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Effect of abnormal egg shell on quality and microbial quality of commercial table egg in Baghdad markets

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Abstract

The aim of this study was to determine the effect of abnormal egg shell on quality and microbial characteristic of commercial table egg in Baghdad markets through determination some quality and microbial characteristics of the eggs. A total of 10000 commercial chicken table eggs were checked and surveyed from retail markets in different popular regions of Baghdad city during the period from January 11th to December 25th of 2018. Results revealed that many types of egg abnormalities were collected during the study periods, which were distributed into three main categories of egg abnormalities (shape, size and texture), each main categories were subdivided into two subcategories of egg abnormalities (round shape, elliptical shape, large size, small size, ridged texture and soft-shelled texture). Significant differences ($P<0.01$) were appeared in the egg weight (gm), Haugh unit, yolk index, egg component (yolk, albumen and shell) percentages among all categories of egg abnormalities compared with normal eggs. The most microbial count on egg shell was *Psychrophilic* bacteria, which made the largest viable counts on all type of eggs, then came Coliform, Staphylococci and Fungi (moulds and yeasts). Significant differences ($P<0.01$) in the egg shell microbial counts were appeared among all categories of egg abnormalities compared with normal eggs. In conclusion, all these shell abnormalities have bad quality appearance and may have high microbial counts which affect the shelf life of table egg during long term storage and must rejected from marketing.

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Introduction

Commercial chicken eggs or called table eggs are very familiar, economical and easy to prepare food, very nutritious, as they provide a well-balanced source of essential and important nutrients for all human ages. Moreover, their high biological value protein and low caloric value make eggs valuable in many fitness and therapeutic diets for adults (Burley and Vadehra, 1989; Bufano, 2000; Matt *et al.,* 2009). Abnormalities of table egg or egg defects are classified as internal and external defects, internal egg quality defects are occur in the yolk and albumen, which are mottled and discolored yolk or white, blood and meat spots, double yolks, rotten eggs, watery white and round worms in eggs, external defects include egg size, egg shape, egg shell texture and cleanliness, these defects in commercial layers are about 10% of the total eggs produced which are downgraded due to external defects while 1% is due to internal defects (King'ori, 2012a; Al-Obaidi and Al-Shadeedi, 2018). Studies revealed that many egg abnormalities or defects appear to have no specific cause, but the incidence are much higher in hens subjected to stress, bad management conditions, rough handling and vaccination during egg production. There are significant increases in the percentage of egg shell texture such as soft-shelled eggs as a result of some viral diseases such as Newcastle disease (ND), infectious bronchitis (IB) and egg drop syndrome (EDS) also Mycoplasma disease (Stadelman and Cotterill, 1995; Brandão *et al.,* 2014; Al-Shadeedi and Al-Hilfi, 2016; Rosales, 2018).

Egg abnormalities and deformed of chicken eggs occur with almost every breed or strain at some points in the egg laying cycle, eggs laid by non-commercially bred vary considerably in size, shape, and color, (Stadelman and Cotterill, 1995). Commercially about 5-7% of table eggs produced are deformed or damaged and do not reach the consumer, about 2-3% of the damages are due to problems during laying whereas 3-4% of the damages will occur after egg laying and during the process and handling. No specific or single factor is usually responsible for egg abnormalities. There are many factors related to egg abnormalities includes genetic factors, diseases, nutritional deficiency, bad management, and environmental conditions. It is therefore important for the egg producers and managers to understand the various types of egg abnormalities and their causes. This will enable them have solvents and device ways to minimize them, so they can improve egg quality (King'ori, 2011King'ori, 2012b; Al-Shadeedi and Al-Hilfi, 2016; Al-Obaidi and Al-Shadeedi, 2018). The aim of this study is to identify the effect of abnormal egg shell on quality and microbial characteristics of commercial table egg in Baghdad markets.

Materials and methods

Eggs collection

A total of 10000 commercial chicken table eggs were checked and surveyed from retail markets in different popular regions of Baghdad city during the period from January 11th to December 25th of 2018, and compared with normal eggs in quality and microbial characteristics.

