Soumis le : *11 Novembre 2013*
Forme révisée acceptée le : *16 Avril 2014*
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**Nature & Technology**

# Quality assessment of marketed eggs in Eastern Algeria

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**Abstract**

The objective of this study was to compare eggs quality between industrial and local chickens in four departments of Eastern Algeria (Bejaia, Jijel, Mila and Setif). A total of 4748 eggs were bought from three marketing channels as following: shops (1184), public markets (2757) and supermarkets (807). The percentage of stained eggs was significantly different (P<0.001) between industrial (15.25%) and local eggs (27.61%). A significant difference (P<0.05) was observed between industrial and local egg weight (61.01 vs 53.28g), egg shell weight (7.10 vs 6.30g), albumen weight (37.44 vs 29.69g), albumen percentage (61.34 vs 55.71%), shell thickness (0.381 vs 0.325mm). However, yolk weight (6.10 vs 6.30g), yolk percentage (27.06 vs 32.44%), shell percentage (11.60 vs 11.89%), yolk/albumen ratio (0.44 vs 0.58), albumen height (5.27 vs 5.93mm), Haugh unit (69.12 vs 77.80), yolk color (9.52 vs 10.94) and egg price (7.67 vs 12.84DA) of local chicken were significantly (P<0.01) higher than in the case of industrial hen. Marketing channels affected significantly (P<0.01) egg weight, yolk weight, albumen weight, albumen height and price of a total studied eggs. Egg weight (59.03g) and egg price (10.87DA) from supermarkets were the highest. Eggs of local hens presented according to the national preference, interesting quality criteria such as freshness, yolk/albumen ratio and yolk color.

**Keywords**: Algeria; eggs price; eggs quality; Haugh units; marketed table eggs.

## Introduction

Since thousands of years, bird's eggs and especially, hen eggs constitute an important food for the human [1]. The egg is a perfect natural food, belonging to a rare category of complete aliment. It contains the nine indispensable amino-acids [2], that the human organism cannot synthesize. It constitutes an easily renewable source of protein, lipid, mineral and vitamin. Proteins are vital for the formation and the maintenance of human tissues. They are also essential to the growth and the development of human organisms. Furthermore, they are responsible for training muscles, organs, skin and hair. In addition, they constitute antibodies, enzymes and hormones [3]. Eggs are accepted worldwide and are not subject of any cultural or religious prohibition [4]. Their low cost make them an important animal source of proteins and lipids [5]. Nowadays, the accompanied development of a fast food with the lifestyle and habits changing, had led to increase eggs demand. In fact, egg proteins are popular ingredients in many foods [6]. Currently, eggs are more than diet food source. Indeed, they are used in diverse food, pharmaceutical and cosmetic industries, thanks to their antioxidant, cryoprotectant, antibacterial, antiviral, antihypertensive, emulsifier and coagulant effects [1, 3, 6].

World eggs production and consumption had tripled since the sixties and continues to grow steadily [7]. Over the past 10 years, annual egg consumption per capita in Algeria has increased from 93 eggs (in 1995) to 110 eggs (in 2005) [8], one of the highest in Africa. Faced to this growing demand, study and analysis of eggs composition can play an important role in the diversification of their market. Egg composition and quality depend on many factors

such as the hen breed, stockage and age [9, 10, 11]. Variability in the quality of eggs available to consumers has been reported by many investigators [9, 12]. However, little is known about the quality of eggs commercialized in Algeria. The main objective of this study was to compare eggs quality between industrial and local chicken in Bejaia, Jijel, Mila and Setif departments (Eastern Algeria).

## Material and methods

A total of 4748 industrial and local chicken eggs were bought from three marketing channels, i.e., shops, public markets and supermarkets (Table 1). Location and duration of the experiment on internal and external eggs quality was considered. The following parameters were measured: eggs weight; freshness (Haugh units); yolk colour; shell thickness and yolk/albumen ratio. Eggs were numbered and then above mentioned parameters were evaluated. Weight and size (length and width) of each egg were measured, using an electronic balance and a caliper, respectively. After that, eggs were broken on a glass surface, in order to measure the internal eggs quality parameters. The thickness of the albumen was measured with the tripod micrometer, at the maximum height. Haugh units expressing the egg freshness were calculated using a formula described by Haugh [13]: HU = 100 log ($H - 1.7\ w^{0.37} + 7.6$); where HU = Haugh units, H = Albumen height (mm), W = egg weight (g). The used apparatus for HU measurement is composed of an electronic balance, a tripod micrometer (both connected to a computer) and a glass surface having a slope slight slope. Yolk and albumen were separated before weighing the yolk. The weight of albumen is obtained by the following formula: Albumen weight = total egg weight - (yolk weight + shell weight). The yolk color was determined with the DSM Yolk Color scale. The thickness of egg shell including shell membranes was measured on three equator points with an electronic micrometer. The average of these three values was considered in the data analysis. In fact, the eggshell is thinner but almost uniform on equatorial zone [14].

