A Comparative Study on Nutritional Value of Quail and Chicken Eggs

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Abstract

The current study was conducted to compare between nutritional quality of quail and chicken eggs. Proximate chemical analysis, minerals, vitamins, fatty acids and amino acid content of quail and chicken eggs were determined. Results showed that the percent of protein, fats, ash of quail eggs was higher than that of chicken egg. There was no significant difference at $P<0.05$ between cholesterol content of quail and chicken eggs which was 12.26 and 12.48 mg/g, respectively. Quail eggs scored higher contents in Fe, Cu, Mg and P, while chicken eggs were higher in Ca, Zn, Na and K. The predominant fatty acids in quail and chicken eggs were oleic, palmitic and linoleic acid which were 42.54 and 40.65, 27.53 and 26.96; 16.61 and 16.33%, respectively. The essential amino acid leucine was recorded the highest level in quail eggs (8.95 g / 100 g protein), while lysine amino acid was the highest in chicken eggs (7.47 g / 100 g protein). Tryptophan was the first limiting amino acid in all investigated samples. The results revealed that the protein efficiency ratio (PER) for both quail and chicken eggs was 3.29 and 3.21, respectively. Therefore, the biological value of the quail egg protein was higher than that of the chicken egg protein. So, the current study confirmed the vital and economic importance of quail eggs, and suggested that it is necessary to more studies to identify the health impact of quail eggs consumption.

Keywords: quail egg, chicken egg, proximate chemical analysis, chemical score, biological value.

Introduction

Poultry plays an important economically and socially role in all over the world. Poultry achieved considerable status in ancient Egypt, The use of its meat and eggs went back to very early times in the history (Farrell, 2015). Eggs are highly varied foods which are considered as an excellent source of many essential nutrients. Eggs have high optimal composition of essential amino acids, suitable composition of fatty acids with a high percentage of polyunsaturated fatty acids and an appropriate ratio of omega 6 to omega 3 fatty acids (Pingel, 2009). Eggs had higher biological value93.97% than of for milk, 84.55%, for fish 76% and for beef 74.3%

(Rehma, 2015). Though chicken eggs are considered the most commonly eaten, nowadays the eggs from other domestic birds such as quail eggs were used for consumption also. Quail eggs are highly nutritious. Even with their small size, the nutritional value of quail eggs is 3 - 4 times greater than chicken eggs (Tunsaringkarn et al., 2013). Quail eggs compared to chicken eggs, contained more essential amino acids, minerals, vitamins, in addition to their chemical composition, they are not harmful for people allergic to albumen in chicken eggs. Moreover, quail eggs had low cholesterol content and a more beneficial ratio of PUFA/SFA than chicken eggs (Lalwani, 2011; Sinanoglou, et al., 2011 and Genchev, 2012).
In Egypt, although chicken eggs are the most commonly eaten by people, and quail egg is attended to increasing consume. Information about nutritional chicken and quail eggs quality characteristics has been limited So, the current study was conducted to study the nutritional value of quail eggs comparing with that of chicken eggs.

Materials and Methods

Materials

Samples of quail and chicken eggs (100g for each) were obtained from quail and chicken farms of South Valley University. The samples were washed with distilled water and dried. After breaking the eggs, whole egg were dried in the oven for 8hr at temperature between 60-70°C.

Methods

Proximate chemical analysis

Quail and chicken dried egg powder were analyzed in triplicate for moisture, protein, fat, ash and fiber contents were determined using the methods described in the AOAC (2010). Carbohydrates calculated by differences:

Carbohydrates (%) = 100 - (% moisture + % protein + % fat + % Ash + % fiber)

Computation of caloric value

Caloric value was estimated using the modified Atwater factor as follows:

Total energy (Kcal/100g) = [(lipid"g"×9) + (protein"g"×4) + (carbohydrates "g" × 1.1 × 3.75)] as described by Falch et al., (2010).

Determination of minerals content

Minerals such Na, K and P were determined according to AOAC (2005) method. (Ca, Fe, Cu, Zn and Mg) were determination by ICP-Inductively Coupled Plasma Emission Spectrometer according to Isaac and Johnson (2002).

Determination of vitamins content

The selected fat-soluble vitamins i.e. V. A was determined as described by Perez-Ruiz et al., (2007) method. V. D was determined according to Nöll, (1996). V. E was determined according to Gimeno et al., (2000). Water-soluble vitamins as thiamine (B1), riboflavin (B2) and niacin (B3) were determined by Scalar (2000) methods.

