



2026 Jan; 22(1):123-135



ISSN: 5361-1858  
رجب 1447 هـ

## Effect of cooking methods (frying and boiling) on white and brown Chicken Egg fats properties

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### To cite this article:

Khadir. E. Abdelhakam<sup>1</sup>, Mohamed .E.Mohamed<sup>2</sup>, Fatin. H. Farahat<sup>3</sup> Sheriff O.Awide<sup>4</sup>, Ezzeldeen m.y.Ali<sup>5</sup>, Effect of cooking methods (frying and boiling) on white and brown Chicken Egg fats properties , Omdurman Islamic University Journal, Sudan

ISSN: 5361-1858

<https://doi.org/10.52981/oij.v1i2.1726>

### المستخلص:

المهدف الرئيسي من هذه الدراسة هو دراسة خواص دهن بيض الدجاج وأثر طرق الطبخ على نوعين من بيض الدواجن ( الأبيض والأسمر ) ، وتم تحليل العينات تم الطبخ بطريقتين (التحمير والسلق). أظهرت النتائج ان الخواص الكيميائية (الرقم اليودي، رقم الحموضة، رقم البيروكسيد، رقم التصبن، المواد الغير قابلة للتصبن والأحماض الدهنية الحرة) لدهن البيض تأثرت معنوياً ( $p \geq 0.05$ ) باختلاف العينات وطرق الطبخ، حيث زادت كل القيم بواسطة الطبخ بالتحمير مقارنة بالسلق. أما الخواص الفيزيائية (معامل الانكسار، الكثافة، نقطة الانصهار، اللزوجة واللون) لدهن البيض نجد أن عملية الطبخ زادت قيم اللزوجة واللون بينما تناقصت قيم نقطة الانصهار واللون الأصفر، وأخذت بقية القيم موقعاً وسطياً. تم تقدير محتوى الكوليسترول الكلي (%) حيث أوضحت النتائج بأن أعلى نسبة له سجلت بواسطة البيض الأبيض المحمر (7.49)، بينما أقل قيمة له فقد وجدت في البيض البني المحمر (2.64)، تأثرت قيم الكوليسترول الكلي معنوياً ( $p \geq 0.05$ ) باختلاف أصناف البيض وطرق الطبخ. الأحماض الدهنية % (حمض اللوريك، الترايديكانويك، المريستوليك، البنثا ديكانويك، الأوليك، سيس -11، 14-ايكوساديك، البالميتيك، الالياديك، سيس -11-ايكوسينويك و سيس -10- بنتا ديكانويك، والپالميتيك) كذلك تم تقديرها وأوضحت نتائج الدراسة بأن اختلاف الأصناف وطرق الطبخ فقد أثرت معنوياً ( $P \geq 0.05$ ) على كل الأحماض الدهنية.

الكلمات المفتاحية: البيض الأبيض - البيض الأسمر - السلق - التحمير - كوليسترول - أحماض دهنية.

## Abstract

The objective of this study is to assessment the egg fats properties and effect of cooking methods on two types of chicken eggs. raw Eggs samples, (white and brown) were cooked by two kind of methods (frying and boiling). The results showed that the Chemical properties (Iodine value, Acid value, Peroxide value, Saponification value, Non-saponification value and Free fatty acids) of Eggs fat affected significantly ( $P \geq 0.05$ ) by varyingly of Eggs and cooking methods, frying increased all Chemical properties in comparison with boiling. Physical properties (Refractive index, Bulk density, Melting point, Viscosity and Colour) determined, results showed that the cooking was increase the Viscosity and red colour, decrease the melting point and Yellow colour, but the other parameters was stable values. Cholesterol content (%) analyzed, results showed that the higher content was found in fried white Egg (7.49), but the lower content was found in fried brown Egg (2.64), Cholesterol content (%) affected by Egg type and cooking methods. Fatty acids % (lauric, tridecanoic, myristoleic, myristic, pentadecanoic, oleic, cis-11,14-eicosadic, palmitoleic, linolenic, elaidic, cis-11-eicosenoic, cis-10-pentadecanoic and palmitic acids) determined, the results showed that the variety of Egg and cooking methods affected significantly ( $P \geq 0.05$ ) of all fatty acids.

