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Effect of addition essential oils and partial substituting of sugar with stevia leaves aqueous extract on the quality of both mango and strawberry jam during storage

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Abstract

In this study, the effects of incorporating essential oils from natural herbs, specifically cloves (*Syzygium aromaticum* L.) and cinnamon (*Cinnamomum zeylanicum*) oils, as well as substituting sugar with an aqueous extract of stevia (*Stevia rebaudiana* Bertoni) leaves, on the chemical, physical, microbiological, and sensory characteristics of mango (*Mangifera indica* L.) and strawberry (*Fragaria ananassa*) jam during a 6-month storage period at room temperature (25ºC±5ºC) were investigated. The objective was to assess the potential impact of these additives on the jam's quality and shelf life. The findings revealed that the incorporation of cloves, cinnamon essential oils, and stevia leaves' aqueous extract led to a significant increase in the ash content and ascorbic acid levels of the jam. Interestingly, the sensory attributes of the mango and strawberry jam remained unaffected by the addition of essential oils. Furthermore, the utilization of these additives resulted in an extension of the jam's shelf life. Based on the results, it is recommended to incorporate cloves and cinnamon oils at a concentration of 0.5 ml per kilogram of jam and replace 50% of the sugar content with the aqueous extract of stevia leaves in both mango and strawberry jam formulations. This formulation adjustment offers the potential to enhance the jam's shelf life without compromising its sensory characteristics.

Keywords: essential oils, clove oil, cinnamon oil, mango, strawberry, jam, stevia leaves extract.

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1. Introduction

Fruits and vegetables are abundant sources of bioactive compounds that exhibit various health-promoting effects in addition to essential vitamins and minerals (Singh *et al.*, 2016). Numerous studies have demonstrated the consumption of fruits and vegetables to be beneficial in reducing the incidence of cardiovascular diseases, cerebrovascular diseases, and tumors, which can be attributed to the antioxidant properties of active substances present in these foods. Notable antioxidants found in fruits include phenolic metabolites, carotenoids, and vitamin C (Silalahi, 2002; Pandey and Rizvi, 2009). However, a considerable percentage of post-harvest losses, approximately 22%, occur in fruits and vegetables (Bons and Dhawan, 2006). To mitigate these losses, preservation techniques and the use of preservatives are employed. Among various fruit preserves, jam, prepared by boiling fruit pulp with sugar (sucrose), pectin, acid, and additional ingredients such as preservatives, coloring agents, and flavoring materials, stands as one of the most popular (Basu *et al.*, 2011). Mango (*Mangifera indica* L.) from the Anacardiaceae family is extensively utilized due to its distinctive taste, attractive color, appealing flavor, affordability, and nutritional qualities. Mango is rich in vitamins, organic acids, carbohydrates, amino acids, phenolic acids (e.g., gallic acid, caffeic acid, tannic acid), and various volatile compounds (Pino *et al.*, 2005). The presence of phenolic acids in mango contributes to its pharmacological properties, owing to their potent antioxidant activity that plays a crucial role in human nutrition (Chiou *et al.*, 2007). Mango pulp is commonly utilized in the production of beverages, sweets, and dairy products, while partially processed mango serves as an industrial raw material used year-round for the production of nectar and other beverages (Sakhale *et al.*, 2012). Strawberry (*Fragaria ananassa*), a herbaceous perennial belonging to the family Rosaceae, is cultivated in numerous countries worldwide. The fruit is firm, possesses red flesh, and has a sweet taste. Glucose accounts for more than 50% of the sucrose content in strawberries. The fruit primarily contains citric acid along with trace amounts of malic acid. The red coloration of strawberries is attributed to the presence of anthocyanin pigments. Various volatile esters responsible for the fruit's flavor are also present (Khan *et al.*, 2012). Strawberry consumption has gained popularity in Pakistan and is largely imported from Western countries. It is considered a non-climatic fruit and is frequently consumed due to its low-calorie carbohydrate content, as well as its potential as a source of vitamin C and dietary fibers, surpassing the vitamin C content of oranges. The nutritional composition of strawberries includes vitamin C (64.0 mg), water (91.75 g), protein (0.61 g), fat (0.37 g), carbohydrates (7.02 g), fiber (2.3 g),

calcium (14.0 mg), potassium (166.0 mg/160 g), and vitamin A (27 IU) (Khan *et al*., 2012). Essential oils are complex and volatile compounds that constitute secondary metabolites in plants (Bakkali et al., 2008). These oils have molecular weights ranging from 50 to 200 Da and can be classified into four major chemical groups: terpenes, terpenoids, polypropenes, and other aromatic compounds. Plants possessing intense odors and aromas tend to have high concentrations of essential oils, which can be extracted from different plant parts, including buds, flowers, leaves, stems, branches, seeds, fruits, roots, and bark (Lee and Ding, 2016). Cinnamon-treated food commodities have an extended shelf life (post-harvest life) due to the presence of phenolic compounds in cinnamon oil. However, it has been observed that phenolic compounds can undergo degradation, leading to undesirable odor and color changes, which restrict the applications of cinnamon oil (Cadena *et al*., 2018; De Souza *et al*., 2018; Ghaderi *et al*., 2017; Lu *et al*., 2010; Ostroschi et al., 2018;). Clove (*Syzygium aromaticum* L.) essential oil, obtained from the dried floral buds of the clove tree, exhibits antimicrobial and antioxidant activities attributed to the presence of eugenol and other phenolic compounds. It acts as a bactericide against several significant foodborne pathogens, including *Staphylococcus aureus*, *Escherichia coli*, *Listeria monocytogenes*, and *Salmonella typhimurium*, and possesses anti-free radical and metal chelating properties (Chaieb *et al*., 2007). The objective of this study is to assess the impact of essential oils, such as cinnamon (*Cinnamomum zeylanicum*) oil and cloves (*Syzygium aromaticum* L.) oil, as well as the aqueous extract of stevia leaves, on the physicochemical components and microbial activity of mango (*Mangifera indica* L.) and strawberry (*Fragaria ananassa*) jam during a storage period of 180 days at room temperature (25 ± 4 °C).

