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REGULAR ARTICLES

Effect of a diet containing date pits on growth performance, diet digestibility, and economic evaluation of Japanese quail (*Coturnix coturnix japonica*)

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Abstract

This study was performed to investigate the effect of feeding different levels of date pits (DP) to growing Japanese quails on growth performance, diet digestibility, blood parameters, carcass traits, and economical value of the farm production. A total of 204 1-day-old quail chicks were randomly divided into 4 groups (three replicates each). DP was chemically analyzed and used as 0%, 2%, 4%, and 6% to formulate 4 balanced experimental diets (control, DP-2, DP-4, and DP-6, respectively). The feed and water were given ad libitum. Feed intake (FI) and body weight gain (BWG) were recorded weekly, and the feed conversion ratio (FCR) was calculated. A digestibility trial was conducted, and the digestion coefficient (DC) was calculated for diet dry matter (DM) and nutrients. At the end of the experiment, carcass traits were measured and blood samples were collected for blood picture analysis. Economical evaluation of the test diets was carried out to determine the net return (NR) of feeding DP to quails. Results showed significant ($P < 0.05$) change in FI and final body weight among treatments. FCR of DP-6 group was the best in all treatments. DC of diet DM and nutrients were reduced with increasing DP level except for nitrogen-free extract (NFE). Carcass traits and blood parameters were within the normal range with no adverse effects. From the economic point of view, quail selling return values were significantly higher ($P < 0.05$) for all the groups supplemented with DP than the control one. Total return (TR) and NR values showed insignificant ($P > 0.05$) differences among the experimental groups; they were higher for DP-fed groups compared with the control. The present results demonstrated a beneficial effect of DP inclusion in the diet of quails in terms of growth performance, blood profiles, carcass traits, and economic value.

Keywords Date pits · Growth · Quail · Efficiency · Profitability · Costs

Introduction

The poultry industry in Egypt is growing rapidly. Limitation of conventional feedstuff and the increase of its prices require alternative feed resources (Donohue and Cunningham 2009). Recently, focus was directed toward agricultural and food processing by-products for feed processing and formulations. Many researches of animal and poultry production are currently investigating the use of food and agricultural by-products to increase the economic efficiency of farms, and food industry, in addition to achieving the environmental safety. Date palm (*Phoenix dactylifera L.*) is a monocotyledonous fruit and one of the *Arecaceae* families, which includes 3000 species (Jassim and Naji 2010). Three essential parts constitute mature palm date fruits: date flesh which represents 85–90% of the date fruit weight (Amira et al. 2011), DP or stone (10–15%), and skin which is a thin layer lining the date flesh for protection (Jassim and Naji 2010). The total world production of date fruits in 2014 reached approximately 7.8 million tons. The top production was from Egypt by 1,465,030 tons/year (FAOSTAT 2017), meaning that about 147–220 thousand tons of date pits (DP) were produced every year in Egypt. The chemical composition of DP is highly variable. Ranges of

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moisture, crude protein, carbohydrates, ash, and fats are 3.1–12.5%, 2.3–6.9%, 74–86.9%, 0.84–1.2%, and 5–12.5%, respectively (Hossain et al. 2014). DP also contains appreciable quantities of minerals and can be used as an energy source for animals and poultry (Feedipedia 2017). Quail represents a small section in the Egyptian poultry industry. These birds are raised for meat and egg production and are expected to be an important segment in food security. The aim of this study is to investigate the response of Japanese quail to a diet containing different levels of DP in terms of growth performance, diet digestibility, blood parameters, carcass quality, and economical profitability of farm production.

Material and methods

The experiment was conducted from January 1 to February 11 in the year 2018 at the Center of Experimental Animal Research, Faculty of Veterinary Medicine, Benha University, Egypt. In total, 204 1-day-old quail chicks were randomly selected and categorized into four groups of different treatments (51 chicks of 3 replicates each). The chicks were kept on well-ventilated litter floor rooms and stocked in a density of 10 birds/m^2. All birds were subjected to the same managerial, hygienic, and housing conditions. In the first 4 days, the brooding temperature was 35 °C. Then it was lowered to 32 °C until the end of the 1st week. From the 2nd week, the ambient temperature was maintained around 29 °C, and the relative humidity was between 60 and 70%, with 23 h/d light throughout the experimental period. DP was collected as residues of the food industry from Toukh city, Qalyobia Governorate, Egypt. It was air-dried then ground into meal. DP sample was chemically analyzed before being used in the diets. Four iso-energetic and iso-nitrogenous diets were formulated for Japanese quails according to National Research Council (NRC 1994). The experimental diets contained yellow corn, soybean meal, and corn gluten meal, in addition to mineral and vitamin supplements. The diets were formulated to contain 0%, 2%, 4%, and 6% DP for control, DP-2, DP-4, and DP-6, respectively as presented in Table 1.

