^{-1}$) as affected by supplemented with okra seed powder.**

| Bacteria types | Treatment of okra seeds powder (%) | | | |
|---|---|---|---|---|
| | 0 | 1 | 2 | 4 |
| Total bacterial count (TBC) ($\times10^{8}$) | $3.64^{a}\pm0.41$ | $2.63^{b}\pm0.42$ | $2.05^{b}\pm0.32$ | $2.47^{b}\pm0.34$ |
| lactic acid bacteria (LAB) ($\times10^{7}$) | $2.99^{b}\pm0.50$ | $5.47^{a}\pm0.54$ | $4.80^{a}\pm0.66$ | $5.19^{a}\pm0.47$ |
| *Escherichia coli* (E. coli) ($\times10^{6}$) | $6.68^{a}\pm0.40$ | $3.48^{b}\pm1.08$ | $6.00^{b}\pm0.48$ | $5.87^{b}\pm0.83$ |

[a,b]Means within main effects with no common superscripts are different significantly p≤0.05).

was increased significantly in dietary okra seeds powder (*Abelmoschus esculentus* L.) supplemented diets as compared to control at the jejunum.

## Discussion

### Growth performance of broiler

The indicated results herein revealed that the supplementation of okra seed powder (OSP)

enhanced the growth performance of broilers (Table 3). However, Liu *et al.* (2008), noticed that supplementation of okra seed powder on broiler diets did not significantly affect the broiler's daily gain and feed efficiency. The positive effects of supplementing okra seed powder on broilers performance may be due to the antimicrobial activity and antioxidants activity of the components of the OSP, which resulted in better intestinal health and improved digestion and absorption (Chaudhari *et al*., 2011; Olorunnipa *et al*., 2013; Kalarani *et al*., 2017).

Among the factors that positively affect the growth rate of birds are the nutritional components present in okra seeds which rich in unsaturated fatty acids especially linoleic acid, with adequate amounts of sulfur-containing amino acid, that could be considered as good sources of protein with good PER and NPU values, additionally rich in important minerals such as phosphorus, magnesium, calcium and potassium (Ndangui *et al*., 2010; Gemede *et al.*, 2015), which may enhancing weight and feed efficiency in chicks. On the other hands, study on nutritional analysis of okra seeds, Dhruve *et al*. (2015), suggested that the consumption of OSP, will provide the necessary energy to the body and important antioxidants that could boast immune body system and prevent diseases. Similar results on the feed intake (Table 3) were reported by Liu *et al*. (2008), when okra stems and leaf powder were used in broiler chicks' diets.

**Carcass characteristics and internal organs**

The supplementation with okra seed powder did not cause any significant differences in carcass traits (Table4) compared with the control. Similarly, no significant differences between relative organ weights (liver, heart, kidney, lungs and brain) were observed in mice ingested with 200 mg. $kg^{-1}$ aqueous and methanolic seed extracts of *A. esculentus* (Doreddula *et al*., 2014). In this study, the spleen, caecum weights and gastrointestinal tract length differed between various okra seed powder levels in diets (Table 5). The significant increase in gastrointestinal tract length obtained in okra seed supplemented diets may cause better digest feed efficiently, which reflected to improve feed efficiency ratio that observed in experimental groups (Table 3). Mabelebele *et al.* (2014) stated that lengthy digestive tracts in broiler chickens indicated a higher surface area for nutrient digestion and absorption. On the other hand, the information presented by Gemede *et al*. (2015) showed that the potential nutritional importance of okra and its role in improved nourishment and health. In addition, it can use it to apply in manufacturing for dietary improvement, due to its several health benefits (Abouel-Yazeed, 2019).

**Blood biochemistry**

Serum cholesterol and ALT activity were significantly ($P \leq 0.05$) decreased in all supplemented groups with okra seed powder as compared with the control group (Table 6). The reduction of serum total cholesterol may be due to okra content such as polysaccharide, fiber or antioxidant. In this respect, Kahlon *et al*. (2007) were pointed that okra polysaccharide reduces the cholesterol concentration in the blood due to its ability to bind bile acids. In this connection, Ngoc *et al*. (2008), detected that the extracts from the total plant of *A. esculentus* by dichloromethane (AE1) or methanol (AE2) and extracts from the fruit by dichloromethane (AE3) or methanol (AE4) in mice, may be useful in lowering cholesterol and triglyceride

levels in hyperlipidemia. Doreddula *et al.* (2014) demonstrated that the pretreatment of mice with aqueous and methanolic seed extracts of *Abelmoschus esculentus* (200 m.kg$^{-1}$ p. o.) for seven days significantly reduced the blood glucose, cholesterol and triglyceride levels elevated by acute restraint stress, their results were similar to our finding in respect of cholesterol, but differ with glucose and triglyceride levels which did not vary significantly. In the sense, the fibers in ladies finger (okra, *Abelmoschus esculentus* L.) lead to stabilize blood sugar by regulating the rate at which sugar is absorbed from the intestinal tract (Doreddula *et al*., 2014). The result from other researchers revealed that okra contains special fiber which takes sugar levels in blood under control, providing sugar quantity, acceptable for the bowels (Kumar *et al.*, 2013).

