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Quality of cold-stored free-range eggs sold in different retail outlets in Alfenas – MG, Brazil

Qualidade de ovos tipo caipira comercializados em diferentes estabelecimentos na cidade de Alfenas – MG, armazenados sob refrigeração

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ABSTRACT

The aim of this study was to assess the internal quality of free-range eggs available for sale in Alfenas – MG, Brazil, and stored under refrigerated conditions (maximum and minimum temperatures of 9.7 and 6.7 °C, respectively). The experimental design was completely randomized, structured as a 2x5 factorial arrangement involving two types of retail outlets (supermarket (S) and open-air market (OA)) and five storage periods (1, 8, 15, 22, and 29 days), resulting in 10 treatments. Each treatment had six replicates, represented by individual eggs. The following parameters were evaluated: Haugh unit (HU); percentage of egg weight loss (WL%); percentages of albumen, yolk, and shell; yolk index (YI); albumen index (AI); yolk pH; and yolk color. Egg weight loss increased ($p<0.05$) with the length of the storage period. Eggs acquired from S were deemed to be of inferior quality (HU < 60), in contrast to those obtained from OA ($p<0.05$). A significant interaction effect was noted for YI ($p<0.05$), with eggs from S exhibiting higher YI values than those from OA at 15 and 22 days of storage. Additionally, eggs from S had diminished AI values ($p<0.05$) when compared to those acquired from OA. The yolk color in eggs from S was more intense than that in eggs from OA ($p<0.05$). A lower yolk percentage was detected in eggs from S relative to those from OA ($p<0.05$). Therefore, eggs sold in Alfenas – MG, Brazil, from open-air markets possess superior quality compared to those sold in supermarkets.

Keywords: alternative poultry farming, *Gallus gallus domesticus*, shelf life

RESUMO

Objetivou-se avaliar a qualidade interna de ovos tipo caipira comercializados na cidade de Alfenas – MG, armazenados sob refrigeração (máxima 9,7°C e mínima 6,7°C). Os ovos foram distribuídos em um delineamento inteiramente casualizado, em esquema fatorial 2x5, sendo dois estabelecimentos comerciais (supermercado (S) e feira livre (FL)) e cinco períodos de armazenamento (um, oito, 15, 22, 29 dias) totalizando 10 tratamentos com 6 repetições (ovo) cada. As variáveis analisadas foram unidade *Haugh* (UH), perda de peso dos ovos (PP%), porcentagem de albúmen, gema e casca, índice de gema (IG) e albúmen (IA), pH de gema e coloração da gema. A PP% aumentou ($p<0,05$) conforme o período de armazenamento. Os ovos do S foram classificados como de baixa qualidade (UH < 60), diferindo dos ovos da FL ($p<0,05$). Para o IG observou-se uma interação significativa ($p<0,05$), de modo que, aos 15 e 22 dias de armazenamento os ovos do S apresentaram maior IG que aqueles provenientes da FL. Os ovos do S apresentaram valores inferiores de IA ($p<0,05$) em relação aos adquiridos na FL. Ovos do S apresentaram coloração de gema mais acentuada que os ovos comercializados na FL ($p<0,05$). Constatou-se menor porcentagem de gema dos ovos do S quando comparados com os da FL ($p<0,05$). Os ovos comercializados na cidade de Alfenas-MG provenientes de feira livre apresentam qualidade superior aos do supermercado.

Palavras-chave: avicultura alternativa, *Gallus gallus domesticus*, tempo de prateleira

INTRODUCTION

Chicken eggs, appreciated for their high biological value and affordability, are widely consumed worldwide. In 2022, the average consumption in Brazil reached 241 eggs per person per year (ABPA, 2023). As stated by Lana et al. (2017), eggs are perishable, with internal quality deteriorating post-laying, evidenced by decreased Haugh unit values, reduced albumen height, and increased albumen pH.

As the days pass, eggs undergo physicochemical changes. Considering the internal aspects that indicate the quality of the freshly laid egg, a high-quality egg features a central, turgid yolk encased by dense and thin albumen layers. In contrast, aged eggs display a flaccid, off-center yolk surrounded by a large expanse of liquid albumen (Solomon, 1997).

Changes in the internal quality of fresh free-range eggs mirror those seen in conventional commercial eggs. While the degradation process is inevitable, storage conditions, particularly refrigeration, play a critical role in slowing this decline and ensuring the safety of the product for consumers.

As pointed out by Carvalho et al. (2022), the current legislation is non-specific for free-range eggs, relying instead on standards set for commercial eggs. This highlights the need for research into the quality of eggs from alternative farming systems, given the limited Brazilian literature on the differences between free-range eggs sold in open-air markets and supermarkets.

In view of the above considerations, this study aimed to assess the internal quality of free-range eggs from a supermarket and a street market in Alfenas – MG, Brazil, following 30 days of refrigerated storage.