Data collection

Feed intake and body weight gain were measured weekly for each quail, and FCR was calculated. At 35 days of age, a digestibility trial was carried out during the last 7 days of the experiment according to Alu (2012). To measure digestibility, the diet and water were removed for about 12 h to evacuate the gut and determine the period of fecal collection. After fasting, the birds were allowed freely to feed and drink water. Feed intake was recorded and feces were collected free from feather or residues for 4 successive days in each group. The fecal output was daily weighed, recorded, dried at 60 °C in hot air oven (Heraeus Ut20, Germany) for 48 h, and then frozen till analysis.

Table 1 Composition and calculated analysis of the experimental diets

	Control	DP-2	DP-4	DP-6
Feed ingredients (% as fed)				
DP	0	2	4	6
Yellow corn	56.4	55	51.9	49.2
Soybean meal (44% CP)	31.5	29.5	30	30
Corn gluten meal (60% CP)	9	10.4	10.3	10.5
Soybean oil	0	0	0.7	1.2
L-lysine	0.3	0.3	0.3	0.3
DL-Methionine	0.1	0.1	0.1	0.1
Vita. and Min. mix.[1]	0.3	0.3	0.3	0.3
Salt	0.4	0.4	0.4	0.4
Limestone	2	2	2	2
Total	100	100	100	100
Calculated chemical composition (%)[2]				
CP	24.1	24	24	24
CF	3.84	4.40	5.05	5.68
Ca	0.86	0.86	0.86	0.86
Available P	0.40	0.39	0.39	0.39
Lysine	1.34	1.30	1.31	1.32
Methionine	0.55	0.56	0.56	0.56
Sodium	0.17	0.17	0.17	0.18
ME (kcal/kg)	2901	2903	2904	2903

[1] Hy-Mix commercial broiler premix purchased by Misr feed additives company, Egypt. Composition (per 3 kg): vitamin A = 12,000,000 IU, D_3 = 4,000,000 IU, E = 60,000 mg, K_3 = 3,000 mg, B_1 = 2,000 mg, B_2 = 6,500 mg, B_6 = 5,000 mg, B_{12} = 20 mg, niacin = 45,000 mg, biotin = 75 mg, folic acid = 2,000 mg, pantothenic acid = 12,000 mg, choline chloride = 1000,000 mg, zinc = 80,000 mg, manganese = 100,000 mg, iron = 45,000 mg, copper = 10,000 mg, iodine = 1,000 mg, selenium = 200 mg, cobalt = 100 mg, calcium carbonate to 3 kg

[2] According to Feed Composition Tables for Japanese quail (National Research Council, NRC for poultry 1994)

At day 42, feed was removed from feeders for 3 h, and 9 birds from each group were randomly selected, weighed, and slaughtered by cutting carotid arteries and jugular veins, then allowing them to bleed for 5 min. Blood samples were taken for analysis. Feathers were removed after dipping birds in hot water bath (60 °C) for 2 min. After separation of head, neck, shanks, and feet, the carcass was eviscerated. The dressing percentage of carcass was obtained according to the formula of Brake et al. (1993):

$$\text{Dressing\%} = \frac{\text{dressed carcass weight}}{\text{live weight}} \times 100$$

Weight of internal organs (heart, gizzard, liver, and intestine) was recorded, and their percentages in relation to live body weight were calculated. Samples of DP, diet, and fecal matter were ground to pass a 1-mm sieve and chemically analyzed according to (AOAC 1995). DM was determined using hot air circulation oven (Heraeus Ut20, Germany) at 105 °C for 3 h (method no. 930.15), crude protein (CP) using Kjeltec system 2100-FOSS, Sweden (method no. 984.13), ether extract (EE) by Soxtec system 2045, FOSS-Sweden (method no. 920.39), and ash using Furance 6000, Thermolyne, USA (method no. 942.05). Neutral detergent fiber (NDF) was estimated according to Van Soest et al. (1991). Organic matter (OM) was calculated by the difference between DM and ash. The non-fiber carbohydrate (NFC) concentration was calculated according to Calsamiglia et al. (1995) using the following equation: NFC = 100 – (CP + NDF + EE + ash). The DC of DM, OM, CP, EE, crude fiber (CF), NDF, acid detergent fiber (ADF), and NFE of the experimental diets was calculated using the formula:

$$\text{Apparent DC} = \frac{\text{Nutrients in feeds}-\text{Nutrients in feces}}{\text{Nutrients in feeds}} \times 100$$

Collected blood samples were analyzed for hematological parameters. Counts of white blood cells (WBCs) and red blood cells (RBCs) were performed using Neubauer hemocytometer in a dilution of 1:200 with Natt and Herrick solution. Differential leukocyte count, hemoglobin (Hgb) concentration and packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) were determined as described by Campbell (1995). An economic evaluation of feeding DP to growing Japanese quail was determined via calculation of total costs (TC) and total returns (TR). TC comprised total variable cost (TVC) and total fixed cost (TFC). TVC included feed consumption cost for each experimental group (cost of DP/ton, 300 Egyptian pounds (LE)). It was estimated for each quail in each group per LE (1 USD ≈ 17.6 LE) during the experimental period. TFC was estimated at 3.79 EGP/quail involving the costs of labor, purchased chick cost, veterinary management cost, equipment depreciation, water, electricity, building rent values, and other miscellaneous costs. These costs were considered equal for all the experimental groups (Shreya et al. 2014). TR was calculated according to Mohamed (2014) as the summation of litter selling return per number of quails at the end of the experiment and the quail selling return per gram. This quail selling return was calculated by multiplying the final body weight per gram × market price per gram (Market price/g = 0.06 LE). Net return (NR) was estimated according to Muhammad et al. (2017) by using the following equation: NR = TR – TC. The economic efficiency measures were calculated according to (Atallah 2004). It included percentages of TR/TC, NR/TC, and NR/TR.

