The Effect of Different Rearing Methods on Domestic Poultry Eggs Qualities in Batticaloa District

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Abstract

The study was carried out to determine the effect of Rearing systems on the egg qualities of Domestic Chicken. Data was collected from (n=200) Domestic Chicken Eggs under Intensive and Semi-Intensive Rearing systems. All data were collected on external egg quality characteristics i,e.,(Egg Weight, Egg Length and Width, Shape Index, Shell Weight, Shell Thickness) and internal egg quality characteristics (Weight of albumen, Weight of yolk, Height of yolk, Height of albumen, The pH of egg yolk and albumen, Haugh unit, Yolk Color) and Nutritional Egg quality characteristic i,e.,(albumen protein content, yolk protein content, albumen fat content, yolk fat content, albumen ash content, yolk ash content, albumen moisture content, yolk moisture content). Data were analyzed using SPSS version 25.0. The results of the study revealed that external egg quality parameters such as Egg Weight, Shell Thickness and Shell Weight significantly ($p < 0.05$) affect by rearing system. Egg Nutritional Qualities Parameters like Albumen and yolk protein, albumen and yolk fat, significantly ($p < 0.05$) affected by the rearing system and egg internal qualities Egg Yolk Color significantly ($p < 0.05$) affected by the rearing system. However, other qualities do not that much affect egg qualities but in the case of egg, yolk color will be highly affected by the rearing system. Typically, consumers tend to favor eggs from semi-intensively reared hens due to the appealing egg size and yolk color. Consequently, farmers are advised to opt for the semi-intensive rearing system, as eggs from birds raised under this method exhibit an enhanced yolk color, making them more attractive to consumers. Conversely, when it comes to raising a large number of birds, the intensive rearing system is preferable over the semi-intensive one.

Keywords: Egg weight, Egg external quality, Egg internal quality, Egg nutritional quality, Domestic chicken

I. INTRODUCTION

All domesticated birds used to produce meat and eggs for human consumption, produce other goods for sale, replenish game populations, or breed these types of birds were referred to as poultry (Wakenell, 2016). Chickens, turkeys, quail, ducks, geese, and guineas are some of the poultry species. Poultry is restricted to the conventional scavenging variety, which means that they were allowed to roam rather than being confined in any way. This allows them to walk about and scavenge for their natural diet with the least amount of human involvement. They are also known as local poultry, family poultry, or village poultry. These poultry species were raised all over the world. Since 1990, there are now more than twice as many chickens as there were. The number of chickens in the globe increased from 14.38 billion in 2000 to 25.9 billion in 2019 (Khan et al., 2021). Poultry farming starts with less capital outlay than other livestock husbandry. Low-income individuals may also launch the business on a modest basis. Bangladesh is a developing nation with an agricultural economy in Southeast Asia, and chicken production is one of the most significant sources of protein (Mamun, 2019). Due to its greater contribution to the national GDP, Sri Lanka's poultry industry has lately been given a higher ranking (Manjula et al., 2018). In 2019, the contribution of poultry to Sri Lanka's GDP was 64% of the total contribution from livestock (Premarathne and Samarasinghe, 2020). Domestic poultry is one of the most crucial tools in a rural low-input-output farming system. According to estimates, there are 1.3 million domestic chickens. 15% of the eggs produced in the nation are produced by them (Weerasinghe, 2019). According to the All-Island Egg Producers Association, Sri Lanka's egg business produces enough eggs to meet the country's daily demand of 6.5 million eggs and significantly more than 7 million eggs during the festival season. Given the growth in the human population, there were

2586.78 million eggs produced overall, or 117.6 eggs per person. Sri Lanka's egg production increased by 18% from 18, 000 tons in 1969 to 86, 000 tons in 2018. In 2020, there will be 24,277,830 chickens in Sri Lanka (Premarathne and Samarasinghe, 2020).

