THE EFFECT OF REPLACING WHEAT FLOUR WITH SESAME AND THYME POWDER ON THE QUALITY ATTRIBUTES OF COOKIES

Eshraq Gehad Khudair
Lecturer
Dept Home Econ, Coll. Educ. Women, University of Baghdad
ishraqjihad@coeduw.uobaghdad.edu.iq

ABSTRACT

This study was aimed to investigate replacing wheat flour with sesame flour and thyme-affected laboratory-made Cookies. We tested nine substitution levels and a control. Thyme (1, 3, and 5) % and sesame (15, 30, and 50%) % substituted wheat flour. The proportions of thyme and sesame were, (1thyme+15 sesame)%,(3thyme+30sesame)%.Moreover, (5 thyme+50 sesame) The chemical composition analysis of the Cookies treatments showed increases in moisture, protein, fat, and ash for treatment A9 (5% thyme and 50% sesame) compared to the control treatment A10, which had 17.90%, 7.60%, and 11.90%, respectively. Treatment A9 (5% thyme + 50% sesame) had 35.8% unsaturated fatty acids. With sesame and thyme replacement ratios, palmitic, linolenic, and oleic acid percentages increased considerably. Raising the thyme replacement ratio alone did not significantly increase. Similarly, replacing thyme and sesame together raised stearic and linoleic acids, but not individually—analysis of Cookies treatments' iron and calcium content. Significant changes (P<0.05) occurred between the control and other treatments. Iron and calcium levels were greatest in treatment A9 (5% thyme + 50% sesame), with 342 and 86.42 ppm per 100g. The Gas Chromatography-Mass Spectrometry analysis identified Thymol as the active ingredient in thyme.

Keywords: bacteria, molds, fatty acids, proteins, food safety.

مجلة العلوم الزراعية العراقية- 2025 :56 (4):1520-1536 خضير

تأثير استبدال طحين الحنطة بمطحون السمسم والزعتر في الصفات النوعية للبرازق

اشراق جهاد خضير
مدرس
قسم الاقتصاد المنزلي , كلية التربية للبنات, جامعة بغداد

المستخلص

تناول البحث تقييم تأثير استبدال دقيق القمح بدقيق السمسم والزعتر على تحضير البرازق مختبريا . أُجريت التجارب على تسع مستويات مختلفة من الاستبدال بالإضافة إلى مجموعة ضابطة. وقد استُبدل دقيق القمح بنسب من الزعتر (1%، 3%، 5%) والسمسم (15%، 30%، 50%).، وزعتر وسمسم بالنسب(1٪ زعتر + 15٪ سمسم)، (3٪ زعتر+ 30٪ سمسم)، (5٪ زعتر+ 50٪ سمسم) . كشفت نتائج تحليل التركيب الكيميائي لعينات البرازق عن زيادة في نسب الرطوبة، والبروتين، والدهون، والرماد في المعاملةA9 ، التي تضمنت 5% زعتر و50% سمسم، مقارنة بالمعاملة الضابطة A10، حيث بلغت نسب الرطوبة، والبروتين، والدهون على التوالي 17.90%، و7.60%، 11.90 أظهرت المعاملةA9(5 زعتر + 50% سمسم) نسبة 35.8% من الأحماض الدهنية غير المشبعة. مع نسب استبدال السمسم والزعتر، ارتفعت نسب أحماض البالمتيك، اللينولينيك، والأوليك بشكل ملحوظ. لم يؤدِ رفع نسبة استبدال الزعتر وحده إلى زيادة معنوية. كما أن استبدال الزعتر والسمسم معاً أدى إلى زيادة أحماض الستياريك واللينوليك، لكن ليس عند استبدالهما بشكل فردي. تم تحليل محتوى الحديد والكالسيوم في معاملات البرازق، حيث حدثت تغييرات معتبرة (P<0.05) بين المعاملة الضابطة والمعاملات الأخرى. كانت مستويات الحديد والكالسيوم الأعلى في المعاملة A9 زعتر + 50% سمسم)، بمقادير 342 و86.42 جزء في المليون لكل 100 جرام. بينما كانت المعاملة الضابطة تمتلك أدنى قراءات للحديد والكالسيوم لكل 100 جرام، والتي كانت 163.01 و5.15 جزء في المليون، على الترتيب. أدت نسب الاستبدال إلى زيادة مستويات الحديد والكالسيوم باستثناء المعاملاتA1 ، A2، وA3. وتم تحليل الكروماتوغرافيا الغاز بالطيف الكتلي للثايمول كمكون فعال للزعتر .

الكلمات المفتاحية: البكتريا, الاعفان, الاحماض الدهنية, بروتينات, سلامة الغذاء .

Received: 11/10/2024, Accepted:12/3/2025, Published: August 2025

INTRODUCTION

As functional meals, healthy baking produced with wheat flour alternatives or strengthened with nutrient-dense additions are becoming more and more popular (13, 50). Glycemic load can be decreased and dietary fiber, protein, and vital micronutrients can be increased by using flour substitutes (33). Furthermore, adding beneficial additions improves antioxidant capacity and promotes cardiovascular health (9, 11). People with diabetes, gluten sensitivity, or those looking for healthier snack options can all benefit from these modified cookies (29, 41). Their potential to provide increased nutritional content without sacrificing consumer satisfaction or sensory appeal is supported by research (44). Sesame *Sesamum indicum* belongs to Pedaliaceae family, categorized under Lamiales. It is cultivated in various places, including Sudan, the United States, and tropical regions (23). Sesame seeds contain 32% oil, 23.5% protein (15) carbohydrates (20-25%), and ash (5-6%) (24it also contains flavonoids and fatty acids such as linoleic, oleic, palmitic, linolenic, stearic, and arachidonic (24). The proportion of saturated fatty acids is 19.25%, while unsaturated fatty acids constitute 42.05% (17). Regarding vitamins, sesame seeds are rich in Vitamin B3, ranging from 4.4 to 4.9 mg/kg, and Vitamin B6, ranging from 105 to 115 mg/kg (24). They also contain essential minerals like calcium (1130-1232 mg/100g), phosphorus (540-640 mg/100g), and iron (10.4-10.6 mg/100g) (46). For its nutritional content, comprising carbohydrates, vitamins, minerals, and many proteins. Chemically, thyme comprises 40% Thymol, phenols, 15% Carvacrol, and essential oils. The constituents of Thymol include (24) Sesame seeds are known for their long shelf life .(28, 38). *Thymus vulgaris* is a perennial herbaceous plant from the Lamiaceae family. It is cultivated in regions such as Spain, Italy, and Canada (12), in addition to the Mediterranean and the Middle East (14). This plant is highly valued % ester, 3% Linalool, 19.4% Borneol, p-cymene, cineol, Tannins, Saponins, Terpinene, and Flavonoids (1, 38). Essential oils from thyme have been categorized as spices and have gained international recognition by the Food and Drug Administration (FDA). (35) The thyme is characterized by its spicy taste and aromatic fragrance (21). Thymol is incorporated in toothpaste production and is an antiseptic and analgesic for pain relief (1). Thyme is utilized medicinally to treat coughs, as an antispasmodic, antiemetic, carminative, analgesic, and nervine stimulant, in cosmetics, and as an antibacterial agent (4) as well as for asthma, bronchitis, and laryngitis (1). It exhibits potential against various strains of bacteria, including *Staphylococcus aureus*. When Thymol is synergized with Carvacrol, it contributes to a reduction in bacterial resistance (40). Essential oils exhibit antimicrobial activities against gram-negative and gram-positive bacteria, attributed to compounds such as phenols responsible for their antimicrobial properties. (4, 48). These oils also exhibit antifungal properties, particularly against toxin-producing fungi such as *Penicillium. SP*. Thyme is used in herbal preparations such as tea, as a carminative, and as a remedy for colds and respiratory infections (4) It is also added to bread, salads, soups, cheeses, meats, and vegetables (12). Even more; Industrial products like ice cream, butter, and confectionery to extend their shelf life, slow oxidation, and reduce color changes (2, 8). ''Sesame was chosen with maximum enzymatic activity'' (11). Thyme has been identified as a post-bake contaminant control agent in Modified Atmosphere Packaging (MAP) (39). Consequently; this study aims to detect the active ingredients in thyme. Study the effect of wheat flour with sesame seed flour and thyme at different concentrations on the qualitative characteristics of laboratory-produced cookies.

MATERIALS AND METHODS

1- Laboratory Production of Cookies

The cookies were produced in a laboratory using a standard Cookies recipe (34). Some modifications were made to the ingredient weights, with the following quantities used: 100g flour, 62.5g vegetable shortening, 62.5g powdered sugar, 10g egg, 3g baking powder, 25ml milk, and 1g vanilla. These quantities constituted the basic recipe for preparing Cookies and served as the control treatment. The wheat flour was substituted with sesame seed flour and thyme flour to investigate the individual and combined effects on the sensory and microbiological properties of the laboratory-produced Cookies and identify the active ingredient in thyme, Thymol.