2. Materials and methods

2.1 Materials

2.1.1 Collecting of fruits

This study was carried out on tow fruit varieties. Mango *(Mangifera indica L.)*, Strawberry (*Fragaria ananassa*), Fruit samples were obtained from Tanta local market, Egypt. Studied fruit samples were collected during the 2020 season.

2.1.2 Stevia leaves

Stevia leaves *(Stevia rebaudiana Bertoni)*. Were obtained from sugar crops Institute Agriculture Research center, Giza, Egypt.

2.1.3 Natural herbs

Cinnamon (*Cinnamomum zeylanicum*) oil and cloves (*Syzygium aromaticum* L.) oil were obtained from Sugar Crops Institute, Agriculture Research Center,

Giza, Egypt.

2.1.4 Chemical and reagents

All chemicals and reagents used in analytical methods were obtained from El-Gomhouria Trading Chemicals and Drugs, Assiut city, Egypt.

2.2 Methods

2.2.1 Preparing of Stevia leaves aqueous extract

Stevia leaves aqueous extract was prepared according to Abou-Arab *et al* (2010) as follows: Stevioside were extracted from the dried ground leaves of stevia plant by using water extraction. The dried ground leaves of stevia were mixed with hot water (65°C) at the ratio of 1:45 (w/v). The mixture was kept at room temperature for 24 h, after properly shaking. It was stirred 2-3 times a day. Then the mixture was filtered through Whatman No. 1 filter paper after 24 h.

2.2.2 Evaluation of Stevia leaves aqueous extract sweetness equivalent

After preparation of stevia leaves powder and stevia leaves aqueous extract, their sweetening power were sensory evaluated according to Savita *et al.* (2004), since it clear that 1g of stevia leaves powder was equivalent to the sweetness of 20g sugar while 0.9 ml of the aqueous extract was equivalent to the sweetness of 1g sugar. So, in preparation of jam, the sugar was replaced by its equivalent in sweetness from stevia leaves aqueous extract.

2.2.3 Jam preparation

The jams were prepared according to the Egyptian Standard Specification 129-2/2013, Codex 296/2009. The mango was peeled very carefully with a clean sharp knife and cut into four halves and the central seed has been removed. Then it is stirred in a blender. The pulp of the fruit was clear. It is obtained by squeezing the pulp of the fruit through a muslin cloth. Strawberry stems removed by hand and cut into small pieces after removing the neck and leaves. Ripe fruits used to make jam: mango and strawberry fruits Smooth fruit pieces in a blender. Then the fruit pulp was mixed differently Jam making ratio. Mix all ingredients together and keep some time for completely dissolving of sugar. Cook it on a low fire and stir continuously with a ladle. Determine the end point using refractmeter method. When the jam is done, remove from the fire and pour in to sterilized bottle. Close the mouth of the bottle and storage at room temperature (25C°±5C°) up to 6 months. In preparing a low-calorie jam for diabetics, stevia leaf extract was used instead of sugar.

2.3 Analytical methods

2.3.1 Chemical composition

The moisture, ash, total and reducing sugars content of jam samples were

determined according to AOAC (2005). Non-reducing sugars were calculated by difference.

2.3.2 pH value

pH of the prepared sample was measured using a pH meter (OAKTON, pH/ mV/°C meter, USA) with a glass electrode at 20ºC according to the method described by A.O.A.C (1995).

2.3.3 Total soluble solids (TSS)

Total soluble solids (TSS) were determined by measuring the refractive index with a hand refractmeter at 20oC as described by Larrigaudiere *et al.* (2002).

2.3.4 Acidity (%)

Acidity was determined as citric acid by titration, according to Dalaly and Al-Hakiem, (1987).

2.3.5 Determination of ascorbic acid or vitamin C

Ascorbic acid using the iodine method was determined according to Elkashif *et al.* (2016).

2.3.6 Determination of stevia leaves aqueous extract sweetness

The sweetness of stevia leaves aqueous extract was determined according to Savita *et al.* (2004).

2.3.7 Microbiological analysis

The enumeration of total bacterial counts was performed utilizing the plate counts technique on a nutrient agar medium, following the protocols outlined in the A.P.H.A (1976) and Difco-Manual (1984). The inoculated plates were incubated at a temperature of 37°C for a duration of 48 hours. Similarly, yeast and mold counts were determined employing the plate counts technique on potato dextrose agar (PDA) as prescribed by the A.P.H.A (1976) and Difco-Manual (1984) guidelines. The incubation of these plates occurred at temperatures ranging from 25 to 28 ºC for a period of 3 to 5 days, dependent on the fungal species under investigation.

2.3.8 Sensory evaluation

Samples of jam and fruit lather were subjected to sensory assessment immediately after production and subsequently during a 6-month storage period at ambient conditions (25 ºC±5ºC). The evaluation was conducted with the assistance of ten panelists, comprising individuals from the staff and graduate students associated with the Food Science and Technology Department at the Faculty of Agriculture, Al-Azhar University, located in Assiut, Egypt. The panelists were responsible for assigning scores to assess distinct quality attributes, namely color, taste, and odor. The assessment method employed in this study followed the protocol outlined by Molander (1960).

