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EFFECT OF CARDAMOM, THYME AND CLOVE POWDER ON THE COMPOSITION AND QUALITY OF WHITE SOFT CHEESE MADE FROM GOAT'S MILK

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Abstract: White soft cheese was made from heated goat's milk (75°C) and Cardamom powder (0.10 and 0.20%) thyme powder (0.10 and 0.15%), and clove powder (0.10 and 0.20%) were added to the cheese curd before whey drainage. The obtained cheese were stored in brine at 6±1ºC and analyzed when fresh and after 15, 30, and 45 days of storage for chemical composition, microbiological quality and sensoric properties. Cheese from different treatments had almost the same moisture, fat, salt and total nitrogen contents, with no significant differences (P≤0.05), but soluble nitrogen (SN) and Non-protein nitrogen (NPN), were less in cheese with different additives as compared with control. The acid- base titration revealed that the ($\oint$ αdpH) decreased gradually during storage. However, cheese with (0.20%) cardamom showed higher ($\oint$ αdpH) compared to other treatments. Cheeses with added cardamom developed less acidity than cheeses from other treatments. Addition of the tisted spices decreased the total viable count (TVC) and yeast and moulds (Y&M) with no effect on psychrophillic counts in cheese compared to control. However, coliforms were present in cheese from different treatments except in cheese with 0.20% clove or 0.15 % thyme where it disappeared after 45 days. Sensoric evaluation showed that the addition of cardamom, thyme and clove powder decreased the total scores of judging especially for body & texture and appearance compared to control. Cardamom was given the highest scores, while thyme recorded the lowest scores. White soft cheese could successfully made from goat's milk, tested spices powder could be used as natural preservatives and improved the flavour of goat's cheese, especially clove and cardamom powder, (0.10 and 0.20%).

Key words: Soft cheese, goat's milk, spices, cheese composition, microbiological quality, sensory properties.

Introduction

Goat's have been among the first animals to be domesticated. They can utilize poor quality feeds. They have astonishing adaptability to adverse climatic and geophysical

conditions Riekeman, (2005). It is well known that goat's have been regarded as a source for milk production. A good dairy goat can produce up to 10% of its body weight of milk (Peterson, 2005). In Egypt, increased attention has been focused towards goat's milk production because of its lower cost compared with cow's milk production and its chemical similarity to cow's milk. The annual Egyptian goat's milk production in 1998 was 116000 tons (F.B.S. 1998) and increased to 132000 tons in 2003 (F.B.S. 2003). The economy of goats' farming can be enhanced in future if goat's milk can be converted into value added products. Goat's milk is much more easily digested than cow's milk, also goat's milk has 13% less lactose than cow's milk and most people who are allergic to cow's milk tend not to be allergic to goat's milk. (Einsiedel, 2005 and Riekeman, 2005). Goat's milk has been used since ancient times for the manufacture of different types of cheeses, throughout the world. Many famous varieties of cheese are made from goat's milk, particularly in France, Spain and Italy, while in Egypt goat's milk products are not highly accepted because of the "goaty flavour". Spices and herbs are used in foods today mainly for their flavours and aroma. In addition to imparting flavour, certain spices prolong the shelf- life of foods due to their bacteriostatic or bacteriocidal activity, and some prevent rancidity by their antioxidant activity (Shelef et al; 1980). Many plant essential oils of spices are active against various food –borne bacteria and molds (antimicrobial activity) (Aureli et al; 1992; Tassou et al; 1995 and Gould, 1996). Spices and oils were distinguishably used for their therapeutic action, for flavouring and much used in popular medicine (Taylar and Robbers, 1999). Several investigators used natural flavouring additives in some dairy products as flavours, preservating and antibacterial materials. (Abou Dawood, 1999, Abd–Alla *et al.*, 2000, El-Nemer *et al.*, 2003 and 2004; and Hussein, 2004). This work aimed to use goat's milk in making good quality white soft cheese with using some herbs and species. The effect of these additives on the chemical, microbiological and sensory properties of the resultant cheese were measured during cold storage.

Material and Methods:

Materials

1- Goat's milk was obtained from a private farm in Fayoum district, Egypt. The gross chemical composition of goat's milk is presented in Table (1).

2- Microbial rennet powder from Murcor meihei (Hannilase) was obtained from Hansen's Laboratories (Denmark).

3- Commercial edible grade table salt (Sodium Chloride) produced by El-Nasr Company for salt, Alex., Egypt was obtained from the local market.

4- Calcium chloride used was obtained from Solvay, Italy.

5- Spices and herbs: Leaves of thyme, seeds of cardamom and flowers clove were obtained from local spices market (Attar) at Fayoum. They were grinded to fine powder before use.

