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Effects of Dietary Inclusion of Ground Pits of Date Palm (*Phoenix dactylifera*) with or without Probiotic *Yeasture*® on Productive Performance, Egg Traits and Some Blood Parameters of Laying Hens

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

A study was conducted to evaluate the effects of dietary inclusion of ground pits of date palm (DP) (*Phoenix dactylifera*) supplementing with a commercial probiotic mixture (*Yeasture*®) on the performance, egg quality characteristics, blood parameters, and excreta pH of laying hens. A total of 144 Lohmann LSL-Lite laying hens were randomly divided in 24 cages. Based on a 3×2 factorial arrangement of treatments in a completely randomized design with four replicates, 6 iso-caloric and iso-nitrogenous experimental diets (ME=2720 kcal/kg and CP=150 g/kg) including: I-corn-soybean meal-based control-1 diet, II-corn-soybean meal-oil-based control-2 diet, and III-corn-soybean meal-based diet included 210 g/kg DP with or without probiotic (0.0 and 0.05 g/kg) were formulated. Dietary treatment had no significant effect on feed intake, feed conversion ratio and body weight as well as egg production and egg mass (P>.05). Probiotic supplementation did not significantly affect laying performance. In the first egg sampling (wk3) egg index, Haugh unit, egg gravity, and egg abnormality were not significantly affected by dietary treatments (P>.05). Shell weight and shell thickness were decreased by diet inclusion of

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DP (*P*=.05). Dietary treatment did not have significant effect on blood parameters except for triglycerides and high density lipoprotein (HDL) contents which was increased by adding probiotic to diet in compared to the control groups (*P*=.05). Dietary combination of DP and probiotic significantly decreased excreta pH in compared to other groups (*P*=.05). From the results of the present study, it can be concluded that DP can be included in diets of laying hens up to 21% with no substantial adverse effect on their performance and egg quality traits.

Keywords: Date pits; probiotic; laying hens; performance; egg quality; blood parameters.

1. INTRODUCTION

The poultry industry has become an important economic activity in many countries. It has been estimated that feed is the major cost associated with commercial poultry production. Hence, inclusion of local unconventional feed resources become of primordial importance in livestock production to maintain the productivity but at a lower cost. Egypt, Saudi Arabia, Iran, Iraq, UAE, Algeria and Pakistan are seven leading countries that produce more than 90% of the world's palm date supply [1]. Date by-products are considered inexpensive local feedstuff for animals in this region and can be used successfully to raise chickens. A study by Vandepopuliere et al. [2] showed that untreated date pits (DP) at levels ranging from 5 to 27% could be included in broiler diets to support growth performance. Kamel et al. [3] found that DP (levels 5, 10 and 15%) added to diets supported chick growth similar to chicks fed control diets. However, Jumah et al. [4] found that diets containing graded levels (0, 5 and 15%) of DP caused a proportional, gradual reduction in broiler weight gain compared to the control diet. Afzal et al. [5] found no significant difference in feed intake (FI), body weight (BW) and feed conversion ratio (FCR), when DP were used for up to 30% in broiler diets.

For many years, antimicrobial compounds have been used in the poultry industry for improvement in health status and performance of birds by reduction or correction of the population of the bacteria present in the gastro-intestinal tract [6]. Growth stimulating antibiotics, by the spread of antibiotic-resistant bacteria, are a threat to human health [7]. Following a severe limitation or a general inhibition of using antibiotics as growth stimulating and therapeutic agents in the poultry industry, probiotics and prebiotics have been suggested as appropriate alternatives [8]. Probiotics are defined as live microbial food supplements, which beneficially influence human [9] and animal health [10-13]. They are nonpathogenic bacteria that can promote bird health by reducing pathogen colonization [14]. Their efficiency was demonstrated for the treatment of gastrointestinal disorders, respiratory infections, and allergic symptoms. Studies have indicated that probiotic supplementation can have positive impacts on poultry performance. Kabir et al. [15] reported the occurrence of a significantly higher carcass yield in broiler chicks fed with the probiotics on the 2nd, 4th and 6th week of age both in vaccinated and non-vaccinated birds. Mahajan et al. [16] recorded in their study that mean values of giblets, hot dress weight, cold dress weight and dressing percentage were significantly higher for probiotic fed broilers. On the other hand, Mutuş et al. [17] investigated the effects of a dietary supplemental probiotic on morphometric parameters and yield stress of the tibia and they found that tibiotarsi weight, length, and weight/length index, robusticity index, diaphysis diameter, modulus of elasticity, yield stress parameters, and percentage calcium (Ca) content were not affected by the dietary supplementation of probiotic, whereas thickness of the medial and lateral wall of the tibia, tibiotarsal index, percentage ash, and phosphorous (P) content were improved significantly by the probiotic.