Egg abnormalities

All checked egg were separated according to shape, size and shell structure, all eggs round shape (74 or higher) and elliptical shape (70 or lower) were collected as shape abnormal (shape index not 72). Egg weight below 40gm or higher than 65gm were collected as abnormal in size. Ridged (rough), soft-shelled and not regular calcium deposited were collected as abnormal structure (Romanoff and Romanoff, 1949; Stadelman and Cotterill, 1995; Al-Shadeedi and Al-Hilfi, 2016). The number of abnormal eggs and its percentages from total collected eggs were calculated according to Al-Shadeedi and Al-Hilfi (2016). Abnormal eggs were collected and its quality and microbial characteristics were examined.

Eggs quality

At sampling, all collected abnormal egg were weighed using Sartorius digital balance and broken onto a flat surface where the height of the inner thick albumen and the upper point of yolk were measured with a

height gauge (Ames micrometer, USA), yolk diameter measured with a vernier caliper device according to the methods revealed by Stadelman and Cotterill (1995). Egg Haugh unit values were determined according to the formula:

$HU = 100 \log (H + 7.57 - 1.7W^{0.37})$.

whereby: HU = Haugh units; H = thick egg white height (mm); W = egg weight (g) (Stadelman and Cotterill, 1995).

Yolk index values were determined by division yolk high values to yolk diameter values according to the formula revealed by Stadelman and Cotterill (1995).

Egg components

Egg components percentage (Yolk, Albumen and shell percentages) were determined according to Stadelman and Cotterill (1995) as described by Al-Obaidi and Al-Shadeedi (2017), all eggs were weighted using a very sensitive digital Sartorius balance and shells were braked then the yolk and the albumen were separated and each were weighted then percentages of each component were determined using the equation:

$$\text{Egg component (\%)} = \frac{\text{Egg component weight (gm)}}{\text{Egg weight (gm)}} \times 100\%$$

Microbial counts

At sampling, all collected abnormal egg were examined for shell microbial viable counts by rinse method according to Yousef and Carlstrom (2003), in which two eggs (per replicate) were placed in sterile poly ethylene bags and carefully rinsed with 50ml of sterile peptone water for 10 min., then several decimal dilutions were done using sterile peptone water in universal 10ml screw caped bottles, *Psychrophilic*, Coliform, Staphylococci, and Fungi (molds and yeasts) counts on egg shell were done by culturing 1ml of each decimal dilutions on Nutrient agar, MacConkey agar, Staph. #110 agar and Saubroud agar plates respectively, all these measurements were done in triplicates biweekly, and final count calculated as colony forming unit per egg (cfu/egg).

Statistical analysis

Data were analyzed by using the General Linear Model Procedure of SAS (2012). Means were compared by the Duncan's Multiple Range test at 5% probability (Steel and Torrie, 1980).

Results and discussion

Fig. (1) Shows some egg abnormalities of commercial table egg in Baghdad markets, Iraq. Many types of egg abnormalities were collected during the study periods, which were distributed into three main categories of egg abnormalities (shape, size and texture), each main categories were subdivided into two subcategories of egg abnormalities (round shape, elliptical shape, large size, small size, ridged texture and soft-shelled texture).

The effect of abnormal egg shell on weight (gm), Haugh unit and yolk index compared with normal of commercial table egg in Baghdad markets shown in Table (1). Significant differences ($P<0.01$) were found in the egg weight (gm) among all categories of egg abnormalities compared with normal eggs (66.8±2.1), high values of egg weight were recorded in elliptical shape (70.1±2.1), soft-shelled (71.5±2.3) and large size (73.2±1.9) categories of abnormal egg, in the same time low values of egg weight were recorded in Round shape (60.2 ±2.3), small size (36.7±2.2) and ridged texture (58.9±2.1) categories of abnormal egg. Table (1) also shown significant differences ($P<0.01$) in the Haugh unit and yolk index values among all categories of egg abnormalities compared with normal eggs.

