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Article

Study of the Sensory, Chemical and Nutritional Properties of Cake Fortified with Black Lemon (Dried Lime) Extract

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Abstract: This study aimed to know the chemical properties and evaluate some sensory and biological properties of cake fortified with dry black lemon extract. The study was conducted in the laboratories of the College of Agriculture/Department of Food Sciences/University of Tikrit. Dry black lemons were obtained from local markets in the city of Tikrit. Dry black lemon was obtained from local markets, and the laboratory cake was manufactured according to laboratory specifications. The aqueous and alcoholic extraction of the dry black lemon extract was carried out. The extract compounds were also identified using HPLC technology, and the animal feed of the experimental animals was fortified with dry black lemon extract. The study included four different treatments. The first treatment (A) was the control treatment without addition, the second treatment (A1) was the aqueous extract, the third treatment (A2) was the alcoholic extract, and the fourth treatment (A3) contained the artificial dye. The sensory evaluation results of the laboratory cake showed that treatment A3 was superior in terms of color, appearance, texture, and flavor, while A1 was superior to the other treatments in terms of softness and general acceptability. The results of HPLC diagnosis showed an abundance of b-pinene, y-terpinene and vitamin C compared to other compounds that appeared in relatively small quantities. As for the biological experiment, the results showed significant differences in weight for treatment B compared to control samples, and no significant differences were shown for cholesterol, HDL and LDL.

Keywords: dry black lemon extract, fortified cake, aqueous extraction, nutrition, anti oxidant

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1. Introduction

In the past years, there been a growing interest in fortifying bakery products with natural extracts to improve health benefits and sensory properties. One of the extract that has attracted attention is the dried black lime extract, known for the unique flavor and the potential health-benefits (Sandoval-Montemayor et al, 2012).

Food fortification becomes known for the nutritional value and it shows to the consumers that approach involves adding micronutrients, vitamins, minerals, and bioactive compounds to the foods during processing to target some nutrient or increase their health-benefits characteristics. In the recent years, there has been interest in fortifying bakery products, such as cakes, with natural extracts to improve their nutritional and sensory characteristics (Gioffre, 2020).

Black dried lemon also known as lomie or the black lemon is dried lemon commonly used in Middle Eastern foods for its unique flavor and aroma. The drying process increase the concentration of certain compounds, including antioxidants and flavonoids that are known for their potential health benefits (Luro. 2020).

Using dried black lime extract to fortify a laboratory cake is based on two important factors Black lime extract is rich in antioxidants which are known to neutralize harmful

free radicals in the body and may help reduce the risk of chronic diseases such as heart disease, cancer, and diabetes. The distinctive citrusy and smoky flavor of black lime extract can also impart a unique taste to the cake, which may enhance its sensory appeal. (Mejia 1994; Dao et al, 2021).

This study focuses on fortifying laboratory cake with dried black lime extract and aims to investigate its sensory and physical properties. Laboratory cake which is often used in food research for its uniform composition and reproducibility, provides an ideal model system to study the effects of fortification on cake quality.

The selection of dried black lime extract for the fortification is based on its rich antioxidant content which may contribute to the overall nutritional value of the cake. In addition the distinctive citrusy and smoky flavor of black lime extract has the potential to enhance the sensory appeal of the cake making it a promising ingredient for product development.

The study will identify some sensory properties of laboratory-made cake enriched with dried black lemon extract. Specifically the study will focus on evaluating the texture, color, taste and aroma of the fortified cake compared to the control group. Physical properties such as cake size density and crumb structure will also be analyzed to assess the effect of fortification on the cake structure and texture.

Studying the sensory and physical properties of laboratory cake fortified with dried black lemon extract this research aims to contribute to the growing of knowledge about enriching bakery products with natural extracts The results of this study may have an impact on the food industry especially in the development of new bakery products with improved nutritional value and sensory appeal (Hanoun, 2007).

Overall, this research aims to contribute to the growing knowledge on fortification of bakery products with natural extracts. The results of this study may have an impact on the food industry especially in the development of new bakery products with improved nutritional value and sensory appeal (Sandoval et al, 2012).

2. Materials and Methods

Sample preparation:

Dried black lemons were purchased from local markets and dark-colored samples were selected because the markets contain two types of dried black lemons. Then the seeds were removed from the samples, after which the samples were ground using a grinder and the samples were stored in polyethylene bags in the refrigerator until use.

