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Research Article

Acceleration Ripening of Ras Cheese Using Slurry Mixture

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Key words:
Ras cheese,slurry mixture, 02,Acceleration, ripening, sensory evaluation.

Abstract:

In this study, four trials of Ras cheese were made from a mix of cow's and buffalo's milk (9: l), using different concentrations of slurry mixture to accelerate Ras cheese ripening, thereby reducing the cost of capital and increasing factory profits. Control Ras cheese without additives and three treatments of concentrations (1, 1.5, and 2%) of the slurry mixture combination consisting of old Ras cheese and evaporated milk. These mixtures were added to the cheese curd during molding. Control and experimental Ras cheese samples were analyzed fresh (7 days of manufacturing), 1, 2, and 3 months for some properties (acidity - pH - total solids - total protein - soluble nitrogen - fat - ash content), ripening indices as (total volatile fatty acids –formol ripening index - soluble tyrosine and tryptophan) and sensory evaluation. The results indicated that Ras cheese ripening was accelerated by addition of the mixture and improved properties of Ras cheese. The sensory evaluation of all treatments improved with the progression of the ripening period. The mixture at 1.5% recorded the highest scores in the sensory evaluation without adversely affecting the quality of Ras cheese than the others.

1. Introduction

Ras cheese is considered the most popular hard cheese in Egypt; it has great acceptance by Egyptian and Arabian consumers. Ras cheese is made from cow's milk or a mixture of cow's and buffalo's milk. Ras cheese is normally consumed after a ripening period of 3 to 6 months. which gives a fully ripened product. Ras cheese is placed in the ripening rooms, where ripening takes place at a nearly constant relative humidity (90% - 95%) and temperature (9˚C - 12˚C) (Hattem et al., 2012; Abd-Ellah et al., 2017).

Ripening is the natural process of all cheeses is very complex and includes both microbiological and biochemical changes. Cheese ripening involves the pathway of glycolysis, lipolysis, and proteolysis that occurs in a cheese after its manufacture and during storage to the curd resulting in flavor, texture, and appearance. The cheese flavor is determined by the balance between many volatile and non-volatile components formed throughout ripening (Lazzi et al., 2016; Amer et al., 2023).

The ripening of cheese is a slow and expensive process that is not fully predictable or controllable. The development of an efficient way to reduce aging time would provide significant savings to the cheese industry. The dairy researchers tried to reduce the maturation time and associated costs by applying some methods to accelerate the cheese ripening without altering the characteristic flavor of the final product.

Cheeses undergo numerous biochemical changes during ripening, which result in the development of appropriate flavor and aroma. This is the result of a lengthy process involving numerous ripening agents. Indigenous milk enzymes are the primary ripening agents involved in cheese ripening. Due to the long periods (6-12 months) required for full flavor development, assessing the contribution of principal ripening agents to starter bacteria, coagulants, secondary starter, and microflora is an expensive and time-consuming process (El-Soda and Pandiah, 1991; Fox, 1993; Amer et al., 2023**).** The lengthy ripening period for the majority of cheese varieties is one of the biggest problems the dairy industry has in the area of cheese production. Ras cheese is typically sold 4-6 months after it has ripened (El-Soda, 1986). Numerous employees have tried various methods to speed up the ripening of Ras cheese, which is made from cow's milk (Nassible, 1974).

Sensory characteristics which attributes (flavor and texture) are critical to identifying food and cheese play an essential role in consumer acceptance. The flavor and texture are considered the two main criteria in determining the acceptability of aged cheese. The time that is required to develop characteristic flavor and texture varies from a few weeks for soft cheeses up to three years for very hard varieties. During this period, cheeses attain their characteristics through a multitude of chemical, microbiological, and biochemical changes whereby protein, fat, and residual lactose are broken down into primary products which are further degraded into secondary products (Drake 2004; Amos 2007).

Depending on the type of cheese, maturation can take anywhere between six months to one year. There are many benefits to cutting the maturing time, including lower cheese production costs. There have been numerous attempts to shorten the ripening process with the inclusion of plant extracts. Because of their particular function and potential for low manufacturing costs, the use of plant extracts to hasten cheese ripening appears promising. Acceleration cheese ripening has been a topic of discussion

for many years, primarily for two reasons: The first is a desire to shorten the storage period, which is frequently extended to 12 months, thereby lowering storage costs. The second motivation is a desire for more cheese flavor (Beach 1991).

