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Research Article

STUDIES ON PEELING PROPERTY AND ACCEPTABILITY OF FRESH AND TREATED HARD COOKED SHELL EGGS FROM DIFFERENT SPECIES OF BIRDS

S.S. AHLAWAT*, N. KHANNA, GAURI JAIRATH, SUMAN BISNOI, MONIKA RANI and NAVEEN SONI
Department of Livestock Products Technology, College of Veterinary Sciences
Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar-125 004, India

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ABSTRACT

The peeling property of fresh and oil coated shell eggs obtained from chicken, duck, turkey and quail were studied at room (25±2^{0}C) and refrigeration (4±1^{0}C) temperature at periodic intervals up to 8 days of storage. Peeling of eggs of different species significantly differed from each other and turkey eggs had the highest peeling score (3.2) followed by duck (3.0), chicken (2.8) and quail (2.5), respectively. The peeling scores were positively associated with shell thickness and pH of albumen. The peeling property was adversely affected by oil coating in all the cases. Fresh eggs were hard to peel and the eggs stored at ambient temperature were easier to peel than those stored under refrigeration. Oil coating prevented the pH to rise at both the storage temperatures and caused difficulty in peeling in all the species of birds. The peeling scores of coated and uncoated eggs were poor till 8 days of storage at refrigeration. The acceptability of uncoated eggs was up to 2 days and oil coated eggs up to 4 days at room temperature. However, the acceptability of oil coated eggs was up to 8 days at refrigeration temperature in all the four species of birds. It is concluded that fresh, oil coated and stored eggs at refrigeration (4±1^{0}C) temperature were difficult to peel but more acceptable as compared to the old, uncoated and stored eggs at room (25±2^{0}C) temperature. Peeling quality was positively correlated with shell thickness (R=0.97) and pH (R=0.98) of egg in all the cases.

Key words: Fresh eggs, oil coating, peeling property, shell thickness, storage

As per the latest estimates, poultry population has increased from 13.60 million in 2003 to 28.70 million in 2007. The egg production also has increased tremendously from 1.28 billion (2003) to 4.11 billion (2011-12) in Haryana (Haryana Kisan Ayog, 2013). To achieve the required per capita consumption of 180 eggs per head per year, the egg production needs to be further increased (Haryana Kisan Ayog, 2013). Due to change in food habits, a steady decline in the religious dogma attached to the consumption of eggs and a greater realization of food value of eggs, the egg cansumption would continue to increase.

Production alone will be of no use unless scientific methods for preservation, packaging, transportation and marketing of eggs are also taken up. A sizeable quantity of eggs for consumption as shell eggs and its utilization as hard-cooked eggs following peeling is a common practice. The present study was therefore undertaken to determine the peeling property of fresh, oil treated and stored shell eggs following hard cooking.

MATERIALS AND METHODS

Eggs of chicken (White Leghorn), duck (White Pekin), turkey (cross of Broad breasted Large White and Beltsville Small White) and quail (*Coturnix coturnix japonica*) of similar age groups, maintained under similar feeding and management conditions, were collected from Poultry Farm of the Lala Lajpat Rai University of Veterinary and Animal Sciences.

The nest clean fresh eggs were collected in batches of 30 eggs of each species within 24 h of laying. Of these, 15 eggs were treated with CFTRI egg coating oil following the spray technique and the remaining 15 eggs acted as control to estimate their peeling property. After that, the eggs were dipped in a sufficient amount of water and heated till boiling. Then the heating source was removed and cooking was done for 12 min. The eggs were then removed from water and allowed to cool at room temperature for 10 min instead of running tap water. The peeling was accomplished with the side of thumb within a period of 90 sec and scoring system was adopted to a scale of 5 to 1, with 5 score meant peeled easily with no torn albumen and score 1 was hard to peel with torn over the entire area of egg during peeling. The intermediate values 4, 3 and 2 corresponded to scores when area equal to 3/4th, ½ and 1/4th of the egg peeled easily, respectively. The average shell thickness of different species of birds was estimated by the procedure of Kilpatrick *et al*. (1961) and the pH of the egg albumen (Trout *et al.*, 1992) by

*Corresponding author: ahlawatss9@gmail.com

means of pH meter.

