The effect of breeds and rearing system on laying performance and egg quality of local chickens

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Abstract

The study was to identify the reproductive performance of Vietnamese local chickens, named Noi chickens from 36 - 46 weeks of age. The study aimed to determine the effect of breeds and rearing system on laying performance and egg quality of local chickens. The study was a factorial design with 2x2 factors and involved with 120 layers. The first factor was 2 rearing systems (experimental free-range farming system in Tra Vinh province and local free-range farming system in Ben Tre province). The second factor was 2 breeds (egg and broiler purpose). The results showed that egg production rate, laying egg per week were significantly different between breeds and rearing systems ($P<0.05$) while feed intake was not different. The highest egg production rate recorded at week 44 with 38.42%. For egg quality, yolk diameter, yolk color and yolk index were different breeds and rearing system. It can be recommended that rearing system in Ben Tre province and egg purpose breed was better for egg production and quality.

Keywords: egg production, local chicken, breed, rearing system

Introduction

Poultry production is a crucial component of agricultural production and plays a substantial role in global food systems. This is exemplified by the escalating demand for poultry, meat, and eggs in rapidly expanding urban areas, leading to a rise in the establishment of economically viable poultry farms in urban and peri-urban regions (1). The indigenous chicken breeds are widely recognized for their limited egg production capabilities, which can be related to their relatively inferior genetic potential (2).

The production of eggs intended for human consumption has undergone significant transformations over the past century. This evolution has seen a shift from small-scale retail outlets to large-scale markets, as well as a transition from eggs laid by locally bred hens to those laid by hybrid hens. Local breeds hold cultural and historical significance and possess the capacity to adapt to changing environmental conditions, such as climate change, as well as meet the demands for egg and meat production. Additionally, these breeds have historically contributed to the production of substantial quantities of maize, cereals and agriculture by-products, which serve as key components in the diet of chickens (3). During the early decades of the previous century, numerous breeds were selectively bred within agricultural settings. Presently, a subset of these breeds continues to persist and is actively managed through conservation efforts. According to (4) Vietnam is recognized as one of the centers for chicken domestication, boasting a significant reservoir of genetic variation within its poultry breeds. The Noi chicken breed is recognized as a native breed that exhibits favorable characteristics for rearing, displaying adaptability to environmental circumstances and care practices commonly found in rural areas (5). Nonetheless, it is worth noting that rural small-scale farmers employ indigenous hens in poultry production, sometimes characterized by poor management practices. Consequently, the output derived from this antiquated production sector is comparatively lower when juxtaposed with the contributions made by exotic and hybrid chicken populations (6). Similarly, Noi hens exhibit a diminished capacity for egg production. Prior research has documented that Noi layers have the capacity to deposit eggs until they reach 50 weeks of age (7). An example of local breed in Ethiopia showed that the annual egg production of indigenous hens under the control of farmers was recorded at 40 eggs (8). Furthermore, the implementation of crossbreeding techniques between indigenous chicken and exotic breeds, high-productivity breeds present a potentially viable strategy for enhancing the egg production capabilities of local chicken populations (7). As previously stated, the reproductive capabilities of indigenous breeds such as Ho chickens and Dong Tao chickens exhibit suboptimal performance, rendering their eggs unsuitable for commercial use. Eggs are frequently employed for the purpose of hatching in order to replenish the flock Indigenous chicken breeds are commonly suggested for organic poultry production due to their inherent adaptability to local settings and their ability to effectively utilize paddocks (9). Nevertheless, the primary hindrance to utilizing these breeds for egg production is in their inferior production performance as compared to hybrids, resulting in subpar economic outcomes (10).

The previous study of (11) recorded the performance of two kinds of local breeds namely, Ho chicken and Dong Tao chicken, these breeds had a week performance in both eggs and growth. Additionally, some studies found morphological traits, production traits, genetic diversity of local breeds and mostly *in ovo/in vitro* study. However, there was less information of Noi chicken breeds and where the breeds are raised. To understand the effect of breeds, raising farming system as well as its interactions on laying performance and egg quality, the study was implemented.

Material and Methods

Location

The study was implemented at Department of Animal Science and Veterinary Medicine in Tra Vinh province and Ben Tre province from May 2022 to December 2022. For animal welfare, the study was following the regulation of local government.

