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Using some plant extracts (*Thymus vulgaris*, *Musa sp*. and *Citrus sinensis*) to prolong the shelf life of local soft cheese

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Abstract

Powder, aqueous and phenolic extract, of thyme leaves (*Thymus vulgaris*) (TVL), orange peels (*Citrus sinensis*) (CSP), and banana peels (*Musa sp*) (MSP) were added to pasteurized milk before renneting separately for testing their abilities to prolonging the storage period of local soft cheese. These additives were successful in prolonging the storage period of the soft local cheese to 28, 30, and 40 days respectively compared with the control treatment (no additives (NA)), 15 days only. Powder plant additions were the best from the other additions; orange peel powder was the best one. Sensory evaluation of the cheese revealed that the cheese was accepted by tasters for its qualities represented by flavor, taste, bitterness, and color. The use of natural plant additions to cheese led to prolonging the duration of storage, and we recommend that it can be used in food processing rather than industrial preservatives.

Keywords: Thymes, Orange, Banana, Soft Cheese.

INTRODUCTION

Cheese production is one of the most important traditional industries used to preserve milk ingredients from pollution (1) and to be stored for an extended period of time. The product varies according to the materials used in its production, production and marketing method (2). Soft cheese is considered as one of the most requested cheeses. The cheese is considered as a suitable growth medium for microorganisms leading to the contamination of cheese. The plant additions are natural substances with many benefits. Some of them work as antioxidants and antimicrobials. Also, they are rich in essential nutrients such as the availability of thyme, fruits of oranges, and bananas. Unfortunately, the peels of these fruits are trashed away without benefit. So our current study was aimed to use leaves of thyme and the peels of bananas and oranges as preservatives to prolong the storage duration of local soft cheese.

MATERIALS AND METHODS

Collection of plant samples

Dried TVL, CS, and MS were obtained from local markets in Al-Qadisiyah Governorate. TVLs were cleaned out of dust and impurities. The fruits of banana and orange were peeled out, and the crusts were left out to dry and crushed down to powder form.

Phenolic compounds extraction

The method of Malik et al., (2008) (3) was adopted with some modifications, where 20gm of plant powder was taken from each substance and placed in a filter paper in the Soxhlet. Moreover, 300 ml of petroleum ether was added until the extract became colorless and removed. Moreover, it was left to dry, then returned to the Soxhlet, and 300ml 70% methanol was added at until the extract became colorless. Concentrated the extract in the rotary evaporator was performed until its size became 5ml. Hydrochloric acid was added to remove the stearic bonds between the acid particles in the case where they were existed, and then the mix was incubated in an 80^0C water bath for 1hr. Then, the extract was placed in a separating funnel and 10ml ethyl acetate was added to three times. It was left for a while, and the top layer was collected and dried (4).

Preparation of the water extract

Gülçin et al., (2003) (5) method was adopted to extract the active substances by mixing 25gm of powder with 250ml distilled water (DW). Then, the mix was left 30min on a magnetic stirrer, then was filtered by a gauze for two consecutive times, then concentrated the filter by a rotary evaporator, dried in an oven at 40°C, was placed in dark bottles, and was saved in a refrigerator until use.

Milk samples

The full-fat milk was brought from the Al-Qadisiyah Cow's Station in the morning in sterile bottles (from the morning ring). Milk was tested to determine some chemical and physiological characteristics such as temperature, acidity, fat, pH, density, and boiling, and the contamination by microorganisms was evaluated to ensure its safety for human consumption.

