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Laying performance and egg quality of four strains of layer duck fed diets with various levels of energy

(Prestasi pengeluaran telur dan mutu telur empat baka itik penelur yang diberi rangsum mengandungi pelbagai aras tenaga)

C. P. Seet* and M. D. Azizah*

Key words: laying duck, energy level, laying performance, egg quality

Abstrak

Empat baka itik penelur iaitu itik Siam yang diimport dari Thailand (ISD), itik tempatan (LD), itik Siam tempatan (LSD) dan Tsaiya yang diimport dari Taiwan (ITT) telah diberi rangsum yang mengandungi tenaga 10.0, 10.9 dan 11.7 MJ setiap kg makanan sejak mula bertelur. Prestasi pengeluaran telur dan mutu telur empat baka itik ini telah dibandingkan. Analisis terhadap kesan baka itik menunjukkan bahawa ISD dan ITT ialah baka itik penelur yang lebih baik dan mengambil makanan yang kurang daripada LSD dan LD. Walau bagaimanapun, telur kedua-dua baka ini adalah lebih kecil daripada telur LSD dan LD. Itik tempatan (LD) mengeluarkan telur yang paling berat antara baka-baka itik yang dikaji tetapi jisim telurnya lebih rendah daripada jisim telur itik ISD dan LSD. Kecekapan penukaran makanan juga kurang baik untuk baka ini kerana LD mengambil makanan yang lebih banyak ($p < 0.05$) daripada baka-baka itik lain. Mutu telur seperti ketumpatan bandingan didapati tertinggi ($p < 0.05$) bagi ITT jika dibandingkan dengan semua baka itik lain. Walau bagaimanapun, unit Haugh adalah lebih tinggi daripada yang terdapat pada telur itik LD. Indeks kuning telur ITT didapati lebih tinggi daripada indeks kuning telur ISD dan setanding dengan dua baka itik yang lain. Rangsum yang mengandungi aras tenaga yang berbeza tidak memberi kesan yang jelas pada prestasi pengeluaran telur, jika baka itik tidak diambil kira. Namun demikian, mutu telur seperti ketumpatan bandingan dan unit Haugh adalah lebih tinggi apabila itik diberi rangsum yang bertenaga rendah (10.0 MJ/kg). Kesan tindak balas antara baka dan tahap kandungan tenaga telah menunjukkan bahawa ITT, LSD dan ISD masing-masing bertindak secara positif terhadap rangsum yang bertenaga tinggi (11.7 MJ/kg) untuk ciri-ciri seperti kadar pengeluaran telur, berat telur dan unit Haugh. Kadar pengeluaran telur LD dan ketumpatan bandingan LSD dan ITT adalah lebih tinggi jika diberi rangsum yang bertenaga rendah (10.0 MJ/kg makanan). Baka ITT didapati mengeluarkan telur yang lebih berat apabila diberi makanan yang mengandungi 10.9 MJ tenaga dalam setiap kg makanan.

Abstract

Four strains of laying duck, namely imported Siamese duck (ISD), local duck (LD), local Siamese duck (LSD) and imported Taiwan Tsaiya (ITT) were fed diets containing 10.0, 10.9 and 11.7 MJ ME/kg of feed from point of lay. The laying performance and egg quality of these ducks were compared. Analysis of

*Livestock Research Division, MARDI, P. O. Box 12301, 50774 Kuala Lumpur, Malaysia
Authors' full names: Seet Chin Puan and Azizah Mohd. Din

the main strain effects indicated that the ISD and ITT were better layers and consumed less feed than the LSD and LD. Their eggs were, however, significantly smaller than that of LSD and LD strains. The LD laid the heaviest eggs, but the egg mass was significantly lower than those from ISD and LSD. Feed conversion efficiency was also poorer in this strain as it consumed significantly more feed than the others. The specific gravity of egg was highest in ITT (p <0.05). Its Haugh unit was, however, significantly higher than that of LD and the yolk index was higher (p <0.05) than that of ISD and comparable with the other two strains of duck. There were no significant effects of different energy levels on the laying performance of ducks regardless of the strains. Egg quality traits such as specific gravity and Haugh unit were slightly better when given diet containing low energy (10.0 MJ/kg) level. The interactions between strain and dietary energy indicated that the ITT, LSD and ISD responded positively to high energy diet (11.7 MJ/kg) for traits such as egg production, egg weight and Haugh unit respectively. The production rate of LD and the specific gravity of LSD and ITT were, however, higher with low energy (10.0 MJ/kg) diet. The ITT strain produced heavier eggs when fed diet with 10.9 MJ dietary energy.