Experimental design

The study was a completely factorial design with 2x2 factors. The first factor was chicken breeds; there were 2 Noi chicken breeds used for this study consisting of B1 for meat purpose (in this case, farmers usually use this breed for cocks fighting) and B2 for egg purpose. The second factor was rearing systems which were in two provinces, namely Tra Vinh (L1) and Ben Tre province (L2) (breed original). A total of 120 Noi layers were utilized in the study. Each experimental unit consisted of thirty Noi layers. All experimental units were equipped with feeds and drinkers that were made accessible without any restrictions. The layers were given unlimited access to eat and water for the duration of the trial.

Feed was formulated following the laying phase of layers. The feed formulation was presented in Table 1.

Table 1. Feed ingredients and chemical composition

Ingredient	Growing period		Chemical composition	Growing period	
	20-40 weeks	After 40 weeks		20-40 weeks	After 40 weeks
Corn	19.8	20	DM	88.6	88.7
Broken rice	13	19	OM	87.2	86.3
Rice bran	35	33	CP	18	16.5
Soybean	24.5	16.3	EE	5.43	5.4
Fish male	0	3	NFE	59.9	61
DCP	0.3	0.3	CF	3.81	3.37
Stone meal	3.5	4	Ca	3.21	3.73
Granular stone	3.5	4	P	0.96	0.95

Lysine	0.1	0.1	ME	2,798	2,832
Mineral premix – vitamin*	0.3	0.3			
Total	100	100			

** Mineral premix and vitamin were formulated following local layers in laying phase 2.*

DCP: dicalcium phosphate; DM: dry matter; OM: organic matter; CP: crude protein; EE: Ether extract; NDF: Neutral detergent fiber; CF: Crude fat; ME; Ca: Calcium; P: Phosphate; Metabolizable energy.

The layers were raised in a controlled system, with a density of 5 bird/m^2. The chickens still have a spacious playground but still ensure there is a net to record separate data between treatments.

Data collection

The dataset comprised the aggregate number of eggs that were gathered. Eggs were systematically gathered from every group on a daily basis as a collective effort. The following criteria were adhered to feed intake, rate of egg production, average egg weight, eggshell thickness, yolk index, albumen index, shape index, Haugh unit, and yolk color. The data were calculated in accordance with the prescribed methods (11)

Data analysis

Reproduction indicators of chickens were analysed according to the two-factor method, using ANOVA of General Linear Model mode from Minitab 16.1.0 software. Tukey test is used to compare Mean values with 95% confidence.

Results and Discussion

Feed intake, egg production of layers in Mekong delta

Table 2 shows the feed intake of layers were not different between treatment. Layers in two locations have a similar feed intake which ranged from 110.22-117.61 g/hen/day. The highest feed intake is in week 46 with 118.30 g/hen/day. The study did not record any interaction between locations and breeds in this study.

Table 3 shows the significant differences of egg production rate of layers between locations and breeds (P < 0.05). At week 36, 40, 42 of age, layers had a higher egg production rate in L2 (P<0.05). Similarly, the study recorded significant effect of breed on egg production rate at week 42. The highest production performance in this period was at 44 weeks of age with 38.42%.

Table 2. Feed intake of layer Noi chickens (g/bird/day)

Week	Locations		Breeds		SEM/P		
	L1	L2	B1	B2	Location	Breed	Location* Breed
Week 36	110.22	111.50	109.50	112.22	5.11/0.86	5.11/0.71	7.23/0.46

Week 38	110.51	111.50	108.66	113.34	5.07/0.89	5.07/0.53	7.18/0.62
Week 40	118.34	111.50	116.50	113.34	6.47/0.47	6.47/0.73	9.15/0.24
Week 42	111.01	111.50	109.16	113.34	5.09/0.94	5.09/0.57	7.19/0.58
Week 44	115.85	118.19	117.02	117.02	3.38/0.63	3.38/0.99	4.78/0.72
Week 46	117.5	123.0	118.83	123.66	1.77/0.06	1.77/0.29	2.51/0.41

Table 4 records the egg performance of hens per day. The highest laying rate per day was at week 44 with 3.35 egg/hen in group L2. The study recorded the difference in egg performance between locations at week 38, 40, 42, 44 ($P<0.05$) while week 42 recorded the difference in egg performance between breeds. There were no interactions between breeds and locations in this study.

