FACULTY OF AGRICULTURE

*Minia J. of Agric. Res. & Develop.*
*Vol. (43), No. 4 , pp. 873 - 886, 2023*

# PHYTOCHEMICAL PROFILE AND ANTIOXIDANT ACTIVITY OF SESAME SEED (SESAMUM INDICUM) BY-PRODUCTS FOR IMPROVING CUPCAKE SHELF LIFE

**Nahla Zaki Askander[1], Hani Mostafa Ali Mohamed[2], Mohamed Ahmed Kenawi[2], Rokaia Ramadan Abdelsalam[3*]**

[1] Master student at Food Science Department, Faculty of Agriculture, Minia University
[2] Professor of Food Science Department, Faculty of Agriculture, Minia University
[3]Associate Professor of Food Science Department, Faculty of Agriculture, Minia University
[*]Corresponding author(s) Rokaia R. Abdelsalam: E-mail(s): rokaia.guaid@minia.edu.eg

**Received : 22 Nov. 2023** **Accepted: 14 Feb. 2024**

**ABSTRACT**

There is an increasing interest in the valorization of agri-food residue to be used for the production of new functional bioactive components for the sustainability of the agri-industry. So, the aim of this study was to ascertain how naturally potent of Tahina industry's by-products antioxidants affected of the cupcakes quality parameters including the antioxidant potential (total phenolic content and % DPPH radical scavenging activity) and sensory attributes (overall acceptability) which stored at room temperature (25±2ºC) for up to eight days. The extracts were added to the cupcake formulation at 2 levels at 100 and 200 ppm as raw sesame reside extract (RE 100 and RE 200), roasted sesame reside extract (RO 100 and 200) and compared with BHT at the same concentration, respectively. The results obtained in this study showed that, natural extracts had a significant phenolic content ranged from 46.23±1.52 to 282.6± 4.08 mg GAE/g) as well as antioxidant activity 34.80± 0.26 to 65.31± 0.17 % DPPH scavenging. Residue sesame seed extracts (SSRE) integrated into cupcakes at various concentrations demonstrated lower energy value than control samples. Cupcakes with up to 200 ppm roasted residue extract (RO 200) showed significant improvements in appearance, crust color, texture and odor. Furthermore, it had lower malonaldehyde component and total count bacteria than another samples during storage period. The current study found that SSRE were a good source of natural antioxidants, especially roasted seed residue at 200 ppm. It can be used as functional additive in food industry.

**Keywords**: Sesame Seed Residue, Quality, Stability, Functional Additive and Biological Activities

## 1. INTRODUCTION

Sesame (*Sesamum indicum. L*) seed has long been considered one of the world's most important health crops. This crop is well-known for its nutritional benefits and is utilized in sweets and confectionaries. **(Namiki, 1995)**. Sesame seeds in particular have been demonstrated to provide a multitude of advantageous health benefits, such as antimutagenic, hepatoprotective, and hypo-cholesterol emic effects **(Chen et al., (2005), Lazarou and Papadopoulos., (2007), Yokota et al., (2007)**. Sesame seeds (*Sesamum indicum*. L) comprise around 20-25 g/100g protein, 50g/100g fat, 14g/100g carbohydrate, and 1-11g/100g fiber **(Green, 1989)**. Furthermore, it was shown that sesame spots, cakes, and seeds have excellent antioxidant and radical scavenging activities, as well as the capacity to protect against oxidative degradation **(Kapoor, 2001).**

In the Middle East, dehulled sesame seeds are commonly used to produce Tahina and Halwai. In general, the most commercial sesame products are made with roasted sesame seeds. Roasting is an important pre-oil extraction procedure for oily seeds. One of the expected consequences of the roasting process is an increase in antioxidant activity caused by the development of Maillard reaction products. The balance between the creation of new antioxidant-active products and the thermal degradation of naturally current antioxidant compounds influences how roasting affects the total antioxidant capacity of the seeds **(Açar et al., 2009).**

Furthermore, sesame seed coats (SSC) are byproducts of tahina or oil extraction and comprise bran, and hull (**Sun and Ho, 2005**). SSCs make up around 12% of the total seed weight (**El-Roby et al., 2020**). Furthermore, SSC are cheap, widely available, and made in large numbers (**Zouari et al., 2016**). They also contain a lot of beneficial chemicals as polyphenolic sesamin and sesamolin (**Elleuch et al., 2012**). SSC have significant antioxidant activity, which is useful in inhibiting LDL oxidation and scavenging free radicals (**Wang et al., 2007**). Moreover, phenolics have anti-inflammatory and anti-cancer characteristics (**Ortega-Hernández et al., 2018**). SSC antioxidant activity in sunflower oil (El-Roby et al., 2020) has been investigated. Sesame oil extracted from intact seeds had a higher oxidative stability than husked seeds **(Mehdi et al., 2020)**. According to **El-Roby et al., (2020)**, an ethanolic extract of sesame seed coat exhibits antioxidant activity comparable to tocopherol. Owing to its potent antioxidant properties, a sesame byproduct has garnered significant attention in the food industry for improving food quality and extending food shelf life.

