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Effect of Fortification Palm Oil with Some Egyptian Spices on Physico-Chemical Composition, Microbiological Analysis, Sensory Evaluation and Economic Study of Tallaga-like Cheese

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Abstract: Four Egyptian spices (Thyme, paprika, cumin and turmeric) with two different concentrations (20 and 50 g/kg) were used for enrichment of palm oil with active compounds to increase the oxidative stability and using for Tallaga-like cheese manufacture during (30 days storage) at 5°C. All fortified palm oil samples showed a good oxidative stability by rancimat measurements and good DPPH radical scavenger. Tallaga-like cheese which were used (Palm oil 20 g/kg turmeric was the best among examined spices for both concentrations and the physico-chemical, microbiological, sensory evaluation and production costs for cheese), followed by turmeric, thyme and paprika while cumin recorded the lowest score

Key words: Palm Oil · Egyptian Spices · Tallaga-Like Cheese · Economic Study

INTRODUCTION

Currently, people prefer natural food, herbal medicines, natural curing practices and even organic farming. This is mostly due to the rampant use of synthetic chemicals, colors and derived products that has lead to various human health hazards. Due to the adverse effect of synthetic dyes, all countries have made strict regulations about the permitted colors to be used as food additives [1]. Of the coloring agents available some of them are soluble in water, some in oil, while others in acid and alkalies. Food industry is looking for natural additives, which are being preferred as these are safer, flavor enhancer and without any side effect comparing to the synthetic or chemical additives [2].

It is possible to suggest that the idea of processed cheese originated from a desire to extend the shelf-life of natural cheese or to develop a new type of cheese which was milder in taste or more stable and also be economic in use. Dairy and non-dairy ingredients could be added to the blend before processing and the use of these ingredients is normally governed by statutory regulation within each country of manufacture [3].

Spices added to food preparations worldwide for their taste and flavor are being recognized for their medicinal, antioxidant, antimicrobial and food stabilizing properties. Various medicinal plants and spices are reported to inhibit the growth of microorganisms. Cumin is a widely used spice in South East, Asia, Arabia and India, it is known for its carminative, stimulant, diuretic and antispasmodic properties [4]. The aqueous extract of cumin is reported to inhibit the growth of some pathogens such as *Escherichia coli*, *staphylococcus aureus*, *Salmonella species*, *Bacillus cereus* and *Aspergillus niger* [5]. Capsicums are a widely consumed, natural food stuff used as a vegetable, spice or color. Paprika extract primarily consists of carotenoid pigments and extracted or added vegetable oil. In addition to carotenoids and capsaicinoids the extract contains mainly oil and neutral lipids including tocopherols derived from the fruit tissues

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and seeds of the dry raw material. Traces of volatile compounds may also be present. Capsanthin and capsorubin are the main compounds responsible for the red color [6].

Turmeric, derived from the plant *Curcuma longa*, is a gold-colored spice commonly used not only for health care but also for the preservation of food and as a yellow dye for textiles. Numerous therapeutic activities have been assigned to turmeric for a wide variety of diseases and conditions, including those of the skin, pulmonary and gastrointestinal systems, aches and liver disorders. Although its ability to preserve food through its antioxidant mechanism, to give color to food and to add taste to the food is well known, its health promoting effects are less well recognized or appreciated. It was once considered a cure for jaundice, an appetite suppressant and a digestive [7]. Curcumin have a wide spectrum of biological actions such as anti-inflammatory [8, 9] antioxidant [10, 11] anticancer [12] antidiabetic [7] antiallergic [13] antiviral, antiprotozoal [14] and antifungal activities [15]. It contains a mixture of powerful antioxidant phytonutrients known as curcuminoids and inhibits cancer at initiation, promotion and progression stages of tumor development. It is a strong anti-oxidant which supports colon health, exerts neuroprotective activity and helps to maintain a healthy cardiovascular system [16].

Plants belonging to the Lamiaceae family have often been used to extract active components. The main classes of phenolic compounds reported to be present in those plants are hydroxycinnamic acids and flavones [17] among Lamiaceae species, thyme (*Thymus vulgaris L.* and *Thymus serpyllum L.*) has been studied widely for its antioxidant activity, due to the high content of phenolic compounds [18]. *Curcuma longa* is a medicinal plant that botanically is related to Zigberiaceas family [15]. A recent trend in cheese manufacture is production of nature flavored cheese made in short time with highly nutritive value and good microbiological quality as for human consumption [19-21]. In Egypt, Karishcum is a novel style of Karish cheese was made by adding *Curcuma longa* (Curcumin or Turmeric) at a rate of 0.3% (w/v).

Mahón cheese made from cow's milk is aged for a minimum of 1 month and has a very characteristic and defined flavor-tart with slight saltiness and a hint of the sea. The rind is rubbed with oil or paprika.

The main aim of this study was to evaluate the effect of fortification palm oil with some Egyptian spices (Paprika, thyme, cumin and turmeric) on physico-chemical composition, microbiological analysis, sensory evaluation and economic study on Tallaga-like cheese.

MATERIALS AND METHODS

Samples of Egyptian Spices: Dry and rubbed paprika, thyme, cumin and turmeric were purchased from a local market in Aswan, Egypt.

