Research Article

Effects of the Date Palm (*Phoenix dactylifera L.*) on Growth Performance and Egg Quality of ISA Brown Laying Hens

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Abstract | This research is conducted to evaluate the effect of use Date Palm (*Phoenix dactylifera* L.) seed as additive on the growth performance and egg quality of ISA BROWN laying hens. The materials in this research were used date palm flour with different levels as follows, T0 = basal diet + 0% control, T1 = basal diet + 2.5% date palm flour, T2 = basal diet + 5% date palm flour, T3 = basal diet + 7.5% date palm flour, T4 = basal feed + 10% date palm flour. The variables observed were production performance and egg physical quality. This research used 125 laying hens aged 26 weeks, consisting of five treatments and five replications. Data analysis from this study Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT). The results show that the treatments had no significant effect (p >0.05) on production performance and egg physical quality. To sum up, using date palm (*Phoenix dactylifera L.*) has positive effect on the growth performance and egg quality of ISA BROWN laying hen because can be alternative feed ingredients to reduce production costs and maximize income.

Keywords | Date palm, Egg quality, Growth performance, Hen day production, Laying hens

Received | June 14, 2022; **Accepted** | July 21, 2022; **Published** | August 13, 2022
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Citation | Karina TN, Sjofjan O, Susilorini TE, Natsir MH (2022). Effects of the date palm (*Phoenix dactylifera* L.) on growth performance and egg quality of isa brown laying hens. Adv. Anim. Vet. Sci. 10(9):1894-1899.
DOI | https://dx.doi.org/10.17582/journal.aavs/2022/10.9.1894.1899
ISSN (Online) | 2307-8316

INTRODUCTION

The success of the management of laying hens are influenced by several factors such as *strain*, management, housing, and feed. Improving feed is one of the important factors in the production of the livestock industry. The feed cost in the poultry industry usually reaches 60-70% of the production cost (Gunya and Masika, 2021). Agricultural by-products are becoming an important component of poultry feed in some areas, largely due to increased competition for conventional ingredients by humans and the food industry. The use of agricultural by-products as alternative feed ingredients is recommended to reduce production costs and maximize income (Sjofjan et al., 2021).

Date Palm (*Phoenix dactylifera L.*) have a role as a source of food for humans and animals in arid and semi-arid areas. Dates are high in carbohydrates, about 70%, most of which are in the form of sugar. Dates also contain most of the minerals such as iron, potassium, and calcium (Al-Farsi and Lee, 2008). One of them is the utilization by-products of processing date palm, namely date palm. Date palms are an inedible part of about 10% of the weight of date fruit (Al-Saffar et al., 2013). However, date palm as alternative feed ingredients are still not widely applied, this is due to the low protein and high crude fiber content. Date palm content is about 71.8% mannose, 26.6% galactose, and 9.8-22.3% β-galactomannan polysaccharide. Moreover, date palm has anti-nutrients in low amounts, such as oxalates, tannins, saponins, alkaloids, and cyanide (Hassan and Al-Aqil, 2015). This shows that date palm can be used as alternative feed ingredients because the anti-nutritional composition is low and will not interfere with other nutrients such as minerals and protein in the body.

Date palm it is also a high content of antioxidants, mainly phenolic compounds and carotenoids. Date palm is high in phenolics (3942 mg/100g) and antioxidants (80,400 mmol/mg) (Attia et al., 2021). The high content of antioxidants in date palm can improve the growth, production, and reproduction performance of laying hens. Moreover, with antioxidant and antimicrobial content, fibre also has functions for the absorption process in the digestion of laying hens (Wu et al., 2013). The carbohydrate content in date palm is a producer of energy for metabolic processes that can help growth (Agboola and Adejumo, 2013). In a previous study, 10% and 15% date palm flour can increase hen day production, egg weight, egg mass, FER, and shell thickness (Hermes and Al-Homidan, 2004; El-Deek et al., 2008; Najib and Al-Yousif, 2012). This study aims to evaluate the effect of date palm (*Phoenix dactylifera* L.) as additive on the growth performances of ISA BROWN laying hens.

MATERIALS AND METHODS

Ethical approval

Ethical approval for the study was given by the Animal Care and Use Committee, University of Brawijaya, No. 44-KEP-UB-2022.

