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Evaluation of Key Egg Quality Parameters in Poultry: Measurement Techniques and Industry Implications

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Abstract

Poultry farming significantly contributes to India's agricultural economy, offering income opportunities and nutritional benefits to small-scale farmers and egg quality is a critical factor in the poultry industry, influencing market value, consumer preference, hatchability, and overall production efficiency. This study evaluates key egg quality parameters and their measurement techniques, providing insights into their role in genetic selection, breeding efficiency, and poultry management. Key Parameters such as egg weight, dimensions, shell strength, yolk color, albumen height, Haugh unit, and yolk-to-albumen ratio are assessed using precision instruments, including Vernier calipers, micrometers, and electronic balances. Understanding these traits aids in optimizing poultry nutrition, enhancing egg quality, and ensuring industry s tandards. By examining genetic variations and environmental influences on egg characteristics, This study aims to enhance productivity and sustainability in poultry farming.

Keywords: Poultry farming, Egg quality, Measurement techniques, Breeding efficiency, Consumer preference, Sustainability

Introduction

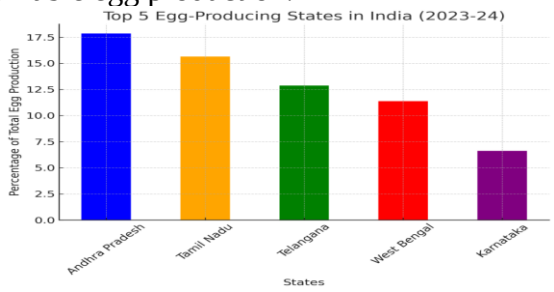
Poultry farming is among the fastest-growing sectors within Indian agriculture. India's total egg production stands at 114.92 billion eggs from commercial poultry (contributing 50.49%) and 2.7 billion eggs from backyard poultry (accounting for 19.30% of total production). Globally, China is the largest egg producer, with 34.4 million tonnes**,** followed by India and the US, each producing 16.5 million tonnes. The per capita egg availability has increased by 0.98% compared to 2022-23**.** In 2022-23, the livestock sector contributed ₹1,355,400 crore to India's Gross Value Added (GVA), with the egg industry alone contributing ₹158,380 crore.

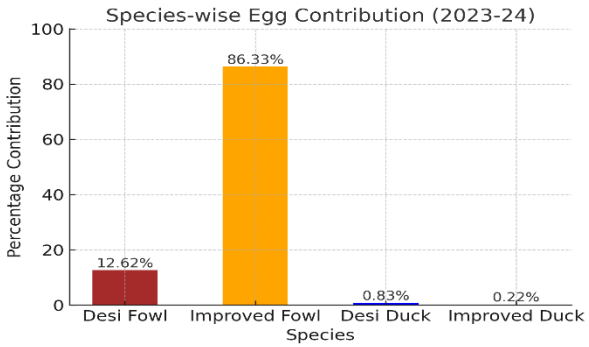
According to the 20th Livestock Census, India's poultry population stands at 851.81 million, reflecting a 16.81% increase compared to the 19th Livestock Census of 2012. This sector plays a crucial role in supporting individuals with minimal or no land ownership by offering an additional source of income while also supplying them with nutritious eggs and meat for personal consumption (Dinesh *et al.*, 2018).

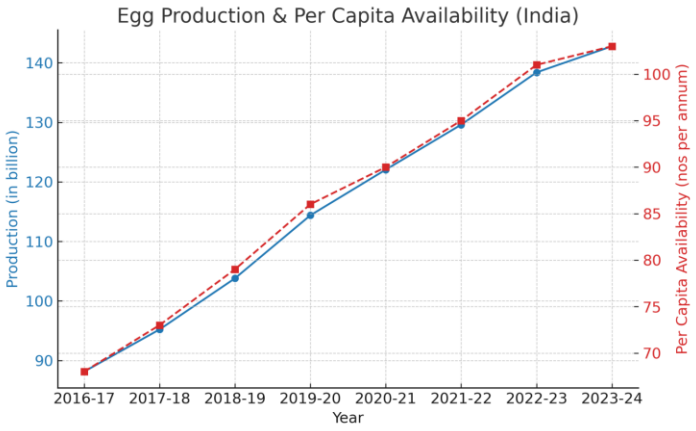
Over the years, the poultry industry has witnessed significant growth. In 2022-23, the country produced a total of 142.77 billion eggs, positioning India as the second-largest egg producer globally. Compared to 2022-23, egg production saw a 3.17% increase as of 2024, the per capita egg availability in India is 103 eggs per year (BAHS Statistics 2024).

India's top five egg-producing states are Andhra Pradesh (17.85%)**,** Tamil Nadu (15.64%)**,** Telangana (12.87%)**,** West Bengal (11.37%)**,** and Karnataka (6.62%)**.**Additionally, as per the 20th Livestock Census (2019), Himachal Pradesh recorded a poultry population of 1.34 million.

Egg parameter plays a vital role in consumer preference and the poultry industry, influencing market value, hatchability in breeding programs, and overall production efficiency. As a staple food worldwide, eggs provide essential nutrition, making their quality assessment crucial for ensuring consumer satisfaction and industry standards. By evaluating key egg parameters, poultry farmers and researchers can gain insights into the health of laying hens, optimize breeding efficiency, and enhance genetic selection for superior breeds. Understanding these traits not only improves productivity but also supports advancements in poultry farming and sustainable egg production.







Key Egg Parameters and Measurement Techniques

1. Egg Weight

- Egg weight is a key factor in determining both quality and market value.
- It is measured using a precision balance.
- Standard egg weight typically falls between 50-70 grams, depending on breed and nutritional factors.