2- The method of worka

The procedure mentioned in (34) was followed to prepare cookies. The cookies were then allowed to cool, packaged in nylon bags, and stored between 28-38°C for 21 days. The tests were conducted chemical, microbiological, and sensory testing before storage. Ten different treatments were prepared as outlined in Table 1. Sesame seeds and thyme type were obtained from local markets.

Table 1. Percentages of replacing wheat flour with sesame and thyme flour in laboratory-produced cookies

Treatments	Thyme (mg)	wheat flour(mg)	Sesame (mg)
A1	1	99	0
A2	3	97	0
A3	5	95	0
A4	0	85	15
A5	0	70	30
A6	0	50	50
A7	1	84	15
A8	3	67	30
A9	5	45	50
A10	0	100	0

Chemical Assessments

The chemical constituents of the sesame and thyme were evaluated, in addition to the Cookies samples were evaluated. The moisture content was determined by placing 3 grams of the model into a thermal oven set at 105°C for 10 hours. The nitrogen percentage was estimated using the Kjeldahl method, adhering to the procedure (47), and subsequently multiplied by a conversion factor of 5.7 to ascertain the protein percentage As for sesame seeds and thyme, multiply by 6.25. The lipid content was quantified using the Soxhlet continuous extraction apparatus based on the method (24). The ash content was measured utilizing a muffle furnace at a temperature of 350°C for 9 hours and the carbohydrate percentage was calculated employing the difference method. This method involved summing the percentages of protein, moisture, lipids, and ash and subtracting the cumulative total from 100.

1- Estimation of Heavy Elements

The levels of iron and calcium were determined by utilizing an Atomic Absorption Spectrophotometer, model AA7000 from Shimadzu Corporation, following the method (30).

2- Estimation of Total Fatty Acids

1. Lipid Extraction from the Sample

The lipids were quantified based on the method (24) employing the Soxhlet lipid extraction apparatus.

2. Lipid Transesterification

The sample was prepared using the established procedure delineated in (24) and centred on lipid transesterification via its reaction with methanolic potassium hydroxide. The upper layer (hexane layer), containing the esterified lipid, was then extracted and injected into the apparatus for further analysis.

3- Chromatographic Analysis of the Sample

The fatty acid compounds were analyzed using a gas chromatograph (GC-2010) of the Shimadzu model, originating from Japan. An Ionization Flame Detector (FID) and a capillary separation column of the SE-30 type were employed, with dimensions (30m * 0.25 mm). The analysis followed under the specific conditions mentioned in reference (27).

4- Detection of Active Compounds in Thyme Oil

1. Oil Extraction: 20 grams of the fresh sample were placed in a flask, and 100 mL of distilled water was added. The mixture was then placed in a Clevenger apparatus for 3 hours. The oil was collected, and 20 mL of hexane was added to separate the oil from the water droplets that had accumulated with the oil. The oil was then collected and stored in a refrigerator until the analysis could be conducted.

2. Analysis Method

The examination was carried out in the laboratories of the Ministry of Science and Technology / Department of Environment and Water using a Shimadzu 2010 gas chromatograph of Japanese origin, utilizing an Ionization Flame Detector (FID) and a DM-5Ms type capillary separation column with dimensions (30m * 0.25 um * 0.25 mm). The injection zone and detector temperatures were set at 280°C and 340°C, respectively. In comparison, the temperature of the separation column was progressively increased from 100°C to 300°C at a rate of 10°C per minute. Nitrogen gas was used as the carrier gas at a rate of 100 KPa, following the procedure outlined in reference (16).

5- Detection of Thymol

Chromatographic conditions: The analysis was performed on an HPLC apparatus with a UV/Vis detector (HPLC model SYKAMN) (Germany). The separation column was C18 (4.6 × 250 mm, 5 µm), and the Mobile phase - acetonitrile: water (in 50:50 ratio V: V) - isocratic, flow rate: 1 ml/min. The injection volume is 100 µl, at detection: 274 nm.

Preparation of standard solutions of Thymol: 0.2 mg from the standard substances of Thymol, after weighing and then dissolving in (50 ml) a solvent mixture (acetonitrile: water 80:20 V: V), the basic solutions were prepared: thymol concentration of 40 mg/ml (19).

6- Microbial tests

1. Preparing the sample to count and diagnose the types of bacteria and molds: 10 grams of faeces were taken and placed in a sterilized electric blender with 70% alcohol, and 90% sterile distilled water was added. The ingredients were mixed for two minutes, and then decimal dilutions were made from 1×10^3 - 8×10^3 according to what was mentioned two replicates were used for each dilution and all types of counting, and they were chosen. Dishes containing $30\text{-}300^x$ colonies and a dilution of 10 were chosen.

2. Counting Total Bacteria and Molds

The total count of bacteria and molds was estimated using the pour plate method. Nutrient Agar was used as the medium for bacteria, and Malt Extract Agar was used for molds. The plates were then incubated at 37°C for 48 hours for bacteria and at 25-30°C for 3-5 days for molds.

3. Morphological and Microscopic Examinations: The morphological characteristics of the bacteria were studied, followed by biochemical tests for the bacteria *Staphylococcus spp*., isolated from the Cookies and the added ground sesame and thyme at all the laboratory concentrations, according to the specific tests for bacteria, The morphological characteristics and biochemical tests for Lactobacillus bacteria were studied according to (45).

7- Diagnosis of Molds: The morphological characteristics of mold colonies isolated from the Cookies, sesame, and thyme at different concentrations were studied.

8- Sensory Evaluation: The sensory evaluation of the cookies was conducted in terms of attributes such as appearance, flavor, freshness, thickness, color, and general acceptance. This evaluation was carried out by Department of Home Economics members of the College of Education for Women, University of Baghdad, utilizing a specially designed evaluation form.

9- Statistical Analysis: The statistical software(43) was employed to analyze the data collected, following a Completely Randomized Design (CRD). Significant differences between the means were compared using the Least Significant Difference (LSD) test (20), and the value of (LSD) was considered.

RESULTS AND DISCUSSION

Chemical composition:

The results in Table (2) show the percentage of the chemical composition of sesame and thyme seeds. Each of them contained moisture, protein, fat, ash and carbohydrates. Their percentages were 5.9, 21.6, 53.0, 6.0 and 13.5% respectively. As for thyme, the percentage was 4.9, 4.5, 1.7, 12.6 and 76.6% respectively.

Tabal 2. Chemical composition sesame and thyme

Chemical composition	sesame	thyme
Moisture	5.9	4.6
Protein %	21.6	4.5
Lipid %	53.0	1.7
Ash %	6.0	12.6
Carbohydrates	13.5	76.6

Table (3) illustrates the impact of substituting wheat flour with sesame powder and thyme powder on the chemical composition of the different cookie treatments. The results reveal significant differences ($p \leq 0.05$) in the chemical composition among the various treatments. A noticeable increase in moisture, protein, fat, and ash content was observed with the rise in substitution ratios, reaching 18.90, 16.20,43.60, and 16.70 mg/100g, respectively, in treatment A9. In contrast, the control treatment A10 displayed 11.90, 5.30, 17.90, and 7.60 g/100g, respectively. Meanwhile, the carbohydrate content decreased from 57.30 to 4.10 g/100g. The results were consistent with the findings of (22), who observed an increase in proteins, fats, fibres, and ash when 40% of wheat flour was substituted with sesame powder in biscuit production, resulting in values of 4.15%, 8.20%, 16.95%, and 16.60 mg/100g, respectively. Additionally, the carbohydrate content decreased as the substitution rates increased, aligning with the findings of (26), who noticed an increase in protein, fiber, fat, and ash content when bread was fortified with sesame flour at rates ranging from 10% to 25%. These results also agree with the findings of (3, 23, 46), who stated that increasing the substitution of wheat flour with sesame flour in bread and cake production increased moisture, protein, fat, and ash content.

