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FEEDING SYSTEM AND FLOOR SPACE ON THE GROWTH, EGG PRODUCTION, AND REPRODUCTIVE PERFORMANCES OF ITIK PINAS KAYUMANGGI (*Anas platyrynchos* L.) UNDER SEMI-CONFINEMENT SYSTEM

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ABSTRACT

The study determined effects of feeding system (*ad libitum* or restricted) and floor space during the growing (12-19 weeks of age; 1.5, 2.0 or 2.5 ft^2) and laying periods (20-38 weeks of age; 3.0, 3.5 or 4.0 ft^2) on Itik Pinas Kayumanggi (IPK) ducks under a semi-confinement system. A total of 480 IPK ducks were assigned to the treatment combination of type of feeding system and floor space laid out in a Completely Randomized Design. Each treatment combination had 5 and 10 replications for the growing and laying periods, respectively. The feed consumption of the growing ducks fed *ad libitum* was higher (*P*<0.01) than those restricted fed. Increased floor space allotment tended (*P*<0.09) to increase their feed intake. A higher (*P*<0.01) egg production, feed intake, egg weight and egg mass were observed in *ad libitum* than in restricted feeding, irrespective of floor space; feed conversion ratio was increased concomitant to higher feed intake of the ducks. The quality, fertility and hatchability of eggs were not affected by any of the factors nor their interactions. The findings indicated that the feeding system and floor space were sensitive factors for the production performance of IPK ducks under the semi-confinement system, especially during the laying period.

Key words: *ad libitum* feeding, floor space, IP-Kayumanggi, restricted feeding

INTRODUCTION

Itik Pinas Kayumanggi (IPK) is one of the superior breeder ducks, developed through selection and breeding, using parents from the Philippine mallard duck or Pateros duck. It is a true to type breed with production performance potential that exceeds the current level of performance of Pateros duck mongrels. It has been reported that the Itik Pinas (IP) lines (Kayumanggi, Itim, and Khaki) have an egg production rate of 70% compared with 50% of the Pateros duck (Parungao, 2017).

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The optimal performance of IP can be achieved by providing them ideal factors such as nutrition and feeding management, housing, and health management, among others. For the IPK ducks to be acceptable and its raising profitable and sustainable, technology components should be made available. Proper feeding systems and space allotment are among factors essential for such ends, which merit research investigations. In particular, responses of IP ducks to restricted or *ad libitum* feeding in terms of growth and egg production performance deserve considerations for this purpose. Hence, this study was conducted.

MATERIALS AND METHODS

A total of 480 IPK ducks were used in the study for both growing (12-20 weeks of age) and laying periods (20-38 weeks of age). The experiment was a Completely Randomized Design with feeding system (restricted vs. *ad libitum*) and floor space (1.5 ft^2, 2.0 ft^2 or 2.5 ft^2 for growing; and 3.0 ft^2, 3.5 ft^2 or 4.0 ft^2 for laying) as factors. There were 5 and 10 replications for each treatment combination for the growing and laying periods, respectively. The basal diet was formulated following the recommendations of Adiova (2017). Both grower (Table 1) and layer (Table 2) diets were corn-rice bran-soybean meal formula.

The IPK ducks were housed in open-sided housing provided with rice hull as litter materials. The diets were offered in mash form via tube-type feeders. The ration of the IPK ducks under the controlled feeding system was approximately 80% of the amount of *ad libitum* feeding. At the laying stage, the IPK ducks were allowed to graze in the range area (2.44 x 4.88 m) for 7 hr from 9 a.m. to 4 p.m. Freshwater was provided via trough-type waterers.

The bodyweight of IPK ducks was determined at the start of the experiment and weekly thereafter using sample ducks. Feed intake was determined daily. The feed conversion ratio (FCR) was determined at the end of each part of the experiment. At the growing stage, FCR was computed as the cumulative feed intake of the IPK ducks divided by the total gain in weight; while in laying stage, FCR was determined as cumulative feed intake of the ducks over total egg weight. Egg mass was derived by multiplying egg weight by the percent daily egg production. Flock uniformity was determined as the percentage of the individual weights within ±10% of the mean weight of the ducks. The relative livability was calculated as the IPK ducks remaining at the end of the growing and laying periods divided by the initial number of IPK ducks for each feeding period.