This work aimed to study the production of high-quality Ras cheese using different concentrations of slurry mixture on the acceleration of the ripening process to decrease the ripening period by about 2 or 3 months and their effect on the physicochemical properties and sensory acceptability, which has an economic impact on Ras cheese production.

2. Materials and Methods

MATERIALS

Cow's milk and buffalo's milk were obtained from a private Farm and separated to obtain fresh cream, and Ras cheese was manufactured with the same milk and separated whey to obtain cream from whey using a milk separator. The cow's milk and buffalo's milk (9: l) were mixed and used for manufacturing. Liquid rennet was obtained from a local market. Evaporated full-fat milk (TS 25.7%, protein 5.9%, fat 8.5%, and carbohydrate 10.3%) made in Holland. Old Ras cheese was brought from a local market. Starter cultures, Freeze-dried lactic culture (YF-L904) for direct vat set (DVS) consists of *Streptococcus thermophilus and Lactobacillus delbreuckii subsp. bulgaricus* was obtained from Chr. Hansen Lab., Denmark. Coarse kitchen salt and Calcium chloride were obtained from EL-Nasr Company, Alexandria.

METHODS

Preparation of slurry mixture

Old Ras cheese was mixed with evaporated milk (2:1) in a (Moulinex) mixer at high speed for 5 min at 45 ^{0}C, before adding this mixture to Ras cheese curd.

Ras cheese manufacture

Ras cheese was made in the dairy plant Alwadi Al Akhdar at Damanhur, Ras cheese was made from a mix of cow's milk and buffalo's milk (9: l), was pasteurized at 72°C for 15 sec and cooled to 38 °C, the milk was transferred to cheese vat. A commercial starter culture (5 unit/100 kg), CaCl2 at level 0.012% (w/w) was added to the milk. After 1 h of milk ripening at 35 °C, the rennet was added to clot the milk for 45 min, then cut the curd, then scalding (raising the temperature gradually to 45 C over 60 min) and held at this temperature for 15 min. The whey was drained and salted (4.5%). After that, adding slurry mixture during molding, Control (C): Ras cheese without additives, Treatment 1 (T1): Ras cheese was made by adding slurry mixture (1%) 10 g/1kg cheese curd, Treatment 2 (T2): Ras cheese was made by adding slurry mixture (1.5%) 15 g/1kg cheese curd and Treatment 3 (T3): Ras cheese was made by adding slurry mixture (2%) 20 g/1kg cheese curd. The curd was molded and pressed for 24 h then the wheals were turned up for more 24 h, then dry salting (4.5%). The cheeses were allowed to ripen under controlled conditions of temperature (12 – 15ºC) and relative humidity (85 - 90%) cheeses were sampled and analyzed at 7, 30, 60, and 90 days of ripening period. Ras cheese was made according to (Hofi et al., 1970)**.**

Physicochemical and chemical properties:

Physicochemical analysis (total solids, total protein, soluble nitrogen, fat, and ash content) According to (A.O.A.C 2020), cheese was analyzed for fat by the Gerber method, total protein by macro Kjeldahl, total solids were determined by drying methods, soluble nitrogen content of cheese samples were measured by blending 5 g of cheese sample in an auto-mixer with 100 ml distilled water for 5 minutes. The mixture was decanted into a 250 ml volumetric flask. The nitrogen was determined in 25 ml aliquots of filtrate by the Kjeldahl method. Titratable acidity was determined by titration methods using NaOH 0.1 N and phenolphthalein. The pH was measured in a slurry prepared by macerating 20 g of grated cheese in 20 ml of deionized water using (pH meter Mi 151 PH / ORP / Temperature Bench Meter). The salt content was determined according to (Pearson 1975).

Determination of Ripening Index:

Total volatile fatty acids (TVFA)were determined according to the method described by Kosikowski (1978)**.** The results were expressed in milliliters of 0.1 N NaOH per 100 gm of cheese. The formol ripening index of cheese was determined as described by Ling (1963). Soluble tyrosine and tryptophan were measured spectrophotometrically using the Vakaleris and Price (1959) method.