2.3.9 Statistical analysis

The experimental procedure was replicated three times for each of the samples, ensuring the reliability of the obtained data. Mean values were calculated and presented as the outcome of the analysis. To examine the statistical significance of the results, a three-way analysis of variance (ANOVA) was conducted, utilizing the statistical software for Windows version 8.1. Additionally, Duncan multiple range tests were carried out at a significance level of $p \leq 0.05$ to ascertain any significant differences among the observed variables.

Table (1): Processors: Essential oils (cinnamon oil, cloves oil, stevia leaf aqueous extract) were added to mango, strawberry jam (per kg).

Treatments		Strawberry pulp (g)	Mango pulp (g)	Citric acid (g)	Pectin (g)	Cloves oil (ml)	Cinnamon oil (ml)	Stevia (g)	Sugar (g)
Mango jam	Control	-	900	8	10	-	-	-	1200
	Cinnamon oil	-	900	8	10	-	1.2	-	1200
	Cloves oil	-	900	8	10	1.2	-	-	1200
	Cinnamon oil + SLAE	-	900	8	10	-	0.55	60	600
	Cloves oil + SLAE	-	900	8	10	0.55	-	60	600
Strawberry jam	Control	900	-	8	10	-	-	-	1200
	Cinnamon oil	900	-	8	10	-	1.2	-	1200
	Cloves oil	900	-	8	10	1.2	-	-	1200
	Cinnamon oil + SLAE	900	-	8	10	-	0.55	60	600
	Cloves oil + SLAE	900	-	8	10	0.55	-	60	600

SLAE = Stevia leaves aqueous extract.

3. Results and Discussion

3.1 Chemical composition of mango and strawberry jam during storage at 25ºC±5ºC for 6 months

Data in the Table (2) illustrated that, moisture, ash, total sugar, reducing and non-reducing sugar of mango jams treated by cinnamon oil, cloves oil (0.5ml v/w) and stevia leaves aqueous extract (50%) substituted with sugar. From the data obtained in Table (2) it could be stated that, moisture content of mango jam slightly decreases with increasing of storage period. On the other hand ash content of mango jam slightly increase with increasing of storage period its ranged between 0.30 to 0.33% at zero time but at the end of storage period ranged between 0.36 to 0.43%, while total sugar content of mango jam ranged between 58.61 to 68.45 at zero time while, at the end of storage period it ranged from 37.15 to 42.85 , on the other side reducing sugar content of mango jam was increase by increment of storage period. From the same table it could be noticed that the same tread was observed with strawberry jam, moisture content of strawberry jam was decrease during of storage period, while ash content was increase during of storage period, its ranged between 0.31 to 0.66% at zero time but at the end of storage period it ranged between 0.37 to 0.71%. From the same table it could be found that, total sugar content of strawberry jam ranged

from 64.73 to 68.59 at zero time, but after storage period it ranged between 30.93 to 51.58. On the other hand, reducing sugar content slightly increase during storage period. Decrement of moisture content during storage period may be due to slow evaporation of moisture (Sultana *et al.*, 2020). the increment in ash contents of all samples during storage period might be due to alteration of moisture. Similar results were obtained by Hussain *et al.* (2014). Roy *et al.*, (2019) reported that, moisture loss was associated with progressive increase in other components. The slightly decrease in total sugars percent during storage might be due to the inversion of sugars to monosaccharide by acid hydrolysis (Hafid *et al.*, 2017), The increment in reducing sugars during storage might be due to inversion of non-reducing sugars to reducing sugars and conversion of polysaccharides to monosaccharide (Sharma *et al.*, 2013).

Table (2): Effect of addition cinnamon oil, cloves oil (0.5ml v/w) and stevia leaves aqueous extract (50%) substituted with sugar on moisture, ash, total sugar, reducing sugar and non-reducing sugar of mango and strawberry jam during storage at 25ºC±5ºC for 6 months.

Treatments		Moisture		Ash		Total sugar		Reducing sugar	
		Storage period (days)							
		0	180	0	180	0	180	0	180
Mango jam	Control	56.20 ±0.07^{Aa}	23.71 ±0.22^{Dg}	0.33±0.005^{Ae}	0.43±0.005^{Aa}	64.79±0.30^{Bb}	40.66±0.35^{Bk}	10.13±0.05^{Af}	25.30±0.15^{Aa}
	Cinnamon oil	46.08 ±0.30^{Ea}	27.45 ±0.35^{Bl}	0.30±0.005^{Bd}	0.36± 0.005^{Da}	68.45±0.35^{Aa}	42.85±0.27^{Al}	6.44±0.16^{Df}	22.79±0.07^{Bb}
	Cloves oil	46.98 ±0.18^{Da}	22.90 ±0.49^{Bl}	0.33±0.005^{Ae}	0.39± 0.005^{Ba}	68.44±0.26^{Aa}	37.15±0.37^{Dg}	4.44±0.06^{Ef}	17.05±0.10^{Eb}
	Cinnamon oil + SLAE	49.46 ±0.30^{BGa}	25.33 ±0.27^{Cg}	0.32±0.005^{Abe}	0.38± 0.000^{Ca}	58.61±0.47^{Db}	42.33±0.52^{Ad}	7.53±0.08^{Cd}	18.02±0.10^{Dc}
	Cloves oil + SLAE	53.57 ±0.10^{Ba}	28.53 ±0.15^{Al}	0.33±0.020^{Af}	0.39± 0.005^{Ba}	59.23±0.18^{Ca}	38.41±0.35^{Cg}	9.41±0.04^{Bd}	21.98±0.06^{Ca}
Strawberry jam	Control	45.74 ±0.51^{Da}	25.07±0.07^{Dg}	0.31± .035^{Bl}	0.37±0.000^{Ca}	64.73±0.56^{Ba}	46.05±0.35^{Bk}	27.14±0.08^{Cc}	31.40±0.18^{Ba}
	Cinnamon oil	47.34 ±0.25^{Ca}	28.56±0.43^{Ae}	0.31± 0.011^{Bl}	0.37±0.005^{Ca}	68.29±0.44^{Aa}	30.93±0.25^{Bk}	13.06±0.09^{Ee}	24.95±0.20^{Db}
	Cloves oil	56.22 ±0.07^{Aa}	27.68±0.07^{Bg}	0.33±0 .026^{Be}	0.39±0.000^{Ba}	68.59±0.35^{Aa}	51.58±0.14^{Al}	29.63±0.09^{Bc}	36.46±0.20^{Aa}
	Cinnamon oil + SLAE	48.40 ±0.33^{Ba}	26.82±0.24^{Cg}	0.31±0 .015^{Bl}	0.37±0.005^{Ca}	68.29±0.35^{Aa}	36.40±0.35^{Dk}	18.66±0.08^{De}	28.12±0.15^{Cb}
	Cloves oil + SLAE	47.41 ±0.31^{Ca}	27.25±0.21^{BT}	0.66±0 .011^{Ae}	0.71±0.005^{Aa}	68.41±0.38^{Aa}	44.25±0.35^{Cg}	34.83±0.11^{Aa}	31.45±0.20^{Bb}

