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RESEARCH ARTICLE

STUDYING THE EFFECT OF USING GUAVA SEED OIL AS AN ANTIOXIDANT TO PROLONG THE SHELF LIFE OF MAYONNAISE

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ABSTRACT

The study was conducted at the laboratories of the Ministry of Science and Technology to investigate the effect of guava seed oil as an antioxidant to extend the shelf life of mayonnaise. This study included the extraction of oil from guava seeds using a Soxhlet apparatus and its examination by Gas Chromatography (GC). Four different formulations of mayonnaise were prepared for the study, represented by Treatment 0 (T0) as the control, which was left without addition, and Treatments 1 (T1), 2 (T2), and 3 (T3) to which guava seed oil was added at different replacement ratios of 0.5%, 1.5%, and 2%, respectively. These formulations were then packed in tightly sealed glass containers and stored at a refrigerator temperature of 5 ± 1°C for 10 and 20 days. Physicochemical and sensory evaluations were conducted, revealing significant differences in the estimation of free fatty acids between the control treatment (T0) and the other mayonnaise treatments (T1, T2, and T3). However, the results indicated no statistically significant differences in pH values and thiobarbituric acid values among the mayonnaise treatments. The peroxide value of the other mayonnaise treatments was lower than that of the control treatment (T0), showing statistically significant differences. Regarding sensory evaluation, statistically significant differences were observed, with the control treatment (T0) receiving the lowest overall acceptance score, while Treatment 3 (T3) outperformed all other treatments after 20 days of storage, indicating that the formulations were acceptable sensory-wise.

INTRODUCTION

Canned and sterilized food products rely on their shelf life to maintain their quality and nutritional value. Mayonnaise, a widely used product in various types of foods and fast-food meals, is one such product. One of the challenges facing the mayonnaise industry and similar products is extending the product's shelf life while maintaining its quality during storage.

Therefore, antioxidants play a role in prolonging the shelf life of these food products. Mayonnaise is considered a stable emulsion and semi-solid, composed of vegetable oil, vinegar, salt, egg yolk, vinegar, and sugar. According to the US Food and Drug Administration (USFDA), mayonnaise is categorized as an emulsified and semi-solid food product produced from edible vegetable oil, vinegar, eggs, lemon juice, and some additives such as sugar, salt, mustard, or some flavourings and spices (Dickinson & Pation, 1999). Given the large quantities of oil in mayonnaise production (65-80%) and the long storage period (9 months) without sufficient attention to appropriate storage temperature conditions, mayonnaise is susceptible to autoxidation of the oil, leading to serious issues.

The oxidation reactions of fats produce free radicals that can transfer to other molecules such as carbohydrates, vitamins, and proteins. Additionally, fat oxidation leads to deterioration in the colour, flavour, smell, and nutritional value of foods containing fats, affecting consumer acceptance (Schaich, 2008). It can be said that inhibition of fat oxidation can be achieved using antioxidants in general. Since the antioxidants used in the food industry are synthetic substances, they can be toxic cause cancer and give negative impressions to consumers.

LITERATURE REVIEW:

A British study published in 1999 indicated that 9.5 million cases of poisoning resulted from eating unhealthy foodstuffs (Star & Jumaa, 2018). Therefore, food scientists try to use natural antioxidants instead of synthetic ones to maintain the health and safety of the body (Li, Im, Lee, & Rhee, 2014). Currently, the search for natural food ingredients and flavours with beneficial properties has become important (Netzel, Tian, Schwartz, & Konczak, 2007). The use of natural antioxidants in food products is a new field and is important for maintaining sensory acceptance of food products. Consuming foods containing plant chemicals with potential antioxidant properties can reduce the risk of human diseases such as cancer, atherosclerosis, arthritis, diabetes, and other age-related diseases (Temple, 2000).

Plant compounds are characterized by high biological activity and stability compared to synthetic compounds (Habib et al., 2012). Extracting antioxidants from natural plants, such as guava, is the first step in isolating biologically active components from plant materials and achieving the maximum concentration of targeted compounds and the highest antioxidant activity in the extracts (Spigno et al., 2007).

Extracting antioxidants from plants is an interesting aspect with biological properties and is the most efficient, economical, and suitable method. Therefore, it is an excellent source of nutritional, biologically active, and functional elements containing many beneficial components for human health (Abdel-Razek et al., 2016). Seeds and other agricultural food waste are considered rich source of plant chemicals such as phenolic compounds, sugars, dietary fibres, and flavour compounds (Elbasiouny et al., 2020). Phenolic compounds found in plants encompass many compounds that vary in their functional activity and chemical structure (Balasundram et al., 2006).