Preparation of dried black lemon extract:

Two methods were used to prepare the extract of dried black lemon, which are as follows:

Aqueous extraction:

The aqueous extraction of dried black lemon powder was carried out according to the method of Duh and Yen (Al-Bayar, 2009) by taking 20 grams of the powder and adding 600 ml of boiling water to it, then leaving it for 10 minutes. Then the mixture was filtered and the filtrate was taken and concentrated using a rotary evaporator at a temperature ranging between (65-68 °C), then dried in glass dishes in an electric oven at a temperature of 40 °C. A basic solution was prepared from the dried crude extract and dissolved in 10 ml of distilled water and called A1. Like it shows in Figure 1, 2, and 3.

Figure 1. Sample dried in the oven

Figure 2. Sample filtration

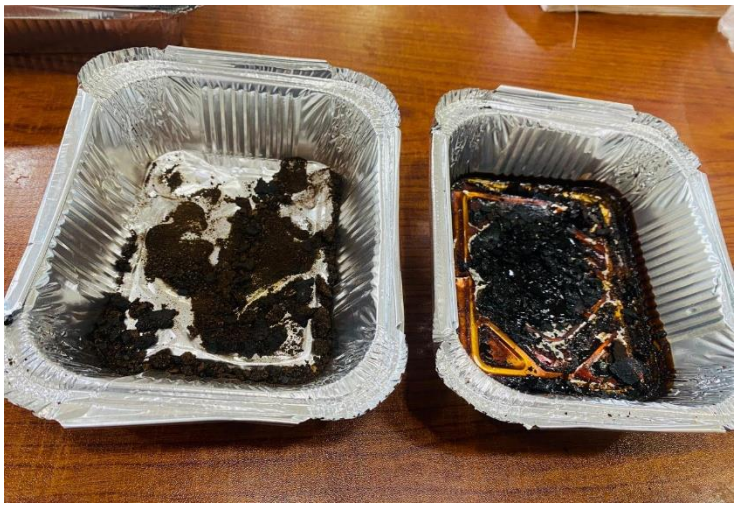

Figure 3. The dry sample

Alcoholic extraction

The alcoholic extraction of dried black lemon powder was carried out according to the Harborne method (Al-Bayar, 2009) by taking 100 g of dried black lemon powder and adding 500 ml of ethyl alcohol (80%). After mixing it with a magnetic mixer for 24 hours at a temperature of 30 °C, the extract was filtered using a Buchner funnel, and the extraction was repeated three times in succession with ethyl alcohol at the same concentration and the difference between each time is 24 hours, then it was evaporated with a rotary evaporator at a temperature of 45-40 °C, it was diluted as mentioned above in the aqueous extract and called A2.

Preparing the laboratory cake

The materials used are as in Table 1.

Table 1. The materials used in preparing the laboratory cake

Ingredients	Quantity
Flour	78g
Fat	41g
Sugar	100g
Eggs	36g
Baking powder	2.9g
Milk	83g
Salt	1.5g
Dried black lemon extract	3g

Method of work

The cake was manufactured in vitro as described by Campbell et al (1976), where it was prepared in the traditional way using an electric mixer. The fat was beaten well, then the sugar and eggs were added and the mixing continued. Then the remaining sugar was gradually added to the previous mixture. Then the flour, baking powder and salt were sifted together and added to the mixing bowl, alternating with the milk and dried black lemon extract, using low and then high mixing speed. 300 grams of the mixture were weighed and placed in greased round cake molds with a diameter of 15 cm. Then it was baked in an oven at 200°C for 45 minutes. The cake was taken out of the oven and cooled. The process was repeated but by replacing the dried black lemon extract with an artificial dye (Lawzena) and called it A3. A cake without dried black lemon extract was used as a control treatment and called it A.

Sensory evaluation

The sensory evaluation of the cake was conducted by 10 specialist evaluators as stated in the evaluation approved by the Department of Food in Kansas/United States of America (1975), which includes sensory characteristics (color, appearance, texture, softness, flavor, general acceptance) represented by seven degrees for each characteristic (Ali, 2018).

Table 2. Sensory evaluation form for laboratory cake

Score	Characteristic
7	Color
7	Appearance
7	Texture
7	Softness
7	Flavor
7	General Acceptability

The highest score given for each sensory characteristic is 7 and the lowest score given for each sensory characteristic is 1, where 7 = excellent, 6 = very good, 5 = good, 4 = median, 3 = acceptable, 2 = poor, 1 = very poor.

