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Araştırma
(Research)

Determination of Egg Quality Traits in Lohmann Sandy Hens Raised in Free Range System

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Abstract

Objective: In this study, it was aimed to determine the egg quality traits of hens belonging to Lohmann Sandy genotype raised in the free-range system.

Materials and methods: In the research, eggs obtained from hens belonging to Lohmann Sandy genotype raised in a private enterprise in Ordu province were used. In each period for egg quality determination, 30 daily eggs were used. After keeping the eggs at room temperature for 24 hours, the internal and external quality traits of eggs were determined.

Results: The albumen index and the Haugh unit values showed a significant change depending on time and were determined as 11.31 and 92.90 on average, respectively. On the other hand, the yolk index value did not show a significant change depending on the time and the average value was found to be 51.21. Egg weight showed a significant change depending on the time and was determined as 58.84 g on average. Shell surface area and egg volume also showed a significant change depending on time and were calculated as 74.58 cm^2 and 54.41 cm^3 on average, respectively. Shell thickness, shape index and specific gravity values did not show a significant change depending on time.

Conclusion: It is of great importance that eggs produced with alternative systems are introduced to the market. In order to increase the consumption level of eggs, the place and importance of eggs in adequate and balanced nutrition should be explained, especially targeting children in developmental age and the elderly.

Keywords: Free range system, Egg weight, Albumen index, Yolk index, Haugh unit

Serbest Sistemde Yetiştirilen Lohmann Sandy Tavuklarında Yumurta Kalite Özelliklerinin Belirlenmesi

Öz

Amaç: Bu çalışmada serbest sistemde yetiştirilen Lohmann Sandy genotipine ait tavukların yumurta kalite özelliklerinin belirlenmesi amaçlanmıştır.

Materyal ve yöntem: Araştırmada Ordu ilinde özel bir işletmede yetiştirilen Lohmann Sandy genotipine ait tavuklardan elde edilen yumurtalar kullanılmıştır. Yumurta kalitesinin belirlendiği her bir dönemde 30 adet günlük yumurta kullanılmıştır. Yumurtalar oda sıcaklığında 24 saat bekletildikten sonra iç ve dış kalite özellikleri belirlenmiştir.

Araştırma bulguları: Ak indeksi değeri ve Haugh birimi değeri zamana bağlı olarak önemli bir değişim göstermiş olup sırasıyla ortalama olarak 11.31 ve 92.90 olarak belirlenmiştir. Buna karşın, sarı indeksi değeri zamana bağlı olarak önemli bir değişim göstermemiş olup ortalama 51.21 olarak tespit edilmiştir. Yumurta ağırlığı zamana bağlı olarak önemli bir değişim göstermiş ve ortalama 58.84 g olarak belirlenmiştir. Kabuk yüzey alanı ve yumurta hacmi de zamana bağlı olarak önemli bir değişim göstermiş olup sırasıyla ortalama 74.58 cm^2 ve 54.41 cm^3 olarak hesaplanmıştır. Kabuk kalınlığı, şekil indeksi ve özgül ağırlık değerleri zamana bağlı olarak önemli bir değişim göstermemiştir.

Sonuç: Alternatif üretim sistemleri ile üretilen yumurtaların piyasaya sunulması büyük önem taşımaktadır. Yumurta tüketim düzeyinin artırılması için özellikle gelişme çağındaki çocuklar ve yaşlılar hedef alınarak yeterli ve dengeli beslenmede yumurtanın yeri ve önemi anlatılmalıdır.

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Anahtar Kelimeler: Serbest sistem, Yumurta ağırlığı, Ak indeksi, Sarı indeksi, Haugh birimi

Introduction

Due to its natural structure, egg is a "protected" food that cannot be cheated. It is a food that contains all the essential nutrients required for adequate and balanced nutrition. Eggs, which have the best protein quality among animal products, are rich in terms of A, D, E, K and B groups vitamins besides the minerals such as iron and phosphorus (Alkan and Derebaşı, 2018; Türkoğlu and Sarıca, 2009). In addition, it has an important place in the nutrition of the elderly, patients, and people on a diet because it is easily digested and has a low caloric value. Since egg protein is rich in essential amino acids, its biological value is accepted as 100. For this reason, this trait of the egg is used as a standard in determining the quality of other foods (Altan, 2015; Türkoğlu and Sarıca, 2009; Alkan and Derebaşı, 2018).