According to Kingori, Wachira and Tuitoek (2010), domestic chickens are raised in an extensive system in Africa to the tune of 70% of all chickens. Domestic poultry contributes roughly 10–15% of all poultry in India. Domestic poultry does not require large initial investments. Poor people can enhance their economic endeavors to better meet their requirements and earnings. suitable for female-headed households that can manage and generate their poultry assets successfully since it involves less work, and has little to no environmental impact. The domestic chicken industry has contributed to the elimination of poverty, the safety and security of food and the economic empowerment of vulnerable groups, notably women and children (Mengesha and Tsega, 2011; Cabarles et al., 2012). Rural Domestic chicken production makes a substantial contribution to human nutrition and serves as a source of income. This is because these species of chickens have advantages over others, such as rapid reproduction, low starting costs, and low maintenance costs (Mengesha and Tsega, 2011). Another benefit is that they reproduce quickly and may be raised on small plots of land per household, but due to poor management skills, their output is still not very good. Around the world, Domestic chicken breeds are raised in a range of climatic regions, customs, religious beliefs, and lifestyles (Amare, Worku and Negussie, 2012). Due to domestic chickens' advantageous characteristics, like their disease resistance, ability to adapt to hard conditions, and capacity for using low-quality feed, this has become crucial (Abeykoon, Weerahewa, and Silva, 2013). However, it is evident that Sri Lanka's domestic livestock and poultry populations are steadily diminishing, and several varieties and species have already disappeared or are in danger of doing so. Domestic chicken plays a special role in food security (Atapattu et al., 2016). Domestic chicken eggs have a special market than commercial chicken eggs due to high-quality eggs. The egg quality traits are very important for egg consumption. The quality characteristics of an egg are those which influence the consumer's acceptance of it. As a result, in today's production-oriented industry, continuous genetic evaluation of different egg quality traits has become necessary to maintain dominance in overall egg quality. Although there has been an increase in demand for locally produced chicken meat and eggs, smallholder farmers still supply a sizable percentage of the market. In general, 30% of all animal protein consumed worldwide comes from poultry products (egg and meat) (Magonka et al., 2018).

A. *Background of the Study*

The study of egg quality characteristics in village chickens under diverse rearing systems in Sri Lanka is crucial due to the significant socioeconomic role of poultry in the country (Thariq et al., 2022). With a diverse array of phenotypic characteristics in domestic chicken breeds and various rearing practices, understanding how different systems affects egg quality is essential for optimizing production efficiency, ensuring food safety, and conserving genetic resources. Despite the substantial contribution of village chickens to Sri Lanka's economy and food security, there exists a gap in knowledge regarding detailed egg quality assessments within specific rearing contexts. Investigating parameters such as shell strength, yolk color, and nutritional content can provide insights into optimizing production, promoting genetic diversity, and fostering environmentally sustainable practices, ultimately benefiting both farmers and consumers. In this scenario, the study of the egg quality with different rearing systems in Sri Lanka important to explore.

II. METHODOLOGY

A. *Experimental Site*

The study was carried out in an integrated model farm in Mandur local farm in Batticaloa district. The site was located in the dry zone of the country. Batticaloa's annual rainfall was 1349 mm, the temperature was between 24 – 32 0C, June is the hottest month of the year, January has the lowest temperature in the past year and the elevation was 9 m above sea level. The primary sources of income in the region were irrigated and rain-fed agriculture, followed by non-farm activities and animal rearing (Mahanama et al., 2014).

B. *Experimental Design and Eggs Collection*

The experiment was arranged in a completely randomized design (CRD) with one breed (Common village chicken - Gam kukula) with two rearing methods (intensive and semi-intensive) as a flock maintained 500 birds in one rearing system and age of the flock was 6.5 months. The eggs were collected from each rearing system as 100 with 3 weeks of period. Collection pattern of the eggs were 06 times per day. The collected eggs were stored 05 days of period and transferred to animal science laboratory of the South Eastern University of Sri Lanka for external, internal and nutritional analysis. 7 0C temperature (Saleh et al., 2020) maintained in all storage period and transferring time. In the laboratory external (egg weight, shell thickness, shell weight, egg length and width and shape index) and internal (Albumen weight, Albumen height, Albumen PH, Yolk weight, Yolk height, Haugh Unit, and Yolk color) parameters were analyzed by the USDA standards of measurements (Joubrane et al., 2019). The nutritional (Moisture content, protein content, Fat content, dry matter, Ash and Energy content) parameters were analyzed by AOAC-2001 methods (Hanusova et al., 2015).

C. Data Analysis

The data analysis involved descriptive statistics, and an independent samples student t-test was conducted using SPSS version 26.0, with a significance level set at 0.05.

III. RESULTS AND DISCUSSION

A. Effect of Different Rearing Methods on External Egg Qualities

1) Egg Weight

The Egg Weight between Intensive and Semi-Intensive management systems; there was a significant difference ($t=4.17$, $df=126$, $p<0.05$) (Table 1). The mean egg weight was significantly higher in an intensive rearing system (50.3±3.8 g) while it is significantly lower in a semi-intensive rearing system (47.8±2.7 g). Ramlah, (1996), also discovered that hens raised under an intensive system of management produced high egg weight than those hens raised under a semi-intensive system of management.