Statistical analysis

Differences between studied groups were analyzed by using the statistical software package SPSS for Windows SPSS/PC "version 16" (SPSS 2004) for one-way analysis of variance. Duncan's multiple range test (Duncan 1955) was used to test differences among means. Statistical significance between mean values was set at ($P < 0.05$). Results were reported as means and standard errors. Figures were drawn by Microsoft Office Excel (2007).

Results

Nutritive value of DP

The average chemical composition of date pits is presented in Table 2. DP contained 7.4% moisture, 5.7% CP, 6.14% EE, 34.8% CF, 48.7% NDF, and 2.05% ash. Nitrogen-free extract was calculated as 43.9%. Metabolisable energy (ME) of DP was calculated as 2306 Kcal/kg DM.

Growth performance and diet digestibility

Data concerning FI, body weight change, and FCR is illustrated in Table 3. The data of total FI and final body weight in grams was 817, 167; 844, 179; 832, 182; and 855, 183 for control, DP-2, DP-4, and DP-6, respectively. The total FI and final body weight of growing quails showed significant ($P < 0.05$) increase over the control group. FCR (Table 3) showed an insignificant improvement ($P > 0.05$) of DP-6 group (4.82) over the control one (5.19).

Results of diet digestibility are presented in Table 3. It was found that with the increase of the DP inclusion rate in the diet, there was a significant decrease in digestibility of DM, OM, CP, fat, CF, NDF, ADF, and ash contents. Only soluble

Table 2 Proximate analysis of DP (*Phoenix dactylifera L.*)

Item	Percentage
Moisture	7.4
Organic matter (OM)	90.5
Dry matter (DM)	92.6
Crude protein (CP)	5.66
Ether extract (EE)	6.14
Crude fiber (CF)	34.8
NDF	48.7
Ash	2.05
Nitrogen-free extract (NFE)	43.9
ME* (Kcal/Kg)	2306

*Metabolisable energy (ME Mcal/kg) was calculated according to the formula derived by Lodhi et al. (1976)

Table 3 Growth performance and diet digestibility of Japanese quail fed the experimental diets

	Control	DP-2	DP-4	DP-6	*P value*
Growth performance					
Total FI (g)	$817^{b} \pm 6.89$	$844^{a} \pm 7.07$	$832^{ab} \pm 10.3$	$855^{a} \pm 8.15$	0.01
Daily FI (g)	$19.4^{b} \pm 0.16$	$20.1^{a} \pm 0.17$	$19.8^{ab} \pm 0.25$	$20.3^{a} \pm 0.19$	0.01
Initial weight (g)	23.7 ± 0.68	23.6 ± 0.79	24 ± 0.65	23.8 ± 0.57	0.98
Final weight (g)	$167^{b} \pm 5.94$	$179^{a} \pm 2.53$	$182^{a} \pm 4.30$	$183^{a} \pm 3.79$	0.02
BWG (g)	150 ± 4.90	156 ± 3.15	159 ± 4.71	160 ± 2.67	0.24
Daily gain (g)	4.24 ± 0.15	4.38 ± 0.09	4.52 ± 0.13	4.53 ± 0.11	0.29
FCR	5.19 ± 0.16	5.03 ± 0.09	4.90 ± 0.16	4.82 ± 0.10	0.20
Apparent DC%					
DM	$83.2^{a} \pm 1.08$	$81.7^{a} \pm 0.69$	$76.0^{b} \pm 1.05$	$73.7^{b} \pm 0.85$	<0.0001
OM	$83.2^{a} \pm 1.16$	$81.5^{a} \pm 0.85$	$76.3^{b} \pm 0.57$	$74.7^{b} \pm 1.04$	<.0001
CP	$68.1^{a} \pm 1.61$	$61.1^{b} \pm 1.08$	$52.9^{c} \pm 0.69$	$49.7^{d} \pm 1.13$	<0.0001
EE	$93.7^{a} \pm 0.86$	$86.6^{b} \pm 0.83$	$85.1^{c} \pm 0.64$	$86.4^{bc} \pm 0.90$	<0.0001
CF	$57^{a} \pm 0.88$	$53.1^{b} \pm 0.68$	$40.5^{b} \pm 0.89$	$41.9^{b} \pm 0.78$	<0.0001
NDF	$58.7^{a} \pm 0.87$	$52.3^{b} \pm 0.72$	$36.9^{c} \pm 1.09$	$34.3^{c} \pm 0.93$	<0.0001
ADF	$56.9^{a} \pm 0.57$	$53.4^{b} \pm 0.60$	$40.4^{c} \pm 0.71$	$41.9^{c} \pm 1.27$	<0.0001
NFE	92.3 ± 0.61	94.0 ± 0.49	91.9 ± 0.57	92.5 ± 1.13	0.24
Ash	$63.1^{a} \pm 0.72$	$61.1^{a} \pm 0.91$	$49.8^{b} \pm 0.68$	$41.3^{c} \pm 0.67$	<0.0001

[ab] Within rows means bearing different superscripts differ significantly at $P < 0.05$

carbohydrates (NFE) showed no significant change when compared with control.

