Comparative physicochemical properties and selected mineral contents of *Gallus domesticus* eggs of famous poultry farms available in lahore, Pakistan

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Abstract

Eggs are low cost food stuff and popular in diet mostly in breakfast menu. The present study was conducted with the purpose to evaluate *gallus domesticus* egg quality by comparison of physicochemical analysis and selected mineral content in albumen and yolk distinctly. The liquid albumen and yolk samples were separated and converted into powder. The standard methods of Association of Official Analytical Chemist were used for physicochemical analysis and atomic absorption spectrophotometer was used for mineral detection. All statistical analysis of albumen and yolk samples (Omega-3, Classic, Sb, Menu, and Domestic) was evaluated by One Way ANOVA with POST HOC-LSD within groups. Findings of physicochemical analysis of albumen and yolk were statistically significant and ensure egg quality traits. The concentration of calcium in all albumen and yolk samples were higher than copper, iron and zinc concentration. In comparison with other minerals copper concentration was lowest in a albumen and yolk samples. Mineral level was statistically insignificantly different in all samples. Present study suggested that all egg samples were safe for human consumption and minerals content was according to the requirement.

Keywords

Gallus gallus domesticus, Albumen and yolk, Poultry farms, Egg quality traits, Food safety.

1. INRODUCTION

Poultry industry is one of the most structured branches of the agro based section (Nabi *et al*., 2020). Hen products egg and meat are cheapest and effortlessly available source of protein to eradicate the gap in the satisfaction of protein in human beings (Pires *et al*., 2019). Government supported this sector by; giving relaxation in tax deposition, approving the Punjab poultry production act and by expansion of suitable slaughter houses (Aslam *et al*., 2020).Pakistan has become the 11th prevalent capon producer in globe. In deve-

developing countries the availability of eggs is constantly escalating at the rate of 4% annually. Pakistan exports live poultry and meat to Turkey, Bahrain, Hong Kong, Afghanistan and Iran (Rehan *et al*., 2019). In the countryside 28,000 profitable poultry farms and 150+ feed mills are in consequence of great venture (Imtiaz *et al*., 2020). Poultry sector invest (1.3%) to the state GDP (Hussain *et al*., 2015).The predictable integer of saleable chickens in the countryside in 2017 was 1,022 million birds with making of 17,083 million eggs and 1,270,000 tons of meat (Aslam *et al*., 2020). Fowl region has twist out to be a great source of employment to more than 1.7 million people (Abbas *et al*., 2018).

Chicken (*Gallus–gallus domesticus*) is an important domestic pullet bird. The layer (egg laying) and the broiler (meat purpose) are focused breeds of chicken (Nisar *et al*., 2019). Phylogenetic studies explores that chickens are evolved from the red jungle fowl (*Gallus gallus*) (Innak *et al*., 2019). In each consecutive year the population of layer and broiler has been increased in Pakistan. Many factors are involved in poultry production and consumption rate such as season, disease out breaks, demand, and price (Hameed *et al*., 2017). Chicken eggs are most prominent food for human being because it fulfills all the requirement of body for better growth and nourishment. In comparison with a particular nutrient supplement, eggs distribute smoothly metabolized nutrients and immune factors (Lutter, Iannotti, Stewart, 2018).

Egg components are shell, yolk and albumen. Egg shell is solid outer part of egg that makes 9-12% of egg, yolk is central part of egg that makes 30-32% of egg and albumen is white liquid that makes 60% of egg. For the interior setup of egg, various membranes performed different finctions as firstly the egg shell play an important role in the formation of embryonic chamber and protect from bacterial and viral attack. It remains disconnect from the albumen due to the inner and outer shell membranes (Zaheer, 2015).

Egg shell prepared from 90% calcium carbonate and egg shell membranes are very thin that can be visible on peeling boiled egg. Chalazae membrane is present in egg, and its structure is like a twisted strand and keeps the yolk in the centre. The vitelline membrane surrounds the yolk and stops the leakage of yolk into albumen (Eddin, Ibrahim, Tahergorabi, 2019). In albumen, different proteins such as; Ovalbumin, Ovomucin and Ovotransferrin are present and keeps yolk in centre and stops bacterial growth (Quan, Benjakul, 2019).