Cheese processing and adding plant extracts

The Iraqi soft cheese was produced using a protocol from the Al-Dahan (1983) (6) by pasteurizing the milk at 63^0C for 30min and cooled to 35^0C. The traditional rennet from local markets was added after it was dissolved in DW at 1%. Salt, NaCl, at 0.25% was added. The hot water (WE) of Thyme (WET), Citrus (WEC), and Musa (WEM), and the phenolic extract (PhE) of Thyme (PhET), Citrus (PhEC), and Musa (PhEM), and the powder (P) of Thyme (PT), Citrus (PC), and Musa (PM) were added separately before clotting the milk at the concentrations mentioned in table (1). The clot was cut after coagulation and left for 5min, then it was placed in a gauze, squeezed, and drained. The clot was packed in plastic containers preloaded with pre-boiled whey and stored in a refrigerator at 7 ± 2^0C until the appearance of unwanted odor, color, or appearance growth of microorganisms. A piece of cheese was taken for the sensory evaluation and the chemical analyses on the first day and every 10 days for 40 days. The chemical tests, lipid ratio and acidity, were measured according to the standard method from (7), and the pH was measured according to (8). The percentage of the yield was measured according to the following formula: Product cheese / Milk weight x 100 (7).

Sensory evaluation

The sensory characteristics of the cheese samples were evaluated after one day and every 10 days by 20 people, from the College of Veterinary Medicine and the College of Biotechnology, University of Al-Qadisiyah, Diwaniyah, Iraq, who tasted the samples and completed a questionnaire form included criteria of flavor, bitterness, odor, and texture following the Hedonic Scale method, 5 grades; 5=excellent, 4=very good, 3=good, 2=middle, and 1=acceptable (9).

RESULTS AND DISCUSSION

The chemical and physiological properties of cheese and milk used in industry

Table (2) shows the chemical and physiological characteristics of the milk used in the produced cheese. The table shows that the milk had chemical and physiological characteristics suitable for the cheese industry.

The results, table (3), show the percentage of fat in the processed cheese that was significantly (p<0.05) different from one treatment to another during the preservation period (PP), 40 days. The highest rate, 29%, was for the PhET followed by PhEM, 28%, and PhEC, 20%. This might be because CSP contains more anti-fat and anti-oxidant substances followed by thyme leaf powder that contains antioxidants for fat. We also noticed a significant (p<0.05) decrease in the fat ratio in some treatments (PhET, WET, WEC, and the NA) during the PP and during the readings every 10 days, and this might be possible due to microbial degeneration and consumption during the PP. The results of our study agreed with the result of (10) regarding the orange peel and recommended that its derivatives can be used in the treatment of heart diseases and reduce the chances of infection.

The results, table (4), showed that the difference in solid ratios was significantly (p<0.05) different. The best treatment was for PC during the PP. It was 8.2 followed by the WEC and WET, 7.16 and 7.1 respectively, and we noted that the percentage of solids was increased significantly (P<0.05) with the increasing of the PP, and that may be due to evaporation of water and increase the concentration of solids. That is due to the effect of orange peel against bacteria, as the smaller the number of microorganisms, the lower the effect on the proportion of fat and protein found in cheese and thus increases the proportion of solids. Al-Mosowy et al., 2009 (11) reported that the presence of artificial inflammation after the injection of cows with *E. coli* led to an increase in the number of microorganisms. Cheese produced from contaminated milk was lower in solids than in milk free of bacteria or less in the presence of bacteria. The results of the present study were not consistent with (12) who stated that solids were higher in control treatment than in the rest of the treatments for which vegetable oils were added. That is due to different plants and extraction method used. The difference in humidity is due to the variation in the viability of water retention in the presence of the extract (13).

Table 1: Concentrations of the plant milk additives (g/l)

Additives type	Thyme leaves	Orange peel	banana peel
Powder	1	1	1
Hot water extract	0.3	0.3	0.3
Phenolic extract	0.5	0.5	0.5

Table 2: the chemical and physiological characteristics of the milk used in the cheese production

Characteristics	temperature	Acidity	Fat Ratio%	pH	Density	Boiling
The value	19°C	0.18	3.9	6.3	1.28	Good

Table 3: The fat ratio of the processed cheese with plant additions (plant powder, hot water and phenolic extracts) of thyme leaves, orange and banana peels during 40 days of preservation