These antioxidant compounds contain anti-inflammatory and anticancer properties (Leyva-Lopez et al., 2020). Recently, there has been a focus on using active plant antioxidants to control and reduce oxidation in food fats, in addition to a trend towards replacing synthetic antioxidants with natural antioxidants that may have health benefits (Uzombah, 2021; Ashrafi et al., 2023).

When considering the study of the effect of guava seed oil as an antioxidant to prolong the shelf life of mayonnaise, we can deduce some key properties of guava seed oil. Guava seed oil contains natural antioxidants such as vitamin E and vitamin C, as well as omega-3 and omega-6 fatty acids.

These components enhance the ability of guava seed oil to prevent oxidation and delay rancidity processes that may occur in stored food products. Additionally, the effect of guava seed oil on oxidation may contribute to stabilizing the colour and flavour and improving the fat stability in mayonnaise, thereby increasing its shelf life. Regarding the seeds, guava seeds constitute a percentage of 6-12% of the total fruit weight. Additionally, the seeds contain about 16% oils, 7.6% proteins, and 61.4% crude fibres. Guava seeds are a good source of oil that can be used in food industries and healthy food supplements. The oil extracted from guava seeds contains phenolic compounds with antioxidant properties capable of scavenging free radicals.

Moreover, the seeds have a high iodine value (134.0 g I2/100 g oil) and a refractive index of 1.4772 at 40°C. The total unsaturated fatty acids and saturated fatty acids in guava seed oil are 87.3% and

11.8%, respectively. The major fatty acids in guava seed oil are linoleic acid (76.4%), followed by oleic acid (10.8%), palmitic acid (6.6%), and stearic acid (4.6%).

Research results have shown that the fatty acid composition of guava seed oil resembles that of sunflower seeds.

Guava seeds may potentially become an alternative for them. Guava seeds contain high levels of carotenoids and total phenolic compounds. Studies have shown that consuming fruits, vegetables, and seeds can be beneficial in preventing risk factors for many diseases due to their biologically active compounds. Traditionally, they have been used as medicinal plants worldwide for various ailments. Seeds are used as antimicrobial, digestive, anti-allergic, and anticancer agents. Plant-derived oil extracted from seeds is the primary source of energy for humans, and therefore, the use of high-quality agricultural plant seeds is a factor contributing to the improvement of food products.

MATERIALS AND WORKING METHODS.

Preparing guava seeds:

- Ready-made guava seeds were purchased from Egyptian origin.
- Method of oil extraction of guava seeds

The oil extraction from ground guava seeds was conducted according to Sultana et al. (2009). Initially, the seeds were washed, cleaned, and dried in an oven. Subsequently, 150 grams of the powdered seeds were placed in a Soxhlet extractor, and 750 ml of hexane solvent was added to a round-bottom flask connected to the Soxhlet apparatus. The extraction process was carried out for 8 hours under reflux using a water bath connected to the Soxhlet apparatus.

After extraction, the solvent was evaporated and concentrated under low pressure at 45 degrees Celsius using a rotary evaporator. The crude dried extract was then weighed to determine the yield and stored in a refrigerator at 4 degrees Celsius until further use.

Determination of fatty acids in guava seed oil extract using a GC device.

The total fatty acids in the guava seed oil extracted were analysed according to the method described by (Marineli et al., 2014), using Gas Chromatography (GC) with some modifications. A 1 ml sample of the extracted oil was taken, and 8 ml of methyl potassium hydroxide (Methanol KOH) was added to it. Then, 5 ml of hexane was added with agitation for one minute until two layers formed; the upper layer consisted of hexane with fatty acid methyl ester methylated, and the lower layer consisted of methyl potassium hydroxide.

One microliter of the upper layer was withdrawn for injection into the apparatus. The injection conditions were as follows: hydrogen gas was used at a flow rate of 100 kph, with a sample volume of 1 microliter. The detector used was a Flame Ionization Detector (FID), with an injection temperature of 250°C, a detector temperature of 330°C, and a separation column temperature ranging from 120 to 290°C at a rate of 10°C per minute.

The concentration of fatty acids in the analysed oil was calculated using the following equation: [Provide the equation here].

Concentration of fatty acid = area of fatty acid x concentration of standard compound/area of standard compound x dilution factor

Detection of active compounds in guava seed oil extract using a (GC) device

The method endorsed by (Jalill, 2014) was utilized to detect the active compounds in guava seed oil extract and separate the active compounds using Gas Chromatography (GC).