Healthy diet has an indispensable function in growth and also in tumbling the diseases (Chand *et al*., 2018). Human can get the required amount of nutritionally important minerals from eggs (Hashish *et al*., 2012). Copper is useful for energy breakdown and blood development (Kiczorowska *et al*., 2015). Calcium acts as a key factor in muscle tightening, bone health, and movement (Waheed *et al*., 2019). Iron is necessary for the production of blood and metabolic functions (Abbas pour *et al*., 2014). Zinc has role in protein synthesis, cell replication, tissue growth and also responsible for genetic expression (Yasuda, Tsutsui, 2016). Minerals deficiency consequences are decrease in efficiency of immune system and increase the possibility of the diseases (Gharibzahedi, Jafari, 2017). For most objectives of research work was to study the comparative account of physico-chemical properties and selected mineral content in albumen and yolk of famous poultry farms eggs accessible in Lahore, Pakistan.

2. MATERIALS AND METHODS

The research work was completed in the Chemistry Department University of Engineering and Technology, Lahore.

Sample collection

Egg samples of three leading poultry industries of Pakistan were purchased from market place Carrefour, Lahore and domestic egg samples were collected from the colony of University of Engineering and Technology Lahore. Omega-3 and Classic eggs were the product of Wahdat poultry farm, Menu eggs were the product of seasons food while the egg product of Sadiq poultry farm was mentioned as Sb eggs (Fig- 1). All egg samples were bought in one dozen packing with stamped expiry date (interval of 2-3 weeks from purchasing date) and stored in a refrigerator at normal temperature before use. Before expiry date all egg samples were converted into powder form and were labeled. Total number of albumen and yolk samples (Omega-3, Classic, Sb, Menu, and Domestic) was15. Analysis of dried powder yolk and albumen sample was performed in triplicate.

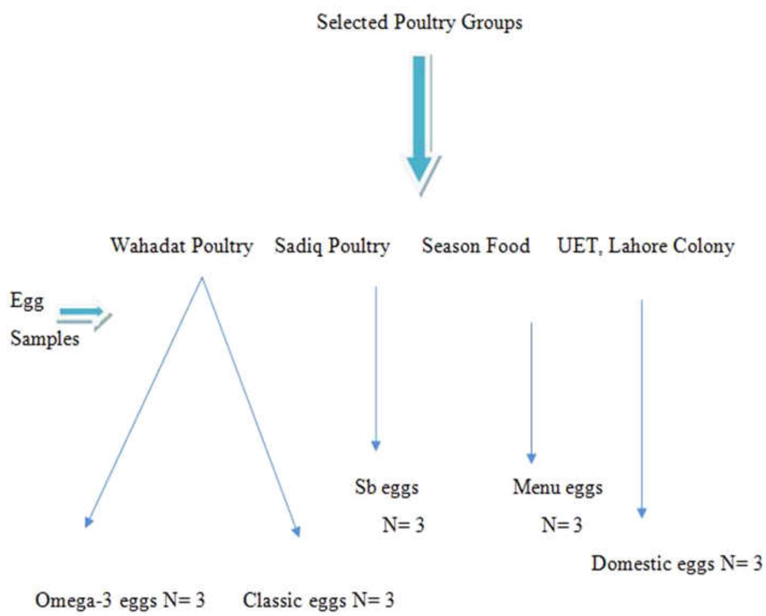

Fig-1: Schematic representation of sample collection

Sample preparation

Randomly cleaned three egg samples from each source were broken in a bowl and their yolk and albumen was placed into two separate petri dishes. The separated sample (albumen and yolk) of each source were kept in an oven for the drying purpose at specific temperature of 60° C for 4 hours. Oven dried albumen and yolk of each sample (Omega-3, Classic, Sb, Menu, and Domestic) were converted into powder form with the help of pestle mortar. Codes used for albumen and yolk were 'A' and 'Y' respectively. All dried samples (Omega-3, Classic, Sb, Menu, and Domestic) were stored in air-tight plastic bottles. These samples were used for physicochemical analysis and mineral analysis by acid digestion method (Ndife *et al*., 2010).