Introduction

Malaysia's duck industry, by comparison with chicken, is not yet a significant activity in the country. The population of layer ducks in 1983 was 600 000 (Anon. 1984a) of which 90% or 540 000 were local Itik Jawa. A total of 40 million eggs were produced and 75% of them were from smallholders found around the rice-growing and coastal fishing areas, the disused mining land and the intercrop cultivation areas (Cha 1985).

The local Itik Jawa is widely reared for both egg and meat production. The female duck are kept as layers while the males are fattened for the table. Besides the local duck, other strains of layer duck are also being reared locally. The Siamese duck which is imported directly from Thailand, is a popular strain. This strain is a crossbred between Thailand native ducks and Khaki Campbell layers. These ducks are multiplied further locally by inter se mating to produce the local Siamese ducks which are also popular among the local duck farmers. The Tsaiya imported from Taiwan is another common strain of duck among the commercial duck farmers. Although these strains of duck are the main source of table duck eggs, very little information pertaining to their laying performance and egg quality is available. This study was, therefore, initiated to investigate the production characteristics of four strains of duck namely imported Siamese duck, local duck, local Siamese duck and imported Taiwan Tsaiya when fed broken rice-based rations varying in energy levels.

Materials and methods

A total of 360 day-old layer ducklings of each strain of imported Siamese duck (ISD), local duck (LD), local Siamese duck (LSD) and imported Taiwan Tsaiya (ITT) were purchased from a local duck supplier. Ducklings of each strain were brooded separately in a brooding pen provided with continuous heat for the first week. Heat was only provided at night during the second week after which the heat source was removed. Four weeks after brooding, ducklings of each strain were randomly divided into three energy treatment groups with three replicates of 40 ducklings each. A total of 1 440 ducklings from the four strains were tested. They were reared in a field with an exercise yard (3 m x 11 m), floor pen (3 m x 3 m) and fresh drinking

Table 1. Standard rations for the layer ducks from day-old to the point of 10% egg production

Ingredient (%)	Starter (0–2 weeks)	Grower (3–4 weeks)	Developer (5 weeks–10% production)
Broken rice	63.24	70.05	66.0
Rice bran	-	4.2	13.0
Soybean meal	24.6	13.7	12.0
Fish meal	8.0	9.8	6.1
Palm oil	2.0	-	-
Limestone	-	-	0.8
Salt	0.4	0.4	0.4
DL-methionine	0.21	0.1	0.15
Vitamin-min. mix	0.15	0.15	0.15
Choline chloride	0.2	0.2	0.2
DCP	1.2	1.4	1.2
CP (%)	20	17	15
CF (%)	2.49	2.27	3.00
EE (%)	4.15	2.58	2.60
ME (MJ/kg)	11.80	11.70	11.50
Lysine (%)	1.22	1.03	0.85
M + C (%)	0.80	0.60	0.58
Ca (%)	1.02	1.19	1.15
P (total) (%)	0.88	1.01	0.94

water. During the adaptation period, all ducklings were given the same type of feed (*Table 1*) from day-old to 10% of egg production. Three experiment layer diets varying in energy level, i.e. 10.0, 10.9 and 11.7 MJ ME/kg of feed (*Table 2*) were fed to each group of ducks from the respective strain after the adaptation period.

The number of eggs laid by each strain of ducks from different replicates was recorded and weighed daily while feed intake was measured weekly. Six eggs from each dietary energy group of each strain were randomly sampled weekly for the determination of egg quality traits such as specific gravity, Haugh unit and yolk index. The data were collected over 48 laying weeks, starting from 4 weeks after the point of lay for the respective strains. Statistical analysis was carried out using the SAS Proc GLM procedure (Anon. 1982). The least-significant difference analysis was employed to test between strain means for each trait.