**Keywords:** white egg - brown egg - frying – boiling-cholesterol-fatty acid

## 1- INTRODUCTION:

Lipids are found in the form of lipoproteins and usually are composed of 62% triglycerides, 33% phospholipids and less than 5% cholesterol (Anton, 2007). Cholesterol is a lipid found in the cell membrane of all animal tissues, and it is transported in the blood plasma of all animals. It is the well known steroid because of its association with atherosclerosis. Cholesterol is the parent molecule from which all steroid in the body are synthesized, which includes bile acid, adrenocortico-hormones, sex hormones and vitamin D, (Murray *etal*, 2003). Cholesterol is a major lipid component of animal cell membranes and blood lipoproteins, acting as the precursor for bile acids, steroid hormones, and vitamin D, and it is closely linked to atherosclerosis and cardiovascular health (Murray et al., 2003; Anton, 2007). In the human body, about two-thirds of cholesterol is synthesized endogenously in the liver, while the remainder is supplied by the diet, in which eggs, meat, and dairy products are among the main contributors (Brown, 2005). Because cholesterol is insoluble in water, it is transported in plasma as part of lipoprotein particles such as HDL and LDL, whose concentrations and balance are key indicators of coronary heart disease risk (Anton, 2007; Wikipedia, 2011). Eggs are an important dietary source of fat and cholesterol, with most of the fat and all of the cholesterol located in the yolk, whereas the white consists mainly of water and protein and contains virtually no fat or cholesterol

(Usayran et al., 2001). Despite concerns that egg consumption might elevate serum cholesterol and increase heart disease risk, several studies indicate that moderate intake (about one egg per day) does not adversely affect cardiovascular health in most individuals, and that the type and amount of dietary fat may be more influential than dietary cholesterol itself (Weggemans et al., 2001; Hu et al., 1999). Current dietary guidelines, such as those of the American Heart Association, therefore allow consumption of whole eggs within recommended limits for total fat, saturated fat, and cholesterol, especially when combined with an overall heart-healthy diet pattern (Wikipedia, 2011): Moreover, different cooking methods may modify the lipid profile, oxidative stability, and bioavailability of egg yolk lipids, which highlights the need to investigate how common household cooking practices affect egg fat quality and potential cardiovascular outcomes

The objective of this study is to assess the egg fats properties and the effect of different cooking methods (frying and boiling) on two types of chicken eggs (white and brown). The study aims to investigate the chemical and physical differences in egg fats resulting from these methods, including analysis of cholesterol content and fatty acids in cooked eggs. The primary goal is to understand how cooking processes affect the quality and composition of egg fats for better nutritional and health insights.

## **2-MATERIALS AND METHODS**

### **2.1. Sample Preparation**

A total of 300 fresh eggs (150 white and 150 brown) were obtained from a local company in Khartoum, Sudan. The eggs were divided into three groups for each type (n=50 eggs per group per type):

Group 1 (Raw): Analyzed without any cooking.

Group 2 (Boiled): Cooked in boiling water at 100°C until hard-boiled.

Group 3 (Fried): Fried without added oil on a preheated pan at 105°C.

The raw samples were homogenized using a blender. The cooked samples (boiled and fried) were minced thoroughly before analysis. All analyses were performed in triplicate.

Cooking: Two types of Egg samples was cooked by two methods (frying and boiling).150 eggs samples was divided to three groups , group one analysed as raw, group two analysed after boiling on 100 ° C,group three analysed after frying without oil on 105 ° C. Samples of Rocks progeny from brown eggs and leghorn progeny from white eggs were taken. 150 eggs were taken from each the raw, fried and poached eggs respectively. The raw sample were mixed with blender to homogenize, boiling and fried sample were (minced) and put in containers.

## 2.2. Proximate and Physicochemical Analysis

Crude Fat Extraction: was performed using the standard Soxhlet method (AOAC, 1995).