Diagnosis using HPLC Technique

High-performance liquid chromatography (HPLC) technique that Shimadzu type, was used in the laboratories of the Iraqi science and technology, as mentioned in (2020 Askar) to separate and diagnose the dry black lemon extract under study and compare it with the standard black lemon extract. The samples were transferred to the device and the graphical forms of the separated compound were determined and the retention time values were compared with the retention time values of the separated standard compounds, depending on the separation column used, by weighing 50 mg of the dry black lemon extract and the standard black lemon extract, each separately, then mixing with 1 ml of hexane according to the (Finnigan Surveyor LC) system. The detector was set at 292 nm and the separation conditions were as follows:

- Wavelength: 325 nm
- Column type: Poroshell 120 EC-C18
- Column dimensions: 2.7*150*3.0 mm
- Injection volume: 10 µl
- Mobile phase: 7% MTBE with isopropanol.
- Flow rate: 8.0 ml/min
- Injection temperature: 25°C

- Biological experiment

Experimental animals

In this study, adult male white rats (Rattus norvegicus) of the Sprague-Dawley strain were used, 2-3 months old, 8 in number, divided into 4 for each group and with weights ranging between 130-150 gm, which were obtained from the College of Veterinary Medicine/Tikrit University and placed in plastic cages with metal covers and a floor covered with sawdust. The cages were cleaned and sterilized carefully, with sawdust replaced every two days. The animals were placed under laboratory conditions under a light cycle divided into two parts, the first part included 12 hours of light and the second part 12 hours of darkness, with a constant temperature of 25 ± 2°C. For three days, the animals were left to adapt to the new conditions and were given food continuously and in sufficient quantities throughout the experiment.

Preparation of the weighed diet

The weighed diet was prepared as stated in the National Academy of Sciences / National Research Council (1990) which contains (158.5 g casein/kg, 100 g glucose/kg, 100 g corn oil/kg, 5 g vitamin mixture/kg, 50 g mineral salt mixture/kg and 536.5 g starch/kg). The percentage of cholesterol was added to the specified groups. Dough pieces were formed to feed the rats by adding distilled water to the mixture to obtain a consistent dough. To dry the dough, it was placed in flat stainless steel containers and passed through hot air in an oven at 50°C until it dried completely. After that, it was packed in polyethylene bags and stored in the refrigerator at a temperature of 5±2°C. Throughout the duration of the experiment.

Experimental design

The experimental animals were randomly distributed into two groups, each group consisting of 4 animals. The first group (A) was the control group and the second group (B) was a group supplemented with 2.5% dry black lemon extract.

Statistical analysis

SAS (2012) was used to analyze the different parameters of the experiment and the significant differences between the means were tested by the least significant difference (LSD) (SAS, 2012).

3. Results

Extraction Efficiency

The results of extracting dried black lemon extract indicated that the aqueous extraction method is more efficient than the alcoholic extraction method, as the results showed that the extract percentage in the aqueous extraction was 34% of the weight of the sample used compared to the alcoholic extraction, in which the extract percentage was 29% of the weight of the sample used, and this is consistent with what was indicated by Al-Bayar (2009) when preparing ginger root extracts. The high percentage of extract in the aqueous extraction method may be due to the abundance of vitamins and water-soluble elements in the dried black lemon extract.

Sensory evaluation

Table 3 shows the results of the sensory evaluation of the cake samples, where it is noted that treatment A3 was superior, which obtained the highest values in the color characteristic compared to the control treatment and the other treatments. There were significant differences between that treatment and the following treatments (A2, A1, and the control treatment). Treatment A1 did not record any significant differences with treatment A2, but it recorded significant differences with the control treatment.

While treatment A3 recorded significant differences with treatments A1, A2 and the control treatment. While none of treatments A1 and A2 recorded any significant differences with the control treatment in evaluating appearance. Treatment A3 recorded significant differences with treatments A1, A2 and the control treatment, while none of treatments A1 and A2 recorded any significant differences with the control treatment in evaluating texture.

As for the softness characteristic, treatment A1 recorded significant differences with both treatments A2 and A3, while no significant differences were recorded for the control treatment. No significant differences were recorded between treatment A2 and treatment A3.

As for the flavor characteristic, we note that significant differences were recorded between treatments A3 and the other treatments, while the first and second treatments did not record any significant differences with the control treatment.