Results and discussion

Egg production

The effects of duck strain and dietary energy level on 48-week laying performance are presented in *Table 3*. The production rate of each strain, irrespective of energy levels, differed even under the same management and feeding systems. The ISD and ITT strains had significantly (p <0.05) higher production rates (58% each) than those from LD (45%) and LSD (54%) strains. The former two strains were reported to produce an average of 265 eggs (ranging from 250 to 280 eggs) annually in Thailand (Ukrit 1983) and Taiwan (Shen 1985). The mean production of 196 eggs achieved in this trial over the 48-week period was 69 eggs less than the number reported by the two countries. Among the two local strains, the F_1 Khaki Campbell x Thai layers (LSD) laid significantly more eggs than the local Jawa ducks (LD). The local Jawa, a dual-purpose duck, is multiplied by natural selection. Hence, it is not bred specifically for any

Table 2. Experimental layer rations for layer ducks from the point of 10% egg production

Ingredient (%)	These energy levels (MJ ME/kg)		
	10.0	10.9	11.7
Broken rice	47.2	55.7	57.9
Rice bran	15.0	7.3	1.7
Soybean meal	18.9	15.9	15.7
Fish meal	4.0	7.1	8.0
Prawn meal	5.0	5.0	5.0
Palm oil	-	1.2	4.0
Limestone	7.5	7.1	7.0
Salt	0.25	0.25	0.25
DL-methionine	0.3	0.06	0.06
Vitamin-min. mix	0.1	0.1	0.1
Choline	0.2	0.2	0.2
Kaolin	1.4	-	-
DCP	0.16	-	-
CP (%)	17	17	17
CF (%)	4.30	3.40	2.80
EE (%)	2.30	3.50	6.10
ME (MJ/kg)	10.00	10.90	11.70
Lysine (%)	0.96	1.00	1.00
M + C (%)	0.77	0.55	0.55
Ca (%)	3.50	3.50	3.50
P (total) (%)	0.80	0.75	0.70

Table 3. Main effects of duck strain and energy level on laying performance (48 laying weeks from point of lay)

	Egg prodn. (%)	Egg wt. (g)	Total feed intake (kg)	Total egg mass (kg)	Feed/egg mass
Strain effect					
ISD	57.99a	63.7c	40.9bc	12.6a	3.25b
LD	44.99c	73.2a	46.1a	11.2b	4.13a
LSD	54.15b	66.9b	41.6b	12.4a	3.35b
ITT	58.38a	59.7d	40.0c	11.8ab	3.39b
Energy effect					
10.0 MJ ME/kg	53.47	65.9	42.8	12.0	3.57
10.9 MJ ME/kg	54.01	65.7	42.1	12.0	3.51
11.7 MJ ME/kg	54.13	66.1	41.5	12.0	3.46

ISD = imported Siamese duck
LD = local duck
LSD = local Siamese duck
ITT = imported Taiwan Tsaiya
Values in the same column for each effect with different letters are significantly different (p <0.05)

laying trait. The egg production rate of LD was lower than all the strains of duck studied. Its laying rate was, however, similar to those reported earlier (Anon. 1984b).

There were no significant effects of energy levels on egg production, irrespective of strains (*Table 3*). However, the interactions between strain and energy level were found significant in LD and ITT strains (*Table 4*). Laying rate of ITT increased significantly when energy level increased from 10.0 MJ/kg to 11.7 MJ/kg. This was contradictory to the findings of Pan et al. (1981) who reported that egg production was not significantly affected by high energy level. The LD responded better (p <0.05) in low energy diets in all the production parameters. Although the ISD and LSD laid more eggs when fed diets containing 11.7 and 10.9 MJ ME/kg respectively, there were no significant differences when comparing the laying rates between other energy groups within the same strain of duck.