### *Statistical analysis*

Statistical analyses were carried out using SAS software [15].The generalized linear model (GLM) was used to perform a variance analysis of each parameter to determine a difference between the three retail sources, breeds and their statistical significance. For each parameter, the least squares means (LSM) and the standard errors were calculated. The chi-square test was used to test independence between the qualitative variables and retail sources.

## Results and Discussion

Due to limited area, this study comment only related factors to a hen breed and marketing channels. In this work, the percentage of dirty eggs from local chicken breed (27.61%) was significantly higher ($P<0.001$) than eggs from industrial hen (15.25%). This situation is explained by a part of farming system. In Algeria, industrial chickens are raised in a cage system with nests to collect eggs, while the local breed chickens are in the open air or in confinement on the ground with laying nests. Vidal *et al.* [16] reported that the replacement of systems in conventional cages by those in enriched cages or by aviaries could increase the number of dirty eggs. Furthermore, 7.97% of total eggs were impure, a proportion which was considered high in comparison to the result found by Moula *et al.* [17] where only 8.97% of total eggs were dirty in a department of Bejaia (Algeria).

Highly significant differences ($P<0,001$) were recorded in the shell thickness of local (0.325mm) and industrial eggs (0.381), this can be explained by the fact that no breeding program has been applied to date in these local breeds regarding eggshell quality. Suk and Park [18] showed that egg shell of the commercial standard chicken (CEC industrial strain) at the age of 55 weeks was thicker than those of the Korean Native Chicken (KNC local hen). Similarly, Offiong *et al.*[19], mentioned that egg shell thickness of studied local and industrial hen were respectively, 0.34 mm vs. 0.36 mm. Benabdeljelil *et al.* [20] found that egg shell of cross breeds (local x industrial: Fayoumi × Leghorn/ ISA × Mandarah) were less thick than industrial eggs (0.388 mm / 0.394 mm) vs. 0.394. Kemps *et al.* [21] reported that eggs of Bovans line with 65. 2 g of whole egg weight had thicker shells (0.353 mm), compared to the Hissex breed (0.351 mm) that reached 59.9g of whole egg weight.
About 4% of studied eggs in this work are of suspicious freshness (table 3). Indeed, when the egg becomes older, the thickest part of the albumen liquefies, causing its spreading. This albumen integrity degeneration is mainly due to the pH rise [9]. This phenomenon is directly linked to dioxide carbon release. The best guarantees of maintaining the egg freshness is to conserve them just after laying in refrigerate.

In this study, most of purchased eggs were according to European classification of medium class (Table 4). Large and X-Large classes were only observed in industrial eggs. The percentages of these classes were much lower than those reported by Abo Omar and Aref [22] in Palestine. All local chicken eggs were medium class. This may be

explained by the fact that local breeds worldwide present eggs with weights less than 55g [17].

Highly significant differences (P<0.001) were observed, according to breeds, in yolk, albumen and shell weights. Industrial hens gave eggs with weights significantly more important than local chicken (61.01 g vs. 53.28g). Similar observations were found for, albumen and shell weights (Table 5 and table 6). Local chicken presenting low albumen proportion (55.67%) showed high yolk (32.44%) and shell percentages (11.89 %) (Table 5). These results are conform with Fikry- Amer [23] which observed low egg weight of local Fayoumi breed (42.15 g) and Dandarawi (42.70 g), comparing to Rhode Island Red industrial line (51.89 g). In addition, Tixier-Boichard *et al.* [24] recorded similar results between Fayoumi breed (42.8 g) and Isabrown line (58.8 g). Furthermore, industrial eggs weights are always more important than local eggs [10]. Indeed, laying type of commercial chickens received intensive selection for generations which offers them the benefit to get main characters, whose the most important yolk, albumen and shell weights [24.25].