Determination of total cholesterol

Total cholesterol was determined according to the methods described in the AOAC (2010).

Determination of fatty acids

Total fatty acids content were determined according to the methods described in the AOAC (2010).

Determination of amino acids content

All amino acids content were determined according to Baxter (1996) method. While, tryptophan content was determined Sastry and Tummuru (1985) method.

Calculation of chemical score

The chemical score was calculated according to Bhanu et al. (1991) as follows:

Chemical score = (mg of essential amino acid in 1 g test protein/mg of essential amino acid in 1 g reference protein) × 100.

Calculation of A/E ratio

The relationship between the content of an individual essential amino acid in the food protein (A) and the total essential amino acids content (E) was calculated according to (FAO, 1965) as follows:

A/E ratio = mg of the individual essential amino acids/g of essential amino acids.

Calculation of protein efficiency ratio (PER)

Protein efficiency ratio was calculated using the equation mentioned by (Alsmeyer et al., 1974) as follows:

PER = -0.684 + 0.456(Leucine) – 0.047 (Proline) (g / 100g protein)

Calculation of biological value (BV)

Biological value of protein was calculated according to the equation of (Oser, 1959) as follows:

BV = 49.09 + 10.53 (PER)

Statistical analysis

The methods of statistical analysis were done using SPSS: analysis without anguish version 20 for windows (Coakes, 2012). The results were expressed as mean±standard deviation. T test to detect the significant differences between the two groups, Duncan Multiple Comparison to recognize the significant differences between averages of the two groups (El-Sherbeeny, 1995).

Results and Discussion

Chemical composition of quail and chicken eggs

Data in Table (1) demonstrated the proximate composition of quail and chicken eggs. Chicken eggs had higher moisture content (74.86%) than quail eggs (72.9%). The protein, fat and ash contents were higher in quail eggs than chicken eggs. There were no significantly differences between them at ($p<0.05$). Similar finding was obtained by Chepkemoi et al., (2015); Chris et al., (2015) and Chepkemoi et al., (2017). The carbohydrate content of quail and chicken eggs were 1.64 and 1.67% respectively with a corresponding high content of carbohydrate of quail egg was lower. Cholesterol content of quail and chicken eggs content were 12.26 and 12.48 mg/g respectively. It can be observed from the same table that quail's eggs contained lower cholesterol content than chicken eggs but there was no significant difference at $P<0.05$ between cholesterol content of quail and chicken eggs. Such result was similar with Al-Obaidi and Al-Shadeedi (2017) and Uzochukwu et al. (2017) who reported that the difference between cholesterol content of quail and chicken eggs may be due to the difference between the weight of the yolk of the quail egg and that of the chicken egg. While that result was differing from that according to Sharaf (2011) who recorded that cholesterol content of quail was higher than chicken eggs. The variability of these results may be due to variation in strain, feed, bird growth stage and environmental condition as recorded by Adeniyi et al. (2016).

Table (1): Chemical analysis (g/100g) and cholesterol content of quail and chicken eggs

Sample	Moisture %	Protein %	Fats %	Ash %	Carbohydrates %	Energy (K.cal./100 g)	Cholesterol mg/g
Quail **egg**	72.9±1.26	12.99±0.91	11.4±1.02	1.07±0.17	1.64±2.16	161.12±5.41	12.26±0.78
Chicken egg	74.86±2.33	11.91±1.18	10.63±2.19	0.93±0.15	1.67±1.27	149.99±6.06	12.48±0.42

Each value represents the mean of three replicates ±SD

Minerals and content of quail and chicken eggs

Minerals are inorganic substances that are vital for good health Adeyeye, (2010). As shown in Table (2) data exhibited the mineral content of quail and chicken eggs. Phosphorus was the most predominant minerals in both investigated samples which were 302.5 and 236.3 mg/100g in quail and chicken eggs respectively. Statistical analysis revealed that a significant difference ($P<0.05$) was appeared in phosphor content. Similar finding was obtained by Sharaf (2011). Quail eggs had the lowest values of calcium, zinc, sodium and potassium content than chicken eggs. The previous result was agree with Isaac and Chiedu, (2016) result which showed that quail eggs had the lowest values of Zn and K than chicken eggs, and such result was in agreed with that by Olusola et al. (2018) in all founding. In the other hand quail eggs had the highest values of iron, copper and magnesium content than chicken eggs. The levels of Fe and Cu were the lowest minerals in investigated samples with mean values in quail and chicken eggs were 3.01and 2.85; 2.28 and 1.95 mg/100g respectively. Such results were in harmony with Isaac and Chiedu, (2016) results.