Egg mass and egg weight

Egg mass is the cumulative weight of eggs laid during the entire experimental period. It is the product of egg weight and the total number of eggs laid within that period. Among the four strains of duck tested, the total egg mass of LD (11.2 kg) was significantly lower (*Table 3*) than those of ISD (12.6 kg) and LSD (12.4 kg). The low egg mass recorded for the LD strain was attributed to the smaller number of eggs laid during the 48-week laying period. The egg weight of the ITT strain (59.7 g) was significantly lighter than those of the other three strains. However, the egg mass did not significantly differ from them. The smaller egg of ITT could be due to the effects of selection pressure in Taiwan for egg number instead of egg size since eggs are sold in

Table 4. Interactive effects of duck strain and energy level on the laying performance (48 laying weeks from point of lay)

Energy level (MJ ME/kg)	Egg prodn. (%)	Egg wt. (g)	Total feed intake (%)	Total egg mass (kg)	Feed/egg mass
ISD					
10.0	57.92	63.5	41.2	12.4	3.32
10.9	55.41	63.7	40.7	11.8	3.45
11.7	60.64	63.9	40.9	13.0	3.15
LD					
10.0	47.45a	73.6	47.5	11.7	4.06
10.9	45.60ab	72.5	47.2	11.1	4.25
11.7	41.91b	73.4	43.7	10.3	4.24
LSD					
10.0	52.57	66.7a	42.0	11.8	3.56
10.9	57.23	66.1a	41.0	12.7	3.23
11.7	52.57	68.0b	42.0	12.0	3.50
ITT					
10.0	55.92a	59.7ab	40.8	11.2	3.64
10.9	57.81ab	60.4a	39.7	11.7	3.39
11.7	61.41b	59.0b	39.5	12.2	3.24

ISD = imported Siamese duck
LD = local duck
LSD = local Siamese duck
ITT = imported Taiwan Tsaiya
Values in the same column for each duck strain with different letters are significantly different (p <0.05)

bulk rather than by individual egg as in Malaysia. Thus, selection emphasis was on increasing egg number without reducing egg weight (Tai 1985). However, the average egg weight quoted by Tai (1985) was 64.9 g while in this study, the mean weight recorded was 59.7 g. The relatively high temperature probably caused this reduction. Even when birds at different temperatures have the same nutrient intake, egg weight is depressed at temperatures above 25 °C. The depression in egg size is also partly due to the inadequate energy intake (Emmans 1974). Egg weight of chicken has been reported to be lighter at high environmental temperatures (Huston 1958; Cunningham et al. 1960; Liu 1985), while in ducks, small and yolkless eggs have also been produced during very hot summer weather (Luttmann and Luttmann 1978).

There were no significant differences in average egg weight and egg mass among the three energy levels, irrespective of strains (*Table 3*). The various levels of energy, however, showed significant effects on egg weight of the LSD and ITT strains. The egg weight of LSD was heavier when given diet containing 11.7 MJ ME/kg compared with those from the other two dietary energy levels (*Table 4*). Bigger eggs were produced by ITT when fed diet with 10.9 MJ ME/kg. The egg weights of ISD and LD were comparable between the three energy diets. There was no significant interaction between strain and energy on egg mass of all the strains of duck, the weights were only numerically heavier for ISD and ITT in the high energy diet (11.7 MJ/kg). For the two local strains, namely LD and LSD, heavier egg masses were obtained with diets of 10.0 and 10.9 MJ ME/kg respectively. The differences of egg mass between other diets were, however, not statistically significant.

Feed conversion efficiency

Feed conversion efficiency for layers is the ratio between feed intake and egg mass (feed/egg mass), thus the lower the ratio, the better the conversion efficiency. The mean ratio of LD (4.13) in this study was significantly poorer than the other three strains of duck (*Table 3*). This was because significantly more feed was taken. The high intake did not result in body weight gain at the end of the 48-week trial period. An average lost of 104.5 g in body weight was recorded between the initial (2 561.0 g) and final body weights (2 665.5 g). The feed utilization of LD was not as efficient as that of the other three strains. For the ISD, LSD and ITT, the respective initial body weight was 1 474.4, 1 526.4 and 1 319.6 g where the final body weight was 1 481.4, 1 698.8 and 1 331.7 g respectively. For these three strains of duck, body weight gain ranged from 7.0 g to 172.4 g although feed intakes were lower ($p < 0.05$) than LD. The feed conversion efficiencies calculated from feed/egg mass were also significantly better for the ISD (3.25), LSD (3.35) and ITT (3.39) than that of LD. High energy level (11.7 MJ/kg) seemed to improve feed efficiency. However, the differences were not statistically significant (*Table 3*). There was no significant interaction between strain and energy in feed conversion efficiency and feed intake for all the strains of duck, although there were some indications that the conversion efficiency was better for the ISD and ITT ducks provided diet with 11.7 MJ ME/kg of feed (*Table 4*). In Muscovy breeder duck , feed efficiency was observed to be significantly better when the diet contained 11.8 MJ ME/kg (Sauveur et al. 1984) compared with the efficiency obtained with other low energy diets. Yeong (1985) also concluded that the conversion ratio improved with an increase in dietary energy concentration in the dual-purpose local Jawa duck. These results indicated that high energy level could lead to better performance in feed conversion efficiency for the domestic ducks.