In recent years, some social sensitivities have emerged in the world and the demand for natural products has increased. This situation has forced animal breeders to consider animal welfare and to implement breeding systems that keep animals away from stress conditions. For this reason, animal rights organizations, especially in European countries, have taken action. As a result, alternative breeding systems that take into account animal welfare have begun to be implemented. The improvement of people's economic situation has led to a change in their consumption habits in course of time. As a result, people started to prefer products grown in natural or near-natural conditions by paying more money (Bayram and Aksakal, 2008). This change in the consumer has directly caused the development of new growing systems. One of the alternative rearing systems applied in laying hens is free-range system laying hen. Animal rights and welfare are taken more into account in free system laying hens and animals are raised in conditions suitable for their nature as much as possible. In this system, hens can move freely in the surrounding areas during the day and benefit from the green grass in these areas (Durmuş and Alkan, 2015).

Ferrante et al. (2009) stated that litter and organic growing systems have developed in Italy in recent years, and consumers consider not only safe food production but also the welfare of animals. In this study, it was aimed to determine the egg quality traits of hens belonging to the Lohmann Sandy genotype raised in free range system.

Material and method

Material

In the research, eggs obtained from hens belonging to the Lohmann Sandy genotype raised in a private enterprise in Ordu province were used. Hens were reared in fully enclosed hen houses at night and in a fenced green grass walking area during the day. A green walking area of 0.2 m^2 is provided for each hen inside the hen houses as well as a 4 m^2 of green grass walking area per hen outside the hen houses. The vegetation of the green grass area is predominantly as Trifolium repens, Trifolium pretense, Lolium perenne, Festuca rubra, Urtica dioica, Bellis perennis and Primula. In the study, 16 hours of lighting was applied to the hens during the laying period. During the egg laying period, 2800 kcal/kg of metabolic energy and 18% crude protein were given to the hens as freely. Egg quality was determined at 24, 28, 32, 36, 40, 44, 48 and 52 weeks of age. For the research, 30 eggs were used in each period in which egg quality was determined.

Method

The equations used to determine the quality traits of eggs are given in Table 1 (Alkan et al., 2015; Alkan et al., 2016; Narushin 2005; Sreenivasiah 2006; Yannakopoulos ve Tserveni-Gousi 1986). The obtained data were analyzed using Minitab 17 package program and Tukey Multiple Comparison Test was used to determine the groups that make up the difference.

Results and discussion

The internal and external quality traits of the eggs are given in Table 2 and Table 3, respectively. As seen in Table 2, the length of albumen showed a significant change depending on the time, and the maximum length was obtained at 52 weeks of age (87.00 mm). The length of the albumen increased due to the increase in egg weight. Similarly, the albumen width showed a significant change depending on the time, as in the albumen length. The greatest albumen width was obtained at 52 weeks of age (79.22 mm). As with the length of albumen, the width of the albumen also increased due to the increase in egg weight. Albumen height also changed depending on time, and the lowest albumen height was obtained at 52 weeks of age (8.44 mm). It is thought that the decrease in the height of the albumen is due to the increase in the length of the albumen.

Table 1. Equations Used to Determine Egg Quality Traits

Name of the traits	Equations
Shape index	100 x (Egg width) / (Egg length)
Eggshell surface area (cm^2)	(3.155-0.013 x Egg width) x (Egg length x Egg width)
Unit surface eggshell weight (g/cm^2)	(Eggshell weight) / (Eggshell surface area)
Eggshell ratio (%)	100 x (Eggshell weight) / (Egg weight)
Albumen index	100 x (Albumen height) / (Albumen length + Albumen width) / 2)
Albumen weight (g)	Egg weight- (Yolk weight + Eggshell weight)
Albumen ratio (%)	100 x (Albumen weight) / (Egg weight)
Yolk index	100 x (Yolk height) / (Yolk diameter)
Yolk ratio (%)	100 x (Yolk weight) / (Egg weight)
Yolk – albumen ratio (%)	100 x (Yolk weight) / (Albumen weight)
Haugh unit	100 log [Albumen height +7.57)- (1.7 x Egg weight $^{0.37}$)]
Egg volume (cm^3)	0.913 x Egg weight
Eggshell thickness (mm)	(Sharp part + Blunt part + Equatorial part) / 3
Specific gravity (g/cm^3)	Egg weight in air/ (egg weight in air- egg weight in water)

Albumen weight increased with time and the highest albumen weight was obtained at 52 weeks of age (40.76 g). Depending on the increase in egg weight, the albumen weight also increased.