Yeasture is a natural product composed primarily of high strength live yeast culture selected from three strains of high fermenting capacity *Saccharomyces (S.) cerevisiae* which were gently harvested and dried to retain its viability also contains microencapsulated and bile resistant *Lactobacillus (L.) casei* and *Streptococcus (S.) faecium* to help improve weight gain and fiber digestion and reduce mortality rate. Yeast cells also absorb mycotoxins from food [18] and improve digestibility and absorption of minerals such as Ca, P, magnesium, copper, potassium, zinc and manganese [19].

The objective of the present study was to evaluate the effects of probiotic (*Yeasture*®) on the performance, egg quality traits, blood parameters, and excreta pH of laying hens fed corn-soybean meal-based diets and a corn-soybean meal-based diet including 21% DP.

2. MATERIALS AND METHODS

All procedures used in this 7-wk experiment were approved by the Animal Ethics Committee of Razi University and complied with the "Guidelines for the Care and Use of Animals in Research". A total of 144 Lohmann LSL-Lite hens (80-wk-old) with an average egg production rate of 90.6±4.8% (late laying phase) and 1,460±24 g live body weight, were obtained from a commercial supplier and after a wk of adaptation, were allocated randomly to one of six dietary treatments. Each treatment consisted of four replicates and each replicate contained six chicks. The hens were placed in individual wire-floored cages (0.3 m wide×0.4 m length×0.4 m height) arranged in a single tier within a conventional open-sided house. The cages were located in a windowless and environmentally controlled room with the room temperature kept at 2l–23ºC and the photoperiod set at 16 h of light (incandescent lighting, 10 lux) and 8 h dark. Each cage had a nipple watered. Water was available ad libitum throughout the experiment. Egg production was measured daily and FI was measured on a weekly basis. Based on a 3×2 factorial arrangement of treatments, 6 iso-energetic and iso-nitrogenous (ME=2720 kcal/kg and CP=150 g/kg) experimental diets were formulated (Table 1). The 6 experimental diets included: I-corn-soybean meal-based control-1 diet (C1), II-corn-soybean meal-oil-based control-2 diet (C2), and III-corn-soybean meal-based diet included 210 g/kg ground DP (E) with and without commercial probiotic (0.0 and 0.05 g/kg *Yeasture*®), respectively. The chemical composition (nutrients contents) of used date pits was as presented here as well as the footer of the diet table (ME=2000 kcal/kg, CP=7.03%, Ether Extract=7.10%, Crude fiber=48.2%, Calcium=0.865%, Available Phosphorous=0.03%). Egg quality characteristics were measured twice on wk 3 and 7 of experiment and each time all eggs during three frequent days were used.

2.1 Blood Sample

At the end of the experiment (7 wk) four hens were selected randomly from each treatment (one hen per replicate) and blood samples were collected from the wing vein into a 5-ml syringe. Part of the blood which had been obtained having been centrifuged (3000×g for 15 min) immediately and serum collected for subsequent analysis, the rest was placed in tubes with heparin as anticoagulant in order to diacritical counts of white blood cells based on the procedures of Gross and Siegel [20]. Briefly, two drops of blood were placed on a slide, spin prepared and stained with May-Grünwald-Giemsa stain. All slides were coded and one hundred leukocytes, including granular (heterophils, eosinophils, and basophils) and nongranular (lymphocytes and monocytes) were counted on one slide per each bird, and the heterophil to lymphocyte (H/L) ratio was calculated. Serum triglycerides, high density lipoprotein (HDL), low density lipoprotein (LDL), and total cholesterol were analyzed using the diagnostic kit (Pars Azmun, Iran), and enzymatic methods.