The dimensions of the capillary column were 5MS, with an injection volume of 1 microliter. The column temperature was maintained at 80 degrees Celsius, while the injection temperature was set at 280 degrees Celsius. Helium was used as the carrier gas at a constant flow rate of 1 ml/min.

Mayonnaise ingredients

The following ingredients were used in the manufacture of mayonnaise, including whole eggs, sugar, salt, white vinegar, and sunflower oil, with all components sourced from local markets, in addition to the oil extracted from guava seeds.

How to make mayonnaise

The necessary ingredients for manufacturing mayonnaise were provided, including guava seed oil, sunflower oil, whole eggs, table salt, sugar, and vinegar, sourced from the local market in Baghdad. Mayonnaise was prepared according to the method described by Johary et al. (2015) using the ingredients listed in Table (2).

The salt, sugar, vinegar, and water were mixed with the whole eggs at medium speed in a blender for 5 seconds. This mixture is referred to as the aqueous phase. Then, the oil was gradually and continuously added without interruption to avoid emulsion breakage, referred to as the oil phase. Three formulations of guava seed oil were used at different substitution levels: 0.5%, 1.5%, and 2%, in addition to a negative control treatment without any guava seed oil, using the same ingredients listed in Table (3). The samples were then packaged in covered glass containers and stored in the refrigerator at 5°C. Physicochemical analyses were conducted on the samples during storage periods of 10 and 20 days.

Mayonnaise manufacturing

Table (1) Percentage of ingredients used in manufacturing mayonnaise.

Transactions	Water ml	Sugar	Salt	Eggs	vinegar ml	Sunflower oil ml	Guava seed oil
Transaction control T0	4.5	2.5	1.5	10	5	70	**0**
T1 transaction	4.5	2.5	1.5	10	5	69.5	**0.5 %**
T2 Transaction	4.5	2.5	1.5	10	5	68.5	**1.5 %**
T3 Transaction	4.5	2.5	1.5	10	5	68	**2 %**

Source: Fanous, Farah Karim (2022). Fortification of flax oil with black seed oil and studying its effect in prolonging the storage life of laboratory-produced mayonnaise, University of Baghdad, College of Education for Girls, which is part of the requirements for obtaining a master's degree in home economics, p. 34.

Physicochemical tests for mayonnaise

Extracting oil from mayonnaise

The oil was extracted from mayonnaise following the method described by Bligh and Dyer (1959). Twenty grams of mayonnaise were taken and mixed with 20 ml of chloroform, 40 ml of methanol, and 1 ml of distilled water, and stirred for 5 minutes. Then, 20 ml of chloroform was added and mixed for another 5 minutes. The mixture was filtered using glass wool followed by filter paper. The filtrate contained methanol, chloroform, oil, and water. The filtrate was then placed in a separating funnel to separate chloroform from the aqueous layer. The chloroform solvent was evaporated at 40°C under reduced pressure using a rotary evaporator to obtain the oil.

Estimation of free fatty acids (FFA)

The acid value was calculated, and from it, the percentage of free fatty acids was determined according to the method described by Al-Mousawi (1995). Twenty-five millilitres of ethyl ether were mixed with 25 ml of 98% ethyl alcohol and 1 ml of 1% phenolphthalein solution, and accurately neutralized with 0.1% basic solution, then, 10 grams of the sample was placed in the prepared solution, filtered, and the filtrate was titrated with 0.1% potassium hydroxide solution for 15 seconds until a stable pink colour appeared, according to the acid value as follows:

Acid number = number of millilitres of potassium hydroxide x 56.1/weight of sample (g)

Free fatty acids % = acid number /2

Estimation of pH

The pH of the different mayonnaise treatments was measured using a device (P Hmeter) according to the method used by (A.O.A.C 2005).

Estimation of peroxide number

The peroxide value was calculated for the different mayonnaise samples according to the A.O.A.C (2005) method. Five millilitres of mayonnaise were dissolved in 30 ml of solvent consisting of 60% glacial acetic acid and 40% chloroform. Then, 0.5 ml of saturated potassium iodide solution was added and left for 5 minutes with continuous stirring. After that, 30 ml of distilled water and 0.5 ml of 1% starch indicator were added. The solution was then titrated with 0.01 molar sodium thiosulfate solution, vigorously shaking, and then calculating the peroxide value based on the number of equivalents per 1 kilogram of oil according to the following equation:

Peroxide value (ml equivalent/kg oil) N×S=×/1000 g

S = ml of sodium thiosulfate $Na_2S_2O_3$

N = sodium thiosulphate titer

g = number of grams of oil (form)