Treatments	Ten days	20 days	30 days	40 days
PT	^{Ea}0.16 ±22	^{Ea}0.16±22	^{Da}0.16 ±22	^{Ba}0.16 ±22
WET	^{Ca}0.16 ±27	^{Cb}0.16±25	^{Cc}0.16 ±24	^{Ad}0 ±23
PhET	^{Aa}0 ±29	^{Ab}0.16 ±28	^{Ab}0.16±28	-
PC	^{Ga}0.16 ±20	^{Ga}0.16 ±20	^{Fa}0.28 ±20	^{Da}0.16 ±20
WEC	^{Da}0.16 ±23	^{Da}0.16±23	^{Db}0.16 ±22	^{Bb}0.28 ±22
PhEC	^{Ca}0.16 ±27	^{Ba}0.16±27	^{Ba}0 ±27	-
PM	^{Ea}0.16 ±22	^{Ea}0.16 ±22	^{Da}0.16 ±22	^{Ba}0 ±22
WEM	^{Fa}0.28 ±21	^{Fa}0.16 ±21	^{Ea}0.28 ±21	^{Ca}0.16 ±21
PhEM	^{Ba}0.16 ±28	^{Aa}0.16 ±28	^{Aa}0 ±28	-
Control	^{Ba}0 ±28	^{Ab}0±28	^{Bb}0.16 ±27	-

*The values represent the mean±SE, the different uppercase letters indicate significant (p<0.05) differences between the averages vertically, while the similar letters indicate no significant (p>0.05) differences. The various small letters indicate significant (p<0.05) differences between horizontal rates, while the similar letters indicate no significant (p>0.05) differences.

Table 4: Percentages of solids in processed cheese and plant extracts (plant powder, hot water and phenolic extracts) of thyme leaves, orange and banana peels during 40 days of conservation

Treatments	Ten days	20 days	30 days	40 days
PT	^{Cc}±3.7 0.05	^{Cb}0.12±4.26	^{Aa}0.17 ±6.3	^{Ca}0.14 ±6.36
WET	^{Ac}0.08 ±5.13	^{Bc}0.08±5.43	^{Ab}0.12 ±6.73	^{Ba}0.05 ±7.1
PhET	^{Db}0.05 ±2.5	^{Eb}0.08±2.83	^{Ba}0.14 ±5.76	-
PC	^{Ac}0.23 ±5.43	^{Ab}0.08 ±6.16	^{Ab}0.11 ±6.6	^{Aa}0.11 ±8.2
WEC	^{Ac}0.15 ±5.5	^{Ab}0.03±6.03	^{Ab}0.15 ±6.7	^{Ba}0.2 ±7.16
PhEC	^{Cc}0.11 ±3.7	^{Cb}0.12±4.16	^{Ba}0.23 ± 5.36	-
PM	^{Ab}0.23 ±5.4	^{Aa}0.18 ±6.36	^{Aa}0.08 ±6.76	^{Ca}0.21 ±6.83
WEM	^{Aa}0.15 ±6.4	^{Bb}0.23 ±5.2	^{Aa}0.11 ±6.2	^{Ca}0.27 ±6.53
PhEM	^{Ab}0.23 ±5.4	^{Aa}0.18 ±6.36	^{Aa}0.08 ±6.76	^{Ca}0.21 ±6.83
Control	^{Cb}0.06 ±3.06	^{Db}0.17±3.46	^{Ba}0.05 ±5.5	-

*The values represent the mean±SE, the different uppercase letters indicate significant (p<0.05) differences between the averages vertically, while the similar letters indicate no significant (p>0.05) differences. The various small letters indicate significant (p<0.05) differences between horizontal rates, while the similar letters indicate no significant (p>0.05) differences.

Table 5: pH in processed cheese and plant extracts (plant powder, hot water and phenolic extracts) of thyme leaves, orange and banana peels during 40 days of storage