Methods

1- Cheese manufacture: White soft cheese was made from heated 35 Kg goat's milk (75°C and cooled to 40°C) as described by Fahmi & Sharara (1950). Calcium chloride, salt and rennet were added at the ratio of 0.02%, 4.0% and 0.003%, respectively, stirred well and set for 2 h. The cheese curd was divided into seven equal portions as follow:

- Cheese curd without additives (as control).
- T_1 & T_2 cardamom powder at ratios of 0.10 and 0.20 %, respectively.
- T_3 & T_4 thyme powder at ratios of 0.10 and 0.15%, respectively.
- T_5 & T_6 clove powder at ratios of 0.10 and 0. 20%, respectively.

Cardamom, thyme and clove powder were added to the curd cheese during packaging the curd, with manual genteelly distribution, and curd was left for 24 h for complete whey drainage.

Resultant different treatments were divided in cubes, packaged into plastic containers, covered with salted whey (4% Nacl). The containers were tightly closed and stored at 6±1°C for 45 days. Cheese samples were taken when fresh and after 15, 30 and 45 days for chemical, microbiological analysis and sensory evaluation. All experiments were performed in triplicates and each analysis in triplicates and average results were recorded in appropriate tables. The selected ratios of Cardamom, thyme and clove powder were used based on the preliminary preference test by panelists.

Chemical analysis:

Samples of White soft cheese were analyzed for moisture and salt contents as described by Bradley *et al.* (1992). The Gerber method was used for fat determination in milk and cheese as described by Ling (1963). Titratable acidity (TA %) of milk and cheese samples were determined as described in A.O.A.C. (2000). pH values of milks and cheese were determined using a digital pH meter (540-GLP, Multical., Germany). The total nitrogen (TN), water-soluble nitrogen (WSN) and non-protein nitrogen (NPN) contents were determined using macro-Kjeldahl method as described by A.O.A.C.

(1990). Total volatile fatty acids (TVFA) were determined by the direct distillation method as described by Kosikowski, (1978), and values are expressed as ml 0.1 NaOH/100gm cheese. The acid–base titration of cheese samples and measurement of hysteresis loop was carried out the modified method of Kirchmeier (1979). The quantitative measurement of hysteresis is performed with the closed integration of ($\oint \alpha dpH$) which represent the hysteresis area. This value of ($\oint \alpha dpH$) is obtained with a simple method through measuring the hysteresis loop and (1.0 α x 1.0 pH) unit using planimeter (digital planimeter, model planix 7).

Microbiological analysis

The total viable and Psychrophillic counts of cheese samples were determined using plate count agar standard medium, while Coliform count was estimated by using MacConkey broth as described by Bridson (1990). .Potato dextrose agar medium was used in counting yeasts and moulds as described by Bradly et al (1985).

Sensory evaluation

Sensory tests were carried out according to the Scheme of (Nelson and Torut, 1981), a panel test of 15 panelists of the staff members of Microbiology, Food Science & Technology and Dairy Science Departments, Faculty of Agriculture, Fayoum 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).

Statistatical analysis

All the experiments were performed in triplicate and the results were analyzed statistatically. General linear Models (GLM) were performed using SPSS (1999) for windows, version 9 software package according to the following model:

$$Y_{ijk} = \mu + T_i + P_j + TP_{ij} + e_{ijk}$$

Where:

Y_{ijk}: Observation of the i^{th} treatment within the j^{th} pickling period.

μ: Grande mean,

T_i: Treatments (i: 1 to 8),

P_j: Pickling period (j: 1 to 4),

TP_{ij}: Interaction of treatment by pickling period and e_{ijk}: random error term.

Significant differences among treatments, pickling periods and the interaction means between them were compared at $P \leq 0.05$ level of significance using Duncan's multiple range test (Duncan, 1955).

Results and Discussion

Gross composition of goat's milk.

Table (1) show the fat, protein, lactose, total solids (TS), solids not fat (SNF) and ash content of goat's milk used in white soft cheese manufacture, which were in accordance with those obtained by EL-Almy *et al.* (1990).

Table (1): Gross composition of goat's milk used in white soft cheese manufacture.

Parameters	Goat's milk
Fat %	4.15
Protein %	3.50
Lactose %	4.90
Total solids %	13.45
Solids not fat %	9.20
Ash %	0.80
Titratable acidity %	0.18
PH	6.80

Changes in the composition of white soft cheese during storage..

Table (2) shows no differences in the moisture content of fresh goat's milk cheese from all treatments as compared to control. However, this data indicated higher moisture content than specified in the Egyptian standards ie.60% (EOS, 2002). The moisture content of cheese from different treatments increased slightly after 15days of storage and a few decrease thereafter. The observed increase in the moisture after 2 weeks can be attributed to the low temperature storage, which would increase the water holding capacity of cheese matrix. However, the developed acidity, thereafter would counter act this effect inducing curd contraction and decrease in the cheese moisture. The present results are in agreement with of Abd El–Kader (2001) and Salama (2004). The fat /dry matter content of cheese from different treatments was in accordance with the standard specification of full fat soft cheese (EOS, 2002). The fat /DM of cheese from different treatments was almost unchanged during storage, that no significant differences ($P \leq 0.05$) in fat / DM can be found between treatments. Similar results were reported (Fahmy & Hanafy, 1992; Abd-El-Kader *et al.*, 2001 and Salama, 2004).

