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Nutritional characteristics of different types of eggs

Medina-Cruz M. Fernanda[1]; Zaráte-Contreras, Diego[2]; Pérez-Ruíz, Rigoberto Vicencio[1]; Arce-Vázquez, María Belem[1]; Rayas-Amor, Adolfo A.[1]; Díaz-Ramírez, Mayra[1]; Aguilar-Toalá, José Eleazar[1]; Rosas-Espejel, Monzerrat[1]; Cruz-Monterrosa, Rosy G.[1*]

[1] Universidad Autónoma Metropolitana, Unidad Lerma. Av. de las Garzas No. 10, Col. El Panteón, Municipio Lerma de Villada, Estado de México, C.P. 52005.

[2] Colegio de Postgraduados, Posgrado Recursos Genéticos y Productividad-Ganadería, Carretera México-Texcoco km 36.5, Montecillo, Estado de México, C.P. 56264.

* Correspondence: r.cruz@correo.ler.uam.mx

ABSTRACT

Objective: To analyze 5 types of poultry eggs (chicken, turkey, ostrich, duck and quail) to compare their nutritional characteristics.

Design/Methodology/Approach: A physical analysis was performed: weight of the entire egg (weight and proportion of the albumin, yolk and shell) length and width of the entire egg, shape index, shell color, and yolk color, nutritional (determination of raw fat, protein, dry matter and ashes). Different types of egg used: chicken, turkey, ostrich, duck and quail.

Results: The egg containing the most amount of protein was that of the duck (13.02±0.46%), while the sample containing the lowest result was that of the ostrich (9.47±0.27%). The type of egg that contained the fattest level was the duck (10.31±0.75%); on the other hand, the type of egg that demonstrated the least amount of fat was that of the chicken egg (8.28±0.39%).

Results/Findings/Conclusion: Even though some physical differences exist in all types of eggs, they are similar and there is minimal variation in terms of their nutritional value. Therefore, these different types of eggs can be applied for consumption as substitutes for chicken eggs and as an alternative source of protein.

Limitations of the study/Implications: Lack of previous research in regard to comparisons of the types of analyzed eggs.

Keywords: egg, chicken, turkey, quail, ostrich, duck, protein, albumin, yolk.

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INTRODUCTION

According to FAO (2023), poultry eggs are the most consumed types of food in the world. Demonstrating a vast increase in consumption over the past years due to their demographic growth, urbanization, and increase in income within developing countries. The egg is a nutritious type of food capable of contributing to a balanced diet. A medium sized chicken egg contains a low caloric value of only 75 calories per unit, counting with sparse contents of carbohydrates and approximately 12 g of optimum quality protein to every 100 g of egg. While the amount of lipids mostly

contains monounsaturated fatty acids that contain minimal quantities of saturated fats. At the same time, it constitutes as one of the main sources of cholesterol in a diet, with approximately 220 mg of cholesterol per unit of a medium sized egg (Distillate *et al.*, 2017). Years ago, the egg was categorized as a common type of food that contributed to the increase of serum cholesterol. However, cholesterol has important functions in the human body, such as the development of hormones (testosterone and oestradiol) and at the same time is a precursor of vitamin D and useful bialy salts for digestion and absorption of fats (Hernández *et al.*, 2021). There is also evidence that egg consumption has little to no influence over serum cholesterol levels (López-Sobaler *et al.*, 2017). The egg is made up of three main components as shell, albumin and yolk (González *et al.*, 2018). The egg white is where you will find the highest biological amount of protein, its richness in essential amino acids makes the egg albumin the main protein. Then there are the ova transferrin and ovomucoid, the lysozyme and the ovomucin (Ramírez-Crespo *et al.*, 2022).

On a different note, the yolk is a dispersion of fatty particles in aqueous matter. This is where you will find the highest amount of lipids in the egg, most abundant in triglycerides (66%). Followed by phospholipids (28%, mainly phosphatidylcholine), and lastly cholesterol and cholesterol esters (6%), here you will also find a high carotenoids level, which give coloration (Gonzalez *et al.*, 2018). The most consumed type of egg is chicken, and however, other poultry eggs are also apt for human consumption and function as an alternative source of mainly proteins (these include quail, duck, turkey, and ostrich eggs). Nonetheless, most testing in relation to eggs is centered around chicken eggs, leaving aside the other provident eggs that come from different types of poultry such as the ones mentioned. This is why the objective of this study is to analyze five types of poultry eggs: chicken, turkey, ostrich, duck, and quail to compare their physical characteristics, and their nutritional and sensory properties.

MATERIALS AND METHODS

Material

Different types of eggs were used: chicken, quail, turkey, duck and ostrich. The samples were gathered from the municipal towns of Metepec, Toluca and Amecameca. Parts from each type of egg were freeze-dried to conduct nutritional testing. While the remaining eggs were used for physical testing.