Table 1. Ingredients and composition of experimental diets

Label	**C1**		**C2**		**E**	
Date Pits	-	-	-	-	21	21
Yeasture®	-	0.05	-	0.05	-	0.05
Feed ingredients	g/100 g diet					
Corn	67.11	67.13	56.62	56.64	44.78	44.80
Fish meal	0	0	4.40	4.40	4.40	4.40
Soybean meal	20.97	20.93	16.61	16.57	15.46	15.42
Date Pits[1]	0	0	0	0	21.0	21.0
Soybean oil	0	0	4.20	4.20	4.20	4.20
Dicalcium phosphate	1.17	1.18	1.28	1.28	1.32	1.32
Lime stone	8.78	8.78	8.33	8.33	7.84	7.84
Common salt	0.29	0.29	0.23	0.23	0.24	0.24
Yeasture®	0	0.05	0	0.05	0	0.05
Vit. & Min. Premix[2]	0.50	0.50	0.50	0.50	0.50	0.50
Sand	1.06	1.02	7.74	7.71	0.11	0.07
DL-Methionine	0.12	0.12	0.09	0.09	0.15	0.15
Calculated analyses						
ME (Kcal/kg)	2720	2720	2720	2720	2720	2720
Crude protein (%)	15	15	15	15	15	15
Ca (%)	3.67	3.67	3.67	3.67	3.67	3.67
Available P (%)	0.33	0.33	0.33	0.33	0.33	0.33
Na (%)	0.14	0.14	0.14	0.14	0.14	0.14
Lysine (%)	0.74	0.74	0.82	0.82	0.75	0.75
Methionine (%)	0.36	0.36	0.38	0.38	0.41	0.41
Met & Cys (%)	0.62	0.62	0.62	0.62	0.62	0.62

[1]The chemical composition (nutrients contents) of used date pits: ME=2000 kcal/kg, CP=7.03%, Ether Extract=7.10%, Crude fiber=48.2%, Calcium=0.865%, Available Phosphorous=0.03%.
[2]Mineral mix supplied the following per kg of diet: Cu, 20 mg; Fe, 100 mg; Mn, 100 mg; Se, 0.4; Zn, 169.4 mg. Vitamins mix supplied the following per kg of diet: Vitamin A, 18,000 IU; vitamin D3, 4,000 IU; vitamin E, 36mg; vitamin K; 4 mg; vitamin B\2, 0.03 mg; thiamine, 1.8 mg; riboflavin, 13.2 mg; pyridoxine, 6 mg; niacin, 60 mg; calcium pantothenate, 20 mg; folic acid, 2 mg; biotin, 0.2 mg; choline chloride, 500 mg

2.2 Collection of Excreta Samples

The excreta were collected on galvanized zinc trays lined with plastic sheets. Dropped feathers, feed particles or foreign materials were removed to prevent contamination. Approximately 200 g samples were collected daily. Each of the excreta samples was mixed and homogenized individually. The pH of 1 g of excreta in 10 mL of distilled water was measured using a digital pH meter (model 632 equipped with the electrode 6.0202.000 containing 3 *M* KCl electrolyte; Metrohm, Herisau, Switzerland).

2.3 Statistical Analysis

Data were analyzed based on 3×2 factorial arrangements in completely randomized design using GLM procedure of SAS [21]. All statements of significance are based a probability of less than .05. The mean values were compared by Duncan's Multiple Range Test. The statistical model used is $Y_{ijk}=\mu+A_i+B_j+(AB)_{ij}+e_{ijkl}$, where Y_{ijk}=tested parameter of laying fed diets containing graded levels of DP (0, 0 and 210 g/kg) and *Yeasture*® (0 and 0.5 g/kg), A_i=dietary inclusion of DP (0, 0 and 210 g/kg), B_j=dietary inclusion of *Yeasture*® (0 and 0.5 g/kg), $(AB)_{ij}$=interaction between DP and *Yeasture*® addition, and e_{ijkl}=random error term. To facilitate the statistical analysis of the data, all of the parameters were keyed in into Microsoft Excel and then transferred to the SAS [21].