Table(2): Change in moisture (%) and fat/dry matter of goat's white cheese as affected by added spices and storage period.

Items	Storage period (days)				
	Fresh	15	30	45	Treatment effect
	Moisture (%)				
Control	65.28^{a}	67.12^{a}	65.54^{a}	64.52^{a}	65.62±0.52^{A}
T1	65.32^{a}	67.20^{a}	65.73^{a}	64.82^{a}	65.77±0.76^{A}
T2	65.30^{a}	67.33^{a}	65.88^{a}	64.91^{a}	65.86±0.45^{A}
T3	65.30^{a}	67.25^{a}	65.77^{a}	64.72^{a}	65.76±0.76^{A}
T4	65.26^{a}	67.40^{a}	65.83^{a}	64.85^{a}	65.84±0.71^{A}
T5	65.30^{a}	67.19^{a}	65.61^{a}	64.68^{a}	65.70±0.76^{A}
T6	65.25^{a}	67.35^{a}	65.70^{a}	64.79^{a}	65.77±0.76^{A}
Period effect	65.08±0.49^{B}	67.13±0.45^{A}	65.58±0.41^{B}	64.53±0.44^{B}	
Fat / Dry matter (%)					
Control	46.08^{a}	47.29^{a}	46.87^{a}	46.51^{a}	46.69±0.33^{B}
T1	46.14^{a}	47.26^{a}	46.69^{a}	46.48^{a}	46.64±0.52^{B}
T2	46.10^{a}	47.18^{a}	46.60^{a}	46.31^{a}	46.55±0.42^{B}
T3	46.11^{a}	47.33^{a}	46.89^{a}	46.49^{a}	46.71±0.53^{B}
T4	46.06^{a}	47.39^{a}	46.68^{a}	46.37^{a}	46.63±0.48^{B}
T5	46.11^{a}	47.24^{a}	46.82^{a}	46.43^{a}	46.65±0.54^{B}
T6	46.04^{a}	47.17^{a}	46.65^{a}	46.29^{a}	46.54±0.51^{B}
Period effect	46.73±0.51^{A}	47.79±0.43^{A}	47.33±0.44 ^{A}	47.05±0.48 ^{A}	

A, B and C: Means within the same effect having different capital superscripts are significantly different (P≤0.05). Control = white soft cheese made from goat's milk

T1 = goat's white soft cheese contained 0.1%. cardamom powder.

T2 = goat's white soft cheese contained 0.2% cardamom powder.

T3 = goat's white soft cheese contained 0.1% thyme powder.

T4 = goat's white soft cheese contained 0.15% thyme powder.

T5 = goat's white soft cheese contained 0.1% clove powder.

T6 = goat's white soft cheese contained 0.2% clove powder.

Table (3) shows that the cheese acidity increased progressively during storage in all treatments as well as the control in accordance with previous report (Mehanna & Hefnawy, 1991 and Ahmed & Abdel–Razig, 1998). The changes in pH value of cheese followed an opposite trend to change in TA. The development of acidity can be attributed to the growth and activity of cheese microflora. However, the development of acidity was slower in cheeses containing added spices especially that containing 0.2% cardamom which showed the lowest developed acidity. This suggests that added spices reduce the growth and activity of cheese microflora. The present results are in agreement with that of Abou-Dawood(1996) ,Hussein (2004)and Abd-Alla et al;(2000) Statistical analysis showed that differences in TA due to treatments and storage period were significant ($P \leq 0.05$).The titration curve gives an indication for changes in cheese proteins during storage. The quantitative measurements of the hysteresis loop is given by ($\oint \alpha dpH$) of cheeses are gives in (Table 3). It is obvious that the ($\oint \alpha dpH$) decreased gradually during storage period suggesting protein degradation. The ($\oint \alpha dpH$) of cheese containing spices were slightly higher than that the control throughout the storage period especially cheese containing 0.2% cardamom which showed the highest ($\oint \alpha dpH$) compared to other treatments suggesting slower proteolysis in this treatment. The present results are in accordance with that reported by El-shobery (1988), Shendy (1989) and El-Tawel (2004). Statistical analysis revealed significant difference ($P \leq 0.05$) in ($\oint \alpha dpH$) for treatments and storage period. It clear from the results that salt content of cheese (Table 3) greatly associated with moisture content. At the beginning of the storage period there were no clear differences between treatments, while salt content of all resultant cheeses were slightly decreased at 15 days, then increased till the end of storage period. The statistical analysis for salt content clarified that; there were no interaction between treatments, whereas period affected significantly ($P \leq 0.05$).