Sensory evaluation:

Ras cheese samples were organoleptically evaluated and scored by a regular score panel of staff members of the Dairy Science & Technology Department, Tanta University, and other members. Sensory evaluation of Ras cheese samples was conducted by panelists. The panelists were asked to evaluate the appearance score marks (10) points, flavor (50) points, and body & texture (40) points. The method described by **(Harper and Hall, 1976).**

Statistical Analysis

Results are expressed as mean ± standard error (SE) for three replicates and subjected to IBM SPSS version 16.0 Statistics for analysis of variance (ANOVA) (Statistical Package for Social Science **(SPSS, 1999).**

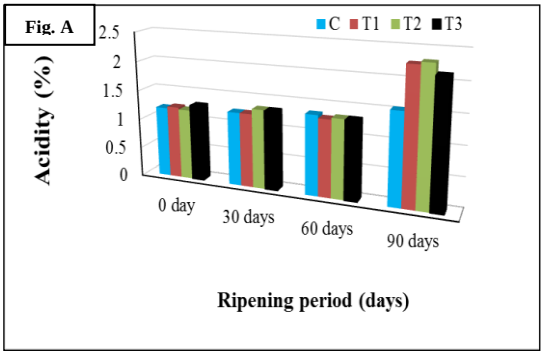
3. RESULTS AND DISCUSSION

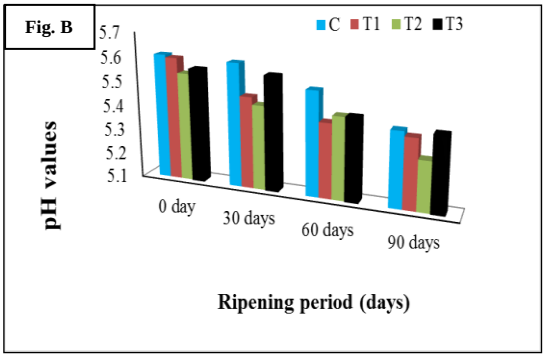
Physicochemical and chemical analysis of Ras cheese:

Data in Fig. (A&B) show the changes in acidity% and pH values of control Ras cheese and Ras cheese produced using different concentrations of slurry

mixture at fresh samples and throughout the ripening period. Acidity (%) was significantly increased during the ripening period in all treatments. These due to the development of acidity that is a direct response of converting the residual lactose in cheese into lactic acid by the viable microflora (Mehanna et al., 2002)**.** The acidity (%) of Ras cheese after 90 days became higher than the control ones. The acidity (%) after 90 days for the C, T1, T2, and T3 treatments were 1.55, 2.27, 2.31, and 2.35 %, respectively.

The pH values were ringing parallel to the titratable acidity when fresh and during the ripening period. pH values of cheese samples were significantly decreased gradually during the ripening period, this was reported in previous studies (Awad 2006; Amer et al., 2023)**.** The values of pH at the end of the ripening period (90 days) were 5.40, 5.38, 5.30, and 5.30 for C, T1, T2, and T3 treatments, respectively.





Total solid content(%):

The obtained results of cheese composition Table (1)indicated that there are significant differences in Ras cheese composition. During the progress of the ripening period, total solid content increased in all treatments and that was a faction to increasing the fat and protein.

The total solid content was lowest at zero time for all treatments. TS (%) values for the C, T1, T2, and T3 treatments were 59.58, 60.64, 61.03, and 61.55%, respectively. The values of TS (%) at the end of the ripening period (90 days) were 63.82, 64.36, 64.44, and 64.92 % for C, T1, T2, and T3 treatments, respectively. The above results are in agreement with those noticed by EL-Gazzar et al., (1979) for Ras cheese made from equal parts of whole cows' and buffalo's milk.