Instruments

Following instruments were used for physicochemical and mineral analysis. Atomic absorption spectrometer (PG-990 Model, UK Equipped), Windy oven (Eyela WFO-450ND Tokyo), Muffle furnace (A product of PCSIR), DSM Yolk Fan™ (With 16 blades) and 1-14 pH test strips (by JIN LI DA).

Physical analysis of egg

Before cracking vernier caliper was used for length and width measurement. Shape index of samples (Omega-3, Classic, Sb, Menu, and Domestic) was calculated by formula.

$$\textbf{SI} = \textbf{width/length} \times \textbf{100}$$

After breaking the weight of egg, (albumen and yolk), and shell was checked by the help of weighing balance (Chand *et al*., 2018).

DSM Yolk Fan ™ (With 16 blades) was used to note the egg Yolk color value and 1-14 pH test strips (by JIN LI DA) was used to check the pH value of albumen and yolk of each sample (Omega-3, Classic, Sb, Menu, and Domestic) (Barbosa*et al*., 2011).

Proximate analysis

All procedures that used for the proximate analysis were according to AOAC (Association of Official Analytical Chemists) methods (AOAC, 1990 ; Rubab *et al*., 2020 a).

Moisture content

Washed, dried and pre-weighed crucibles were used. 1g powder albumen and yolk of each sample (Omega-3,Classic, Sb, Menu, and Domestic) was taken into separate crucibles. All labeled crucibles were placed in an oven at temperature 105°C for 2 hours. The sample containing crucibles were placed in desiccators until reweighed. The loss in weight was considered as percentage moisture. The process was performed in triplicate for yolk and albumen samples separately. By using following formula, the percentage of loss water was calculated (Al-awwal *et al*., 2015).

$$\textbf{Moisture \%} = (w_1 - w_2) / w_1 \times 100$$

w_1 = Weight of sample + crucible before drying
w_2 = Weight of the sample after drying

Ash content

1g oven-dried albumen and yolk of samples (Omega-3, Classic, Sb, Menu, and Domestic) were taken in pre-weighed crucibles (w_1). After labeling, the crucibles were kept in an electric muffle furnace at 600- 650°C for 6-7 hours. All albumen and yolk samples were ignited into grey or white ash. Ash containing crucibles were relocated into the desiccators for cooling purposes. Cool crucibles were weighed instantaneously (w_3). Triplicate analysis was performed for egg albumen and yolk separately. Percentage ash was calculated by listed formula (Gul, Safdar, 2009).

$$\textbf{Ash \%} = w_3 - w_1 / w_2 \textbf{ (wt. of sample)} \times 100$$

Crude fat analysis

1g albumen and yolk of samples (Omega-3, Classic, Sb, Menu, and Domestic) was placed separately in pre-weighed filter paper. Samples were tightly packed into filter paper and kept in a beaker. The n- hexane was added in each sample beaker and kept them overnight. After the solvent vaporized, the filter paper was weighed again. The difference between the initial and final weight of filter paper was considered as the crude fat content in both yolk and albumen samples.

Crude fat % = w_1-w_2/s × 100

w_1= Initial weight of filter paper + sample
w_2= Final weight of filter paper + extracted fat
s= Sample weight (Al-awwal *et al*., 2015; Kovalcuks *et al*., 2017).

Minerals analysis

For the analysis of selected mineral content the albumen and yolk samples (Omega-3, Classic, Sb, Menu, and Domestic) were prepared by acid digestion method.