Specific gravity of egg

The average specific gravity (SG) for the eggs of the four strains of duck ranged from 1.084 to 1.087 (*Table 5*) which were close to the values (1.085–1.086) quoted by Yeong and Faizah (1985) but higher than the values for chicken eggs (1.077–1.078) reported by Khalid and Yeong (1984). Eggs laid by ITT had significantly higher SG (1.087) implying that the egg shell was thicker than that of other strains of duck. Energy levels also showed significant effects on SG (*Table 4*). When fed low (10.0 MJ/kg) and intermediate (10.9 MJ/kg) energy diets, the ducks, irrespective of strains, laid eggs with thicker shell (p <0.05) than those from high energy diets (1.085, 1.086 vs. 1.084).

The response of individual strain to various diets (*Table 6*) indicated that the LSD and ITT strains on low energy diet laid eggs with significantly thicker shell compared with those fed diet with high energy levels. The SG of the other two strains, however, were not significantly affected by the energy level of the diet.

Haugh unit

The Haugh unit (Haugh 1937) obtained for the eggs of ISD, LSD and ITT was 88.8, 89.7 and 89.8 respectively. The differences between these values were, however, not

Table 5. Main effects of duck strain and energy level on egg quality

	Specific gravity	Haugh unit	Yolk index
Strain effect			
Imported Siamese duck	1.085a	88.8ab	0.42a
Local duck	1.084a	88.4b	0.43b
Local Siamese duck	1.085a	89.7ab	0.43b
Imported Taiwan Tsaiya	1.087b	89.8a	0.43b
Energy effect			
10.0 MJ ME/kg	1.086a	89.4a	0.43
10.9 MJ ME/kg	1.085a	88.0b	0.43
11.7 MJ ME/kg	1.084a	89.3a	0.43

Values in the same column for each effect with different letters are significantly different (p <0.05)

Table 6. Interactive effects of duck strain and energy level on egg quality

Energy level (MJ ME/kg)	Specific gravity	Haugh unit	Yolk index
Imported Siamese duck			
10.0	1.085	88.9ab	0.41
10.9	1.084	87.3b	0.42
11.7	1.084	90.1a	0.42
Local duck			
10.0	1.084	89.0	0.44
10.9	1.085	88.0	0.43
11.7	1.083	88.1	0.43
Local Siamese duck			
10.0	1.086a	89.5	0.43
10.9	1.085ab	87.7	0.43
11.7	1.084b	88.9	0.42
Imported Taiwan Tsaiya			
10.0	1.088a	90.1	0.44
10.9	1.087ab	89.1	0.42
11.7	1.085b	90.3	0.43

Values in the same column for each duck strain with different letters are significantly different (p <0.05) statistically significant (*Table 5*). The Haugh unit of the eggs from LD (88.4) was only significantly lower than that of the eggs from ITT strain. There were significant effects of energy levels on the albumen quality regardless of the strains. In ISD, the Haugh unit was found to be lower ($p < 0.05$) when given diet with 10.9 MJ ME/kg as compared with the units for the eggs from other strains (*Table 6*). This reduction effect was consistent for other strains of duck although the differences were not statistically significant.

Egg yolk index

The egg yolk index of ISD was significantly lower than those from the other three strains (*Table 5*). Generally, different energy levels in the diet did not show any significant effects on this index. The interactive effect of strain and energy level was also not statistically significant (*Table 6*).