Fat content (%):

Fat contents for all treatments were the lowest % at zero time. The average values of fresh cheese were: 28.50, 28.83, 28.67, and 28.90% for C, T1, T2, and T3 treatments, respectively. The values of fat at the end of the ripening period (90 days) were 33.50, 34.17, 34.17, and 34.25 % for C, T1, T2, and T3 treatments, respectively. it could be observed that the fat content increased significantly for all the treatments during the storage period which may be attributed to the gradual decrease in cheese moisture during storage. These results are in agreement with those of (Fitzgerald and Buckley, 1985).

Total protein content(%):

There were significant differences between treatments in total protein levels, the protein content of fresh cheese was 21.07, 21.20, 21.33, and 21.51% for C, T1, T2, and T3 treatments, respectively. Their values increased during ripening, which is obviously due to the loss of moisture. The values of total protein reach their maximum at the end of the ripening period (90) days, being 23.38, 23.81, 23.88, and 23.95%for C, T1, T2, and T3 treatments, respectively. These results are partly in agreement with **(Shehata, 2004)** who reported that protein content increased during the ripening period.

Soluble nitrogen content(%):

The soluble nitrogen content (S.N) is taken as an index for cheese protein proteolysis during the ripening period. Data in Table (1) revealed that in the soluble nitrogen (%) of control Ras cheese and Ras cheese treatments, the (S.N) concentrations were lowest at zero time. For the C, T1, T2, and T3 treatments, the average SN for fresh cheese was 1.261, 1.318, 1.389, and 1.395%, respectively. At the end of the ripening period (90 days), the SN of all treatments climbed progressively and was 1.809, 1.943, 1.982, and 1.994% in that order. It could be noted that the S.N content increased significantly throughout the ripening period for all cheese treatments. These results are in agreement with (Gooda *et al.*, 2000; Awad 2006; Ibrahim *et al.*, 2017).

Salt content (%):

Salt is an indispensable ingredient because it is necessary to improve the safety and quality of cheese. Salt improves the texture of the cheese through the hydration state into a viscous texture and regulates the chemical activity of microorganisms. The salt content was lowest for all treatments at zero time. For the C, T1, T2, and T3 treatments, the average fresh cheese values were 2.37, 2.37, 2.29, and 2.40%, respectively. At the end of the ripening period (90 days), the equivalent values of salt content were, in the same order, 3.47, 3.40, 3.44, and 3.40%.From the obtained results, it can be observed that there are insignificant differences between the treatments when the cheese is fresh and at the end of the ripening period. There was a significant increase in salt content in all treatments during the ripening period, which resulted from a reduction in moisture.

These results are in agreement with (Awad et al., 2003; El-Hamshary et al., 2022; Amer et al., 2023).

Table (1): Some chemical analysis of Ras cheese at fresh and during ripening period.