Preparation of Palm Oil Rich with Natural Colourants and Antioxidants: Palm oil "Shortening": palm oil produced by premium from vegetable oils B–H–D–S–L–O 66M, Galate taimahdeoa–baser 81707 Malaysia. For the preparation of palm oil rich with colournat, natural antioxidant and active compounds from the examined spices, two different concentrations of plant material were tested (20 and 50 g plant material /kg Palm oil). Samples were mixed with palm oil, stirred for 1h at 50°C then put into oven at 50°C for 24 h and stirred again for 1h at the same conditions followed by vacuum filtration of the oil to remove the plant material [22]. The mixtures were stored in a refrigerator at 6°C until use.

Tallaga-like Cheese Ingredients: Fresh skim cow milk was obtained from the herd of faculty of Agriculture, Damietta University, Table (1). Materials used were spray non–fat dry milk powder, low heat, of USA origin, palm oil "Shortening", as previously, calcium chloride "Flakes77%" made in Sweden imported by Kemira Kemi AB, Helsingborg, potassium sorbate imported by Gersy Commercial Co. "Alex.", production by Z.K.W. China, salt "Iodized salt", produced by EL-Nasr Saline's Co., Alex., stabilizer "Yone cream 300" obtained from The Egyptian Company for Dairy Products and Food Additives, 10th of Ramadan city, Egypt and powder rennet imported from Semiramis International Trading, Cairo, Egypt.

Determination of the Total Phenolic Compounds of Produced Palm Oil: After treatment of palm oil with spices material, with two different concentrations, 25.0 g of the resulting oil was extracted three times with 50 mL of 60:40 acidified methanol:water (0.3% HCl) and after evaporating the solvent the extract was redissolved in 5mL of the extraction solvent [23]. The amount of total phenolic compounds was measured by a modified Folin–Ciocalteau method of Taga *et al*. [23]. In brief, 100µl of the resulting solution was added to 2mL of 2% Na_2CO_3 and after 2 min 100µl of a Folin–Ciocalteau reagent (Merck) (Diluted with methanol (1:1) was added. After further 30 min the absorbance was measured at 750nm using a spectrophotometer. The concentration was calculated using Gallic acid as standard.

Table 1: Chemical composition of skim milk

	F (%)	TS (%)	pH	SNF (%)	Lactose (%)
Skim milk	0.50	10.22	6.51	9.65	5.00

SNF (%): Solid not Fat%

Table 2: Tallaga-like cheese formulation

	Palm oil (control)	Palm with Turmeric	Palm with Thyme	Palm with Paprika	Palm with Cumin
Skim Milk (Kg)	20	20	20	20	20
Skim Milk Powder (Kg)	20	20	20	20	20
palm oil "Shortening" (Kg)	18	18	18	18	18
Rennet (gm)	5	5	5	5	5
Calcium chloride (gm)	20	20	20	20	20
Potassium Sorbate (gm)**	20	20	20	20	20
Stabilizer "Yone cream 300" (gm)	300	300	300	300	300
Salt (Kg)*	2.5	2.5	2.5	2.5	2.5
Water (L.)	41.61	41.61	41.61	41.61	41.61
Total (L.)	100	100	100	100	100

* Salt (Kg): 2.5% in cheese + 6% in salting solution (62.5 liter pasteurized water 6%, each package 5 liter salting solution), therefore, the total salt = 6.25 Kg/ 100 Kg cheese.

** Potassium Sorbate: 2% in cheese and 2% in salting solution, therefore, the total potassium Sorbate = 40 (gm)/ 100 kg cheese.

DPPH Radical Scavenging Activity Produced Palm Oil: For the determination of the antioxidant activity stable 1-diphenyl-2-picrylhydrazyl (DPPH) (Sigma, Germany) radical was used according to the method described by Hatano *et al*. [24] with some modifications; 0.1 mL of a methanolic solution of the extract was added to DPPH solution. After being mixed gently and incubated for 45 min in the dark at room temperature. The decrease in absorbance was measured at 515 nm against a blank without samples with a spectrophotometer.

DPPH radical scavenging effect(%) = [(A0-A1)/A0]×100

where, A0 was absorbance of the control and A1 was absorbance of the sample.

Oxidative Stability of Produced Palm Oil: The oxidative stability of the oils was determined by the Rancimat method [25]. All experiments were carried out with a 743 Rancimat (Metrohm, Germany). In brief, 3.6 g oil was weighed into the reaction vessel, which was placed into the heating block kept at 120°C. Air flow was set at 20 L/h for all determinations. Volatile compounds released during the degradation process were collected in a receiving flask filled with 60mL of distilled water. The conductivity of this solution was measured and recorded. The software of the Rancimat evaluated the resulting curves automatically. For better comparison of the induction periods with the induction period of the control the stabilization (Protection) factor was calculated [25]. Stabilization factor (F)= IPA/ IP0, with IPA= induction period of a stabilized sample and IP0= induction period of a control sample.

Processing of Tallaga–like cheese : Recombined *Tallaga–like* cheeses were processed according to Tamime [26] with some modifications:

Table (2) shows the required ingredients for processing 100 Kg of each recombined cheese separately. Milk powder was dissolved in pasteurized warm water at 45±2°C. Melting the palm oil at the same temperature, then salt was added. The admixture temperature was raised to 65°C, then emulsifier was added and the stirring velocity, gradually increased to reach 1400 RPM and homogenization (150 bar) and heat treatments at 85°C for18 sec. and cooling 45±2°C, The hot admixture was poured into stainless steel trays. Rennet dissolved in tap water 5 g for /100 Kg. of admixture was distributed among trays at 45±2°C and left for complete coagulation and cooling. The resultant cheese was cut similarly like Domiati cheese, but only 8 kilo/plastic container and pickling cheese covered surfaces with salting solution. Salting solution consisted of pasteurized water and soluble 6% salt and added 2% potassium sorbate [27].