3. RESULT AND DISCUSSION

3.1 Productive Performance and Egg Quality Characteristics of Laying Hens

As shown in Table 2, dietary treatments did not have any significant effect on egg production (EP) and egg mass (EM, P>.05). Dietary inclusion of date pits increased FI and FCR when compared with the control diets; however, this increase did not statistically significant (P>.05).Similarly, probiotic supplementation did not significantly affect laying hens' performance (P>.05).There was no interaction between DP and probiotic on FI, FCR, EP, and EM (P>.05). In general, few studies have been done about the effect of dietary inclusion of DP on laying hens. The results of the present study are in general agreement with the results of the other studies concerning the effect of dietary inclusion of DP or dietary supplementation with probiotics on performance characteristics of poultry. Perez et al. [22] in their experiment found that up to 50% DP in the laying hens diet did not affect FCR, whereas Kim et al. [23] reported that weight gain and FCR significantly improved when 0.1 to 0.5% probiotics with *Lactobacillus* species (sp.), Bacillus sp. and yeast were fed to broiler chickens. In another study, supplementation of 0.1 to 0.3% mixed probiotics containing *L. acidophilus, Bacillus (B.) subtilis, S. cerevisiae* to broiler diets improved weight gain and FCR as well as FI [24]. However, our results do not agree with those of Al-saffar et al. [25], who reported suppressed productive performance due to dietary inclusion rate of 15% DP in Fayoumi × Barred Plymouth Rock laying hens. The differences in their results and ours may be due to the higher soybean oil level we used for balance of energy among the experimental diets and its subsequent effect on improving nutrient utilization [26, 27]. Najib et al. [28] and Radwan et al. [29] also reported the negative effects of DP level on laying hens' performance. However, this effect may depend on breed, physiological condition, and variety of DP.

Table 2. Effects of diet inclusion of ground pits of date palm (0, 0 and 210 g/kg), with or without probiotic (*Yeasture*®1) on productive performance of Lohmann LSL-lite laying hens (weeks 80-87of age)[a]

Treatments	Feed intake (g/hen/day)	Feed conversion ratio (g feed : g egg)	Hen-day egg production (%)	Egg mass (g/hen/day)
Date Pits (DP)				
0 (g/100g diet)	111.59±5.01	2.02±0.14	89.67±5.80	56.76±7.15
0 (g/100g diet)	113.78±3.71	2.02±0.05	91.51±3.68	56.70±2.39
21 (g/100g diet)	114.67±5.06	2.18±0.21	86.22±6.02	53.13±3.34
***Yeasture*® (Y)**				
0.00 (g/100g diet)	114.25±3.83	2.07±0.15	89.74±5.39	56.23±5.68
0.05 (g/100g diet)	112.44±5.32	2.07±0.18	88.53±5.80	54.99±3.96
Pooled SEM	0.94	0.03	1.12	0.99
***P* values**				
Date Pits (DP)	.41	.09	.18	.30
Yeasture® (Y)	.35	.94	.59	.54
DP×Y	.36	.48	.58	.52

[a]*Means±SD,* [ab]*Means within a column showing different superscripts are significantly different (P< 0.05), Duncan's multiple-range test were applied to compare means*
[1]*Commercial probiotic mixture including S. cerevisiae, L. acidophilus and L. casei*