Chemical Properties: Iodine value, acid value, peroxide value, saponification value, and free fatty acids were determined according to the official methods of AOAC (1995).

Physical Properties: Refractive index, bulk density, melting point, viscosity, and color were analyzed as per AOAC (1995) guidelines.

Cholesterol Content: was determined spectrophotometrically using the Zak ferric chloride method (AOAC, 1995).

## 2.3. Fatty Acid Analysis

Fatty acid methyl esters (FAMES) were prepared via base-catalyzed transesterification. The FAMES were separated and quantified using a Gas Chromatograph (Shimadzu GC-14A) equipped with a Flame Ionization Detector (FID) and a polar BPX70 capillary column. Peaks were identified by comparing retention times with those of known standards.

## 2.4. Statistical Analysis

All data were subjected to statistical analysis, each determination was carried out and analyzed in triplicate and figures were then averaged. The means were tested by analysis of variance (ANOVA) with a probability  $P \leq 0.05$ . (Duncan, 1955).

## 3- RESULTS AND DISCUSSION

### 3-1 Chemical properties of egg fats

Iodine value: As shown in table 1 the results showed that the iodine value of raw eggs was found to be 80.12 and 78.71 in brown and white eggs respectively 130.31, 126.35, 80.35, and 79.75 in fried white, fried brown, boiled white, and boiled brown eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, but there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs. Cooking (Boiled and fried) increased the iodine value significantly ( $P \leq 0.05$ ), it was increased high significantly by cooking by boiled and fried in brown eggs.

Acid value: As shown in table 1 the results showed that the acid value of raw eggs was found to be 0.569 and 0.395 in brown and white eggs respectively, 0.668, 0.546, 0.487, and 0.477 in fried white, fried brown, boiled brown, and boiled white eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white eggs. Cooking (boiled and fried) was increased the acid value

significantly ( $P \leq 0.05$ ), it was increased high significantly by cooking by boiled and fried in brown eggs.

Peroxide value: As shown in table 1 the results showed that the Peroxide value of raw eggs was found to be 1.074 and 0.923 in white and brown eggs respectively, 2.669, 2.306, 1.747 and 1.272 in fried white, fried brown, boiled brown, and boiled white eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white eggs. Cooking (Boiled and fried) was increased the Peroxide value significantly ( $P \leq 0.05$ ), it was increased high significantly by cooking by boiled and fried in brown eggs.

Saponification value: As shown in table 1 the results showed that the saponification value of raw eggs was found to be 146.69 and 129.02 in white and brown eggs respectively, 161.55, 153.69, 131.10 and 130.08 in fried white, fried brown, boiled brown, and boiled white eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white eggs but there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white eggs. Cooking (boiled and fried) was increased the saponification value significantly ( $P \leq 0.05$ ), it was increased high significantly by cooking by boiled and fried in brown eggs.

Non-saponification value: As shown in table 1 the results showed that the non saponification value of raw eggs was found to be 2.651 and 2.483 in white and brown eggs respectively, 2.971, 2.550, 1.363 and 1.330 in fried white, fried brown, boiled brown, and boiled white eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was no significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white eggs. Cooking (boiled and fried) was increased the non saponification value significantly ( $P \leq 0.05$ ), it was increased high significantly by cooking by boiled and fried in brown eggs.

Free fatty acids: As shown in table 1 the results showed that the free fatty acid of raw eggs was found to be 0.2846 and 0.1975 in brown and white eggs respectively, 0.3340, 0.2730, 0.2435 and 0.2385 in fried white, fried brown, boiled brown, and boiled white eggs respectively. The results showed that there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and also there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs. Cooking (Boiled and

fried) was increased the free fatty acid significantly ( $P \leq 0.05$ ), it was increased high significantly by cooking by boiled and fried in brown eggs.