Chemical Analyses of Produced Cheese: Moisture content of milk and cheese was determined according to the AOAC [26]. Fat contents of samples were determined according to AOAC [28] *by Rose-Gottlieb Method, (905.02)*. pH values were determined using glass electrode pH meter (Model 810) Fisher Scientific

according to AOAC [28]. Total volatile fatty acids (TVFA) were determined according to Kosikowski [29].

Microbiological Analysis of Produced Cheese: Samples were prepared under aspectic conditions as outlined by Luck [30] which can be summarized as follows:

One gram of the cheese sample was accurately weighed under sanitary conditions, emulsified with 2% sterile sodium citrate solution and serial decimal dilutions were then conducted in sterile Ringer's solution and the standard plate count was used for counting the following group of bacteria:

Total bacterial count of cheese samples were determined according to APHA [31] using nutrient agar medium [32]. It consists of (g/L): beef extract 3 g; peptone, 5 g; agar agar, 15 g; distilled water 1 L and sterilized by autoclaving at 121°C for 15 min. The pH was adjusted to 6.8, plates were incubated at 30°C for 3 days before counting. Poured plate method was used, one ml of suitable fold serial dilutions of all cheese samples were inoculated onto a plate containing potato dextrose agar (PDA) medium (Three replicates). Approximately fifteen ml of PDA medium at about 50°C was poured in each plate, then thoroughly mixed and left for solidification. The plates were incubated at 25°C for 5 days. After the incubation period, developed colonies were counted per each plate. The mean count of plates was recorded to represent fungal count [31]. Most probable number (MPN) of coliform was determined according to APHA [31] using Mac Conkey broth, it consists of (g/L): Peptone 20 g; Lactose 10 g; Bile salts 5g; Sodium chloride 5 g; Neutral red 0.075 g; distilled water 1 L and sterilized by autoclaving at 121°C for 15 min. The pH was adjusted to 7.4, plates were incubated at 37°C for 2 days before counting. Psychrophilic and Thermophilic bacteria were counted according to the method described in the APHA [31]. Dilutions of the cheese and plates were prepared in the same manner described for the standard plate count except incubation of the plates, which was carried out at 5–7°C for 7-10 days in Psychrophilic Bacteria, while, the using of 15-18 ml agar and incubation of the plates for 48 hrs at 55°C in counting thermophilic bacteria.

Statistical Analysis: Data were analyzed using [33] computer program, GLM analysis of variance (ANOVA). Differences between means were detected by Duncan's Multiple Range Test [34].

Sensory Evaluation: Sensory tests were carried out according to the Scheme of Nelson and Torut [35]; a panel test of 15 panelists of the staff members of Microbiology, Food Science & Technology and Dairy Science Departments, Faculty of Agriculture, Damietta University. The cheese samples were evaluated for flavour (Out of 50 points), body & Texture (Out of 35 points) and color & appearance (Out of 15 points).

RESULTS AND DISCUSSION

Changes of Palm Oil Stability Parameters as Affected by Fortification with Spices

Total Phenolic Content: Determination of the total phenolic compounds is an important parameter to assess the benefit of the extraction of unknown plant materials for compounds with certain antioxidant activity, which gives an initial evidence whether the extraction of the material is worthwhile or not, the total amount of phenolic compounds extracted from the oil after treatment with spices material under conditions mentioned above determined by the Folin-Ciocalteau assay. The results of this colorimetric method expressed as Gallic acid equivalents ranged from16.7 mg/100g for palm oil to 143.2 mg/100g for turmeric sample (Table 3). From the results it seems that palm oil has a remarkable amount of phenolic compounds. A number of acidic and neutral phenolic compounds in crude palm oil, totaling about 100ppm. Most of these compounds have antioxidant properties and a major proportion of the compounds remain in the oil after refining [36]. Extraction of phenolic compounds by oil seems to be more selective for turmeric, while the amount of phenolic compounds was lower in the other plant material. Palm oil rich with turmeric spice has the highest value of phenolic compounds for both concentrations among the examined materials. At the same time the other spices have a remarkable level of phenolic compounds that ranged between 18.98 and 24.4 mg/100g (Table 3). Turmeric contains a wide variety of phytochemicals, including curcumin, demethoxycurcumin, bisdemethoxycurcumin, zingiberene, curcumenol, curcumol, eugenol, tetrahydrocurcumin, triethylcurcumin, turmerin, turmerones and turmeronols. Curcumin is hydrophobic in nature and frequently soluble in dimethylsulfoxide, acetone, ethanol and oils [15].