Blood profiles and carcass quality

Data concerning blood parameters are presented in Table 4. Results showed no significant ($P > 0.05$) difference among the experimental groups. Lymphocyte percentage was insignificantly increased ($P > 0.05$) in birds fed with a diet supplemented with DP relative to the control group. Results of some carcass traits are displayed in Table 4. No significant change ($P > 0.05$) was detected in dressing weight, dressing percentage, and weights of the intestine, gizzard, liver, and heart. A non-significant increase in the size of gizzard was recorded in DP-6 group.

Economic evaluation

The effects of using DP as feed ingredient of quail on economic evaluation are represented in Table 5. In regard to feed consumption cost, there was insignificant ($P > 0.05$) difference among the experimental groups (4.65, 4.79, 4.70, and 4.79 LE/quail for control, DP-2, DP-4, and DP-6, respectively). Consequently, TC had no significant differences among the experimental groups. The cost of one ton of feed is reduced at all levels of DP, saving about LE 10, 47, and 81/ton for DP-2, DP-4, and DP-6, respectively. Meanwhile, the control diet has the highest feed cost/ton. Quail selling return values were significantly higher ($P < 0.05$) for all the groups supplemented with DP than those for the control one. The highest value (10.9 LE/quail) was recorded for the DP-6 group. TR and NR values showed insignificant ($P > 0.05$) difference. They were higher among DP-fed groups compared with the control. The values were (11.3, 2.68; 11.2, 2.75; and 11.1, 2.48 LE/quail) for DP-6, DP-4, and DP-2, respectively. Percentages of TR/TC, NR/TC, and NR/TR showed insignificant differences ($P > 0.05$) among groups. They were higher for DP-4, DP-6, and DP-2 than those for the control one.

Discussion

Results of the chemical composition of DP in this study (Table 2) were within the range values of different varieties of DP formerly determined by many researchers (Mohebbifar and Torki 2011; Suresh et al. 2013). Only result of ash content was higher (2.05%), but also within the range values (1.3–3.2%) reported by Feedipedia (2017) and (1.68–3.94%) by Assirey (2015). High fiber content of DP is considered a limiting factor in diet formulation for poultry. Therefore, in this study, the inclusion of DP in the diet of quails was limited to a maximum of 6% to give the upper limit of crude fiber (5%). In the review article of Hossain et al. (2014), moisture, protein, oil, and carbohydrate contents ranged from 3.1–12.5, 2.3–6.9, 5.0–12.5, and 70.9–86.9 g/100 g DP, respectively. However, this wide range of values may be attributed to the stage of maturity, varieties, the agronomic condition (El-Deek et al.

Table 4 Blood parameters and carcass traits of growing Japanese quail at 42 days of age

Item	Control	DP-2	DP-4	DP-6	*P* value
Hgb (g/dl)	16.2 ± 0.51	17.2 ± 0.45	16.8 ± 0.91	15.5 ± 0.66	0.32
RBCs (10^6/mm^3)	3.18 ± 0.11	3.32 ± 0.14	3.25 ± 0.17	3.15 ± 0.10	0.80
PCV%	40.4 ± 1.28	42.6 ± 1.76	42.9 ± 2.17	39.5 ± 1.18	0.45
MCV (fl)	127^{bc} ± 0.75	129^{b} ± 0.65	132^{a} ± 0.45	125^{c} ± 1.09	0.001
MCH (pg)	51.2 ± 1.25	51.9 ± 0.81	51.6 ± 0.91	49.4 ± 1.45	0.40
MCHC (%)	40.2 ± 0.77	40.4 ± 0.65	39.2 ± 0.72	39.3 ± 0.84	0.57
WBCs (10^6/mm^3)	13.9 ± 0.17	13.2 ± 0.27	13.1 ± 0.54	13.4 ± 0.54	0.57
Neutrophils (%)	18.7 ± 0.66	15.4 ± 0.83	15.5 ± 2.88	15.9 ± 2.28	0.55
Lymphocytes (%)	68.6 ± 0.96	73.5 ± 1.49	73.2 ± 3.32	72.5 ± 3.08	0.45
Carcass traits (g)					
Live weight	187 ± 7.68	192 ± 3.39	209 ± 13.7	205 ± 10.1	0.33
Dressing weight	129 ± 5.7	130 ± 4.1	141 ± 7.81	134 ± 5.10	0.48
% of live weight					
Dressing	69.1 ± 2.48	67.7 ± 1.42	67.7 ± 1.27	65.6 ± 2.0	0.62
Intestine	4.69 ± 0.37	5.06 ± 0.18	5.42 ± 0.45	5.35 ± 0.28	0.42
Gizzard	2.87 ± 0.16	2.40 ± 0.30	2.68 ± 0.33	3.15 ± 0.13	0.21
Liver	2.74 ± 0.13	2.37 ± 0.25	2.86 ± 0.25	2.37 ± 0.26	0.34
Heart	1.28^{a} ± 0.03	1.05^{b} ± 0.06	0.99^{b} ± 0.04	1.13^{ab} ± 0.07	0.011

[ab] Within rows means bearing different superscripts differ significantly at $P < 0.05$

2010), or to variation in the processing methods (Mohamed et al. 1971) of dates.

