Research Article

Effect of Pomegranate Peel Powder Supplementation on Growth Performance, Carcass Characteristics and Blood Metabolites of Japanese Quails

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Abstract:
This study aimed to assess the impacts of pomegranate peel powder on growth performance, carcass characteristics and blood metabolites of Japanese quails. A total of 300 one-week-old male Japanese quails were randomly distributed into 4 equal groups (75 birds into 5 replicates/group). The 1st group (control) was fed the basal diet without any pomegranate peel powder, while pomegranate peel powder was added at levels of 300, 600, and 900 g per ton of feed, respectively in the 2nd, 3rd and 4th groups. At 5 wks of age, the best values of productive performance represented in body weight, weight gain, feed conversion ratio and feed consumption were achieved in groups fed diet supplemented with 900 g pomegranate peel powder/ton. No significant differences between all treatments for carcass characteristics were observed, except for the relative weights of lymphoid organs (bursa of Fabricius, thymus and spleen) which were improved by using pomegranate peel powder at the level of 900 g/ton of feed. Additionally, dietary 900 g/ton pomegranate peel powder improved plasma concentration of total protein, albumin, globulin, triglycerides, cholesterol, HDL-cholesterol, and LDL-cholesterol. It could be concluded that, supplemented diet with pomegranate peel powder up to 900 g/ton improved the productive performance traits, carcass characteristics and blood biochemical of Japanese quails.

1. Introduction

The growing concerns of consumers on the use of antibiotic as a growth promoter in poultry feed have fueled the interest in alternative products. In view of the ban on antibiotic growth promoters (AGP) in the European Union and in Egypt and the expected expansion of this trend to the rest of the world, intensive research has been focused on the development of alternative strategies to maintain health and performance status in modern livestock production systems. Different substances, referred to as natural growth promoters (NGP), have been identified as effective alternatives to AGP (Roth et al., 2019; Abd El-Hack et al., 2020).

At present, a large number of NGP are available on the market, including organic acids, immune-modulators, probiotics, prebiotics, enzymes and phytobiotics (Ebeid and Al-Homidan, 2022). All these products have the potential to beneficially affect gut health and growth performance by establishing and maintaining a well-balanced gut microflora which protects the host against pathogenic invasion. In some cases, however, scientific reports are inconsistent regarding the efficacy of NGP, whilst their mode of action remains, at least partly, undiscovered (Alagawany et al., 2018, 2021; Elgeddawy et al., 2020; Rehman et al., 2020).

These feed additives have been tested in the form of extracts, cold-pressed oils, and essential oils in a number of animals but the results are variable. Therefore, their application as feed additives has been limited, largely owing to their inconsistent efficacy and lack of full understanding of the modes of action. The future of these feed additives depends on the characteristics of herbs, the knowledge of their major and minor constituents, the in-depth knowledge of their mode of action, and their value based on the safety of the animal and its products (Saleh et al., 2019; Reda et al., 2021; Hussein et al., 2023).