Consequently, the primary objective of this work was to study the ideal conditions for achieving high polyphenol yields and potent antioxidant activity from sesame by-products residue in every Tahina processing stage. The secondary objective was to ensure a high-quality cupcake product at 100 and 200 ppm levels of residue extract and compared with butylated hydroxy

toluene (BHT) at the same levels during eight days of storage.

## 2. MATERIAL AND METHODS

### 2.1 Materials

Shandaweel 3 sesame was obtained from the Malloy Research Center for this investigation. Sesame By-products were obtained from Samalout Shepherd Production line, Taibah, Minia, Egypt

#### 2.1.1 Chemicals and Reagents

Fisher Synthetic compounds (Thermo Fisher Logical, Waltham, Mama, USA) gave the methanol, ethanol, n-hexane, and glacial acetic acid. Logical and MS grade solvents were used for extraction and portrayal, separately. Sigma-Aldrich (St. Louis, MO, USA) gave diphenyl-picrylhydrazyl (DPPH), Folin and Ciocalteu's phenol reagent, sodium carbonate, and phenolic norms. El-Gomhoria Trading Chemicals and Drugs Company (Egypt) gave all compounds and reagents of logical quality.

### 2.2 methods

#### 2.2.1 Preparation of Samples

Samples were obtained from factory, after that cleaned, dried and milled by using laboratory mixer and passed through a 1000 µ sieve. The dried samples were then sealed in a polyethylene bag and stored at 4 °C until further analysis.

#### 2.2.2 Chemical Composition of Sesame and their By-products

The fundamental component of sesame seed and their residues including moisture, ash, crude fat, fiber, and protein were determined in triplicate using AOAC standard techniques (**2005**). The carbohydrate content was determined using difference. The energy value of the seeds and their outcomes were calculated using the requirements and parameters described below:

Total energy = 16.7 (protein%+ carbohydrate %) + 37.4* fat%

#### 2.2.3 Mineral Concentration

The ash content was evaluated by burning the sample in a muffle furnace at 550°C for 12 hours. The residue was dissolved in $HNO_3$ with 50 g/L $LaCl_3$, and the mineral ingredients (Ca, K, Mg, and Na) were examined individually with an atomic absorption spectrophotometer (Hitachi Z6100, Tokyo, Japan) (AOAC, 2005).

#### 2.2.4 Assessment of bioactive activity

##### 2.2.4.1 Preparation of Seed Samples

Ten grams of seed and result powder were checked and suspended in 100ml of 90% ethanol for 2 hours of shaking. After filtration, the models were vacuumed. The gather was redissolved in 2 mL of 90% ethanol and the antioxidant activity and phenolic content were determined.

##### 2.2.4.2 DPPH Radical Scavenging Activity

Sesame extracts' antioxidant activity was measured using the diphenyl-2-picryl hydrazyl (DPPH) radical. Before adding 30 µl of sesame extract ethanolic arrangement, an aliquot of 0.5ml of DPPH arrangement was attenuated in 4.5ml of methanol. There was also a control group that did not get any extract. The combination was enthusiastically unsettled and permitted to remain in obscurity for 45 minutes prior to estimating absorbance at 515nm (Liu et al., 2007). The antioxidant activity of the extract was calculated using the subsequent formula:

% Scavenging Activity= ((Absorbance sample – Absorbance control) / Absorbance control) * 100.

**2.2.4.3 Total Phenolic Content**

The complete phenolic parts were resolved utilizing the strategy depicted by **Hajimahmoodi et al. (2010**); 15 mg of concentrate was weakened in 1ml of 90% ethanol. Two milliliters of 2% $Na_2CO_3$ were joined with a 10th of a microliter of the subsequent arrangement. Following 2 minutes, 100 microliters of Folin-Ciocalteu reagent (weakened with water 1:1) were added. After an additional 30 minutes, the absorbance at 750 nm was estimated. The concentration was evaluated using gallic acid as a standard, and the results were expressed as milligrams of gallic acid counterparts per milligrams of concentrate. The phenolic component content was calculated using the gallic acid standard curve:

$Y = 0.01816 X- 0.01015$; ( $R^2 = 0.9982$)

where: Y is the concentration and x are the absorbance

The results were expressed in mg of gallic acid equivalents per 100 g dry weight sample (mg GAE 100 $g^{-1}$ DW).

**2.2.5 Preparation of Cupcakes**

The instructions in Table 1 were used to create cupcakes using the approach presented by **Doweidar, 2001** with minor alterations such as replacing butter with BHT or antioxidant extraction at 100 and 200 ppm. The egg and vanilla were briefly whipped, and the spread was rationally and thoroughly beaten at low speed for 5 minutes. From there, pure sweetener was added and thoroughly mixed for 5 minutes on low speed. Finally, the other dry ingredients were added to the blender and mixed for 2 minutes on high-speed using a hand mixer. Cupcake was baked for 20 minutes at 180°C in small cupcake pans. The cupcakes were allowed to cool before being placed in polypropylene sacks and stored for additional analysis.