Yolk color (10.94vs 9.52) of local chicken was significantly (P<0.01) higher than that of the industrial one. The observed difference in yolk color could be explained by the diversity of the chicken feeding system [27]. The yolk color results from lutein and *Zeaxanthine*, carotenoids pigments [28]. Hens receiving biological feed that contains high doses of lecithin protein, possesses walleye yolk color [29].

Algerian local hens presented higher yolk/albumen ratio (0.58 vs 0.44 for industrial eggs). Suk and Park [18] reported that eggs of KNC and CEC chicken had yolk/albumen ratios of 0.55 and 0.38, respectively. Furthermore, Moula *et al.* [9, 10] showed that yolk/albumen ratio is negatively correlated with egg weight. Albumen height was significantly higher in local chicken eggs (5.27mm) compared to industrial eggs (5.27 mm). Haugh units were significantly (P<0.001) lower in industrial chicken eggs, indicating a lesser freshness (Table 5). This result may be explained by the exposure of industrial eggs to air inside being conserved in the fridge. The storage conditions, including temperature, humidity, presence of $CO_2$, and duration, influence also egg quality [30]. Storage duration and temperature appear to be the most crucial factors affecting albumen quality or Haugh unit. The good quality of local eggs, in this work, could be due to the fact that they are produced in low quantities which led farmers to sell them quickly.

The price of local chicken egg (12.84DA) was significantly (P<0.001) higher than that of industrial hens (7.67DA). This makes eggs price per kilogram, twice expensive in local chickens (240.99DA) compared to industrial hens (125.73DA). In this work, the marketing channel affected significantly all studied egg quality parameters (Table 6).

## Conclusion

In general, commercialized eggs in this work were fresh according to HU values. Indeed, it is a proof that this market is characterized by a steady and a variety of supply and consumption (eggs of local and industrial chickens; three marketing channels). Local eggs are of small class but of higher price, this could presents an unprecedented opportunity for the conservation of local breed chickens in Algeria, and developing labeled eggs for their market.

**Table 1-** Eggs number by marketing channel and chicken breed

| | Number of eggs (%) | | | |
|---|---|---|---|---|
| **Breed** | **Total** | **Food shops** | **Public markets** | **Supermarkets** |
| **Local** | 1036(22) | 416(9) | 578(12) | 42 (1) |
| **Industriel** | 3712 (78) | 768 (16) | 2179 (46) | 765 (16) |
| **Total** | 4748 (100) | 1184(25) | 2757(58) | 807(17) |

**Table 2-** Distribution (%) of clean eggs

| | **Total** | **Breed** | | **Chi2-Value** | **P-value** |
|---|---|---|---|---|---|
| | | **Industrial** | **Local** | | |
| **Clean** | 82.03 | 84.75 | 72.39 | 84.01 | *** |
| **Dirty** | 17.97 | 15.25 | 27.61 | | |

**Table 3** Number and percentage of eggs whose albumen is plated and liquefied

| Damaged eggs: number (%) | | | | |
|---|---|---|---|---|
| **Breed** | **Food shops** | **Public markets** | **Supermarkets** | **Total** |
| **Local** | 0 (0%) | 30 (4.93%) | 0 (0%) | 30 (2.81%) |
| **Industrial** | 49 (6.00%) | 103 (4.51%) | 19 (2.42%) | 171 (4.40%) |
| **Total** | 49 (3.97%) | 133 (4.60%) | 19 (2.30%) | 201 (4.06%) |

**Table 4-** Egg weight classes' distribution (%).

| **Egg weight classes**[1] | **Breed** | **Consumer Channels** | | | **Mean** |
|---|---|---|---|---|---|
| | | **Foodshops** | **Public markets** | **Supermarkets** | |
| **X-Large** | **Industriel** | 4.04 | 1.47 | - | 1.47 |
| | **Local** | - | - | | - |
| | **Total** | 2.62 | 1.16 | - | 1.16 |
| **Large** | **Industriel** | 28.39 | 31.12 | 57.48 | 31.12 |
| | **Local** | - | - | - | - |
| | **Total** | 18.41 | 24.59 | 54.77 | 24.59 |
| **Medium** | **Industriel** | 63.93 | 44.06 | 42.22 | 44.06 |
| | **Local** | 40.38 | 42.91 | 100 | 42.91 |
| | **Total** | 55.66 | 43.82 | 45.23 | 43.82 |
| **Small** | **Industriel** | 3.65 | 23.36 | - | 23.36 |
| | **Local** | 59.62 | 57.09 | - | 57.09 |
| | **Total** | 23.31 | 45.23 | - | 30.43 |