2) Egg Length

The egg length between Intensive and semi-intensive systems; there was no significant difference ($t=1.21$, $df=126$, $p>0.05$) (Table 1). Hence, the Intensive rearing system had numerically better egg length than the semi-intensive rearing system. The mean egg length for the intensive rearing system and semi-intensive rearing system were 52.86±2.1 mm and 52.45±1.7 mm respectively.

3) Egg Width

The Egg Width between Intensive (40.6±1.1 mm) and Semi-Intensive rearing systems (40.2±1.0 mm), there was no significant difference ($t= 1.93$, $df=126$, $p>0.05$) (Table 01).

2) Shape Index

In the Egg Shape Index between Intensive (76.8±2.8) and Semi-Intensive (76.5±2.) systems, there was no significant difference ($t= 0.52$, $df=126$, $p>0.05$) (Table 01). There are several studies Champati et al., (2020) that reported the effect of different rearing systems on egg shape indices not to be statically significant. On the contrary, Bekele et al., (2022) discovered that eggs from the intensive system had a higher egg shape index than eggs from the semi-intensive. Sokołowicz, Krawczyk and Dykiel (2018), made similar findings and discovered that birds raised in the deep litter had greater egg-shape indices than those raised in free-range and organic environments.

4) Shell Thickness

In the Egg shell thickness between Intensive (0.45±0.4 mm) and Semi-Intensive (0.4±0.0 mm) systems, there was a significant difference ($t= 3.81$, $df=126$, $p<0.05$) (Table 01). Low feeding quality insufficient calcium (Ca) and other trace mineral intake are most likely to blame for the Semi-Intensive System eggs' poorer values for shell quality features. Calcium supplementation is necessary for eggshell quality (Mosa and Al-Asadi, 2022).

3) Shell Weight

The eggshell weight between Intensive (5.7±0.5 g) and Semi-Intensive (5.6±0.7 g) systems, there was a significant difference ($t= 1.56$, $df=126$, $p<0.05$) (Table 01). According to research by Nweke-Okorocha, Agaviezor and Chineke (2020) deep litter systems generated thicker eggshells than cage systems. However, according to Ingelmann et al. (2018) could not find differences in the shell weight of eggs from different rearing strategies. The thickness and weight of the shells of the eggs from the free-range and litter floor systems were identical (Dikmen et al., 2017).

B. Effect of Different Rearing Methods on Internal Egg Qualities

1) Albumen Weight

The Egg Albumen Weight between Intensive (29.8±3.1) and Semi-Intensive (27.8±1.9) systems there was no significant difference ($t= 1.65$, df=126, p>0.05) (Table 02). According to Tadesse et al. (2015) Bovan Brown (BB) and Potchefstroom Koekoek (PK) albumen weight did not differ between intensive and semi-intensive rearing systems on the contrary, The weight of albumin in the semi-intensive (Grass and Pasture) was higher than that of the intensive (deep litter) (Sekeroglu et al., 2014).

Table 04: Eggs' External Parameters

External Parameters	Intensive system	Semi-intensive system	t value (p-value)
Egg Weight (g)	50.3±3.8	47.8±2.7	4.17 (0.000)
Egg Length (mm)	52.9±2.1	52.4±1.7	1.21 (0.251)
Egg Width (mm)	40.6±1.1	40.2±1.0	1.93 (0.350)
Shape Index	76.8±2.8	76.5±2.6	0.52 (0.253)
Shell Thickness (mm)	0.4±0.0	0.4±0.0	3.81 (0.000)
Shell Weight (g)	5.7±0.5	5.6±0.7	1.56 (0.000)

(mean ± SD)

2) Albumen Height

The egg albumen height between Intensive (5.2±0.9) and semi-intensive (5.4±0.6) systems, there were no significant differences (t= 1.71, df=126, p>0.05) (Table 02). Tadesse et al. (2015) reported album height of exotic chickens did not differ under intensive and semi-intensive rearing systems. in regards to this albumen height, Liu et al. (2020) found no variations in rearing methods. However, improved management and feeding of the birds, which have a substantial impact on internal egg quality attributes, may be linked to the higher albumen height score for eggs from intensive farming than semi-intensive farming (Hanusova et al., 2015).