Acid digestion

1g oven dried albumen and yolk samples (Omega-3, Classic, Sb, Menu, and Domestic) were taken into conical flasks separately. 20 ml nitric acid was added into the flask for digestion process. These samples were placed overnight. The next day, both yolk and albumen samples were boiled on pre-heated sand baths. 10ml sulfuric acid was added into boiled sample. The digestion of the sample continued until a clear solution was obtained. After that, the clear solution was filled with 100ml distilled water. At the end, sample solution was filtered and sealed into plastic bottles. According to the standard method of Atomic Absorption Spectrometer (PG-990 Model, UK Equipped) the minerals were determined (Ul Islam *et al*., 2014).

Statistical analysis

Initially data was organized using Mean and standard deviation. All statistical analysis to estimate the physicochemical properties and concentration of selected minerals in albumen and yolk samples (Omega-3, Classic, Sb, Menu, and Domestic) were performed using SPSS. All data was evaluated by One Way ANOVA with POST HOC-LSD within groups. The P- value of d 0.05 was statistically significant (Rubab *et al*., 2020 b).

3. RESULTS AND DISCUSSION

3.1. Physical analysis

In the present investigation the physical analysis of samples (Omega-3, Classic, Sb, Menu, and Domestic) were evaluate. The results of yolk color, yolk pH, yolk weight, albumen pH, albumen weight, and shell weight and shape index were significantly different from each other with P-value d" 0.05. Table I showed the results of physical analysis of all samples.

3.2. Proximate analysis

Moisture content of albumen and yolk samples (Omega-3, Classic, Sb, Menu, and Domestic) was calculated**.** Moisture content in all albumen samples was in between (49±0.57% - 87.7±1.15%). Omega-3 albumen showed a high percentage (78.3±2.30%) of moisture. Menu albumen showed the lowest percentage of moisture in albumen (49.7±0.57%). Moisture content in all yolk samples was in between (45±5.13% - 51.7±1.52%). The moisture content in Sb yolk was high (51.7±1.52%). The lowest percentage of moisture was in Omega -3 yolk samples (45.7±5.13%). Menu yolk showed high moisture content (87.7±1.15%) than Sb yolk.

There was a significant difference (Pd" 0.05) in moisture content between the Omega-3 and Menu egg (albumen and yolk) while other samples were showing insignificant differences with P value d"0.05.

Table 1. Physical analysis of selected egg albumen and yolk samples

Sr. No	Samples	Yolk Colour	Yolk pH	Albumen pH	Yolk Weight(g)	Albumen Weight(g)	Shell Weight(g)	Total Egg Weight(g)	Shape Index
1	Omega-3	13.3±0.5 *	9±0	9±0	16.7±0.05	33.1±0.05	7.9±0.1*	58.2±0.66	76.0±0.23
2	Classic	8±0.0	5±0	9±0	16.4±0.05	34.3±0.05*	8±0.0.1	58.8±0.2	76.9±0.90
3	Sb	7.6±0.5	5±0	9±0	16.7±0.05	37.2±0*	7.1±0.1*	61.0±0.15*	76.0±0.23
4	Menu	7±0	9±0	9±0	16.2±0.11	35.2±0.05*	7.3±0.1	58.6±0.51	74.4±0.81
5	Domestic	8.6±0.5	5±0	9±0*	17.5±0.05 *	30.7±0.05	7.6±0.05	56±0.1*	74.9±0.80

Means on the each column with a superscript *are statistically significant, P =0.05.

Ash content

Ash content in all albumen samples (Omega 3, Classic, Sb, Menu and Domestic) was in series of (2.8±0.17% - 3.8±0.2%). Three albumen samples (Domestic, Menu ,classic) showed the same ash content (3±0.11%). While albumen samples of Sb and Omega-3 showed ash content (2.8±0.17%). Ash content in all yolk samples (Omega-3, Classic, Sb, Menu, and Domestic) was in between (3±0.11%-3.8±0.2%). Only Sb albumen was showing significant difference with P value d"0.05.

Crude fat

All albumen samples (Omega-3, Classic, Sb, Menu, and Domestic) had the fat content in between (1.33±0.57% - 2.66±0.57%). Only the Omega-3 albumen had high fat (2.66±0.57%).

