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Performances of upgraded Dwarf-Fayoumi chicken genotype in different feeding systems under smallholder farm management

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ABSTRACT

The experiment was conducted to evaluate the performance of upgraded Dwarf-Fayoumi genotype (IDC♂ × Fay♀) with three different feeding regimes from onset of lay to 72 weeks of age. A total of 90 IDC♂ × Fay♀ birds of third generation (F_3) at 16 weeks of age were distributed to 15 selected farmers nearby three villages of Bangladesh Agricultural University, Mymensingh. The villages were Kewatkhali, Boyra and Sutiakhali that selected for intensive, semi-scavenging and scavenging feeding systems, respectively. Each farmer was also given 5 pullets and 1 cockerel. The birds of full feeding and semi-scavenging system were given 76 g and 38 g mash feed per day, respectively. Pullets of semi-scavenging condition were allowed to scavenge in the farmer homesteads. The birds under scavenging condition reared without supplementation and were allowed to scavenge all day long. Result showed a significant difference ($p<0.05$) among the feeding systems (intensive, semi-scavenging and scavenging) in production and reproduction traits, where intensive full feeding system exerted better performances. However, performance efficiency index (52.24), egg-feed price ratio (2.81) and return over feed cost (4.48) were found to be significantly higher ($p<0.001$) in semi-scavenging feeding system. The egg weight ($p<0.01$), breaking strength ($p<0.01$) and dry yolk weights ($p<0.05$) were significantly lower in the birds reared under scavenging feeding system, however, these traits were found statistically similar in the birds of intensive and semi-scavenging feeding system. Feeding systems had no impact on survivability of the experimental birds. Taking altogether, it could be concluded that IDC♂ × Fay♀ upgraded chicken under semi-scavenging system performed better than intensive and scavenging system under smallholder farm management.

Introduction

The scavenging chickens still hold promise to the nutrition security and rural household economy of Bangladesh (Shanta et al., 2016, Sarkar and Zalal, 2023). Under a backyard scavenging

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system, 89% of rural households rear native chickens, with an average flock size of 5.33 per holding (Bhuiyan et al., 2013). The indigenous chicken genotypes have relatively better disease resistance and are highly adapted to scavenging system with sub-standard management, poor housing facilities at variable temperature and humidity as prevailed in tropical harsh condition of Bangladesh (Hossain et al., 1991). On the other hand, exotic genotypes are very much sensitive to sub-standard management and to changes in the quality and quantity of nutrients (Barua and Yoshimura, 1997). As a result, rearing of exotic chicken under scavenging condition is almost impossible. By introducing upgraded or crossbred genotypes into a semi-scavenging poultry model in Bangladesh, smallholder egg production might be increased within the current production system (Rahman et al., 2004). Most of the past efforts were concentrated to improve indigenous stock through upgrading and crossbreeding (Ahmed and Islam, 1985, Amber, 2000; Islam and Nishibori, 2010). However, all of these upgraded and crossbred genotypes could not adopt well due to adverse environment and higher nutritional requirement from scavenging feed resource base (Huque et al. 1992; Rashid et al., 2005; Rahman and Howlider, 2006). On the other hand, the scavenging area is reducing gradually due to increased grain production throughout the country. Moreover, availability of nutrients is insufficient in scavenging/semi-scavenging rearing system (Ukil, 1992). Therefore, successful scavenging or semi-scavenging rearing system in Bangladesh needs a type of chicken having an intermediate egg production between poor producer indigenous and high yielding commercial hybrids with a lower maintenance feed requirement.