Table 3. The effect of replacing wheat flour with sesame and thyme flour on the chemical composition of laboratory-made Cookies

Code of transactions	Content % Percentage of replacement	Moisture	Protein	Fat	Ash	Carbohydrates
A1	1Thyme	12.60±1.00 bc	7.20±0.20 Ef	18.50± e 1.05	8.30±1.00 bc	53.60±3.00 bc
A2	3Thyme	13.00±1.00 def	7.90± 1.00 De	19.20±1.00 E	8.30±1.00 bc	51.60±1.00 cd
A3	5Thyme	13.70±1.00 def	8.20±1.00 D	21.30±1.00 E	8.90±1.00 bc	47.90±1.00 d
A4	15 sesame	14.80±1.00 cdef	9.60±1.00 D	27.50±1.00 D	9.20±1.00 bc	38.90±1.00 e
A5	50 sesame	15.20±1.20 bcde	12.30±1.00 c	30.10±2.00 Cd	10.10±1.00 bc	32.30±2.00 f
A6	50sesame	15.80±0.20 bcd	15.10±1.00 ab	33.40±1.00 C	10.60±0.20 b	47.90±1.00 ab
A7	1thyme+15sesame	17.50.0.10 abc	12.50±1.00 bc	39.50±0.10 B	15.80±1.00 a	14.70±1.00 g
A8	3Thyme +30 sesame	18.10±1.00 ab	15.80±1.00 a	42.50±1.00 Ab	16.20±0.20 a	7.40±0.20 h
A9	5thyme+50sesame	18.90±1.00 a	16.20±1.00 a	43.60±1.00 A	16.70±1.00 a	4.10±1.00 h
A10	Control	11.90±1.00 f	5.30±0.10	17.90±1.00 E	7.60±0.10 c	57.30±0.30 a
	L.S.D.	3.217 *	0.952 *	3.578 *	2.641 *	5.029 *
	Sesam	5.9	21.6	53.0	6.0	13.5
	thymes	4.6	4.5	1.7	12.6	76.7

*averages with different letters within the same column are significantly different among them (P≤0.05)
*According to Duncan's test *each number represents the average of two repetitions

Mineral Elements in Different Cookies Treatments: Table (4) shows the content of various mineral elements, including iron and calcium, in al-Barazaq transactions. The results indicate that there are no statistically significant differences (p>0.05) in the iron content of transactions A1 and A2. While the increase was statistically significant for the other treatments, and when the ratio of replacing wheat flour with sesame flour for treatments A6, A5, A4 increased, the concentration of iron reached 60.51, 48.52, and43.72 mg/Kg

Table 4. The content of mineral elements for Cookies coefficients

coefficients	replacement ratio%	Fe ppm	Ca ppm
A1	1 Thyme	16.80 fg±3.1	133.38 de ±23.0
A2	3 Thyme	20.02 cfg ± 10.0	141.47 de±18.9
A3	Thyme5	38.02± of 2.0	bc 146.66± 6.0
A4	15 sesame	43.72 cde±10.0	201.66 cd± 30.0
A5	30 sesame	48.52 bcd ±8.00	e 210.88± 10.0
A6	30 sesame flour	60.51± bcd 4.89	bc 225.61±1.8
A7	1 Thyme + 15 sesame	67.26± abc 11.0	201.66±30.0 cd
A8	5 Thyme + 30 sesame flour	70.73± ab10.0	202.31±22.0 cd
A9	50+5 sesame flour	86.42± a10.0	342.51 at30.0
A10	Control coefficient	5.15± g 1.0	163.01± 13.0 cde
	LSD	24.9	69.91

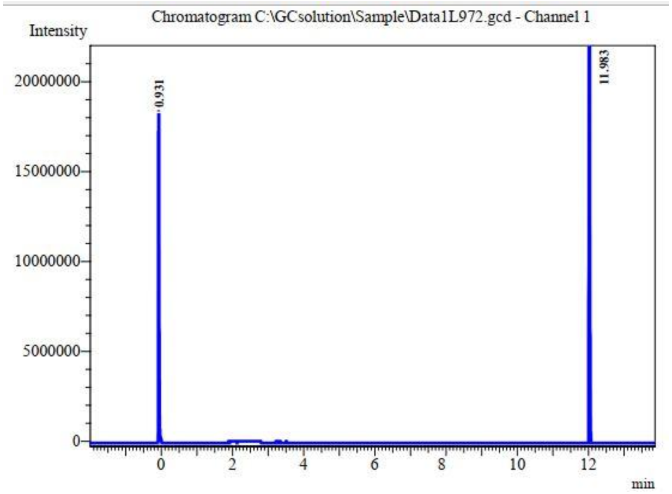
One of these increases peaked when substituting (5% sesame + 5% sesame) for treatment A9(5% thyme + 50% sesame), reaching 86.42 mg/1kg. Also, the results in the table below indicate a decrease in calcium content when substituting mint flour with ground thyme. If it reached 133.38, 141.47, and 146.55 mg/Kg per A1, A2, A3, respectively, compared to the control treatment. When it reaches 163.1 mg /kg when the replacement ratio increases by 15, 30, and 50%, the increase in the calcium ratio increases with the replacement ratio. It reached 201.66, 210.88, 225.61amalgam / Kg of A4, A5, A6, respectively. It reached the highest level when treating A9, reaching 342.51 mg/1 kg. The results align with the study (22, 23). Ses-ame seeds can also be used as aseasoning in soups,as they are rich in oil ,protein,and calcium

Standard fatty acid detection

The identification of certain fatty acids in sesame using high-performance liquid chromatography (GC). Revealed the presence of various fatty acids, as listed in Table (5). The longest retention time recorded was11.983 minutes for palmitic acid, while the shortest was 5.100 minutes for lenolenic acid. Additionally, Table (5). indicated the retention times of sesame oil compounds when analyzed using an (GC) device. As in Figures 1, 2, 3, 4 and 5.

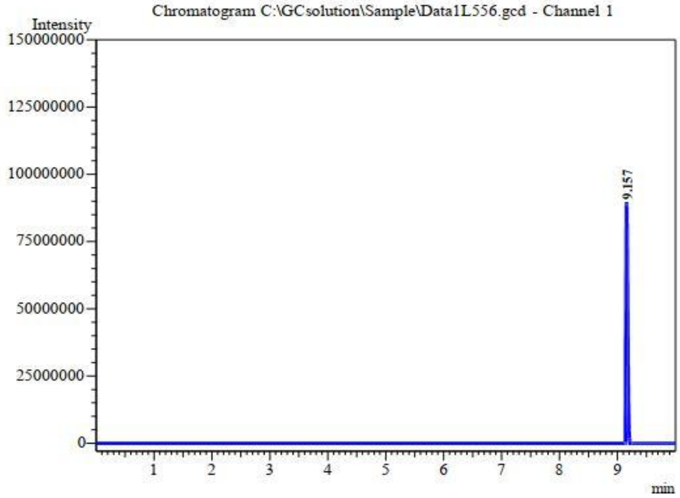
Table 5. Illusrates the e retention of time times of fatty acids in sesame using Gas chromatography (GC)

Concentration of Standard %	retention time in minutes	fatty acids
0.5	11.983	palmitic
0.5	10.206	oleic
0.5	9.157	stearic
0.5	7.356	lenolic
0.5	5.100	lenolenic



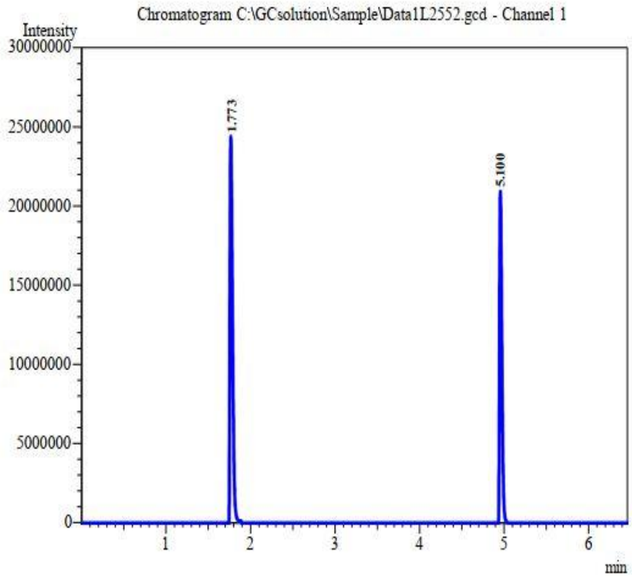
Peake Table-channel 1					
Peak#	Ret. Time	Area%	Area%	Height	Name
1	0.931	23182622	29.7773	18113069	
2	11.983	54670617	70.2227	40656462	
Total		77853239	100.0000	58769531	

Figure 1: Diagnosis certain fatty acid Palmatic



Peake Table-channel 1					
Peak#	Ret. Time	Area%	Area%	Height	Name
1	9.157	125065578	100.000	78583462	
Total		125065578	100.000	78583462	

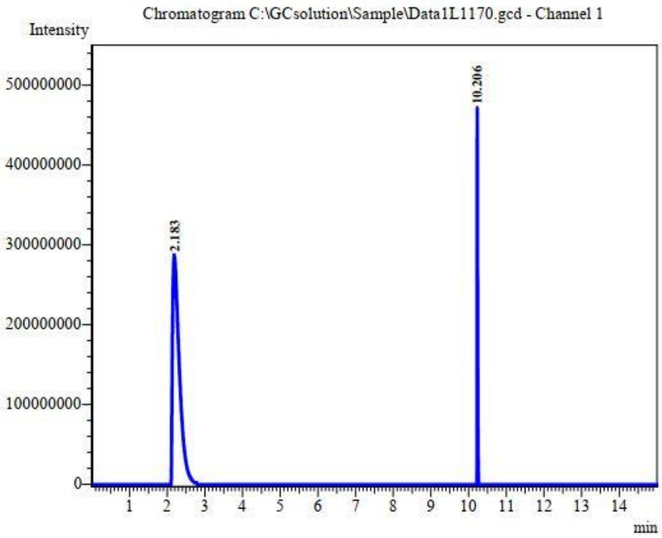
Figure 2: Diagnosis certain fatty acid Stearic