The egg production rate was calculated by dividing the total egg production in a week by the total duck-days for the week multiplied by 100. The egg quality was determined weekly using two egg samples per replication taken randomly. Albumen height and eggshell thickness were measured using a digital caliper. The yolk color was subjectively scored using a DSM yolk color fan (DSM Nutritional Products, 2003). Eggshell weight was determined after a day of drying under the sun. The weight of egg yolk and albumen were measured using a digital weighing scale. The fertility and hatchability of eggs were determined using 10 eggs per replication taken randomly within five days after eggs were laid. Eggs were hatched for 28 days. The fertility rate was computed as the number of fertile eggs at day 10 divided by the number of eggs set in the incubator multiplied by 100. Percent hatchability was determined by dividing the number of ducklings hatched with the number of fertile eggs multiplied by 100.

Table 1. Ingredients and nutrient composition (as fed basis) of diet for IP-Kayumanggi ducks during growing stage.

Ingredients	**Amount (%)**
Corn, yellow	50.582
Soybean meal, US	14.567
Ricebran, full fat	30.000
Coconut oil	0.358
Lysine HCl	0.154
DL-methionine	0.169
L-threonine	0.024
Monodicalcium phosphate 21%	1.380
Limestone, fine	1.780
Salt, iodized	0.374
Choline chloride 60%	0.100
Vitamin premix	0.050
Trace mineral premix	0.100
Antioxidant	0.012
Antimold	0.050
Toxin binder	0.300
Total	100.000
Calculated analysis	
DM, %	89.51
AME, kcal/kg	2800
Crude protein, %	14.51
ADF, %	5.03
NDF, %	13.70
Crude fiber, %	3.27
Crude fat, %	2.46
Linoleic acid, %	1.02
Lysine, %	0.73
Meth+cystine, %	0.60
Threonine, %	0.50
Tryptophan, %	0.16
Calcium, %	1.00
Phosphorus, Av., %	0.42

Table 2. Ingredients and nutrient composition (as fed basis) of diet for IP-Kayumanggi ducks during laying stage.

Ingredients	Amount (%)
Corn, yellow	54.426
Soybean meal, US	20.538
Ricebran, full fat	10.000
Lysine HCl	0.072
DL-methionine	0.247
L-threonine	0.049
Monodicalcium phosphate 21%	1.181
Limestone, fine	8.433
Salt, iodized	0.441
Choline chloride 60%	0.100
Vitamin premix	0.050
Trace mineral premix	0.100
Antioxidant	0.012
Antimold	0.050
Toxin binder	0.300
Total	100.000
Calculated analysis	
DM, %	89.53
AME, kcal/kg	2,676
Crude protein, %	15.37
ADF, %	3.85
NDF, %	11.13
Crude fiber, %	2.64
Crude fat, %	2.48
Linoleic acid, %	1.20
Lysine, %	0.74
Meth+cystine, %	0.68
Threonine, %	0.56
Tryptophan, %	0.17
Calcium, %	3.50
Phosphorus, Av., %	0.35

All data were analyzed by ANOVA using GLM procedure of the SAS software (SAS Inst. Inc., Cary, NC) following the statistical model below:

$$Y_{ijk} = \mu + F_i + S_j + (FxS)_{ij} + e_{ijk}$$

Where Y = variable; μ=overall mean; F = feeding system; S = floor space; FxS is the interaction between F and S; and e = residual error. Least square means were calculated for each independent variable. When treatment was a source of variation, means were separated using the PDIFF option of the same software**.**

RESULTS AND DISCUSSION

The growth performance of the IPK ducks as influenced by feeding systems and stocking density is presented in Table 3. The feed intake of the IPK ducks was significantly affected by the feeding system, which was higher ($P<0.05$) for *ad libitum* than the controlled feeding system. A tendency ($P<0.09$) for higher feed intake as the floor space allotted increased was also noted. However, there was no interaction between floor space and feeding systems for weight gain, feed intake, FCR, and livability of the IPK ducks during the growing stage.

Table 3. Mean (+SD) growth performance of growing IP-Kayumanggi ducks raised under different feeding systems and floor space.