Physical Characteristics

In order to conduct the physical characteristics, 8 eggs of each type were numbered. All with the exception of the ostrich egg which was not evaluated due to the quantity of samples being only two. The evaluated variables were as follows: Weight of the egg (W, g), Length (L, cm), Width (Wid, cm), Shape Index (SI), Volume (Vol, cm^3), Shell Color (SC), Yolk Color (YC), Egg White Weight (EWl, g), Yolk Weight (YW, g), Shell Weight (SW, g), Egg White Proportions (EWPl), Yolk Proportions (YPP) and Shell Proportions (SPP). The variable weight was determined by using an electric scale with a capacity of 65 g ± 0.01 in precision (Model PA64, Brand OHAUS). The L and Wid of each egg were measured by using a Vernier (Model VER-6PX, PRETUL) with a range of measurement of 0 to 150 mm and 1.0 mm of resolution. The length was determined by the longitude axle of the egg and the width of the transversal axle at mid height of the longitude axle. The SI was calculated using the following Duman *et al.* (2016): $SI=(Wid/L)\times 100$. The variable volume was calculated using the following expression, according to Etches (1996): $Vol=0.913\times$weight of the egg. The color of the yolk and shell were calculated by using the portable equipment MINOLTA (Chroma Meter CR-200), with which the color coordinates were determined as colors L*(luminosity), a* (± red-green) and b* (± yellow-blue). Components EWI, YW and SW were obtained by using an electric scale of 2200 g ± 0.01 in precision (Model H-7294, OHAUD Scout). The weight of each egg was documented, then divided by using an egg white divider which separated each egg component to document weight. Components EWPI, YPP and SPP were calculated according to the weight of the entire egg.

Nutritional Characteristics

The following techniques were applied for the bromatological/nutrimental testing:

- Fat determination: Goldfish Method
- Protein determination: Micro Kjeldahl Method
- Absolute humidity determination: Gravimetric Method
- Ash determination: Gravimetric Method

Statistical Anslysis

A variant analysis was conducted (ANOVA) to observe the differences in nutritional and physical aspects of different types of eggs via the statistical program SPSS (2016).

RESULTS AND DISCUSSION

Table 1 shows the data from the physical analysis. As expected, the weight parameters, length, width, albumin weight, yolk weight, shell weight and volume variate, however no significant differences ($P>0.05$) between types. But, total eggs weights had differences between groups ($P<0.05$), this value was due to the size of the egg. In terms of the length variable, the sample that obtained the least values was that of the quail. Resulting in 3.38±0.23 cm. on opposing ends, the highest value belonged to the turkey egg with a result of 6.45±0.13 cm. Both had significant differences amongst other types, all while finding no significant differences ($P>0.05$) between the chicken and duck eggs. the quail eggs was 2.63±0.1 cm, containing significant differences ($P<0.05$) in comparison to the other eggs, while the chicken, duck and turkey eggs had values of 4.38±0.083 cm, 4.48±0.14 cm and 4.47±0.11 cm, respectively. In terms of the index formula values, the quail and turkey types are significantly different ($P<0.05$) from all samples with results of 78.03±3.46 y 69.39±1.70, respectively. On the other hand, in terms of the variable albumin weight, the quail sample was the only one that demonstrated a significant difference ($P<0.05$), in comparison to the other samples with a result of 6.94±1.25 g also being the lowest result. In terms of yolk weight, all samples were significantly different ($P<0.05$). Shell weight in quail demonstrated the lowest data (1.41±0.25 g) with a significant difference ($P<0.05$) in comparison to the other samples. In terms of the albumin proportion, the highest result was 56.98±1.78 %, belonging to the chicken sample. The lowest result belonged to the duck sample with a value of 49.20±3.20%. Samples chicken and quail, and quail, duck and turkey were not significant ($P>0.05$) amongst themselves. While samples duck and turkey demonstrated a significant difference ($P<0.05$) in comparison with the chicken sample. The yolk proportions had the highest result was that of the duck egg, which was 37.76±3.34%, while the sample with the lowest value was 29.42±1.46%, obtained from the chicken egg. The chicken and quail, quail and turkey, and duck and turkey samples did not had significant differences ($P>0.05$) amongst themselves. The shell proportion had the highest data in the turkey eggs with 12.73±1.66%. Nonetheless, this sample did not have significant differences ($P>0.05$) with the chicken and duck samples. Lastly, in terms of volume variables, the duck sample had the highest result which was 61.89±7.12 cm^3. However, it did not have significant differences ($P>0.05$) with the chicken and turkey samples. The quail sample had significant differences ($P<0.05$) with all other types, being the one that had the lowest data of 11.70±1.61 cm^3.