3) Albumen pH

The eggs' albumen pH between intensive (8.6±0.2) and semi-intensive (8.6±0.2) systems, was no significant difference (t= 0.25, df=126, p>0.05) (Table 02). Dahloum, Yakubu, and Halbouche (2018), reported that the rearing systems had an impact on various albumen quality traits of the egg, with the exception of albumen pH.

4) Haugh Unit

The Haugh unit (HU) is calculated using the weight of an egg and the height of the inner thick albumen, which is regarded as a typical indicator of albumen quality. It is widely acknowledged that the quality of the egg increases with the Haugh unit value. In this study, The Egg Haugh unit between intensive (74.0±7.2) and semi-intensive (77.1±4.7) systems, there was no significant difference (t= 0.68, df=126, p>0.05) (Table 02). According to Gerber et al. (2015), improved management and feeding of the birds, which have a substantial impact on internal egg quality attributes, could be linked to the higher score in the Haugh unit for eggs from intensive farming as opposed to semi-intensive farming. Furthermore, Sokołowicz, Krawczyk and Dykiel (2018), discovered a substantial rearing system effect, with deep litter system eggs outperforming free-range eggs in terms of Haugh unit value. Liu et al. (2020), did not identify any changes across rearing systems, in contrast to the current finding.

5) Yolk Weight

The egg yolk weight between intensive (14.8±1.3 g) and semi-intensive (14.6±1.4 g) systems, there was no significant difference (t= 0.90, df=126, p>0.05) (Table 02). However, with the highest values (14.8±1.3) recorded for birds maintained on an intensive rearing system, the current study demonstrated a substantial effect of the rearing strategy on yolk weight. A follow-up study by Dikmen et al. (2017), found that the yolk weight was higher in the free-range/semi-intensive system than in the conventional-cage and enriched-cage systems.

6) Yolk Height

The egg yolk height between intensive (14.6±0.9 mm) and semi-intensive (14.5±0.9 mm) systems, there was no significant difference (t= 0.64, df=126, p>0.05) (Table 02). In the study by Tadesse et al. (2015), it was observed that yolk height demonstrated an upward trend with increasing egg weight. Additionally, Khobondo et al. (2015), found similarities in egg length, egg width, and yolk height across various rearing systems.

7) Yolk Color

The egg yolk color between intensive (4.9±0.8) and semi-intensive (11.1±0.8) systems there was a significant difference (t= 43.80, df=126, p<0.05) (Table 02). Khobondo et al. (2015), reported the rearing systems significantly (p<0.05) affected only the yolk color while other internal and external qualities were not significantly (p>0.05) affected. Birds on semi-intensive farms recorded a higher value for the yolk color (golden yellow), whereas deep-litter farms recorded a higher value for the (yellow color).

8) Yolk pH

The egg yolk pH between intensive (6.2±0.1) and semi-intensive (6.2±0.0) systems, there was no significant difference (t=1.3, df=126, p>0.05) (Table 02). These results are largely in line with earlier research. Therefore, Yolk pH and yolk/albumen ratio were not affected by the housing or rearing system (Wijnen et al., 2020).

Table 05: Eggs' Internal Parameters

Internal Parameters	Intensive system	Semi-intensive system	T value (p-value)
Albumen Weight (g)	29.8±3.1	27.8±1.9	1.65 (0.101)
Albumen Height (mm)	5.2±0.9	5.4±0.6	1.71 (0.086)
Albumen pH	8.6±0.2	8.6±0.2	0.25 (0.152)
Haugh Unit	74.0±7.2	77.1±4.7	0.68 (0.250)
Yolk Weight (g)	14.8±1.3	14.6±1.4	0.90 (0.502)
Yolk Height (mm)	14.6±0.9	14.5±0.9	0.64 (0.388)
Yolk Color	4.9±0.8	11.1±0.8	43.8 (0.000)
Yolk pH	6.2±0.1	6.2±0.0	1.3 (0.246)

(mean ± SD)

C. Effect of Different Rearing Methods on Nutritional Egg Qualities

1) Albumen Protein

The egg albumen protein between intensive (12.1±0.4 %) and semi-Intensive (11.6±0.6 %) systems, there was a significant difference (t= 3.62, df=68, p<0.05) (Table 03). The albumen of eggs from intensive hens had higher protein content. It was generally known that the hen's diet has a significant impact on the protein content of the egg (Rizzi, 2021).