Peake.Table-Channel

Peak#	Ret. Time	Area%	Area%	Height	Name
1	1.773	53874434	56.8070	23590743	
2	5.100	40963208	43.1930	20056921	
Total		94837642	100.0000	43647664	

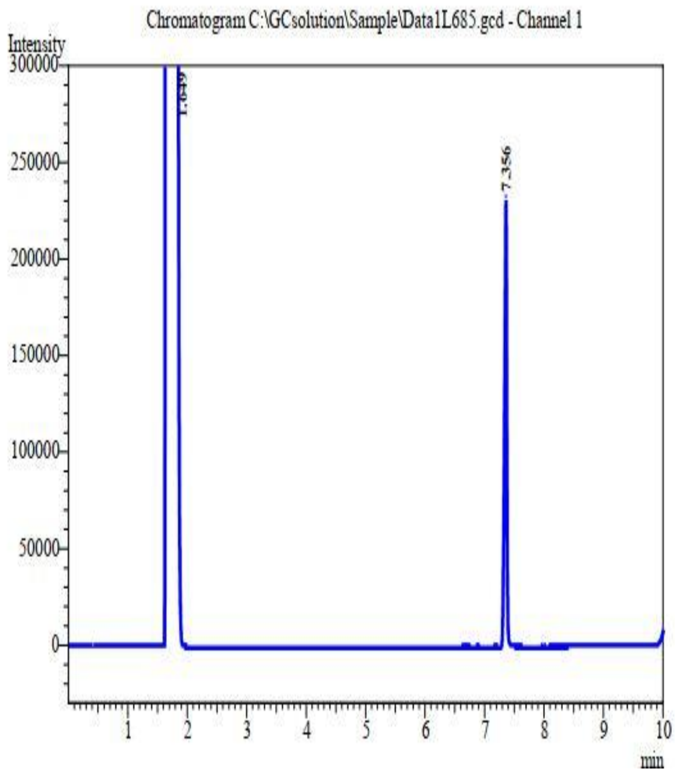
Figure 3. Diagnosis certain fatty acid *a*-



Peake.Table-Channel

Peak#	Rit. Time	Area%	Area%	Height	Name
1	2.183	3729866399	89.1168	8666665169	
2	10.206	455500242	10.8832	18008483	
Total		4185366641	100.0000	04613652	

Figure 4. Diagnosis certain fatty acid Oleic



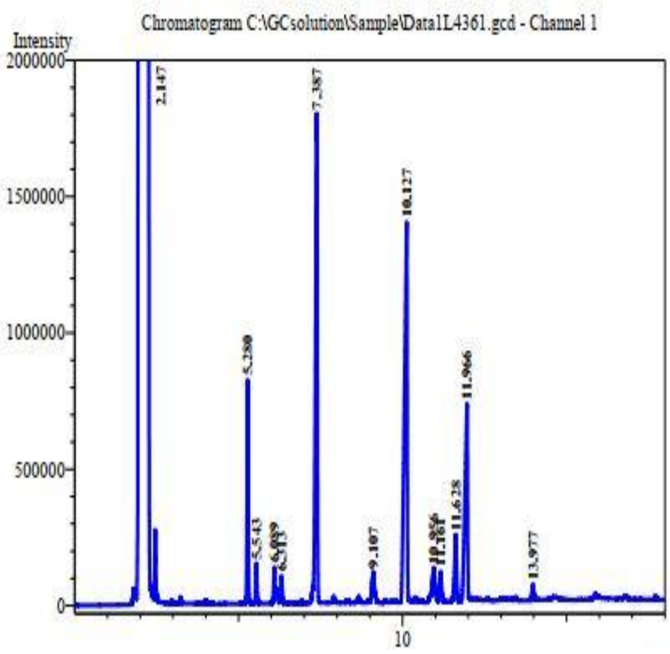
Peake.Table-Channel

Peak#	Rit. Time	Area%	Area%	Height	Name
1	1.649	23902873	97.816	7280479	
2	7.356	533648	2.183	215984	
Total		24436521	100.000	7496403	

Figure 5. Diagnosis certain fatty acid lenolic

Chemical analyzes

Table(6). Delineates the distribution of essential and non-essential fatty acids across various Cookies cookie treatments. Substitution of wheat flour with thyme led to a statistically insignificant increase ($p<0.05$) in palmitic, linoleic, oleic, stearic, and linolenic acids, except treatment A3 (5% thyme), where the increase in linoleic and oleic acids was statistically significant. Concerning the cookies that included sesame at substitution levels of 15%, 30%, and 50%, the content of fatty acids notably increased, except for stearic and linolenic acids, where the increase was not statistically significant. The simultaneous substitution of sesame and thyme resulted in a statistically significant progressive increase in fatty acid percentages ($p < 0.05$). Treatment A9 registered the highest values in fatty acids, including palmitic, linolenic, oleic, stearic, and linoleic acids, amounting to 20%, 14.5%,



Peak#	Rit. Time	Area%	Area%	Height	Name
1	2.147	6436638157	99.6159	83882770	
2	5.280	2074295	0.0321	810059	
3	5.543	366680	0.0057	144402	
4	6.089	311483	0.0048	118226	
5	6.313	269711	0.0042	97211	
6	7.387	706331	0.1093	1783964	
7	9.107	590574	0.0091	109673	
8	10.127	7937222	0.1228	1381810	
9	10.956	598609	0.0093	112379	
10	11.161	428531	0.0066	106735	
11	11.628	1041391	0.0161	242959	
12	11.966	3933223	0.0609	712608	
13	13.977	200810	0.0031	53095	
Total		6461454001	100.0000	89555891	

Figure 6 . Diagnosis certain fatty acid

17.9%, 3.3%, 2.3%, and 27% per 100g respectively. According to(27), linoleic and oleic acids represent 37.4% and 46.9% of the total unsaturated fatty acids, respectively. In contrast, palmitic acid, a saturated fatty acid, constitutes 9.1%. The elevation in fatty acids is attributed to sesame's increased fatty acid content. The percentages of oleic, linoleic, and palmitic acids are higher in black sesame seed oil than in white and brown sesame seed oil, with respective values of 21.67%, 50.73%, and 58.88% (42). This study depicts that the extract of Thymus vulgaris ,‘‘ Origanum vulgare, and Rosmarinus officinalis extracts possess very good antifungal and antibacterial ” (2)

Table 6. Fatty acid content (mg/100gm) for Cookies's different treatments

transaction code	Concentrations%	palmitic	Linolenk	Oleic	stearic	linoleic	SFA	USFA
A1	1Thyme	de 13.5±1.0	cd 10.3±	cd 12.5±0.25	de 1.9±1.9	bc 1.1±1.1	20.5	23.05
A2	3Thyme	d14.0±1.0	cd 11.1±	cd 12.9±1.00	cde 2.2±0.20	abc 1.4± 0.20	21	27
A3	5Thyme	cd 15.5±0.8	bc 11.9±	bc 14.2±0.20	bcde 2.4±0.4	abc 1.6±0.2	22.5	26.3
A4	15Sesame	bc 17.3±1.0	abc 12.4±	ab 15.8±1.00	bcde 2.5±1.00	abc 1.3±0.3	23.4	29.2
A5	30Sesame	ab 18.0±1.00	abc 12.9±	ab 16.2±0.9	bcde 2.7± 1.00	abc 1.5±1.00	25.2	30
A6	50Sesame	ab 18.6±1.0	ab 13.2±	ab 16.8±1.00	bcde 2.9±1.00	abc 1.7± 0.1	25.3	31
A7	1Thyme +15 sesame	ab 19.1±1.1	ab 13.7±	ab 17.1±1.0	abcd 3.0±0.1	ab 1.9±0	25.2	31.8
A8	3Thyme + 30sesame	a 19.7±0.2	ab 14.0±	ab 17.3±1.0	a 3.1± 1.0	ab 2.1± 1.0	27.1	32.3
A9	5Thyme +50sesame	a 20±0.1	a 14.5±	a 17.9±1.0	a 3.3±0.1	a 2.3±0.1	27	33.4
A10	Control	e 11.6±1.0	d 9.6±	d 10.8±1.00	e 1.6±0.35	C 0.8±0	15.35	21.4
Value LSD		*2.80	*2.471	*3.528	*0.860	*1.09		

***Averages with different letters within the same column are significantly different among them (P≤0.05)**
***According to Duncan's test *Each number represents the average of two repetitions**

Active compounds in thyme. thymol oil The antibacterial effects of essential oils and their active components are considered exceptional from a physiological perspective. As a result, they have been widely utilized in food manufacturing. Consequently, this study investigated the antibacterial properties of Thymol essential oil, Table 7 shows according to chromatography analysis and GC-MS. The active compounds in thymol oil were identified, which amounted to 40 components. The highest percentage was 12.26% for the compound Normal-heptadecane and the lowest percentage was 0.10% for the compound Alpha-pinene3.1.1. This is consistent with what was stated in (32), as Figure (7) indicates that the highest retention time was 29.11 minutes for the compound Bromotriacontane - I- and the lowest time was 5.039 minutes for the compound Bicyclo (3,1,,1) hept-2-ene,2,6,6 trimethyl.