Treatments	10 day	20 day	30 day	40 day
PT	0.33 ±5.33 ^{Aa}	0.33 ± 5.23^{ABa}	0 ±5 ^{Aa}	0.66 ±4.66 ^{Aa}
WET	0.66 ±5.33 ^{Aa}	0 ±5^{Ba}	0.33 ±5.23 ^{Aa}	0.33 ±5.46 ^{Ba}
PhET	0 ±6 ^{Aa}	0 ±6^{Aa}	0.33 ±5.83 ^{Aa}	-
PC	0.33 ±5.46 ^{Aa}	0.33 ±5.46 ^{Aa}	0.33 ±5.43 ^{Aa}	0.33 ±4.56 ^{Aa}
WEC	0 ±6 ^{Aa}	0 ±6 ^{Aa}	0.33 ±5.76 ^{Aa}	0.33 ±7.33^{Cb}
PhEC	0.56 ±5.33 ^{Aa}	0 ±6 ^{Aa}	0.33 ±5.66 ^{Aa}	-
PM	0.33 ±5.36 ^{Aa}	0 ±5^{Ba}	0.33±5.33 ^{Aa}	0.33 ±5.83 ^{ABa}
WEM	0 ±6 ^{Aa}	0 ±5.48^{Ba}	0.33 ±5.13 ^{Aa}	0 ±5 ^{ABa}
PhEM	0 ±6 ^{Aa}	0 ± 5.34^{Ba}	0 ±5.64^{Aa}	-
Control	5.56 ±5.56 ^{Aa}	0 ±6^{Ab}	0.33±5.53 ^{Aab}	-

*The values represent the mean±SE, the different uppercase letters indicate significant (p<0.05) differences between the averages vertically, while the similar letters indicate no significant (p>0.05) differences. The various lowercase letters indicate significant (p<0.05) differences between horizontal values, while the similar letters indicate no significant (p>0.05) differences.

The results, table (5), showed that the pH values did not show a significant (p>0.05) difference in the first 10 days of storage whereas in the second ten days there were some differences in pH values between the stored cheeses. The pH of the stored cheese showed significant (p<0.05) differences between the pH values in the last ten days. We observed decreases in the pH of cheese treatments of PhET, PT, PC, PM, PhEM, and WEM. In the last ten days, we noted that there are no significant (p>0.05) differences between pH ratios in cheese. In the last 10 days, we observed decreases in the pH values of PT and PC, while increases in the pH values of orange peel to equalization. WET and PhEM were the lowest in changes of the pH ratios. The results showed no significant (p>0.05) differences in pH values for all treatments and during all storage periods except for the treatment of water extract for orange peel. Significant (p<0.05) differences were found between pH values at storage for 40 days as compared to another storage period. That may be because the additives have increased the antimicrobial effect and thus reduced their activity resulting in reduced pH. For that, (14) showed that when the number and activity of bacteria were decreased, the pH was increased. Also, the results of a study by (Al-kotami et al., 2013) (15) showed an inverse relationship between the pH value and the number of microorganisms. Hassanien et al. (2014) (16) reported that decreased pH values during the storage period was due to continuing fermentation of lactose to lactic acid, as well as increased acidification of cheese gradually.

Table (6) shows that the percentage of yield plant and plant extracts (powder, water and phenolic extracts) of thyme leafs and banana peels ranged from 15% to 20% in the laboratory-made cheese while 25% in the control group, the average ratio in the case of the use of bovine milk and increases the proportion of fat in milk. The results of the present study may be because the highest yield rate was found in the treatment of control and then the processed cheese with phenolic extracts of thyme and orange and banana peel which had the lowest effect on fat percentage in cheese. Mohammed (2013) (17) confirmed that high proportion of fat increased the percentage of yield. The results of the study were consistent with the results of Abd El Gawad and Ahmed (2011) (18) And Abdul- Rahman (2013) (13), the percentage of yield of cheese with the extract was less significant than the cheese control. Fats, proteins, and total solids are positively correlated with cheese yield (16). The highest percentage of yield was in the control treatment. That may be due to the addition of extracts was affected by the coagulation process (13).

Table 6: The percentage of yield in cheese produced and processed by plant extracts (plant powder, hot water and phenolic extracts) of thyme leaves, and orange and banana peel

Treatments	PhEM	WEM	PM	PhEC	WEC	PC	PhET	WET	PT	Control
%	20	20	16	19	15	16	20	15	19	25

Table 7: Evaluation of cheese smell of cheese (mean±SE) treated with plant extracts (powder, hot water and phenolic extracts) of thyme leaves, and banana and orange peels during 40 days of storage.