All yolk samples (Omega-3, Classic, Sb, Menu, and Domestic) had fat content(49±1.52% - 56±2%) while Domestic yolk samples had lowest fat content (49±1.52%) than all other samples. Here Classic yolk samples showed significant difference with P value d" 0.05.The results of moisture content, ash content, and fat content were shown in Table 2.

Mineral detection

For the analysis of samples (Omega-3, Classic, Sb, Menu, and Domestic) minerals were detected in yolk and albumen separately during the research work. The results of the concentration of minerals (Ca, Fe, Zn, and Cu) were analyzed statistically as shown in Table 3.

Table 2. Proximate analysis of selected egg albumen and yolk samples

Sr. No	Samples	Proximate analysis					
		Moisture %		Ash %		Fat %	
		A	Y	A	Y	A	Y
1	Omega-3	78.3±2.30*	45.7±5.13	3±0.11	3.8±0.20	2.66±0.57	50±1.00
2	Classic	87.7±1.15	50.3±0.57	3.8 ±0.21	3±0.11	1.33±0.57	56±2.00*
3	Sb	86.7±0.57	51.7 ±1.52	2.8±0.17*	3.8±0.20	1.33±0.57	49±0.57
4	Menu	49.7±0.57*	87.7±1.15*	3.8±0.21	3.8±0.20	2.33±0.57	50±0.57
5	Domestic	87.3±1.52	48.7±1.52	3.8±0.11	3.8±0.11	1.33±0.57	49±1.52

Means on the each columns with a superscript *are statistically significant with P=0.05, where A=Albumen and Y=Yolk.

Table 3. Mineral analysis of selected egg albumen and yolk samples

Minerals analysis									
Sr. No	Samples	Calcium(ppm)		Copper (ppm)		Iron (ppm)		Zinc (ppm)	
		A	Y	A	Y	A	Y	A	Y
1	Omega-3	7.12±2.41	6.00±0.48	0.88±0.03	0.03±0.01	3.47±0.41	3.45±0.22	0.39±0.04	3.45±0.22
2	Classic	5.98±1.18	6.56±0.72	0.21±0.06	0.10±0.01	5.35±1.21	3.74±0.27	0.82±0.02	3.74±0.27
3	Sb	5.31±0.58	5.31±0.48	0.22±0.02	0.03±0.01	3.72±0.03	4.43±0.76	0.8±0.01	4.43±0.76
4	Menu	8.57±2.46	8.23±0.73	0.17±0.04	0.07±0.02	15.1±12.0	4.00±0.54	2.22±1.45	4.00±0.54
5	Domestic	6.43±0.54	5.84±0.53	0.27±0.03	0.24±0.09	4.1±0.35	3.83±0.10	0.91±0.17	3.83±0.10

Means on albumen and yolk column are statistically insignificant (P=0.05), where A=Albumen and Y=Yolk.

Concerntration of Calcium

Calcium concentrations in albumen samples (Omega-3, Classic, Sb, Menu, and Domestic) were in between (5.31±0.58ppm-8.57±2.4ppm). In albumen samples (Classic, Domestic, Omega-3) calcium concentration gradually increase. Menu albumen had the high concentration (8.57 ± 2.41 ppm) while Sb albumen showed less calcium concentration (5.31 ± 0.58 ppm). Menu yolk had high concentration (8.23 ± 0.73 ppm) while in other yolk samples the concentration of calcium gradually decrease. Here results showed calcium content in albumen and yolk samples (Omega-3, Classic, Sb, Menu, and Domestic) are not significantly different with P d" 0.05.

Concentration of Copper

Copper concentration in albumen samples (Omega-3, Classic, Sb, Menu, and Domestic) was involving (0.88±0.03ppm - 0.27±0.03ppm). In all yolk samples the concentration of copper was (0.03±0.01ppm- 0.10±0.01ppm). Here results of copper content in albumen and yolk were statistically insignificant with P d" 0.05.

