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A Comparative Study of Physical Characteristics and Albumin Protein Content of Different Avian Eggs

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Abstract: ***Introduction: Eggs play a vital role in avian reproduction by providing a protective environment for embryonic development. The physical characteristics of avian eggs, including size, weight, shape, shell thickness, and yolk-to-albumin ratio, vary across species and are adapted to ecological and physiological requirements. Egg albumin is crucial in supplying nutrients and offering antimicrobial protection, making the study of albumin protein content across avian species significant for biological and nutritional sciences. Methodology: This study aimed to compare the physical characteristics and albumin protein content of eggs from four avian species: Broiler chicken (Gallus gallus domesticus), Domestic chicken (Gallus gallus), Domestic duck (Anas platyrhynchos domesticus), and Common quail (Coturnix coturnix). Eggs were collected from local sources and analyzed for whole egg weight, albumin and yolk weight, yolk color, albumin pH, and protein concentration. Results: The results indicated that Domestic Duck eggs had the highest weight (68.57±1.35 gm), while Common Quail eggs were the lightest (10.95±0.45 gm). The pH of albumin was highest in Duck eggs (8.66±0.07) and lowest in Gavran eggs (7.67±0.02). Yolk color varied from yellow in Broiler to deep orange in Duck eggs. Quail eggs showed the highest albumin protein concentration (2.99±0.20 mg/ml), making them nutritionally dense. Conclusion: These findings highlight species-specific differences influenced by genetic and environmental factors and offer insights into avian reproductive adaptations and the nutritional significance of eggs.***

Keywords: Avian egg, egg whole weight, albumin protein, albumin pH, yolk color

1. Introduction

Eggs play a crucial role in avian reproduction, serving as protective enclosures that support embryonic development [1]. Avian eggs exhibit considerable variation in physical characteristics such as size, shape, weight, shell thickness, and yolk-to-albumin ratio, which are adaptations to the ecological and physiological needs of different bird species [2]. Egg albumin is particularly significant as it provides essential nutrients and protects against microbial invasion, making its study important in biological and nutritional sciences [3].

The physical characteristics of avian eggs are shaped by evolutionary pressures, habitat conditions, and reproductive strategies. Egg size and weight generally correlate with bird body size, with larger species producing larger eggs [4]. Egg shape, defined by elongation and asymmetry indices, varies among species and reflects nesting behaviors, incubation strategies, and predation risks [5]. For instance, seabirds nesting on cliffs lay pyriform (pointed) eggs to prevent rolling [6]. Shell thickness is crucial for structural integrity and gas exchange, with thicker shells providing better protection against breakage and microbial infiltration [7]. Shell porosity affects water loss and embryonic respiration, with species in arid environments having thicker shells to minimize desiccation [2].

Egg albumin, or egg white, comprises approximately 88-90% water and 10-12% proteins, offering essential amino acids and bioactive compounds for embryo development [8]. Albumin protein content varies across species due to genetic, dietary, and environmental factors [9]. Key proteins include ovalbumin, ovotransferrin, ovomucoid, lysozyme, and avidin, each contributing to nutritional and antimicrobial properties [10]. Ovalbumin, making up about 54% of total egg white protein, serves as a primary nutrient source. Ovotransferrin and lysozyme inhibit bacterial growth, while avidin binds biotin to restrict microbial access [11].

Comparative studies reveal interspecific variations in egg composition shaped by reproductive strategies and environmental adaptations [12]. While domesticated chicken eggs are well-studied, wild species' eggs remain less characterized [8]. Waterfowl eggs, adapted to aquatic environments, exhibit higher albumin protein content and stronger antimicrobial properties (Board & Scott, 1980). Understanding these variations is vital for ornithology, food science, and conservation biology [5, 10].

2. Materials and Methods

The present study involved the selection and analysis of eggs from four avian species: broiler chicken (*Gallus gallus domesticus*), domestic or Gavran chicken (*Gallus gallus*), domestic duck (*Anas platyrhynchos domesticus*), and common quail (*Coturnix coturnix*). Broiler chicken eggs were procured from a licensed chicken shop, while domestic chicken, duck, and quail eggs were sourced from farmers in nearby villages. The physical examination of the eggs included measuring the whole egg weight, albumin weight, and yolk weight. The yolk color was visually inspected and documented. The pH of the egg albumin was measured using a pH meter to determine its acidity or alkalinity.

Additionally, the total protein content of the egg samples was analyzed following the method described by Lowry et al. [13].

3. Results

Weight of Whole Egg, Albumin, and Yolk

The data indicates that the Domestic Duck eggs have the highest weight (68.57±1.35 gm), while Common Quail eggs have the lowest (10.95±0.45 gm). The Broiler egg albumin weight (29.65±2.4 gm) is higher than Gavran (27.69±2.12 gm), but lower than Duck (32.84±2.7 gm). Similarly, the yolk weight is highest in Duck eggs (26.88±3.54 gm) and lowest in Quail eggs (3.34±0.3 gm). This suggests that the size and composition of the egg vary significantly between species, which may be influenced by genetic and environmental factors (Table 1; Figure 1).