**Table 1: Ingredients of Control Cupcake**

| **Ingredients** | (g) |
|---|---|
| Flour | 110 |
| Sugar | 110 |
| Butter | 110 |
| Eggs | 85 |
| Vanilla | 0.6 |
| Baking powder | 1 tsp |
| Salt | 1 tsp |

**2.2.5.1 TBA Determination**

The method involved with refining thiobarbituric acid (TBA) was done by **Salih et al.'s** (1987) guidelines. Ten grams of cupcakes were refined after 2.5 mL of HCL and refined water arrangement (1:2). The test tube was loaded up with a 5 ml aliquot of distilled solution and 5 ml of the solution (0.288 g TBA/100 ml distilled water). The test tube was shaken and set in a 95°C water bath for 35 minutes. A

spectrophotometer (PG Instruments LTD T 80 UV/VIS spectrophotometer) was used to compare absorbance at 538 nm to a clear solution containing purified water and TBA solution.

**2.2.5.2 Microbiological Analysis**

In an aseptic blender, 10 grams of each example were blended with 90 milliliters of clean saline salt (9 grammes of NaCl per liter of purified water) to form a 1/10 dilution solution. For microbiological testing, serial dilutions were made. The standard plate count (SPC) for absolute microbiological count was produced by brooding plates at 37° C for 24 hours, according to **APHA, (1976).**

**2.2.5.3 Sensory Evaluation**

The sensory properties of various cupcake treatments were assessed using ten-point hedonic sensory evaluations. For the purpose of this endeavor, ten panelists were chosen from among the faculty's staff and students. They were given instruction on cupcake softness and hardness of the texture, crust and crumb color, flavor, and overall acceptability of the cupcake, according to **Lee et al., (2008**). Each sample was coded and sent to the panelists. In this evaluation, the range of points granted was established as a maximum of 10 (very excellent) and a minimum of 1 (very bad) (**Daraei et al., 2011 and Lee et al., 2008**). Sensory assessments were done on days 0, 2, 4, 6, and 8 after baking to assess the influence of storage duration on product texture and quality.

**2.2.6 Statistical Analysis**

The quantifiable research was accomplished using the SPSS program (version 19) with multi-capability application for the trial plan at a significance level of 0.05 for the overall results. **Steel et al. (1997)** reported on many relationships linking SD and Duncan

**3. Results and Discussions**

**3.1. Approximate Chemical Composition**

The chemical contents of various sesame seeds and their residue during Tahina processing were determined, and the results are shown in Table 2. Sesame seeds had 5.71% moisture, 52.13% crude fat, 19.95% crude protein, 6.43% ash, 6.40% crude fiber, and 15.08% carbs. **Elleuchet et al., 2012** discovered that 14 to 25% of sesame seeds' carbohydrates are predominantly reduced sugars and dietary fibers found in the outer layers, or envelopes, where hemicellulose (type A and type B) is present at a rate of 0.58% to 2.59%.

Mildly, raw and roasted sesame residue raised the protein and ash levels. The fat content of dehulled seeds and Tahina was greater than that of the other components. Addition of both dehulled seeds and Tahina, especially with low ash and mineral concentrations. In terms of ash content, no significant difference ($p>0.05$) was discovered between roasted sesame residue and first wash sesame. The energy value of the SSRE put into cupcakes at various concentrations was lower than the control samples. The SSRE had the lowest energy, with values ranging from 1414.88 to 1481.90 $kJg^{-1}$. These findings are consistent with what has already been found. **(Rababah, et al., 2017 and El Hanafi et al., 2023).**

**3.2. Total Phenolic Compounds and Antioxidant Activity**

The plant kingdom is rich in phenolic substances. These compounds serve as vital antioxidants due to their

capacity to donate a hydrogen atom or an electron to the formation of stable radical intermediates. As a result, they inhibit the oxidation of a variety of biological substances **(Laguerre et al., 2007)**. To be accurate, phenolic compounds found in a variety of oilseeds and their derivatives have been studied in an effort to find natural antioxidants that are safe to be consume **(Langyan et al., 2020).** The results obtained in this study showed that 90% ethanol extracts of both raw and roasted sesame residue had more threefold higher antioxidant activity than the other Tahina process components.

Consequently, the cupcake blends were enhanced with the previously mentioned extracts, which exhibited strong antioxidant activity. Total phenolic contents were 282.66 ± 4.08, 264 ± 1.96, and 247.33 ±1.21 (mg GAE /g dw) in Tahina, sesame roasted oven residue, and fresh sesame residue, respectively. The total phenolic compound of seed coat was reported to be higher than potato peels (2.91 mg GAE/ g dw)), banana peels (2.32 mg GAE/g dw)), and wheat bran (1.0 mgGAE/ g dw)) **(Mohdali, 2010).** The external layers of cereal grains, such as the husk, pericarp, and aleurone cells, have been shown to have the greatest concentration of total phenolics. **(Agidew et al., 2021** and **Morsy et al., 2022)**. Tahina, on the other hand, showed decreased antioxidant activity when compared to sesame roasted oven residue, fresh sesame residue, and sesame seed coat. The presence of a significant quantity of polyphenolic chemicals does not always correspond with antioxidant activity **(El Hanafi et al., 2023).**

### 3.3. Chemical Attributes of Cupcakes

#### 3.3.1. Effect of SSRE on Cupcake Oxidations

The level of oxidative rancidity is a key measure of the quality of preserved foods. TBA was tested during storage to detect the development of rancidity in cupcakes; the results are shown in Figure 1. TBA was affected by storage periods and extract type ($p \leq 0.05$). TBA was increased gradually during the storage time in all cupcakes. After eight days, the degradation in mg malonaldehyde $kg^{-1}$ was much higher in the control cupcakes than in the other cupcakes.