Ripening period (days)	Cheese treatments*			
	C	T1	T2	T3
		TS (%)		
0	59.58±0.19^{bD}	60.64±0.49^{aD}	61.03±0.26^{aD}	61.55±0.18^{aD}
30	61.02±0.14^{aC}	62.24±0.27^{aC}	62.38±0.21^{aC}	62.90±0.31^{aC}
60	62.42±0.06^{cB}	63.10±0.05^{bB}	63.23±0.05^{abB}	63.50±0.09^{aB}
90	63.82±0.06^{cA}	64.36±0.03^{bA}	64.44±0.04^{bA}	64.92±0.11^{aA}
		Fat (%)		
0	28.50±0.00^{bD}	28.83±0.17^{abC}	28.67±0.17^{abD}	28.90±0.09^{aD}
30	31.33±0.17^{bC}	31.83±0.17^{abB}	32.00±0.00^{abC}	32.19±0.21^{aC}
60	32.67±0.17^{aB}	33.33±0.17^{aAB}	33.17±0.17^{aB}	33.31±0.05^{aB}
90	33.50±0.00^{bA}	34.17±0.17^{aA}	34.17±0.17^{aA}	34.25±0.03^{abA}
		TP (%)		
0	21.07±0.06^{aD}	21.20±0.03^{bD}	21.33±0.00^{cD}	21.51±0.00^{cD}
30	21.90±0.01^{cC}	22.00±0.00^{bC}	22.00±0.00^{bC}	22.05±0.01^{aC}
60	22.80±0.00^{bB}	23.00±0.00^{abB}	23.17±0.17^{aB}	23.20±0.15^{aB}
90	23.38±0.10^{aA}	23.81±0.00^{aA}	23.88±0.06^{aA}	23.95±0.07^{aA}
		SN (%)		
0	1.261±0.03^{bD}	1.318±0.03^{abD}	1.389±0.01^{aD}	1.395±0.00^{aD}
30	1.340±0.01^{cC}	1.601±0.02^{bcC}	1.640±0.01^{bC}	1.680±0.02^{aC}
60	1.611±0.01^{cB}	1.801±0.02^{bB}	1.858±0.04^{bB}	1.878±0.02^{aB}
90	1.809±0.01^{dA}	1.943±0.02^{cA}	1.982±0.00^{bA}	1.994±0.01^{aA}
		Salt (%)		
0	2.37±0.01aC	2.37±0.01aC	2.29±0.01aC	2.40±0.06aC
30	2.50±0.06bB	3.20±0.15aB	3.37±0.09aB	3.27±0.03aB
60	3.21±0.03bA	3.53±0.03aA	3.60±0.06aA	3.17±0.00bB
90	3.47±0.03aA	3.40±0.06aA	3.44±0.01aA	3.40±0.00aA
		Ash (%)		
0	4.17±0.02cD	4.21±0.01abC	4.30±0.01aC	4.25±0.02bC
30	4.29±0.01bC	4.42±0.02abB	4.44±0.04abC	4.58±0.08aB
60	4.58±0.03aB	4.72±0.01aB	4.86±0.01aB	4.71±0.21aB
90	5.17±0.09cA	5.46±0.02bA	5.56±0.02bA	5.92±0.03aA

*(C): Control Ras cheese without additives.
(T1): Ras cheese was made by adding a slurry mixture (1%) 10 g/1kg cheese curd.
(T2): Ras cheese was made by adding a slurry mixture (1.5%) 15 g/1kg cheese curd.
(T3): Ras cheese was made by adding a slurry mixture (2%) 20 g/1kg cheese curd.
*Values represent the mean ± SE; *n* = 3. Means with various small (a–d) letters within the same row with different superscripts differed significantly for the effect of different treatments (P≤0.01), and capital (A–D) letters within the same column with different superscripts for the effect of storage time differed significantly (P≤0.01).

Ash content (%):

The ash content of Ras cheese control and Ras cheese treatments were a significant difference (P≤ 0.01) during the ripening period. It was noticed that ash content was increasing in all cheese treatments during the storage period. The average fresh Ras cheese values were 4.17, 4.21, 4.30, and 4.25 %, respectively. At the end of the ripening period of 90 days, the equivalent values of ash content were, in the same order, 5.17, 5.46, 5.56, and 5.92 %. From the previous result which reveals that significant differences were recorded in ash content, the treated cheese had the highest ash content %, but the control treatment had the lowest TS content. Also, it was concluded that the ash content gradually increased during the ripening period. These results are in agreement with El-Hamshary et al., (2022), who indicated that the ash percentage of hard cheese increased when the amount of cheese slurry increased.

Ripening index of Ras cheese during ripening period.

Total volatile fatty acids:

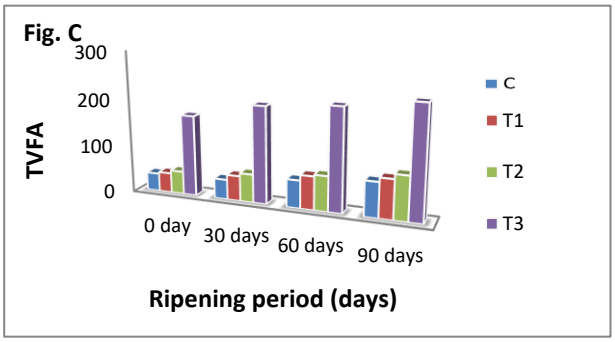
The total volatile fatty acid amounts were lowest for all treatments at zero time, according to the data in Fig. (C). For the C, T1, T2, and T3 treatments, the average fresh cheese values were 38.00, 41.67, 48.33, and 50.20 (ml 0.1 NaOH 100 gm cheese) respectively, the TVFA content of all samples significantly (p≤0.01) increased during the progress of ripening period. At the end of the ripening period (90 days), the equivalent values of total volatile fatty acids were

74.00, 83.00, 93.00, and 97.20 (ml 0.1 NaOH 100 gm cheese) for the C,T1,T2 and T3 treatments respectively. These results are in agreement with those obtained by Hamdy et al**.,** (2017), who showed that the cheese treated with a slurry mixture had higher TVFA contents.