Parameters		Gain in Weight (g)	Feed Intake (g)	FCR (g/g)	Livability (%)
Main Effects					
Feeding System					
Restricted		334 ± 92	5765 ± 215**	18.46 ± 4.9	99.44 ± 2.1
Ad libitum		355 ± 76	6310 ± 297	18.54 ± 4.0	98.03 ± 4.4
Floor Space					
1.5		369 ± 85.9	5890 ± 330	16.82 ± 4.3	99.17 ± 2.5
2.0		351 ± 86.4	6086 ± 327	18.20 ± 3.9	99.17 ± 2.5
2.5		314 ± 76.6	6135 ± 451	20.49 ± 4.6	97.88 ± 4.9
Feeding System	Floor Space (ft^2/b)				
Restricted	1.5	351 ± 97	5642 ± 193	17.30 ± 17	98.33 ± 3.6
	2.0	354 ± 115	5852 ± 135	17.81 ± 18	100.00 ± 0.0
	2.5	298 ± 66	5801 ± 276	20.28 ± 20	100.00 ± 0.0
Ad libitum	1.5	388 ± 79	6139 ± 231	16.33 ± 16	100.00 ± 0.0
	2.0	347 ± 59	6321 ± 292	18.60 ± 18	98.33 ± 3.6
	2.5	329 ± 91	6470 ± 320	20.70 ± 20	98.75 ± 3.6
Sources of Variation (*P*-value)					
Feeding system		0.52	0.0001	0.96	0.27
Floor space		0.37	0.09	0.20	0.62
Feeding system x Floor space		0.83	0.63	0.90	0.18

**highly significant

The results indicated that restricted and *ad libitum* feeding, irrespective of floor space allotment, effected comparable weight gain and FCR of the IPK ducks. *Ad libitum* feeding was translated in commensurate weight gain, resulting in FCR that was comparable with restricted feeding. The extra nutrients, therefore, were well utilized by the IPK ducks. In studies by Pingel (1999), Mallard ducks (22 and 84 days of age) on *ad libitum* feeding had higher weight gain and FCR than those on restricted feeding (60% of *ad libitum*). The conditions in his study, though, were entirely different as older ducks and lower levels of feed restriction were imposed in the present study.

The present data also demonstrated that the IPK ducks allotted floor space of only 1.5 ft^2/duck performed satisfactorily, irrespective of feeding system, and that adverse effects on the gain in weight and FCR were evident with higher floor space allotment. These observations were associated with higher energy expenditures of the IPK ducks when provided with wider space to move around. In meat-type white Pekin ducks (at 14-42 days of age), growth performance was found negated by decreasing floor space from about 2.0 ft^2/duck to 1.2 ft^2/duck (Xie *et al*., 2014), which were a different case since these were meat-type ducks which grow faster and bigger than the IPK ducks.

Table 4 presents the egg production performance of IPK ducks as influenced by feeding systems and floor space. The egg production parameters of the IPK ducks were significantly affected by the feeding systems, but not floor space, nor was there an interaction of these factors. The egg production, egg weight, and egg mass were higher (P<0.01) in IPK ducks fed *ad libitum* than those subjected to restricted feeding, irrespective of floor space allotment; these were associated with an increase in feed intake which concomitantly increased FCR.

The superior egg production parameters from the IPK ducks that were *ad libitum* fed were possibly associated with their increased nutrient and energy intakes than those restricted fed. As they had access to their ration at all times, the IPK ducks consumed an optimal amount to support their requirements for maintenance and production. The energy density and concentration of the diet (Table 2) cannot be discounted in this respect. The energy density plays an influence on the voluntary feed intake of the ducks (Leeson and Summers, 2008). The increase in FCR with *ad libitum* feeding was possibly related to the shorter transit time of the digesta due to the large fill of the digestive tract (Svihus, 2014) and or decreased nutrients digestibility, absorption and utilization. Although benefits on egg production of ducks (Olver, 1984 and 1995) and chickens (Lewis *et al*., 2008) have been reported, the conditions and duck species in the present study varied with those in their studies. Besides, knowledge on the nutrition of ducks, in general, is still lacking to date as per recent review on this topic (Fouad *et al*., 2018). Thus, *ad libitum* feeding at 3.0 ft^2/duck floor space is satisfactory for optimal egg production for IPK ducks.

Although feed intake and FCR were lower (P<0.05) for IPK ducks under restricted feeding, their livability for both feeding systems regardless of the floor space was found comparable (P>0.05). There was no interaction between feeding systems and floor space in any of the egg production parameters of the IPK ducks during the period. Irrespective of the floor space, higher egg production performance was observed in IPK ducks fed *ad libitum*. Therefore, *ad libitum* feeding during the laying period is essential to achieve optimum egg production performance of the IPK ducks under the semi-confinement system.