Estimating the value of thiobarbiturate

The value of Thio barbituric acid was calculated according to the method (Witte et al., 1989) as follows: 1 gram of sample was prepared and added to 25 ml of a solution containing ((20% of trichloroacetic acid TCA)) inside the homogenizing device dissolved in phosphoric acid at a concentration of M2 for 2 minutes, then the mixture was transferred to a 50 ml conical flask and the volume was completed to the final mark using distilled water, then the mixture was mixed and 25 ml were withdrawn from it and the centrifugation process was performed at a speed (3000 rpm) for (30 minutes), after that The mixture was filtered using filter paper No. 1, and 5 ml of the filter was transferred to a test tube with a concentration of 0.005 M and 5 ml of reagent solution (TBA) dissolved in distilled water was added. After mixing the mixture, it was placed in the test tubes, closed tightly, and stored in a dark place for (15-16 hours at room temperature or heated in a water bath for (30 minutes).

A control sample was used without adding Blank (with the same steps mentioned previously, except for the oil addition step, and the absorbance of the resulting colour (A) was measured at a wavelength of 530 nm using a spectrophotometer according to the TBA value by multiplying the absorbance value by the following equation:

TBA value (mg malonaldehyde/kg) = A × 5.2

Sensory calendar

The sensory evaluation of the various mayonnaise treatments was conducted in the Department of Food Science/College of the Agricultural Engineering Sciences/University of Baghdad, by a group of professors and students specialized in this field, according to the sensory evaluation form, which included the characteristics (flavour, aroma, colour, texture, and general acceptability) approved by Al-Jubouri. (2023)) as in Table (2).

Table (2) Sample sensory evaluation questionnaire for mayonnaise.

Adjective	**Model Number**			
	T3	T2	T1	**T0**
Flavour (20)				
Scent (20)				
Colour (20)				
Textures (20)				
General Acceptance (20)				

Source: The Author depends on the information in the article.

Statistical analysis

The statistical program (SAS-Statistical Analyses Systems, (2018)) was used to analyse the data, to study the effect of various factors on the studied characteristics, according to a completely randomized design (CRD), and the significant differences between the means were compared with the least significant difference test (Least Significant Difference_LSD).).

RESULTS AND DISCUSSION

Extracting oil from guava seeds

The extraction process for guava seed oil was carried out using a Soxhlet device. The seeds were placed in a thimble of the Soxhlet device weighing 150 grams, depending on the size of the thimble of guava seeds. After completing the extraction process, 7 ml of pure seed oil was obtained. The amount of extracted material varies, for several factors, the most important of which is the type and varieties of seeds and extraction conditions. The reason for this is the difference in oil contents in different types of plant seeds (Amara et al., 2008).

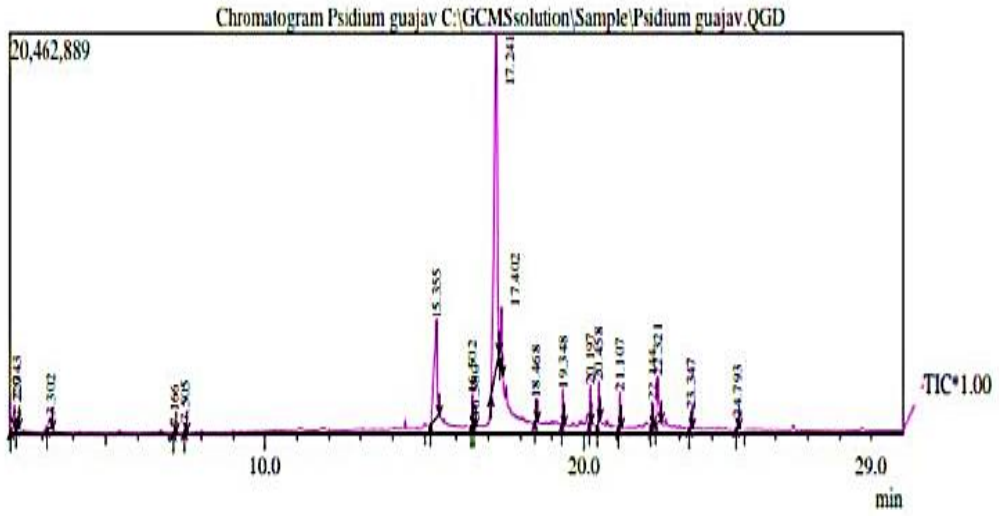
Determination of total fatty acids in guava seed oil extract by Gc-mas

Table (3) shows the percentages of fatty acids found in extracted guava seed oil, such as palmitic, stearic, oleic, linoleic, linolenic, azelaic, and stearic acids. The predominant fatty acids were linoleic and oleic, which is consistent with the findings of Rockenbach et al. (2010), who found that the proportion of unsaturated fatty acids was higher than saturated fatty acids in guava seed oil.

