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Quality Analysis of External and Internal Traits of Chicken Eggs Produced Under Different Farm Conditions in India

Deepak Singh[1*], Nazim Ali[1], D.S. Sahu[1], M.K. Bharti[2], Ahmad Fahim[3], Raj Kumar[4] and Deepak Kumar[1]

[1]Department of Animal Husbandry, SVPUA&T Meerut, Uttar Pradesh, INDIA
[2]Department of Veterinary Physiology and Biochemistry, SVPUA&T Meerut, Uttar Pradesh, INDIA
[3]Department of Livestock Production Management, SVPUA&T Meerut, Uttar Pradesh, INDIA
[4]Department of Agriculture, IIMT University, Ganganagar, Meerut, Uttar Pradesh, INDIA

[*]Corresponding author: D Singh; E-mail: deepakpatel8423@gmail.com

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ABSTRACT

The purpose of this study was to examine egg features from various types of farming systems such as mechanized farm, semi-mechanized and non-mechanized farm. To examine the quality of eggs from different categories of farms, eggs were gathered from different regions of India and compared based on external and internal features. The egg weight was considerably ($P<0.01$) higher in semi-mechanized farms, according to the findings. Similarly, the semi-mechanized farm had a higher shape index than the non-mechanized farm. Egg shell thickness was found to be 0.390.00 mm on average, with no differences amongst the different production systems. The average shell weight was reported to be 6.66±0.02 g. The overall mean for albumen weight was 33.98±0.09g, and the albumen index was 3.3±0.00, both of which were statistically significant ($P<0.01$) for each farm. Mechanized farms had the greatest albumen weight (34.04±0.19g), followed by semi-mechanized (33.75±0.19g) and non-mechanized (33.04±0.19g) poultry farms. As a result, automated farm (mechanized farm) eggs were found to be of higher overall quality.

HIGHLIGHTS

- To evaluate the external and internal traits of chicken eggs produced from different farm system.
- The results revealed that the external and internal egg traits of mechanized farm were found to be superior as compared to other farms.

Keywords: External egg trait, Internal egg trait, Mechanized farm, Non-mechanized farm, Semi-mechanized farm

In India, 60% of the rural population relies mostly on agriculture for their income. Most backyards have had chickens for centuries; they provide the family with food and income. 30% of eggs were once produced in backyard henhouses. The demand for chicken products in India will grow at a pace of 4.8 percent per year over the next ten years, while the supply will increase at a rate of 5.2 percent per year a rate that is quicker than that of any other animal product. Production of agricultural crops has been growing at a rate of 1.5–2% per year, whereas production of eggs and broilers has been growing at a rate of 8–10% per year, albeit this expansion has only been seen in commercial poultry (Dhillon *et al.,* 2018). Indigenous types of breed plays a dynamic role in rural people's livelihood and food security, as they are raised in backyard production systems with cheap inputs and limited resources (Maddheshiya *et al.,* 2020). For a very long time, people have valued poultry eggs as a wholesome food with a balanced nutritional composition. Due to their high nutritional value, eggs are beneficial for many people with special dietary

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requirements (Tamilvanan *et al.,* 2014). The mechanized farm is used for large-scale commercial poultry production, including meat and egg production. These farms are well-equipped with cutting-edge technology for automating a variety of tasks in order to maximize labour efficiency. Semi-mechanized poultry farms are medium-investment layer farms that are run on a commercial scale in the majority of rural and urban regions, and have technologies that can increase hygiene standards and farm production (Andersen, 2015). Eggs were collected from chicken farms in non-mechanized farms, which practised egg production on a low-investment manner. The majority of farm operations and management are done by hand, with no use of instruments or machinery to suit the day-to-day demands of the birds (Park *et al.,* 2018). Eggs are an excellent source of animal protein, choline, essential fatty acids, sphingomyelin, lutein, and zeaxanthin, as well as other bioactive substances, antioxidants, and high-quality protein (Skender and Kanbay, 2014; Zdrojewicz *et al.,* 2016). Cleanliness, freshness, egg weight, shell quality, yolk index, albumen index, Haugh unit, and chemical composition are all aspects of an egg's quality that have an impact on consumer acceptance. Egg quality also includes other aspects of an egg's quality such as its weight, shell quality, yolk index, albumen index, and chemical composition (Bekele *et al.,* 2022). This study was started to check the difference between different types of poultry farms for performance of egg quality traits with the objectives of to evaluate egg quality traits internal and external part of eggs of indigenous chickens across different types of poultry farms.