The following benefits of mini hens are the reason for the current interest in the practical application of dwarf gene: better utilization of nutrients for production (Galal and Younis, 2006; Galal et al., 2007), higher survivability (Garces et al., 2001), higher stocking density (Charpentier, 2009), superior reproduction capability (Decuypere et al., 2012) and better resistance to heat stress (Gowe and Fairfull, 1995; Rashid et al., 2005; Islam, 2005). Decreasing adult body size is an important means of reducing maintenance feed requirement and increasing feed efficiency through the introduction of dwarf chicken that could be synthesized by using indigenous autosomal dwarf chicken and exotic light breed like Fayoumi. This approach might fulfill the existing demand and increase village level meat and egg production of chicken under deficient feed resource condition. Remarkably, the adaptability of Fayoumi chicken under tropical environment of Bangladesh was found better as compared to other exotic chicken breeds (Khan et al., 2006). Earlier studies reported the performances on Fayoumi crossbred genotypes mostly under intensive management condition (Rahman et al., 2004; Yeasmin et al., 2003; Rashid et al., 2005; Howlider and Afrin, 2013). However, there is lack of information about rearing of Dwarf-Fayoumi crossbred under rural settings. So, the resultant upgraded chicken through crossing between Indigenous Dwarf chicken and Fayoumi would improve the productivity of fowl to be reared under rural settings. With those ideas in view, the present study was designed to evaluate the productivity and profitability of upgraded Dwarf-Fayoumi chicken in different feeding systems under smallholder farm management.

Materials and Methods

Experimental chickens and farmers selection

A total of 90 (75 females and 15 males) Dwarf-Fayoumi (IDC♂ × Fayoumi♀) upgraded birds of third generation (F_3) at 16 weeks of age were selected to conduct this experiment. Fifteen farmers (5 farmers from each village) were selected from 3 villages namely Kewatkhali, Boyra, Sutiakhali for intensive, semi-scavenging and scavenging feeding systems, respectively. Each farmer was given 6 birds (5 pullets and 1 cock). The layout of the experiment is presented in Table 1. From the onset of laying, farmers reared the birds for one laying year to record the egg production data. Farmers were trained to ensure uniform management practices to their birds.

Table 1. Layout for feeding regimes trial

Village	No. of chicken (female and male)					
	Farmer-1	Farmer-2	Farmer-3	Farmer-4	Farmer-5	Total
Kewatkhali (intensive)	5+1	5+1	5+1	5+1	5+1	25+5
Boyra (semi-scavenging)	5+1	5+1	5+1	5+1	5+1	25+5
Sutiakhali (scavenging)	5+1	5+1	5+1	5+1	5+1	25+5
Total (female and male)						75+15

The supplementation of feeds (18% CP and 2750 kcal ME/kg) was provided based on the previous experiment by Ferdaus (2018). The birds raised under intensive condition where 76 g feed were given daily. The pullets raised on the semi-scavenging condition were allowed to scavenge in the farmer homesteads and 38 g mash feed was given to each bird daily. Half of the allocated feed was supplied at early of the morning and rest half of the feed was supplied at evening. The birds were under scavenging condition reared without any supplementary feed. They took their feed themselves by scavenging on outdoor feed as well as household wastage and scattered grains.

The open sided houses were provided to the birds of all feeding system. Each house was made of wood, bamboo, wire net, polythene and tin or paddy straw as roofing materials. Pen size was 1.5 m^2 (1.5 m × 1 m) and provision of floor space was 0.25 m^2 per bird. Pullets were reared on rice husk littered floor. Feed and water troughs were also made of local materials or old plastic or aluminum basins. Artificial lighting was not provided during the experimental period. The birds were vaccinated (New castle and Fowl cholera) according to routine procedure and dewormed (Avinex powder) once in every two months.

Record keeping

The age at which two hens out of five had started laying in a farmer house, was considered as the age at sexual maturity. The egg production characteristic included hen-day egg production, egg weight, weight of 1^{st} egg, egg mass, feed intake, FCR, age and weight at sexual maturity and survivability. Egg production was recorded at daily evening in a pre-designed record sheet for each flock. All sorts of egg production data were recorded for a period of 52 weeks from the onset of laying. Survivability percent of the birds were calculated separately for each group, dividing the number of birds alive by the total number of birds housed multiplying by 100. A total of 45 eggs, 15 from each feeding system (3 eggs from each farmer) were used to determine the egg quality characteristics. In addition, performance efficiency index, egg-feed price ratio and return over feed cost were recorded during egg production period. Performance efficiency index

(PEI) was determined by using the formula suggested by Morgan and Carlson (1968):

Performance efficiency index = $\frac{\text{Average egg weight} \times \text{production (\%)}}{\text{Average daily feed consumption}}$

Egg-Feed price ratio (EFPR) was calculated according to the procedure of Sujatha et al. (2014). EFPR was used to find out the ratio between the receipts from egg and expenditure on feed.