Experimental design

A total of 125 heads of ISA Brown Laying hens (26 weeks old) were used in a week with adaptation period and an eight-week trial. The laying hens were raised in the battery house-controlled room (47 cm x 36 cm x 30 cm). All laying hens were allowed *ad libitum* access to water through adjustable nipple drinkers. In contrast, restricted feeding was applied with 120 g/hen/day. Each treatment was randomized as a completed design. (Five replicates with five laying hens per replication pen). The treatments as follows: T_0 = basal diet + 0% control, T_1 = basal diet + 2.5% date palm flour, T_2 = basal diet + 5% date palm flour, T_3 = basal diet + 7.5% date palm flour, T_4 = basal feed + 10% date palm flour. The formulated feed was consisted yellow maize, maize gluten meal, meat and bone meal, soya bean meal, Distillery Dry Grain Soluble (DDGS), poultry meat meal, palm oil, mineral premix, and vitamin custom premix. Furthermore, representative of the feed was conducted wet analyzed for metabolizable energy (Kcal/kg). crude protein (CP), and crude fibre (CF) by following (AOAC, 2000). The composition of formulated feed based on dry matter (DM) showed in the Table 1.

Table 1: Formulated feed of ISA BROWN laying hens (26 old week).

Ingredients (% as is basis)	**T_0**	**T_1**	**T_2**	**T_3**	**T_4**
Yellow maize	51.61	48.89	46.17	46.45	47.74
Maize gluten meal	16.00	18.20	20.00	21.00	21.00
Soybean	16.13	16.13	16.13	16.13	16.13
Meat and Bone meal	7.00	7.00	7.00	7.00	7.00
Poultry Meat meal	5.26	6.00	7.00	5.00	4.00
Palm oil	2.00	2.00	2.00	2.00	1.99
Custom Mineral premix*	1.00	1.00	1.00	1.00	1.14
Vitamin premix**	0.50	0.50	0.50	0.50	0.50
DDGS	0.20	0.20	0.20	0.82	0.20
Date palm	0.30	0.08	0.00	0.10	0.30
Total	100	100	100	100	100
Calculated composition					
ME (Kcal/kg)	2800.00	2800.00	2800.00	2800.00	2800.00
Crude Protein (CP)	17.25	17.25	17.25	17.25	17.25
Crude fibre (CF)	4.00	4.00	4.00	4.00	4.00
Calcium (Ca)	0.60	0.60	0.60	0.60	0.60
Phosphorus (P)	0.50	0.50	0.50	0.50	0.50
Lysine	1.70	1.70	1.70	1.70	1.70
Methionine	0.80	0.80	0.80	0.80	0.80
Threonine	1.10	1.10	1.10	1.10	1.10
Tryptophan	0.34	0.34	0.34	0.34	0.34
Proximate composition (Wet chemical analysed)					
ME (Kcal/kg)	2856,43	2848,89	2841,36	2833,82	2826,39
Crude Protein (CP)	17.18	17.18	17.18	17.18	17.18
Crude fibre (CF)	4.59	4.77	4.94	5.11	5.28

: Vitamin A, 6000IU, Vitamin D3, 1000IU, Vitamin E, 10mg, Vitamin K3, 1.5mg, Vitamin B1, 5mg, Vitamin B2, 2.5mg, Vitamin B6 0.5mg, Vitamin B12, 2.0mg, niacin, 5.5mg, pantothenic acid, 0.2mg, betaine, 30mg. *: Iron, 12.50mg, copper, 3mg, manganese, 37.5mg, zinc, 31.32mg, iodine, 5mg and selenium 0.0625mg*Carrier was $CaCo_3$

Hen day production (%), egg mass, and income over fed cost (IOFC)

Hen day production (%) was recorded on a day as the number of eggs produced divided by the number of hens alive on a day. Egg mass were weighed using a digital scale and multiple of egg production. Feed intake was calculated as the difference between feed given and rest of feed. The feed intake was collected at the day morning. In the end, feed egg ratio (FER) was expressed by dividing the mount of feed offered by the total number of eggs collected by following formulae from (Adli, 2021).