**Table (1): Physicochemical properties of raw, fried and boiled two species of eggs (brown and white)**

| Sample                    | Iodine value (mg I / g Oil)  | Acid value (mg NaoH/g oil)   | Peroxide value (ml eq peroxide/kg oil) | Saponification value (mg koH/g oil) | Non-saponification value (%) | Free fatty acids (%)          |
|---------------------------|------------------------------|------------------------------|----------------------------------------|-------------------------------------|------------------------------|-------------------------------|
| <b>Crude brown</b>        | 80.12 <sup>c</sup><br>±0.26  | 0.569 <sup>ab</sup><br>±0.04 | 0.923 <sup>c</sup><br>±0.09            | 129.02 <sup>d</sup><br>±0.35        | 2.483 <sup>a</sup><br>±0.29  | 0.2846 <sup>b</sup><br>±0.29  |
| <b>Crude white</b>        | 78.71 <sup>c</sup><br>±1.28  | 0.395 <sup>c</sup><br>±0.02  | 1.074 <sup>de</sup><br>±0.22           | 146.69 <sup>c</sup><br>±7.05        | 2.651 <sup>a</sup><br>±0.49  | 0.1975 <sup>d</sup><br>±0.29  |
| <b>Fried brown</b>        | 126.35 <sup>b</sup><br>±3.54 | 0.546 <sup>ab</sup><br>±0.03 | 2.306 <sup>b</sup><br>±0.12            | 153.69 <sup>b</sup><br>±3.51        | 2.550 <sup>a</sup><br>±0.29  | 0.2730 <sup>bc</sup><br>±0.29 |
| <b>Fried white</b>        | 130.31 <sup>a</sup><br>±0.88 | 0.668 <sup>a</sup><br>±0.02  | 2.669 <sup>a</sup><br>±0.25            | 161.55 <sup>a</sup><br>±0.68        | 2.971 <sup>a</sup><br>±0.18  | 0.3340 <sup>a</sup><br>±0.29  |
| <b>Boiled brown</b>       | 79.75 <sup>c</sup><br>±0.48  | 0.487 <sup>bc</sup><br>±0.10 | 1.747 <sup>c</sup><br>±0.06            | 131.10 <sup>d</sup><br>±0.63        | 1.363 <sup>b</sup><br>±0.06  | 0.2435 <sup>cd</sup><br>±0.29 |
| <b>Boiled white</b>       | 80.35 <sup>c</sup><br>±0.06  | 0.477 <sup>bc</sup><br>±0.14 | 1.272 <sup>d</sup><br>±0.09            | 130.08 <sup>d</sup><br>±1.24        | 1.330 <sup>b</sup><br>±0.06  | 0.2385 <sup>c</sup><br>±0.29  |
| <b>Lsd<sub>0.05</sub></b> | 2.836 <sup>**</sup>          | 0.1258 <sup>*</sup>          | 0.2756 <sup>*</sup>                    | 5.831 <sup>**</sup>                 | 0.4872 <sup>*</sup>          | 0.0629                        |
| <b>SE±</b>                | 0.9205                       | 0.04082                      | 0.08944                                | 1.892                               | 0.1581                       | 0.02041                       |

Values are mean ±S Mean value(s) having different superscript(s) in a column are significantly different ( $P \geq 0.05$ ) according to DMRT

### 3-2 Physical properties of egg fats

Refractive index: As shown in table 2 the results showed that the refractive index of raw eggs was found to be 1.466 and 1.462 in brown and white eggs respectively, 1.471, 1.467, 1.448, and 1.443 in fried white, boiled white, boiled brown, and fried brown eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white eggs.

Bulk density: As shown in Table 2 the results showed that the bulk density in raw eggs was found to be 0.937 and 0.905 in brown and white eggs respectively, 0.939, 0.911, 0.828, and 0.823 in fried brown, fried white, boiled brown, and boiled white eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was no significant

difference ( $P \leq 0.05$ ) between fried brown and fried white eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Melting point: As shown in Table 2 the results showed that the melting point in raw eggs was found to be 24.30 and 22.03 in white and brown eggs respectively, 21.30, 19.14, 19.07, and 18.47 in boiled white, fried white, boiled brown, and fried brown eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was no significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs but there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white eggs.