Table(3): Change in titratable acidity (%), pH values, degree of hysteresis ($\oint$ αdpH) area and salt content % of goat's white cheese as affected by added spices and storage period.

Items*	Storage Period (days)				
	Fresh	15	30	45	Treatment effect
	TA (%)				
Control	0.22^{g}	0.55^{e}	0.77^{d}	1.10^{a}	$0.66\pm.097^{A}$
T1	0.22^{g}	0.45^{f}	0.60^{e}	0.85^{bc}	$0.53\pm.096^{D}$
T2	0.22^{g}	0.40^{f}	0.55^{e}	0.80^{cd}	$0.49\pm.064^{E}$
T3	0.22^{g}	0.48^{f}	0.60^{e}	0.95^{b}	$0.56\pm.079^{C}$
T4	0.22^{g}	0.40^{f}	0.55^{e}	0.90^{b}	$0.52\pm.075^{D}$
T5	0.22^{g}	0.50^{e}	0.70^{d}	1.00^{a}	$0.61\pm.086^{B}$
T6	0.22^{g}	0.42^{f}	0.65^{e}	0.92^{b}	$0.55\pm.079^{C}$
period effect	$0.22\pm.0016^{D}$	$0.46\pm.011^{C}$	$0.63\pm.016^{B}$	$0.93\pm.019^{A}$	
PH values					
Control	6.35	5.35	4.90	4.70	
T1	6.40	5.50	5.10	4.80	
T2	6.40	5.60	5.20	4.95	
T3	6.40	5.40	5.10	4.80	
T4	6.45	5.60	5.15	4.90	
T5	6.35	5.40	4.95	4.75	
T6	6.40	5.55	5.00	4.90	
degree of hysteresis ($\oint$ αdpH) area					
Control	0.412cd	0.315g	0.280h	0.254gh	0.315±.0180F
T1	0.395de	0.368ef	0.347fg	0.317g	0.357±.0092C
T2	0.397de	0.384de	0.369ef	0.343fg	0.373±.007B
T3	0.409cd	0.329g	0.313g	0.284h	0.333±.014E
T4	0.402cd	0.378ef	0.355f	0.315g	0.363±.0098C
T5	0.395de	0.323g	0.297h	0.268h	0.321±.015F
T6	0.409cd	0.368ef	0.308g	0.295h	0.345±.014D
Period effect	0.417±.0085A	0.368±.0104B	0.335±.0086C	0.306±.0080C	
salt content %					
Control	2.90^{a}	2.80^{a}	2.98^{a}	3.25^{a}	$2.98\pm.059^{A}$
T1	2.85^{a}	2.75^{a}	2.88^{a}	3.15^{a}	$2.91\pm.054^{A}$
T2	2.85^{a}	2.73^{a}	2.80^{a}	3.10^{a}	$2.90\pm.046^{A}$
T3	2.85^{a}	2.75^{a}	2.85^{a}	3.18^{a}	$2.91\pm.054^{A}$
T4	2.85^{a}	2.70^{a}	2.82^{a}	3.13^{a}	$2.86\pm.050^{A}$
T5	2.90^{a}	2.75^{a}	2.95^{a}	3.20^{a}	$2.95\pm.060^{A}$
T6	2.85^{a}	2.70^{a}	2.91^{a}	3.15^{a}	$2.90\pm.061^{A}$
Period effect	$2.88\pm.02^{B}$	$2.75\pm.021^{C}$	$2.92\pm.029^{B}$	$3.17\pm.027^{A}$	

* See Table (2)

A, B, C, D and E: Means within the same effect having different capital superscripts are significantly different (P≤0.05). a, b,c,d,e.f,g,….and h: Means within the same interaction having different small superscripts are significantly different (P≤0.05).

Changes in cheese proteins.

The changes in cheese proteins during storage was followed by determining total nitrogen (TN) soluble nitrogen (SN) and SN /TN (Table 4) and non protein nitrogen (NPN) (Table 5) Slight changes were found in TN in all treatments during storage, being decreased slightly after 15 days and increased thereafter. These changes coincided with changes in cheese moisture content (Kandeel *et al.*, 1991; Ahmed&Abdel–Razig, 1998). The changes in TN due to storage were found significant ($P \leq 0.05$). Slight but not significant differences were found in cheese with level of spices as compared to control. Also (Table 4) shows that the SN and SN /TN of cheese from different treatments increased with progressive storage suggesting proteolysis (Mehanna & Hefnawy, 1991; Hamed *et al.*, 1992; Ahmed&Abdel–Razig, 1998; and Salama, 2004). However, the addition of tested spices decreased slightly the development of SN and SN /TN. This can be attributed to decreased growth and activity of cheese microflora. The present results were in agreement with that of Salama, (2004). Statistical analysis for SN and SN /TN. ratios showed a significant differences for both treatments, storage period, and the interaction between treatments and storage period ($P \leq 0.05$).