SLAE = Stevia leaves aqueous extract Means within a same column with different superscript capital letters are significantly different ($p \leqslant 0.05$); means within a same row with different superscript small letters are significantly different ($p \leqslant 0.05$).

3.2 pH value of mango and strawberry jam during storage at 25ºC±5ºC for 6 months

Data given in Table (3) illustrated pH values of different mango and strawberry jam samples prepared by the additions of cinnamon oil, cloves oil (0.5ml v/w) and stevia leaves aqueous extract (50%) substituted with sugar during storage period at 25Cº±5Cº up to 6 months. From statistical analysis of these results, it could be noticed that there were no significant differences ($P<0.05$) in pH values between different mango jam treatments and control sample except mango jam containing cinnamon oil and stevia leaves aqueous extract at zero time. The highest pH value for mango jam (4.96) was recorded for mango jam treated by cinnamon oil and stevia leaves aqueous extract, followed by (4.93) for mango jam containing cloves oil and stevia leaves aqueous extract. Meanwhile, the lowest pH value (4.80) was recorded for mango jam containing cinnamon oil and control sample at zero

time. At the end of storage period there were significant differences (P<0.05) in pH values between control sample and other treatments. The highest pH value (4.00) was recorded for mango jam treated by cloves oil and stevia leaves aqueous extract, followed by (3.90, 3.80) and (3.60) for mango jam containing cinnamon oil and stevia leaves aqueous extract, cloves oil and cinnamon oil, respectively. Meanwhile, the lowest pH value (3.40) was recorded for control sample. On the other hand, data revealed that, there were no significant differences (P<0.05) in pH values between strawberry jam treatments and control sample it was ranged from (4.36 to 4.50) compared with control sample (4.40) at zero time. But, at the end of storage period there were no significant differences (P<0.05) in pH values between control sample and all strawberry jam treatments except strawberry jam containing cloves oil and stevia leaves aqueous extract pH values ranged from (3.30 to 3.50), while control sample was (3.30). These decrement in pH values of jam samples during storage period proportional to the increasing in acidity has been confirmed by several researchers and may be attributed to the presence of citric acid in the jam samples (Bajwa *et al.*, 2003; Hussain *et al.*, 2008).

Table (3): Effect of addition cinnamon, cloves oils (0.5ml v/w) and stevia leaves aqueous extract (50%) substitute with sugar on PH value of mango and strawberry jam during storage at 25Cº±5ºC for 6 months.

Treatments		Storage Periods (months)						
		0	1	2	3	4	5	6
Mango jam	Control	4.80 ± 0.10^{Ba}	4.70 ± 0.10^{Bab}	4.50 ± 0.30^{Abc}	4.30 ± 0.10^{Cc}	3.90 ± 0.10^{Cd}	3.60 ± 0.10^{Ce}	3.40 ± 0.10^{De}
	Cinnamon oil	4.80 ± 0.10^{Ba}	4.80 ± 0.10^{Aba}	4.60 ± 0.20^{Aab}	4.46 ± 0.15^{BCb}	4.10 ± 0.10^{Bc}	3.80 ± 0.10^{Bd}	3.60 ± 0.10^{Cd}
	Cloves oil	4.86 ± 0.05^{ABa}	4.80 ± 0.10^{Aba}	4.70 ± 0.30^{Aa}	4.60 ± 0.10^{ABa}	4.20 ± 0.10^{Bb}	3.90 ± 0.10^{Bc}	3.80 ± 0.10^{Bc}
	Cinnamon oil + SLAE	4.96 ± 0.05^{Aa}	4.90 ± 0.10^{Aa}	4.60 ± 0.20^{Ab}	4.50 ± 0.20^{BCb}	4.40 ± 0.10^{Abc}	4.20 ± 0.10^{Ac}	3.90 ± 0.10^{ABd}
	Cloves oil + SLAE	4.93 ± 0.05^{ABa}	4.90 ± 0.10^{Aa}	4.80 ± 0.30^{Aa}	4.80 ± 0.10^{Aa}	4.40 ± 0.10^{Ab}	4.20 ± 0.10^{Abc}	4.00 ± 0.10^{Ac}
Strawberry jam	Control	4.40 ± 0.10^{Aa}	4.30 ± 0.10^{Aa}	4.20 ± 0.20^{Aab}	4.00 ± 0.20^{ABbc}	3.80 ± 0.10^{Ac}	3.50 ± 0.10^{Bd}	3.30 ± 0.10^{Bd}
	Cinnamon oil	4.36 ± 0.15^{Aa}	4.30 ± 0.10^{Aa}	4.00 ± 0.20^{Ab}	3.90 ± 0.20^{Bb}	3.80 ± 0.10^{Abc}	3.60 ± 0.10^{ABc}	3.30 ± 0.10^{Bd}
	Cloves oil	4.50 ± 0.10^{Aa}	4.40 ± 0.30^{Aa}	4.30 ± 0.30^{Aa}	4.20 ± 0.10^{Aa}	3.80 ± 0.10^{Ab}	3.50 ± 0.10^{Bbc}	3.30 ± 0.10^{Bc}
	Cinnamon oil + SLAE	4.43 ± 0.11^{Aa}	4.40 ± 0.10^{Aa}	4.30 ± 0.30^{Aa}	4.20 ± 0.10^{Aa}	3.80 ± 0.10^{Ab}	3.70 ± 0.10^{Ab}	3.40 ± 0.10^{ABc}
	Cloves oil + SLAE	4.50 ± 0.10^{Aa}	4.40 ± 0.10^{Aa}	4.10 ± 0.10^{Ab}	4.00 ± 0.10^{ABb}	3.70 ± 0.10^{Ac}	3.70 ± 0.10^{Ac}	3.50 ± 0.10^{Ad}