Egg quality

Shell thickness was expressed by using egg tester by following (Marwi et al., 2021). Moreover, yolk index was determined by dividing between egg yolk diameter and egg yolk height (Zahroojian et al., 2013). In the end, we determined the albumen index (AI) by following (Englmaierova et al., 2014).

$$AI = \{\frac{albumen\ height}{\frac{1}{2}\ x\ (long\ diameter\ of\ albumen + short\ of\ diameter\ albumen)}\ x\ 100\%$$

Data analysis

Prior to statistical analysis conducted analysis of variance (ANOVA) using general linear model (GLM) was carried out using SAS OnDemand for Academics (ODA, Cary, NC, USA). The results were presented as standard error mean (SEM). Moreover, probability values were calculated using least significant different testing. The following model was used:

$$Y_{ij} = \mu + \pi_i + \varepsilon_{ij}$$

Where; Y_{ij} was parameters observed, μ was the overall mean, π_i was the effect level of date palm flour, and ε_{ij} the amount of error number. T_0 = basal diet + 0% control, T_1 = basal diet + 2.5% date palm flour, T_2 = basal diet + 5% date palm flour, T_3 = basal diet + 7.5% date palm flour, T_4 = basal feed + 10% date palm flour.

RESULTS AND DISCUSSION

Effects of adding date palm on the growth performance of ISA brown laying hens

The results of measuring growth performance of ISA BROWN laying hens can be seen in Table 2. Based on the results of statistical analysis the use of date palm in the feed did not have a significant effect (p>0.05) on feed intake (1.10). The use of date palm did not affect feed intake because the content of feed treatment T_0, T_1, T_2, T_3, and T_4 had iso protein and iso energy of 17% and 2800 kcal/kg, respectively. This is in accordance with Scott et al. (1992) that the balance between protein and energy on feed affects feed consumption in livestock. The energy content contained in the feed can also affect feed intake. The energy content contained in the feed can also affect feed consumption. Feeds with low energy content given to chicken cause chickens to eat more, compared to feeds that have high energy content, the chickens will consume less feed. The average feed intake in this study from the highest to the lowest was T_2 (118.80 g/head/day), T_4 (118.80 g/head/day), T_3 (118.60 g/head/day), T_0 (118.60 g/head/day), and T_1 (118.40 g/head/day). In line, Hassan and Aqil (2015), mentioned the date palm consisted non-starch polysaccharides (NSP) which is increasing intestinal viscosity. In contrast, Agboola and Adejumo (2013) mentioned the increasing feed flow are related to metabolism and amino acid activity in the intestinal. The higher of not-starch polysaccharides (NSP) had negative impact on feed intake, HDP, and egg mass. Therefore, addition date palm did non effect on feed intake (Hassan and Aqil, 2015).

Table 2: Hen day production (%), egg mass, and income over fed cost (IOFC).

Parameters	T_0	T_1	T_2	T_3	T_4	SEM
FI (g/head/day)	118.60	118.40	118.40	118.60	118.80	1.10
HDP (%)	82.60	81.81	82.57	82.10	82.38	5.35
FER	2.44	2.42	2.43	2.38	2.39	0.20
Egg mass (g)	48.64	49.14	49.17	50.03	50.12	4.5
IOFC (IDR/ head/day)	371.50	386.23	388.69	410.69	415.27	6.3

FI: feed intake; FER: feed egg ratio; HDP: Hen Day production; IOFC: Income over feed cost. [a, b, c, d] Means with different superscripts in the row differ significantly ($p \leq 0.05$).. T_0 = basal diet + 0% control, T_1 = basal diet + 2.5% date palm flour, T_2 = basal diet + 5% date palm flour, T_3 = basal diet + 7.5% date palm flour, T_4 = basal feed + 10% date palm flour.