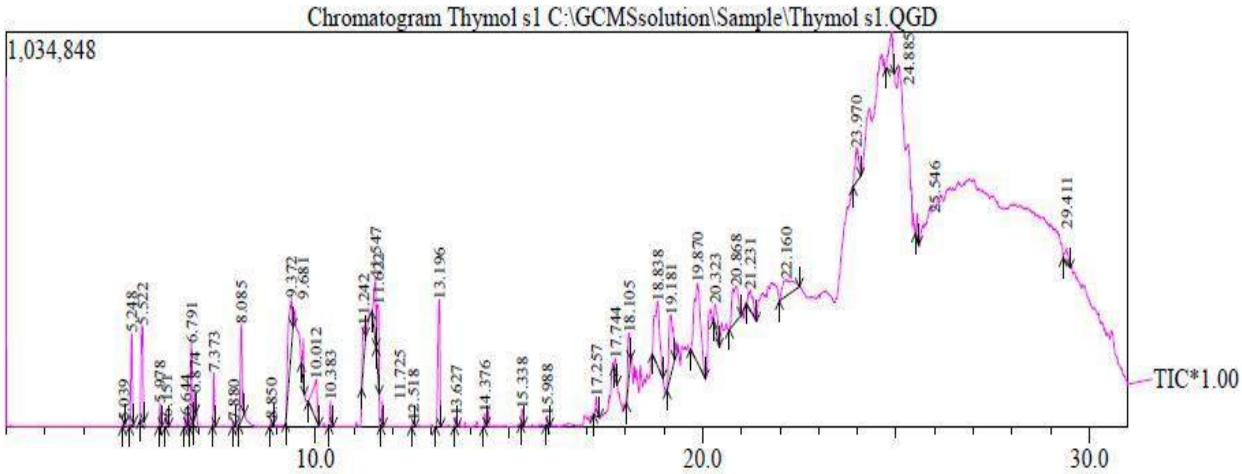


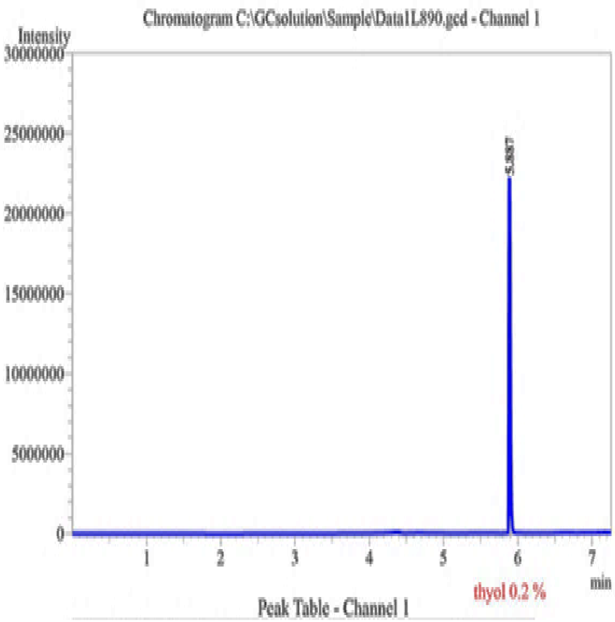
Figure 7. chromatogram thymol (GC/MS)

Table 7. Active compounds of thyme. thymol oil

NO	R.Time	Area%	Chemical Compounds of Thymol Oil	Mul	Percentage %
1	5.039	0.10	Bicyclo (3,1,,1) hept-2-ene,2,6,6 trimethyl	136	6.6
2	5.284	3.48	Alpha-pinene3.1.1	136	0.10
3	5.522	4.54	Bicyclo 2.2.1 heptane	136	3.48
4	5.978	0.65	Pinene 3.1.1heptane	136	4.54
5	6.151	0.28	Myrcene S	136	0.65
6	6.644	0.30	sp-mentha-1,4(8)-diene	136	0.28
7	6.791	2.99	1,3-cyclopentadiene,1,2.3,4-tetramethyl-5-methylene-s	134	0.30
8	6.874	0.55	1,5- cyclooctadiene,5-dimethyl-s	136	0.55
9	7.373	1.40	1,4-cyclohexadien	136	1.40
10	7.880	0.15	S p--mentha-1,4 (8)-diene S	136	0.15
11	8.085	4.03	1,6-Octadien-3-Ol	154	2.03
12	8.850	0.19	Bicyclo (2,2,1) heptane-2-one	152	1.19
13	9.372	6.30	S 2,7,7-Trimethlbicyclo (2,2,1) heptan -2- Ol	154	6.30
14	9.681	1.09	Bicyclo (2,2,1) heptane-2-ol	182	1.09
15	10.012	4.18	S Alpha-Terpineol S	154	4.18
16	10.383	0.73	Thymol methyl ether S	164	0.73
17	11.242	2.24	Carvacrol	150	2.24
18	11.547	2.71	Thyme camphor	150	2.71
19	11.622	2.97	3,4-xylenel,6-ethyl	150	2.97
20	11.725	0.52	Alpha-Limonene diepoxide	168	0.52
21	12.518	0.21	Biccyclo [4.1.0]-3-heptene	204	0.21
22	13.196	6.24	Bicyclo [7.2.0] undec -4-ene ,	204	6.24
23	13.627	0.25	1,3,7-Octatriene	136	0.25
24	14.376	0.35	GermacreneD	204	0.35
25	15.338	0.42	Trans-z-alpha-Bisabolone exoxide	220	0.42
26	15.988	0.29	Alpha-Bisabolol	222	0.29
27	17.257	0.80	Hexadecane, 3-methyl	240	0.80
28	17.744	0.59	Nonadecane,2-melhyl	282	0.59
29	18.105	2.63	Pentadecane,2,6,10-Trimethyl	254	2.63
30	18.838	7.94	n-Heneicosane	240	7.94
31	19.181	6.12	7-methyl hexadecane	240	6.12
32	19.870	12.26	Normal-heptadecane	240	12.26
33	20.323	1.88	Tritetracontane	604	1.88
34	20.868	5.52	n- Tetracosane	338	5.52
35	21.231	2.36	I- Decanol,2-ethyl	186	2.36
36	22.160	4.18	n-triacontane	478	4.18
37	23.970	3.09	Tetrapentacontane1, 54-dibromo	914	3.09
38	24.885	3.57	n-Eicosane	282	3.57
39	25.546	0.85	-Heptacosane,2,3-dimethyl	268	0.85
40	29.411	1.07	I-Bromotriacontane	550	1.07
		100.00			

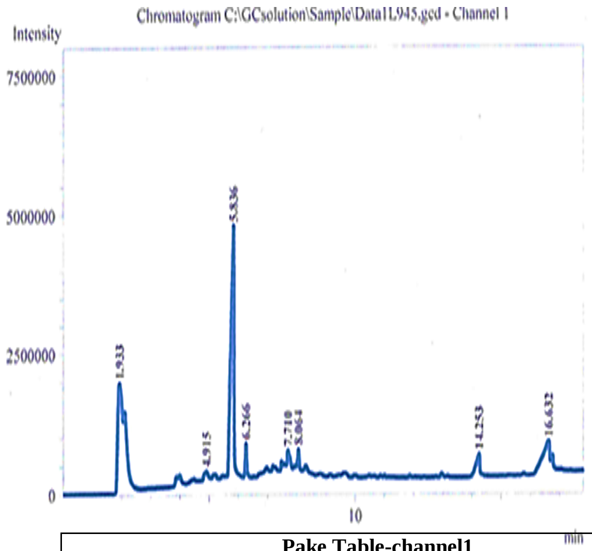
The use of GC to detect of thymol Compounds

GC was used to detect the presence of thymol from thyme seeds. The result showed that the retention time for the standard was 5.889 minutes and 5.836 minutes for the sample



Peak#	Rit. Time	Area%	Area%	Height	Name
1	5.887	25968696	100.0000	1359338	
Total		25968696	100.0000	1359338	

A



Pake Table-channel1					
Peak#	Rit. Time	Area%	Area%	Height	Name
1	1.933	10852528	19.5144	1275979	
2	4.915	1125649	2.0241	133630	
3	5.836	30453491	54.7599	44393326	
4	6.266	2019066	3.6306	591057	
5	7.710	1552781	2.7921	273603	
6	8.064	1148057	2.0644	329776	
7	14.253	2709304	4.8717	354711	
8	16.632	5751905	10.3428	379307	
Total		55612781	100.0000	7777389	

B

Figure 6. Figure 7. Chromatographic analysis for thymol A and thymol extracted from thyme seeds B