Statistical analysis revealed that significant differences ($P<0.01$) in the egg components percentages values among all categories of egg abnormalities compared with normal eggs (Table 2), high values of egg yolk percentages were recorded in round shape, small size and ridged texture (32.4, 32.7 and 32.4% respectively) categories of abnormal egg. Whereas, high values of egg albumen percentages values were recorded in elliptical shape and soft-shelled texture (60.0 and 59.7% respectively) categories of abnormal egg. Also Table (2) shown that high values of egg shell percentages values were recorded in round shape and small size (11.1 and 11.0% respectively) categories of abnormal egg compared with normal eggs.

Table (3) shown the effect of abnormal egg shell on some microbial counts (cfu/egg) of commercial table egg in Baghdad markets. The most microbial count on egg shell was *Psychrophilic* bacteria, which made the largest viable counts on all type of eggs, then came Coliform, Staphylococci and Fungi (moulds and yeasts). Significant differences (P<0.01) in the egg shell microbial counts were appeared among all categories of egg abnormalities compared with normal eggs. Large size and ridged texture categories of abnormal egg had the highest values of all studied microbial counts among all egg categories.

Fig. 1. Some egg abnormalities of commercial table egg in Baghdad markets

Table 1. Effect of abnormal egg shell on weight (gm), Haugh unit and yolk index of commercial table egg in Baghdad markets.

Type of egg abnormalities		Egg weight (gm)	Haugh unit	Yolk index
	Normal egg	66.8±2.1^{c}	91.7±1.2^{a}	49.6±1.0^{a}
Shape	Round shape	60.2±2.3^{d}	88.6±1.4^{b}	49.4±1.0^{a}
	Elliptical shape	70.1±2.1^{b}	90.2±1.0^{a}	49.5±1.1^{a}
Size	Large size	73.2±1.9^{a}	90.5±1.6^{a}	48.6±1.0^{b}
	Small size	36.7±2.2^{e}	90.4±1.2^{a}	49.3±1.1^{a}
Texture	Ridged (rough)	58.9±2.1^{d}	89.6±1.1^{ab}	48.7±1.1^{b}
	Soft-shelled	71.5±2.3^{ab}	87.0±1.4^{c}	48.1±1.1^{c}

Values with different superscripts in a column significantly (p<0.01)

Table 2. Effect of abnormal egg shell on component percentages (%) of commercial table egg in Baghdad markets.

Type of egg abnormalities		Yolk (%)	Albumen (%)	Shell (%)
	Normal egg	31.5±1.3^{b}	58.0±1.8^{c}	10.2±0.1^{b}
Shape	Round shape	32.4±1.2^{a}	54.5±1.5^{e}	11.1±0.1^{a}
	Elliptical shape	30.4±1.4^{c}	60.0±1.6^{a}	9.6±0.1^{b}
Size	Large size	31.4±1.1^{b}	58.9±1.5^{b}	9.7±0.1^{b}
	Small size	32.7±1.2^{a}	56.3±1.4^{d}	11.0±0.1^{a}
Texture	Ridged (rough)	32.4±1.1^{a}	56.8±1.6^{d}	10.8±0.1^{a}
	Soft-shelled	31.0±1.3^{b}	59.7±1.7^{a}	9.3±0.1^{c}

Values with different superscripts in a column significantly ($p<0.01$)

Table 3. Effect of abnormal egg shell on some microbial counts (cfu/egg) of commercial table egg in Baghdad markets.

Type of egg abnormalities		Psychrophilic	Coliform	Staphylococci	Fungi
	Normal egg	61X10^{5}±35.8^{b}	49X10^{4}±18.4^{b}	86X10^{2}±28.1^{b}	53X10^{2}±12.3^{a}
Shape	Round shape	72X10^{5}±40.1^{b}	12X10^{4}±16.1^{b}	47X10^{2}±25.7^{c}	34X10^{2}±13.5^{a}
	Elliptical shape	127X10^{5}±37.6^{a}	63X10^{5}±15.6^{a}	36X10^{3}±27.1^{a}	69X10^{2}±11.0^{a}
Size	Large size	95X10^{6}±39.5^{a}	157X10^{5}±19.3^{a}	114X10^{3}±27.3^{a}	97X10^{2}±11.6^{a}
	Small size	58X10^{4}±40.2^{c}	39X10^{3}±16.9^{c}	30X10^{2}±26.5^{c}	37X10^{2}±12.0^{a}
Texture	Ridged (rough)	68X10^{6}±36.1^{b}	81X10^{5}±18.3^{b}	142X10^{3}±28.7^{b}	69X10^{2}±13.4^{a}
	Soft-shelled	55X10^{5}±37.5^{a}	97X10^{4}±17.6^{a}	87X10^{2}±28.3^{b}	56X10^{2}±11.8^{a}