In another study (Leite et al. 2009), it was demonstrated that high levels of unsaturation are significant as they play a crucial role in reducing cholesterol levels in the blood and the treatment of atherosclerosis. One study also indicated that saturated fats found in vegetable oils do not harm humans (Salman, 2018).

Therefore, guava seed oil is considered a good source of food and as a source of the essential fatty acid linoleic. The percentage of unsaturated fatty acids in guava seed oil was 87.06%, while the percentage of saturated fatty acids was 4.48%. The research results indicate that guava seed oil resembles the fatty acid composition found in sunflower seed oil and therefore could be a potential substitute for it.

Figure (1) shows the standard curve for fatty acids in guava seed oil extract.



Source: Republic of Iraq, Ministry of Environment. (2023). Department of Environment and Water, Environmental Research Center Esam, GCMS Analysis Results, p.4.

Table 3: Determination of total fatty acids in guava seed oil extract by GC

Fatty acids	**R. Time**	**Area%**
Pentadecanoic acid	2.043	**0.99**
9- Octadecanoic acid	3.302	**1.75**
Oxalic acid	7.166	**0.27**
Linolenic acid	7.505	**0.45**

Oleic acid	15.355	**16.02**
Acetic acid	16.502	**1.44**
Arachidic acid	16.580	**0.34**
Linoleic acid	17.241	**58.00**
Palmitic acid	17.402	**3.80**
Stearic acid	18.468	**1.18**
Tridecanoic acid	19.348	**1.60**
Eicosanoic acid	20.197	**1.71**
Tetradecanoic acid	20.458	**2.06**
Pentafluoro propionic acid	21.107	**1.84**
cis-5-Dodecenoic acid	22.144	**1.40**
17-Octadecanoic acid	22.321	**4.72**
Cyclopentane undecanoic acid	23.347	**1.13**
Hexadecenoic acid	24.793	**0.74**

Source: Fanous, Farah Karim (2022). Fortification of flax oil with black seed oil and studying its effect in prolonging the storage life of laboratory-produced mayonnaise, University of Baghdad, College of Education for Girls, which is part of the requirements for obtaining a master's degree in home economics, p. 36.

Detection of active compounds in guava seed oil extract by gas chromatography (GC). The active compounds in guava seed oil extract were identified and characterized using Gas Chromatography (GC), following the method outlined by (Jalill, 2014). The contribution of each compound was determined by its relative area (%) of the peak in the chromatogram obtained, represented by the peaks shown in Figure (2). These peaks were compared with those appearing in the standard curve of active compounds by calculating the area under the curve for each compound. Subsequently, the percentage contribution of each compound was calculated, as shown in Table (4), which presents the active compounds along with their partial formula, retention time, relative area percentage, and molecular weight.

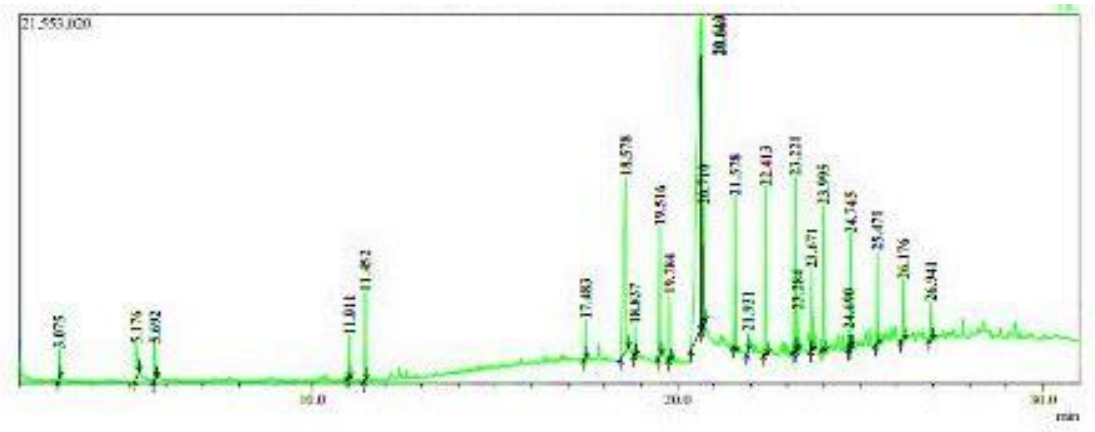
Table (4) Identification of active compounds in guava seed oil using gas chromatography-mass (GCMAS) technique.