According to the report of Hu *et al*. (2014) the ladies finger polysaccharide has been possesses hepatoprotective, besides antidiabetic (Aligita *et al*., 2019). Additionally, antidiabetic and antihyperlipidemic activities were reported in rats. According to previous study published by Sabitha *et al*. (2011, 2012) the diabetic rats that fed okra peel and seed powder at 100 and 200 mg.kg-1 dose, exhibited a significant decrease in sera glucose levels and a boost in body weight as the comparison with untreated, diabetic rats. Furthermore, the antidiabetic activity of the okra fruit extract with a dose of 50 mg. kg$^{-1}$ BW, with the mechanism of action by increasing insulin secretion and rising insulin sensitivity, as well as inhibited carbohydrate absorption in the intestine (Aligita *et al*., 2019).

**Micro-bacterial count**

The results showed that there was a significant ($p \leq 0.05$) reduction in total bacterial and *Echerichiae coli* count (Table 7), whereas the *Lactobacilli* population was increased significantly in dietary okra (*Abelmoschus esculentus* L.) supplemented diets as compared to control in jejunum. The reduction in count of *E*. coli was in accordance with the study of Chaudhari *et al.* (2011), De Carvalho *et al*. (2011) and Kalarani *et al*. (2017), who showed that okra extracts (*A. esculentus* L.) had bactericidal activity against *E. coli*, besides other pathogenic bacteria. In addition, Olorunnipa *et al*. (2013) suggested that anti-Helicobacter pylori activities exhibited by *A. esculentus* L. Moench its local use in the treatment of gastrointestinal diseases associated with the *H. pylori* species. Moreover, the effectiveness of *A. esculentus* (okra) in treating gastric irritations and inflammatory diseases was due to polysaccharides that inhibit the adhesion of H. pylori to stomach tissue (Messing *et al*., 2014). According to the report of Jones (2017) antimicrobial impact of purified okra seed proteins (POP) against pathogens in water treatment marked an excellent inactivation of approximately 100% of fecal coliform and *E-coli* count in raw water was achieved and zero re-growth of bacteria after 72-hour post-treatment, in this sense, the use of POP in water treatment may improve access to clean water and could help in reducing the import of water treatment chemicals in developing countries. The inactivation of total bacteria and *E-coli* count by the okra seed may be due to the presence of various phytochemical compounds such as tannin, saponin, and alkaloids in the seeds, (Jones, 2017).

## Conclusion

It was concluded that supplementation okra seed powder (up to 4% of diet) can reduce the levels of serum total cholesterol and ALT activities, Moreover, the supplementation of OSP led to the reduction of harmful bacteria (*E. coli*) and increased numbers of beneficial (lactic acid) in the jejunum which can help to improve intestinal health. In this trial, OSP at levels 1 and 2 % had the ability to enhance the productive performance of broilers.

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### Conflict of interest

The author doesn't have any probable conflict of interest regarding the publisher's policy requirements.

### Ethical approval

In this study, all ethical standards issued by national and international institutions related to poultry breeding and care was applied.

### ORCID:

**Abbas: https://orcid.org/0000-0003-1330-9894**

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# تأثير إضافة مستويات مختلفة من مسحوق بذور الباميا (*Abelmoschus esculentus* L.) في أداء النمو، خصائص الذبيحة، المعايير الدمية والمجتمع الميكروبي لأمعاء فروج اللحم

**ربيعة جدوع عباس**

قسم الإنتاج الحيواني، كلية الزراعة، جامعة البصرة، العراق

**المستخلص:** اجريت الدراسة الحالية لمعرفة تأثير اضافة مسحوق بذور الباميا (*Abelmoschus esculentus* L.) الى العليقة في الأداء الانتاجي, صفات الذبائح, بعض معايير الدم واعداد البكتريا في الامعاء لفروج اللحم. تم توزيع 216 فرخاً بعمر يوم واحد من فروج اللحم عشوائياً على اربع مجاميع وبواقع ثلاث مكررات للمجموعة الواحدة وبواقع 18 فرخا لكل مكرر وفقا للتصميم العشوائي الكامل. كانت الاولى معاملة السيطرة (العليقة الاساسية) وأضيف مسحوق بذور الباميا الى العليقة الأساسية بالمستويات 1 ،2 و 4 % في المجاميع الثانية والثالثة والرابعة على التوالي أظهرت النتائج ان أعلى معدل لوزن الجسم النهائي، الزيادة الوزنية, وافضل معدل للتحويل الغذائي تحقق في المجموعة على اعطيت 1 و 2٪ من مسحوق بذور الباميا, في حين لم يتأثر معدل استهلاك العلف وصفات الذبائح بمعاملات الاضافة. لوحظ ان أعلى وزن نسبي للطحال والأعورين تحقق في مجموعة السيطرة ، بينما ظهرت أقل قيمة عند المستوى 4٪ و 2٪ من مسحوق البذور على التوالي, وسجلت مجموعة 2% افضل الاطوال للقناة الهضمية مقارنة بالمجاميع الأخرى. وحصل انخفاض معنوي في تركيز الكوليسترول وفي فعالية انزيم ALT مقارنة بالسيطرة. وأظهر المستوى 2٪ اعلى تركيز من الألبومين مقارنة بالمستوى 1٪. وحصل انخفاض معنوي في اعداد البكتريا الكلية وبكتريا coli *Escherichia* في امعاء مجاميع الاضافة, فضلاً عن تحسن معنوي في اعداد بكتريا الـ *Lactobacilli* مقارنة بالسيطرة. تؤكد الدراسة على ان أفضل النتائج تحقق عند المستوى1 و 2٪ من مسحوق بذور الباميا لتعزيز الأداء الإنتاجي في علائق فروج اللحم.

**الكلمات المفتاحية:** فروج اللحم, مسحوق بذور الباميا، الاداء الانتاجي، الصفات الكيموحياتية للدم.

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