Table 1: Weight of Whole egg, albumin and yolk of Broiler, Gavran, Duck, and Quail Eggs (gm)

Physical Parameter	Broiler	Domestic or Gavran	Domestic Duck	Common Quail
Whole Egg Weight	54.096±2.95	47.77±1.3	68.57±1.35	10.95±0.45
Weight of Egg Albumin	29.65±2.4	27.69±2.12	32.84±2.7	5.764±0.11
Weight of Egg Yolk	16.45±1.06	12.25±0.34	26.88±3.54	3.34±0.3

*Values are presented as Mean±SD

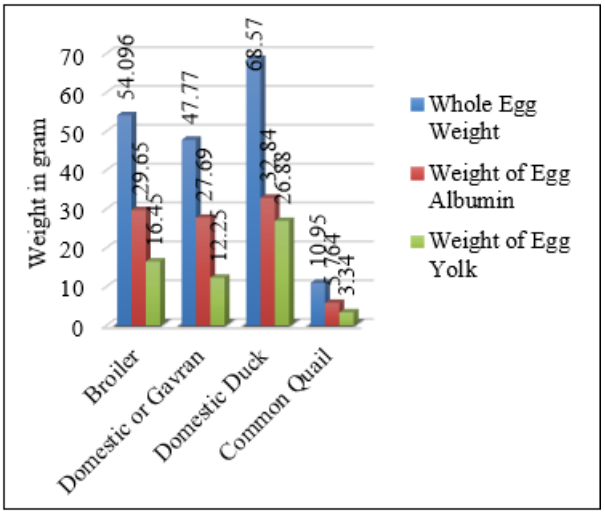

Figure 1: Weight of Whole egg, albumin and yolk of Broiler, Gavran, Duck, and Quail Eggs

pH of Albumin

The pH of Duck egg albumin (8.66±0.07) is the highest, followed by Broiler (8.28±0.02), Quail (7.8±0.16), and Gavran (7.67±0.02) (Table 2; Figure 2). The higher pH in Duck eggs indicates increased alkalinity, which can affect the egg's stability and protein structure.

Table 2: pH of Broiler, Gavran, Duck, and Quail Egg Albumin

Broiler	Domestic or Gavran	Domestic Duck	Common Quail
8.28±0.02	7.67±0.02	8.66±0.07	7.8±0.16

*Values are presented as Mean±SD

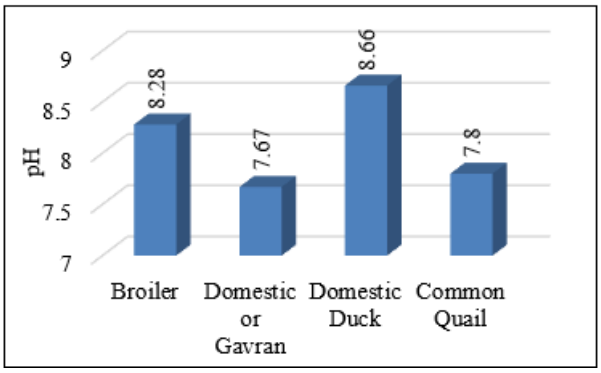

Figure 2: Albumin pH of selected eggs

Color of Yolk

The color of the yolk varies across species: Yellow in Broiler, Golden Yellow in Gavran, Deep Orange in Duck, and Golden in Quail (Figure 3). This variation in yolk color reflects differences in diet and carotenoid content, which directly influences the nutritional value and consumer preference.

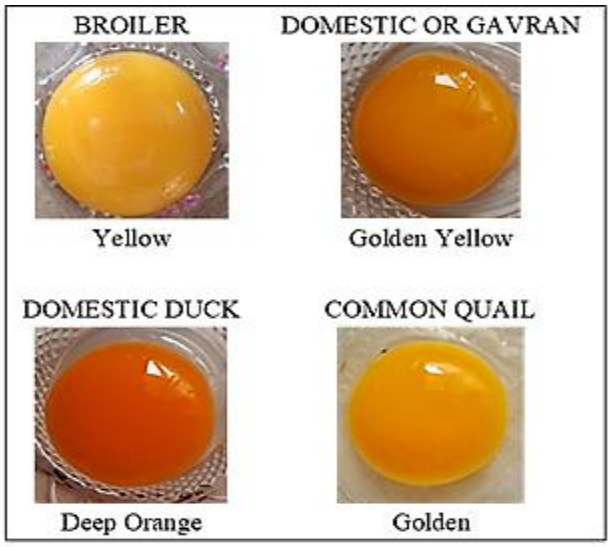

Figure 3: Yolk Color of Broiler, Gavran, Duck, and Quail Eggs

Albumin Protein

The protein content is highest in Quail eggs (2.99±0.20 mg/ml), followed by Broiler (2.97±0.22 mg/ml), Duck (2.83±0.22 mg/ml), and lowest in Gavran eggs (2.04±0.08 mg/ml) (Table 3; Figure 4). This indicates that smaller eggs, such as Quail, are more protein-dense, which can be beneficial for dietary purposes.