Formol ripening index (FRI):

Results in Fig. (D) demonstrated that for control and Ras cheese treatments, the formol ripening indices were lowest at zero time. For the C, T1, T2, and T3 treatments, the average values of fresh cheese were 26.67, 26.00, 28.67, and 30.20, respectively. At the end of the ripening period (90 days), the values of FRI for the C, T1, T2, and T3 treatments were 141.33, 153.33, 161.33, and 169.50, respectively.

In comparison to other treatments, the increases were more noticeable in the treatment (T3). The rates of growth for C, T1, T2, and T3 therapies, respectively, were 4.99, 8.96, 4.64, and 5.76 percent after 30 days. After 60 days, the equivalent growth rates were 204.95, 251.27, 266.24 and 286.59% %. Additionally, for C, T1, T2, and T3 therapies, respectively, the rates of growth after 90 days were 429.92, 489.73, 462.71, and 461.26%. We can see that values at the end of the ripening period increased at the largest rate compared to previous times. These findings are in line with those made by (Abo El-Ella et al., 1978, EL-Ghandour et al.,1984 and El-Hawary ***et al.,*** 2015)**,** who discovered that the formol ripening index increased more rapidly in experimental cheese than control.



Tyrosine and Tryptophan content:

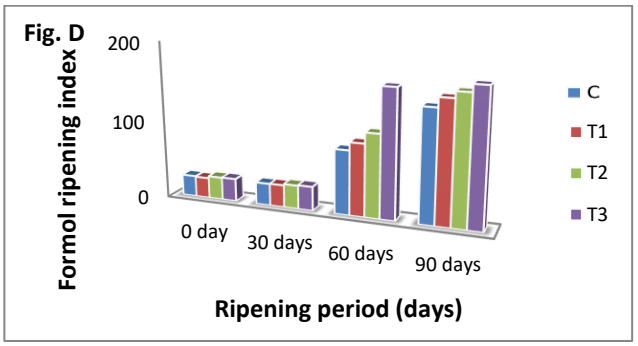
Cheese is therefore one of the most fermented products widely associated with the formation of free amino acids. Tyrosine and tryptophan are the most important free amino acids (FAA) formed during the ripening period in Ras cheese. The free amino acids in Fig. (E&F) showed that tyrosine and tryptophan had the highest values in treated cheese samples belonging to T1, T2, and T3. Also, the values gradually increased during the ripening period. The rate of increase was much higher in T3.

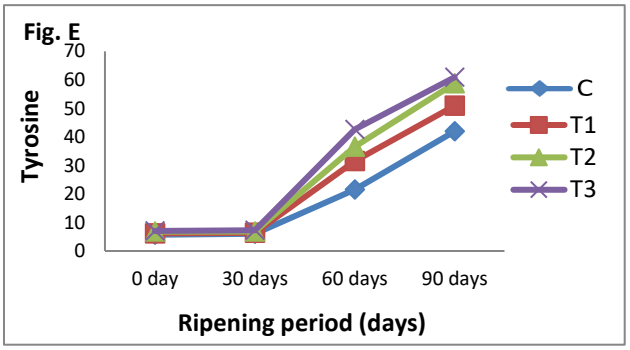
According to the data in Fig. (E), tyrosine content was lowest for all treatments at zero time. For the C, T1, T2, and T3 treatments, the average fresh cheese values were 5.70, 6.17, 6.77, and 7.03mg/g dry matter, respectively. At the end of the ripening period (90 days), the equivalent values of tyrosine content were, in the same order, 41.93, 50.90, 58.73, and 60.90 mg/g dry matter.