The effects of feeding system and floor space on egg quality of IPK ducks are presented in Table 5. Both feeding systems and floor space nor their interactions did not affect

Table 4. Mean (± SD) egg production performance of IP-Kayumanggi ducks raised under different feeding systems and floor space.

Parameters		Egg Prod'n (%)	Feed Intake (g)	FCR (g/g)	Egg weight (g)	Egg mass (g)	Livability (%)
Main Effects							
Feeding System							
Restricted		70.19 ± 5.71**	133 ± 0.78**	3.44 ± 0.66**	61.42 ± 1.09**	43.28 ± 3.53**	98.00 ± 4.55
Ad libitum		77.08 ± 5.95	175 ± 6.02	4.32 ± 1.13	64.83 ± 1.59	50.77 ± 3.75	98.40 ± 4.15
Floor Space							
3.0		75.00 ± 6.43	154 ± 22.06	3.80 ± 0.99	63.22 ± 2.07	47.86 ± 4.68	99.40 ± 2.68
3.5		73.45 ± 7.80	154 ± 21.88	3.67 ± 0.58	63.30 ± 2.33	47.02 ± 6.04	97.60 ± 4.92
4.0		72.47 ± 5.97	153 ± 20.84	4.17 ± 1.32	62.87 ± 2.24	46.18 ± 4.99	97.60 ± 4.92
Feeding System	Floor Space (ft^2/b)						
Restricted	3.00	73.17 ± 4.81	133 ± 0.92	3.27 ± 0.85	61.70 ± 1.29	45.29 ± 2.82	98.80 ± 3.79
	3.50	68.88 ± 6.79	133 ± 0.92	3.37 ± 0.58	61.33 ± 0.44	42.36 ± 4.14	97.60 ± 5.06
	4.00	68.53 ± 4.56	133 ± 0.52	3.68 ± 0.48	62.23 ± 1.35	42.18 ± 2.93	97.60 ± 5.06
Ad libitum	3.00	76.82 ± 7.53	175 ± 5.72	4.34 ± 0.86	64.73 ± 1.51	50.44 ± 4.86	100.00 ± 0.00
	3.50	78.01 ± 5.99	175 ± 5.90	3.96 ± 0.41	65.27 ± 1.64	51.68 ± 3.44	97.60 ± 5.06
	4.00	76.42 ± 4.46	173 ± 6.75	4.66 ± 1.71	64.50 ± 1.69	50.17 ± 2.94	97.60 ± 5.06
Sources of Variation (*P*-value)							
Feeding system		0.0001	0.0001	0.0006	0.0001	0.0001	0.72
Floor space		0.39	0.67	0.21	0.59	0.34	0.34
Feeding system x Floor space		0.30	0.58	0.69	0.56	0.18	0.88

**highly significant
SD - standard deviation

Table 5. Mean (±SD) egg quality of IP-Kayumanggi ducks raised under different feeding systems and floor space.

Parameters		Albumen		Yolk		Egg Shell	
		Height (mm)	Weight (g)	Weight (g)	Color	Weight (g)	Thickness (mm)
Main Effects							
Feeding System							
Restricted		7.69 ± 7.69	41.94 ± 2.28	22.40 ± 1.26	8.03 ± 0.89	7.25 ± 0.30	0.42 ± 0.02
Ad libitum		7.78 ± 7.78	42.02 ± 1.32	22.18 ± 1.06	8.00 ± 0.59	7.35 ± 0.38	0.42 ± 0.03
Floor Space							
3.0		7.71 ± 0.88	42.12 ± 1.61	22.22 ± 1.22	8.01 ± 0.55	7.30 ± 0.31	0.42 ± 0.02
3.5		7.78 ± 0.79	41.58 ± 1.32	22.42 ± 1.33	7.95 ± 0.60	7.23 ± 0.33	0.42 ± 0.02
4.0		7.71 ± 0.91	42.23 ± 2.40	22.22 ± 0.95	8.00 ± 1.03	7.37 ± 0.40	0.43 ± 0.02
Feeding System	Floor Space (ft^2/b)						
Restricted	3.00	7.52 ± 0.88	42.19 ± 1.93	22.54 ± 1.29	8.1 ± 0.57	7.33 ± 0.32	0.41 ± 0.02
	3.50	7.57 ± 0.85	41.78 ± 1.69	22.66 ± 1.39	7.9 ± 0.57	7.18 ± 0.26	0.42 ± 0.02
	4.00	7.97 ± 0.75	41.85 ± 3.18	22.00 ± 1.12	8.1 ± 1.37	7.26 ± 0.35	0.42 ± 0.02
Ad libitum	3.00	7.90 ± 0.88	42.05 ± 1.52	21.91 ± 1.11	8.1 ± 0.57	7.28 ± 0.32	0.42 ± 0.02
	3.50	7.99 ± 0.71	41.39 ± 0.87	22.18 ± 1.30	8.0 ± 0.67	7.29 ± 0.40	0.42 ± 0.03
	4.00	7.44 ± 1.01	42.62 ± 1.31	22.44 ± 0.74	7.9 ± 0.67	7.48 ± 0.43	0.43 ± 0.03
Sources of Variation (*P*-value)							
Feeding system		0.36	0.46	0.72	0.93	0.96	0.40
Floor space		0.90	0.68	0.80	0.40	0.77	0.85
Feeding system x Floor space		0.50	0.88	0.70	0.59	0.55	0.49