TBA levels were nearly identical for all cupcake samples at the start of the storage period (≈0.45 mg malonaldehyde/kg), and these results agree with **Mahmoudi *et al.* ,2020).** The TBA mean gradually ($p \leq 0.05$) increased in all cupcake samples as storage time increased. The cupcake containing extracts exhibited a lower ($p \leq 0.05$) mean TBA (0.45 mg malonaldehyde/kg) than the other cupcake samples. TBA found that roasted sesame extract (ROE) with cupcakes was the most stable while storage. However, substituting raw sesame (RE) 100 and 200 ppm residue may reduce oil rancidity and TBA, whilst increasing RO residues more than twofold may cause TBA in cupcakes to decrease throughout storage periods. Furthermore, AA could improve the shelf-life stability of bakery products and prevent oil oxidation, particularly in cake products made with food processing residues. These findings are consistent with **(Moraes *et al.*, 2010).**

#### 3.3.2. Microbiological Characteristics

The data shown in Table **3** refer to the investigation of the microbiological characteristics, including total plate count (TPC) for different cupcakes that were substituted with SSRE residue and stored at room temperature for the two, fifth, sixth and eighth days. TPC was increased considerably as storage period was extended ($p \leq 0.05$). During the storage period, substituted cupcakes containing both SSRE residues often had lower TBC levels than BHT and control cupcakes. After two days the control cupcake had the highest TBC. On the other hand, cupcake with 200 ppm reside extract had lower TPC than all cupcakes after five and eight days of storage period. However, no significant difference between sample had 100 and 200 ppm of raw sesame residue during the storage period. Our data were match with Egyptian Organization for Standardization and Quality Control

**3.3.3 Sensory Evaluation of Cupcake**:

Sensory evaluation is considered as an effective strategy for handling problems with food acceptance, product enhancement quality maintenance, and new product manufacturing **(Hafez, 2012).** Based on the data shown in Figure **2**. It was found that cupcakes produced with Roasted 100 ppm and Raw 200 ppm maintained their good taste and acceptability during all storage periods. Significant reductions in odor and color were observed as BHT and control levels were increased. The overall score of all samples differed significantly to the control. In all samples, it was noticeable that the sensory qualities of the enhanced cupcake reduced as the storage times increased. Consequently, it was found that by-product extract can be used to enhance nutritional quality with good acceptability up to 200ppm.

## 4. CONCLUSION

The current research shows that SSRE can effectively stabilize cupcake at all concentrations. SSRE prevent heat deterioration of sesame by enhancing its hydrolytic stability, preventing double bond conjugation, and lowering PUFA losses. Sesame cake extract demonstrated dose-dependent antioxidant activity in a variety of experimental conditions. Furthermore, the pattern of action of the extract varied among experiments. Sesame residue extract has a stabilization efficacy equivalent to commonly used synthetic antioxidants BHT at their legal limit at a concentration of 200 ppm. During the first and final stages of storage, sesame by-product extract has a high antioxidative impact. As a result, SSRE can be recommended as an effective antioxidant source for the stabilization of food systems, particularly bakery products. The antioxidant activity of sesame by-products appears to be mediated by phenolic substances, while more research is needed to determine if they contain other antioxidative factors.