Phytogenic are a heterogeneous group of feed additives originating from plants and consist of herbs, spices, fruit, and other plant parts. These feed additives are reported to have a wide range of activities including antimicrobial, anthelmintic, antioxidant, growth enhancer, and immune modulator (Al-Homidan et al., 2020). Besides these properties they are also reported to stimulate feed intake and endogenous secretion and enhance production. They include many different bio-active ingredients such as alkaloids, bitters, flavonoids, glycosides, mucilage, saponins, tannins phenolic, polyphenols, terpenoids, and polypeptide (Reda et al., 2021). In this sense, pomegranate (Punica granatum L.) peel is one of several natural feed additives that have gained popularity as prophylactics and growth enhancers in poultry feeding throughout the recent years. It is a by-product made from pomegranate fruit that is typically left over following the juice production. Pomegranate peel powder is a novel feed additive because it has a high fiber, lipids and proteins content. In terms of crude
fibre (CF), ether extract (EE), ash, and lignin concentration, dried pomegranate peel outperforms yellow corn. In contrast to dried pomegranate peel, yellow maize had higher concentrations of CP, nitrogen-free extract (NFE), neutral detergent fibre (NDF), acid detergent fibre (ADF), hemicellulose, cellulose, and gross energy (GE) (Omer et al., 2019). It may provide health advantages due to its high antioxidant polyphenol content. The principal constituents in pomegranate peels include phenolic compounds with high antioxidant potential, such as punicalagin, gallic acid, fatty acids, catechin, quercetin, rutin, flavonols, flavones, flavanones, and anthocyanidins (Derakhshan et al., 2018 and Sharifian et al., 2019). The peel contains some of the weight-loss and health-improving properties of antibiotics and hormones without the negative side effects, and it may produce meat with higher amounts of beneficial antioxidants (Shabtay et al., 2008).

According to Lansky and Newman, (2007) and Viuda-Martos et al., (2010), the peel of pomegranate fruits can be used as a functional ingredient because it is a good source of crude fibres, which have a number of health benefits, including the ability to lower serum LDL-cholesterol levels, improve glucose tolerance and insulin response, lower hyperlipidaemia and hypertension, improve gastrointestinal health, and prevent some cancers, such as colon cancer. Furthermore, the bioactive compound (punicalagin, ellagitannins, ellagic acid, and gallic acid) in the peel have been shown to have strong anti-bacterial and antiviral action. Phenolic chemicals can precipitate membrane proteins and impede enzyme function, resulting in bacterial mortality. In small intestinal colitis, Al-Zoreky et al. (2009) discovered that pomegranate peel extract (PPE) absorption successfully reduced Listeria monocytogenes, Staphylococcus aureus, Escherichia coli, and Yersinia pestis. The antiviral effects are mostly attributable to polyphenol extracts inhibiting virus RNA replication (Haidari et al., 2009). So, the goal of the current study was to evaluate the effect of pomegranate peel powder (PPP) as a feed supplement on quail productivity, carcass traits, and blood metabolites.

2. Materials and Methods

2.1. Experimental Design

2.1.1. Birds and management

Three hundred one-week-old male Japanese quail chicks were randomly divided into 4 experimental groups with five duplicates of fifteen birds. The first group served as control and fed the basal diet without any PPP, while PPP were added at levels of 300, 600, and 900g per ton of feed in the 2nd, 3rd, and 4th groups; respectively. Throughout the five-week of study, all experimental groups were raised in conventional cages (100x50x40 cm) and reared under similar managerial and hygienic conditions.

2.1.2. Experimental diet

The basal diet was a commercial corn-soybean meal diet formulated to meet or exceed the nutritional requirement of growing Japanese quail as recommended by the National Research Council (NRC, 1994) as shown in Table (1).

**Table (1):** The composition and calculated analysis of basal diet.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>kg/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow corn (8.5%)</td>
<td>518.0</td>
</tr>
<tr>
<td>Soybean meal (44%)</td>
<td>367.0</td>
</tr>
<tr>
<td>Corn gluten meal (62%)</td>
<td>52.10</td>
</tr>
<tr>
<td>Premix1</td>
<td>3.00</td>
</tr>
<tr>
<td>Soybean oil</td>
<td>29.00</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>16.50</td>
</tr>
<tr>
<td>Limestone</td>
<td>7.00</td>
</tr>
<tr>
<td>Salt</td>
<td>3.00</td>
</tr>
<tr>
<td>DL-Methionine</td>
<td>1.10</td>
</tr>
<tr>
<td>L. Lysine</td>
<td>1.30</td>
</tr>
<tr>
<td>Choline chloride</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Total 1000

1 Each 3kg of premix contained: Vit. A 12000IU, Vit. D 2200IU, Vit. E 10mg, Vit. K3 2000mg, Vit. B1 1000mg, Vit. B2 3000mg, Vit. B3 1500mg, Vit. B12 10mg, Pantothenic acid 10mg, Niacin 30mg, Folac acid 1000mg, Biotin 50mg, Choline chloride 300mg, Manganese 60mg, Zinc 50mg, Copper 10mg, Iron 30mg, Iodine 1000mg, Selenium 100mg, Cobalt 100mg and CaCo3 to 3g.