Hen day production (HDP) is a measure of the productivity of laying hens. The results of research related to HDP are presented in Table 2. The average HDP in this study from the highest to the lowest was T_0 (82.6%), T_2 (82.57%), T_4 (82.38%), T_3 (82.10%), and T_1 (81.81%). Meanwhile, the factor that affects egg production is the nutrients in the feed. HDP is also influenced by feed consumption, especially protein (Lengkong et al., 2015). The nutritional content of the feed is a major factor in influencing the level of egg production because the nutrients contained in the feed are needed to produce eggs. The used of the date palm unsuccessfully differences (p> 0.05) on HDP (5.35). Because hen day production can be influenced by several factors such as breed, physical conditions of laying, and variety of date palm (Salajegheh et al., 2017). The addition of date palm flour can reduce energy metabolism and amino acid availability due to an increase in the rate of feed flow through in digestive tract. In a previous study, the feed containing 0% date seed flour can reduce HDP than without treatment, it can be seen that date seed have high crude fiber content and the presence of non-starch polysaccharides (NSP) as anti-nutrients which can increase intestinal viscosity, thus giving negative impact on feed intake, HDP, and egg mass (Hassan and Aqil, 2015).

The results of research related to egg mass are presented in Table 2. Based on the results of the analysis of use date palm had no significant effect ($p>0.05$) on the egg mass (4.5) of laying hens. The egg mass is influenced by protein content in the feed. This is also related to egg mass which is influenced by albumen and yolk weight, therefore high protein intake causes high egg mass (Suherman et al., 2015). The average egg mass in this study from the highest to the lowest was T_4 (50.12 g/head), T_3 (50.03 g/head), T_2 (49.17 g/head), T_1 (49.14 g/head), and T_0 (48.64 g/head). The addition date palm flour can increase egg mass. Egg mass can be influenced by several factors such as breed, physical conditions of laying, and variety of date palm (Salajegheh et al., 2017).

The feed egg ratio is a measure of how well the livestock converts feed intake into egg production. Based on the results of the analysis in Table 2, the use of date palm had no significant effect ($p>0.05$) on the FER (0.20) of laying hens. Several things that can affect the FER include the environment, maintenance management, feeding management, egg production, and feed intake (Risnajati, 2014). This condition is related between FER, HDP, and feed intake. If high feed intake is not followed by hen day production, the feed conversion will be bad (Pradikta et al., 2018). The average FER in this study from the lowest to the highest was T_3 (2.38), T_4 (2.39), T_1 (2.42), T_2 (2.43), and T_0 (2.44). T_3 has the lowest FER value, this shows that in T_3 use of feed is more efficient. Meanwhile, T_0 (2.44) has the highest FER value. High feed conversion is caused by the lowest feed intake; it can be seen that T_0 has a low feed intake. Marwi et al. (2021) stated that improving FER would decrease feed intake and increase egg production.

The results of research related to IOFC are presented in Table 2, based on the results of the analysis of use date palm had no significant effect ($p > 0.05$) on IOFC (6.3) of laying hens. IOFC is influenced by feed intake, HDP, egg mass, feed cost, and egg cost (Suherman et al., 2015). The average IOFC in this study from the highest to the lowest was T_4 (415.27 IDR/head/day), T_3 (410.69 IDR/head/day), T_2 (388.69 IDR/head/day), T_1 (386.23 IDR/head/day), and T_0 (371.5 IDR/head/day). T_4 had higher results than other treatments in IOFC because T_4 has the highest egg mass (50.11 g) and feed intake (118.80 g/head/day). The increase is due to the optimization of freed absorption so that egg production is better with sufficient feed.

Effects of adding date palm on the egg quality of ISA brown laying hens

The results of research related to shell thickness are presented in Table 3, based on the results of the analysis of use date palm had no significant effect ($p > 0.05$) on the shell thickness (0.03) of laying hens. The results of this study are from research conducted by Al-Saffar et al. (2013) that the addition of date palm did not affect the shell thickness and the percentage of the shell. Because the chemical compounds contained in date seed have not been able to influence the formation of shell thickness optimally. The shell thickness is formed from the absorption of calcium and phosphorus contained in the feed. The average shell thickness in this study from the highest to the lowest was T_1 (0.578 mm), T_3 (0.575 mm), T_4 (0.568 mm), T_0 (0.567 mm), and T_2 (0.55 mm). T_1 had a higher result than T_0 in shell thickness variables because T_1 has the highest egg weight and shell weight than T_0. Moreover, high mineral content in date seed which is phosphorus, magnesium, potassium, sodium, iron, manganese, zinc, and cobalt, is known to increase the composition of shell thickness. It can be understood that shell thickness has a positive correlation with eggshell quality. Juliambarwati (2010) stated that the quality of the eggshell is determined by the thickness and structure of the shell, the content of Ca and P in the feed has a role in the quality of the eggshell because in the formation of the eggshell it is necessary to have sufficient carbonate ions and Ca ions to form an eggshell.