MATERIAL AND METHODS

The trial took place in the Chemical Analysis Laboratory of the Agronomy

Department at Professor Édson Antônio Velano University (UNIFENAS). A total of 60 free-range eggs were acquired from two retail outlets within Alfenas – MG, Brazil: 30 from a supermarket and 30 from a street market.

Following their purchase, each egg was individually weighed using a precision digital scale with an accuracy of 0.01 g. Subsequently, the eggs were labeled and placed in refrigerated storage. The maximum and minimum temperatures (°C) were recorded every seven days using a thermometer positioned near the eggs (Table 1).

Table 1. Average, maximum, and minimum temperatures (°C) observed during the cold storage of free-range eggs from two retail outlets (supermarket and street market) in Alfenas – MG, Brazil

Days of storage	Average (°C)	Maximum (°C)	Minimum (°C)
1	7.1	7.4	6.7
8	8.0	8.5	7.5
15	8.5	9.4	7.5
22	8.2	9.2	7.1
29	8.8	9.7	7.8

Source: original work (2023).

The eggs were allocated using a completely randomized design laid out in a 2x5 factorial arrangement involving two types of retail outlets (a supermarket and an open-air market) and five storage periods (1, 8, 15, 22, 29 days), resulting in a total of 10 treatments with six replicates (eggs) each. The assessed parameters included Haugh unit; percentage of egg weight loss; albumen, yolk, and shell percentages; yolk and albumen indices, yolk pH; and yolk color.

During the evaluation periods, 12 eggs were weighed individually to determine weight loss before being cracked open on a smooth, flat surface. The heights of the albumen and yolk were measured with an electronic digital caliper mounted on a tripod, while the diameters of the yolk and albumen were measured using a digital caliper (Digimess). The yolk and albumen indices were calculated as the height-to-diameter ratio. The proportions of yolk and albumen were determined by comparing the average weight of these components to the average egg weight. The Haugh unit was computed according to Lana et al. (2017), employing the formula $HU = 100 \log (H+7.57-1.7W^{0.37})$, where H denotes albumen height (mm) and W signifies egg weight (g).

Subsequently, the yolks were carefully separated from the albumen using a small polyethylene squeegee, facilitating the weighing of both components on a precision scale accurate to 0.01 g. The percentages of yolk and albumen were calculated based on their average weight relative to the average egg weight. To calculate the shell percentage, the formula %Shell = (100 – (% Yolk + % Albumen)) was used. Yolk color was assessed using a DSM colorimetric scale ranging from one to fifteen. After weighing, the yolks were placed against a white backdrop and the color was visually matched to the scale on the fan, with the corresponding score noted. A digital pH meter (MinyMix) was used to measure yolk pH, with readings taken from a mixture of three egg yolks.

Statistical analysis was conducted through analysis of variance, with mean comparisons made using the Scott-Knott test at a 5% significance level. These analyses were performed using SISVAR software, version 5.8, as described by Ferreira (2011).

RESULTS AND DISCUSSION

Egg weight loss (WL%) increased ($p<0.05$) with storage time (Table 2), irrespective of the purchase location. Santos et al. (2009) explain that egg weight loss results from the transfer of moisture from the albumen to the external environment through the shell, a process that occurs continuously.

Table 2. Weight loss (WL%), Haugh unit (HU), yolk index (YI), albumen index (AI), yolk color, and yolk pH of cold-stored free-range eggs from two retail outlets in Alfenas – MG, Brazil

Location (L)	WL%	HU	YI	AI	Yolk color	Yolk pH
Supermarket	4.47	53.55b	0.38	0.03b	12a	6.22
Open-air market	4.38	64.89a	0.36	0.06a	5b	6.15
Days of storage (D)						
1	3.24d	63.37a	0.38b	0.05	9	6.07
8	3.36d	60.77a	0.41a	0.05	9	6.15
15	4.02c	61.61a	0.35b	0.05	9	6.02
22	6.04a	60.08a	0.36b	0.04	9	6.30
29	5.47b	50.24b	0.37b	0.04	8	6.37
			P-value			
L	0.559	<0.001	0.06	<0.001	<0.001	0.571
D	<0.001	0.03	0.01	0.08	0.06	0.357
L*D	0.53	0.06	<0.001	0.41	<0.001	0.069
CV (%)	13.28	17.74	10.5	31.83	10.62	4.32

CV (%) - coefficient of variation. Means followed by different letters in the column differ from each other using the Scott-Knott test ($p<0.05$).