Sensory Evaluation of Laboratory-Manufactured Cookies Coefficients

Table 8. The impact of substituting wheat flour with sesame flour and thyme in the sensory attributes of various Cookies coefficients. The results signify the presence of substantial differences (P‹0.05) among the Cookies treatments and the control treatment. Treatment A1 achieved the highest rating in appearance, scoring 6.50. In contrast, treatment A8 obtained the lowest value, amounting to 4.20, exhibiting significant variance compared to the other distinct treatments. Regarding texture, the control treatment acquired the highest value, reaching 6.40, followed by treatment A4, scoring a 6.30, and then treatment A9, achieving a 6.00. Treatment A2 demonstrated a significant disparity compared to treatments A1, A4, A6, A7, A8, in addition to the control treatment. Concerning tenderness, treatment A5 markedly surpassed all other treatments and manifested significant differences with treatments A2, A3, A6, and A8, respectively. As for the flavor characteristic, treatments A9 and A5 both obtained a value of 6.30, differing significantly from treatments A2, A3, A6, A8, and A10 (control), except treatments A1, A4, A5, and A7 sequentially. Treatment A3 obtained the lowest values in flavor, thickness, color, and overall acceptability, with scores of 4.90, 4.50, 4.30, and 3.80, respectively. Despite these significant differences, the treatments were still socially acceptable. These results are in concordance with those reported by (21) (4, 10), In a study ‘‘ Sensory characteristics were highest in patties treated with 0.05% TLE’’.

Table 8. Effect of replacing sesame and thyme flour with wheat flour on the sensory properties of laboratory-made brazieq

Transactions	Concentrations	Sensory qualities appearance	texture	freshness	Flavor	thickness	color	general acceptance
A1	1thyme	6.50 ± 0.22 a	5.50 ± 0.16 bc	5.50 ± 0.22 abc	5.60 ± 0.22 abc	5.60 ± 0.16 bc	6.10 ± 0.10 a	6.10 ± 0.18 ab
A2	3thyme	4.40 ± 0.22 e	4.90 ± 0.37 d	5.00 ± 0.26 cd	4.00 ± 0.44 of	4.60 ± 0.22 de	4.60 ± 0.34 cd	5.00 ± 0.39 c
A3	5thyme	5.10 ± 0.23 d	5.20 ± 0.25 cd	4.90 ± 0.31 cd	3.80 ± 0.35 f	4.30 ± 0.30 e	4.50 ± 0.31 d	4.90 ± 0.31 c
A4	15sesame	6.30 ± 0.21 ab	6.30 ± 0.15 a	6.00 ± 0.14 a	6.20 ± 0.29 ab	5.90 ± 0.18 ab	6.10 ± 0.27 a	6.30 ± 0.30 a
A5	30sesame	6.00 ± 0.02 abc	5.10 ± 0.10 cd	6.10 ± 0.18 a	6.30 ± 0.21 a	6.10 ± 0.17 ab	6.00 ± 0.26 ab	6.10 ± 0.31 ab
A6	50sesame	5.80 ± 0.13 bc	5.50 ± 0.16 bc	5.10 ± 0.31 bcd	4.70 ± 0.26 de	5.60 ± 0.22 bc	5.70 ± 0.21 ab	5.70 ± 0.15 abc
A7	1thyme 15 + sesame	5.60 ± 0.22 cd	5.60 ± 0.22 bc	5.50 ± 0.16 abc	5.50 ± 0.22 abcd	5.10 ± 0.37 cd	5.70 ± 0.21 ab	5.60 ± 0.26 abc
A8	3thyme + 30sesame	4.20 ± 0.13 e	4.10 ± 0.18 e	4.80 ± 0.20 d	4.90 ± 0.35 cd	4.70 ± 0.21 de	4.60 ± 0.30 cd	5.30 ± 0.49 bc
A9	5thyme 50 + sesame	5.70 ± 0.15 c	6.00 ± 0.21 ab	5.80 ± 0.25 a	6.30 ± 0.26 a	6.40 ± 0.16 a	5.90 ± 0.23 ab	5.90 ± 0.10 ab
A10	control	6.40 ± 0.16 a	6.40 ± 0.16 a	5.70 ± 0.26 ab	5.40 ± 0.22 bcd	5.70 ± 0.36 abc	5.30 ± 0.30 bc	6.30 ± 0.15 a
volu LSD		0.513 *	0.594 *	0.668 *	0.825 *	1.986 *	0.739 *	0.818 *

*** Each number in the Table represents the average of the sensory properties of barazek for ten raters**

***Similar letters indicate no significant differences between the treatments at the probability level ($P<0.05$) according to Duncan's multinomial test.**

*** 7 (excellent) represents the highest rating, 6 (very good), 5 (good), 4 (high average), 3 (average), 2 (acceptable), and 1 (very poor) represents the lowest rating.**

Diagnostic characteristics of bacteria in study samples

1. The Agricultural Characteristics of *Staphylococcus aureus* Bacteria: The various bacterial species appearing in the pastries, supplemented with sesame powder and thyme, were diagnosed. In cases where the *S. aureus* bacteria was present, it manifested in a spherical cocci form with cells clustered in grape-like structures. It tested positive for the Gram stain, did not produce spores, and exhibited growth on the Mannitol Salt Agar (MSA) medium, acquiring a creamy color and changing its hue from pink to yellow. The bacteria were negative for oxidase tests and starch hydrolysis but positive for catalase tests, gelatin hydrolysis, sugar fermentation, clot hydrolysis, indole test, and the Voges-Proskauer test, as well as urea hydrolysis.

2. The Agricultural Characteristics of *Lactobacillus* Bacteria: The bacterial cells isolated from the pastries were diagnosed to which ground sesame and ginger had been added. The isolates of this bacteria tested positive for the Gram stain, appeared as rod-shaped cells, produced acids, and were negative for catalase and gelatinase tests.

3. Diagnosis of Two Types of Filamentous Fungi: Two filamentous fungi, isolated from the pastries supplemented with sesame powder and thyme for laboratory use, were diagnosed as *Aspergillus spp*. and *Penicillium spp.*, following diagnostic keys (40).

The Inhibitory Effectiveness of Bacteria in Different Types of Pastries (Cookies)

Table 9. Illustrates the impact of varying storage durations on the total bacterial count, where the pastry product was stored for 21 days at a temperature range of 20-38°C. It contained positive and negative bacteria for the Gram stain, namely *Staphylococcus aureus* and *Lactobacillus spp.* It was observed that the bacterial count after 3, 7, 10, 14, and 21 days of storage had a range of bacterial colonies between $1x10^3$ to $3x10^3$ CFU for treatments A1 (1% thyme) and A6 (15% sesame), respectively, after 72 hours of storage. No bacterial growth was observed for the remaining treatments except for the control treatment, which reached $2x10^3$ CFU. This is consistent with the findings of(11), where it was found that the minimum inhibitory concentration of *Staphylococcus aureus and E.Coli* from thyme extract added to biscuits

made from thyme, cinnamon, and sweet fennel (anise) was at a concentration of 5 microliters/ml. The appearance of bacteria in the pastries was delayed until the seventh day for treatment A2 (3% thyme), which reached $2x10^3$CFU, compared to A5 (30% sesame), which reached $5x10^3$ CFU. The bacterial count ranged between $2x10^3$ to $7x10^3$CFU for treatments A3 (5% thyme) and A10 (control) on the tenth day of storage. Concentrations A3 (3% thyme) and A9 (5% thyme + 50% sesame) delayed the appearance of bacteria until the tenth day. The bacterial count for the control treatment increased, reaching $12x10^3$CFU. As the storage period grew, so did bacterial numbers, ranging between $4x10^3$ to $15x10^3$CFU at the end of the storage period.
The inhibitory effectiveness of thyme is attributed to active compounds such as carvacrol thymol and linalool, pinene, borneol, and eugenol (11, 26). These results are in concordance with those reported by(4) (3, 21,38, 48) The alcoholic extract was more effect on Pseudomonas aeruginosa than another bacteria Staphylococcus aureus and Escherichia coli and as found " The antibacterial effect of different concentrations of Aloe vera gel, Sesame Oil, and Camphor Oil against P. aeruginosa (25). It was also found that the concentration of 20mg/ ml gives high inhibition to *Staphylococcus aureus, Salmonella spp. E.coli, Pseudomonas auregenosa* (11) According to the Iraqi specification issued by the Iraqi Central Agency for Standardization and Quality Control No. 2270 part10 for the year 2006 indicates that the bacteria microbiological limits in Cakes and pastries in permitted foods are $1x10^2$ cfu / g, where treatments A8, A7, A6, A5, A4, A2, A1 exceeded. In addition to the control treatment, while treatments A9, A3 were within the permitted limits. The results show that thyme extract at the same concentration inhibited the growth of B. cinerea completely. Highest value of minimum inhibitor concentration (mic) was (0.09) of thymol against staphylococcus aureus''