To study the effect of storage period and temperatures, the eggs were collected in batches of 200 each. Of these, 100 eggs were treated with egg coating oil. Fifty coated and 50 control eggs were stored in a refrigerator (4 ± 1^0C) while the other 50 uncoated (control) and 50 coated eggs were stored at room temperature (25 ± 2^0C). Then eggs in batches of 10 were withdrawn on 0, 2, 4, 6 and 8 days of storage. The acceptability of eggs was ascertained by the organoleptic evaluation with a semi-trained panel of 6 judges using 9 point hedonic scale. The experiment was repeated three times and results of all the experiments described above were statistically analyzed using completely randomized design (Snedecor and Cochran, 1989).

RESULTS AND DISCUSSION

Peeling quality score of fresh hard cooked eggs was the highest in turkey (3.2) followed by duck (3.0), chicken (2.8) and quail (2.5) and these differences were statistically significant (Table 1). The average shell thickness of turkey, duck, chicken and quail eggs was 0.41, 0.35, 0.31 and 0.13 mm, respectively. Differences in the shell thickness might be one of the possible reasons for the observed variation in the peeling score. A highly significant (R=0.97) positive correlation between peeling score and shell thickness of fresh hard cooked eggs substantiates the explanation that the peeling property was better in birds with higher egg shell thickness. Average peeling scores for oil coated fresh hard cooked eggs were significantly lower than the average peeling scores for uncoated fresh hard cooked eggs in all the four species of birds. It indicated that peeling property was adversely effected by oil coating. Various workers also reported that oil treated hard cooked eggs were more difficult to peel than uncoated eggs (Fuller and Angus, 1969; Arumugam, 2012).

The results of this study also revealed that there was a highly significant positive correlation (R=0.98) between pH and peeling score (Table 1). These findings were in agreement with the reports of Arumugam (2012) who also reported that the eggs with lower albumen pH (<8.7) were hard to peel. However, oil coating of eggs maintained excellent interior quality and inhibited the rise in albumem pH, but it increased the difficulties in peeling. Arumugam (2012) and Parsons (2013) gave similar correlation and further explained that albumen pH affected the shell membranes and adhering of albumen which directly influences peeling quality.

Peeling scores of chicken, duck, turkey and quail uncoated eggs were maximum (5) and significantly higher from their initial scores by 6th day, 4th day and 8th day, respectively at room temperature (Table 2). Similarly, the peeling scores in oil coated eggs were significantly higher from their initial scores. Thus the peeling score increased with the increase in storage period, however, the increase was more in uncoated eggs in all the cases. A similar trend had also been reported by Arumugam (2012).

When the eggs were stored at refrigeration temperature, the peeling scores of chicken, duck, turkey and quail uncoated hard cooked eggs were also significantly higher than their initial scores but peeling was poor till 8th day of storage. The peeling scores of oil coated eggs also increased but not significantly in case of chicken and quail eggs. In oil coated eggs of duck and turkey, the peeling scores increased significantly after 4th and 6th day of storage, respectively but the peeling scores were still poor till 8th day of storage as compared to uncoated eggs. Hence, the increase in peeling score of oil coated eggs was lower than uncoated eggs in all the four species of birds and peeling was poor when the eggs were stored at refrigeration. These results were in agreement with the findings of Parsons (2013) who reported that eggs stored

Table 1
Peeling score of fresh hard cooked eggs in relation to oil coating and shell thickness obtained from different species of birds