Extraction Effectiveness: Palm oil was used to extract different dried spices plant material under adjustment condition for the enrichment of the oil with both oil

Table 3: Total phenolic content of palm oil enriched with different spices

	Phenolic compounds [mg/100 g oil] as Gallic acid equivalent	
	Spices Concentration	
Samples	20 g/kg	50 g/kg
Palm oil (control)	16.7	
Palm with Paprika	19.04	18.98
Palm with Turmeric	84.8	143.2
Palm with Thyme	21.9	24.4
Palm with Cumin	20.1	22.7

Table 4: Oxidative stability of palm oil enriched with different spices

	Induction time		
Samples	20 g/kg	50 g/kg	Increase oxidative stability%
Palm with oil (Control)	15.05		
Palm with Paprika	16.3	16.8	2.9
Palm with Turmeric	19.2	23.1	17
Palm with Thyme	16.7	17.1	2.3
Palm with Cumin	16.9	17.5	3.4

soluble antioxidant active compounds and natural colourants from the plant material into the palm oil, the success of the extraction was measured by Rancimat test at 120°C to evaluate the extraction efficiency in addition to assess the activity of the extracted compounds on inhibiting the oxidation of the produced oil during accelerated heating.

Table (4) shows that control palm oil (Without spices treatment) has an induction period of 15.05 h at 120°C, while the oxidation stability increased after treatment with, turmeric, cumin, thyme and paprika spices, respectively. The highest increase was recorded for all plant material with an extraction over 24h at 50°C for the amount of plant material 50g/kg comparing with the concentration of plant material 20g/kg with increasing amount of plant material used for the extraction an improvement of the stability of the oils in the Rancimat test at 120°C took place, which the induction time for all plant material with the amount 20g/kg was 19.2h, 16.9h, 16.7h and 16.3h for turmeric, cumin, thyme and paprika, respectively. The increase with concentration of 50g/ kg was 23.05h, 17.51h, 17.1h and 16.8h, respectively for the same plant order. Doubling the extracted plant material only resulted in a 17% increase in oxidative stability as a maximum increase that recorded for turmeric. These results are in agreement with Taha *et al*. [22] who indicated that, doubling the extracted plant material only resulted in a 20% increase in oxidative stability when refined rapeseed oil was used for the extraction of active compounds of rosemary, sage and thyme.

Looking at these results, it is important to take into consideration that palm oil as a control without antioxidant treatment has good oxidative stability at elevated temperature used in this method, which contains a higher amount of saturated fatty acid that promote high oxidative stability for palm oil.

1-Diphenyl-2-Picrylhydrazyl (DPPH) Free Radical Scavenging Activity: An important parameter for the assessment of the activity of the produced palm oil in this experiment is the evaluation of the antioxidant activity, The DPPH free radical assay has been widely used for the characterization of the antioxidant activity of wide range of plant material. The results from the DPPH method for palm oil rich with natural antioxidants from spices are presented in Fig (1). The% for inhibition values ranged from 6.3 to 37.8%. Increasing the scavenging activity is not dose-dependently for all examined spices excepted for turmeric. Among oils, palm oil rich with turmeric had highest antiradical capacity for both concentrations (20 and 50 g/) kg showing, 28.3 and 37.8% scavenging effect against DPPH, respectively.

Curcumin is an oil-soluble pigment, practically insoluble in water at acidic and neutral pH and soluble in alkali. Curcumin has been shown to exhibit antioxidant, anti-inflammatory, antiviral, antibacterial, antifungal and anticancer activities and thus has a potential against various diseases [7].

In addition, the smallest effect was for palm oil rich with cumin spices. Also, palm oil with paprika and thyme spices showed a remarkable scavenging activity against

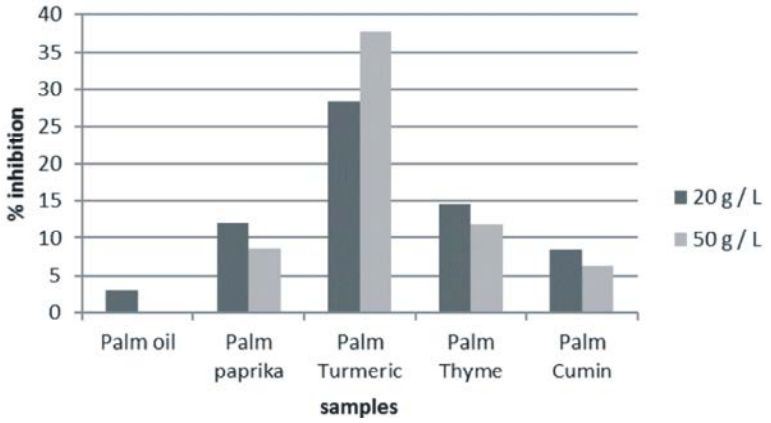

Fig. 1: Effect of enrichment of palm oil with spices on DPPH free radical (% inhibition).

DPPH. At the same time, palm oil without spices also showed 3.4% DPPH scavenging activity. Methanolic extracts of spices contain phytochemicals including polyphenols are reported to exhibit considerably high free radical scavenging and peroxide inhibition activity indicating its reducing character Anita *et al.* [37] composition, concentration of the constituents and extraction procedure are some factors which affect the efficiency of the extract.

Thus, the improved oxidative stability of the treated oils can be attributed to the presence of extracted lipophilic phenolic compounds. Taha *et al*. [22] found that only lipophilic components of the herbal materials were extracted into the oils and none of the polar phenolic compounds in the herbs was found in the extracted oils. Who also found that, in thyme treated rapeseed oil only thymol was detected despite the high level of rosmarinic acid in the original herb?

From this result it was derived that oil samples for the further Tallaga-like cheese made processes were prepared by treatment with 20 g plant material/kg oil for 24 h at 50°C.