Treatments	10 day	20 day	30 day	40 day
PT	0 ± 5^{Aa}	0.27 ± 4.1^{Bb}	0.16 ± 4.5^{A}	0.15 ± 3.7^{Bb}
WET	0 ± 5^{Aa}	0.13 ± 4.8^{Aa}	0.16 ± 4.4^{Ab}	0.21 ± 2^{Ac}
PhET	0 ± 5^{Aa}	0.15 ± 4.7^{Aa}	-	-
PC	0 ± 5^{Aa}	0.16 ± 4.6^{Aa}	0.16 ± 4.6^{Aa}	0.16 ± 3.6^{Bb}
WEC	0 ± 5^{Aa}	0 ± 5^{Aa}	0.25 ± 4.5^{Aa}	0.23 ± 1.9^{Ab}
PhEC	$\pm 5^{Aa}$	0.39 ± 4^{Bb}	-	-
PM	0 ± 5^{Aa}	0.1 ± 4.9^{Aa}	0.16 ± 4.6^{Aa}	0.13 ± 3.8^{Bb}
WEM	0 ± 5^{Aa}	0.42 ± 3.7^{Bb}	0.16 ± 4.6^{Aa}	0.21 ± 2^{Ab}
PhEM	0 ± 5^{Aa}	0.13 ± 4.8^{Aa}	-	-
Control	0 ± 5^{Aa}	0.25 ± 3.2^{Bb}	-	-

Length of category = 0.80 and categories distributed as follows: 1-1,79 = lousy, 1,80-2.59 = average, 2,60-3,39 = good, 3,40-4,19 = very good, The large numbers indicate significant differences between the rates vertically, while the large capital letters indicate no significant differences (p>0.05). The various small letters indicate significant differences between the horizontal rates while the similar characters indicate no significant differences in (p>0.05).

Sensory evaluation of soft cheese treated with plant additives during storage duration

The sensory evaluation showed that the control group cheese was not acceptable after the storage period for 15 days at the refrigerator temperature. There were flavors that were not acceptable with bitterness and aroma and the emergence of fungal growth while the cheese that had been treated with additives was with acceptable flavor, taste, and good cohesive texture for 40 days of the storage in the refrigerator. The treatment of PC was the best than other treatments regarding the preserving of the sensory properties of soft cheeses followed by the treatment of PM (p<0. 05). These changes in the sensory characteristics are due to the chemical changes that occurred in the cheese during the storing in the refrigerator for different periods. Cheese is a product of biological and biochemical nature, in which some changes happen during its production and maturity (19). Several factors affect the sensory properties such as microbial contamination, light, enzymatic efficacy, and cheese additive. Light affects positively color of the products. Microbial contamination effects cause abnormal flavors and abnormal consistency of soft cheese (20).

Al-Mosowy et al., (2009) (11) agree with the results. They found that cheese made from milk without bacteria give excellent sensory properties and is established gradually and continuously while with contaminated milk, it quickly grows and deteriorates.

Table 8: Evaluation of the textures (mean±SE) in processed cheese with plant extracts (powder, hot water and phenolic extract) of thyme leaves, and banana and orange peels during 40 days of storage

Treatments	10 day	20 day	30 day	40 day
PT	0 ± 5^{Aa}	$0.13 \pm 4,8^{Ba}$	0.15 ± 4.3^{Ab}	0.14 ± 4^{Bb}
WET	0.1 ± 4.9^{Aa}	0 ± 5^{Ba}	0.16 ± 4.6^{Aa}	0.16 ± 3.6^{Bb}
PhET	0.13 ± 4.8^{Aa}	0.16 ± 3.5^{Ab}	-	-
PC	0 ± 5^{Aa}	0.1 ± 4.9^{Aa}	0.13 ± 4.2^{Ab}	0.23 ± 4.1^{Bb}
WEC	0 ± 5^{Aa}	0.15 ± 4.7^{Aa}	0.15 ± 4.3^{Ab}	0.16 ± 3.6^{Bc}
PhEC	0.13 ± 4.8^{Aa}	0.15 ± 4.7^{Ab}	-	-
PM	5 ± 0^{Aa}	0 ± 5^{Aa}	0.16 ± 4.6^{Aa}	0.15 ± 3.7^{Bb}
WEM	0.1 ± 4.9^{Aa}	0 ± 5^{Bb}	0.16 ± 4.6^{Aa}	0.13 ± 2.8^{Ac}
PhEM	0.13 ± 4.8^{Aa}	0.15 ± 3.7^{Aa}	-	-
Control	0.1 ± 4.9^{Aa}	0.16 ± 4.5^{Bb}	-	-