SLAE = Stevia leaves aqueous extract Means within a same column with different superscript capital letters are significantly different (p≤0.05); means within a same row with different superscript small letters are significantly different (p≤0.05).

3.3 Total soluble solids (TSS) of mango and strawberry jam during storage at 25ºC±5ºC for 6 months

Data given in Table (4) reviled those total soluble solids of different mango and strawberry jam samples prepared by the additions of cinnamon oil, cloves oil (0.5ml v/w) and stevia leaves aqueous extract (50%) substitute with sugar during storage period at 25Cº±5Cº up to 6 months. From statistical analysis of these results it could be noticed that, there were no significant differences (P<0.05) in total soluble solids between, mango jam containing cinnamon oil, cloves oil and stevia leaves aqueous extract (61.5 and 60.5) compared with

control sample (65 %) at zero time, The highest total soluble solids of mango jam (66%) was recorded for mango jam treated by cloves oil, the lowest total soluble solids (60.5%) were recorded for mango jam containing cloves oil and stevia leaves compared with control sample (65%) at zero time.

Table (4): Effect of addition cinnamon oil, cloves oil (0.5ml v/w) and stevia leaves aqueous extract (50%) substitute with sugar on total soluble solids (TSS) of mango and strawberry jams during storage at 25Cº±5ºC for 6 months.

Treatments		Storage Periods (months)						
		0	1	2	3	4	5	6
Mango jam	Control	65.00±1.00^{Aa}	65.30±1.00^{Aa}	65.50±1.00^{Aa}	65.50±1.00^{Aa}	65.70±1.00^{Aa}	65.90±1.00^{Aa}	66.20±1.00^{Aa}
	Cinnamon oil	65.00±1.00^{Aa}	65.30±1.00^{Aa}	65.50±1.00^{Aa}	65.60±1.00^{Aa}	65.80±1.00^{Aa}	66.00±1.00^{Aa}	66.30±1.00^{Aa}
	Cloves oil	66.00±1.00^{Aa}	66.40±1.00^{Aa}	66.60±1.00^{Aa}	66.80±1.00^{Aa}	66.90±1.00^{Aa}	66.10±1.00^{Aa}	66.40±1.00^{Aa}
	Cinnamon oil + SLAE	61.50±1.00^{Ba}	61.80±1.00^{Ba}	61.90±1.00^{Ba}	62.00±1.00^{Ba}	62.20±1.00^{Ba}	62.50±1.00^{Ba}	62.70±1.00^{Ba}
	Cloves oil + SLAE	60.50±1.00^{Ba}	60.70±1.00^{Ba}	60.80±1.00^{Ba}	60.90±1.00^{Ba}	61.10±1.00^{Ba}	61.40±1.00^{Ba}	61.60±1.00Ba
Strawberry jam	Control	65.00±1.00^{Aa}	65.40±1.00^{Aa}	65.60±1.00^{Aa}	65.80±1.00^{Aa}	66.00±1.00^{Aa}	66.20±1.00^{Aa}	66.50±1.00^{Aa}
	Cinnamon oil	65.00±1.00^{Aa}	65.30±1.00^{Aa}	65.40±1.00^{Aa}	65.60±1.00^{Aa}	65.80±1.00^{Aa}	66.10±1.00^{Aa}	66.40±1.00^{Aa}
	Cloves oil	65.00±1.00^{Aa}	65.40±1.00^{Aa}	66.60±1.00^{Aa}	65.70±1.00^{Aa}	65.90±1.00^{Aa}	66.20±1.00^{Aa}	66.50±1.00^{Aa}
	Cinnamon oil + SLAE	60.50±1.00^{Ca}	60.70±1.00^{Ca}	60.80±1.00^{Ca}	60.90±1.00^{Ca}	61.20±1.00^{Ca}	61.50±1.00^{Ca}	61.60±1.00^{Ca}
	Cloves oil + SLAE	62.50±1.00^{Ba}	62.70±1.00^{Ba}	62.90±1.00^{Ba}	63.10±1.00^{Ba}	63.30±1.00^{Ba}	63.60±1.00^{Ba}	63.90±1.00^{Ba}

SLAE = Stevia leaves aqueous extract Means within a same column with different superscript capital letters are significantly different (p≤0.05); means within a same row with different superscript small letters are significantly different (p≤0.05).