Effects of adding DP and probiotic to laying hen diets on egg quality characteristics are presented in Tables 3 and 4. In the first egg sampling (wk3) egg index, Haugh unit and egg gravity were not affected significantly by dietary treatments (*P*>.05). Shell weight and shell thickness were significantly decreased by dietary inclusion of DP (*P*=.05). Dietary supplementation of probiotic had no significant effect on shell thickness (*P*>.05), whereas shell weight was significantly increased as a result of dietary probiotic supplementation (*P*=.05). There were interactions between DP and probiotic on yolk index (*P*<.001) and yolk color (*P*=.05). Statistical analysis based on 6 separated dietary groups indicated no significant difference between treatments on yolk index (*P*>.05), whereas hens that received DP either alone or in combination with probiotic showed significantly lower yolk color compared with other treatments (*P*<.001). In second egg sampling (wk7), dietary inclusion of DP decreased yolk color and increased yolk index in comparison to control groups (*P*=.05). No effect of dietary treatments or their interactions were observed on the other measured egg traits (*P*=.05). The decrease in shell quality due to dietary inclusion of DP at level of 21% in the present study is consistent with the results of Perez et al. [22] and Al-saffar et al. [25]. However, Abd El-Rahman et al. [30] found that dietary inclusion of DP up to 30% had no effect on shell thickness and shell percentage. The decrease in shell quality could be explained partially by dietary inclusion of oils. The fatty acids and especially the linoleic acid deceased egg shell quality [31] because of the formation of insoluble mineral soaps especially with palmitic acid [27]. The insignificant effect of the probiotic supplementation on egg quality traits was not unexpected which have already been reported [32,33]. The increased shell weight as a result of dietary probiotic supplementation has not been observed by other investigators [32,33] and no reasonable explanation can be offered for the improved egg shell weight in the present study.

Table 3. Effects of diet inclusion of ground pits of date palm (0 and 210 g/kg), with or without enzyme (*Yeasture*®) on egg quality characteristics (first egg sampling on wk 3)[a]

Egg quality traits (wk 3)								
Treatments		**Egg index**	**Yolk index**	**Haugh unit**	**Yolk color (Roch)**	**Specific gravity**	**Shell weight (gr)**	**Shell thickness (mm×10-2)**
Date Pits (DP)								
0 (g/100g diet)		76.89±2.53	39.00±1.55	71.16±3.40	6.91±0.15[a]	1.09±0.00	6.23±0.21[a]	36.67±2.36[a]
0 (g/100g diet)		74.85±1.71	39.01±0.85	69.90±2.99	5.25±0.47[c]	1.09±0.00	6.23±0.63[a]	34.91±2.08[ab]
21 (g/100g diet)		75.99±1.31	38.72±0.97	69.44±1.79	6.12±0.79[b]	1.09±0.00	5.70±0.32[b]	33.87±1.36[b]
***Yeasture*® (Y)**								
0.00 (g/100g diet)		75.78±2.25	38.63±1.10	69.16±1.85	6.08±0.77	1.09±0.00	5.89±0.25[b]	34.94±2.37
0.05 (g/100g diet)		76.03±1.86	39.19±1.12	71.17±3.26	6.11±0.84	1.09±0.00	6.21±0.60[a]	35.36±2.16
Pooled SEM		0.41	0.23	0.57	0.16	0.00	0.10	0.45
***P* values**								
Date Pits (DP)		.15	.76	.43	.001	.06	.01	.04
Yeasture® (Y)		.77	.14	.08	.85	.88	.04	.62
DP×Y		.51	.001	.49	.04	.68	.07	.49
***P* values**								
DP	Y							
1	-		37.72±0.78		7.00±0.00[a]			
1	+		40.27±0.83		6.83±0.19[ab]			
C1	-		39.19±0.54		5.42±0.57c[d]			
C1	+		38.83±1.14		5.08±0.42[d]			
21	-		38.95±1.37		5.83±0.19[c]			
21	+		38.48±0.38		6.41±0.42[b]			
CV			2.63		5.79			
P values			.38		.001			

[a]*Means±SD,* [ab]*Means within a column showing different superscripts are significantly different (P< 0.05), Duncan's multiple-range test were applied to compare means*

Table 4. Effects of diet inclusion of ground pits of date palm (0 and 210 g/kg), with or without enzyme (*Yeasture®)* on egg quality characteristics (second egg sampling on wk 7)[a]