The length of the class = 0.80 and the categories distributed as follows: 1-1,79 = lousy, 1,80-2.59 = average, 2,60-3,39 = good, 3,40-4,19 = very good, 4 , 20-5 = excellent, the values represent the mean±SE, the various capital letters indicate significant differences between the averages vertically, while the significant capital letters indicate no significant differences at (p>0.05), Small letters indicate significant differences between horizontal rates, while similar characters indicate no significant differences in at (p>0.05).

Table 9: Evaluation of the bitterness of cheese (mean±SE) with plant extracts (powder, hot water and phenolic extracts) of thyme leaves, and banana and orange peels during 40 days of storage

Treatments	10 day	20 day	30 day	40 day
PT	0.13 ±4.8 ^{ABa}	0.17±4.1^{Ab}	0.16 ±4.4^{ABCab}	0.16 ±4.4^{Bab}
WET	0.16 ±4.4 ^{Aa}	0.26±4.2^{Aa}	0.15 ±3.4 ^{ABCb}	0.3 ±2.4 ^{Cc}
PhET	ABa 4.8± 0.13	Ab3.8±0.23	-	-
PC	0.1 ±4.9 ^{Ba}	0.23 ±4.2^{Ab}	0.15 ±4.7 ^{Ca}	0.23 ±4.1 ^{Bb}
WEC	0.1 ±4.9 ^{Ba}	0.21±4^{Ab}	0.16 ±4.5 ^{BCa}	0.23 ±3.1^{ABc}
PhEC	0.16 ±4.5 ^{ABab}	0.13±4.2 ^{Aab}	-	-
PM	0.15 ±4.3 ^{Aa}	0.14 ±4^{Aa}	-	-
WEM	0.15 ±3.4 ^{Aa}	0.26 ±3.7^{Ab}	0.1 ±4.1^{ABb}	0.27 ±3.9 ^{Bb}
PhEM	0.1 ±4.9 ^{Ba}	0.23 ±4.1^{Ab}	0.1 ±3.9 ^{Aa}	0.27 ±2.9 ^{Ab}
Control	0.15 ±4.3 ^{Aa}	0.16±4.5^{Ba}	-	-

*Length of category = 0.80 and categories distributed as follows: 1-1,79 = lousy, 1,80-2.59 = average, 2,60-3,39 = good, 3,40-4,19 = very good. The large numbers indicate significant differences between the rates vertically, while the large capital letters indicate no significant differences (p>0.05), The various small letters indicate significant (p<0.05) differences between the horizontal rates, while the similar characters indicate no significant differences in (p>0.05).

Table 10: Determination of cheese flavor (mean±SE), with plant extracts (powder, hot water and phenolic extracts) of thyme leaves, and banana and orange peels during 40 days of preservation

Treatments	**10 day**	**20 day**	**30 day**	**40 day**
PT	0.29 ±4.2 ^{Ba}	^{BDa}0.3±4.3	^{ABa}0.16 ±4.5	^{Ca}0.16 ±4.6
WET	0.1 ±4.9 ^{Aa}	^{Da}0.22±4.5	^{ABa}0.16 ±4.5	^{Bb} 0.17 ±3.9
PhET	0.13 ±4.8 ^{Aa}	^{BDb}0.4±4.1	-	-
PC	0 ±5 ^{Aa}	^{Da}0.16 ±4.6	^{Ba}0.1 ±4.9	^{Ca}0.16 ±4.6
WEC	0.1 ±4.9 ^{Aa}	^{CDa}0.1±4.9	^{Ba}0.13 ±4.8	^{Bb}0.2 ±3.8
PhEC	0.1 ±4.9 ^{Aa}	^{Ab}0.4±3.5	-	-
PM	0 ±5 ^{Aa}	^{BDb}0.32 ±4.2	^{Ba}0.13 ±4.8	^{ABb}0.16 ±3.5
WEM	0.13 ±4.8 ^{Aa}	^{ABb}0.5 ±4.9	^{Aa}0.26 ±3.4	^{Ab}0.27 ±3.1
PhEM	0.13 ±4.8 ^{Aa}	^{Ab}0.47 ±3.6	-	-
Control	0 ±5 ^{Aa}	^{Ab}0.42±3.6	-	-