Viscosity: As shown in table 2 the results showed that the viscosity in raw eggs was found to be 99.23 and 97.40 in brown and white eggs respectively, 178.98, 171.53, 151.30, and 113.29 in boiled brown, fried white, fried brown, and boiled white eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was no significant difference ( $P \leq 0.05$ ) between fried brown and fried white eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white eggs .

## **Color**

### **Yellow color:**

As shown in table 2 the results showed that the yellow color in raw eggs was found to be 18.90 and 15.30 in brown and white eggs respectively, 5.80, 4.30, 3.80, and 3.30 in boiled white, fried brown, boiled brown, and fried white eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white eggs.

Red color: As shown in table 2 the results showed that the Red color in raw eggs was found to be 1.70 and 1.30 in white and brown eggs respectively, 18.13, 17.80 , 17.80, and 15.70 in fried white, boiled brown, fried brown, and boiled white eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was no significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white eggs.

Blue color: As shown in table 2 the results showed that the blue color in raw eggs was found to be 0.30 and 0.30 in brown and white eggs respectively, 1.20, 1.30 , 0.00, and 0.00 in boiled brown boiled white,, fried brown, and fried white eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was no significant difference ( $P \leq 0.05$ )

between fried brown and fried white eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white eggs.

**Table (2): Physical properties of Egg Fatsof raw, fried and boiled two species of eggs (brown and white)**

| Sample                    | Refractive index (°)        | Bulk density (g/Cm <sup>3</sup> ) | Melting point ( C <sup>0</sup> ) | Viscosity (CPs)               | Colour( C <sup>0</sup> )    |                             |                            |
|---------------------------|-----------------------------|-----------------------------------|----------------------------------|-------------------------------|-----------------------------|-----------------------------|----------------------------|
|                           |                             |                                   |                                  |                               | Yellow                      | Red                         | Blue                       |
| <b>Crude brown</b>        | 1.466 <sup>c</sup><br>±0.01 | 0.937 <sup>a</sup><br>±0.04       | 22.03 <sup>b</sup><br>±1.53      | 99.23 <sup>a</sup><br>±0.84   | 18.90 <sup>a</sup><br>±0.10 | 1.30 <sup>a</sup><br>±0.10  | 0.30 <sup>b</sup><br>±0.10 |
| <b>Crude white</b>        | 1.462 <sup>d</sup><br>±0.01 | 0.905 <sup>a</sup><br>±0.01       | 24.30 <sup>a</sup><br>±0.95      | 97.40 <sup>a</sup><br>±1.57   | 15.30 <sup>b</sup><br>±0.10 | 1.70 <sup>a</sup><br>±0.10  | 0.30 <sup>b</sup><br>±0.10 |
| <b>Fried brown</b>        | 1.443 <sup>f</sup><br>±0.01 | 0.939 <sup>a</sup><br>±0.04       | 18.47 <sup>c</sup><br>±0.35      | 151.30 <sup>a</sup><br>±0.76  | 4.30 <sup>d</sup><br>±0.10  | 17.80 <sup>a</sup><br>±0.10 | 0.00 <sup>c</sup><br>±0.10 |
| <b>Fried white</b>        | 1.471 <sup>a</sup><br>±0.01 | 0.911 <sup>a</sup><br>±0.01       | 19.14 <sup>c</sup><br>±1.44      | 171.53 <sup>a</sup><br>±0.47  | 3.30 <sup>f</sup><br>±0.10  | 18.13 <sup>a</sup><br>±0.49 | 0.00 <sup>c</sup><br>±0.10 |
| <b>Boiled brown</b>       | 1.448 <sup>e</sup><br>±0.01 | 0.828 <sup>b</sup><br>±0.04       | 19.07 <sup>c</sup><br>±1.00      | 178.98 <sup>a</sup><br>±2.58  | 3.80 <sup>e</sup><br>±0.10  | 17.80 <sup>a</sup><br>±0.10 | 1.30 <sup>a</sup><br>±0.10 |
| <b>Boiled white</b>       | 1.467 <sup>b</sup><br>±0.01 | 0.823 <sup>b</sup><br>±0.01       | 21.30 <sup>b</sup><br>±0.40      | 113.29 <sup>a</sup><br>±11.48 | 5.80 <sup>c</sup><br>±0.10  | 15.70 <sup>a</sup><br>±0.10 | 1.20 <sup>a</sup><br>±0.10 |
| <b>Lsd<sub>0.05</sub></b> | 0.0005626*                  | 0.0562*                           | 1.871*                           | 8.665**                       | 0.1779*                     | 0.3938**                    | 0.1488*                    |
| <b>SE±</b>                | 0.0001826                   | 0.01826                           | 0.6072                           | 2.812                         | 0.05774                     | 0.1278                      | 0.0483                     |