Egg quality traits (wk 7)							
Treatments	**Egg index**	**Yolk index**	**Haugh unit**	**Yolk color (Roch)**	**Specific gravity**	**Shell weight (gr)**	**Shell thickness (mm×10-2)**
Date Pits (DP)							
0 (g/100g diet)	74.17±1.63	43.55±0.93[ab]	71.20±5.61	6.62±1.01[a]	1.11±0.06	5.86±0.41	37.42±2.11
0 (g/100g diet)	74.66±1.60	43.10±1.10[b]	67.11±1.86	5.50±0.59[b]	1.08±0.00	5.77±0.26	36.88±1.26
21 (g/100g diet)	74.80±1.89	44.38±0.77[a]	69.40±4.90	5.79±0.62[b]	1.08±0.00	5.57±0.33	35.12±2.17
Yeasture® (Y)							
0.00 (g/100g diet)	74.80±1.40	44.03±0.76	69.34±5.09	5.83±0.76	1.10±0.05	5.75±0.41	36.58±1.87
0.05 (g/100g diet)	74.29±1.91	43.32±1.21	69.13±4.20	6.11±1.00	1.08±0.01	5.71±0.29	36.36±2.33
Pooled SEM	0.34	0.21	0.93	0.18	0.01	0.07	0.42
***P* values**							
Date Pits (DP)	.76	.02	.16	.02	.277	.30	.08
Yeasture® (Y)	.50	.05	.90	.37	.32	.80	.79
DP×Y	.79	.15	.05	.17	.46	.81	.63

[a]Means±SD, [ab]Means within a column showing different superscripts are significantly different (P< 0.05), Duncan's multiple-range test were applied to compare means

3.2 Blood parameters

As shown in Tables 5 and 6, dietary treatments had no significant effects on the blood parameters with the exception of triglycerides and HDL-cholesterol contents, which were higher than the control in laying hens receiving dietary supplementation with probiotic (P=.05). These findings were in agreement with Kurtoglu et al. [34] and Mohiti Asli et al. [33] who showed that probiotic did not affect serum or yolk total cholesterol in 30-days period of their experiments. But they did not support Mohan et al. [35] or Mahdavi et al. [32] who reported that probiotics could depress serum concentrations of cholesterol and triglyceride. The effect of probiotics on the serum and egg yolk lipid profile of laying hens requires further investigation.

3.3 Excreta pH and Body weight

Effects of dietary inclusion of DP and probiotic on excreta pH and body weight of laying hens are presented in Table 7. Neither the dietary inclusion of DP nor dietary supplementation of probiotic significantly affected BW of the laying hens (P>.05). There was an interaction between DP and probiotic on excreta pH (P=.05). Statistical analysis based on 6 separated dietary groups indicated that the excreta pH decreased because of simultaneous inclusion of dietary DP and probiotic in laying hen diets (P=.05). Litter or excreta pH has been shown to be correlated with litter moisture content [36]. In fact, the increase of excreta acidity might associate with drier excreta. Wet litter is a problem in the laying industry. Apart from ventilation problems and water spillage, wet litter is directly associated with excessive excretion of watery droppings [37]. No published data concerning the effect of dietary inclusion of DP on pH excreta were available. However, the results of the present study clearly indicated that the dietary combination of DP and probiotic supplementation associated with a reduced excreta pH in laying hens. Sakata et al. [38] reported that probiotic bacteria actually increase the production rates of volatile fatty acids, lactic acid, and occasionally succinic acids due to the increase in the breakdown of indigestible carbohydrates. On the basis of these findings, it can be inferred that dietary addition of DP may supply more available carbohydrates for *Lactobacillus* sp. and stimulate the growth of other lactic acid-producing bacteria. However, further investigations are required to support this proposition.

Table 5. Effects of diet inclusion of ground pits of date palm (0, 0 and 210g/kg), with or without commercial probiotic (*Yeasture*®) on white blood cell counts (heterophil, lymphocyte, monocyte, eosinophil, basophil and Heterophil to Lymphocyte ratio)[a]

	White blood cell counts (%)					
Treatment	**H[1]**	**L**	**M**	**E**	**B**	**H/L**
Date Pits (DP)						
0 (g/100g diet)	34.38±6.59	63.50±6.68	0.88±0.99	0.50±0.53	1.25±0.89	0.55±0.15
0 (g/100g diet)	34.38±6.17	62.25±7.65	0.88±1.25	0.63±0.74	1.88±1.36	0.57±0.16
21 (g/100g diet)	36.50±9.62	59.88±9.40	1.38±1.60	0.88±1.64	1.50±1.07	0.64±0.25
***Yeasture*® (Y)**						
0.00 (g/100g diet)	36.92±5.82	59.25±6.76	0.92±1.08	0.83±1.19	1.92±1.16	0.64±0.16
0.05 (g/100g diet)	33.25±8.48	64.50±8.13	1.17±1.47	0.50±0.90	1.17±0.94	0.54±0.20
SEM	1.50	1.59	0.26	0.21	0.22	0.04
CV	21.46	12.68	120.27	171.39	72.12	32.54
***P* values**						
Date Pits (DP)	.81	.65	.66	.80	.54	.63
Yeasture ® (Y)	.25	.12	.63	.48	.12	.21
DP×Y	.37	.59	.14	.80	.74	.49