Table 3: Albumin Protein of Broiler, Gavran, Duck, and Quail Eggs (mg/ml)

Broiler	Domestic or Gavran	Domestic Duck	Common Quail
t2.97±0.22	2.04±0.08	2.83±.22	2.99±0.20

*Values are presented as Mean±SD

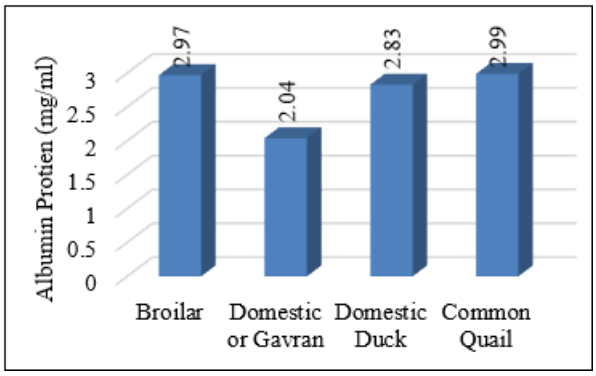

Figure 4: Albumin Protein of Broiler, Gavran, Duck, and Quail Eggs

4. Discussion

The comparative analysis of the physical characteristics and albumin protein content of different avian eggs reveals significant variations influenced by species-specific genetic and environmental factors. Domestic Duck eggs exhibit the highest weight (68.57±1.35 gm), while Common Quail eggs are the lightest (10.95±0.45 gm), aligning with research suggesting larger bird species produce heavier eggs due to evolutionary adaptations for embryo protection and nutrient supply [14]. Albumin and yolk weights follow a similar pattern, with Duck eggs having the heaviest albumin (32.84±2.7 gm) and yolk (26.88±3.54 gm), while Quail eggs have the lowest (3.34±0.3 gm), reflecting the influence of dietary intake and metabolic efficiency [15].

The pH analysis indicates Duck egg albumin has the highest alkalinity (8.66±0.07), followed by Broiler (8.28±0.02), Quail (7.8±0.16), and Gavran (7.67±0.02) eggs. Elevated pH levels suggest species-specific albumin composition and its role in protein stability and microbial resistance [16, 17]. Yolk color varies from Yellow in Broiler, Golden Yellow in Gavran, Deep Orange in Duck, to Golden in Quail, influenced by carotenoid intake, which enhances yolk pigmentation and nutritional value [18].

Albumin protein concentration is highest in Quail eggs (2.99±0.20 mg/ml), followed by Broiler (2.97±0.22 mg/ml), Duck (2.83±0.22 mg/ml), and Gavran eggs (2.04±0.08 mg/ml), consistent with findings on egg size and protein density [19]. These differences underscore the impact of genetics and environment on egg quality, suggesting further exploration into dietary modifications for improving nutritional profiles.

5. Conclusion

A comparative study on the physical characteristics and albumin protein content of different avian eggs reveals species-specific variations due to genetic and environmental factors. Domestic Duck eggs had the highest weight, albumin, and yolk content, while Common Quail eggs were the lightest. Duck eggs showed the highest pH, enhancing microbial defense, and their deep orange yolk color reflected higher carotenoid content. Quail eggs contained the highest protein concentration, highlighting their nutritional value. These findings enhance the understanding of avian egg diversity and their nutritional significance, offering insights into species-specific egg properties and their potential dietary benefits.

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Author Profile

Ms. Jessica Philip Pinto, a dedicated and meritorious student of Third Year B.Sc. Zoology at AKI's Poona College of Arts. Science and Commerce, Camp, Pune (Maharashtra), exemplifies academic excellence and a strong passion for research. With a keen interest in advanced branches of life sciences, she possesses remarkable research temperament and high moral values. Her diligence and perseverance have earned her accolades in various state and national-level co-curricular competitions. Jessica's ambition is to contribute significantly to the scientific community as a researcher, constantly striving for innovation and excellence. Her commitment to learning and exploration makes her a promising young scientist, ready to make meaningful contributions to the field of life sciences.

Dr. Shoeb Ahmad (M.Sc., Ph.D., Post. Doc) is an Assistant Professor of Zoology at AKI's Poona College of Arts, Science, and Commerce, Pune, with eight years of teaching experience at UG and PG levels and 11 years of research experience. He was awarded India's prestigious SERB-DST Fast Track Scheme for Young Scientists and the DERO-Young Scientist Award. His academic contributions include 30 research papers (17 in international and 13 in national journals), one textbook, and five book chapters. As a recognized Ph.D. guide at Savitribai Phule Pune University, three students are currently pursuing their Ph.D. under his mentorship. Dr. Ahmad has presented 11 research papers at national and international conferences and serves on the advisory board of WJPR, Bulgaria, and the editorial board of GJMS, Jabalpur. He holds life memberships in esteemed scientific organizations, including SOBSI, ISCA, DERO, and TERA, reflecting his dedication to academic excellence and research.