2. Egg Length and Width

- Measuring egg length and width is crucial for evaluating quality, hatchability, and production efficiency. These dimensions contribute to calculating the egg shape index.
- In genetic and breeding research, egg measurements offer insights into heritability and genetic correlations related to egg production.
- A Vernier caliper is used to measure egg length and width (Rath *et al*., 2015).
- Studies by Niranjan *et al.* (2008) and Sinha *et al.* (2018) reveal significant breed variations in egg size, with Desi breeds averaging 35.51 mm in length and 37.1 mm in width, while Rhode Island Red (RIR) eggs measure around 57.8 mm in length and 44.3 mm in width**.**

3. Egg Shape Index

- The egg shape index is an indicator of egg quality, shell durability, and market acceptability. It also impacts hatchability, as irregularly shaped eggs may reduce embryo survival.
- The formula for calculating the egg shape index is:

(Egg width/Egg length) × 100 (Şekeroğlu *et al.* ,2014).

- The typical egg shape index ranges from 57% to 92%, with values outside 74% linked to an increased risk of cracking (Narushin, 2005; Popova-Ralcheva *et al.*, 2009).

4. Shell Thickness

- Shell thickness influences egg strength and resistance to breakage.
- It is measured at three different points—broad end, narrow end, and equatorial region—using a micrometer, with the final value being the average (Şekeroğlu *et al.* ,2014).

- The ideal shell thickness typically falls between 0.3-0.4 mm.

5. Shell Strength

- Shell strength ensures eggs can withstand handling and transportation. It is primarily influenced by calcium levels in the hen's diet.
- This parameter is measured using an eggshell strength tester.

6. Yolk Color

- The color of the yolk is primarily determined by the hen's diet, especially carotenoid-rich feeds.
- Yolk pigmentation is evaluated using a Roche Yolk Color Fan, which provides standardized shades from pale yellow to deep orange.

7. Albumen Height

- Albumen height serves as an important indicator of egg freshness and protein quality.
- It is measured using a tripod micrometer and is essential for calculating the Haugh unit, a widely used metric for assessing internal egg quality**.**

8. Haugh Unit

- The Haugh unit is a key standard for evaluating egg freshness and protein content, with higher values indicating superior quality.
- It is calculated using the formula: **100log10 (height of albumin + 7.5 - 1.7 (weight of egg) 0.37).**

9. Yolk-to-Albumen Ratio

- This ratio is critical in determining an egg's nutritional balance and suitability for various culinary applications.
- It is determined by weighing both yolk and albumen separately (Rath *et al*., 2015).

10. Albumen Length and Width

- Measuring the length and width of the albumen provides insights into egg freshness and internal quality.
- Larger albumen dimensions indicate higher water-holding capacity, which impacts hatchability and consumer preference.
- A Vernier caliper is used for consistent measurement.

11. Yolk Height and Width

- These parameters are used to assess egg nutritional value and quality. A greater yolk height indicates higher freshness.
- Yolk dimensions are measured using a Vernier caliper, with yolk width calculated as the average of two different measurement points.

12. Yolk Weight

- Yolk weight plays a crucial role in evaluating an egg's nutritional composition and energy value.
- It is significant in breeding programs and dietary studies for analyzing the impact of genetics and nutrition.
- A precision electronic weighing balance is used for measurement.

13. Shell Weight

- Shell weight is an important factor in assessing eggshell strength and thickness, influencing breakability and hatchability.
- It is closely linked to the hen's mineral intake and overall health.
- After drying the eggshell for two consecutive days, its weight is measured using an electronic weighing balance (Rath *et al.*, 2015).

14. Albumen Index

- The albumen index, which represents the ratio of albumen height to its length and width, is a key parameter for assessing freshness and structural integrity.
- The formula for calculating the albumen index is: **[Albumen height / (Albumen length + Albumen width) / 2] × 100**
- Jha and Prasad (2013) found that improved breeds generally have higher albumen index values compared to indigenous breeds, with native birds showing an average albumen index of 10.17±0.19.

15. Albumen Weight

- Albumen weight is crucial in determining the protein content and overall commercial value of eggs.
- It is calculated using the formula: **Egg weight - (Yolk weight + Shell weight).**

16. Yolk Index

- The yolk index, representing the ratio of yolk height to yolk diameter, is a key measure of yolk quality and freshness. A higher value signifies a firmer, fresher yolk, which is desirable for both table eggs and hatching.

- It is calculated as:
  (Yolk height / Yolk diameter) × 100.

17. Shell Percentage

- Shell percentage, which reflects the proportion of shell weight relative to total egg weight, is essential for evaluating shell quality.
- It impacts microbial protection and resistance to mechanical damage.
- Shell percentage is calculated as: **(Shell weight / Egg weight) × 100** (Abdallah *et al.*, 1993).
- Studies indicate that younger hens tend to produce eggs with higher shell percentages, although each hen maintains relatively consistent shell quality throughout her laying period (Marion *et al.*, 1965).

18. Egg Surface Area

- The egg surface area is a critical factor in estimating heat and gas exchange during incubation.
- It also plays a role in evaluating eggshell quality and optimizing commercial egg processing and packaging.
- The formula for calculating egg surface area is: **Egg surface area = 3.9782 × egg weight$^{0.70}$**

Conclusion

Evaluating egg quality parameters is essential for maintaining high-quality egg production. These evaluations help optimize breeding strategies, improve poultry nutrition, enhance consumer satisfaction, and contribute to the economic growth of the poultry industry. Whether for commercial egg production or research, understanding these parameters ensures better outcomes in the poultry industry.

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