[a]*Means±SD,* [ab]*Means within a column showing different superscripts are significantly different (P< 0.05), Duncan's multiple-range test were applied to compare means*

[1]*Heterophil, Lymphocyte, Monocyte, Eosinophil, Basophil, Heterophil to Lymphocyte ratio*

Table 6. Effects of diet inclusion of ground pits of date palm (0, 0 and 210g/kg), with or without commercial probiotic (*Yeasture*®) on serum biochemical metabolites (cholesterol, triglycerides, high density lipoprotein cholesterol, low density lipoprotein cholesterol)[a]

	Serum biochemical metabolites (mg/dL)			
Treatments	**CHOL[1]**	**TG**	**HDL-c**	**LDL-c**
Date Pits (DP)				
0 (g/100g diet)	170.00±31.87	2046.88±561.65	41.63±6.14	107.88±15.64
0 (g/100g diet)	154.00±14.91	1795.00±189.51	38.75±2.71	102.38±11.36
21 (g/100g diet)	155.00±18.18	1567.50±694.81	38.25±8.43	100.00±20.46
***Yeasture*® (Y)**				
0.00 (g/100g diet)	151.17±20.04	1575.42±530.39[b]	37.33±6.34[b]	101.42± 16.06
0.05 (g/100g diet)	168.17±28.84	2030.83±469.04[a]	41.75±5.28[a]	104.08± 26.25
SEM	6.04	110.65	1.25	3.24
CV	1.24	23.95	12.71	13.38
P values				
Date Pits (DP)	.39	.10	.36	.47
Yeasture® (Y)	.12	.02	.04	.15
DP×Y	.05	.05	.05	.05

[a]Means±SD, [ab]Means within a column showing different superscripts are significantly different (P< 0.05), Duncan's multiple-range test were applied to compare means

[1]Cholesterol, Triglycerides, High density lipoprotein cholesterol, Low density lipoprotein cholesterol

Table 7. Effects of diet inclusion of ground pits of date palm (0, 0 and 210g/kg), with or without commercial probiotic (*Yeasture*®) on Feces pH and body weight (BW)[a]

Treatments		Feces pH	BWG
Date Pits (DP)			
0 (g/100g diet)		7.51±0.29[a]	12.92±85.83
0 (g/100g diet)		7.11±0.26[b]	23.85±54.27
21 (g/100g diet)		6.96±0.53[b]	28.75±51.92
Yeasture® (Y)			
0.00 (g/100g diet)		7.24±0.35	11.25±78.88
0.05 (g/100g diet)		7.15±0.51	15.27±52.96
SEM		0.09	13.42
CV		4.67	496.82
***P* values**			
Date Pits (DP)		.01	.40
Yeasture® (Y)		.52	.88
DP×Y		.03	.25
DP	Y		
1	-	7.38±0.34[ab]	
1	+	7.63±1.20[a]	
2	-	7.05±0.35[bc]	
2	+	7.17±0.18[ab]	
21	-	7.28±0.38[ab]	
21	+	6.64±0.48[c]	
CV		4.67	
P value		.01	

[a]Means±SD, [ab]Means within a column showing different superscripts are significantly different (P< 0.05), Duncan's multiple-range test were applied to compare means

4. CONCLUSION

All at all, from the results of the present study, it can be concluded that DP can be included in diet of laying hens up to 21% with no adverse effect on their performance. However, dietary inclusion of DP has some adverse effect on egg yolk color and egg shell weight that can be ameliorated by dietary probiotic supplementation. Moreover, the results of the present study indicate that the simultaneous inclusion of DP and probiotic in laying hen diets decreased the excreta pH when compared to other diets.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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