Length of category = 0.80 and categories distributed as follows: 1-1, 79 = lousy, 1, 80-2.59 = average, 2, 60-3, 39 = good, 3, 40-4, 19 = very good, 4, 20-5 = Excellent. The values represent the mean±SE, the various uppercase letters indicate that there are significant (p<0.05) differences between the averages vertically, while the similar large characters indicate no significant differences (p>0.05). The various lowercase letters indicate significant (p<0.05) differences between horizontal rates, while similar characters indicate no significant differences in (p>0.05).

Table 11: Total number of isolates of laboratory-processed cheese with plant extracts (plant powder, hot water and phenolic extracts) of thyme leafs, and orange and banana peels during 40 days of storage (Log CFU/g)

Treatments	**10 day**	**20 day**	**30 day**	**40 day**
PT	4,01±5,45^{Aa}	4,11±5,50 ^{Ba}	4,39±5,56^{Ba}	1,44±3,69^{Aa}
WET	3,06±4,47^{ABa}	3,79±4,72^{ABa}	3,86±5,06^{Aa}	-
PhET	3,51±4,86^{ABa}	4,88±5,96^{Aa}	3,64±4,36^{Aa}	-
PC	3,76±3,30^{Aa}	3,36±4,75^{ABa}	4,59±6,62^{Da}	5,53±6,64^{Ba}
WEC	0±0 ^{ABa}	3,18±5,55^{Ba}	3,56±4,86^{Aa}	-
PhEC	3,89±5,16^{Aa}	4,30±5,46^{Ba}	5,18±6,30^{Ca}	-
PM	4,11±5,13^{Aa}	4,50 ±5,70 ^{Ba}	4,95±6,08^{Ea}	5,04 ±7,30^{Da}
WEM	0±0 ^{Aa}	1,51±3,52^{Ba}	4,06±6,07^{Ea}	-
PhEM	1,20±3,22^{Aa}	3,16±4,88^{Ba}	4,93±6,13^{Ea}	-
Control	0± 0^{ABa}	3,41±4,75^{Aa}	-	-

The various uppercase letters indicate that there are significant (p<0.05) differences between the rates vertically, while similar uppercase letters indicate no significant (p>0.05) differences. The various lowercase letters indicate significant (p<0.05) differences between the horizontal rates, while similar characters indicate no significant (p>0.05) differences.

E. coli isolated from processed cheese and plant extracts (phenolic, aqueous and plant powder) of thyme and banana and orange peel

Microbiological test of soft cheese manufacturer:

Total bacteria isolated from processed cheese with plant extracts (phenolic, water and plant powder) of thyme, and banana and orange

Table (11) shows the total number of isolated bacteria from laboratory-processed cheese. Note that the total number of bacteria in the thyme leaves was increased during the second 10 days, 5.96±4.88, and decreased in the third 10

days, 4.36 ± 3.64. The treatment of control showed that the bacteria did not appear until after twenty days. We can explain this as the plant extracts enriched the medium with nutrients. It encouraged the growth of bacteria and their appearance as plant materials are rich in sugars and minerals essential for the growth of microorganisms. The total number of bacteria did not exceed the limit of 108 according to the specifications approved by the assessment device and quality control. Also, González-Montelongo et al. (2010) (21) and Imam and Akter (2011) (22) showed that banana peel extracts affected bacteria as their numbers were decreased. The containment of banana peels on polyphenol, dopamine, and antibacterial agents that reduce the number of these bacteria thus prolonging the shelf life of the food and reducing the number of bacteria. The study by (23) proved that thyme has antimicrobial properties, and researches showed its good efficacy against antibiotic-resistant strains in several different types of bacteria.