The NPN (Table 5) seems to constitute the major part of SN in cheeses from different treatments. The changes in NPN and NPN / TN followed similar trend as SN as affected by added spices and storage period. These results are in accordance with that of Kandeel *et al.*, (1991).

Changes in Total volatile fatty acids (TVFA):

The changes in TVFA are regarded as a measure of lipolysis level during storage of goat's white cheese Table (6). The TVFA of cheeses from different treatments had similar trends to those of SN/TN and NPN/TN. This means that either factors inhibited or stimulated proteolysis had the same effect on lipolysis. TVFA of all cheese samples increased significantly ($P \leq 0.05$) throughout the storage period. (Kandeel *et al.*, 1991; Hamed et al., 1992 and Ahmed & Abdel–Razig, 1998).There were some slight differences between the control and all other treatments in TVFA at the first stage of storage and the rate of increase in TVFA varied considerably among the treatments during storage. Cheese treated with 0.15% thyme (T_4) had the lowest value throughout the storage period (45 days) while, control had the highest value of TVFA than other treatments (Abdel-Kader *et al.*, 2001). This suggests that added spices to the curd of cheese led to a slight decrease in TVFA as a result of inhibition of lipolytic microbial enzymes. The statistical analysis for TVFA content showed significant differences for both treatments, during storage period and the interaction between treatments and pickling period ($P \leq 0.05$).

Table (4): Change in TN, SN, and SN /TN (%) of goat's white cheese as affected by added spices and storage period.

Items	Storage period(days)				
	Fresh	15	30	45	Treatment effect
	TN%				
Control	2.40[a]	2.22[a]	2.45[a]	2.70[a]	2.44±.054[B]
T1	2.40[a]	2.20[a]	2.40[a]	2.60[a]	2.40±.050[B]
T2	2.38[a]	2.18[a]	2.35[a]	2.55[a]	2.37±.045[B]
T3	2.40[a]	2.18[a]	2.38[a]	2.65[a]	2.40±.057[B]
T4	2.38[a]	2.15[a]	2.35[a]	2.58[a]	2.37±.052[B]
T5	2.40[a]	2.20[a]	2.42[a]	2.68[a]	2.43±.058[B]
T6	2.40[a]	2.16[a]	2.40[a]	2.60[a]	2.39±.054[B]
Period effec	2.42±.024	2.20±.018[C]	2.42±.022	2.65±.024[A]	
SN%					
Control	0.182f	0.219e	0.280b	0.350a	.195±.0049F
T1	0.182f	0.202e	0.235d	0.275b	.231±.0065D
T2	0.176f	0.198e	0.230d	0.265c	.276±.0073B
T3	0.176f	0.204e	0.235d	0.290a	.181±.0022G
T4	0.185f	0.200e	0.232d	0.270b	.204±.0034E
T5	0.182f	0.206e	0.255c	0.300a	.246±.0067C
T6	0.182f	0.198e	0.240d	0.280b	.291±.011A
Period effec	0.223±.013	0.220±.007B	0.224±.008	0.230±.009A	
SN/TN%					
Control	7.58f	9.44cd	11.43a	12.96a	8.79±0.28D
T1	7.58f	9.18d	9.79cd	10.58b	9.47±0.34C
T2	7.39f	9.08d	9.79cd	10.39b	10.32±0.32E
T3	7.33f	9.36cd	9.87c	10.94ab	9.38±.032C
T4	7.77f	9.30cd	9.87c	10.47b	9.25±0.10C
T5	7.58f	9.36cd	10.54b	11.19a	10.27±0.23B
T6	7.58f	9.17d	10.0c	10.77b	11.15±0.34A
Period effec	8.82±0.47C	9.22±0.24B	9.36±0.25A	9.52±0.28A	

* See Table (2).

A, B, C, H….and F: Means within the same effect having different capital superscripts are significantly different (P≤0.05).

a,b,c,d,e,f….and g: Means within the same interaction having different small superscripts are significantly different (P≤0.05).

Table (5): Change in NPN and NPN /TN of goat's white cheese as affected by added spices and storage period.