**Table 2: Chemical composition and energy values of different sesame parts during Tahina processing**

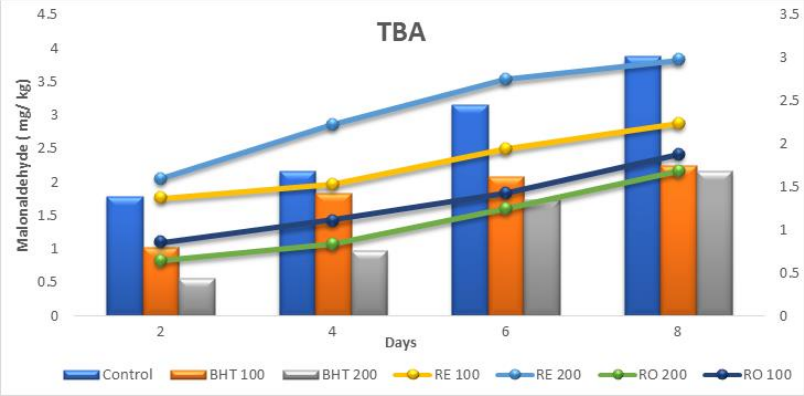
| Samples | Fat | Ash | Fiber | Protein | Carbohydrate | Energy value ($kJ \cdot g^{-1}$)* |
|---|---|---|---|---|---|---|
| **Sesame Fresh** | 52.13 [b] ± 0.33 | 6.43 [d] ± 0.07 | 6.40 [d] ± 0.08 | 19.95 [i] ± 0.74 | 15.08 [e] ± 0.21 | 2534.66 [c] |
| **Residue fresh Sesame** | 2.50 [e] ± 0.31 | 10.74 [c] ±0.10 | 3.62 [f] ± 0.26 | 46.36 [a] ± 0.22 | 36.78 [b] ±0.11 | 1481.94 [e] |
| **Sesame Roasted Oven** | 52.17 [b] ± 0.37 | 5.89 [e] ± 0.07 | 6.76 [d] ± 0.33 | 22.32 [f] ± 0.02 | 12.85 [f] ±0.01 | 2538.50 [c] |
| **Residue Sesame Roasted Oven** | 2.31 [e] ± 0.14 | 10.88 [c] ± 0.31 | 7.26 [c] ±0.09 | 41.76 [b] ± 1.04 | 37.79 [a] ±0.34 | 1414.88 [f] |
| **First Sesame Wash** | 52.94 [a] ± 0.22 | 5.81 [e] ± 0.08 | 9.24 [b] ± 0.07 | 22.28 [f] ± 0.17 | 20.76 [c] ±0.08 | 2659.92 [b] |
| **Seeds coat** | 40.30 [d] ±0.30 | 15.71 [b] ± 0.16 | 6.46 [d] ±0.06 | 29.96 [c] ± 0.53 | 7.57 [h] ±0.05 | 2133.97 [d] |
| **Dehulled seeds** | 52.56 [a] ±0.37 | 2.89 [f] ± 0.10 | 5.56 [e] ±0.13 | 23.24 [e] ± 0.10 | 15.75 [g] ±0.03 | 2761.78 [a] |
| **Tahina** | 51.47 [c] ±0.30 | 2.80 [f] ± 0.10 | 2.65 [f] ±0.19 | 24.81 [d] ± 0.13 | 18.27 [d] ±0.19 | 2644.41 [b] |

* Percentages (%) were used in the data calculation. The values were all derived on a dry weight basis. a,b,c: Means in the same column with the same letter are not statistically different ($p > 0.05$).

**Table 3: Total phenolic compounds and antioxidant activity of various sesame parts during Tahina processing**

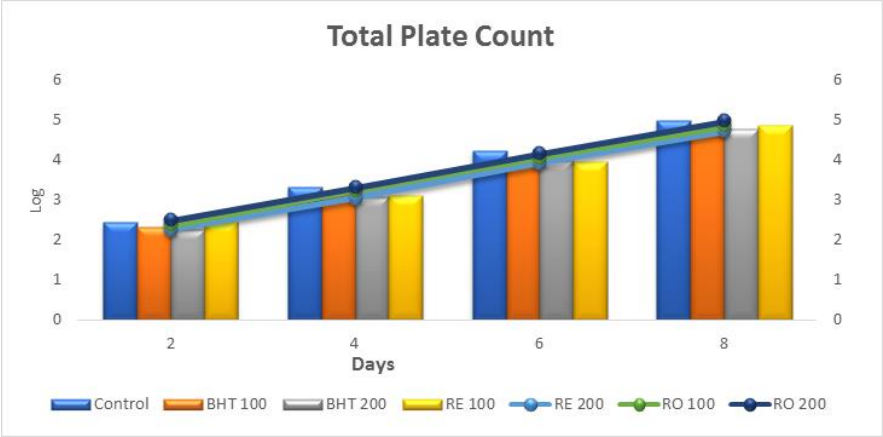
| Samples | AA*** | TPC** |
|---|---|---|
| Residue fresh Sesame | 65.31 [a] ± 0.17 | 247.3 [c] ± 1.21 |
| Residue Sesame Roasted Oven | 51.68 [d] ± 0.30 | 264 .1 [b] ± 1.96 |
| First Sesame Wash | 55.72 [b] ± 0.19 | 230.66 [f] ± 2.16 |
| Seeds coat | 34.80 [d] ± 0.23 | 46.23 [e] ± 1.52 |
| Dehulled seeds | 53.95 [c] ± 0.20 | 259.77 [d] ± 0.30 |
| Tahina | 51.30 [d] ± 0.27 | 282.6 [a] ± 4.08 |

*a, b, and c: Means with the same letter in the same column are not substantially different ($p > 0.05$). **Total phenolic compounds have been estimated as mg GAE g−1 dw. ***Antioxidant activity by DPPH scavenging (%).