Though the diet was formulated to contain similar levels of energy and crude protein for all test groups, there was significantly higher feed intake (Table 3) of groups fed with DP than control which was reflected in the final body weight. Increased feed intake may be attributed to the decrease in the metabolisable energy of diet which resulted in increasing the intake of crude protein and essential amino acids that were required for optimum growth of quails (Masoudi et al. 2011). Also, FCR (Table 3) was best in chicks fed with 6% DP between test groups. This increase in total FI and FCR may be attributed to high NFE (soluble carbohydrate) content in DP which was found to be rich in monosaccharide, mainly glucose and fructose (Sawaya et al. 1983). Other research studies (Daneshyar et al. 2014; Al-Farsi and Lee 2008) on date palm seeds attributed the increment in the body weight of broiler chickens to its content of mannan-oligosaccharides (MOS) in addition to selenium, phenolic, and carotenoid compounds. MOS was found to improve poultry productivity through the reduction of pathogenic intestinal flora (Castillo et al. 2008) and increment of gut beneficial bacteria (Rekiel et al. 2007). This favorable effect increases the gut absorption capacity of trace elements (Sohail et al. 2011). Also, MOS improved gut histology (Iji et al. 2001) and reduced gut ammonia concentration in animals (Juskiewicz et al. 2003). Selenium, phenolic, and carotenoid compounds which are natural antioxidant and immunomodulation agents in DP added a beneficial effect on the growth performance (Amany et al. 2012). Also, the added oil in diets of DP-4 and DP-6 improved energy utilization for the growth of chicks. The DP also contained a significant amount of mineral elements such

Table 5 Effect of date pits as feed ingredients for quail on the economic evaluation

	Control	DP-2	DP-4	DP-6	*P* value
Dietary cost (LE/ton)	5698	5688	5651	5617	–
Feed consumption cost per quail (LE)	4.65 ± 0.04	4.79 ± 0.04	4.70 ± 0.06	4.79 ± 0.05	0.09
Selling return (LE)	10^{b} ± 0.33	10.8^{a} ± 0.15	10.8^{a} ± 0.26	10.9^{a} ± 0.23	0.02
Total return (LE)	10.3 ± 0.27	11.1 ± 0.15	11.2 ± 0.25	11.3 ± 0.21	0.06
Total cost (LE)	8.45 ± 0.04	8.58 ± 0.04	8.49 ± 0.06	8.58 ± 0.05	0.09
Net return (LE)	1.85 ± 0.27	2.52 ± 0.16	2.71 ± 0.28	2.72 ± 0.21	0.14
TR/TC	122^{b} ± 3.13	129 ± 1.89	132 ± 3.3	132 ± 2.42	0.14
NR/TC	22 ± 3.13	29 ± 1.89	32 ± 3.3	32 ± 2.24	0.15
NR/TR	18 ± 1.97	22.7 ± 1.18	24.1 ± 1.76	24 ± 1.46	0.07

[ab] Within rows means bearing different superscripts differ significantly at $P < 0.05$

as potassium, magnesium, calcium, phosphorus, sodium, and iron (Nehdi et al. 2010). In harmony with the obtained data of this study, Kamel et al. (2016) found that inclusion of 2.5% and 5% DP improved growth performance of quails. Up to 4% DP was found to increase the weight gain of broiler chickens by El-Far et al. (2016). Kamel et al. (1981) found that the inclusion of DP at 5%, 10%, and 15% in the diet of broiler chicks improved growth similar to control. Another study (Mohebbifar and Torki 2011) recorded no significant effect of feeding diet containing up to 10% DP on FI or production performance of broiler chicks. Also, Hussein et al. (1998) concluded that feeding DP at a level of 10% enhanced growth performance of broiler chickens, while more than 10%, feed intake was reduced due to the presence of non-starch polysaccharides which increase the viscosity of gut contents (Ghasemi et al. 2014). In laying hens, Al-Harthi et al. (2009) recommended that using DP as alternative feedstuff enhanced maturity and of Lohmann pullets and reproduction performance of layers. These research studies on DP attributed the improvement in performance to its content of MOS (Daneshyar et al. 2014) in addition to selenium, phenolic, and carotenoid compounds (Al-Farsi and Lee 2008). In previous studies, no unfavorable effect on growth performance of broilers was found by the inclusion of DP in the cereal-based diet (Hussein et al. 1998; Masoudi et al. 2010).