A significant difference ($p<0.05$) was found in Haugh unit (HU) values between the two types of retail outlets. Eggs sourced from open-air markets exhibited superior HU scores. Haugh unit, recognized globally as a key parameter, reflects the albumen height adjusted for egg weight (Lana et al., 2017). Based on egg quality classification, where excellent quality is indicated by HU above 72, high quality by HU between 60 and 72, and low quality by HU below 60 (USDA, 2005), eggs from supermarkets fell into the low-quality category (HU < 60). The storage duration also significantly affected HU ($p<0.05$), with eggs displaying diminished HU after 29 days. Nevertheless, refrigeration demonstrated a beneficial effect on HU, aiding in preserving egg quality to a certain extent. Eggs from both retail environments managed to largely retain their HU scores from the initial to the final day of analysis.

Regarding the yolk index (YI), no significant difference was detected between the retail outlets ($p>0.05$). However, a significant interaction ($p<0.05$) was observed between the establishments and the storage duration. Specifically, at 15 and 22 days of storage, supermarket eggs showed higher YI than those from the street market (Table 3). A higher YI indicates a more turgid yolk, suggesting superior internal quality. The variance seen at 15 and 22 days could be attributed to the interval between laying and sale of the eggs, with open-air market eggs potentially lacking consistency in laying and sale dates.

Table 3. Decomposition of the interaction for yolk index in cold-stored free-range eggs from two retail outlets in Alfenas – MG, Brazil

Yolk index					
Location	Days of storage				
	1	8	15	22	29
Supermarket	0.37	0.39	0.40a	0.41a	0.36
Open-air market	0.39	0.43	0.30b	0.31b	0.39

Means followed by different letters in the column differ from each other according to the Scott-Knott test ($p<0.05$).

Albumen index (AI) A differed significantly ($p<0.05$) between establishments, with supermarket eggs exhibiting lower AI values than those purchased from open-air markets. This discrepancy might be attributed to the period of exposure of eggs in the commercial establishment, as eggs from supermarkets were bought nearing their expiration dates in this study. Supporting evidence for these findings is seen in the studies of Barbosa et al. (2008) and Santos et al. (2009), which indicated that eggs stored for extended periods at ambient temperatures demonstrated a significantly lower AI compared to those stored for shorter durations.

Furthermore, a notable difference ($p<0.05$) was observed in yolk color between retail outlets, with supermarket eggs displaying more intense yolk hues than those from street markets (Table 4). The deeper yolk color could suggest a more diverse diet typical of free-range systems, or the inclusion of natural or synthetic colorants, potentially indicating a higher level of carotenoids — antioxidants and precursors of vitamin A (Carvalho et al., 2022).

Table 4. Decomposition of the interaction for yolk color in cold-stored free-range eggs from two retail outlets in Alfenas – MG, Brazil

Yolk color					
Location	Days of storage				
	1	8	15	22	29
Supermarket	12a	13a	13a	12a	13a
Open-air market	6b	5b	5b	6b	4b

Means followed by different letters in the column differ from each other according to the Scott-Knott test ($p<0.05$).

Consumers should exercise caution, as there exists a common misconception that brown/red-shelled eggs sold at open markets originate from free-range poultry. In contrast, eggs available in supermarkets are indeed produced under alternative systems, a fact that must be disclosed on packaging labels as per the legislation (Brazil, 2019).

A significant difference ($p<0.05$) was also detected in the yolk percentage (%Y) between the two types of retail outlets, with supermarket eggs showing a reduced %Y in comparison to those from street markets. The decline in yolk quality, evidenced by a lower %Y, may be due to water migration from the albumen to the yolk during storage, resulting in a more fragile vitelline membrane (Santos et al., 2009).

Table 5. Albumen, yolk, and shell percentages in cold-stored free-range eggs from two retail outlets in Alfenas – MG, Brazil

Location (L)	Albumen (%)	Yolk (%)	Shell (%)
Supermarket	57.17	28.55b	14.27
Open-air market	55.83	30.75a	13.41
Days of storage (D)			
1	56.33	28.22	15.45a
8	56.72	29.32	13.95a
15	54.34	30.88	14.75a
22	57.81	30.53	11.65b
29	57.30	29.30	13.40a
P-value			
L	0.10	0.01	0.17
D	0.08	0.28	<0.001
L*D	0.91	0.46	0.26
CV (%)	5.45	10.93	17.47

CV (%) – coefficient of variation. Means followed by different letters in the column differ from each other according to the Scott-Knott test ($p<0.05$).

A significant variation ($p<0.05$) in eggshell percentage was observed across storage durations. After 22 days of storage, this variable was found to be reduced, contrary to the expected increase in shell percentage due to internal changes within the egg over time (Moura et al., 2022). This unexpected result could be attributed to the lack of uniformity in the eggs sampled.

CONCLUSION

The quality of free-range eggs is influenced by the storage conditions and duration within commercial establishments. Therefore, eggs sold in Alfenas – MG, Brazil, from open-air markets demonstrated superior outcomes in terms of Haugh unit and albumen index when contrasted with supermarket eggs.

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