Comp Name	Chemical formula	R. Time	Area%	Mol Weight
Hexanal	C6H12O	3.075	0.57	**100**
Dimethyl. l Sulfoxide	C2H6OS	11.010	1.39	**78**
2-Heptenal (E)-	C7H12O	5.692	0.93	**112**
2,4-Dodecadienal, (E, E)-	C12H2O2	11.011	0.91	**180**
2,4-Dodecadienal, (E, E)-	C16H32O2	11.452	1.97	
n-Nonadecanol-l	C19H40O	17.483	0.89	**284**
n-Hexadecanoic acid	C16H32O2	18.578	11.11	**256**
Heneicosane	C21H44	18.837	1.46	**296**
1-(Piperidin-2-ylmethyl) piperidine	C11H22N2	20.613	32.57	**182**

9,12-Octadecadienoic acid (Z, Z)-	C18H32O22	0.669	11.45	**280**
2-Methylhexacosane	C27H56	20.710	5.05	**380**
Tetracosane	C4H82	26.176	1.55	**562**
Glycidyl palmitate	C19H36O	21.578	3.05	**216**
Pentacosane	C25H52	22.413	4.26	**352**
Tetracosane		23.221	4.75	**562**
9,12-Octadecadienoic acid (Z, Z)-, 2,3-dihy	C21H38O4	23.284	1.01	**354**
9,12-Octadecadienoic acid (Z, Z)-, 2-hydro	C21H38O4	23.671	3. 60	**354**
Tetracosane	C4H82	23.995	2.90	**562**
Tetracosane	C4H82	24.754	2.39	**562**
Tetracosane	C4H82	25.471	2.39	**562**
Tetracosane	C4H82	26.176	1.55	**562**
Dotricontane	C32H66	26.941	1.11	**450**

Source: Fanous, Farah Karim (2022). Fortification of flax oil with black seed oil and studying its effect in prolonging the storage life of laboratory-produced mayonnaise, University of Baghdad, College of Education for Girls, which is part of the requirements for obtaining a master's degree in home economics, p. 40.

Figure (2) Standard curve for active chemical compounds in the guava seed oil extract



Source: Republic of Iraq, Ministry of Environment. (2023). Department of Environment and Water, Environmental Research Center Esam, GCMS Analysis Results, p.7.

Estimation of free fatty acids (FFA).

The content of free fatty acids (FFA) is one of the most important components in the refining of vegetable oils. FFAs can act as oxidizing agents in oils by accelerating the rate of hydroperoxide breakdown. Consequently, a high content of free fatty acids in oil may lead to increased oxidation, resulting in the formation of undesirable flavours and odours, thus affecting the quality and shelf life of the product (Garcia et al., 2021).

By observing the results in the statistical table (Table 5), significant differences are evident between the control treatment (T0) and the other treatments. The FFA values for T1, T2, and T3 were 0.875, 0.643, and 0.561, respectively, after 10 days of storage, while after 20 days of storage, they were 1.594, 1.372, and 1.122 for T1, T2, and T3, respectively. The decrease in free fatty acid

content indicates the quality of the oil and suggests hydrolytic degradation of triglycerides in vegetable oils (Vatansever et al., 2000).

Table (5): The effect of adding guava seed oil on estimating the percentage of free fatty acids (FFA) for different mayonnaise treatments during the storage period of 10 and 20 days at a temperature of 5) ±1°C.

FFA		
Storage duration (days)		**Transaction**
20	10	
1.683	0.841	**(T0) Transaction control**
1.594	0.875	**T (1) Mayonnaise + Guava Seed Oil 0.5%**
1.372	0.643	**(T2) mayonnaise + guava seed oil 1.5%**
1.122	0.561	**(T3) mayonnaise + guava seed oil 2%**
0.397*	0.269*	**LSD value**
***(P≤0.05)**		

Source: Fanous, Farah Karim (2022). Fortification of flax oil with black seed oil and studying its effect in prolonging the storage life of laboratory-produced mayonnaise, University of Baghdad, College of Education for Girls, which is part of the requirements for obtaining a master's degree in home economics, p. 47.