2) Yolk Protein

The egg Yolk protein between intensive (16.2±0.4 %) and semi-Intensive (15.9±0.4 %) systems, there was a significant difference (t= 2.73, df=68, p<0.05) (Table 03). Eggs from intensive reared hens had a higher protein level in the yolk. However, Kucukyılmaz et al. (2012), found no impact of the rearing technique on the yolk protein in the egg.

3) Albumen Ash

The albumen ash between intensive (0.5±0.1 g) and semi-intensive (0.6±0.1 g) systems, there was no significant difference (t= 1.19, df=68, p>0.05) (Table 03). The different rearing System was not significantly (p>0.05) affected by egg Ash albumen. Bughio et al. (2021), reported that greater albumen ash levels (p>0.05) in the semi-intensive and free-range systems may be related to increased bird movement and better feed ingredient utilization, which eventually led to improved egg size and interior quality.

4) Yolk Ash

The yolk ash between intensive (1.7±0.2 g) and semi-intensive (1.6±0.1 g) systems, there was No significantly difference (t= 1.16, df=68, p>0.05) (Table 03). Heflin et al. (2018), reported that the ash concentration of egg yolk would differ among rearing system in summer season but different in winter season.

5) Albumen Fat

The egg albumen fat between intensive (0.4±0.0 %) and semi-intensive (0.3±0.0 %) systems, there was a significant different (t= 1.78, df=68, p<0.05) (Table 03). Egg albumen contain less than 0.19% of fat was reported in the study of Rehault et al. (2019).

6) Yolk Fat

The egg yolk fat between intensive (27.1±0.4 %) and semi-intensive (26.3±0.4 %) there was a significant difference (t= 8.43, df=68, p<0.05) (Table 03). Bughio et al. (2021), reported that the yolk fat was higher in the intensive system than in semi-intensive rearing system. Rizzi (2021), found no difference in the egg yolk fat concentration, which contrasted with the findings of Minelli et al. (2007), who found that the egg yolk fat concentration was lower in the conventional/intensive system.

7) Albumen Moisture

The egg albumen moisture between intensive (87.0±0.6 %) and semi-intensive (86.6±0.5 %) systems, there was no significant difference (t= 1.27, df=68, p>0.05) (Table 03). On the contrary, Bughio et al. (2021), reported that, higher albumen moisture in the free-range than in semi-intensive systems.

Table 06: Eggs' Nutritional Parameters

Nutritional Parameters	Intensive system	Semi-intensive system	T value (p-value)
Albumen protein (%)	12.1±0.4	11.6±0.6	3.62 (0.000)
Yolk protein (%)	16.2±0.4	15.9±0.4	2.73 (0.000)
Albumin ash (g)	0.5±0.1	0.6±0.1	1.19 (0.203)
Yolk ash (g)	1.7±0.2	1.6±0.1	1.16 (0.150)
Albumen fat (%)	0.4±0.0	0.3±0.0	0.78 (0.001)
Yolk fat (%)	27.1±0.4	26.3±0.4	8.43 (0.008)
Moisture albumen (%)	87.0±0.6	86.6±0.5	1.27 (0.098)
Yolk moisture (%)	54.9±0.5	55.3±0.6	1.73 (0.200)

(mean ± SD)

8) *Yolk Moisture*

The egg yolk moisture between intensive (54.9±0.5 %) and semi-intensive (55.3±0.6 %) systems there was no significant difference (t=1.73, df=68, p>0.05) (Table 03). According to Wagt et al. (2020), reported that, yolk of the intensive reared hen's egg had more moisture and fat. The same results were also reported by Minelli et al. (2007), who also noted significant moisture content in the yolk of eggs from confined (intensive) hens.

IV. CONCLUSION

The current study's findings indicate that the rearing systems exerted a notable influence on the external, internal, and nutritional qualities of eggs. Specifically, external attributes such as egg weight, shell thickness, and shell weight exhibited significant variations based on the rearing system. Likewise, nutritional qualities, including albumen and yolk protein, as well as albumen and yolk fat, were significantly impacted by the rearing systems. Among the internal qualities assessed (weight of albumen, weight of yolk, height of yolk, height of albumen, pH of the egg yolk and albumen, haugh unit), yolk color was notably influenced by the rearing system. Notably, semi-intensive rearing systems yielded a higher yolk color value of 11.08 (golden yellow) compared to the intensive system, which recorded a value of 4.91 (yellow color). It is important to highlight that while yolk color demonstrated significant variations based on rearing systems, it did not exert a discernible influence on the nutritional composition of eggs.

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