The albumen index also changed depending on time. The highest albumen index values were obtained at the 28 and 32 weeks of age and were determined to be 11.31 on average. The normal limits of the egg albumen index value are between 8-11.8 (Friars ve ark., 1978). Benli and Durmuş (2015) stated in their study that the albumen index value varied between 4.946-7.543. In some studies, it has been reported that albumen height and Haugh unit value decrease with age (Doyon ve ark., 1985). In the study conducted by Uruk (2011) it was determined that the albumen index value varied between 9.13-11.24. In another study, Şekeroğlu and Sarıca (2005) determined the average albumen index values as 9.409 and 8.825 in the free range and litter growing systems, respectively. The albumen ratio changed with time and decreased depending on time. The egg yolk diameter also changed depending on the time and, the egg yolk diameter increased with increase of time.

The egg yolk index showed a significant change on time and was determined as 51.21 on average. In the study conducted by Benli and Durmuş (2015), it was stated that the egg yolk index value ranged between 38.310-39.551. It is stated that the egg yolk index value, which is the indicator of the egg yolk's ability to stand upright without spreading, is between 36-44 in fresh eggs (Mineki and Kobayashi 1998; Doğan, 2008). In contrast, Sarıca and Erensayın (2009) reported that the egg yolk index should be higher than 46. In the Turkish Food Codex Egg Notification, egg yolk should be in the form of a round shadow in the center in light examination, it should not be clearly separated from the center when the egg is rotated, and it should not contain foreign matter (Anonymous, 2014). In the study conducted by Uruk (2011), the egg yolk index value was found to be between 41.97-44.33, and Durmuş et al. (2004) stated that it varied between 45.297-48.966. In their study, Şekeroğlu and Sarıca (2005) determined the average egg yolk index values as 42.983 and 43.552 in the free-range and litter growing system. The ratio of egg yolk showed a significant change depending on time. The egg yolk weight also showed a significant change depending on the time, and the highest egg yolk weight was obtained at the 52 weeks of age (17.13 g). Depending on the increase in egg weight, the yolk weight increased.

The Haugh unit also showed a significant change depending on time and was calculated as 92.90 on average. Depending on the time, the albumen height decreased and was determined as 8.91 on average. Albumen height is one of the variables used in the calculation of the Haugh unit. For this reason, the Haugh unit was also high in the weeks when the albumen height was high. Benli and Durmuş (2015) stated in their study that the Haugh unit ranged from 61.973 to 79.343. The Haugh unit is the most widely used criterion for various purposes in determining egg quality. It is an important criterion used to determine the freshness of an egg (Doğan, 2008). Durmus et al. (2004) stated in their study that the value of the Haugh unit varies between 73.646-78.052. In the study conducted by Uruk (2011), it was determined that it varies between 85.94-89-27. Şekeroğlu and Sarıca (2005) in their study, found the average Haugh unit values to be 87.419 and 84.817, respectively, in the free-range and litter growing systems. Egg width and egg length showed significant changes on time and increased with age. Depending on the increase in egg weight, egg width and length also increased. Egg weight also showed a significant change depending on time. Egg weight increased with increasing age and egg weight was determined as 58.84 g on average. The weight of a standard egg is accepted as 57.6 g (Türkoğlu ve Sarıca, 2009). In the Turkish Standards Institute TS 1068, eggs weight less than 52 grams are classified as small, between 53-62 grams as medium, between 73-72 grams as large and over 73 grams as very large eggs. It was determined that taking into account the average egg weight (58.84 g), the eggs used in this study were classified as medium-sized eggs. For comparison, in a previous study conducted by Şekeroğlu and Sarıca (2005), the average egg weight was determined as 61.22 g, and in the study by Artan and Durmuş (2015) it was determined as 61.96 g. In some studies, it has been stated that hens raised in the free-range system give lighter eggs than those in the other systems (Keeling ve Dun, 1988; Pavlovski ve ark, 1994; Mostert ve ark., 1995).