Species of birds	Av. peeling scores of fresh eggs		Av. shell thickness (mm)	Av. pH of fresh eggs	
	Uncoated	Oil coated		Uncoated	Oil coated
Chicken	$2.8^{bB}\pm0.07$	$1.8^{bA}\pm0.09$	$0.31^{b}\pm0.004$	$8.65^{bB}\pm0.01$	$8.52^{bA}\pm0.02$
Duck	$3.0^{cB}\pm0.06$	$1.9^{bA}\pm0.08$	$0.35^{c}\pm0.009$	$8.68^{cB}\pm0.02$	$8.56^{cA}\pm0.01$
Turkey	$3.2^{dB}\pm0.07$	$2.1^{cA}\pm0.07$	$0.41^{d}\pm0.004$	$8.71^{dB}\pm0.02$	$8.59^{dA}\pm0.03$
Quail	$2.5^{aB}\pm0.09$	$1.4^{aA}\pm0.08$	$0.13^{a}\pm0.008$	$8.62^{aB}\pm0.01$	$8.46^{aA}\pm0.01$

Means±SE with different small letter superscripts indicate significant difference column-wise and capital letter superscripts indicate significance difference row-wise for a parameter (P<0.05). n=30; R-value of peeling score and pH=0.98; R-value of peeling score and shell thickness=0.97.

Table 2

Peeling score of fresh and treated hard cooked shell eggs obtained from different species of birds during storage

S. days	T	Peeling score in eggs of			
		Chicken	Duck	Turkey	Quail
Storage temperature (25±2^{0}C)					
0	UC	2.5^b±0.10	2.8^b±0.11	3.0^b±0.14	2.3^b±0.10
	C	1.8^a±0.09	2.0^a±0.10	2.5^a±0.11	1.7^a±0.11
2	UC	4.6^f±0.08	4.8^e±0.04	4.9^f±0.02	4.5^e±0.08
	C	2.8^c±0.08	3.0^b±0.10	3.7^c±0.10	2.7^c±0.12
4	UC	4.8^g±0.04	5.0^f±0.02	5.0^f±0.01	4.6^e±0.08
	C	3.0^{cd}±0.10	3.1^{bc}±0.12	3.8^{cd}±0.10	2.8^c±0.10
6	UC	5.0^h ±0.00	5.0^f±0.00	5.0^f±0.02	4.9f±0.01
	C	3.1^d±0.10	3.3^c±0.10	4.0^{de}±0.08	3.0^c±0.10
8	UC	5.0^h ±0.00	5.0^f±0.00	5.0^f±0.01	5.0^f±0.00
	C	3.5^e ±0.09	3.8^d±0.09	4.2^e±0.09	3.3^d±0.10
Storage temperature (4±1^{0}C)					
0	UC	2.0^b±0.03	2.3^c±0.08	2.5^c±0.07	1.7^b±0.08
	C	1.5^a±0.08	1.8^a±0.03	1.9^a±0.08	1.3^a±0.10
2	UC	2.4^c±0.07	2.6^d±0.07	2.8^d±0.88	2.0^c±0.08
	C	1.6^a±0.09	1.9^{ab}±0.07	2.0^{ab}±0.09	1.4^a±0.08
4	UC	2.5^{cd}±0.08	2.6^d±0.06	2.9^d±0.07	2.1^c±0.06
	C	1.6^a±0.07	2.0^b±0.08	2.0^{ab}±0.08	1.4^a±0.09
6	UC	2.6^d±0.06	2.7^{de}±0.07	2.9^d±0.08	2.1^c±0.04
	C	1.7^a±0.09	2.0^b±0.09	2.1^b±0.07	1.5^{ab}±0.07
8	UC	2.6^d±0.06	2.8^e±0.05	3.0^d±0.06	2.2^c±0.09
	C	1.7^a±0.08	2.1^{bc}±0.07	2.1^b±0.06	1.5^{ab}±0.10

S.days=Storage days; T=Treatment; n=30; UC=Uncoated; C=Coated Means±SE (within the same storage temperature and same species of birds) with different superscripts differ significantly (P<0.05).