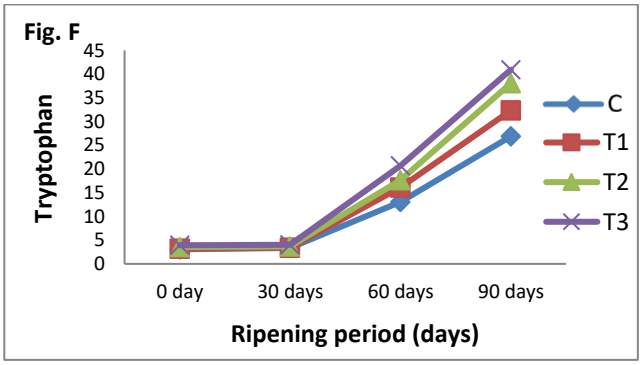
also, the data in Fig. (F), showed that tryptophan content was lowest for all treatments at zero time. For the CN, T1, T2, and T3 treatments, the average fresh cheese values were 3.07, 3.20, 3.53, and 3.93mg/g dry matter, respectively.

At the end of the 90-day ripening period, the equivalent values of tryptophan content were, in the same order, 26.87, 32.33, 38.07, and 40.93mg/g dry matter.

It can be noticed that the FRI as tyrosine and tryptophan in 60 and 90 days cheese from T3 had the highest values compared to the corresponding values of T1 and T2 suggesting the important role of using mixture slurry in making Ras cheese. All samples were lower than the allowable level of tyrosine and tryptophan according to the FDA (2001) and EOS (2005). The above results are in agreement with El-Tahra et al., (2002).







Sensory evaluation:

The obtained results in Table (2) show that the control cheese has a flat flavor when treated at a young age. The flavor lowered to a bitter taste at 30 days and became mild in flavor at 90 days of age, but the flavor improved and became good at the end of the age ripening period (90) days. The attained total scoring points of control cheese were 66, 86, 90, and 92 at 0, 30, 60, and 90 days, respectively. Ras cheese treated with a 1.5% slurry combination per 1 kg of cheese curd (T1) lowered the flat taste when fresh from ripening. The flavor became good at 60 days with a total score of 96 points and rose to 95 points at 90 days of age.

Treatment (T2) showed a more pronounced improvement regarding cheese ripening acceleration, with which the cheese became smooth with good flavor and consistency at 90 days of age, with a total score of 98 points.

Table (2) Organoleptic properties of different Ras cheese treatments at fresh and during the ripening period.

Cheese treatments	Ripening period (days)	Flavor (50)	Body &Texture (40)	Appearance (10)	Total (100)	Criticisms
C	0	30	28	8	66	Flat flavor
	30	42	35	9	86	bitter flavor
	60	45	37	8	90	Milled flavor
	90	48	36	8	92	good flavor
T1	0	41	32	8	81	Flat flavor
	30	45	36	9	90	Milled flavor
	60	48	39	9	96	good flavor
	90	49	38	8	95	good flavor
T2	0	41	32	9	82	Flat flavor
	30	46	38	9	93	good flavor
	60	48	39	9	96	good flavor
	90	49	40	9	98	superior
T3	0	32	27	8	67	Flat flavor
	30	40	30	8	78	Milled flavor
	60	43	36	8	87	good flavor
	90	43	36	9	88	good flavor

This treatment developed more good properties with aging; the aging total score was 96 and 98 at 60 and 90 days, respectively. The total score points of T3 were 67, 78, 87, and 88 points at 0, 30, 60, and 90 days, respectively. The cheese with an age of 90 days was described as having a good flavor, which is nearly equal to that of the control cheese.

These results are in agreement with the results obtained by El-Hawary *et al.* (2015) who reported that the best results were obtained from cheese manufactured by different slurries respectably the best agents to accelerate the ripening of Ras since it grained better ripening indices and organoleptic properties after 30 days as compared to control.

*See legend to Table (1) for details.

4. CONCLUSION

Finally, The results indicated that using a slurry mixture may be useful for the production of Ras cheese and acceleration ripening period without adversely affecting the physicochemical properties, sensory evaluation and quality of Ras cheese. The treatment (T2) slurry mixture of 1.5% of curd had the best characteristics among all treatments besides these treatments (T2) accelerated ripening period (2-3 months).

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