2 Calculated according to NRC (1994).

2.2. Measurements

2.2.1. Performance traits

Live body weight (LBW), weight gain (WG), feed consumption (FC) and feed conversion ratio (FCR) were evaluated at first and fifth wks of age, as follow:

\[
WG = LBW_2 - LBW_1
\]

\[
FCR = \frac{Feed \ consumed \ (g) \ during \ a \ certain \ period}{Body \ weight \ gain \ (g) \ during \ the \ same \ period}
\]

2.2.2. Carcass characteristics:

At the end of the trial, fifteen birds from each group (3 birds from each replicate) were randomly chosen for the slaughter test, weighed, and then slain by having their jugular veins severed in the morning. The birds were then scalded and defeated following total bleeding. Spleen, bursa of Fabricius, thymus, liver, heart, and gizzard were individually weighed after the carcasses had been carefully dissected and eviscerated. All organ weights were converted to an arc sine expression and represented as a percentage of body weight.

2.2.3. Blood plasma biochemical parameters:

At the end of the trial, blood samples were col-
lected from 5-week-old Japanese quails into heparinized tubes and centrifuged for 15 min at 3000 rpm to obtain plasma. Plasma samples were examined for levels of total protein, albumin, globulin, triglycerides, cholesterol, HDL-cholesterol, LDL-cholesterol, VLDL, and the activity of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) enzymes using a microplate spectrophotometer with a commercial detection kit (Bio-diagnostic, Egypt), following the manufacturer's instructions.

2.3. Statistical analysis

Data were statistically analyzed by one-way ANOVA, using the general linear model procedure (SAS, 1996). Tests of significance for differences among treatments were done according to Duncan (SAS, 1996). Tests of significance for differences (1955). The statistical model was used for the analysis of variance to estimate the effect of PPP supplementation levels on Japanese quail performance and physiological status as follows:

\[ Y_{ij} = U + T_i + e_{ij} \]

Where:
- \( Y_{ij} \) = The observations
- \( U \) = Overall mean
- \( T_i \) = Effect of treatments (i = 1, 2, 3and 4)

3. Results

3.1. Productive performance traits

Data of Japanese quail chick's BW, WG, FC and FCR as influenced by PPP supplementation level (0, 300, 600 and 900 g/ton feed) are illustrated in Table (2). The PPP supplementation significantly impacted BW, WG, FC and FCR at 5 wks of age. Chicks fed diets supplemented with PPP at the level of 300 g/ton showed the highest BW and WG (P≤0.05). On the other hand, feed consumption of Japanese quail chicks was significantly decreased by increasing PPP supplementation levels (P≤0.05). The highest BW and FCR value was observed for the group received dietary 900 g PPP /ton followed by those received 600 g PPP /ton and then those treated with 300 g PPP /ton of feed respectively, as compared to the control.

3.2. Carcass characteristics

Table (3) shows the effect of PPP supplementation levels on carcass characteristics of Japanese quails. Results indicated that there were no significant (P>0.05) differences between all treatments for all carcass characteristics indices except the relative weights of lymphoid organs (bursa of Fabricius, thymus and spleen), which were significantly increased by increasing the PPP supplementation level from 300 up to 900 g/ton of feed, as compared to the control group (P≤0.05).
Table (4): Blood biochemical of Japanese quail affected by pomegranate peel powder supplementation levels.