The remarkable high contents of crude fiber in DP (34.8%) might be considered the negative factor in diet digestibility (Table 3). Similar result was recorded by El-Sheikh et al. (2013). They found that laying hens fed on the control diet had better DC of DM, CP, EE, and NFE compared with other DP-fed groups, while Al-Harthi et al. (2009) recorded reduced digestibility of CF and NFE and improvement of CP, OM, DM, and EE for laying hens fed with diet containing DP compared with the control one.

The limiting factor in poultry diets is the lignocellulosic structure of crude fiber in feed stuffs like DP. According to Babatunde et al. (1975), this adverse effect could be reduced by using exotic digestive enzymes. In this study, the growth parameters of DP-fed groups were relatively similar to or better than the control group, even though with the reduced digestibility of DM and most of the nutrients.

In regard to blood profile, all resulting data for Hgb, RBCs, PCV, MCV, MCH, MCHC, WBCs, neutrophils, and lymphocytes were within the normal range of quail according to Agina et al. (2017). Lymphocytes were increased ($P > 0.05$) in chicks fed DP when compared with the control group. This increment reflected a positive immune response which could be attributed to the high levels of phenolics, flavonoids, and gallic acid in DP (Ardekani et al. 2010). These substances are active antioxidant, antimicrobial, and anti-inflammatory (Diplock et al. 1998). The antioxidant role is working by scavenging and elimination of harmful free radicals that are produced by cell activity. Also, DP contains MOS which has a positive effect on both cellular and humeral immunity of broiler chickens according to Savage (1996).

Results of carcass characteristics and inner organs in all experimental groups revealed non-significant change by adding DP to the diet of quails. In this trend, EL-Deek et al. (2010) detected that feeding whole dates at levels of 17.5% and 35% did not adversely affect dressing weight and internal organs of broiler chickens. The relative gizzard weight was increased in this study only in chicks fed with 6% DP. A similar result was recorded by Zangiabadi and Torki (2010) when they added date waste at 30% in the diet of broiler chickens. The authors attributed this effect to the hard tissue of DP and crude fiber content.

Economically, the inclusion of DP into quail diet at 2%, 4%, and 6% resulted in decreasing feed costs compared with the control diet. This result was in harmony with the findings of Malik et al. (2016), who found that the cost of feed decreased with increasing the level of dried dropping date in the diet. Also, this result agreed with Zanu et al. (2012) who reported that the addition of DP resulted in reducing feed costs. The highest financial return and the highest profitability from quail selling were obtained from diets supplemented with DP, as there was a significant increase of final BW. Similar result was recorded by Muhammad et al. (2017) who found that maximum net profit was achieved from broilers fed with 4% DP, closely followed by those broilers fed with 3% DP.

Conclusion

DP inclusion as a waste material up to 6% in quail diets was profitable for farm production and was found to support growth performance without adverse effect on health and carcass quality. Due to the high fiber content of DP, more researches are required in the future to investigate using pro-and/or prebiotics and exotic enzymes to improve DP utilization for partially replacing energy feeds for animals and poultry.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

Agina, O. A., Ezema, W. S. and Iwuoha, E. M. (2017). The Haematology and Serum Biochemistry Profile of Adult Japanese Quail (Coturnixcoturnix japonica). Not SciBiol. (9) 1, 67-72

Al-Farsi, M. A. and Lee, C. Y. (2008). Nutritional and functional properties of dates: a review Critical Reviews in Food Science and Nutrition. 48 (10), 877–887.

Al-Harthi, M. A., El-Deek, A. A., Yakout, H. M. and AL-Refaee, M. (2009). The Nutritive Value of Date Waste Meal as a Feedstuff for Lohmann Brown Pullets and Layers. Journal of Poultry Science. 46, 303-312.

Alu, S. E. (2012). Nutrient digestibility and serum biochemistry of laying quails (Cortunixcortunix japonica) fed sugarcane scrapping meal-based diets supplemented with exogenous enzyme. Journal of Agriculture and Veterinary Science. (5) 1, 29-35.

Amany, M. M., Shaker, M. A. and Abeer, A. K. (2012). Antioxidant activities of date pits in a model meat system. International Food Research Journal. (19) 1, 223-227.

Amira, E., Guido, F., Behija, S., Manel, I., Nesrine, Z. and Lotfi, A. (2011). Chemical and aroma volatile compositions of date palm (Phoenix dactylifera L.) fruits at three maturation stages. Food Chemistry. 127, 1744–1754.

Association of Official Analytical Chemists. (1995). In: Official Methods of Analysis of the Association of Official Analytical Chemists, 16th edition.

Ardekani, M. R., Khanavi, M., Hajimahmoodi, M., Jahangiri, M. and Hadjiakhoondi, A. (2010). Comparison of antioxidant activity and total phenol contents of some date seed varieties from Iran. Iranian Journal of Pharmaceutical Research. 9, 141-146.

Assirey, E. A. R. (2015). Nutritional composition of fruit of 10 date palm (Phoenix dactylifera L.) cultivars grown in Saudi Arabia. Journal of Taibah University for Science. 9, 75–79.