Conclusion

The ducks from Thai origin (ISD and LSD) and the Taiwan Tsaiya (ITT) were superior layers to the local duck (LD). The LSD, however, laid slightly less eggs than the two imported strains. The LD had the heaviest eggs but it was a poor feed converter. Egg quality was comparable among all strains. Overall, energy levels had no significant effect on the laying performance, irrespective of strains. The egg quality traits such as specific gravity and Haugh unit were however, better with low energy diet (10.0 MJ/kg).

The interactions between strain and dietary energy on the laying parameters and egg quality traits were inconsistent. The ITT, LSD and ISD strains responded positively to the high energy diet (11.7 MJ/kg) with regard to egg production, egg weight and Haugh unit respectively. The specific gravities of eggs from LSD and ITT were, however, higher with low energy ration (10.0 MJ/kg). The egg production was also higher in LD strain with low energy diet. Feed containing 10.9 MJ ME/kg only produced heavier eggs in the ITT strain.

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References

Anon. (1982). *SAS User's guide : Statistic* 1982 ed. Cary, North Carolina: SAS Institute Inc.

____ (1984a). Strategi dan program sektor ternakan berpandukan Dasar Pertanian Negara, Jabatan Perkhidmatan Haiwan, Malaysia (mimeo.)

_____ (1984b). Progress Report 1984, Livestock Research Division, MARDI, Serdang, Selangor, Malaysia (in Bahasa Malaysia, mimeo.)

Cha, T. Y. (1985). Duck production in Peninsular Malaysia. *Proc. duck production science and world practice* (Farrell, D. J. and Stapleton, P., ed.) p. 399–417. 18–22 Nov. 1985, Bogor, Indonesia Australia: University of New England

Cunningham, F. E., Cotterill, O. J. and Funk, E. M. (1960). The effect of season and age of bird (1) on egg size, quality and yield. *Poult. Sci. 39:* 289–99

Emmans, G. C. (1974). The effect of temperature on the performance of laying hens. In *Energy requirement of poultry* (Morris, T. K. and Freeman, R. M., ed.) p. 79–90. Edinburgh: British Poultry Science Ltd.

Haugh, R. R. (1937). Haugh unit for measuring egg quality. *U.S. Egg and Poult. Mag. 43*: 552–5

Huston, T. M. (1958). The influence of high environmental temperature on egg size, shell quality and albumen height of domestic fowl. *Poult. Sci. 37*: 1213–4

Khalid, M. S. A. and Yeong, S. W. (1984). Effects of calcium source and level on performance of layers and egg shell quality. *Proc. 8th ann. conf. MSAP* 13–14 Mar. 1984, Genting Highlands, Malaysia, p. 45–9. Serdang: Malaysian Soc. of Animal Production

Liu, L. L. (1985). Effectiveness of water fogging for hen cooling. *Proc. 3rd AAAP animal science congress* 6–10 May 1985, Seoul, Korea, p. 1198–200

Luttmann, R. and Luttmann, G. (1978). *Ducks and geese in your backyard* Emmaus, Pa.: Rodale Press

Pan, C. M., Lin, E. I. and Chen, P. C. (1981). Protein and energy requirements of Tsaiya (*Anas platyrhynchos* var. *domestica*). *Taiwan Livestock Res. l4:* 39–44

Sauveur, B., de Carville, H. and Ferre, R. (1984). Influence lu taux energetique du regime et de la temperature sur les performances des canes de Barbarie reproductrices. *Arch. Geflugelk, 48*: 52–6. Cited by Sauveur, B. and de Carville, H. In *Proc. duck production science and world practice* p. 293–305

Shen, T. F. (1985). Nutrient requirements of egg laying ducks, p. 364–71. *See* Cha (1985)

Tai, C. (1985). Duck breeding and artificial insemination in Taiwan, p. 193–203. *See* Cha (1985)

Ukrit, Im-Erb (1983). Ducks in Thailand, past, present and future. *Poult. International 22(4):* 52–8

Yeong, S. W. (1985). Utilization of local feedstuffs in diets of meat and laying ducks in Malaysia, p. 323–32. *See* Cha (1985)

Yeong, S. W. and Faizah, M. (1985). The effects of prawn meal and broken rice in the laying performance of ducks. *Proc. 9th ann. conf. MSAP* 11–12 Mar. 1985, Serdang, Malaysia., p. 106–9. Serdang: Malaysian Soc. of Animal Production

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