Table 3

pH of fresh and oil coated hard cooked eggs obtained from different species of birds during storage

S. days	T	Peeling score in eggs of			
		Chicken	Duck	Turkey	Quail
Storage temperature (25±2^{0}C)					
0	UC	8.61^{ab}±0.05	8.62^{ab}±0.05	8.65^{ab}±0.06	8.60^{bc}±0.05
	C	8.50^a±0.04	8.60^a±0.08	8.64^a±0.04	8.48^a±0.02
2	UC	8.91^c±0.03	8.93^c±0.04	8.95^b±0.03	8.90^d±0.03
	C	8.55^a±0.03	8.65^a±0.05	8.68^{ab}±0.05	8.50^{ab}±0.04
4	UC	8.94^c±0.04	8.96^{cd}±0.06	9.00^{bc}±0.05	8.91^d±0.04
	C	8.62^{ab}±0.06	8.66^a±0.04	8.72^{ab}±0.03	8.55^{ab}±0.03
6	UC	9.00^{cd}±0.06	9.08^{de}±0.04	9.10^{cd}±0.06	8.98^d±0.06
	C	8.71^b±0.05	8.73^b±0.03	8.76^{ab}±0.05	8.70^c±0.06
8	UC	9.10^d±0.04	9.18^e±0.03	9.20^d±0.04	9.00^d±0.06
	C	8.72^b±0.03	8.75^b±0.04	8.80^b±0.06	8.70^c±0.05
Storage temperature (4±1^{0}C)					
0	UC	8.50^{ab}±0.05	8.55^{ab}±0.06	8.60^{ab}±0.04	8.45^{ab}±0.03
	C	8.45^a±0.06	8.50^a±0.05	8.55^a±0.04	8.40^a±0.06
2	UC	8.60^{bc}±0.03	8.68^{bc}±0.04	8.70^{bc}±0.05	8.55^{bc}±0.04
	C	8.49^a±0.04	8.53^a±0.04	8.60^{ab}±0.05	8.45^{ab}±0.04
4	UC	8.62^{bc}±0.05	8.68^{bc}±0.05	8.72^{bc}±0.03	8.55^{bc}±0.06
	C	8.58^{ab}±0.05	8.55^{ab}±0.03	8.62^{ab}±0.03	8.45^{ab}±0.05
6	UC	8.65^{bc}±0.06	8.70^{bc}±0.05	8.74^{bc}±0.06	8.58^{bc}±0.06
	C	8.53^a±0.03	8.58^{ab}±0.04	8.65^{ab}±0.04	8.50^{abc}±0.03
8	UC	8.66^c±0.03	8.71^c±0.03	8.77^c±0.00	8.60^c±0.05
	C	8.55^{ac}±0.05	8.60^{abc}±0.05	8.66^{abc}±0.05	8.50^{abc}±0.04

S.days=Storage days; T=Treatment; n=30; UC=Uncoated; C=Coated Means±SE (within the same storage temperature and same species of birds) with different superscripts differ significantly (P<0.05).

in a refrigerator had poor peeling score than the eggs stored at room temperature and easiness in peeling of hard cooked eggs was increased with the increase in storage period.

The pH of uncoated egg albumen was significantly higher on 2nd day of storage at room temperature as compared to fresh chicken, duck and quail eggs. However, but in case of turkey, the pH of uncoated egg albumen increased significantly on 6th day (Table 3). The pH of oil coated egg albumen increased significantly on 6th day of room temperature storage in chicken, duck and quail, where as it increased significantly on 8th day in oil coated turkey eggs. The pH of uncoated egg albumen increased significantly on 6th day of storage at refrigeration, where as oil coated eggs albumen pH did not show statistical difference during the refrigeration storage period in all the four species. The pH of stored eggs was more than fresh eggs and the increase was more in uncoated as compared to oil coated eggs. Oil coating caused less extensive rise in albumen pH than uncoated eggs as reported by Parsons (2013). The pH of the oil coated eggs in all the four species of birds did not increase significantly till 8 days in refrigeration storage, but the untreated eggs showed a significantly higher pH in similar storage conditions (Arumugam, 2012).