EFPR = $\frac{\text{Total value (Taka) of egg produced)}}{\text{Total value (Taka) of feed consumed}}$

Return over feed cost (ROFC) was measured according to the procedure of Sahasnani et al. (2013). Return over feed (Taka) cost was calculated on per egg basis.

ROFC = Egg price - F_{cost}

Feed cost per egg (F_{cost})= $\frac{\text{Feed consumption per egg (g)} \times \text{Feed cost (Tk)}}{1000}$

Statistical analysis

The collected data was compiled in excel sheet of MS office from the record sheet maintained during the experimental period. The data was then processed through sorting and removing of extreme value. Data were then analyzed using analysis of variance technique by using SAS statistical package in accordance with the principle of Completely Randomized Design (SAS, 2009). Duncan's Multiple Range Test was used to determine the significant differences between means.

Result

Production and reproduction potentialities

A production and reproduction potentiality of the IDC♂× Fay♀ chickens under the different feeding systems is presented in Table 2. The results indicated that there was highly significant difference ($p<0.001$) in several traits like age and body weight at sexual maturity, egg mass and hen day egg production among the hens reared under the three different feeding systems. The results also indicated that, earlier age of sexual maturity and higher weight at maturity was recorded among the birds reared under intensive followed by semi-scavenging and scavenging feeding systems. Similar trend was also observed in the egg production and egg mass. In addition, average egg weight ($p<0.01$) and weight of the first egg ($p<0.05$) varied significantly across the feeding systems. The highest and the lowest egg weight recorded among the hens reared under the intensive and scavenging feeding system, respectively. On the other hand, performance efficiency index, egg-feed price ratio and return over cost of feed (Table 3) were found to be higher ($p<0.001$) among the birds reared on semi-scavenging vis-a-vis those reared on the intensive system. However, survivability of the birds of 3 different feeding systems did not differ significantly.

Table 2. Production and reproduction potentialities of upgraded Dwarf-Fayoumi (IDC♂ × Fay♀) chicken in different feeding systems under farm management

Trait	Mean ± SE			Significance level
	Level of feed supplementation			
	Intensive 76 g feed/bird (n=25)	Semi- scavenging 38 g feed/ bird (n=25)	Scavenging no supplementation (n=25)	
Age at sexual maturity (days)	$150.0^{c}\pm1.41$	$156.0^{b}\pm1.08$	$174.8^{a}\pm1.85$	***
Weight at sexual maturity (g)	$1107.6^{a}\pm2.7$	$1095.0^{b}\pm2.01$	$1081.8^{c}\pm2.5$	***
Weight of 1st egg (g)	$27.60^{a}\pm0.24$	$27.20^{ab}\pm0.37$	$26.20^{b}\pm0.37$	*
Average egg weight§ (g)	$42.51^{a}\pm0.17$	$42.07^{ab}\pm0.17$	$41.63^{b}\pm0.17$	**
Egg mass§ (g/bird/day)	$22.68^{a}\pm0.63$	$19.85^{b}\pm0.55$	$9.89^{c}\pm0.26$	***
Hen day egg production§ (%)	$52.73^{a}\pm1.30$	$46.63^{b}\pm1.17$	$23.56^{c}\pm0.56$	***
Survivability (%)	96.0±4.0	96.0±4.0	92.0±4.89	NS

SE: Standard Error, Row wise different superscripts denote significant level at *p<0.05, **p<0.01, ***p<0.001, NS: Non-significant, § = weekly average, n = No. of birds.