Physico-chemical composition of Tallaga-like cheese treatments during storage period: Table 5 presented the effect of fortification of palm oil with Egyptian spices on pH, moisture, fat and TVFA values during the storage period (30 days) at refrigeration (5±2°C). The storage period had significant effect on all physico-chemical composition of treated Tallaga-like cheese, while non-significant effects for different treatments were showed on pH Values at the beginning and the ending of the storage period. The highest values of pH, moisture and fat estimated in Tallaga-like cheese treated with different additions were recorded at the begining of the storage period at the first day after manufacturing and began to decline significantly (p=0.05) to become at least after 30 day from the storage. In contrast, maximum values of TVFA were showed at the end of storage, while minmum values were printed after one day from manufacturing.

Similar results were found by El-Tantawy Ratiba *et al*. [38] it was reported that the white soft cheese treated with 0.15% thyme powder had the lowest value throughout the storage period (45days) while, control had the highest value of TVFA than other treatments. The acid- base titration revealed that the pH decreased gradually during storage. Previous studies on the labneh decided on the addition of thyme oil 0.2 ppm affected the pH, soluble nitrogen-to-total nitrogen and total volatile fatty acids. On the other hand, total solids and fat-to-dry matter values were only slightly affected [39]. On the other hand, the addition of cumin derived essential oil at (0.3, 0.5 and 0.8%) affected the pH and total volatile fatty acid values of the prepared labneh, while, total solids and fat values were slightly affected [40].

Microbiolical Analysis of Tallaga-like Cheese Treatments During Storage Period: The effects of palm oil fortification with some Egyptian spices on total viable bacterial counts, mould and yeast counts, Thermophilic and Psychrophillic bacterial counts were illustrated in Table 6. The total viable bacterial counts, moulds and yeasts, Thermophilic and Psychrophillic bacterial were observed in all treatments and decreased till the end of storage.

The effect of the storage period was found to be highly significant (p=0.001) on the number of total bacterial counts in Tallaga-like cheese with different additions (Palm oil, palm with Turmeric, palm with Thyme, palm with Paprika and palm with cumin), the highest number of total bacterial counts was recorded at the begining of the storage period and had almost the same value, that ranged from 3.50 to 3.53 X 10^2 and began to decline gradually to become in the range of 3.11 to 3.27 X

Table 5: Physico-chemical composition of Tallaga-like cheese treatments during storage period

		Treatments					
Properties	Storage Period	Control	T_1	T_2	T_3	T_4	Means±SD
pH	0	6.00^{a}	6.01^{a}	6.03^{a}	6.00^{a}	5.98^{a}	6.00±0.01^{A}
	7	^{B}5.50^{b}	^{AB}5.52^{b}	^{AB}5.55^{b}	^{AB}5.58^{b}	^{A}5.62^{b}	5.55±0.04^{B}
	15	^{C}4.93^{c}	^{B}4.99^{c}	^{B}5.01^{c}	^{B}5.03^{c}	^{A}5.12^{c}	5.02±0.06^{C}
	21	^{CD}4.75^{d}	^{CB}4.77^{d}	^{B}4.81^{d}	^{A}4.87^{d}	^{D}4.71^{d}	4.78±0.06^{D}
	30	4.47^{e}	4.50^{e}	4.51^{e}	4.50^{e}	4.61^{e}	4.52±0.05^{E}
	Means±SD	5.13±0.61	5.16±0.60	5.18±0.60	5.20±0.59	5.21±0.58	
Moisture	0	^{C}58.50^{a}	^{CB}58.60^{a}	^{A}58.80^{a}	^{C}58.45^{a}	^{AB}58.70^{a}	58.61±0.14^{A}
	7	^{A}58.40^{a}	^{AB}58.30^{b}	^{AB}58.30^{b}	^{AB}58.35^{ab}	^{B}58.20^{b}	58.31±0.07^{B}
	15	^{C}58.00^{b}	^{A}58.30^{b}	^{AB}58.20^{b}	^{AB}58.25^{b}	^{CB}58.10^{b}	58.17±0.12^{B}
	21	^{B}57.10^{c}	^{A}57.40^{c}	^{A}57.50^{c}	^{B}57.20^{c}	^{B}57.10^{c}	57.26±0.18^{C}
	30	^{CB}56.10^{d}	^{B}56.20^{d}	^{A}56.40^{d}	^{C}56.00^{d}	^{CB}56.15^{d}	56.17±0.14^{D}
	Means±SD	57.62±1.01	57.76±0.98	57.84±0.92	57.65±1.05	57.65±1.01	
Fat	0	^{AB}18.10^{a}	^{A}18.20^{a}	^{AB}18.10^{a}	^{BC}18.00^{a}	^{C}17.90^{a}	18.06±0.11^{A}
	7	^{A}17.70^{b}	^{A}17.80^{b}	^{A}17.80^{b}	^{A}17.60^{b}	^{B}16.93^{b}	17.57±0.36^{B}
	15	^{CB}17.20^{c}	^{AB}17.30^{c}	^{A}17.40^{c}	^{CD}17.10^{c}	^{D}17.00^{c}	17.20±0.15^{C}
	21	^{AB}16.80^{d}	^{AB}16.80^{d}	^{A}16.90^{d}	^{BC}16.70^{d}	^{C}16.60^{d}	16.76±0.11^{D}
	30	^{AB}16.40^{e}	^{B}16.30^{e}	^{B}16.50^{e}	^{B}16.30^{e}	^{AB}16.40^{e}	16.38±0.08^{E}
	Means±SD	17.24±0.68	17.28±0.75	17.34±0.65	17.18±0.68	16.97±0.57	
TVFA	0	7.44^{a}	7.45^{a}	7.43^{a}	7.44^{a}	7.43^{a}	7.44±0.01^{A}
	7	^{B}9.55^{b}	^{B}9.51^{b}	^{B}9.63^{b}	^{A}9.80^{b}	^{C}9.22^{b}	9.54±0.21^{B}
	15	^{C}12.80^{c}	^{E}11.60^{c}	^{B}13.20^{c}	^{D}12.50^{c}	^{A}13.40^{c}	12.70±0.70^{C}
	21	^{C}16.10^{d}	^{B}16.30^{d}	^{A}16.50^{d}	^{D}15.20^{d}	^{C}16.10^{d}	16.04±0.49^{D}
	30	^{A}18.00^{e}	^{B}16.80^{e}	^{C}17.20^{e}	^{D}16.40^{e}	^{E}17.60^{e}	17.20±0.63^{E}
	Means±SD	12.78±4.39	12.33±4.12	12.79±4.24	12.27±3.71	12.75±4.35	