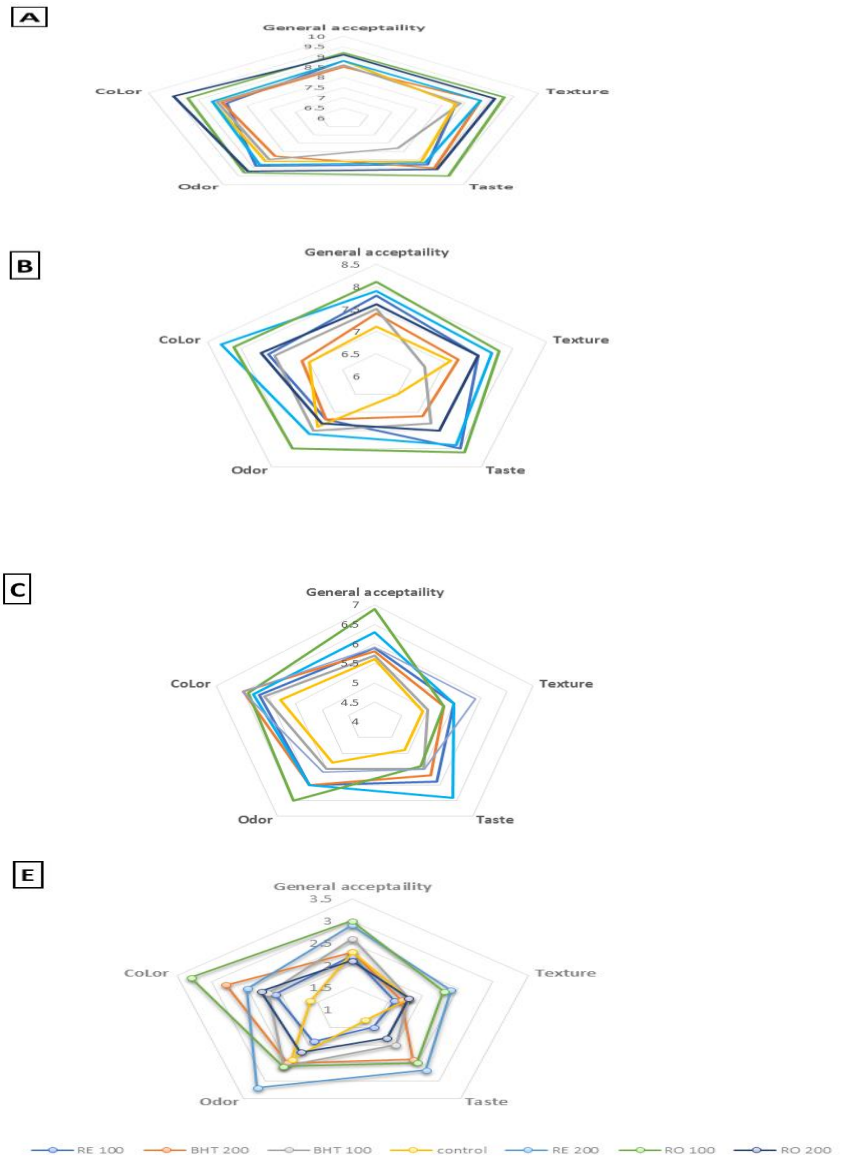

***BHT 100 and 200 means cupcake with 100 and 200 ppm concentration of BHT, respectively. RE 100 and 200 means raw sesame reside extract were added at 100 and 200 ppm concentration to cupcake, respectively: RO 100 and 200 means roasted sesame reside extract were added at 100 and 200 ppm concentration to cupcake, respectively**

**Figure 1: Effect of SSRE on Cupcake Oxidations during storage period**




***BHT 100 and 200 means cupcake with 100 and 200 ppm concentration of BHT, respectively. RE 100 and 200 means raw sesame reside extract were added at 100 and 200 ppm concentration to cupcake, respectively: RO 100 and 200 means roasted sesame reside extract were added at 100 and 200 ppm concentration to cupcake, respectively**

**Figure 2: Effect of SSRE on Cupcake total plate count (TPC) during storage period**




****BHT 100 and 200 means cupcake with 100 and 200 ppm concentration of BHT, respectively. RE 100 and 200 means raw sesame reside extract were added at 100 and 200 ppm concentration to cupcake, respectively: RO 100 and 200 means roasted sesame reside extract were added at 100 and 200 ppm concentration to cupcake, respectively. A: at zero time: B: after two days: C: after four days: D: after six days and E: after eight days**

**Figure 3: Sensory evaluation of cupcake during storage period at ambient temperature**

**REFERENCES**

**Açar, Ö. Ç., Gökmen, V., Pellegrini, N., and Fogliano, V. (2009):** Direct evaluation of the total antioxidant capacity of raw and roasted pulses, nuts and seeds. *European Food Research and Technology*. 229: 961-969.

**Agidew G., Dubale A. A., Atlabachew M., and Abebe W., (2021):** Fatty acid composition, total phenolic contents and anti-oxidant activity of white and black sesame seed varieties from diferent localities of Ethiopia. *Chemical and Biological Technologies in Agriculture*. 8:1-14

**AOAC.** Official Methods of Analysis. 19$^{th}$ Edn. Association of Official Analytical Chemists, Washington, DC. USA. 2005

**APHA (1976):** American Public Health Association, Compendium of Methods for the Microbiological Examination of Foods. Speck, M. L. ed., Washington D. C., USA

**Chen, P. R., Chien, K. L., Su, T. C., Chang, C. J., Liu, T. L., Cheng, H., and Tsai, C. (2005):** Dietary sesame reduces serum cholesterol and enhances antioxidant capacity in hypercholesterolemia. *Nutrition Research*. 25: 559-567.