At the end of storage period there were no significant differences (P<0.05) in total soluble solids between mango jam containing cinnamon oil, cloves oil and control sample while there were significant differences (P<0.05) in total soluble solids values between control and mango jam containing cinnamon oil, cloves oil and stevia leaves aqueous extract , The highest total soluble solids of mango jam (66.4%) was recorded of mango jam treated by cloves oil followed by (66.3%) for mango jam containing cinnamon oil. Meanwhile, the lowest total soluble solids (61.6%) were recorded of mango jam containing cloves oil and stevia leaves aqueous extract. From the same table it could be noticed that total soluble solids of strawberry jam samples ranged between (60.5% to 65%) at zero time. but at the end of storage period, it ranged between (61.60% to 66.5%) compared with control sample (66.5%). However, the changes in total soluble solids during storage period may be due to the conversion of sucrose to glucose and fructose at low pH. Similar results were recorded by Akhtar *et al.* (2010) and Durrani *et al.* (2012).

3.4 Acidity of mango and strawberry jam during storage at 25ºC±5ºC for 6 months

Data presented in Table (5) showed that acidity values of different mango and strawberry jam samples prepared by the additions of cinnamon oil, cloves oil (0.5 ml v/w) and stevia leaves aqueous extract (50%) substituted with sugar during storage period at 25Cº±5Cº up to 6 months. From statistical analysis of these results, it could be noticed that there were significant differences (P<0.05) in acidity values between all samples and control

sample at zero time, The highest acidity value of mango jam (0.33%) was recorded for control (0.33). followed by (0.26%) for the mango jam containing cinnamon oil, cloves oil and stevia leaves aqueous extract, the lowest acidity value (0.23%) were recorded for mango jam containing cinnamon oil, cloves oil at zero time. At the end of storage period there were significant differences ($P<0.05$) in acidity values between all samples and control sample. The highest acidity value of mango jam (1.13%) was recorded for control (1.13). followed by (1.01%) for mango jam containing cinnamon oil, cloves oil and stevia leaves aqueous extract, the lowest acidity value (0.78%) were recorded for mango jam containing cloves oil. From the same table it could be noticed that the highest acidity value for strawberry jam (0.43%) was recorded for strawberry jam containing cloves oil and stevia leaves aqueous extract, while the lowest acidity value (0.34%) was recorded for strawberry jam containing cinnamon oil, cloves oil compared with control sample (0.37). at zero time. At the end of storage period the highest acidity value of strawberry jam (1.13%) was recorded for cloves oil and stevia leaves aqueous extract while the lowest acidity value (0.93%) was recorded for strawberry jam containing cloves oil, cinnamon oil compared with control sample 1.00%. This increment in acidity might also be due to formation of acid by degradation of polysaccharides and oxidation of reducing sugars or by breakdown of pectic substances (Hussain *et al.*, 2008).

Table (5): Effect of addition cinnamon oil, cloves oil (0.5ml v/w) and stevia leaves aqueous extract (50%) substituted with sugar on acidity (%) of mango and strawberry jams during storage at 25C°±5°C for 6 months.

Treatments		Storage Periods (months)						
		0	1	2	3	4	5	6
Mango jam	Control	0.33 ± 0.02^{Ae}	0.83 ± 0.03^{Ad}	1.03 ± 0.03^{Ac}	1.04 ± 0.03^{Abc}	1.07 ± 0.03^{Aabc}	1.11 ± 0.03^{Aab}	1.13 ± 0.03^{Aa}
	Cinnamon oil	0.23 ± 0.03^{Bef}	0.60 ± 0.09^{BCc}	0.66 ± 0.02^{BCc}	$0.70\pm0.24B^{Cbc}$	0.86 ± 0.03^{Bab}	0.91 ± 0.03^{Ba}	1.01 ± 0.03^{Ba}
	Cloves oil	$0.23\pm0.05Be$	0.54 ± 0.01^{Cd}	0.56 ± 0.03^{Dcd}	0.57 ± 0.03^{Ccd}	0.62 ± 0.04^{Dbc}	0.67 ± 0.03^{Db}	0.78 ± 0.02^{Da}
	Cinnamon oil + SLAE	$0.26\pm0.03Bd$	0.61 ± 0.06^{BCc}	0.63 ± 0.07^{CDc}	0.63 ± 0.07^{BCc}	0.74 ± 0.03^{Cb}	0.80 ± 0.02^{Cab}	0.86 ± 0.03^{Ca}
	Cloves oil + SLAE	$0.26\pm0.01Be$	0.67 ± 0.03^{Bd}	0.72 ± 0.02^{Bd}	0.80 ± 0.04^{Bc}	0.81 ± 0.03^{Bc}	0.92 ± 0.03^{Bb}	1.01 ± 0.03^{Ba}
Strawberry jam	Control	0.37 ± 0.01^{ABf}	0.79 ± 0.01^{Ce}	0.83 ± 0.04^{Bde}	0.87 ± 0.03^{Bcd}	0.90 ± 0.02^{Bbc}	0.96 ± 0.02^{Bab}	1.00 ± 0.04^{Ba}
	Cinnamon oil	0.34 ± 0.03^{Bc}	0.84 ± 0.01^{Bb}	0.86 ± 0.03^{Bab}	0.90 ± 0.03^{Bab}	0.91 ± 0.05^{Bab}	0.92 ± 0.03^{Bab}	0.93 ± 0.05^{Ba}
	Cloves oil	0.34 ± 0.03^{Bd}	0.83 ± 0.01^{BCc}	0.84 ± 0.02^{Bc}	0.85 ± 0.03^{Bbc}	0.88 ± 0.04^{Babc}	0.90 ± 0.03^{Bab}	0.93 ± 0.02^{Ba}
	Cinnamon oil + SLAE	0.40 ± 0.03^{ABd}	$1.02\pm0.03^{A}c$	1.03 ± 0.03^{Abc}	1.04 ± 0.03^{Aabc}	1.06 ± 0.04^{Aabc}	1.09 ± 0.02^{Aab}	1.11 ± 0.03^{Aa}
	Cloves oil + SLAE	0.43 ± 0.03^{Ac}	1.02 ± 0.02^{Ab}	1.04 ± 0.05^{Aab}	1.06 ± 0.07^{Aab}	1.07 ± 0.05^{Aab}	1.09 ± 0.04^{Aab}	1.13 ± 0.05^{Aa}

SLAE = Stevia leaves aqueous extract Means within a same column with different superscript capital letters are significantly different ($p\leq0.05$); means within a same row with different superscript small letters are significantly different ($p\leq0.05$).