[1]European classes

**Table 5-** Least Squares Means and standard errors by breed, of egg quality evaluation traits and price per egg (DA).

| | **Breed** | |
|---|---|---|
| **Egg quality parameters** | **Industriel** | **local** |
| **Egg weight (g)** | 61.01 ±0.09[a] | 53.28±0.28[b] |
| **Yolk weight (g)** | 16.47±0.03[a] | 17.28±0.09[b] |
| **Shell weight (g)** | 7.10±0.02[a] | 6.30±0.06[b] |
| **Albumen weight (g)** | 37.44±0.07[a] | 29.69±0.21[b] |
| **Yolk (%)** | 27.06±0.05[a] | 32.44±0.14[b] |
| **Albumen (%)** | 61.34±0.06[a] | 55.67±0.17[b] |
| **Shell (%)** | 11.60±0.02[a] | 11.89±0.07[b] |
| **Y/A ratio** | 44.44±0.12[a] | 58.45±0.36[b] |
| **Albumen high (mm)** | 5.27±0.02[a] | 5.93±0.06[b] |
| **Haugh unit** | 69.12±0.15[a] | 77.80±0.45[b] |
| **Yolk color** | 9.52±0.02[a] | 10.94±0.07[b] |
| **Shell thickness (.01mm)** | 38.08±0.10[a] | 32.52±0.31[b] |
| **Price/egg (DA)** | 7.67±0.02[a] | 12.84±0.06[b] |

a,b: By row, values with different superscripts are significantly different (P<0.05).

**Table 6-** Least Squares Means and standard errors by breed and marketing channels of egg quality evaluation traits and price per egg (DA).