The acceptability score of chicken eggs was the highest followed by turkey, duck and quail eggs (Table 4). The acceptability score of uncoated eggs was significantly lower on 4th day and in case of oil coated eggs; it reduced significantly on 6th day at room temperature in all the four species of birds. The acceptability of uncoated eggs could be maintained up to 2 days and that of oil coated eggs up to 4 days, when stored at room temperature. However, the acceptability could be maintained up to 8 days in oil coated eggs at refrigeration temperature in all the four species of birds. Arumugam (2012) and Parsons (2013) have reported that washing and oil coating of eggs not only improved the microbial quality of eggs but also its albumen pH which indirectly might be responsible for better odour and overall acceptability. Parsons (2013) reported that acceptability of hard cooked eggs could be maintained in refrigerated temperature as compared to room temperature.

Table 4

Acceptability of fresh and oil coated hard cooked eggs obtained from different species of birds during storage.

S. days	T	Peeling score in eggs of			
		Chicken	Duck	Turkey	Quail
Storage temperature (25±2^{0}C)					
0	UC	8.75^{aA}±0.10	8.40^{abBC}±0.11	8.60^{abAB}±0.10	8.20^{abC}±0.12
	C	8.80^{a}±0.10	8.52^{a}±0.09	8.65^{a}±0.11	8.50^{a}±0.11
2	UC	8.50^{a}±0.11	8.10^{b}±0.10	8.30^{b}±0.11	8.00^{b}±0.10
	C	8.65^{a}±0.09	8.40^{ab}±0.11	8.50^{ab}±0.09	8.30^{a}±0.09
4	UC	8.00^{b}±0.11	7.60^{c}±0.09	7.80^{c}±0.12	7.50^{c}±0.11
	C	8.50^{a}±0.10	8.30^{ab}±0.10	8.40^{ab}±0.10	8.20^{ab}±0.10
6	UC	6.50^{d}±0.09	6.00^{e}±0.08	6.30^{e}±0.09	5.80^{e}±0.09
	C	8.00^{b}±0.11	7.60^{c}±0.09	7.80^{c}±0.11	7.40^{c}±0.11
8	UC	5.30^{e}±0.10	4.90^{f}±0.10	5.20^{f}±0.11	4.70^{f}±0.10
	C	7.50^{c}±0.11	7.00^{d}±0.10	7.30^{d}±0.10	7.00^{d}±0.10
Storage temperature (4±1^{0}C)					
0	UC	8.80^{aA}±0.10	8.50^{aBC}±0.09	8.70^{aAB}±0.08	8.40^{abC}±0.1
	C	8.75^{a}±0.12	8.52^{a}±0.10	8.64^{ab}±0.10	8.50^{a}±0.08
2	UC	8.62^{abc}±0.10	8.49^{a}±0.10	8.51^{abc}±0.10	8.38^{ab}±0.11
	C	8.69^{abc}±0.11	8.50^{a}±0.11	8.59^{abc}±0.09	8.48^{ab}±0.10
4	UC	8.55^{abc}±0.11	8.42^{ab}±0.11	8.43^{abc}±0.12	8.30^{abc}±0.12
	C	8.65^{abc}±0.10	8.46^{ab}±0.10	8.55^{abc}±0.11	8.45^{ab}±0.10
6	UC	8.50^{bc}±0.10	8.33^{ab}±0.12	8.40^{bc}±0.11	8.20^{bc}±0.09
	C	8.62^{bc}±0.10	8.43^{a}±0.09	8.54^{abc}±0.10	8.42^{ab}±0.11
8	UC	8.40^{c}±0.10	8.20^{b}±0.10	8.35^{c}±0.08	8.10^{c}±0.10
	C	8.60^{abc}±0.11	8.40^{ab}±0.08	8.52^{abc}±0.10	8.37^{abc}±0.11

S.days=Storage days; T=Treatment; n=30; UC=Uncoated; C=Coated Means±SE (within the same storage temperature and same species of birds) with different superscripts differ significantly (P<0.05).

It is concluded that the fresh and oil coated eggs were more acceptable but difficult to peel as compared to stored and uncoated eggs. However, the peeling scores increased and acceptability decreased as the storage period increased at both the temperatures, but the eggs stored at 4±2^{0}C were more acceptable and difficult to peel as compared to the eggs stored at 25±2^{0}C. The peeling quality was positively correlated with shell thickness (R=0.97) and pH (R=0.98) of the egg albumen in all the cases.

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