Table 9. Effect of replacing sesame and thyme seed flour with wheat flour on bacteria numbers during the storage period of manufactured brazek(cfu/10³)

		storage period (day)					
Transactions	**Concentrations%**	**0**	**3**	**7**	**10**	**14**	**21**
A1	1Thyme	0	2	3	5	5	6
A2	3 Thyme	0	0	2	4	6	8
A3	5 Thyme	0	0	0	0	3	4
A4	15 sesame	0	0	1	3	5	9
A5	30 sesame	0	2	5	6	9	11
A6	50 sesame	0	3	4	7	8	10
A7	1Thyme+15sesame	0	0	0	4	5	7
A8	3Thyme+30sesame	0	0	0	2	6	8
A9	5Thyme+50sesame	0	0	0	0	3	7
A10	Control	0	2	4	7	12	15

Inhibitory Efficacy against Molds in Various Barazek Treatments: Table 10. Displays the results of microbiological examinations conducted on 10 samples of barazek prepared in the laboratory by substituting different concentrations of sesame seed flour and thyme for wheat flour. Species of *Penicillium* and *Aspergillus sp.* were identified, and mold colonies appeared on the third day of storage for all treatments except for treatments A6, A10 (control), A4, A1, and A5. The counts ranged between $1×10^3$and $4×10^3$cfu. These results are consistent with Ameen (12), where various concentrations of thyme extract were used, and the lowest inhibitory concentration was 0.5 µL/mL. However, 0.25 µL/mL and 0.1 µL/mL concentrations were less effective. when using concentrations in treatments A4 and A7, mold colonies began to appear on the seventh day, with counts ranging between $1×10^3$and $2×10^3$cfu, respectively. On the tenth day, mold colonies appeared in treatments A3 and A8, with counts of $2×10^3$and $3×10^3$cfu, respectively. Growth did not appear until the fourteenth day of storage for concentration A9. where the count was $4×10^3$cfu. Molds continued to appear in all treatments, with counts ranging from $6×10^3$ to $18×10^3$ cfu. Concentration A3 was the least inhibitory for mold colonies. In contrast, concentration A9 was significant because it inhibited the appearance of colonies until the fourteenth day. These results are in concordance with those reported (5).

Table 10. The effect of replacing sesame and thyme seed flour with wheat flour on the number of molds during the storage period of manufactured Barazek

transactions	concentrations	numbers of molds x10³ CFU storage period (day)					
		0	3	7	10	14	21
A1	1thyme	0	2	3	5	7	9
A2	3thyme	0	0	1	4	5	7
A3	5thyme	0	0	0	2	3	6
A4	15sesame	0	2	4	6	7	9
A5	30sesame	0	1	3	5	8	10
A6	50sesame	0	4	5	9	12	15
A7	1thyme +15sesame	0	0	2	6	9	12
A8	3thyme + 30sesame	0	0	0	3	7	11
A9	5thyme + 50sesame	0	0	0	0	5	8
A10	Control	0	2	4	15	17	18

CONCLUSION

In conclusion, the use of flour substitutes enriched with sesame and thyme in cookie production presents a promising approach to creating healthier baked goods without compromising taste or texture. These ingredients not only enhance the nutritional profile by providing essential fatty acids, fiber, and antioxidants, but also introduce functional health benefits, including anti-inflammatory and antimicrobial properties. The resulting cookies offer a balanced alternative for health-conscious consumers, particularly those with dietary restrictions or preferences for natural ingredients.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not received a fund.

REFERENCES

1- Abass, W. F., Hala,. A. A. Y and A. M. H. AL shaibani, 2017. Effect of utilization of date fiber from date syrup manufacture on organoleptic properties of chocolate cake and .extending the storage life of the product International Journal of Science and Nature,8(3):662-666.

2- Amin Mousavi Khaneghah, Lorenzo, Jose M., , Mohsen Gavahian, Krystian Marszałek, Ismail Eş, Paulo ES Munekata, Isabel CFR Ferreira, and F. J. Barba. 2019. Understanding the potential benefits of thyme and its derived products for food industry and consumer health: From extraction of value-added compounds to the evaluation of bioaccessibility, bioavailability, anti-inflammatory, and antimicrobial activities. Critical reviews in food science and nutrition, 59(18), 2879-2895. https://doi.org/10.1080/10408398.2018.1477730

3-Abozid, M. M.,, and M. Asker, 2013. Chemical composition, antioxidant and antimicrobial activity of the essential oil of the thyme and rosemary. International Journal of Academic Research 5(3): 186-195 doi:10.7813/2075-4124.2013/5-3/A.26

4- Agwanande,W., P. M. J. Dongmo, T. N. Leopold., P. Prabhakaran., V. B. Manilal.,K. Bhaskaran., and H.A.Z., Paul., 2017.Effect of the essential oils of Thymus vulgaris, Cinnamomum zeylan-icum and Mentha piperita on fungal growth and morphology African Journal of Biotechnology16(9): 388-399.doi:10.5897/AJB2017.15881

5-Ahmad, A., A .Khan., F.Akhtar., S.Yousuf.,I .Xess., L. A. Kha., and N. Manzoor., 2011 Fungicidal activity of thymol and carvacrol by disrupting ergosterol biosynthesis and membrane integrity against Candida. European Journal of Clinical Microbiology & Infectious Diseases 30: 41-50..doi: 10.1007/s10096-010-1050-8

6-Akinoso, R, S. A. Aboaba and T. M. A. Olayanju.,2010 Effects of moisture content and heat treatment on peroxide value and oxidative stability of un-refined sesame oil. African Journal of Food, Agriculture, Nutrition and Development 10.10p:4268-4285. doi: 10.4314/ajfand.v10i10.62908

7-Akusu O. M., D. B., Kiin-Kabari., and A. Ohwesiri. 2020.Anti-nutrients, bioaccessibility and mineral balance of cookies produced from processed sesame seed flour blends. Int J Food Sci Nutr Eng 10(1): 1-11. doi:10.5923/j.food.20201001.01

8-. Anžlovar, Sabina, Dea Baričevič, Jerneja Ambrožič Avguštin, and Jasna Dolenc Koce.2014. Essential oil of common thyme as a natural antimicrobial food additive. Food Technology and Biotechnology, 52(2), 263-268. https://hrcak.srce.hr/122382

9- Almoumen, Alaa, Huda Mohamed, Athira Subash, Ali H. Al-Marzouqi, Mutamed Ayyash, Ayesha S. Al Dhaheri, and Afaf Kamal-Eldin, A. 2025. Fortifying bread rolls with date fruit fiber: Effects on dietary fiber, antioxidant capacity, mineral content, and glycemic response. NFS Journal, 100229. https://doi.org/10.1016/j.nfs.2025.100229

10-Al-snafi, A. E. 2019. Iraqi medicinal plants with AntibacterialEffect-AReview IOSR Journal of Pharmacy 9 (8).22-109. series1

11- Ajani, Richard, Ganiyu Oboh, Stephen Adeniyi Adefegha, Kate E. Nwokocha, and Afolabi Akintunde Akindahunsi. 2020. Sensory attributes, nutritional qualities, and glycemic indices of bread blends produced from cocoa powder flavored yellow-fleshed cassava-wheat composite flours. Journal of Food Processing and Preservation, 44(9), e14673. https://doi.org/10.1111/jfpp.14673

12- Ameen, W., J. Mahmoud., T. Yassin., and Z. S. Hussein., 2011 The effect of alcoholic extract of Thym-bra spicata on some pathogenic bacteria. AL-Qadisiyah Journal of Veterinary Medicine Sciences 10(2); 126-130.

13- Anilakumar, K. R., Pal, A., Khanum, F., & Bawa, A. S. 2010. Nutritional, medicinal and industrial uses of sesame (Sesamum indicum L.) seeds-an overview. Agriculturae Conspectus Scientificus, 75(4), 159-168. https://hrcak.srce.hr/66001

14-Aslan, O., and G. U.l. Mevlut.,2017. Economic structure and the problems of thyme producer farms in Denizli International Journal of Social and Economic Sciences 7(1); 64-69.

15-Ayo, Y.O., O.Gonuoha., V. A. Ayo., and V. Ekele., 2010 .Effect of added defatted beniseed on the quality of acha-based biscuits. Continental Journal Food Science and Technology 4: (7-13).

16-.Behbahani, B. A., F. T Yazdi,., F. Shahidi, S. A. Mortazavi,. and M. Mohebbi., 2017 Principle component analysis (PCA) for investigation of relationship between population dynamics of microbial pathogenesis, chemical and sensory characteristics in beef slices containing Tarragon essential oil, Microbial Pathogenesis., (105):37-50. https://doi.org/10.1016/j.micpath.2017.02.013

17- Borchani, C., S. Besbes., C. Bleckes., and H. Attia., 2010. Chemical characteristics and oxidative stability of sesame seed, sesame paste, and olive oils. Journal of Agricultural Science and Technology 12(5); 585-596

18-Chochkov, R and G. Gercheva., 2017. Sensory evaluation of pastry biscuits with thyme, Oregano, and sage. International Journal of Scientific & Engineering Research 8(1). 430-433

19-Dedić, M., E.becic., B. imamovic., N. ziga.,S. medanhodzic-vuk., and M. Sober., 2018 . HPLC method for determining the content of thymol and carvacrol in Thyme tincture. Bulletin of the Chemists and Technologists of Bosnia and Herzegovina. (50):pp :1-6.