Items	Storage period (days)				
	NPN %				
	Fresh	15	30	45	Treatment effect
Control	0.098^{g}	0.126^{f}	0.168^{d}	0.210^{a}	$0.115\pm.0031^{C}$
T1	0.098^{g}	0.120f	0.16^{de}	0.189^{bc}	$0.15\pm.0058^{B}$
T2	0.08^{h}	0.116^{f}	0.154^{e}	0.182^{c}	$0.192\pm.0027^{A}$
T3	0.098^{g}	0.120^{f}	0.154^{e}	0.196^{ab}	$.092\pm.0025^{D}$
T4	0.09^{g}	0.116^{f}	0.145^{ef}	0.179^{c}	$0.119\pm.0017^{C}$
T5	0.098^{g}	0.122^{f}	0.168^{d}	0.20^{a}	$0.155\pm.003^{B}$
T6	0.098^{g}	0.118^{f}	0.154_{c}	0.182^{c}	$0.188\pm.0044^{A}$
Period effect	0.135±.0092	0.137±.0078	0.137±.0074	$0.143\pm.0077^{A}$	
NPN /TN %					
Control II	4.08^{mn}	5.68^{j}	6.86^{ef}	7.78^{a}	6.10 ± 0.42^{A}
T1	4.08^{mn}	5.46^{jk}	6.67^{g}	7.27^{bcd}	5.88 ± 0.37^{BC}
T2	3.36^{o}	5.32^{k}	6.55^{gh}	7.14^{cde}	5.59 ± 0.44^{D}
T3	4.08^{mn}	5.51^{jk}	6.47^{ghi}	7.40^{bc}	5.86 ± 0.37^{C}
T4	3.78^{n}	5.40^{jk}	6.17^{i}	6.94^{ef}	5.57 ± 0.35^{D}
T5	4.08^{mn}	5.54^{jk}	6.94^{ef}	7.46^{b}	6.01 ± 0.40^{AB}
T6	4.08^{mn}	5.46^{jk}	6.42^{ghi}	7.00^{def}	5.74 ± 0.34^{C}
Period effect	3.82 ± 0.09^{D}	$5.32\pm.095^{C}$	6.34 ± 0.15^{B}	7.15 ± 0.090^{A}	

* See Table (2).

A, B, C, D and E: Means within the same effect having different capital superscripts are significantly different (P≤0.05).

a,b,c,d,e,f,g,h,I,j,k,m,n,o,p….and h: Means within the same interaction having different small superscripts are significantly different (P≤0.05).

Table (6): Change in total volatile fatty acids** of goat's white cheese as affected by added spices and storage period.

Items*	Storage Period (days)				
	Fresh	15	30	45	Treatment effec
Control	7.40^{i}	13.00^{f}	18.00^{c}	22.00^{a}	15.10 ± 1.65^{A}
T1	7.40^{i}	12.00^{g}	16.00^{d}	19.00^{b}	13.6 ± 1.32^{C}
T2	7.30^{i}	11.50^{g}	14.00^{e}	18.00^{c}	12.7 ± 1.18^{D}
T3	7.50^{i}	12.00^{g}	15.00^{d}	19.00^{b}	13.38 ± 1.28^{C}
T4	7.45^{i}	11.00^{g}	14.00^{e}	17.50^{c}	12.49 ± 1.13^{D}
T5	7.40^{i}	13.00^{f}	16.00^{d}	20.00^{b}	14.10 ± 1.39^{B}
T6	7.40^{i}	12.00^{g}	15.00^{d}	19.00^{b}	13.35 ± 1.29^{C}
Period effec	$6.87\pm.309^{D}$	$11.19\pm.512^{C}$	$14.38\pm.640^{B}$	$17.94\pm.762^{A}$	

* See Table (2).

A, B,C,D…and E: Means within the same effect having different capital superscripts are significantly different ($P\leq0.05$).

a, b,c,d,e,f,g,h,I,j….and k: Means within the same interaction having different small superscripts are significantly different ($P\leq0.05$). ** Expressed as ml NaOH 0.1 N/100gm cheese samples.

Changes in cheese microfflora

Table (7) shows that the TVC of control significantly increased ($P\leq0.05$) throughout the storage period while, counts of different treatments decreased up to 15 days, then slightly increased till the end of storage period. Cardamom, thyme and clove concentration of 0.20, 0.15, and 0.20 % respectively had the highest effect on TVC especially 0.20% cardamom. This suggests that the added spices had antimicrobial effect on cheese microflora. These results are in agreement with that of Abd-Alla *et al.* (2000), Hussein (2004) and Abou-Dawood, (1996). Statistical analysis showed significant differences in TVC as affected by addition and storage period. The changes in Psychrophillic bacterial count (PsC) and yeasts and moulds followed similar trends as the TVC (Table7). They increased all through the storage reaching a maximum after 45 days of storage. Addition of the used spices was found to decrease the counts of Psychrophillic (PsC)

Table(7): Change in Psychrophillic bacterial, yeasts and moulds and coliforms counts of goat's white cheese as affected by added spices and storage period