3.5 Ascorbic acid content of mango and strawberry jams during storage at 25ºC±5ºC for 6 months

Data given in Table (6) illustrated ascorbic acid content of different mango and strawberry jam samples prepared by additions of cinnamon oil, cloves oil (0.5ml v/w) and stevia leaves aqueous extract (50%) during storage period at 25ºC±5ºC up to 6 months. From statistical analysis of these results, it

could be noticed that the highest ascorbic acid content (28.63 mg/100g) was recorded for mango jam containing cinnamon oil and cinnamon oil and stevia leaves aqueous extract while the lowest ascorbic acid content (24.23 mg/100g) was recorded for mango jam containing cloves oil, cloves oil and stevia leaves aqueous extract compared with control sample (26.43 mg/100g). at zero time. At the end of storage period, the highest ascorbic acid content (11.01 mg/100g) was recorded for mango jam containing cinnamon oil and stevia leaves aqueous extract and cloves oil and stevia leaves aqueous extract, while the lowest ascorbic acid content (6.61 mg/100g) were recorded for control sample. From the same table it could be noticed that the highest ascorbic acid content for strawberry jam (24.23 mg/100g) was recorded for strawberry jam containing cloves oil and stevia leaves aqueous extract, while the lowest ascorbic acid (17.62 mg/100g) were recorded for anther samples. At the end of storage period, the highest ascorbic acid content for strawberry jam (11.01 mg/100g) was recorded for cloves oil, cinnamon oil and stevia leaves aqueous extract and cloves oil and stevia leaves aqueous extract while, the lowest ascorbic acid content (8.81 mg/100g) were recorded for strawberry jam containing cinnamon oil and control sample. The decrement of ascorbic acid content may be due to the oxidation of ascorbic acid to de hydro ascorbic acid and then further degraded to 2, 3-diketo-gluconic acid by the action of ascorbic acid oxidase enzyme (Bons *et al.*, 2011; Kinh *et al.*, 2001).

Table (6): Effect of addition cinnamon oil, cloves oil (0.5ml v/w) and stevia leaves aqueous extract (50%) substitute with sugar on ascorbic acid content of mango and strawberry jams during storage at 25ºC±5ºC for 6 months.

Treatments		Storage Periods (months)						
		0	1	2	3	4	5	6
Mango jam	Control	26.43 ± 2.20^{ABa}	17.62 ± 2.20^{Ab}	11.01 ± 2.20^{Bc}	11.01 ± 2.20^{Ac}	11.01 ± 2.20^{Ac}	6.61 ± 2.20^{Cd}	6.61 ± 2.20^{Bd}
	Cinnamon oil	28.63 ± 2.20^{Aa}	19.82 ± 2.20^{Ab}	15.42 ± 2.20^{Ac}	13.21 ± 2.20^{Acd}	11.01 ± 2.20^{Ade}	$8.81\pm2.20B^{Ce}$	8.81 ± 2.20^{ABe}
	Cloves oil	24.23 ± 2.20^{Ba}	19.82 ± 2.20^{Ab}	13.21 ± 2.20^{ABc}	13.21 ± 2.20^{Ac}	11.01 ± 2.20^{Acd}	11.01 ± 2.20^{ABcd}	8.81 ± 2.20^{ABd}
	Cinnamon oil + SLAE	28.63 ± 2.20^{Aa}	19.82 ± 2.20^{Ab}	15.42 ± 2.20^{Ac}	13.21 ± 2.20^{Acd}	13.21 ± 2.20^{Acd}	13.21 ± 2.20^{Acd}	11.01 ± 2.20^{Ad}
	Cloves oil + SLAE	24.23 ± 2.20^{Ba}	17.62 ± 2.20^{Ab}	13.21 ± 2.20^{ABc}	11.74 ± 3.36^{Ac}	11.01 ± 2.20^{Ac}	11.01 ± 2.20^{ABc}	11.01 ± 2.20^{Ac}
Strawberry jam	Control	17.62 ± 2.20^{Ba}	17.62 ± 2.20^{Ba}	15.42 ± 2.20^{Bab}	13.21 ± 2.20^{ABb}	13.21 ± 2.20^{ABb}	13.21 ± 2.20^{ABb}	8.81 ± 2.20^{Ac}
	Cinnamon oil	17.62 ± 2.20^{Ba}	15.42 ± 2.20^{Bab}	13.21 ± 2.20^{Bbc}	11.01 ± 2.20^{Bcd}	11.01 ± 2.20^{Bcd}	11.01 ± 2.20^{Bcd}	8.81 ± 2.20^{Ad}
	Cloves oil	17.62 ± 2.20^{Ba}	15.42 ± 2.20^{Bab}	13.21 ± 2.20^{Bbc}	11.01 ± 2.20^{Bc}	11.01 ± 2.20^{Bc}	11.01 ± 2.20^{Bc}	11.01 ± 2.20^{Ac}
	Cinnamon oil + SLAE	17.62 ± 2.20^{Ba}	15.42 ± 2.20^{Ba}	15.42 ± 2.20^{Ba}	11.01 ± 2.20^{Bb}	11.01 ± 2.20^{Bb}	11.01 ± 2.20^{Bb}	11.01 ± 2.20^{Ab}
	Cloves oil + SLAE	24.23 ± 2.20^{Aa}	24.23 ± 2.20^{Aa}	19.82 ± 2.20^{Ab}	15.42 ± 2.20^{Ac}	15.41 ± 2.20^{Ac}	15.42 ± 2.20^{Ac}	11.01 ± 2.20^{Ad}

SLAE = Stevia leaves aqueous extract Means within a same column with different superscript capital letters are significantly different ($p\leq0.05$); means within a same row with different superscript small letters are significantly different ($p\leq0.05$).