20-Duncan. D. B., 1955 Multiple range and Multiple F-Tests. Biometrics, 11, 1-42. doi.org/10.2307/3001478

21-El Asbahani. A.,K. Miladi ., W. Badri., M. Sala., E. H. Ait Addi., H. Casabianca., El.Mousadik., A. D Hartmann., A. Jilale, F.N.R.Renaud., and A.Elaissari., 2015 . Essential oils: From extraction to encapsulation. International Journal of Pharmaceutics 483(1-2): 220-243 doi.org/10.1016/j.ijpharm.2014.12.069

22-El-Enzi, S. M., N. M Andigani., N. A. ALTamimi., and G. A. Gabr., 2018 Physico chemical and sensory evaluation of the fortified biscuits with sesame cake flour. Asian food Science Journal 5(4) 1-8. doi: 10.9734/AFSJ/2018/45232

23-Emmanuel-Ikpeme, Ch.,Ch. Eneji., and G. Igile., 2012 Nutritional and organoleptic properties of wheat (*Triticum aestivum*) and beniseed (sesame indicum) composite flour baked foods..Journal of Food Research 1(3): 84-91.doi:10.5539/jfr.v1n3p84

24 -Essa, Y. R., R. S. Abd Elhady., H. Kassab., and A. Ghazi.,2015. Isolation and

charcteristizaten of protein isolated from sesame seeds (Sesamum indicum) meal. Weber Agricultural Research & Management 1(1) 1-9.

25-Flayyih, M.T., and R. Q. Majeed., 2012. The effects of aloe vera gel, sesame oil and camphor Oil on *Pseudomonas aeruginosa* isolated from Burnt patients. Iraqi J Pharm Sci 21(2); 18-23. doi**.** https://doi.org/10.31351/vol21iss2pp18-23

26-Gandhi, A. P., and J. Srivastava., 2007 Studies on the production of protein isolates from defatted sesame seed *(Sesamum indicum*) flour and their nutritional profile. Asean Food Journal 14(3). 175-180

27-Gharby. S., H. Harhar., Z. bouzoubaa.,A. Asdadi., A. El.yadini., and Z. charrouf.,2017 Chemical characterization and oxidative stability of seeds and oil of sesame grown in Morocco. Journal of the Saudi Society of Agricultural Sciences 16(2); 105-111. doi: 10.1016/j.jssas.2015.03.004

28-Gomoril, C.,A.Vidacs, E. B. Kereskes.,E. Nacsa-Farkas., A.Boszormenyi., C. Vagvolgyi and J. Krissch 2018. Altered antimicrobia and anti. The biofilm effect of thyme essential oil is due to changes in composition. Natural Product Communications.13(4);483-487.

29- Hasan, S. T., Al-Sarsj, A. F., Al-Ameedee, Z. M., and Saadi, A. M. 2024. Influence of Sesame Flour and Ascorbic Acid on the Nutritional and Rheological Qualitiy of Dough and Bread. Élelmiszervizsgálati Közlemények, 70(3), 15-22.

30-Holcombe, J A., and D. C. Hassell., 2002 Atomic absorption, atomic emission, and flame emission spectrometry. Analytical Chemistry 62(12) : 169-184.

31-Ighere, D A., A O. Dave-Omoregie., N. Abaku. and S. L. A. Dickson.,2019 .Proximate composition of biscuits produced from wheat, yellow maize and sesame flours. International Journal of Agriculture and Food Science 1(1): 1-4. doi:10.13140/RG.2.2.19814.57920

32-IMElouant B., A.Hassan.,J.P. wathelet.,M. Ankit., K. khedid., and A.A. ELbachiri.,2009 Chemi-cal composition and Antimicrobial Activity of Essential oil of thyme(thymus Vulgaris) from Eastern Morocco.International Journal of Agriculture & Biology.11(2) 1560-8530.

33- Ijarotimi, Oluwole Steve, Tosin Grace Ogunmola, and Timilehin David Oluwajuyitan. 2022. Effect of some traditional processing operations on the chemical, functional, antioxidant, glycaemic index and glycaemic load of groundnut (Arachis hypogea L.) seed flour. Journal of Food Measurement and Characterization, 16(3), 2024-2040. https://doi.org/10.1007/s11694-022-01320-6

34-Labensky, S. R..,A.M. Hause., and P.AMarte. 2024. On cooking.atextbook of culinary fundamentals.7th edition. pearson. Prentice Hall;.pp: 300.

35-Luna, A., M.C. Labague., M.E.Fernandez., J. A. Zygadlo., and R. H. Marin., 2018.Effects of feed-ing thymol and isoeugenol on plasma triglycerides and cholesterol levels in Japanese quail. The Journal of Animal and Plant Sciences, 28(1):56-62.

36-Oliveira, R. C., M. Caevajal-Mereno., B. Correa., and F. Rojo-callejas., 2020. Cellular, physiological and molecular approaches to investigate the antifungal and anti-aflatoxigenic effects of thyme essential oil on Aspergillus flavus.. Food Chemistry. 315:126096. doi:10.1016/j.foodchem.2019.126096

37-Onabanjo. O, O., and D. Ighere, 2014. Nutrition, functional and sensory properties compositor, Journal of Food Technology and Research.1(2):111-121doi:10.18488/journal.58/2014.1.2/58.2.111.121

38-Onsaard, E., 2012. Sesame proteins. International Food Research Journal 19(4); 1287-1295

39-Ozogul, Y., E. K. bogo, I. Akyol., M. Durmus., Y. Yucor., J. M. Regenstein ., and A. R. Kosker., 2020. Antimicrobial activity of thyme essential oil nanoemulsions on spoilage bacteria of fish and food-borne pathogens. Food Bioscience36. 100635 https://doi.org/10.1016/j.fbio.2020.100635.

40-Palaniappan, K, and A.H. Richard.,2010. Use of natural antimicrobials to increase antibiotic susceptibility of drug-resistant bacteria. International Journal of Food Microbiology 140(2 -3): 164-168.

41- Sowmya, M., Jeyarani, T., Jyotsna, R., & Indrani, D. 2009. Effect of replacement of fat with sesame oil and additives on rheological, microstructural, quality characteristics and fatty acid profile of cakes. Food Hydrocolloids, 23(7),

1827-1836.
https://doi.org/10.1016/j.foodhyd.2009.02.008

42-Saeed, F., A. Oamar., M Nadeem. , R. Ahmed. M Arshad.,and M. Afzaal., 2015 Nutritional composition and fatty acid profile of some promising sesame cultivars. Pakistan Journal of Food Sciences 25(2). 98-103.

43-SAS. 2012. Statistical Analysis System, User's Guide. Statistical. Version 9.1 th ed. Inst Inc. Cary. NC. The USA

44- Sowmya, Mauri, Thangaraj Jeyarani, Rajiv Jyotsna, and D. Indrani. 2009. Effect of replacement of fat with sesame oil and additives on rheological, microstructural, quality characteristics and fatty acid profile of cakes. Food Hydrocolloids, 23(7), 1827-1836. https://doi.org/10.1016/j.foodhyd.2009.02.008

45-Santos, R.R M . Andrade,., N.R., de Melo, F, Santos, R.D., I.D.A., Neves, and M.G.D. Garvalho, 2017. Biological activities and major components determination in essential oils intended for a biodegradable food packaging, Industrial Crops and Products., 97: 201–210.
https://doi.org/10.1016/j.indcrop.2016.12.006.

46-Urugo, M. M., and A. Z. Woldegiorgis. 2022. Aflatoxins and aflatoxigenic fungi in export standard white and red sesame seeds (*Sesamum indicum L.*) from Ethiopia. Croatian Journal of Food Science and Technology 14(1); 90-97.

47-Van Dijk, D., and V. J. G. Houba., 2000. Homogeneity and stability of materials distributed within the Wageningen evaluating programmes for analytical laboratories. Communications in Soil Science and Plant Analysis 31(11-14);1745-1756.

48- Wattanasatcha, A., Rengpipar, S., and S. Wanichwecharungrung, 2012. Thymol nanospheres as an effective antibacterial agent. International Journal of Pharmaceutics, 434(1-2), 360-365.
doi: 10.1016/j.ijpharm.2012.06.017

49-Wenzhong, H. U..,K.e.Feng, Z. Long Xiu., A. Jiong., and Lao., 2019 Thyme oil alginate-based edible coatings inhibit the growth of pathogenic microorganisms spoiling fresh-cut cantaloupe Food Bio-science. 32: 100467.
https://doi.org/10.1016/j.fbio.2019.100467

50- Zouari, R., Besbes, S., Ellouze-Chaabouni, S., & 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.
https://doi.org/10.1016/j.foodchem.2015.08.064