Table (2): Minerals content of quail and chicken eggs (mg/100g)

Sample	Ca	Fe	Cu	Zn	Mg	Na	K	P
Quail egg	31.45±1.51	3.01±2.17	2.28±2.08	3.16±2.56	19.8±0.53	25.7±1.36	20.86±1.46	302.5±4.61
Chicken egg	35.46±1.19	2.85±2.04	1.95±1.86	3.54±2.50	17.32±0.48	31.83±2.44	23.81±1.63	236.3±2.68

Each value represents the mean of three replicates ±SD

Vitamins content of quail and chicken eggs

Table (3) showed that quail and chicken eggs contained the fat-soluble vitamins i.e. vitamin A, D and E. The most abundant vitamin was vitamin E and its values for quail and chicken eggs were 5.9 and 5.3 mg/100g, respectively. Water-soluble vitamin in samples were determined vitamins B1, B2, B3 and B6 of quail and chicken eggs were 0.12 and 0.15, 0.47 and 0.30, 0.09 and 0.2 & 0.65 and 0.6; respectively. The results were similar with that of Sahin et al. (2006) and Tunsaringkarn et al. (2013) results.

Table (3): Vitamins content of quail and chicken eggs mg/100g

Sample	A	E	D	B1	B2	B3	B6
Quail egg	0.36±1.63	5.9±1.26	0.45±0.64	0.12±1.27	0.47±1.18	0.09±0.17	0.65±1.51
Chicken egg	0.40±1.86	5.3±2.17	0.45±0.53	0.15±1.19	0.30±0.78	0.2±0.32	0.60±1.62

Each value represents the mean of three replicates ±SD

Total fatty acids content of quail and chicken eggs

Data in Table (4) showed the major fatty acids identified in quail and chicken eggs were capric, myristic, palmitic, stearic, arachidic, palmitoleic, oleic, gadoleic, linoleic, linolenic and eicosadienoic acid. Similar fatty acid contents were identified by Tolik et al., (2014) and Tunsaringkarn et al., (2013). As shown from data stated in Table (4) the total MUFA was higher than that of SFA and PUFA, and the percent of SFA, MUFA & PUFA of quail and chicken eggs were 34.07, 47.47 & 18.46 and 36.97, 44.9 &

18.13% respectively. These results were in agreed with those obtained by Polat et al., (2013) and Bayomy et al. (2017). The most MUFA observed in quail and chicken eggs were oleic acid which were 42.54 and 40.65% respectively. While, the most PUFA found in them were linoleic acid which represented 16.61 and 16.33% respectively. The previous result was agreed with Polat et al. (2013); Tanasorn et al., (2013) and Tolik et al., (2014) results.

Table (4): Fatty acids content of quail and chicken eggs

Common name	Lipid name		Fatty acid %	
Saturated fatty acids (SFA)			**Quail egg**	**Chicken egg**
Capric acid	Decanoic	C10:0	0.18	0.27
Myristic acid	1-Tetradecanoic	C14:0	0.94	0.48
Palmitic acid	Hexadecanoic	C16:0	27.53	26.96
Stearic acid	Octadecanoic	C18:0	5.34	9.08
Arachidic acid	Elcosanoic	C20:0	0.08	0.18
Mono-unsaturated fatty acids (MUFA)			**Quail egg**	**Chicken egg**
Palmitoleic acid	(Z)-Hexadec-9-enoic	C16:1	4.85	4.07
Oleic acid	9-Octadecenoic	C18:1	42.54	40.65
Gadoleic acid	9-eicosenoic	C20:1	0.08	0.18
Poly-unsaturated fatty acids (PUFA)			**Quail egg**	**Chicken egg**
linoleic acid	9,12-octadecadienoic	C18:2	16.61	16.33
linolenic acid	Octadeca-9,12,15 – Trienoic acid	C18:3	0.65	0.82
eicosadienoic acid	cis-11,14-eicosadienoicacid	C20:2	1.20	0.98
SFA %			**34.07**	**36.97**
MUFA %			**47.47**	**44.9**
PUFA %			**18.46**	**18.13**

Total amino acids content of quail and chicken eggs

Genchev et al., (2008) stated that content of essential amino acids was the most important criterion in food quality. As cleared from Table (5) the total amino acids content recorded 91.46 and 90.87 g/100g protein for quail and chicken eggs, respectively. With regard to essential amino acids, leucine was the prevalent essential amino acid with value 8.95 and 8.79 g/100g protein. Such result was in agreed with Genchev (2012) and Bayomy et al. (2017). result. Leucine had beneficial and functional to protein structure and blood sugar level regulation which maintains a balance of insulin and glucose On the other hand, for non-essential amino acids, glutamic acid was the predominant in both quail and chicken eggs with values 14.29 and 14.16 g/100g respectively. Similar finding was obtained by Genchev, (2012) and Aletor and Famakin, (2017). Augustine et al., (2007) reported that glutamic acid had vital role for healthy brain development and function.