3.6 Sensory characteristics of mango and strawberry jams during storage at 25ºC±5ºC for 6 months

Sensory attributes (color, odor, taste, texture and overall acceptability) of mango and strawberry jams were evaluated at the beginning of storage after adding cinnamon, cloves oils (0.5ml v/w) and stevia leaves aqueous extract

(50%) substitute with sugar. Data in Table (7) showed that there were no significant differences (P<0.05) in color, odor, taste and overall acceptability between control sample and mango jam treated by cinnamon and cloves oil, the highest mean values on color, odor, taste, texture, and overall acceptability of mango jam (8.46, 8.93, 9.00, 9.16 and 8.22), respectively recorded with control sample compared with other mango jam treatments. From the same table it could be noticed that, color of strawberry jam samples ranged between (6.93 to 8.00) compared with control sample which was (8.40), odor ranged between 6.94 to 7.16 compared with control sample (8.37), taste ranged between (6.16 to 9.36) compared with control sample (9.00), texture ranged between (5.63 to 8.5) compared with control sample (9.33) and Overall acceptability ranged between (6.50 to 8.1) compared with control sample (8.50). The results obtained for all the monitored sensory parameters agree with findings of Muhammad *et al.* (2009).

Table (7): Effect of addition cinnamon oil, cloves oil (0.5ml v/w) and stevia leaves aqueous extract (50%) substitute with sugar on sensory evaluation of mango and strawberry jams during storage at 25ºC±5ºC for 6 months.

Treatments		Color	Odor	Taste	Texture	Overall acceptability
Mango jam	Control	8.46 ± 0.55^{A}	8.93 ± 0.20^{A}	9.00 ± 0.50^{A}	9.16 ± 0.28^{A}	8.22 ± 0.56^{A}
	Cinnamon oil	8.33 ± 0.73^{A}	8.20 ± 0.43^{AB}	8.46 ± 0.45^{A}	8.40 ± 0.40^{B}	7.66 ± 0.76^{AB}
	Cloves oil	8.18 ± 0.81^{A}	8.36 ± 1.00^{AB}	8.73 ± 0.58^{A}	8.56 ± 0.15^{AB}	7.90 ± 0.36^{AB}
	Cinnamon oil+ SLAE	7.23 ± 0.80^{AB}	7.16 ± 0.76^{B}	6.36 ± 0.51^{C}	7.00 ± 0.50^{C}	6.76 ± 0.25^{B}
	Cloves oil + SLAE	$6.63\pm0\ 49^{B}$	7.11 ± 0.99^{B}	7.26 ± 0.25^{B}	6.50 ± 0.50^{C}	6.90 ± 1.00^{B}
Strawberry jam	Control	8.40 ± 0.65^{A}	8.37 ± 0.82^{A}	9.00 ± 0.50^{A}	9.33 ± 0.28^{A}	8.50±0.50A
	Cinnamon oil	7.96 ± 0.55^{AB}	7.02 ± 0.50^{A}	9.36 ± 0.32^{A}	8.50 ± 0.43^{AB}	8.13 ± 0.32^{A}
	Cloves oil	8.00 ± 1.00^{AB}	6.94 ± 0.96^{A}	7.93 ± 0.40^{B}	8.00 ± 1.00^{BC}	7.63 ± 0.70^{AB}
	Cinnamon oil+ SLAE	6.93 ± 0.23^{B}	7.00 ± 1.32^{A}	6.23 ± 0.49^{C}	7.10 ± 0.52^{C}	6.96 ± 0.45^{BC}
	Cloves oil + SLAE	7.49 ± 0.44^{AB}	7.16 ± 0.57^{A}	6.16 ± 0.35^{C}	5.63 ± 0.32^{D}	6.50 ± 0.50^{C}

SLAE = Stevia leaves aqueous extract Means within a same column with different superscript capital letters are significantly different ($p\leq0.05$); means within a same row with different superscript small letters are significantly different ($p\leq0.05$).

3.7 Microbiological evaluation of mango and strawberry jams during storage at 25ºC±5ºC for 6 months

No microbial (bacteria, yeasts and fungi) load was detected for up to four months in all samples in mango, strawberry jam. But after five months of storage the control samples of mango and strawberry jam spoiled, and the spoilage was in the form of bulges in the bottle, at the end of the storage period, no microbial growths (bacteria, yeasts and fungi) were detected in all other treatments (Vidya and Narin, 2010).

4. Conclusion

The addition of cloves, cinnamon oils and aqueous extracts of stevia leaves at concentration 0.5ml and 50% to mango and strawberry jam had a noticeable effect on prepared jam chemical characteristics live improve mineral,

ascorbic acid and extension the shelf life also, jam produced by the addition cloves, cinnamon oils and aqueous extract of stevia leaves was found to be the most accepted samples compared to the control sample .overall, it could be recommended to utilize cloves, cinnamon and aqueous extracts of stevia leaves in jam. Productions and other foods products as natural preservatives.

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