<table>
<thead>
<tr>
<th>PPP levels (g/ton feed)</th>
<th>TP (mg/dl)</th>
<th>Alb. (mg/dl)</th>
<th>Glob. (mg/dl)</th>
<th>A/G Ratio</th>
<th>ALT (U/l)</th>
<th>AST (U/l)</th>
<th>Trigly. (mg/dl)</th>
<th>Chols. (mg/dl)</th>
<th>HDL-Chols. (mg/dl)</th>
<th>LDL-Chols. (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.62b</td>
<td>1.78a</td>
<td>1.84a</td>
<td>0.97</td>
<td>10.50</td>
<td>9.33</td>
<td>192.42b</td>
<td>191.77a</td>
<td>114.18b</td>
<td>60.59a</td>
</tr>
<tr>
<td>300</td>
<td>3.76b</td>
<td>1.83b</td>
<td>1.93ab</td>
<td>0.95</td>
<td>11.16</td>
<td>8.16</td>
<td>176.27b</td>
<td>178.21b</td>
<td>121.83ab</td>
<td>44.29b</td>
</tr>
<tr>
<td>600</td>
<td>4.14a</td>
<td>2.06a</td>
<td>2.08a</td>
<td>0.99</td>
<td>9.74</td>
<td>8.72</td>
<td>158.71c</td>
<td>175.88b</td>
<td>124.72a</td>
<td>39.16b</td>
</tr>
<tr>
<td>900</td>
<td>4.00a</td>
<td>1.98a</td>
<td>2.02a</td>
<td>0.98</td>
<td>9.58</td>
<td>8.16</td>
<td>141.07d</td>
<td>162.35b</td>
<td>128.24a</td>
<td>29.12c</td>
</tr>
<tr>
<td>SEM</td>
<td>±0.23</td>
<td>±0.06</td>
<td>±0.05</td>
<td>±0.04</td>
<td>±0.85</td>
<td>±0.76</td>
<td>±22.25</td>
<td>±7.45</td>
<td>±6.37</td>
<td>±3.48</td>
</tr>
</tbody>
</table>

- TP= total protein, Alb= albumin, Glob= globulin, ALT= alanine aminotransferase, AST= aspartate aminotransferase, Trigly= triglycerides, Chols= cholesterol, HDL= high density lipoprotein, LDL= low density lipoprotein.

3.3. Blood plasma metabolites

Data illustrated in Table (4) shows the effect of PPP supplementation levels on blood plasma biochemical parameters of Japanese quail. No significant (P>0.05) differences between all treatments were observed for the activity of AST and ALT enzymes and A/G ratio. On the other hand, the concentration of plasma total protein, albumin, globulin and HDL-cholesterol were significantly increased by increasing PPP supplementation level from 300 up to 900 g/ton of feed (P<0.05). However, the plasma concentration of triglycerides, cholesterol and LDL-cholesterol were significantly decreased by increasing PPP supplementation level from 300 up to 900 g/ton of feed (P<0.05).

4. Discussion

Results of growth performance that illustrated in Table 2 recorded that when PPP incorporated at different levels (300, 600, and 900g/ton), it caused an improvement in their gain while decreasing their FC and improving their FCR. The positive effect of PPP on productive performance parameters (BW, WG, and FCR) may be due to the higher content of various nutrients and functional ingredients such as fiber and protein which have the capacity to provide the body with the necessary amino acids and non-essential nitrogen needed for protein synthesis, improve gastrointestinal health and stimulates the growth rate (Lansky and Newman, 2007; Khil et al., 2017; Omer et al., 2019; El- Hamamsy and El- khamissy, 2020). In addition, PPP is an excellent source of natural antioxidants such as punicalagin, ellagitannins, ellagic acid, and gallic acid which can precipitate membrane proteins and impede enzyme function, resulting in pathogenic bacterial mortality and balancing the gut microbial ecosystem (Al-Zoreky et al., 2009; Kanatt et al., 2010; Rowayesh et al., 2013; Rajalai et al., 2013).