Table (5): Amino acids content of quail and chicken eggs

Essential Amino Acid (EAA)	Quail egg g/100g protein	Chicken egg g/100g protein	Non-essential Amino Acid (NEAA)	Quail egg g/100g protein	Chicken egg g/100g protein
Threonine	4.07±0.71	4.18±0.50	Aspartic	9.49±0.74	8.19±1.59
Valine	4.6±0.93	5.41±1.04	Serine	5.47±2.21	5.78±1.85
Methionine	2.73±0.32	2.86±0.03	Glutamic Acid	14.29±0.72	14.16±0.38
Tryptophan	0.80±0.28	0.67±0.14	Glycine	4.08±0.68	3.68±0.39
Isoleucine	4.92±0.39	4.31±0.36	Alanine	5.94±0.66	5.47±0.60
Leucine	8.95±0.25	8.79±0.76	Tyrosine	3.41±0.25	3.31±0.46
Phenylalanine	6.34±0.15	5.35±0.17	Histidine	2.29±0.56	2.39±0.21
Lysine	6.81±1.66	7.47±1.96	Arginine	5.14±0.79	6.57±1.26
			Proline	2.13±2.26	2.28±1.90
Total EAA	**39.22**	**39.04**	**Total NEAA**	**52.24**	**51.83**

EAA: essential amino acid, NEAA: non-essential amino acid, Each value represents the mean of three replicates ±SD

Chemical score and limiting amino acids of quail and chicken eggs

Chemical score was one of method for assessing dietary protein quality was by determining a diet's (Bell et al., 1991). The ratio of a gram of the limiting amino acid in a test diet to the same amount of the corresponding amino acid in a reference diet (e.g., whole-egg protein) multiplied by 100 was calculated to obtained the chemical score values. As cleared from Table (6) the chemical score indicated that the first limiting amino acid of all tested samples was tryptophan followed by the second limiting amino acid was valine.

Table (6): Chemical score and limiting amino acids of quail and chicken eggs

E.A.A. / Groups		Ile.	Leu.	Lys.	Met.	Phe.	Thr.	Try.	Val.	First limiting amino acid	Second limiting amino acid
Whole egg (G)	mg E.A.A/g protein	56	83	63	32	51	51	18	76		
Casein (K)		52	96	69	16	35	46	17	60		
Quail egg	G	87.85	107.83	108.1	85.31	124.3	79.80	44.44	60.52	Try.	Val.
	K	94.61	93.22	98.69	170.6	181.1	88.47	47.05	76.66	Try.	Val.
Chicken egg	G	76.96	105.90	118.5	89.37	104.9	81.96	37.22	71.18	Try.	Val.
	K	82.88	91.56	108.2	178.7	152.8	90.86	39.41	90.16	Try.	Val.

E.A.A.: essential amino acid G: Egg K: Casein

The values of PER and B.V of quail and chicken eggs

The protein efficiency ratio (PER) is still used frequently as the biologically determined measure of protein quality. Quail eggs were considered to be higher protein source than chicken eggs. As cleared from Table (7) the protein efficiency ratio of quail egg was 3.29 and chicken eggs was 3.21g. According to Hoffman and Falvo, (2004) who reported that any protein efficiency ratio (PER) value exceeds 2.7 is considered to be an excellent protein source; quail and chicken eggs were considered to be an excellent protein source.

The biological value (BV) provides a measurement of how efficient the body utilizes protein consumed in the diet. A food with a high value correlates to a high supply of the essential amino acids (Hoffman and Falvo, 2004). Biological value of quail and chicken eggs were calculated.

As observed from Table (7) quail eggs had biological value (83.73 %) higher than that of chicken eggs (82.89%), and both of them had biological values lower than that obtained by Rehma, (2015) who reported that biological value of eggs was 93.97%, the differences of these results may be due to differences in kind of bird, strain, feed, bird growth stage and environmental condition as recorded by Adeniyi et al., (2016).