MATERIALS AND METHODS

Collection of egg

Eggs were collected from different farms under different production system located in different regions of India. These farms were classified based on the levels of mechanization, i.e. mechanized, semi-mechanized and non-mechanized. These eggs were compared based on external and internal traits to assess the quality of eggs.

Recording of observation

External egg trait

The colour of egg was described as brown and light brown based on visual appraisal of the egg shell. Clean or dirty stained eggs were noted visually. The weight of the egg was determined on digital weighing balance. The length and width of an egg was measured to vernier caliper. The shape index was calculated according to Shultz, (1953) (SI = breadth of the egg/ length of the egg × 100). Specific gravity of egg was determined by weighing the egg and then dividing the weight by the volume of the egg.

Internal egg traits

After measuring the external characters, the eggs were broken open on the egg breaking stand for measuring their internal characteristics. The internal characteristics of egg were studied based on qualitative characteristics and bio-chemical composition of eggs. Shell thickness was measured with shell thickness gauge. The eggs shell was washed to remove the adhering albumin to determine the thickness of shell. The weight of shell after removing the inner content of egg. The yolk was gently separated from the albumin, adherent albumin was removed by rolling the yolks over a filter paper and the yolk weight was recorded. Albumin weight (g) was determined based on differences between shell weight and yolk weight to record the albumin weight. The height of the thick albumin was measured using spheareometer on a table glass. The length and width of the thick white were we measured using a vernier caliper and the mean diameters were calculated. It was used to determine albumen index based on height of albumen/ width of albumen. The height of yolk was measured using a spheareometer on a table glass. The length and width of the yolk was measured using vernier caliper. It was used to determine yolk index based on yolk height/yolk width. Yolk colour was measured by the egg analyser used for automatic evaluation of quality of hen's egg. The score was given on 1 to 16 scales according to the DSM (formerly Roche) yolk colour fan. Haugh unit is the ratio between heights of thick albumen weight of the whole egg.

It was measured based on readings of egg analyser. The range of haugh unit was from 0 to 130 HU. Egg defects was analysed based on the presence of blood or meat spots detected in the egg and Egg grades was assessed based on the readings of egg analyzer which gives grade as AA, A, B, C.

STATISTICAL ANALYSIS

The mean values calculated for each trait was analyzed according to Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

External egg traits

The least square mean for external egg traits in different production systems of layer birds are presented in Table 1. The average egg weight was 57.31±0.11 g for mechanized, semi-mechanized, and non-mechanized farm. The egg weight was significantly (P<0.01) higher for semi mechanized production system (57.80±0.18g) than in mechanized and non-mechanized production systems. Ciecek and Kartalkanat (2009) in a similar study comparing egg produced from commercial farms and under village condition reported that the average weight for commercial eggs was 64.21±.77 g, which was significantly (P<0.05) greater than the village eggs (52.24±1.26 g). Mwalusanya *et al.* (2002), in another study determined the value of egg weight under rural conditions to be 44.1 g. The average egg weight of commercial eggs in their study was 57.21 g. Monira *et al.* (2003) found the value of egg weight of 64 g in commercial farms. They also found that village eggs were lighter than commercial eggs. The average egg volume was 55.11±0.19cc for all three production systems. The average egg volume of chicken eggs was significant (P<0.01) in different production systems. The average for mechanized, semi-mechanized and non-mechanized systems was 55.81±0.19, 54.34±0.19, and 55.19±0.19cc respectively. The variation in egg volume was due to variation in length and breadth of egg, which was peculiar to farm characteristics. The average egg length was 54.48±0.79 mm in chicken eggs from different conditions. The length of eggs from different farms was found to be similar. The average egg width was 42.66±0.04 mm for different farms of chicken egg. The egg width of eggs from different farms was found to be significant in all farms. According to Altuntas and Sekeroglu (2008), for various types of farms, the average length, breadth, or thickness of chicken eggs, as well as the geometric mean diameter and unit mass of the eggs, ranged from 52.90 to 58.63 mm, 41.87 to 46.61 mm, 45.09 to 50.11 mm, and 52.23 to 71.58 g, respectively. The average shape index was 79.18±0.15 for different production systems of eggs. The average shape index of chicken eggs was significant (P<0.01) in all production systems. The variation in shape index is due to variation in length and width of egg, which is peculiar to a particular farm. Semi-mechanized farms had highest value of shape index 79.97±0.26 and non-mechanized farms had lowest value of shape index 78.33±0.26. The average specific gravity was 1.04±0.00 for chicken eggs from different farms. The specific gravity of eggs was highest in semi-mechanized farms (1.07±0.00) and lowest in non-mechanized farms (1.02±0.00) which was found to be significant (P<0.01) in different farms. Similarly, Altuntas and Sekeroglu (2008) reported that the average shape index value in chicken eggs is 79.18, 78.63, 78.37 and 79.56 for medium, large, extra-large and jumbo sized eggs, respectively. The average specific gravity was 1.04±0.00 for chicken eggs from different farms.