Items	Storage period (days)				
	Total viable counts (count × 10^6 cfu / g)				
	Fresh	15	30	45	Treatment effect
Control	34^{f}	92^{d}	250^{c}	670^{a}	261.5 ± 75.02^{A}
T1	35^{f}	9.6^{g}	20^{fg}	100^{d}	41.15 ± 10.62^{F}
T2	30^{f}	4.2^{g}	8.0g	86^{d}	32.05 ± 9.87^{G}
T3	32^{f}	12.5^{g}	35^{f}	360^{b}	109.63 ± 43.69^{C}
T4	29^{f}	6.7^{g}	9.5^{g}	90^{d}	33.80 ± 10.13^{G}
T5	35^{f}	10^{g}	65^{e}	450^{b}	140 ± 54.29^{B}
T6	30^{f}	8.3^{g}	40^{f}	300^{b}	94.58 ± 35.95^{E}
Period effect	28.5 ± 2.09^{C}	20.04 ± 5.73^{D}	63.44 ± 15.54^{B}	295.75 ± 39.92^{A}	
psychrophillic bacterial count(count × 10^4 cfu / g)					
Control	2.40e	12e	85^{cd}	440^{b}	134.85 ± 54.0^{B}
T1	2.60^{e}	7.8^{e}	60^{d}	100^{cd}	42.60 ± 12.11^{D}
T2	2.70^{e}	2.0^{e}	12^{e}	95^{c}	27.93 ± 11.73^{E}
T3	2.60^{e}	9.3^{e}	49^{e}	250^{c}	77.73 ± 30.47^{C}
T4	2.70^{e}	3.1^{e}	30^{e}	150^{c}	46.45 ± 18.34^{D}
T5	2.30^{e}	11^{e}	90^{cd}	400^{b}	134.16 ± 53.38^{B}
T6	2.50^{e}	5.1^{e}	71^{d}	240^{c}	79.65 ± 29.12^{C}
Period effect	2.49 ± 0.044^{D}	7.79 ± 0.78^{C}	69.63 ± 8.8^{B}	313.54 ± 46.53^{A}	
total yeast & mould counts(count × 10^2 cfu / g)					
Control	1.0^{gh}	4.0^{d}	6.0c	18^{b}	7.25 ± 1.95^{A}
T1	1.5^{fg}	1.1^{gh}	0.8^{gh}	2.5^{ef}	1.48 ± 0.19^{E}
T2	1.5^{fg}	0.6^{gh}	0.1^{h}	0.8^{gh}	0.75 ± 0.15^{F}
T3	1.8^{fg}	1.6^{fg}	0.5^{h}	4.0^{d}	1.98 ± 0.40^{CD}
T4	2.0^{ef}	0.4^{h}	0.2^{h}	4.0^{d}	1.65 ± 0.46^{DE}
T5	2.5^{ef}	2.0ef	2.8^{ef}	9.0c	4.08 ± 0.87^{B}
T6	1.6^{fg}	0.8^{gh}	1.3^{fg}	5.0^{cd}	2.18 ± 0.50^{C}
Period effect	1.68 ± 0.089^{B}	1.75 ± 0.26^{B}	1.90 ± 0.40^{B}	7.91 ± 1.42^{A}	
Coliform count (count x10^2 cfu*/g)					
Control	0.46^{d}	1.10^{b}	1.30^{a}	ND	0.72 ± 0.16^{B}
T1	0.33^{e}	0.49^{d}	1.10^{b}	0.13^{g}	0.51 ± 0.11^{D}
T2	0.23^{f}	0.33^{e}	0.79^{c}	0.46^{d}	0.45 ± 0.064^{E}
T3	0.23^{f}	0.33^{e}	0.70^{c}	0.09^{h}	0.34 ± 0.069^{F}
T4	0.49^{d}	0.70^{c}	1.30^{a}	ND	0.62 ± 0.14^{C}
T5	0.49^{d}	0.70^{c}	0.79^{c}	0.14^{g}	0.53 ± 0.08^{D}
T6	0.23^{f}	0.33^{E}	0.4e	ND	1.14 ± 0.50^{A}
Period effect	31 ± 3^{C}	50 ± 6^{B}	125 ± 23^{A}	10 ± 3^{D}	

* See Table (2).

A, B,C,D,E,F….and G: Means within the same effect having different capital superscripts are significantly different (P≤0.05). cfu*= colony forming unit. a, b,c,e,f,g….and h**:** Means within the same interaction having different small superscripts are significantly different (P≤0.05). ND= not detected**.**

and yeasts and moulds and the decrease ran parallel to the concentration of added spices. Abd-El Kader *et al.* (2001) indicated that thyme at 0.1% concentration, and clove at 0.2% concentration, to inhibit the growth of yeasts & moulds in pickled soft cheese after 30 days of storage in accordance with present results. Statistical analysis revealed significant differences ($P \leq 0.05$) in Psychrophillic (PsC) and yeasts and moulds as affected by added spices and storage period. The count of Coliforms gradually increased till 30 days of storage period, then decreased at the end of storage period probably due to the developed acidity which was not suitable for Coliforms growth, The count of Coliforms in all treatments lower than control throughout the storage period and not detected in some cheese samples T_4 and T_6 at the end of storage period.