**Daraei A., Aghajani, N., and Kashiri, M. (2011):** Use of hydrocolloids as edible covers to produce low fat French fries. *Latin American **Applied Research*. 41: 211-216.**

**Doweidar, M. M. (2001):** Chemical and physical studies on some natural resources used in improving bakery products (Doctoral dissertation, Ph. D. Thesis, Food Science Department, Fac. Of Agric, Cairo Univ., 2001, Egypt).

**El Hanafi, L., Mssillou, I., Nekhla, H., Bessi, A., Bakour, M., Laaroussi, H., and Aboul-Soud, M. A. (2023):** Effects of Dehulling and Roasting on the Phytochemical Composition and Biological Activities of Sesamum indicum L. Seeds. *Journal of Chemistry*. *2023*.

**Elleuch, M., Bedigian, D., Besbes, S., Blecker, C., and Attia, H. (2012):** Dietary fiber characteristics and antioxidant activity of sesame seed coats. *International Journal of Food Properties.* 15: 25-37.

**El‐Roby, A. M., Hammad, K. S. M., and Galal, S. M. (2020):** Enhancing oxidative stability of sunflower oil with sesame (Sesamum indicum) coat ultrasonic extract rich in polyphenols. *Journal of Food Processing and Preservation*. 44: e14564.

**Green, B. D. (1989):** Processing and utilization of sesame seeds. Food uses of whole oil and protein seeds". *Champaign: American oil Chemist's society*. 218-230.

**Hafez, A. A. (2012):** Physico-chemical and sensory properties of cakes supplemented with different concentration of marjoram. *Australian Journal of Basic and Applied Sciences*. *6*: 463-470.

**Hajimahmoodi, M., Faramarzi, M. A., Mohammadi, N., Soltani, N., Oveisi, M. R., and Nafissi-Varcheh, N. (2010):** Evaluation of antioxidant properties and total phenolic contents of some strains

of microalgae. *Journal of Applied Phycology*. *22*: 43-50.

**Kapoor L. D. (2001):** Hand Book of Ayurvedic Medicinal Plants, Herbal Reference Library Edition. CRC Press, New York.

**Laguerre, M., Lecomte, J., and Villeneuve, P. (2007):** Evaluation of the ability of antioxidants to counteract lipid oxidation: Existing methods, new trends and challenges. *Progress in lipid research*. 46: 244-282.

**Langyan, S., Yadava, P., Sharma, S., Gupta, N. C., Bansal, R., Yadav, R., and Kumar, A. (2022):** Food and nutraceutical functions of Sesame oil: An underutilized crop for nutritional and health benefits. *Food Chemistry*. *389*: 132990.

**Lazarou, D., Grougnet, R., and Papadopoulos, A. (2007):** Antimutagenic properties of a polyphenol-enriched extract derived from sesame-seed perisperm. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*. *634*:163-171.

**Lee, C. C., Wang, H. F., and Lin, S. D. (2008):** Effect of isomalto-oligosaccharide syrup on quality characteristics of sponge cake. *Cereal Chemistry*. 85: 515–521

**Liu, X., Ardo, S., Bunning, M., Parry, J., Zhou, K., Stushnoff, C., and Kendall, P. (2007):** Total phenolic content and DPPH radical scavenging activity of lettuce (*Lactuca sativa L*.) grown in Colorado. *LWT-Food Science and Technology*. 40: 552-557.

**Mahmoudi, L., Tavakoilpour, H., Roozbeh-Nasiraie, L., and Kalbasi-Ashtari, A. (2020):** Ultrasonication and encapsulation of Butcher broom (Ruscus Hyrcanus L.) extract and its bioactive effects on qualitative properties, oxidative stability and shelf life of cake. *Sustainable Chemistry and Pharmacy*. *17*: 100295.

**Mehdi, L., Ahmed, Z., Ouassila, L., and Abdeslam-Hassen, M. (2020):** Supercritical fluid extraction of oil from (de-hulled and ground) sesame seeds: Statistical and phenomenological modelling. In *2020 11 th International Renewable Energy Congress (IREC)* (pp. 1-6).

**Mohdali, A. A. A. (2010):** Evaluation of some food processing by-products as sources for natural antioxidants.

**Moraes, É. A., Dantas, M. I. D. S., Morais, D. D. C., Silva, C. O. D., Castro, F. A. F. D., Martino, H. S. D., and Ribeiro, S. M. R. (2010):** Sensory evaluation and nutritional value of cakes prepared with whole flaxseed flour. *Food Science and Technology*. *30*: 974-979.

**Morsy, M. K., Sami, R., Algarni, E., Al-Mushhin, A. A., Benajiba, N., Almasoudi, A. G., and Mekawi, E. (2022):** Phytochemical profile and antioxidant activity of sesame seed (Sesamum indicum) by-products for stability and shelf-life improvement of refined olive oil. *Antioxidants.11*: 338.