Table 3. Egg production rate of layer Noi chickens in Mekong delta (%)

Week	Locations		Breeds		SEM/P		
	L1	L2	B1	B2	Location	Breed	Location* Breed
Week 36	25.46^b	31.93^a	28.38	29.01	1.35/0.01	1.35/0.75	1.91/0.96
Week 38	26.91	29.20	28.78	27.34	0.95/0.12	0.95/0.31	1.35/0.06
Week 40	21.78^b	27.95^a	25.19	24.54	1.83/0.45	1.83/0.80	2.60/0.86
Week 42	21.42^b	28.29^a	22.70^b	27.00^a	1.29/0.01	1.29/0.04	1.83/0.75
Week 44	21.43^b	27.96^a	23.92	25.47	0.94/0.01	0.94/0.28	1.33/0.73
Week 46	24.53	30.22	25.04	29.71	1.36/0.18	1.36/0.42	1.92/0.03

Table 4. Egg performance of layer Noi chickens in Mekong delta (egg/hen/week)

Week	Locations		Breeds		SEM/P		
	L1	L2	B1	B2	Location	Breed	Location* Breed
Week 36	1.68	2.67	1.92	2.43	0.25/0.23	0.25/0.18	0.35/0.27
Week 38	1.76^b	2.43^a	1.85	2.34	0.11/0.01	0.11/0.01	0.16/0.26
Week 40	1.49^b	2.07^a	1.83	1.73	0.13/0.01	0.13/0.62	0.19/0.95
Week 42	1.45^b	2.56^a	1.83^b	2.19^a	0.10/0.01	0.10/0.04	0.14/0.49
Week 44	1.50^b	2.2^a	1.9	1.83	0.15/0.01	0.15/0.63	0.22/0.43
Week 46	1.72^b	2.62^a	20.6	2.27	0.22/0.02	0.22/0.52	0.31/0.46

The laying rate and laying productivity of native chickens cannot achieve maximum productivity like other chicken breeds because egg-laying productivity partly depends on genetic characteristics, genes and care conditions (3). Different response of laying performance due to rearing systems might be caused by the different genotype of hens and the environment (temperature and humidity) as described by (12). The differences in farming methods, food and genetics are possible reasons to explain this difference (11). Certain genotypes exhibit enhanced production performance in a rearing system with outdoor access compared to an indoor system, as they are more responsive to the outdoors and unlimited movement (10). Multiple studies have conducted comparisons between indigenous breeds and commercially bred strains within an organic farming framework, revealing that the commercial layers consistently yield eggs of greater weight (9), however, it is widely recognized that the distinct genetic characteristics of hybrid and local genotypes manifest in their production performance. This is mostly due to the fact that commercial strains are specifically chosen for their superior egg production and yield capabilities (13).

Egg quality of layers in Mekong delta

Table 5 shows that between two kinds of Noi breeds, egg weight was different. The higher egg weight was record in breed B2. It was the same for egg width in this study. Yolk diameter was significantly higher in group of B2 while raising in L1 performed a higher yolk diameter. For yolk diameter, the result had an interaction. Yolk colour and yolk index were better in group B1, compared to B2. The yolk colour can reach 12.26 following colour range for egg. The Haugh index was not different between groups and was higher than 80.

Table 5. Egg quality of layer Noi chickens in Mekong delta

Criteria	Locations		Breeds		SEM/P		
	L1	L2	B1	B2	Location	Breed	Location *Breed
Egg weight, g	45.17	44.5	43.26	46.41	0.08/0.58	0.08/0.03	1.20/0.07
Egg length, mm	53.18	51.91	52.56	52.52	0.53/0.13	0.53/0.96	0.76/0.87
Egg width, mm	39.22	38.81	38.31	39.72	0.35/0.43	0.35/0.02	0.50/0.08
Eggshell weight, g	5.7	5.69	5.62	5.77	0.09/0.92	0.09/0.31	0.13/0.22
Albumen height, mm	6.36	6.32	6.29	6.39	0.16/0.88	0.16/0.69	0.22/0.28
Yolk height, mm	16.64	16.22	16.54	16.32	0.49/0.56	0.49/0.76	0.69/0.41
Yolk diameter, mm	42.48	37.8	37.97	42.31	0.63/0.01	0.63/0.01	0.89/0.01
Yolk colour	10.13	11.47	12.26	9.34	0.53/0.11	0.53/0.01	0.75/0.11
Shape index[1]	1.35	1.33	1.37	1.32	0.01/0.47	0.01/0.09	0.02/0.19
Albumen index[2]	0.09	0.08	0.09	0.08	0.00/0.84	0.00/0.24	0.00/0.90
Yolk index[3]	0.39	0.42	0.43	0.38	0.01/0.06	0.01/0.01	0.01/0.11

Haugh index[4]	84.31	84.28	84.57	84.01	0.99/0.98	0.99/0.70	1.41/0.62

[1]Shape index = egg weight/egg length

[2]Albumen index = albumenheight/albumen width

[3] Yolk index = yolk height/yolk width

[4] Haugh index = 100*log((albumen height)-1.7((total weight) 0.37 + 7.6)))).