Table 3. Economics of production of upgraded Dwarf-Fayoumi (IDC♂×Fay♀) chicken in different feeding systems under farm management

Trait	Mean ± SE			Significance level
	Level of feed supplementation			
	Intensive 76 g feed /bird (n=25)	Semi-scavenging 38 g feed/bird (n=25)	Scavenging no-supplementation (n=25)	
Performance efficiency index§	$29.84^{b}\pm0.82$	$52.24^{a}\pm0.146$	-	***
Egg-feed price ratio§ (EFPR)	$1.588^{b}\pm0.04$	$2.81^{a}\pm0.07$	-	***
Return over feed cost§ (ROFC)	$2.175^{b}\pm0.23$	$4.48^{a}\pm0.13$	-	***

SE: Standard Error, Row wise different superscripts denote significant level at ***p<0.001, NS: Non-significant, § = weekly average, n = No. of birds.

Egg quality characteristics

Egg quality traits of the IDC♂× Fay♀ chicken reared under the different feeding regimes are presented in Tables 4 and 5, respectively. The egg weight and egg breaking strength varied significantly ($p<0.01$) among the chickens reared across the different feeding systems (Table 4). The findings indicate that egg weight and egg breaking strength were lower among the chickens reared under the scavenging system. The study further indicated significant differences ($p<0.05$) in dry yolk weight among the chickens reared under the different feeding regimes (Table 5), with lower values recorded among the chickens raised on scavenging system. However, non-significant difference was observed for this trait between semi-intensive and intensive management systems.

Table 4. External egg quality traits of upgraded Dwarf-Fayoumi (IDC♂ × Fay♀) chicken in different feeding systems

Trait	Mean ± SE			Significance level
	Level of feed supplementation			
	Intensive 76 g feed/bird (n=15)	Semi-scavenging 38 g feed/bird (n=15)	Scavenging no-supplementation (n=15)	
Egg weight (g)	40.81^a±0.11	40.61^a±0.14	40.17^b±0.12	**
Egg length (mm)	46.77±0.31	46.68±0.44	45.90±0.43	NS
Egg width (mm)	35.39±0.26	35.32±0.23	35.14±0.18	NS
Shape index	75.69±0.57	75.74±0.69	76.66±0.80	NS
Shell thickness (mm)	0.363±0.004	0.357±0.005	0.349±0.004	NS
Shell membrane thickness (mm)	0.032±0.00	0.032±0.001	0.033±0.001	NS
Shell weight (g)	3.94±0.01	3.95±0.06	3.93±0.06	NS
Shell (%)	9.64±0.01	9.72±0.15	9.79±0.15	NS
Egg breaking strength (Kg/cm^2)	1.514^a±0.004	1.507^a±0.005	1.495^b±0.004	**
Surface area (cm^2)	48.44±0.55	48.26±0.60	47.74±0.46	NS
Egg volume (cm^3)	31.78±0.55	31.61±0.58	30.76±0.43	NS

SE: Standard error, Row wise different superscripts denote significance level at ** p<0.01, NS: Non-significant, n = No. of eggs

Table 5. Internal egg quality traits of upgraded Dwarf-Fayoumi (IDC♂ × Fay♀) chicken in different feeding systems

Trait	Mean ± SE			Significance level
	Level of feed supplementation			
	Intensive 76 g feed/bird (n=15)	Semi- scavenging 38 g feed/ bird (n=15)	Scavenging no-supplementation (n=15)	
Albumen index	6.64±0.04	6.77±0.10	6.63±0.12	NS
Yolk index	43.05±0.50	44.04±0.55	42.51±0.60	NS
Yolk color score	7.06±0.18	7.13±0.13	6.93±0.16	NS
Haugh unit	75.95±0.11	75.83±0.20	76.07±0.20	NS
Fresh yolk weight (g)	13.63±0.07	13.58±0.08	13.36±0.11	NS
Dry yolk weight (g)	7.39^a ±0.13	7.09^{ab}±0.113	6.91^b±0.12	*
Yolk dry matter (%)	54.21±0.98	52.20±1.05	51.75±0.92	NS
Fresh albumen weight (g)	20.57±0.10	20.62±0.19	20.34±0.23	NS
Dry albumen weight (g)	2.75±0.03	2.76±0.05	2.62±0.07	NS
Albumen dry matter (%)	13.38±0.15	13.39±0.19	12.83±0.24	NS