**Namiki, M. (1995):** The chemistry and physiological functions of sesame. *Food Reviews International*. 11: 281-329.

**Ortega-Hernández, E., Coello-Oliemans, C., Ornelas-Cravioto, A., Santacruz, A., Becerra-Moreno, A., and Jacobo-Velázquez, D. A. (2018):** Phytochemical characterization of sesame bran: an unexploited by-product rich in bioactive compounds. *CyTA-Journal of Food*. 16:814-821.

**Rababah, T., AL-U'datt, M.D., AL-Mahasneh, M. I., Odeh, A., Ajouly, T. E., and Feng, H. (2017):** Effect of processing and storage at different temperatures on the physicochemical and minerals content of sesame seeds and Tehina. *Bulgarian Journal of Agricultural Science*. *23:*30-38.

**Salih, A. M., Smith, D. M., Price, J. F., and Dawson, L. E. (1987):** Modified extraction 2-thiobarbituric acid method for measuring lipid oxidation in poultry. *Poultry Science*. 66: 1483-1488.

**Steel, R., Torrie, J., and Dickey D. (1997):** Principles and Procedures of Statistics: A Biometrical Approach. 3 Sub Edition, McGraw-Hill, New York.

**Sun, T., and Ho, C. T. (2005):** Antioxidant activities of buckwheat extracts. *Food chemistry*. 90: 743-749.

**Wang, B. S., Chang, L. W., Yen, W. J., and Duh, P. D. (2007):** Antioxidative effect of sesame coat on LDL oxidation and oxidative stress in macrophages. *Food Chemistry*. 102: 351-360.

**Yokota, T., Matsuzaki, Y., Koyama, M., Hitomi, T., Kawanaka, M., Enoki‐Konishi, M., and Sakai, T. (2007):** Sesamin, a lignan of sesame, down‐regulates cyclin D1 protein expression in human tumor cells. *Cancer science*. *98*:1447-1453.

**Zouari, R., Besbes, S., Ellouze-Chaabouni, S., and Ghribi-Aydi, D. (2016):** Cookies from composite wheat–sesame peels flours: Dough quality and effect of Bacillus subtilis SPB1 biosurfactant addition. *Food Chemistry*. 194:758-769.

**الملخص العربي:**

## المركبات الحيوية والنشطة المضادة للأكسدة لبعض مستخلصات من بذور السمسم

**نهلة ذكى اسكندر- هانى مصطفى على- محمد أحمد قناوى- رقية رمضان عبد السلام**
قسم علوم الأغذية – كلية الزراعة – جامعة المنيا

هناك اهتمام متزايد بمخلفات الأغذية الزراعية لتكون قادرة على إنتاج مكونات وظيفية جديدة ذات أنشطة حيوية من أجل استدامة الصناعة الزراعية. لذلك كان الهدف من هذه الدراسة هو معرفه مدى تأثير مضادات الأكسده الناتجه من المكونات الثانويه خلال مراحل انتاج و صناعة الطحينة على معايير جودة الكعك بما في ذلك مضادات الأكسدة (المحتوى الفينولي الإجمالي ونشاط DPPH) والصفات الحسية (القبول العام) التي تم تخزينهاعلى درجة حرارة الغرفة (25 ± 2 درجة مئوية) لمدة تصل إلى ثمانية أيام. تمت إضافة المستخلصات إلى تركيبة الكب كيك على مستويين عند 100 و 200 جزء في المليون كمستخلص بذور السمسم الخام (100 RE و 200 RE)، ومستخلص بذور السمسم المحمص (100 RO و 200) ومقارنتها مع BHT بنفس التركيز، على التوالي. وجدت دراستنا أن المستخلصات الطبيعية تحتوي على محتوى فينولي كبير يتراوح من 46.23 ± 1.52 إلى 282.6 ± 4.08 مجم GAE / جم) بالإضافة إلى نشاط مضادات الأكسدة 34.80 ± 0.26 إلى 65.31 ± 0.17٪ DPPH). كان لـ SSRE المضاف للكب كيك بتركيزات مختلفة محتوى للطاقة أقل من عينات الكنترول. أظهر الكعك الذي يحتوي على ما يصل إلى 200 جزء في المليون من مستخلص البقايا السمسم المحمصة تحسينات كبيرة في المظهر ولون القشرة والملمس والرائحة. علاوة على ذلك، كان محتوى المالونالدهيد والعدد الكلي للبكتيريا أقل من العينات الأخرى خلال فترة التخزين. وجدت الدراسة الحالية أن بقايا مستخلصات بذور السمسم تعتبر مصدرا جيدا لمضادات الأكسدة الطبيعية، وخاصة بقايا البذور المحمصة عند اضافتها بتركيز 200 جزء في المليون ويمكن استخدامه كمادة مضافة وظيفية في صناعة المواد الغذائية.

الكلمات الدالة : بقايا بذور السمسم، الجودة، الثبات، المضافات الوظيفية، والأنشطة البيولوجية