Table (7): The values of PER and B.V of quail and chicken eggs

Samples	PER (g)	B.V. %
Quail egg	3.29	83.73
Chicken egg	3.21	82.89

PER: protein efficiency ratio B.V.: biological value

A/E ratio of quail and chicken eggs compared with FAO/WHO/UNU (1985)

Ratios of individual to total essential amino acids (A/E) in studies samples were compared with each other, and with values of (FAO/WHO, 1985) recommendations for child and adults. Data given in Table (8) showed that A/E of Thr., Met. and Phe. of both quail and chicken egg were lower than that of FAO/WHO (1985) recommendations for child, while they were higher than that of FAO/WHO (1985) recommendations for adults. The A/E and Try. of Ile. of both quail and chicken eggs were lower than those of FAO/WHO (1985) recommendations for child and adults. On the other hand, Val., Leu. and Lys. of both quail and chicken eggs were higher than those of FAO/WHO (1985) recommendations for child and adults.

Table (8): A/E ratio of quail and chicken eggs compared with FAO/WHO/UNU (1985)

E.A.A.	Quail egg	Chicken egg	FAO (1985)	
			Schoolchildren	Adult
Threonine	103.77	109.88	126	81
Valine	117.28	142.21	112	117
Methionine	69.60	75.18	99	53
Tryptophan	20.39	17.61	126	117
Isoleucine	125.44	113.30	198	171
Leucine	228.19	231.07	99	171
Phenylalanine	161.65	140.46	198	144
Lysine	173.63	196.37	40	45

E.A.A.: essential amino acid

Conclusion

Quail eggs were considered as an excellent source of many essential nutrients; protein, essential amino acids, minerals, vitamins, suitable composition of fatty acids with a high percentage of mono-unsaturated fatty acids and polyunsaturated fatty acids. It can be recommended that quail eggs were suitable for special age groups as infants, children and teenager for good growth and development.

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دراسة مقارنة على القيمة الغذائية لبيض السمان وبيض الدجاج

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المستخلص

أجريت الدراسة الحالية لدراسة الجودة الغذائية لبيض السمان مقارنة ببيض الدجاج. تم تقدير التركيب الكيميائي التقريبي والمحتوى المعدني ومحتوى الفيتامينات والأحماض الدهنية والأحماض الأمينية لكلا منهما. أظهرت النتائج أن محتوى بيض السمان من البروتين والدهون والرماد كان أعلى من نظيرها في بيض الدجاج. لم تظهر نتائج التحليل الاحصائي وجود فروق معنوية عند مستوى دلالة ٠,٠٥ بين محتوى الكوليسترول في بيض السمان وبيض الدجاج والتي سجلت ١٢,٢٦ و ١٢,٤٨ ملجم / جرام ، على التوالي. سجل بيض السمان قيم أعلى في محتواه من الحديد والنحاس والماغسيوم والفسفور ، بينما كان محتوى بيض الدجاج أعلى في الكالسيوم والزنك والصوديوم والبوتاسيوم. كما أوضحت النتائج أن الأحماض الدهنية الأوليك والبالمتيك واللينوليك هي السائدة في كلا من بيض السمان وبيض الدجاج والتي بلغت نسبتها ٤٢,٥٤ و ٤٠,٦٥ ، ٢٧,٥٣ و ٢٦,٩٦ ، ١٦,٦١ و ١٦,٣٣ ٪ في كلا منهما على التوالي. سجل الحمض الأميني الأساسي الليوسين أعلى قيمة له في بيض السمان (٨,٩٥ جم/١٠٠جم بروتين) ، بينما سجل الحمض الأميني اللايسين أعلى قيمة له في بيض الدجاج والتي بلغت (٧,٤٧ جم/١٠٠جم بوتين). كان التربتوفان الحمض الأميني المحدد في كل العينات المدروسة. كما اتضح من النتائج المتحصل عليها أن معدل الكفاءة النسبية للبروتين لكل من بيض السمان وبيض الدجاج كانت ٣,٢٩ ، ٣,٢١ على التوالي ، وبالتالي فإن القيمة الحيوية لبروتين بيض السمان كانت أعلى من القيمة الحيوية لبروتين بيض الدجاج. لذا خلصت الدراسة إلى التأكيد على الأهمية الحيوية والاقتصادية لبيض السمان كما توصي بضرورة إجراء المزيد من الدراسات البيولوجية للتعرف التأثير الصحي لاستهلاك بيض السمان.

الكلمات المفتاحية: بيض السمان ، بيض الدجاج ، التركيب الكيميائي ، القيمة الحيوية.