^{abcde} Letters indicate significant differences between storage period.

^{ABC} Letters indicate significant differences between palm oil treatment.

Control: Palm oil, T_1: Palm with Turmeric, T_2: Palm with Thyme, T_3: Palm with Paprika and T_4: Palm with Cumin

* Expressed as ml NaOH 0.1 N/100gm cheese samples.

Table 6: Microbiolical analysis of Tallaga-like cheese treatments during storage period

Classification	Storage period	Control	T_1	T_2	T_3	T_4	Mean±SD
Total viable Bacterial Counts (log 10^2)	0	3.53^{a}	3.50^{a}	3.51^{a}	3.51^{a}	3.53^{a}	3.51±0.01^{A}
	7	^{A}3.47^{b}	^{B}3.44^{b}	^{A}3.47^{b}	^{A}3.47^{b}	^{A}3.50^{a}	3.47±0.02^{A}
	15	^{A}3.44^{b}	^{B}3.34^{c}	^{A}3.41^{c}	^{B}3.34^{c}	^{A}3.41^{b}	3.38±0.04^{B}
	21	^{A}3.39^{c}	^{C}3.25^{d}	^{AB}3.37^{d}	^{C}3.25^{d}	^{B}3.34^{c}	3.32±0.06^{C}
	30	^{A}3.25^{d}	^{B}3.14^{e}	^{A}3.27^{e}	^{B}3.11^{e}	^{A}3.25^{d}	3.20±0.07^{D}
Mean±SD		3.41±0.10	3.33±0.14	3.40±0.09	3.33±0.16	3.40±0.11	
Psychrophillic Bacterial Counts (log 10)	0	^{AB}2.99^{a}	^{B}2.95^{a}	^{A}3.04^{a}	^{A}3.07^{a}	^{A}3.07^{a}	3.02±0.05^{A}
	7	2.90^{ab}	2.90^{ab}	2.95^{ab}	2.99^{ab}	2.90^{b}	2.92±0.04^{AB}
	15	2.77^{b}	2.77^{cb}	2.90^{cb}	2.90^{cb}	2.84^{cb}	2.83±0.06^{B}
	21	^{B}2.59^{c}	^{AB}2.69^{c}	^{A}2.84^{cd}	^{A}2.48^{cd}	^{A}2.77^{cd}	2.67±0.14^{C}
	30	2.59^{c}	2.69^{c}	2.77^{d}	2.77^{d}	2.69^{d}	2.70±0.07^{C}
Mean±SD		2.76±0.18	2.80±0.12	2.90±0.10	2.84±0.23	2.85±0.14	
Mould and Yeast Counts (log 10)	0	^{B}2.59^{a}	^{AB}2.69^{a}	^{B}2.59	^{A}2.77^{a}	^{A}2.84^{a}	2.69±0.11^{A}
	7	2.46^{ab}	2.59^{a}	2.59	2.59^{ab}	2.69^{a}	2.58±0.08^{A}
	15	2.46^{ab}	2.46^{ab}	2.46	2.59^{ab}	2.69^{a}	2.53±0.10^{AB}
	21	2.25^{cb}	2.25^{b}	2.46	2.47^{cb}	2.59^{a}	2.40±0.14^{B}
	30	2.00^{c}	2.00^{c}	2.25	2.26^{c}	2.25^{b}	2.15±0.13^{C}
Mean±SD		2.35±0.23	2.39±0.27	2.47±0.13	2.53±0.18	2.61±0.22	
Thermophilic Bacterial Counts (log 10)	0	^{A}3.07^{a}	^{A}3.07^{a}	^{B}2.99^{a}	^{A}3.08^{d}	^{B}2.99^{a}	3.04±0.04^{A}
	7	2.99^{ab}	2.99^{ab}	2.95^{a}	2.90^{a}	2.90^{b}	2.94±0.04^{AB}
	15	2.90^{b}	2.90^{cb}	2.90^{ab}	2.77^{ab}	2.84^{b}	2.86±0.05^{B}
	21	^{AB}2.77^{c}	^{A}2.84^{c}	^{A}2.84^{cb}	^{B}2.69^{cb}	^{B}2.69^{c}	2.76±0.07^{C}
	30	^{AB}2.69^{c}	^{AB}2.69^{d}	^{A}2.77^{c}	^{BC}2.59^{c}	^{C}2.47^{d}	2.64±0.11^{D}
Mean±SD		2.88±0.15	2.89±0.14	2.89±0.08	2.80±0.19	2.77±0.20	

^{abcde} Letters indicate significant differences between storage period.