SD - standard deviation

any of the egg quality parameters. This observation indicated that these factors had not influenced egg components synthesis. It must be pointed out that the absolute intake of nutrients associated with feed restriction or *ad libitum* feeding and or the net amount of energy and nutrients as influenced by the physical activities of the IPK ducks differed with their floor space allotment. Intake of energy, methionine, and linoleic acid influence egg production and egg size (Leeson and Summers, 2008). Sub-optimal intake of any of these nutrients results in a concomitant reduction in production, egg size, or both depending on the extent of deficiency of the aforementioned dietary factors. As highlighted above, feed restriction adversely affected egg production. Production and egg weight decreased with lower intake of the nutrients, but egg components and quality of the IPK ducks were not affected. It was likely that factors that affect external and internal attributes of eggs such as calcium, phosphorus, vitamins, and health (Roberts, 2004) were not compromised by the feeding system and floor space for the IPK ducks.

The fertility and hatchability of eggs from IPK ducks subjected to different feeding systems and floor space are presented in Table 6. Both of these parameters were not affected

Table 6. Mean (± SD) fertility and hatchability of eggs of IP-Kayumanggi ducks raised under different feeding systems and floor space.

Parameters		Fertility (%)	Hatchability (%)
Main Effects			
Feeding System			
Restricted		82.16 ± 10.03	56.58 ± 10.54
Ad libitum		84.50 ± 7.92	56.33 ± 6.61
Floor Space			
3.0		84.75 ± 8.47	56.00 ± 7.31
3.5		79.75 ± 10.77	56.38 ± 9.08
4.0		85.50 ± 7.05	56.99 ± 10.23
Feeding System	Floor Space (ft^2/b)		
Restricted	3.00	81.50 ± 9.45	54.58 ± 3.43
	3.50	82.00 ± 14.62	59.30 ± 12.51
	4.00	83.00 ± 6.94	55.86 ± 14.3
Ad libitum	3.00	88.00 ± 6.71	57.42 ± 10.17
	3.50	77.50 ± 5.86	53.46 ± 2.50
	4.00	88.00 ± 6.94	58.11 ± 5.27
Sources of Variation (*P*-value)			
Feeding system		0.48	0.94
Floor space		0.31	0.97
Feeding system x Floor space		0.34	0.51

SD - standard deviation

by restricted or *ad libitum* feeding, the floor space allotted, nor the interaction of these factors was not evident. Thus, these factors were possibly not profound sources of variability on these reproductive parameters in the present study. It must be pointed out though that fertility was satisfactory; however, hatchability was quite low. Apparently, the calibration of the new setter-hatcher unit used in the study was not optimized yet for satisfactory hatching of duck eggs. In a related study, feed restriction increased fertility but not hatchability of duck eggs (Olver, 1984). Also, fertility and hatchability of eggs from ducks raised under semi-intensive and extensive production systems were comparable, but egg production was higher in the former than in the latter (Widiyaningrum *et al*., 2016).

The results indicated that growing IPK ducks under the semi-confinement system perform satisfactorily with restricted feeding at a floor space of no more than 1.50 ft^2/bird. For the laying period, the IPK ducks attained egg production performance with *ad libitum* feeding; this was achieved with the least floor space of 3.0 ft^2/duck. With these findings, both the feeding system and allotment of floor space need considerations in raising IPK ducks under the semi-confinement system.

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