Also, the improvement in quail productive performance upon addition of PPP may be attributed to its positive effect in stimulating the gastro-intestinal enzymatic activity, and consequently enhancing nutrient digestibility and absorption (Fayed et al., 2012; Banerjee et al., 2013). The reduction in the amount of feed consumed by group received PPP may be attributed to the high concentration of tannin in PPP which negatively effect on palatability (Reed, 1995; Kushwaha et al., 2013). The current results are compatible with that observed by some authors who studied the effect of PPP or its extract (PPE) as a feed additive on the performance traits of poultry and they revealed that PPP or its extract improved BW, WG, FC and FCR (Abdel-Wahab and Mosad, 2018; Akuru et al., 2020; Ahmadipour et al., 2021; Akuru et al., 2021; Elnaggar et al., 2022). On the other direction, some authors observed that PPP or its extract affected negatively the performance traits (Hamad et al., 2019; Sadabadi et al., 2021). While, some authors did not find any significant effects of adding PPP on the productive performance of poultry (Abas et al., 2017; Yaseen et al., 2014).

The improvement in the relative weights of lymphoid organs considered a clear evidence for the improvement of the immune response and that may attribute to the functional ingredient and its high antioxidant polyphenol content which can significantly reduce the adverse effects of reactive oxygen and nitrogen species on normal physiological and immunological functions (Saleh et al., 2019; Akuru et al., 2020; Sadabadi et al., 2021). These results are in the line with those observed by Hamady et al. (2015) who found that, the internal organs were not affected by the addition of pomegranate peel extract at a rate of (10g/100kg of feed). Additionally, Elnaggar et al. (2022) and Baqer and Iqrahim, (2022) found that supplementation of PPP or PPE are able to improve the relative weight of lymphoid organs significantly.

Results of the present study indicated that the supplementation of PPP in the Japanese quail diet improved liver function, and this was evident in the improvement of plasma total protein, Albumin, globulin, cholesterol, HDL, and LDL concentrations. The current results of blood metabolites agreed with the finding of Rahman and Aldeba (2016) who suggested that dietary supplementation of PPP showed a potential hepatoprotective effect depending on the presence
of phenolic and antioxidant compounds in PPP such as punicalagin, gallic acid, fatty acids, catechin, quercetin, rutin, flavonols, flavones, flavanones, and anthocyanidins. Furthermore, PPE is reported to be able to inhibit the activity of pancreatic lipase which depress fat absorption in the intestine and is excreted through feces (Kishawy et al., 2019). This assumption is supported by the findings of Kumar et al. (2018) that a diet of 100 mg/kg of PPE recorded the lowest serum cholesterol levels. Saki et al (2019) found a decrease in the level of plasma total lipids and glucose because of feeding birds pomegranate peels, which may be due to the high percentage of fiber. The lower cholesterol in the blood and triglycerides by PPP could possibly be due to phenol compounds such as pontiacagen and pontiacin, in particular and it may stimulate pomegranate polyphenols and promote cholesterol metabolism by modifying HDL transport (Esmailzadeh et al., 2004).

The PPP supplementation decreased the LDL levels, which is in agreement with the results obtained by supplementation of PPP (Yaseen et al., 2014; Kishawy et al., 2019; Akbari et al., 2023). This reduction confirmed the lower cholesterol levels observed in this study because HDL and LDL molecules are the chief transporters of cholesterol from its site of synthesis, i.e. the liver, to the body tissues and they consequently decrease cholesterol and triglycerides available for tissue metabolism, lipogenesis in liver and fat accumulation in carcasses (Alvarenga et al., 2011).

5. Conclusions

In conclusion, it could be recommended that supplemented diet with PPP up to the level of 900 g/ton improved productive performance traits and physiological response of Japanese quails.

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Data Availability Statement: “Not applicable”

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5. References