Finally, as for the general acceptability characteristic, we note from the table that treatment A1 is the only treatment that recorded significant differences with the other treatments and the control treatment.

Table 3. Statistical analysis of sensory evaluation characteristics

General Acceptability	Flavor	Softness	Texture	Appearance	Color	Treatment
5.78a	6.5b	5.3b	5.9b	5.7b	5.5b	A
6.04a	6.3a	5.0a	5.8a	5.2a	4.9 b	A1
5.02b	6.0a	4.6b	5.2b	5.0b	4.3.b	A2
5.18b	5.9b	4.9b	4.1c	4.7b	6.3 a	A3

A* Control, A1 Aqueous Extraction, A2 Alcoholic Extraction, A3 Industrial Formula.

It is noted from the results that most of the differences were in treatment A3, which is represented by samples with added artificial dyes. The reason may be due to the effect of these dyes on the moisture content of the laboratory cake, which was proven by Al-Muthanna (2018) when the cake was fortified with artificial dyes. It may also be attributed to the amount of water-binding materials present in the dried black lemon extracts.

This study did not agree with the findings of the study (Mostafa, 2024), as it recorded a significant decrease in the general appearance characteristic when evaluating the effect of replacing 5 and 10% of soft wheat flour with kumquat powder (KP), while it recorded a significant increase in the general acceptability characteristic.

The results were consistent with Aamer et al. (2017) who reported that prepared functional beverages were more widely accepted when fresh and mashed golden orange paste was added to the whey and pickling as well. Similar results were reported by Olcay & Demir (2021) who found that the replacement rate of golden orange powder used affected the sensory properties of the samples as the replacement rate increased.

HPLC tests

The results of HPLC tests of samples of dried black lemon extract showed the presence of percentages of vitamins and important nutrients added to a number of antioxidants, as shown in the table below:

Table 4. HPLC tests of samples of dried black lemon extract

Quantity 100 g / Mg	Material
13	β- pinene
4	Citral
15.3	¥- terpinene
0.5	α- terpinol
19	Vitamin C
0.6	Flavonoids
0.4	Phenols
59	Ascorbic Acid
0.5	Niacin
0.2	Thiamin

It is noted from the above table that ascorbic acid recorded the highest percentage of components in the extract. This is consistent with what was stated by Sauls (2015), who stated that the percentage of ascorbic acid in lemon extract reaches about 65 mg/100 g. The reason for this percentage may be attributed to the fact that ascorbic acid is not affected by drying factors compared to other components that are considered volatile substances.

Biological experiment

The results of the biological experiment and the effect of adding dry black lemon extract to the feed on the weight of laboratory rats in addition to the blood lipid profile showed significant differences in weight between the control sample and the fortified sample, as the weight of the control sample reached 143.8 g compared to the sample fortified with dry black lemon extract, which reached 127.3 g. This decrease is consistent with a study conducted by (Kazeem et al., 2020).

They explained that the reason for weight loss when eating dried black lemon is due to the amount of vitamins and antioxidants that work to lose weight by increasing or stimulating the metabolism process within the body. The results agreed with what (Shagun Jain et al, 2020) reached regarding weight loss due to increased metabolism, and the reason may also be attributed to the possibility of enhancing loss of appetite.

Table 5. The results of the biological experiment and the effect of adding dry black lemon extract

VLDL	LDL	HDL	T.G	T.C	Weight/g	Sample
14.74 a	31.42 a	54.11 a	73.47 a	97.82 a	143.8 a	A
17.33 a	29.35 b	54.13 a	71.67 b	97.79 a	127.2 b	B

(A) Control sample

(B) Sample fortified with dry black lemon extract

The results did not show any significant differences for the other tests, while they showed a significant difference for triglycerides and LDL. This may be attributed to the fact that the effectiveness of the antioxidants present is not of the required quality to affect cholesterol or that the chemical composition of the antioxidants is different from the composition of cholesterol and therefore does not crowd cholesterol in the digestive system as other antioxidants do (Spritzer, 2007).

The results of the study are consistent with what was concluded by (Taha & Abbo, 2022) that adding antioxidants protects glucose, fats and proteins in blood plasma from damage by antioxidants.

4. Conclusion

As for the biological experiment, the results showed significant differences in weight for treatment B compared to control samples, and no significant differences were shown for cholesterol, HDL and LDL.

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