^{ABC} Letters indicate significant differences between palm oil treatment.

Control: Palm oil, T1: Palm with Turmeric, T2: Palm with Thyme, T3: Palm with Paprika and T4: Palm with Cumin

10^2 at the end of the storage after 30 day. Also the storage period had significant effect on the number of psychrophillic bacterial counts that ranged from 3.07 X 10 (Cheese with palm plus Paprika and cheese with palm plus cumin) at the first day after manufacturing to 2.59 X 10 (Cheese with palm oil, only) after 30 day from manufacturing. Regarding the number of mould and yeast counts, the storage period also had significant effect on all treated cheese except for cheese with palm oil plus thyme (p=0.14) and the maximum number (2.84 X 10) was showd in cheese with palm plus cumin, while the minimum number (2.00 X 10) was in cheese with palm oil only and palm oil plus turmeric. In connection with the number of thermophilic bacterial count was at range from 3.07 X 10 in cheese with palm oil only and palm oil plus Turmeric to 0.47 X 10 in cheese with palm oil plus cumin.

The results in Table (6) indicated that the number of total bacterial count was at range from 3.11 X 10^2 in cheese with palm oil plus paprika after 30 day from manufacturing to 3.53 X 10^2 in cheese with palm oil, only and with palm oil plus cumin after one day from manufacturing. In connection with the number of psychrophillic bacterial counts, the highest number (3.07 X 10) was recorded in cheese with palm oil plus paprika and cheese with palm oil plus cumin at the begining of the storage period, while the lowest (2.48 X 10) was showed in cheese with palm oil plus paprika after 21 day from the storage. Regarding the number of mould and yeast counts, the lowest number (2.00 X 10) was recorded in cheese with palm oil only and palm oil plus turmeric after month from manufacturing, while the highest number (2.84 X 10) was showd in cheese with palm oil plus cumin after one day from the storage. The number of thermophilic bacterial count was at range from 2.47 X 10 in cheese with palm oil plus cumin at 30 day from the storage to 3.08 X 10 in cheese with palm oil plus paprika at the begining of the storage period. Al.Otaibi and El. Demerdash [39] found that the Total viable counts, as well as counts of *Streptococcus thermophilus* and *Lactobacillus delbrueckii ssp. bulgaricus* in the treated labneh by thyme oil 0.2 ppm increased and reached a maximum after 7 days of storage where after it decreased until the end of the storage period, while Hosny *et al*.[41] revealed that addition of aqueous curcumin extract (0.3%) to cheese milk of Karishcum achieved a reduction of bacterial counts about one log of *Salmonella typhimurium*, two log of *Pseudomonas aeruginosa* and *E. coli* 0157:H7, respectively. Meanwhile each of *S. aureus, B. cereus* and *L. monocytogenes* were vanished at the end of the cold storage period (14 days).

The coliforms bacteria could not be found in all treatments, this results are in agreement with Thabet *et al*. [40] who reported that the coliform and staphylococcus bacteria were not detected, while yeasts and moulds were detected insignificantly in some treated labneh for cumin derived essential oil at (0.3, 0.5 and 0.8%). Al. Otaibi and El. Demerdash [39] found that the yeasts and moulds and coliform bacteria were not detected in the treated labneh by Curcumin extract. On the other side, Ratiba El-Tantawy *et al*. [38] found that the coliforms were present in cheese from different treatments except in cheese with 0.15% thyme powder where it disappeared after 45 days and the addition of the tested spices decreased the total viable count and yeast and moulds with no effect on psychrophilic counts in cheese compared to control. Bajpai *et al*. [42] found that the spices such as allspice, bay leaf, caraway, coriander, cumin, cassia bark and liquorice have been reported to have significant bacteriostatic/inhibition properties for pathogenic and spoilage micro-organisms**,** while, Ceylan and Fung [43] decided that, Cumin (Cuminum cyminum) was effective against *Bacillus cereus, Bacillus subtilis, Clostridium botulinum, Listeria monocytogenes, Pseudomonas fluorescens, Salmonella enteritidis* and *Staphylococcus aureus*. Agaoglu *et al*. [44] found that the Cumin showed the strongest antimicrobial effects against *Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa, Escherichia coli, Enterococcus faecalis, Mycobacterium smegmatis, Micrococcus luteus* and *Candida albicans* as test strains, with inhibition zones between <10 and >30 mm by the disc-diffusion method.