Table 2, demonstrates color data (L*, a* and b*correspond to yolk color from all five test samples. Value L* was highest ($P<0.05$) in the chicken sample, with 73.71±4.90, where no significant differences ($P>0.05$) were found between that and the ostrich and duck samples. On the other hand, the lowest result was that of 52.63±1.18, belonging to the quail sample. The values to a*, the highest ($P<0.05$) data was that belonging to the yolk from the duck eggs and the lowest was from the ostrich sample, with 14.69±5.01 y 2.47±0.34, respectively, Significant differences ($P<0.05$) were observed between the chicken samples, quail, and ostrich. Even then, no significant differences ($P>0.05$) between the quail and ostrich samples. In the values of b*, the sample with the lowest value ($P<0.05$) was that of the quail and the highest was that of the duck resulting in 40.28±1.56 and 73.26±4.95,

Table 1. Chicken, quail, duck, and turkey eggs physical analysis.

	Chicken	**Quail**	**Duck**	**Turkey**
Weight (g)	62.42 ± 2.45^{a}	12.81 ± 1.76^{b}	67.79 ± 7.81^{a}	63.88 ± 8.63^{a}
Length (cm)	5.9 ± 0.11^{b}	3.38 ± 0.23^{c}	6.12 ± 0.34^{b}	6.45 ± 0.13^{d}
Width (cm)	4.38 ± 0.083^{b}	2.63 ± 0.1^{a}	4.48 ± 0.14^{b}	4.47 ± 0.11^{b}
Shape Index	74.37 ± 1.43^{c}	78.03 ± 3.46^{a}	73.35 ± 1.87^{c}	69.39 ± 1.70^{b}
Albumin Weight (g)	35.56 ± 1.70^{b}	6.94 ± 1.25^{a}	33.41 ± 4.91^{b}	32.51 ± 9.28^{b}
Yolk Weight (g)	18.37 ± 1.29^{a}	4.03 ± 0.56^{b}	25.60 ± 3.85^{c}	22.45 ± 1.32^{d}
Shell Weight (g)	7.83 ± 0.37^{b}	1.41 ± 0.25^{a}	7.59 ± 0.66^{b}	8.02 ± 0.55^{b}
Albumin Proportion (%)	6.98 ± 1.78^{a}	53.98 ± 4.70^{ab}	49.20 ± 3.20^{b}	49.97 ± 8.06^{b}
Yolk Proportion(%)	29.42 ± 1.46^{a}	31.76 ± 4.24^{ac}	37.76 ± 3.34^{b}	35.90 ± 6.51^{bc}
Shell Proportion (%)	12.54 ± 0.33^{a}	11.00 ± 1.07^{b}	11.25 ± 0.70^{ab}	12.73 ± 1.66^{a}
Volume (cm^3)	56.98 ± 2.23^{ac}	11.70 ± 1.61^{b}	61.89 ± 7.12^{ac}	58.32 ± 7.87^{c}

[a, b, c, d] Different letters in the same row indicate significant differences throughout ($P<0.05$) ± means standard deviation.

respectively. The samples belonging to the turkey and ostrich were found to be the only one where no significant differences ($P>0.05$) between them.

Table 3 includes data obtained from the color of the shell from the egg samples that were tested. It is important to note that the values of the quail and duck samples may not be entirely accurate, due to the fact that they do not have a uniform appearance in color with the spots that are presented on both shells.

The L* had the highest value in the ostrich eggs with significant differences ($P<0.05$) from all samples. The a* had a highest value to duck sample and it was similar ($P>0.05$) with the quail and chicken eggs. But the smallest value was that of -0.056 ± 0.20, belonging to the ostrich. The b* value of duck, turkey and ostrich samples had significant differences ($P<0.05$) from all samples, while the chicken and quail had no significant differences ($P>0.05$) between them.

Table 4 shows the data of nutritional analysis. Eggs duck had the highest protein level (13.02±0.46%), and the lowest protein level was the ostrich egg (9.47±0.27%, $P<0.05$). On the other hand, the quail, chicken and turkey samples had 11.93±0.41%, 11.73±0.39% and 11.41±0.35%, respectively, without significant differences ($P>0.05$) between them. Meanwhile, the amount of fat in duck was 10.31±0.75% and the turkey eggs was 10.17±0.18%, did not present significant differences ($P>0.05$). On the other hand, the type of egg that demonstrated the least amount of fat was that of the chicken egg (8.28±0.39%) without significant differences ($P>0.05$) with the ostrich egg. The ash level was the highest percentage in quail with 4.22±0.11%, on the contrary, duck ash had 3.74±0.13%.