Atallah, S. T. (2004). Effect of cattle diseases on reproductive, productive and economic efficiency of dairy farms. Minufiya Veterinary Journal 1, 99.

Babatunde, G. M., Fetuga, B. L., Odumosu, O. and Oyenuga, V. A. (1975). Palm kernel meal as a major protein concentrate in the diets of pigs in the tropics. Journal of Science of Food and Agriculture. 26, 1279-1291.

Brake, J., Havenstein, G. B., Scheidele, BE., Perket, P. R. and Rives, D. V. (1993). Relationship of sex, age, and body weight to broiler carcass yield and offal production. Journal of Poultry Science. 72, 1137-1145.

Calsamiglia, S., Stem, M. D. and Frinkins, J. L. (1995). Effects of protein source on nitrogen metabolism in continuous culture and intestinal digestion in vitro. Journal of Animal Science. 73, 1819.

Campbell, T. W. (1995). Avianhaematology and cytology, 2nd Ed. Iowa state Uni. Press. Ames.

Castillo, M., Martin-Orue, S., Taylor-Pickard, J., Perez, J. and Gasa J. (2008). Use of mannan-oligosaccharides and zinc chelate as growth promoters and diarrhea preventative in weaning pigs: Effects on microbiota and gut function. Journal of animal science, 86: 94- 101.

Daneshyar, F., Afzali, N. and Farhangfar, H. (2014). Effects of different levels of date pits in broilers' feed contaminated with aflatoxin B1 on broilers' performance and carcass characteristic. African Journal of Biotechnology. 13 (1), 185–193.

Diplock, A., Charleux, J., Wilii, G., Koko, K., Rice-Evans, C. and Roberfroid, M. (1998). Functional food sciences and defense against reactive oxidative species. British Journal of Nutrition. 80, 77-82.

Donohue, M. and Cunningham, D. L. (2009). Effects of grain and oilseed prices on the costs of US poultry production. Journal of Applied Poultry Research. 18:325–337. doi: https://doi.org/10.3382/japr.2008-00134

Duncan, D. B. (1955). Multiple range and multiple F- test. Biometerics. 11, 1-42.

EL-Deek, A. A., Attia, Y. A. and AL-Harthi, M.A. (2010). Including whole inedible date in grower-finisher broiler diets and the impact on productive performance, nutrient digestibility and meat quality. Animal. 4, 1647-1652.

El-Far, A. H., Ahmed, H. A and Shaheen, H. M. (2016). Dietary Supplementation of Phoenix dactylifera Seeds Enhances Performance, Immune Response, and Antioxidant Status in Broilers. Oxidative Medicine and Cellular Longevity, Article ID 5454963, 9.

El-Sheikh, S. E. M., Al-Shokiry, N. A., Salama, A. A. and Khidr, R. E. (2013). Utilization of Azzawi Date Meal in Local Laying Hen Diets. Egypt. Journal of Poultry Science. 33 (IV), 1115-1127.

Feedipedia (2017). Animal feed resources information. https://www.Feedipedia.org/node/687.

Food and Agriculture Organization of the United Nations Statistics Division (FAOSTAT) (2017). http://www.fao.org/faostat/en/#data/QC. Accessed November.

Ghasemi, R., Torki, M., Ghasemi, H. A. and Zarei, M. (2014). Single or combined effects of date pits and olive pulps on productive traits, egg quality, serum lipids and leucocytes profiles of laying hens. Journal of Applied Animimal Research. 42, 103-109.

Hossain, M. Z., Waly, M. I., Singh, V., Sequeira, V. and Rahman, M. S. (2014). Chemical Composition of Date–Pits and Its Potential for Developing Value–Added Product – a Review. Polish Journal of Food Nutrition and Science. 64 (4), 215–226.

Hussein, A. S., Alhadrami, G. A., Khalil, Y. H. (1998). The use of dates and date pits in broiler starter and finisher diets. Bioresource Technology. 66, 219-223.

Iji, P. A., Saki, A. A. and Tivey, D. R. (2001). Intestinal structure and function of broiler chickens on diets supplemented with a mannan oligosaccharide. Journal of Science of Food and Agriculture, 81: 1186–1192.

Jassim, S. A. A. and Naji, M. A. (2010). In vitro evaluation of the antiviral activity of an extract of date palm (Phoenix dactylifera L.) pits on a Pseudomonas phage. Evidence-Based Complementary and Alternative Medicine. 7, 57-62.

Juskiewicz, J., Zdunczyk, Z. and Jankowski, J. (2003). Effect of adding mannan oligosaccharide to the diet on the performance, weight of digestive tract segments, and caecal digesta parameters in young turkeys. Journal of Animal and Feed Sciences, 12: 133-142.

Kamel, B. S., Diab, M. F., Iliau, M. A. and Salman, A. J. (1981). Nutritional value of whole dates and date pits in broiler rations. Journal of Poultry Science. 60, 1005-1011.

Kamel, E. R., Manaa, E. A. and Farid, A. S. (2016). The Effects of Dietary Date Pit on the Productive and Economic Efficiency of Japanese Quail. Alexandria Journal of Veterinary Sciences. 51(2), 211-221.