Senesory Evaluation of Tallaga-like Cheese Treatments During Storage Period: The results given in Table 7 described the influence of palm oil fortification with spices and using for Tallaga-like cheese producing then storage at cold temperature for 30 days on the organoleptic properties of the cheese. The results showed that, no pronounced differences were observed in body and texture scores of different cheese treatments. The main differences were found in sensory evaluated color & appearance and flavour. Formulation ingredients of treatments control, turmeric and paprika granted the resultant cheese had the highest scores of flavour at zero time (48) out of 50 for fresh cheese and during storage period, while, cheese with cumin treatment had nearer value (40) out of 50. With respect to color and appearance, cheese treatments of with control, turmeric

Table 7: Senesory evaluation of Tallaga-like cheese treatments during storage period (Means)

Treatment	Storage period	Flavour (out of 50 points)	Body&Texture (out of 35 points)	Color&appearance (out of 15 points)	Total (100 points)
Palm with oil (Control)	0	48	33	14	95
	7	46	32	14	92
	15	45	31	14	90
	21	41	30	13	84
	30	38	28	13	79
Palm with Turmeric	0	48	33	14	95
	7	45	33	14	92
	15	42	32	14	88
	21	38	31	13	82
	30	35	28	13	76
Palm with Thyme	0	46	33	14	93
	7	45	32	14	91
	15	45	32	13	90
	21	38	31	12	81
	30	35	29	12	76
Palm with Paprika	0	48	32	10	90
	7	46	31	9	86
	15	44	30	9	83
	21	40	29	8	77
	30	35	25	7	67
Palm with Cumin	0	40	32	13	85
	7	40	32	13	85
	15	38	30	12	80
	21	36	29	11	76
	30	32	28	10	70

Table 8: Tallaga-like cheese ingredients prices (100 kg)

Ingredients	Skim Milk (Kg)	Skim Milk powder (Kg)	Shortening palm oil (Kg)	Rennet (gm)	Calcium chloride (gm)	Potassium Sorbate (gm)	Stabilizer (gm)	Salt (Kg)	Spices price	Total Price (LE)
Price (LE)	2.50	25	9.6	900	20	45	40	0.75	--	--
Palm oil (control)	50	500	172.8	4.5	0.4	0.9	0.4	12	--	741
Palm with Turmeric	50	500	172.8	4.5	0.4	0.9	0.4	12	10.8	751.8
Palm with Thyme	50	500	172.8	4.5	0.4	0.9	0.4	12	11.52	752.52
Palm with Paprika	50	500	172.8	4.5	0.4	0.9	0.4	12	11.52	752.52
Palm with Cumin	50	500	172.8	4.5	0.4	0.9	0.4	12	14.4	755.4

and thyme gained higher scores than that of other treatments (14) out of 15 for fresh cheese and cheese with paprika had nearer value (10) out of 15.

Total scoring points were highly marked for cheese with control and turmeric 95 out of 100, while cheese with thyme and paprika had only 93 and 90 out of 100, respectively. Cheese with cumin gained 85 points out of 100. However, at the end of storage periods (30 days) samples made by all ingredients gained the lowest scores. Similar results were found by Thabet *et al*. [40]. Hosny *et al*. [41] decided to addition 0.3% (w/v) curcumin in cheese milk before making of Karishcum to get good taste and long shelf-life. On the other side, sensoric evaluation showed that the addition of thyme powder improved the flavor and quality of white soft cheese made from goats' milk. Therefore, could be successfully made from goats' milk with thyme powder used as natural preservatives and improved the flavour of goat's cheese with storage at 6±1°C for 45 days [38].

Economic Study: Data in Tables 8 and 9 show the simple economic analysis for fortification of palm oil with four different spices in analogue Tallaga-like cheese manufacture. The costs of the ingredients used in the analyzed blends as well as the total price are shown in the same table. As usual by 20% concentration of spices added for enrichment of palm oil used for Tallaga-like cheese production the costs of production increased. Total prices for production of 100 kg of Tallaga- like cheese fortified with spices were 741, 751.8, 752.52, 752.52 and 755.4 L.E. for control, turmeric, thyme, paprika and cumin, respectively.

Table 9: Economic analysis of Tallaga-like cheese samples

Treatments	Total price*	Processing (15%)	Total	Increase in Production cost (LE)**	Increase in Production cost (%)
Palm oil (control)	741	111.15	852.15	--	--
Palm with Turmeric	751.8	112.77	864.57	12.42	1.46
Palm with Thyme	752.52	112.88	865.4	13.25	1.55
Palm with Paprika	752.52	112.88	865.4	13.25	1.55
Palm with Cumin	755.4	113.31	868.71	16.56	1.94

*One American Dollar ($) = 8 Egyptian pounds (L.E.)

**One Egyptian pounds (L.E.) = 100 piasters (PT).

After adding 15% of total ingredients prices as a cost of processing in addition to the costs of packaging process the increase in production cost (L.E) was 12.42 (For turmeric), 13.25 (For thyme), 13.25 (For paprika) and 16.56 (For cumin). It could be appeared that the increase after enrichment with spices was not high comparing to control cheese and it recorded only 1.46, 1.55, 1.55 and 1.94% for Turmeric, thyme, paprika and cumin, respectively.

Finally, adding of 20% spices to palm oil and use for Tallaga–like cheese production could be used economically and achieved the desired effect of the produced cheese in the same time.

CONCULASION

In conclusion, using of palm oil fortified with natural active compounds from some Egyptian spices (Paprika, thyme, cumin and turmeric) for Tallaga-like cheese processing could be recommended not only for improvement of the resultant cheese quality but also for increment its microbial stability, economic study and enhancement its organoleptic properties by economical manner. Turmeric and thyme are highly recommended for this purpose.

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