Values with different superscripts in a column significantly ($p<0.01$).

Hen egg is the product of the normal function of reproductive system and any temporary or permanent impairment in the efficiency of the reproductive system may result in defect or malformations of the produced egg (Stadelman and Cotterill, 1995). Al-Shadeedi and Al-Hilfi (2016) native market study recorded that egg abnormalities is about 6% of table eggs produced in different regions in Baghdad city. Studies found that most ridged, flattened (slab-sided), soft-shelled and double-shelled eggs are the result of eggs colliding in the shell gland region of the hen oviduct when an ovum or yolk is released too soon after the previous one, the two full-sized eggs can be found in the shell gland pouch. As the second egg comes in contact with the first, pressure will change the pattern of mineralization, so the first egg will be white and chalky shell appearance, while the second egg is flattened on its contiguous shell surface. Ridged eggs may have been retained too long in the shell gland region, so it will have more shell mineralization (Bennett, 1992; Roque and Soares, 1994; Stadelman and Cotterill, 1995). Also, studies found that defect or abnormality in egg size due to the starting or end of a laying period, hens produce small egg in the starting period whereas hens produce large egg in the end period, also unusual egg size may appear unexpectedly at any point in series of normal eggs or any clutch size of a hen (Romanoff and Romanoff, 1949; Stadelman and Cotterill, 1995; Al-Obaidi and Al-Shadeedi, 2018), Rosales (2018) reported that many egg defects or abnormalities appear to have no specific cause, but the incidence is much higher in hens subjected to stress and bad management conditions. Al-Obaidi and Al-Shadeedi (2014) native study recognized significant variation in avian egg phenotypes due to season, also. Al-Obaidi and Al-Shadeedi (2015) recorded significant variation in avian egg size and components due to species.

Table egg quality is a very important issue for future egg marketing and consumption in Baghdad. Although, many categories of egg abnormalities our study revealed that table eggs marketed in retail stores in Baghdad have high internal quality, this survey agreed with Al-Obaidi *et al.* (2011) native study founded that marketed table eggs in retail stores of Baghdad city were of good quality (Haugh Units in more than 70% of the samples where above 80) and where fit for consumption as shell eggs. According to the USDA Grading Manual, eggs declared as very good quality

must have at least 72 Haugh Units, yolk index not less 35 (USDA, 2000; 2007). Table egg contamination can occur through contact with contaminated surfaces (nesting material, dust, feed, shipping and storage containers), handlers and animals (pets, rodents and insects), so refrigeration of shell eggs is required for retarding multiplication of microorganism during transportation and throughout storage (Olivier *et al.,* 2009; Shenga *et al.,* 2010), so in this condition *Psychrophilic* microorganism will dominated and reached the highest level among all microbial indicators, studies also confirm that coliform and Staphylococci bacteria are mainly recognized in tale egg shell (Stadelman and Cotterill, 1995; Al-Obaidi *et al.*, 2011). Ridged texture will made a good surface and shelter for contaminants and dirt so the count of microorganism will be high, this agree with our results that large and ridged abnormality eggs have the high counts of microbial and will support microbial growth during long term of storage.

Conclusion

Many types of egg abnormalities were appeared in commercial table eggs marketed in Baghdad city during the study periods, which were distributed into three main categories of egg abnormalities (shape, size and texture). Although good interior quality, all these shell abnormalities have bad quality appearance and may have high microbial counts which affect the shelf life of table egg during long term storage and must rejected from marketing.

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