Concentration of Iron

All albumen samples had iron concentration (3.47±0.27ppm-15.1±12.0ppm). Menu albumen showed high concentration of iron than all other samples which was (15.1±12.0ppm). Iron concentration in all yolk samples was (3.83 ± 0.01 ppm - 4.43 ± 0.76 ppm). All albumen and yolk samples had the same concentration of iron but only the Menu albumen sample showed variation. Iron content in albumen and yolk samples was statistically insignificant with P d"0.05.

Concentration of Zinc

The concentration of zinc in albumen samples (Omega-3, Classic, Sb, Menu, and Domestic) was in between (0.82±0.02ppm-0.39±0.04ppm). Domestical bumen samples had the low concentration of zinc (0.91±0.17ppm). Zinc concentration in all yolk samples was (3.45±0.02ppm-4.43±0.76ppm). Sb yolk samples had high concentration of zinc (4.43±0.76 ppm) while Omega-3 yolk showed less concentration of zinc (3.45±0.02 ppm) than Menu yolk (4.00±0.54ppm) and Classic yolk (3.74±0.27ppm). Zinc content in all albumen and yolk samples was statistically insignificantly different with P d" 0.05.

All samples (Omega-3, Classic, Sb, Menu, and Domestic) were showing comparable results with the work of (Tolik *et al.,*2014) on Japanese chicken eggs, reporting that Japanese chicken eggs showed 55.8g albumen weight, 31.9g yolk weight, 12.3g shell weight, these reported results are higher than the present findings. Moisture content in albumen samples was 87.7% and moisture content in yolk samples was 48.7 % same as according to current results. Ash in albumen was 0.6 % which was less than our finding. (Bashir *et al*., 2015) reported the nutritive value of albumen and yolk of different breeds of chicken, according to their results the moisture content was (60.45 ± 0.14% in yolk) and (87.45 ± 0.71% in albumen),While the moisture content in present investigation showed that (87.7±1.15% in albumen) and (51.7±1.52 % in yolk). Similarly mineral content was also higher than our findings in different breeds of chicken eggs. These findings also showed similarities with the work of (Türker *et al*., 2019) that analyzed the physical and chemical properties of chicken egg samples reared in two different housing systems.

However albumen and yolk samples (Omega-3, Classic, Sb, Menu, and Domestic) showed insignificant difference in percentage of ash content. Percentage of ash was 0.6% in yolk but it was 1.0% in albumen samples. These findings of the research work were comparable with the results of (Ndife *et al*., 2010) that analyzed the effect of different oven drying temperatures on the properties of albumen and yolk. All yolk and albumen samples were showing statistically significant differences in % of crude fat; obtained results were comparable with the findings of (Kiczorowska *et al*., 2015). All obtained findings of omega-3 eggs were comparable with the reported work of (Khan *et al.,* 2017).

The results of minerals content (Ca, Cu, Fe and Zn) in the current research work are comparable with the work of (Hashish *et al*., 2012) according to the reported work on albumen and yolk samples the amount of calcium was 58.6 ± 1.37mg/kg higher in yolk and albumen but the amount of all other minerals iron, copper and zinc was according to present obtained results. Albumen and yolk samples were showing significant differences in moisture content and fat content while mineral concentrations in yolk and albumen were statistically insignificantly different. These results are comparable with scientific studies and have been determined that the physicochemical properties and mineral content in yolk and albumen samples can be effected by housing systems, feed, breed of layers, temperature, storage time and condition of egg samples in poultry farms (Rehault *et al.,* 2019).

4. CONCLUSION

The present investigation showed the protruding results which could be helpful to update the nutritional data set about egg samples (yolk and albumen) of famous poultry farms (Wahdat poultry farm, Sadiq poultry farm seasons food and domestic eggs) found in Pakistan. The present study suggested that eggs produced through Pakistan's leading poultry industry would be good for human health and have no negative impact on health. In major prospective the results of physicochemical and mineral analysis in all samples would vary due to difference in feed quality and rearing environment of poultry farm because these factors could affect the quality of eggs.

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