Sensory properties

Table (8) shows that control cheese gained the highest score for flavour, body & texture and color & appearance compared to cheeses containing the different spices. Cheese samples containing thyme powder at two concentrations (0.15 and 0.10%) gained the lowest scores for different quality attributes as compared other treatments. While cheese samples containing 0.10 and 0.2 % cardamom gained the highest scores throughout the storage period compared to other treatments, also clove powder at each concentration were better than cheese treated with thyme. The statistical analysis for total scores Table (8) showed a significant difference for both treatments, storage period and the interaction between treatments and storage period ($P \leq 0.05$). Conclusions according to the present results, white soft cheese can be made from goat's milk with added 0.10 and 0.2 % cardamom and clove powder and stored at 6±1ºC.for up to 45 days.

Table (8): Statistical analysis for total scores of goat's white soft cheese as affected by adding cardamom, thyme and clove powder compared to control buffalo's cheese during pickling period.

Items*	Pickling period (days)				
	Fresh	15	30	45	Treatment effec
Control	83^{b}	80^{bc}	78^{cde}	76^{defg}	79.25 ± 0.88^{B}
T1	74^{fghi}	71^{ij}	79^{cd}	73^{ghi}	74.25 ± 1.02^{C}
T2	74^{fghi}	72^{hi}	80^{bc}	75^{efgh}	75.25 ± 0.95^{C}
T3	64^{jk}	60^{jk}	70^{ij}	61^{jk}	63.75 ± 1.22^{E}
T4	62^{ik}	60^{jk}	68^{ij}	62^{jk}	63.0 ± 1.0^{E}
T5	74^{fghi}	71^{ij}	75^{efgh}	62^{jk}	70.5 ± 1.63^{D}
T6	73^{gh}	70^{ij}	71^{ij}	64^{jk}	69.50 ± 1.06^{D}
Period effect	74.13 ± 1.76^{B}	71.88 ± 1.99^{C}	76.25 ± 1.35^{A}	68.75 ± 1.41^{D}	

* See Table (2) A, B, C, D….and E: Means within the same effect having different capital superscripts are significantly different ($P\leq0.05$).

a, b,c,d,e,f,g,h,.i, j ….and k: Means within the same interaction having different small superscripts are significantly different ($P\leq0.05$)

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تأثير مسحوق الحبهان و الزعتر والقرنفل على تركيب وجودة الجبن الأبيض الطري المصنع من لبن الماعز

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صنع الجبن الأبيض الطري من لبن الماعزالمعامل حراريا على 75^{0}م وأضيف كل من مسحوق الحبهانcardamom (0.1 ، 0.2%)، الزعترthyme (0.1 ، 0.15%)، القرنفلclove (0.1 ، 0.2%). الى خثرة الجبن قبل تصفية الشرش.وخزن الجبن الناتج فى محلول ملحى على درجة حرارة 6±1°م وتم تحليل التركيب الكيماوى ، والجودة الميكروبيولوجية ، والخواص الحسية للجبن الطازج وبعد التخزين على درجة حرارة 6±1°م لمدة 15 ، 30 ، 45 يوما.وكانت النتائج كما يلى .

- إحتوى الجبن الناتج من المعاملات المختلفة على نفس محتوى الرطوبة والدهن والملح والنيتروجين الكلىمع عدم وجود فروق معنوية($P\leq0.05$). ولكن كان محتوى النتروجين الذائب (SN) ، النتروجين الغير بروتيني(NPN) قل فى الجبن مع الأضافات المختلفة بالمقارنة مع الكنترول.
- أشارت معايرة الحموضة والقلوية أن $\oint \alpha dpH$ تقل تدريجيا أثناء التخزين بينما أعطى الجبن الحبهان(0.2%) أعلى قيمة لل $\oint \alpha dpH$ مقارنة بالمعاملات الأخرى.وقد زادت الحموضة قليلا فى الجبن المضاف لها حبهان عن الجبن الناتج من المعاملات الأخرى.
- أضافة التوابل المستخدمة أدى الى قلة أعداد المجاميع الميكروبية(TVC)ولخمائر والفطريات دون التأثيرعلى أعداد الميكروبات المحبة للبرودة (PsC)فى الجبن مقارنة بالكنترول. ووجدت بكتيريا القولون Coliforms فى الجبن الناتج من المعاملات المختلفة ماعدا الجبن المعامل بالقرنفل (0.2%)، والزعتر (0.15%) حيث أختفت بعد 45 يوما.
- أوضح التقييم الحسى أن أضافة الحبهان و القرنفل والزعتر تقلل من درجات التقييم الحسى لكل من القوام والتركيب والمظهر مقارنة بالكنترول بينما أعطى الجبن المعامل بالحبهان أعلى درجات التقييم والزعتر أقلها . ويمكن صناعة الجبن الطرى من لبن الماعز مع أضافة التوابل المختبرة والتى تستخدم كمواد حافظة طبيعية وتحسن من نكهة جبن الماعز وخاصة الحبهان و القرنفل بتركيز (0.1 ، 0.2%)