Estimation of pH

Table 6 presents the pH values for different mayonnaise treatments, where after 10 days of refrigerated storage, the pH value for the control treatment (T0) was 4.16, while the pH values for the other treatments, T1, T2, and T3, were 4.13, 4.09, and 4.02, respectively. Statistical analysis results indicate no significant differences between the various mayonnaise treatments after 10 days of storage. These findings align with a study conducted by Instituto Adolfo Lutz (2008), which indicated that pH values for some mayonnaise samples ranged between 4.0 and 4.6. However, during storage, a decrease in pH values was observed for all treatments, with pH values after 20 days being 4.2 for the control treatment (T0) and 4.03, 4.02, and 4.00 for treatments T1, T2, and T3, respectively.

The results indicate that the pH values for treatments supplemented with guava seed oil were slightly higher than those for the control treatment (T0). This slight increase can be attributed to the strong antioxidant effectiveness present in guava seed oil, which is consistent with a study by Johary et al. (2015), which found that pH values for mayonnaise did not exceed 4.1.

Table (6): The effect of adding guava seed oil on the pH values of the different mayonnaise treatments during the storage period of 10 and 20 days at a temperature of 5 ± 1 °C.

PH
Storage duration (days)

20	10	Transaction
4.2	4.16	**T0** **Transaction control**
4.03	4.13	**T1** **Mayonnaise + Guava Seed Oil 0.5%**
4.02	4.09	**T2** **mayonnaise + guava seed oil 1.5%**
4.00	4.02	**T3** **mayonnaise + guava seed oil 2%**
0.329 NS	0.207 NS	**LSD**
NS: Non-Significant		

Source: the author based on previous data in: Fanous, Farah Karim (2022). Fortification of flax oil with black seed oil and studying its effect in prolonging the storage life of laboratory-produced mayonnaise, University of Baghdad, College of Education for Girls, which is part of the requirements for obtaining a master's degree in home economics, p. 40.

Estimation of peroxide number (PV).

Table 7 illustrates the peroxide value (PV) of various mayonnaise treatments over different storage periods at a refrigerator temperature of (5) ± (1)°C. After 10 days of storage, the results for the control treatment (T0) showed a PV of 8.0, while for the other treatments, T1, T2, and T3, the PV values were 7.12, 5.41, and 5.12, respectively. Statistical analysis results indicate significant differences between the different mayonnaise treatments at a significance level of *(P≤0.05). These values gradually increased after 20 days of storage, reaching 8.75 for the control treatment (T0) and 7.57, 5.58, and 5.45 for treatments T1, T2, and T3, respectively.

The statistical analysis results show significant differences between all mayonnaise treatments and the control treatment (T0) after 20 days of storage at a significance level of *(P≤0.05). It is noteworthy that treatment T3, which included 2% guava seed oil extract, demonstrated superiority over all other mayonnaise treatments in maintaining the peroxide value within acceptable limits until the end of the storage period. Guava seed oil is known for its potent antioxidant properties, effectively inhibiting free radicals, which prolongs product shelf life, as supported by research by Jumaa and Ghazal (2011).

The peroxide value is a measure of the amount of peroxide in 1 kilogram of oil or fat, indicating the degree of oil deterioration during storage. International standards prohibit an increase in peroxide value for oils used in food, with a maximum limit of 20 milliequivalents per kilogram of oil (Nicto et al., 2011). The peroxide value is considered an important criterion for determining oil quality, as it indicates the oil's suitability and resistance to rancidity, which depends on the quantity of antioxidants present in the oil, expressed as a percentage. Thus, the stability of mayonnaise made with guava seed oil indicates its antioxidant content (Almoselhy, 2020).

Table (7) Effect of adding guava seed oil on the peroxide number (POV) values for different mayonnaise treatments during the storage period of 10 and 20 days at a temperature of (5±1)°C.

POV values (mE/kg fat)	
Storage duration (days)	

20	10	**Transaction**
8.75	8.0	**T0** **Transaction control**
7.57	7.12	**T1** **Mayonnaise + Guava Seed Oil 0.5%**
5.58	5.41	**T2** **mayonnaise + guava seed oil 1.5%**
5.45	5.12	**T3** **mayonnaise + guava seed oil 2%**
2.067*	1.964*	**LSD**
***(P≤0.05).**		

Source: Author based on previous data: Fanous, Farah Karim (2022). Fortification of flax oil with black seed oil and studying its effect in prolonging the storage life of laboratory-produced mayonnaise, University of Baghdad, College of Education for Girls, which is part of the requirements for obtaining a master's degree in home economics, p. 45.