Egg thickness did not show a significant change depending on time. Depending on the age, the eggshell thickness values decreased numerically and the eggshell thickness was found to be 0.40 mm on average. In the study conducted by Artan and Durmuş (2015), the average eggshell thickness was stated as 0.376 mm, and in the study by Şekeroğlu and Sarıca (2005) it was stated as 0.344 mm. Sarıca and Erensayın (2009) reported that the eggshell thickness should be between 0.33-0.35 mm for edible eggs. Eggshell thickness is one of the important criteria related to shell quality and is a factor that directly affects shell durability. Eggshell thickness is an important factor in the collection, washing, classification, packaging, transportation and storage of eggs. Therefore, the shell thickness should not be less than 0.33 mm (Çelebi 2003; Doğan, 2008). It is very important that the rate of broken and cracked eggs is low during transportation and marketing. For this reason, the eggshell thickness of the eggs should be within normal limits. Eggs in different shell thicknesses can be obtained depending on the feeding programs and the ration content. Eggs of hens, which are generally fed with diets deficient in calcium and vitamins, have thinner shells (Turan, 2006). No value has been specified in the Turkish Standards Institute TS 1068 on eggshell thickness. It is worth mentioning that thin-shelled eggs can break easily during packaging and transportation, and their shelf life can be short. In the current study, eggshell weight also changed significantly over time. With increasing age, the eggshell weight increased and was determined as 6.03 g on average. It is thought that this situation is due to the increase in egg weight. In the study conducted by Şekeroğlu and Sarıca (2005), the eggshell weight was stated as 6.985 g.

The egg shape index did not show a significant change depending on time and was determined as 76.52 on average. Egg shape index is related to genetic structure and the shape of the egg is formed in the magnum. The egg shape index of a standard egg should be between 72-76 and on average 74. Eggs outside these limits are generally not preferred because they do not settle well in the viols and cause losses during storage and transportation (Jacob ve ark., 1998; Şenköylü, 2001; Sarıca ve Erensayın, 2004). In the study conducted by Şekeroğlu and Sarıca (2005), egg shape index was stated as 76.80 on average, and in the study by Artan and Durmuş (2015) it was stated as 79.095. Similar to other studies, Aygün (2007) reported that egg shape index varied between 76.68-76.94, while Durmuş (2006) reported that it ranged between 77.08-77.90.

The eggshell surface area changed significantly over time, and increased with increasing age. It is thought that this situation is due to the increase in egg weight. In the study conducted by Akkuş and Yıldırım (2018), eggshell surface area was calculated as 74.491 cm^2, 79.560 cm^2 and 79.995 cm^2 in hens at 28, 52 and 70 weeks of age, respectively. The eggshell surface area obtained in the 52nd week of this study was found to be 79.13 cm^2, which was similar to the value reported by Akkuş and Yıldırım (2018). The eggshell ratio did not show a significant change depending on the time. Egg volume also showed a significant change with time and increased with increasing age. It is thought that this situation is due to the increase in egg weight. Egg specific gravity did not change significantly depending on time and was determined as 1.10 g/cm^3 on average. The specific gravity of a standard egg should be 1.090 g/cm^3 (Şenköylü, 2001; Sarıca ve Erensayın, 2004). Specific gravity values have an important place in egg quality due to the positive correlation between the specific gravity and the shell thickness and eggshell breaking resistance (Şekeroğlu, 2002). Specific gravity of the egg is important in terms of representing both internal and external quality and is one of the best criteria that determine the freshness of the egg.