SE: Standard error, Row wise different superscripts denote significant level at *p<0.05, NS: Non-significant, n = No. of eggs

Discussion

Production and reproduction potentialities

Age at sexual maturity was higher in the birds reared under scavenging system (174.80 d), and attain earlier maturity (150 d) under intensive condition those who received 76 g of feed. The results pertaining to the weight at sexual maturity too followed the same trend. Corroborating with present findings Barua et al. (1998) claimed that chickens provided with supplementary feed matured early. The observations are also in close accordance with those of Zaman et al. (2004) and

Rahman et al. (1997). Similar to this study, Adomaka (2009) found that sexual maturity was significantly lower in the indigenous Naked neck and Frizzle crossed birds reared under the intensive system than those reared under the semi-scavenging and extensive system. The semi-scavenging and intensive system did not differ significantly for average egg weight and weight of 1st egg but had significant difference with scavenging condition. The observations are almost close to the findings of Adomaka (2009), Barua et al. (1998) and Zaman et al. (2004). Similar trend was also observed among egg mass and hen day egg production. Hen day egg production was reduced by 11.6% and 55.3% in chickens raised under semi-scavenging and scavenging system than those raised under intensive system. The observations are in close accordance with the findings of Adomako (2009). Findings of a study by Barua et al. (1998) indicated higher egg production among the crossbred chicken when they were provided with feed compared to those who reared solely on scavenging condition in same rural areas. Similar findings were observed by Zaman et al. (2004) in Fayoumi breed and three other crossbreeds, and Ahmed and Islam (1985) in backyard poultry. They reported that significant improvement in egg production with a provision of supplementary feed. This may be ascribed to nutritional fulfillment of the birds raised under the intensive management while those raised under scavenging system usually have negative nutritional balance. This would therefore lead to low production among the scavenging chickens. Moreover, the quality and quantity of feed also vary across the homestead of the respondents and irregular supply of feed can be ascribed to poor development of the chickens and thereby low productivity. Another important reason for delayed maturity and low productivity of the chickens raised under scavenging system can be attributed to higher incidences in gastrointestinal tract parasitic load and also mycotoxins in the feed scavenged (Islam and Jabbar, 2003; Islam et al. 2004). All the above-mentioned factors would often lead to decrease body mass development and also egg production.

Survivability

Survivability was found to be lower among the chickens reared on scavenging condition while it was highest among those reared intensively. This finding is in close agreement with the observations of Adomako (2009) who reported lower incidences of predatory attacks and parasitic infestations among the chickens reared under intensive management. It has also been reported that chickens reared under scavenging system usually have low levels of immunity when compared to those reared under intensive management (Huque et al., 1999). Barua et al. (1998) reported that provision of extra feeding increased the survivability of scavenging birds under rural condition of Bangladesh. Findings of a study by Zaman et al. (2004) indicated that survivability of the chickens was more among those receiving supplementary feed.

Economics of production

The estimated performance efficiency index (PEI) was higher among the chickens reared under semi-intensive system vis-a-vis those of the intensive feeding system. Pandey et al. (1995) reported that the PEI for crossbred dwarf pullets to be 58.97 and 38.96 at 28 and 40 weeks of age, respectively which is in partial agreement with the present findings. Joshi et al. (1996) reported that the value of PEI varied between 27.48-37.83 in laying hens up to 52 weeks of age and is in agreement with the chickens raised under intensive system however the values were higher than the chickens reared under the scavenging system. The differences as observed in the study may be ascribed to the overall feed efficiency to those of the egg production and the weight of the eggs.