Determination of thiobarbituric acid (TBA)

Table 8 presents the results of the thiobarbituric acid (TBA) test for the manufactured mayonnaise samples over 10 and 20 days of storage at a refrigerator temperature of (5±1)°C. The first period was examined after 10 days of production, yielding results of 0.384 for the control treatment (T0) and 0.372, 0.369, and 0.358 milligrams of malondialdehyde per kilogram of fat for treatments T1, T2, and T3, respectively. Statistical analysis results indicate no significant differences in all different mayonnaise treatments compared to the control treatment (T0). These values increased further after 20 days of storage, reaching 0.426 for the control treatment (T0) and 0.416, 0.405, and 0.391 milligrams of malondialdehyde per kilogram of fat for the other treatments, respectively.

All treatments maintained the Thio barbituric acid value within acceptable limits compared to the control treatment (T0) throughout the storage period. Treatment T3, which included a 2% concentration of guava seed oil extract, demonstrated superiority over all other mayonnaise treatments in maintaining the Thio barbituric acid value within the allowed limits until the end of the storage period. This can be attributed to the presence of natural antioxidants in guava seed oil, which preserve oils from oxidation and reduce rancidity. These antioxidants react quickly with peroxide radicals by donating a hydrogen atom from the hydroxyl group, like the action of tocopherols. Generally, this test is conducted on foods containing high concentrations of unsaturated fatty acids sensitive to fat oxidation, as increased levels can lead to loss or alteration of taste, odour, and structural properties of mayonnaise. To prevent oxidation, mayonnaise is stored under refrigerated conditions (Abu-Salem and Abou-Arab, 2008).

Table (8) Effect of adding guava seed oil on Thio barbituric acid (TBA) values for different mayonnaise treatments during the storage period of 10 and 20 days at a temperature of (5±1) °C.

TBA	
Storage duration (days)	

20	10	**Transaction**
0.426	0.384	**T0** **Transaction control**
0.416	0.372	**T1** **Mayonnaise + Guava Seed Oil 0.5%**
0.405	0.369	**T2** **mayonnaise + guava seed oil 1.5%**
0.391	0.358	**T3** **mayonnaise + guava seed oil 2%**
0.066 NS	0.075 NS	**LSD**
NS: Non-Significant.		

Source: Author based on previous data.

Sensory calendar

Table 9 illustrates the sensory evaluation results for different mayonnaise treatments, including attributes such as flavour, aroma, colour, texture, and overall acceptance, by a group of food science specialists. The results showed significant differences at the (P≤0.05) level among the different mayonnaise treatments in the scores given for the colour attribute. Treatment T3 surpassed the control treatment (T0) in all sensory attributes, including colour, followed by treatments T1 and T2 with a significant difference in colour evaluation scores, respectively. Regarding the aroma attribute, significant differences were observed at the (P≤0.05) level among the different mayonnaise treatments compared to the control treatment (T0).

Treatment T3 obtained the highest scores for aroma, followed by treatments T1 and T2, respectively. The results also indicated significant differences at the (P≤0.05) level among the different treatments for mayonnaise regarding the scores obtained for flavour and texture attributes, with treatment T3 obtaining the highest scores compared to the control treatment (T0), followed by treatments T1 and T2. After 10 days of storage, treatment T3 also showed significant differences in all sensory attributes compared to the control treatment (T0), with treatment T3 outperforming the control treatment (T0) and all other treatments (T1 and T2) in the sensory evaluation scores. This was reflected in the overall acceptance attribute, indicating higher overall acceptance among the evaluators compared to the control treatment (T0), consistent with the findings of Khojah (2016).

Table (9) Effect of adding guava seed oil on the sensory characteristics of different mayonnaise treatments during the storage period of 10 and 20 days at a temperature of (5±1)°C.

Sensory characteristics							
Total (100)	General Acceptance	Textures (20)	Colour (20)	Scent (20)	Flavour (20)	Storage duration (days)	**Model Number**

	(20)						
89	17	17	18	18	19	10	**T 0**
79	15	16	16	16	16	20	
95	19	18	19	19	20	10	**T 1**
90	18	18	18	18	18	20	
97	19	19	19	20	20	10	**T 2**
91	18	18	18	19	18	20	
99	20	19	20	20	20	10	**T 3**
93	18	19	19	19	18	20	
6.85 *	3.02 *	2.56 *	2.72 *	2.69 *	2.87 *	**LSD value**	
***(P≤0.05)**							

Source: Author based on data: Chromatogram psidiun juajava C:\GCMSsolution\Data\Project1\psidiun juajava.QGD

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