**Values are mean ±S Mean value(s) having different superscript(s) in a column are significantly different ( $P \geq 0.05$ ) according to DMRT**

**3-3 Cholesterol content (%):** As shown in table 3 the results showed that the cholesterol content of raw eggs was found to be 6.34 and 3.40 in brown and white eggs respectively. 7.49, 5.48, 5.44, and 2.64 in fried white, boiled brown, boiled white, and fried brown eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs, but there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

**Table (3): Cholesterol content (%) of raw, fried and boiled two species of eggs (brown and white)**

| Sample  | Brown                   | White                   |
|---------|-------------------------|-------------------------|
| Row     | 6.34 <sup>b</sup> ±0.00 | 3.40 <sup>d</sup> ±0.00 |
| Fried   | 2.64 <sup>c</sup> ±0.00 | 7.49 <sup>a</sup> ±0.00 |
| Boiled  | 5.48 <sup>c</sup> ±0.00 | 5.44 <sup>c</sup> ±0.00 |
| Lsd0.05 | 0.0529*                 |                         |
| SE±     | 0.0138                  |                         |

Values are mean ±S Mean value(s) having different superscript(s) in a column are significantly different (P≥0.05) according to DMRT

### 3-4 Fatty acids content

Lauric acid: As shown in table 4 the results showed that the Lauric acid of raw eggs was found to be 0.4784 and 0.4111 in brown and white eggs respectively, 0.2629, in fried white and NIL, in boiled brown, boiled white, and fried brown eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs but there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Tridecanoic acid: As shown in table 4 the results showed that the Tridecanoic acid of raw eggs was found to be 2.1566 and 1.1821 in brown and white eggs respectively, 2.2142, 2.1952, 1.3498 and 1.0030 in boiled white, fried brown, boiled brown, and fried white eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Myristoleic acid: As shown in table 4 the results showed that the Myristoleic acid of raw eggs was found to be 0.8139 and 0.5986 in brown and white eggs respectively, 0.7760, 0.3613, 0.3232 and NIL in fried brown, fried white, , boiled brown, and boiled white eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Myristic acid: As shown in table 4 the results showed that the Myristic acid of raw eggs was found to be 36.75 and 35.74 in brown and white eggs respectively, 37.15, 36.89, 36.37, and NIL in boiled white, fried brown, boiled brown, and fried white eggs respectively. The results showed there was a

significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Pentadecenoic acid: As shown in table 4 the results showed that the Pentadecenoic acid of raw eggs was found to be 50.93 and NIL in brown and white eggs respectively, 50.92, 50.70, and NIL in boiled white, fried brown, fried white and boiled brown eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Oleic acid: As shown in table 4 the results showed that the Oleic acid of raw eggs was found to be 6.22 and NIL in brown and white eggs respectively, 6.96, 6.42, and NIL in boiled white, fried brown, fried white and boiled brown eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Cis-11.14-Eicosadic acid: As shown in table 4 the results showed that the Cis-11.14-Eicosadic acid of raw eggs was found to be 2.65 and NIL in brown and white eggs respectively, 3.01, 2.75, and NIL in fried brown, boiled white, fried white and boiled brown eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Palmitoleic acid: As shown in table 4 the results showed that the Palmitoleic acid of raw eggs was found to be 1.2184 and NIL in white and brown eggs respectively, 1.0785, 0.7733, and NIL in boiled brown, fried white, fried brown and boiled white eggs respectively. The results showed there was a significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was a significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Lamda- linolenic acid: As shown in table 4 the results showed that the Palmitoleic acid of raw eggs was found to be 0.5543 and NIL in white and brown eggs respectively, and NIL in fried brown, fried white, boiled brown, and boiled white eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was no significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Elaidic acid: As shown in table 4 the results showed that the Elaidic acid of raw eggs was found to be 5.08 and NIL in white and brown eggs respectively, 4.24, 3.08 and NIL in boiled brown, fried white, fried brown, and boiled white eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, but there was a significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Cis-11-Eicosenoic: As shown in table 4 the results showed that the Cis-11-Eicosenoic of raw eggs was found to be 1.5235d NIL in white and brown respectively, 0.8046, 1.6355 and NEL fried white boiled brown, fried brown and boiled white eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was no significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Cis-10-Pentadeconic: As shown in table 4 the results showed that the Cis-10-Pentadeconic of raw eggs was found to be NIL in white and brown respectively, 37.22 and NIL fried white boiled brown, fried brown and boiled white eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was no significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

Palmitic acid: As shown in table 4 the results showed that the Palmitic acid of raw eggs was found to be 53.69 and NIL in brown and white and respectively, 56.49, 54.60 and NEL fried white boiled brown, fried brown and boiled white eggs respectively. The results showed there was no significant difference ( $P \leq 0.05$ ) between two types of raw eggs, and there was no significant difference ( $P \leq 0.05$ ) between fried brown and fried white Eggs and there was no significant difference ( $P \leq 0.05$ ) between boiled brown and boiled white Eggs.

**Table (4): Fatty acids (%) of raw, fried and boiled two species of eggs (brown and white)**

| Compound name        | Crude brown                        | Crude white                       | Fried brown                       | Fried white                        | Boiled brown                      | Boiled white                      | Lsd <sub>0.05</sub>   | SE $\pm$ |
|----------------------|------------------------------------|-----------------------------------|-----------------------------------|------------------------------------|-----------------------------------|-----------------------------------|-----------------------|----------|
| Lauric acid M.E      | 0.4784 <sup>a</sup><br>$\pm 0.00$  | 0.4111 <sup>a</sup><br>$\pm 0.00$ | Nil                               | 0.2629 <sup>a</sup><br>$\pm 0.00$  | Nil                               | Nil                               | 0.3701 <sup>n.s</sup> | 0.0245   |
| Tridecanoic acid M.E | 2.1566 <sup>bc</sup><br>$\pm 0.00$ | 1.1821 <sup>c</sup><br>$\pm 0.00$ | 2.1952 <sup>a</sup><br>$\pm 0.00$ | 1.0030 <sup>cf</sup><br>$\pm 0.00$ | 1.3498 <sup>d</sup><br>$\pm 0.00$ | 2.2142 <sup>b</sup><br>$\pm 0.00$ | 0.0465 <sup>*</sup>   | 0.0097   |
| Myristoleic M.E      | 0.8139 <sup>a</sup><br>$\pm 0.00$  | 0.5986 <sup>b</sup><br>$\pm 0.00$ | 0.7760 <sup>a</sup><br>$\pm 0.00$ | 0.3613 <sup>c</sup><br>$\pm 0.00$  | 0.3232 <sup>c</sup><br>$\pm 0.00$ | Nil                               | 0.0676 <sup>*</sup>   | 0.0816   |
| Myristic acid M.E    | 36.75 <sup>b</sup>                 | 35.74 <sup>c</sup>                | 36.89 <sup>b</sup>                | Nil                                | 36.37 <sup>b</sup>                | 37.15 <sup>a</sup>                | 0.8241 <sup>*</sup>   | 0.0199   |