Lodhi, G. N., Singh, D. and Ichoponani, I. (1976). Variation in nutrient contents of feeding stuffs rich in proteins and reassessment of the chemical methods of metabolizable energy estimation for poultry. Journal of Agricultural Science. 86, 293-303.

Malik, M. K., Said, A., Fawzy, I. M. and Ahmed, K. G. (2016). The effect of different levels of discarded Date palm on the growth performance of Nile tilapia fingerlings (oreochromisniloticus). Journal of Agricultural Science Research. Kafr el-sheikh uni.42, 25-40.

Masoudi, A., Bojarpour, M., Chaji, M., Eslami, M. and Mirzadeh, K. (2010). Economic value of date Pits replaced with maize in broiler chicken diet. Journal of Animal and Veterinary Advances. 9, 1578-1581.

Masoudi, A., Chaji, M., Bojarpour, M. and Mirzadeh, K. H. (2011). Effects of different levels of date pits on performance, carcass characteristics and blood parameters of broiler chickens. Journal of Applied Animal Research, Vol. 39, No. 4, , 399-405.

Mohamed, A. A., El-Shazly, K. and AbouAkkada, A. R. (1971). The use of some agriculture by-products in feeding of farm animals. Alexandria Journal of Agricultural Research. 19, 25-32.

Mohamed, A. E. (2014). Economic Evaluation of Probiotic (Lactobacillus acidophilus) Using in Different broiler Breeds within Egypt. Benha Veterinary Medical Journal. 26 (2), 52-60.

Mohebbifar, A. and Torki, M. (2011). Growth performance and humeral immune response of broiler chicks fed diets containing graded levels of ground date pits with A Mixture of dried Garlic and Thyme. Global Veterinaria . 6 (4), 389-398.

Muhammad, H. T., Rani, W., Farman, A. S., Daryoush, B., Ohaib, A. B., Muhammad, A. A. and Muhammad, S. (2017). Effect of various levels of date palm kernel on growth performance of broilers. Veterinary World, 2231-916

National Research Council (NRC). (1994). Nutrient requirements of domestic animals. Nutrient requirements of poultry, 9th edn. Washington DC, National Academy Press.

Nehdi, I., Omri, S., Khalil, M. I. and Al-Resayes, S.I. (2010). Characteristics and chemical composition of date palm (Phoenix canariensis) seeds and seed oil. Industrial Crops and Products. 32, 360–365.

Rekiel, A., Bielecki, W., Gajewska, J., Cichowicz, M., Kulisiewicz, J., Batorska, M., Roszkowski, T. and Beyga K. (2007). Effect of addition of feed antibiotic flavomycin or prebiotic BIO-MOSS on production results of fatteners, blood biochemical parameters, morphometric indices of intestine and composition of microflora. Arch. Tierz. Dummerstorf, 50: 172-180.

Savage, T. F. (1996). The effects of feeding a mannanoligosaccharide on immunoglobulins, plasma IgG and bile IgA, of Wrolstad MW male turkeys. Journal of Poultry Science, 75:143-148.

Sawaya, W. N., Khalil, J. K., Khatchadourian, H. A., Safi, W. M. and Mashadi, A. S. (1983). Sugars, tannins and some vitamins contents of twenty five date cultivars grown in Saudi Arabia at the Khalal mature color and Tamer ripe stages. 468-477. Proceedings of the 1st Symposium on date palms in Saudi Arabia, Al-Hassa, Saudi Arabia.

Shreya, V., Amarapurkar, C., Murthy, B. and Naik, K. (2014). Costs and returns in commercial broiler rearing in Dharwad district. International Journal of Commerce and Business Management. 7, 316-319.

Sohail, M. U., Rahman, Z. U., Ijaz, A., Yousaf, M. S., Ashraf, K., Yaqub, T., Zaneb, H., Anwar, H. and Rehman, H., (2011). Single or combined effects of mannan oligosaccharides and probiotic supplements on the total oxidants, total antioxidants, enzymatic antioxidants, liver enzymes, and serum trace minerals in cyclic heat-stressed broilers. Journal of Poultry Science, 90: 2573-2577.

SPSS. (2004). Statistical Package for Social Sciences. Release 16.0.1 version. SPSS Inc.

Suresh, S., Guizani, N., Al-Ruzeiki, M., Al-Hadhrami, A., Al-Dohani, H., Al-Kindi, I. and Rahman, M. S. (2013). Thermal characteristics, chemical composition and polyphenol contents of date–pits powder. Journal of Food Engineering. 119, 668–679.

Van Soest, P. J., Robertson, J. B. and Lewis, B. A. (1991). Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science. 74, 3583-3597.

Zangiabadi, H. and Torki M. (2010). The effect of β-mannanase-based enzyme on growth performance and humoral immune response of broiler chickens fed diets containing graded levels of whole dates. Tropical Animal Health and Production Journal. 42, 1209-1217.

Zanu, H. K., Abangiba, J., Arthur-Badoo, W., Akparibo, A. D. and Sam, R. (2012). Laying chickens' response to various levels of palm kernel cake in diets. International Journal of Livestock Production. 3(1), 12-16.