As a result, the egg weight of free-range Noi chickens is smaller than that of other native Vietnamese chicken breeds such as H’mong chickens. H’mong chicken eggs are about 51.43 g (11). When compared with commercial chicken eggs or industrial chicken eggs, free-range chicken eggs have a relatively small weight. The egg weight of cross-bred chickens is often higher than that of purebred native chicken breeds (14). Another important criterion is the color of the yolk that can be seen directly by the consumer. In this study, the yolk color of Noi chicken is darker than the yolk color of other native chickens in Vietnam. For example, yolk color at 40 weeks of age for Ri chickens is 10.57 (15). The yolk color of Noi chicken is also higher than that of black H’mong chicken with 8.08 points (16). Besides, the yolk color of free-range Noi chickens is also higher than that of Ac chickens in the study of Linh et al. (3). The Haugh unit is often regarded as the primary determinant of egg quality, as it provides a comprehensive assessment of both freshness and protein quality attributes. The investigation conducted on the quality of Noi chicken eggs has revealed that the Haugh unit exceeds 84, indicating a high nutritious content in Noi chicken eggs. According to the United States Department of Agriculture (USDA), eggs of superior quality are characterized by a Haugh unit measurement of 72 or above. The Haugh unit from Noi chicken eggs is quite higher than recommended, proving that the quality of chicken eggs is quite high. This result is similar to the statement of (11) eggs from native breeds are often fresher and of better quality. To compare with other chicken breeds in the world, the Haugh unit is also higher than the value of chicken breeds such as Barred Plymouth Rock chicken, White Leghorn chicken, Rhode Island Red chicken and White Rock chicken ranging from 45.81 to 58.68. The results of the Haugh unit were also higher than those of other indigenous chicken breeds in Vietnam with 76.14-77.67 for Ri chickens and 81.53-82.15 for Ho and Dong Tao chickens (1). Moreover, the study conducted by (10) revealed that the genotype of the chickens had a notable impact on many aspects of egg quality, including external, internal, and eggshell quality. The breeds exerted a significant impact on the quality of eggs. Additionally, the raising technique was found to have a distinct influence solely on egg weight. Furthermore, the interaction between the observed components was found to significantly affect several parameters related to egg quality. Nevertheless, it is worth noting that both factors had distinct and autonomous impacts on various parameters related to the quality of eggs, as demonstrated by (17).

Conclusion

The local rearing farming method exhibited superior production performance and egg quality in comparison to the experimental rearing farming circumstances. The influence of different breeds on several egg quality indicators was found to be substantial, whereas the impact of the rearing system was seen to mostly affect yolk diameter. No significant interactions were seen between the raising system and breeds in relation to the performance of Noi layers.

Conflict of Interest

The authors have no conflict of interest.