|                        |                             |                              |                             |                              |                              |                             |                       |        |
|------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|-----------------------------|-----------------------|--------|
|                        | ±0.00                       | ±0.00                        | ±0.00                       |                              | ±0.00                        | ±0.00                       |                       |        |
| Pentadecenoic acid M.E | 50.93 <sup>a</sup><br>±0.00 | Nil                          | 50.70 <sup>a</sup><br>±0.00 | Nil                          | Nil                          | 50.92 <sup>a</sup><br>±0.00 | 0.5234 <sup>n.s</sup> | 0.0426 |
| Oleic acid             | 6.22 <sup>a</sup><br>±0.00  | Nil                          | 6.42 <sup>a</sup><br>±0.00  | Nil                          | Nil                          | 6.96 <sup>a</sup><br>±0.00  | 0.2547 <sup>n.s</sup> | 0.0237 |
| Cis-11.14-Eicosadic    | 2.65 <sup>b</sup><br>±0.00  | Nil                          | 3.01 <sup>a</sup><br>±0.00  | Nil                          | Nil                          | 2.75 <sup>b</sup><br>±0.00  | 0.0395 <sup>*</sup>   | 0.0098 |
| Palmitoleic acid M.E   | Nil                         | 1.2184 <sup>a</sup><br>±0.00 | Nil                         | 0.7733 <sup>c</sup><br>±0.00 | 1.0785 <sup>a</sup><br>±0.00 | Nil                         | 0.0157 <sup>*</sup>   | 0.0057 |
| Lamda-linolenic acid   | Nil                         | 0.5543<br>±0.00              | Nil                         | Nil                          | Nil                          | Nil                         |                       |        |
| Elaidic acid M.E       | Nil                         | 5.08 <sup>a</sup><br>±0.00   | Nil                         | 3.08 <sup>c</sup><br>±0.00   | 4.24 <sup>b</sup><br>±0.00   | Nil                         | 0.6112 <sup>*</sup>   | 0.0246 |
| Cis-11-Eicosenoic acid | Nil                         | 1.5235 <sup>a</sup><br>±0.00 | Nil                         | 0.8046 <sup>a</sup><br>±0.00 | 1.6355 <sup>a</sup><br>±0.00 | Nil                         | 0.3526 <sup>n.s</sup> | 0.0412 |
| Cis-10-Pentadeconic    | Nil                         | Nil                          | Nil                         | 37.22<br>±0.00               | Nil                          | Nil                         |                       |        |
| Palmitic acid M.E      | Nil                         | 53.69 <sup>c</sup><br>±0.00  | Nil                         | 56.49 <sup>a</sup><br>±0.00  | 54.60 <sup>b</sup><br>±0.00  | Nil                         | 0.8214 <sup>*</sup>   | 0.0278 |

Values are mean ±SD Mean value(s) having different superscript(s) in a column are significantly different (P≥0.05) according to DMRT

#### 4-Conclusion

This study showed that different cooking methods, boiling and frying, have a clear effect on the chemical and physical properties of fats in white and brown chicken eggs, where frying led to an increase in most chemical indicators compared with boiling, reflecting higher levels of oxidation and lipid hydrolysis. The results also indicated that cooking alters some physical properties of fats, such as viscosity, melting point, and color, which influences the characteristics of the final product as well as its suitability for consumption and storage. The findings revealed that cholesterol content varies according to egg type and cooking method, with the highest level recorded in fried white eggs and the lowest in fried brown eggs, highlighting the importance of selecting both egg type and cooking method when evaluating the health implications associated with egg consumption. Moreover, the fatty acid profile showed significant differences in response to egg variety and thermal treatment, which is reflected in the nutritional value and health-related properties of the extracted fats. Accordingly, there is a need to raise awareness among consumers and workers in the food industry about choosing the most appropriate cooking method that balances food safety, preservation of nutritional value, and reduction of potential negative effects of elevated lipid components. The study

also recommends conducting further research on other egg varieties and additional cooking methods, while expanding the scope of measurements to include more health indicators, in order to develop more precise and appropriate dietary recommendations for different consumer groups.

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