Table 2. Internal quality traits of eggs

Egg traits	24th week	28th week	32th week	36th week	40th week	44th week	48th week	52th week	Average
Albumen length (mm)	84.06±1.15^{a}	84.22±1.13^{a}	83.70±1.15^{a}	83.10±1.40^{a}	87.29±1.03^{b}	86.35±1.18^{b}	86.95±1.14^{b}	87.00±1.17^{b}	**85.33±0.42**
Albumen width (mm)	66.40±0.90^{a}	71.10±0.92^{ab}	71.90±1.08^{abc}	70.22±1.35^{ab}	75.78±1.33^{bcd}	74.37±2.48^{bcd}	77.19±1.19^{bcd}	79.22±1.40^{d}	**73.27±0.55**
Albumen height (mm)	9.70±0.23^{c}	9.50±0.27^{c}	9.20±0.40^{c}	8,35±0.19^{ab}	8.55±0.22^{ab}	8.98±0.24^{bc}	8.62±0.23^{bc}	8.44±0.22^{ab}	**8.91±0.11**
Albumen weight (g)	35.09±0.49^{a}	39.40±0.47^{b}	35.65±0.48^{a}	36.14±0.47^{a}	38.70±0.58^{b}	38.95±0.57^{b}	39.15±0.70^{b}	40.76±0.80^{b}	**37.98±0.24**
Albumen index	12.67±0.42^{b}	12.37±0.47^{b}	12.94±0.59^{b}	11.04±0.37^{ab}	10.37±0.35^{a}	10.32±0.41^{a}	10.61±0.38^{a}	10.23±0.33^{a}	**11.31±0.20**
Albumen ratio (%)	65.83±0.39^{c}	64.62±0.34^{b}	64.16±0.39^{b}	64.90±0.35^{b}	64.39±0.43^{b}	63.74±0.32^{a}	63.20±0.36^{a}	63.25±0.44^{a}	**64.26±0.15**
Yolk diameter (mm)	36.02±0.20^{a}	36.71±0.28^{a}	38.76±0.33^{b}	38.18±0.49^{b}	39.13±0.48^{b}	40.63±0.26^{c}	40.07±0.24^{bc}	39.99±0.31^{bc}	**38.68±0.16**
Yolk height (mm)	19.80±0.14^{b}	20.34±0.21^{bc}	20.00±0.35^{bc}	20.29±0.15^{bc}	18.23±0.22^{a}	20.55±0.15^{bc}	20.48±0.22^{bc}	20.78±0.20^{c}	**20.05±0.12**
Yolk index	51.55±0.48	51.29±0.62	51.94±0.83	51.35±0.81	50.74±0.49	50.62±0.45	51.19±0.70	51.00±0.51	**51.21±0.26**
Yolk ratio (%)	23.54±0.35^{a}	25.58±0.33^{b}	25.85±0.35^{b}	27.57±0.33^{c}	25.42±0.45^{b}	27.27±0.32^{c}	26.39±0.33^{bc}	26.70±0.34^{bc}	**26.04±0.16**
Yolk weight (g)	12.51±0.17^{a}	15.67±0.26^{cd}	14.37±0.27^{b}	16.08±0.24^{cde}	15.31±0.37^{c}	16.89±0.22^{ef}	16.45±0.17^{def}	17.13±0.27^{f}	**15.55±0.13**
Yolk/albumen ratio (%)	35.88±0.74^{a}	39.88±0.72^{b}	40.43±0.78^{b}	44.67±0.78^{c}	39.66±0.96^{b}	43.56±0.74^{c}	42.36±0.75^{bc}	42.37±0.85^{bc}	**41.10±0.32**
Haugh unit	94.47±0.98^{bc}	96.20±1.33^{c}	94.25±1.41^{bc}	91.34±1.12^{bc}	91.27±1.33^{bc}	93.62±1.18^{bc}	91.83±1.18^{bc}	90.26±1.24^{ab}	**92.90±0.62**

a, b, c, d, e ,f letters: The differences between the means shown with different letters on the same line are significant ($P< 0.05$)