Internal egg traits

The internal egg traits were studied for the mechanized, semi mechanized, and non-mechanized production systems. The value of shell thickness in mechanized, semi-mechanized, and non-mechanized farms was 0.39±0.00,

Table 1: Least square means for external egg traits

Parameters	Non mechanized	Semi mechanized	Mechanized	Overall mean
Egg weight (g)	56.31±0.18^{a}	57.80±0.18^{c}	57.27±0.18^{b}	57.31±0.11
Egg volume (cc)	55.19±0.19	54.34±0.19	55.81±0.19	55.11±0.19
Egg length (mm)	53.30±0.19	54.03±0.19	56.12±0.19	54.48±0.79
Egg width (mm)	42.81±0.07^{a}	43.34±0.07^{b}	44.14±0.07^{c}	43.66±0.04
Shape index	78.33±0.26^{a}	79.97±0.26^{c}	79.23±0.26^{b}	79.18±0.15
Specific gravity	1.02±0.00^{a}	1.07±0.00^{b}	1.03±0.00^{a}	1.04±0.00

Least square means being different superscript in row differ significantly (P<0.01).

Table 2: Least square means for Internal egg traits

Parameters	Non mechanized	Semi mechanized	Mechanized	Overall Mean
Shell thickness(mm)	0.39±0.00	0.39±0.00	0.39±0.00	0.39±0.00
Shell weight (g)	6.61±0.03	6.74±0.03	6.63±0.03	6.66±0.02
Yolk weight (g)	16.57±0.05^{b}	16.31±0.05^{a}	16.60±0.05^{b}	16.94±0.03
Albumen weight (g)	33.14±0.19^{a}	33.75±0.19^{b}	34.04±0.19^{c}	33.98±0.09
Albumen index	0.03±0.00^{a}	0.03±0.00^{ab}	0.03±0.00^{b}	0.33±0.00
Yolk index	0.38±0.00^{a}	0.40±0.00^{c}	0.39±0.00^{b}	0.39±0.00
Yolk colour	1.61±0.08^{b}	1.86±0.08^{c}	1.56±0.08^{a}	1.54±0.05
Haugh unit	48.31±0.78^{b}	45.84±0.78^{a}	50.82±0.78^{c}	48.35±0.45

Least square means being different superscript in row differ significantly (P<0.01).

0.39±0.00, and 0.39±0.00 mm respectively. The average for egg shell thickness was found to be 0.39±0.00 mm which was non-significant in different production system. On contrary, Ciecek and Kartalkanat (2009), reported that the shell thickness of village eggs was 0.37±0.00 mm on an average, it was 0.34±0.00 mm in commercial eggs which was statistically significant. Senkoylu (2001), reported shell thickness related with breaking strength of egg. In the present study, shell thickness was not affected by production system and value indicated superiority of these eggs in terms of their breaking strength. In discordance to our study, Altuntas and Sekeroglu (2008), observe that chicken egg shell thickness range from 0.32 mm to 0.36 mm, which is lower than the values in present study. The shell weight in different production system was found to be 6.66±0.02 g. The shell weight in present study was significant (P<0.01) among all farms. It was found to be highest in semi mechanized farms (6.74±0.03 g), where, it was lowest (6.61±0.03 g) in the non-mechanized production farms. According to our finding, Ciecek and Kartalkanat (2009) reported that there was a statistically significant difference between the two groups' average shell weights of 5.350.15 g for village eggs and 6.530.11 g for commercial eggs. The weight of the shell in the current study is consistent with the results from the previous study's analysis of commercial chicken eggs. The result on shell weight also corresponds to the results in the studies of Ahamad *et al.* (2005) and Farla *et al.* (2000).