The results, table (12), revealed that *E. coli* did not appear during the first ten days of cheese preservation in all treatments and appeared in the second or third ten days of some treatments. That is explained by the fact that *E. coli* is present in the milk from which the cheese was made. The main milk contaminants, which resist pasteurization and remain in milk products even after processing and conservation, but their small numbers were not allowed to appear even in the slightest dilution but after increasing number began to appear in the successive days of conservation. These results were agreed with (24) who detected that *E. coli* was found to be present in milk and remained present after yogurt was produced and then decreased with cooling and then returned to increase again.

The results, table 13, showed that the molds and yeast did not appear until the second 10 days of conservation in the control treatment only. The powders and aqueous extracts showed no appearance of fungi except during the fourth ten days of conservation and in the treatment of orange peel powder only. The plant extracts showed a strong inhibitory effect on the growth of fungus due to the presence of active compounds. Phenolic and aquatic treatments and the three plants did not show any fungal growth. This is known to have inhibitory effects on the growth of the fungus. We noticed that no fungal growth was observed in all orange treatments during the first 30 days of conservation. That may be due to the presence of vitamin C and its inhibitory effect on yeast, according to previous studies (25–28) that confirmed that orange peel contains substances that have an inhibitory effect against microorganisms such as *Candida albicans*, *Penicillium digitatum*, and *P. italicum*.

Table 12: Numbers of *E. coli* isolated from processed cheese with plant extracts (plant powder, hot water and phenolic extracts) of thyme leaves, orange and banana peel during 40 days of conservation (Log CFU/g)

Treatments	10 day	20 day	30 day	40 day
PT	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}
WET	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	-
PhET	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	-
PC	0 ± 0^{Aa}	$4,69\pm4,72^{Bb}$	0 ± 0^{Aa}	0 ± 0^{Aa}
WEC	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	-
PhEC	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	-
PM	0 ± 0^{Aa}	0 ± 0^{Aa}	$1,44\pm3,69^{Bb}$	$1,81\pm3,48^{Bb}$
WEM	0 ± 0^{Aa}	$1,51\pm3,52^{Cb}$	0 ± 0^{Aa}	-
PhEM	0 ± 0^{Aa}	0 ± 0^{Aa}	$1,81\pm3,82^{Bb}$	-
Control	0 ± 0^{Aa}	$1,51\pm3,52^{Cb}$	-	-

Values represent the mean±SE. The various uppercase letters indicate that there are significant (p<0.05) differences between the rates vertically, while similar large letters indicate no significant differences (p>0.05). The various lowercase letters indicate significant (p<0.05) differences between the horizontal rates, while the similar characters indicate no significant (p>0.05) differences.

Yeast and molds isolated from processed cheese and processed with plant extracts (plant powder, hot water and phenolic extracts) of thyme leaves, orange and banana peel

Table 13: Number of yeasts and molds isolated from processed cheese with plant extracts (plant powder, hot water and phenolic extracts) of thyme leaves, orange and banana peel during 40 days of conservation (Log CFU/g)

Treatments	10 day	20 day	30 day	40 day
PT	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}
WET	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	-
PhET	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	-
PC	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	$4,48\pm2,77^{Bb}$
WEC	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	-
PhEC	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	-
PM	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}
WEM	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	-
PhEM	0 ± 0^{Aa}	0 ± 0^{Aa}	0 ± 0^{Aa}	-
Control	0 ± 0^{Aa}	$2,52\pm5,52^{Bb}$	-	-

Values represent the mean±SE. The various uppercase letters indicate that there are significant (p<0.05) differences between the rates vertically, while similar large letters indicate no significant differences (p>0.05). The various lowercase letters indicate significant (p<0.05) differences between the horizontal rates, while similar characters indicate no significant (p>0.05) differences.

CONCLUSION

The plant additions of thyme leaves and orange and banana peels have succeeded in prolonging the preservation duration of local soft cheese.

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