| | Breed | Marketing Channels | | | P-value | | | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| | | Food Shops | Public markets | Supermarkets | Breed (B) | Marketing Channels (MC) | B*C | |
| **Egg weight (g)** | **Industrial** | 60.77±0.18$^{ax}$ | 59.48±0.11$^{bx}$ | 62.78±0.18$^{cx}$ | *** | *** | ** | .32 |
| | **Local** | 52.23±0.25$^{az}$ | 52.34±0.21$^{az}$ | 55.27±0.78$^{bz}$ | | | | |
| | **Total** | 56.50±0.16$^{a}$ | 55.90±0.12$^{b}$ | 59.03±0.40$^{c}$ | | | | |
| **Yolk weight (g)** | **Industrial** | 16.22±0.06$^{ax}$ | 16.68±0.03$^{bx}$ | 16.52±0.06$^{cx}$ | *** | ** | *** | .03 |
| | **Local** | 16.93±0.08$^{az}$ | 16.74±0.07$^{ax}$ | 18.19±0.25$^{bz}$ | | | | |
| | **Total** | 16.57±0.05$^{a}$ | 16.71±0.04$^{b}$ | 17.35±0.13$^{c}$ | | | | |
| **Shell weight (g)** | **Industrial** | 6.96±0.04$^{ax}$ | 7.00±0.02$^{ax}$ | 7.34±0.04$^{bx}$ | * | *** | * | .10 |
| | **Local** | 6.34±0.05$^{az}$ | 6.24±0.04$^{az}$ | 6.33±0.16$^{az}$ | | | | |
| | **Total** | 6.65±0.03$^{a}$ | 6.62±0.02$^{a}$ | 6.83±0.08$^{b}$ | | | | |
| **Albumen weight (g)** | **Industrial** | 37.60±0.14$^{ax}$ | 35.79±0.08$^{ax}$ | 38.93±0.14$^{bx}$ | *** | *** | *** | .43 |
| | **Local** | 28.96±0.19$^{az}$ | 29.36±0.16$^{bz}$ | 30.75±0.59 $^{cz}$ | | | | |
| | **Total** | 33.28±0.12$^{a}$ | 32.57±0.09$^{b}$ | 34.84±0.30$^{c}$ | | | | |
| **Yolk (%)** | **Industrial** | 26.69±0.09$^{ax}$ | 28.21±0.05$^{bx}$ | 26.28±0.09$^{cx}$ | *** | *** | *** | .41 |
| | **Local** | 32.42±0.12$^{az}$ | 31.99±0.10$^{bz}$ | 32.91±0.38$^{az}$ | | | | |
| | **Total** | 29.55±0.08$^{a}$ | 30.10±0.06$^{b}$ | 29.59±0.20$^{a}$ | | | | |
| **Albumen (%)** | **Industrial** | 61.91±0.11$^{ax}$ | 60.03±0.06$^{bx}$ | 62.10±0.11$^{ax}$ | *** | *** | *** | .36 |
| | **Local** | 55.39±0.15$^{az}$ | 56.04±0.13$^{bz}$ | 55.58±0.47$^{abz}$ | | | | |
| | **Total** | 58.65±0.09$^{a}$ | 58.03±0.07$^{b}$ | 58.84±0.24$^{a}$ | | | | |
| **Shell (%)** | **Industrial** | 11.41±0.05$^{ax}$ | 11.75±0.03$^{bx}$ | 11.63±0.05$^{cx}$ | ** | * | *** | .03 |
| | **Local** | 12.20±0.06$^{ax}$ | 11.97±0.05$^{bx}$ | 11.51±0.20$^{cx}$ | | | | |
| | **Total** | 11.80±0.04$^{az}$ | 11.86±0.03$^{az}$ | 11.57±0.10$^{b}$ | | | | |
| **Y/A ratio** | **Industrial** | 43.41±0.24$^{ax}$ | 47.41±0.14$^{bx}$ | 42.50±0.24$^{cx}$ | *** | *** | *** | .41 |
| | **Local** | 58.73±0.32$^{az}$ | 57.33±0.27$^{bz}$ | 59.31±1.10$^{abz}$ | | | | |
| | **Total** | 51.07±0.20$^{a}$ | 52.37±0.15$^{b}$ | 50.91±0.52$^{a}$ | | | | |
| **Albumen high (mm)** | **Industrial** | 5.40±0.04$^{ax}$ | 5.18±0.02$^{bx}$ | 5.23±0.04$^{bx}$ | *** | *** | *** | .22 |
| | **Local** | 6.19±0.05$^{a}$ | 6.23±0.04$^{az}$ | 5.35±0.16$^{bx}$ | | | | |
| | **Total** | 5.80±0.03$^{a}$ | 5.70±0.02$^{b}$ | 5.29±0.08$^{c}$ | | | | |
| **Haugh unit** | **Industrial** | 71.02±0.29$^{ax}$ | 69.43±0.17$^{bx}$ | 68.70±0.30$^{cx}$ | *** | *** | *** | .22 |
| | **Local** | 79.68±0.40$^{az}$ | 80.42±0.34$^{az}$ | 73.32±1.26$^{bz}$ | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Total** | 75.35±0.25$^{a}$ | 74.93±0.19$^{a}$ | 71.01±0.65$^{b}$ | | | | |
| **Yolk color** | **Industrial** | 9.52±0.05$^{ax}$ | 9.53±0.03$^{ax}$ | 9.51±0.05$^{ax}$ | *** | *** | *** | .13 |
| | **Local** | 11.13±0.06$^{az}$ | 10.29±0.06$^{bz}$ | 11.40±0.21$^{az}$ | | | | |
| | **Total** | 10.32±0.04$^{a}$ | 9.91±0.03$^{b}$ | 10.46±0.10$^{a}$ | | | | |
| **Shell thickness (.01mm)** | **Industrial** | 38.93±0.19$^{ax}$ | 36.06±0.11$^{bx}$ | 39.31±0.18$^{ax}$ | *** | *** | *** | .22 |
| | **Local** | 31.31±0.25$^{az}$ | 32.14±0.21$^{bz}$ | 30.67±0.77$^{az}$ | | | | |
| | **Total** | 35.12±0.15$^{a}$ | 34.10±0.12$^{b}$ | 34.99±0.40$^{a}$ | | | | |
| **Price/egg (DA)** | **Industrial** | 7.54±0.04$^{acx}$ | 7.77±0.02$^{bx}$ | 7.60±0.04$^{cx}$ | *** | *** | *** | .75 |
| | **Local** | 11.54±0.06$^{az}$ | 12.83±0.05$^{bz}$ | 14.14±0.18$^{cz}$ | | | | |
| | **Total** | 9.54±0.03$^{a}$ | 10.30±0.03$^{b}$ | 10.87±0.09$^{c}$ | | | | |

a,b,c: By row, values with different superscripts are significantly different (P<0.05); x, z: By column, values with different superscripts are significantly different (P<0.05). ***: P<0.0001; **: P<0.001; *: P<0.05. Season: S; Marketing Channels: C. $R^2$: coefficient of determination

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