References

1. Nkukwana, T.T. 2018. Global Poultry Production: Current Impact and Future Outlook on the South African Poultry Industry. South African J. Anim. Sci., 48(5):869–884. DOI:10.4314/sajas.v48i5.
2. Mengesha, Y.; E. Kebede and A. Getachew. 2022. Review of Chicken Productive and Reproductive Performance and Its Challenges in Ethiopia. All Life, 15(1): 118–125. DOI:10.1080/26895293.2021.2024894
3. Linh, N.T.; N.T.K. Dong and N.V. Thu. 2022. Survey of Muscovy Duck Production in Rural Areas of Tra Vinh Province, Vietnam. J Indonesian Trop. Anim. Agri, 47(2):138–145. DOI:10.14710/jitaa.47.2.138-145.
4. Pham, M.H.; C. Berthouly-Salazar; X.H. Tran; W.H. Chang; R.P.M.A. Crooijmans; D.Y. Lin; V.T. Hoang; Y.P. Lee; M. Tixier-Boichard and C.F. Chen. 2013. Genetic Diversity of Vietnamese Domestic Chicken Populations as Decision-Making Support for Conservation Strategies. Anim. Genetics, 44(5):509–521. DOI:10.1111/age.12045.
5. Khoa, D.; N. Tuoi; N. Nguyen; N. Thuy; S. Okamoto; K. Kawabe and T. Shimogigri. 2019. Some Quantitative Genetic Traits in Vietnamese Indigenous Noi Chicken from 0 to 28 Days Old. Bio Anim. Husb. 35(2):141–151. DOI:10.2298/BAH1902141K.
6. Hinsemu, F.; Y. Hagos; Y. Tamiru and A. Kebede. 2018. Review on Challenges and Opportunities of Poultry Breeds. Dairy Vet. Sci. J, 7(2):1–9. DOI:10.19080/JDVS.2018.07.555706
7. Dang, V.H.; V.D. Duong; T.H. Nguyen; N.K. Do; T.H. Le; M.H. Nguyen; T.U. Tran; H.N. Nguyen and T.N Dang. 2022. Growing and Laying Performances of Two Varieties of Noi Chickens Raised in an Intensive Farming System. Vietnam J Sci. Tech. Engineer. 64(2):54–58. DOI:10.31276/VJSTE.64(2).54-58.
8. Getiso, A.; B. Bekele; B. Zeleke; D. Gebriel; A. Tadesse; E. Abreham and H. Jemal. 2017. Production Performance of Sasso (Distributed by Ethio-Chicken Private Poultry Farms) and Bovans Brown Chickens Breed under Village Production System in Three Agro-Ecologies of Southern Nations, Nationalities, and Peoples Regional State (SNNPR), Ethiopia. Int. J. Livestock Production, 8(9):145–157. DOI: 10.5897/IJLP2017.0391
9. Sokołowicz, Z.; M. Dykiel; J. Krawczyk; A. Augustyńska-Prejsnar. 2019. Effect of Layer Genotype on Physical Characteristics and Nutritive Value of Organic Eggs. CyTA – J. Food, 17(1):11–19. DOI:10.1080/19476337.2018.1541480
10. Rakonjac, S.; V. Dosković; S.B. Bošković; Z. Škrbić; M. Lukić; V. Petričević and D.M. Petrović. Production Performance and Egg Quality of Laying Hens as Influenced by Genotype and Rearing System. Braz. J. Poult. Sci, 23(2):eRBCA. DOI:10.1590/1806-9061-2019-1045.
11. Nguyen Van, D.; N. Moula; E. Moyse; L. Do Duc; T. Vu Dinh and F. Farnir. 2020. Productive Performance and

Egg and Meat Quality of Two Indigenous Poultry Breeds in Vietnam, Ho and Dong Tao, Fed on Commercial Feed. Animals, 10(3):408, DOI:10.3390/ani10030408.

a12. Rakonjac, S.; S. Bogosavljević-Bošković; Z. Pavlovski; Z. Škrbić; V. Dosković; M.D. Petrović and V. Petričević. 2014. Laying Hen Rearing Systems: A Review of Major Production Results and Egg Quality Traits. World's Poult. Sci. J, 70(1):93–104. DOI:10.1017/S0043933914000087.

13. Di Rosa, A.R.; B. Chiofalo; V. Lo Presti; V. Chiofalo and L. Liotta. 2020. Egg Quality from Siciliana and Livorno Italian Autochthonous Chicken Breeds Reared in Organic System. Animals, 10(5): 864. DOI:10.3390/ani10050864.

14. Moula, N.; C. Michaux; F.-X. Philippe; N. Antoine-Moussiaux and P. Leroy. 2013. Egg and Meat Production Performances of Two Varieties of the Local Ardennaise Poultry Breed: Silver Black and Golden Black. Anim. Genetic Resources, *53*: 57–67. DOI: 10.1017/S2078633613000350

15. Moula, N.; D.D. Luc; P.K. Dang; F. Farnir; V.D. Ton; D.V. Binh; P. Leroy and N. Antoine-Moussiaux. 2011. The Ri Chicken Breed and Livelihoods in North Vietnam: Characterization and Prospects. *J. Agr.* Rural Development in the Tropics and Subtropics, 112(1):57–69.

16. Van Duy, N.; T. Vu Dinh and P. Nguyen Thi. 2017. The Growth and Meat Quality of H'mong Chicken Raised by Industrial Farming. J Sci. Agri. Vietnams, 15(4): 438-445

17. Franco, D.; D. Rois; A. Arias; J.R. Justo; F.J. Marti-Quijal; S. Khubber; F.J. Barba; M. López-Pedrouso and J. Manuel Lorenzo. 2020. Effect of Breed and Diet Type on the Freshness and Quality of the Eggs: A Comparison between Mos (Indigenous Galician Breed) and Isa Brown Hens. Foods, 9(3):342. DOI:10.3390/foods9030342.