Table 3. External quality traits of eggs

Egg traits	24th week	28th week	32th week	36th week	40th week	44th week	48th week	52th week	Average
Egg width (mm)	41.68±0.16^{b}	43.77±0.16^{cd}	41.98±0.19^{b}	38.61±0.42^{b}	43.26±0.23^{c}	43.92±0.17^{cd}	43.73±0.16^{cd}	44.23±0.23^{d}	**42.64±0.14**
Egg length (mm)	54.33±0.24^{b}	56.13±0.30^{c}	54.35±0.29^{b}	51.66±0.52^{a}	56.85±0.38^{cd}	57.21±0.35^{cd}	57.09±0.44^{cd}	57.74±0.37^{d}	**55.67±0.18**
Egg weight in air (g)	53.26±0.53^{a}	55.25±0.64^{a}	55.57±0.65^{a}	58.35±0.65^{b}	60.12±0.85^{bc}	62.03±0.70^{cd}	61.84±0.83^{cd}	64.32±0.93^{d}	**58.84±0.24**
Egg weight in water (g)	4.33±0.07^{a}	6.67±0.22^{c}	7.12±0.29^{c}	5.04±0.17^{b}	4.84±0.09^{ab}	4.90±0.07^{ab}	4.86±0.07^{ab}	5.13±0.11^{b}	**5.36±0.08**
Eggshell thickness (mm)	0.42±0.003	0.41±0.002	0.41±0.001	0.41±0.03	0.40±0.001	0.39±0.001	0.39±0.001	0.39±0.005	**0.40±0.004**
Eggshell weight (g)	5.65±0.08^{a}	6.02±0.07^{b}	5.54±0.08^{a}	6.13±0.07^{b}	6.11±0.12^{b}	6.18±0.09^{b}	6.24±0.08^{b}	6.42±0.08^{b}	**6.03±0.04**
Egg shape index	76.75±0.38	76.02±0.36	76.30±0.40	76.75±0.54	76.15±0.52	76.83±0.49	76.71±0.60	76.66±0.49	**76.52±0.18**
Eggshell surface area (cm^2)	70.22±0.47^{a}	71.13±0.60^{a}	70.77±0.59^{a}	74.04±1.22^{b}	76.21±0.77^{c}	77.82±0.62^{c}	77.36±0.74^{c}	79.13±0.76^{c}	**74.58±0.49**
Unit surface shell weight (g/cm^2)	0.80±0.001	0.80±0.000	0.80±0.000	0.81±0.001	0.80±0.001	0.80±0.001	0.80±0.00	0.81±0.001	**0.81±0.00**
Eggshell ratio (%)	10.22±0.14	10.08±0.08	10.38±0.10	10.52±0.10	10.18±0.19	10.28±0.12	10.11±0.10	10.05±0.19	**10.28±0.05**
Egg volume (cm^3)	48.63±0.48^{a}	50.73±0.59^{a}	55.92±0.59^{c}	53.27±0.59^{b}	54.89±0.77^{bc}	56.63±0.64^{cd}	56.46±0.75^{cd}	58.73±0.85^{d}	**54.41±0.31**
Egg specific gravity (g/cm^3)	1.10±0.001	1.12±0.003	1.13±0.005	1.09±0.002	1.09±0.002	1.08±0.001	1.08±0.000	1.09±0.001	**1.10±0.001**

a, b, c, d letters: The differences between the means shown with different letters on the same line are significant ($P < 0.05$)

The results obtained in this study are close to the values reported by Doğan (2008), Durmuş et al., (2010) and Durmuş (2006). Şekeroğlu and Sarıca (2005) in their study, determined the average egg specific gravity as 1.095 g/cm^3 and 1.093 g/cm^3 in the free and litter rearing systems, respectively. No value has been specified in the Turkish Standards Institute TS 1068 regarding the specific gravity of eggs.

Conclusion

Egg production and consumption have an important place in meeting the animal protein needs of people, because, egg is a nutritionally excellent nutrient with its high biological value, mono and polyunsaturated fatty acids, and rich vitamin and mineral content. At the same time, eggs are one of the most important sources of nutrients of animal origin in solving unbalanced nutrition problems. Consumption habits are also affected depending on the change in the social structure in the world and in Turkey. Again, consumers increasingly want to consume nutrients that are produced in conditions that do not harm human and animal health and do not pollute the environment and that they believe are healthier. For this reason, egg producers should review their egg offerings to the market, taking into account the preferences, behaviors and habits of consumers. It should not be forgotten that the egg is a traditional food and is loved and consumed by people. For this reason, it is of great importance that eggs produced with different production systems are introduced to the market. In order to increase the consumption level of eggs, the place and importance of eggs in adequate and balanced nutrition should be explained, especially targeting children in developmental age and the elderly.

Especially recently, publications containing false and incomplete information have been made in both written and visual media regarding egg and egg consumption. While this situation leads to information pollution, it also causes consumers to be confused under the influence of misdirections. For this reason, first of all, sufficient and accurate information should be given by experts and authorized persons or institutions on the importance of eggs and egg production systems in both written and visual media, and consumers should be made conscious. It should not be forgotten that healthy societies consist of healthy individuals. For this, the individuals who make up the society need to be fed in an adequate and balanced way. One of the most important of these nutrients is eggs.

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