The average of albumen weight was found to be 33.98±0.09 g and albumen index was 3.3±0.00 which was significant (P<0.01) for different farm. Mechanized farms eggs had highest albumen weight (34.04±0.19 g), followed by semi-mechanized (33.75±0.19 g) and non-mechanized poultry farm (33.04±0.19 g). Similarly, the albumen index on mechanized farms was 3.4±0.10, followed by semi-mechanized (3.3±0.10) and non-mechanized 3.2±0.10 poultry farms. Lewko and Gornowicz (2011) reported that albumen weight ranged from 31.95 g in litter base production system to 34.89 g in hens house in cages. They found albumen content to be higher in cage system (57.04%) followed by litter (56.74%) and free range (56.17%) system with a significant difference. Dukic-Stojcic *et al.* (2009) compared the quality of eggs from caged layers and those from restricted and free-range layers and found that heavier eggs with higher albumen content was laid by caged hens. The findings reported above for albumen weight confirms the result of our study, in which the weight of eggs from caged hens under mechanized system was higher than other production system. On contrary, Sekeroglu *et al*. (2010) reported that the most favourable quality traits of albumen from the analysed eggs were greatest from hens raised on litter. Ciecek and Kartalkanat (2009) reported that the albumen index did not vary significantly for village and commercial eggs. They reported higher values i.e. 9.27% for village eggs and 8.64% for commercial eggs. The average yolk weight in different production system of eggs differ significantly (P<0.01). The average for yolk weight in different production systems was 16.94±0.03 g. Mechanized farm eggs had higher yolk weight (16.60±0.05 g) followed by non-mechanized farm (16.57±0.05) and semi-mechanized farms (16.31±0.05 g). The overall mean for yolk index was found to be 0.39±0.00 in different production system of egg under present study. In this study, the semi-mechanized farms had highest value 0.40±0.00 followed by non-mechanized farms 0.39±0.00 and mechanized farms had lowest value 0.38±0.00. The mean for different production systems was found to be significant ($P<0.01$). Ciecek and Kartalkanat (2009) in similar study reported that the yolk index of village eggs was 45.3% and the yolk index for commercial index was 43.9%.

The average for yolk colour was 1.61±0.08, significant difference ($P<0.01$) in yolk colour was found. The highest value of yolk colour was found to be semi-mechanized form (1.86±0.08) followed by non-mechanized forms (1.61±0.08) and mechanized forms (1.56±0.08). The difference in management was found to affect the yolk colour. In agreeing with our study, Ciecek and Kartalkanat (2009) reported that the yolk colour of non-mechanized farm was darker than the mechanized farm. In this characteristic, a statistically significant difference was found. Yolk colour changes depending on how chicken are fed. Also, Yenice *et al.* (2016) observed that yolk colour of eggs obtained from the family type system was superior to that obtained from the cage and free-range systems. The average for haugh unit was found to be 48.35±0.45, which was significant in different types of farms. The highest value of haugh unit was found to be in mechanized forms (50.82±0.78) followed by non-mechanized forms (48.31±0.78) and semi mechanized farms (45.84±0.78). Similarly, Suto *et al.* (1997) and Sekeroglu (2002) reported that housing system had a significant effect on haugh unit. On contrary, Ciecek and Kartalkanat (2009) reported that the haugh unit, which is based on albumen height and egg weight, was 85.82±1.56 for village eggs and 82.64±1.60 for commercial eggs were statistically non-significant.

CONCLUSION

In this research we concluded that the eggs from mechanized farm were found to be superior as compared to non-mechanized and semi mechanized farms. Mechanized farm eggs are superior in yolk colour, albumen height, albumen index, egg weight, haugh unit and also good in shape index. Non-mechanized and semi-mechanized farm systems do not always signify the better welfare because of cannibalism, stress, lack of feed, parasites and diseases etc., which can affect the egg quality. The external and internal egg traits differ with the level of mechanization.

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