The data values for albumin proportion were ~52% for the chicken, duck and turkey. While the yolk proportions were ~34.3 for the chicken, duck and turkey. Both variables, in comparison with the study conducted by Sadaf *et al.* (2022) are similar in terms of the values. However, within this same study, but in the variable shell proportion, the values coming from the duck are higher than the values reported in this research. While the values demonstrated in the chicken and turkey eggs are similar. On the other hand, the shape index of the chicken and turkey eggs obtained in this research were ~71.8, according to Camacho *et al.* (2019), the data from the creole chicken and native turkeys were similar in this study.

The weight, albumin weight, yolk weight, shell weight, albumin proportion, yolk proportion and shell proportion of the eggs coming from the turkey found in this study

Table 2. Color metrics of chicken, quail, duck, turkey, and ostrich eggs.

Type of egg	L*	a*	b*
Chicken	73.71 ± 4.90^{ac}	12.07 ± 4.39^{bc}	62.92 ± 4.73^{a}
Quail	52.63 ± 1.18^{d}	3.90 ± 1.60^{a}	40.28 ± 1.56^{b}
Duck	75.29 ± 4.48^{bc}	14.69 ± 5.01^{cd}	73.26 ± 4.95^{c}
Turkey	64.57 ± 5.25^{e}	12.58 ± 3.08^{bd}	55.51 ± 4.34^{d}
Ostrich	70.28 ± 0.70^{ab}	2.47 ± 0.34^{a}	57.51 ± 0.75^{d}

$^{a, b, c, d, e}$ Different letters in the same row indicate significant differences throughout ($P<0.05$)
± means standard deviation.

Table 3. Color metrics of the eggshell belonging to the chicken, quail, duck, turkey and ostrich eggs.

Type of egg	L*	a*	b*
Chicken	55.49±2.07[ab]	1.65±0.20[ac]	3.70±0.39[a]
Quail	18.95±2.07[d]	2.35±0.20[ab]	4.74±0.39[a]
Duck	52.92±2.07[bc]	1.84±0.20[bc]	7.64±0.39[b]
Turkey	55.96±2.07[ac]	3.27±0.20[d]	12.56±0.39[c]
Ostrich	83.14±2.07[e]	−0.056±0.20[e]	21.50±0.39[d]

[a, b, c, d, e] Different letters in the same row indicate significant differences throughout ($P<0.05$) ± means standard deviation.

Table 4. Protein, fat and ashes in ostrich, quail, chicken, turkey and duck eggs.

Type of egg	% Raw protein	% Raw fat	% Ashes
Ostrich	9.47±0.27[b]	8.84±0.50[ab]	4.05±0.7[ab]
Quail	11.93±0.41[a]	9.99±0.43[ac]	4.22±0.11[a]
Chicken	11.73±0.39[a]	8.28±0.39[b]	3.86±0.13[bc]
Turkey	11.41±0.35[a]	10.17±0.18[c]	3.88±0.12[bc]
Duck	13.02±0.46[c]	10.31±0.75[c]	3.74±0.13[c]

[a, b, c, d] Different letters in the same row indicate significant differences throughout ($P<0.05$) ± means standard deviation.

were variable. Compared with the results obtain by Galic *et al.* (2018), the weight and weight of the yolk were similar to all data reported in this study. In terms of volume, the albumin weight, shell weight and albumin percentage demonstrated higher values within both mentioned research cycles; while the yolk percentage was less in the study and only the shell percentages were similar within both cycles. These variations may have been due to the conditions and exposure type in which the turkeys were raised (Galic *et al.*, 2018). According to González *et al.* (2018), the reported date for protein and fat in the quail eggs were ~13.11 g/100 g. These data were slightly higher in protein and fat according to this study, while the data by Congjiao Sun *et al.* (2019) had lower protein and ash levels from the chicken, quail, turkey and duck eggs. Few data were found in regard to the ostrich egg, however, research conducted by Al-Obaidi *et al.* (2015), detected 29% lipids and 10.8% in albumin in the yolk of the ostrich eggs. Nonetheless, it is not possible to compare with this research since Al-Obaidi *et al.* (2015) reported separate data in terms of albumin and yolk.

In general, the quality of the egg is found through various factors as the weight, weight of the albumin and yolk, flavor, color of shell, sensory attributes, etc. These characteristics can be affected by age, genetic differences amongst breeds (Hocking *et al.*, 2003; Hussain *et al.*, 2018), feeding (Cortes Cuevas *et al.*, 2016), stress factors within the production system (Ortiz *et al.*, 2013). Because of this, not all types of eggs from tested birds have the same quantity or proportion of certain parameters or do not match other studies.

CONCLUSION

The different types of egg belonging to analyzed birds have some physical differences. However, they have similarities in terms of nutritional value, with few differences. Due to this, the substitution of traditional consumption of the chicken egg for any of the tested types can be applied to diets that require protein and/or fats levels, and this data can also be applied to the food industry. Aside from its nutritional properties, the egg has different technological properties thanks to its foaming, emulsifying and jellifying abilities to name a few.

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