Table 3: Hen day production (%), egg mass, and income over fed cost (IOFC).

Parameters	T_0	T_1	T_2	T_3	T_4	SEM
ST (mm)	0.56	0.57	0.55	0.57	0.56	0.03
YI (%)	0.48	0.48	0.477	0.47	0.46	0.02
AI (%)	0.13	0.15	0.14	0.13	0.12	0.02

ST: shell thickness; YI: yolk index; AI: albumen index, [a, b, c, d] Means with different superscripts in the row differ significantly ($p \leq 0.05$). T_0= basal diet + 0% control, T_1= basal diet + 2.5% date palm flour, T_2 = basal diet + 5% date palm flour, T_3= basal diet + 7.5% date palm flour, T_4 = basal feed + 10% date palm flour.

The yolk index is the ratio between the height and diameter of the yolk after the yolk is separated from albumen. The results of research related to the yolk index are presented in Table 3. Based on the results of the analysis of use date palm had no significant effect ($p>0.05$) on the yolk index (0.02) of laying hens. Because yolk index is influenced by the nutritional content of the feed, especially protein and amino acid in the feed. The availability of protein and amino acids in the feed can affect the yolk index because protein and amino acids are components of the vitelline membrane that functions to hold the yolk so the yolk index depends on the protein intake by livestock (Sartika et al., 2018). The average yolk index in this study from the highest to the lowest was T_1 (0.483%), T_0 (0.480%), T_3 (0.478%), T_2 (0.477%), and T_4 (0.469%). T_4 has the lowest yolk index values, it can be understood that the yolk index is influenced by the height and diameter of the yolk, where the value of T_4 on the height and diameter of the yolk has the lowest average value of other treatments. Another factor that affects the lowest yolk index is also caused by storage time. Storage time causes an increase in the size of the yolk, due to the displacement of albumen and yolk fluid. Moreover, it also causes a weakening of the strength and elasticity of the vitelline membrane so that it can decrease the yolk index (Pribadi et al., 2015).

Albumen index is a ratio between height with the average long and short diameter of the albumen. The average albumen index in this study from the highest to the lowest was T_1 (0.15%), T_2 (0.14%), T_0 (0.13%), T_3 (0.13%), and T_4 (0.12%). T_1 has the highest albumen index values than other treatments. It can be understood that the albumen index has a positive correlation between height and diameter albumen, where T_1 has the highest average height and diameter albumen than other treatments. Date seed are known to contain protein, amino acids, and vitamins that can help the formation of albumen. Amino acids and protein as constituent components of albumen will affect the albumen quality. Harmayanda et al. (2016) stated that the main ingredient for determining albumen height and formation of ovomucin lies in protein consumption. The higher protein consumption, the greater formation of ovomucin, so the higher the albumen index. Based on the results of the analysis of use date palm had no significant effect (p>0.05) on the albumen index (0.02) of laying hens. Because, the factors that affect the albumen viscosity include genetics such as age, strain, the ability of the digestive tract of livestock, and nutritional needs of animal feed, especially protein for poultry (Wijaya et al., 2017).

CONCLUSIONS AND RECOMMENDATIONS

Using date palm (*Phoenix dactylifera* L.) until 10% level has positive effect on the growth performance and egg quality of ISA BROWN laying hens because can be alternative feed ingredients to reduce production costs and optimisalisasion income.

ACKNOWLEDGEMENTS

This work was supported and sponsored by the PT. Rumah Desa Sejahtera, Surabaya, East Java, Indonesia.

NOVELTY STATEMENT

This research is the first time using date palm as feed additive for laying hens in Indonesia. Date palm are rich in carbohydrates, a source of minerals, vitamins, and fiber, so they can increase the performance production and improve egg quality. The use of date palm can also reduce production costs and maximize income.

AUTHOR'S CONTRIBUTION

MHN and OS: designing and conducting the research and writing manuscript.
TES: did methodology, reviewed and edited the manuscript.
TNK: did the experiments, collected the samples, and wrote the original draft.

Conflict of interest

The authors have declared no conflict of interest.

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