Egg feed price ratio (EFPR) and return over feed cost (ROFC) were significantly higher ($p<0.001$) among the hens raised under semi-scavenging feeding system compared to intensive feeding system. Jaishankar et al. (2014) noted that the EFPR ranged from 1.47 to 1.59 across commercial layer in intensive management which is very close to the results of intensive birds of this study and lower than those of the chickens raised under semi-scavenging system. Moorthy et al. (2009) indicated that ROFC was higher among the chickens reared under in group fed birds. In another study, Sahasnai et al. (2013) observed that ROFC was higher among the birds fed with low protein and low energy diet than high protein and high energy diet. However, Galal et al. (2007) reported that the loss of revenue due to reduction in egg production associated with dwarf gene may be exceeded through the revenue saved from lower feed intake and better feed efficiency. Their findings support the present investigation. Adomako (2009) reported that the average annual profit was higher among chickens raised under the semi-scavenging system when compared to those reared under intensive and extensive system. This observation is in close consonance with the present investigation. Similarly, studies by Zaman et al. (2004) concluded that with improved conditions, RIR × Fayoumi pullets had better potential in semi-scavenging production system.

Egg quality characteristics

Most of the investigated traits regarding external and internal egg quality did not differ significantly among the three feeding systems. The findings of this study indicate that the egg weight (40.17 g) was lower among the chickens reared under the scavenging system. The result also indicated that egg weight did not differ significantly in between the birds of intensive (40.81 g) and semi-intensive (40.61 g) feeding system. The egg weight of IDC♂ × Fay♀ chicken in this study is slightly higher than the findings of Yeasmin et al. (2003) who found 38.36 g egg weight. However, Rashid (2000) observed that average egg weight of Fay × *adw* was found 31.83 g up to 30 weeks of age which is lower than the present findings. Results from a study by Yeasmin (2001) indicated that Haugh unit of Fay × *adw* was found 81.07 which is higher than the present study. However, Rashid (2000) reported that Haugh unit of Fay × *adw* was 56.72 which is quite lower than the current investigation. On the other hand, Melesse et al. (2013) reported that Haugh unit of WL-dw birds was 76.8 which is in close accordance with those of the present findings.

Egg breaking strength (EBS) was found to be lower (1.49 kg/cm^2) in the birds of scavenging system and was higher (1.51 kg/cm^2) under intensive and semi- intensive system. Yeasmin (2001) reported that EBS of crossbred dwarf chickens ranged from 1.40-1.61 kg/cm^2 which includes the values of the present study. Ferdaus (2018) reported that EBS of IDC♂ × Fay♀ chicken was 1.51 kg/cm^2 under intensive management condition which is in close agreement with the present findings. Dry yolk weight was found to be higher in the birds of intensive system and lower in scavenging feeding system. However, the parameter did not differ significantly in the birds of intensive and semi-intensive feeding systems. Yeasmin (2001) reported that dry yolk weight of crossbred dwarf chickens varied from 6.0-6.71 g which is slightly lower than the present findings. The difference between the present and previous studies regarding internal egg contents might be associated with genotype, age and feed supplementation of the birds.

Conclusion

The findings indicated that the parameters involved with performance and revenue were found to be higher in semi-scavenging system. However, feeding systems had non-significant effects on survivability of the experimental birds. In addition, the influence of feeding systems on external and internal egg quality was minimum. So, considering the traits of production, reproduction and cost involvements, it could be concluded that the upgraded Dwarf-Fayoumi chicken under semi-scavenging feeding system performed economically better than intensive and scavenging feeding system at smallholder farm management. This study provides some basic and needful information about the potentialities of upgraded Dwarf-Fayoumi genotypes which could be utilized as mini layer under semi-scavenging system of Bangladesh.

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Authors Contribution

Abu Jafur Md. Ferdaus: Conceptualization, conducted the research and drafting the manuscript. Begum Mansura Hassin: Assisted research activities and manuscript preparation. Shamsun Nahar: Critically review the manuscript. Mohammad Shamsul Alam Bhuiyan: Design of the study, methodology, writing-review and editing. Md. Shawkat Ali: data analysis and reviewed the manuscript.

Data Availability

All the necessary data used in this research will be made available as per the authorization of the authors.

Conflict of interest

No conflict of interests regarding the publication of this paper.

Consent to Participate

All authors have fully agreed to publish this research in Bangladesh Journal of Animal Science.

Consent for Publication

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