Effect of protein feeding system on the quality of milk and its resultant Domiati Cheese

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Abstract: The use of Sunflower meal (SFM) and Leucaena leaves (LL) as a source of 30% of protein requirements in the feeding system of dairy buffaloes and its effect on the yield and composition of milk as well as its resultant Domiati cheese was investigated. The yield of fresh cheese was determined and cheese was pickled in salted whey for 4 months. Samples were taken from milk and also from cheese monthly during storage and were analyzed for moisture, fat, lactose, acidity, amino acids and nitrogen fractions. Formol & Schilovich ripening indices and total volatile fatty acids contents of cheese were estimated as well as their organoleptic properties.Using of SFM and LL increased total solids, fat and total protein of milk. However, the mean values of ash content of milk were lower for SFM and LL treatments. LL milk of LL was the highest in the essential amino acids.Satisfactory of fresh cheese yield (32.12%) for LL treatment, which was higher than control (30.25%) and SFM treatment (30.12%).No significant differences were found among all treatments for the gross composition. Domiati cheese made with LL milk showed the highest total nitrogen and the lowest acidity at the end of ripening period SN/TN % was higher with LL during ripening than SMF and control, while TVFA was higher with control than LL and SFM treatments. Ripening indices FRI & SRI shows that the LL ranged the higher values, followed by that made with SFM and control treatments. The total evaluation scores of fresh cheese were almost the same for all treatments. However, Domiati cheese from LL higher scores than control and SFM at the end of storage period. It can be concluded that sunflower meal and Leucaena leaves can be use as a source of 30% of protein requirements in the feeding system of dairy buffaloes and the milk yielded from this buffaloes can be successfully used in the manufacture of more quality of Domiati cheese.

[EL-Sheikh, M.M.; S.A.H. Abo EL-Nor; Nadia M. Shahein and N.S. Abd Rabou. **Effect of protein feeding system on the quality of milk and its resultant Domiati Cheese**. Journal of American Science 2011;7(1):282-290]. (ISSN: 1545-1003). http://www.jofamericanscience.org.

Key Words: Domiati cheese system, Sunflower meal ,Leucaena leaves

1. Introduction:

To solve the problem of shortage of milk production, many producers applied various feed-additives to enhance milk yield for providing significant economic income.

Recent development of new feeding system of dairy animals to express protein requirements has placed emphasis not only the protein content of diet but also the protein quality (Satter and Roffer, 1975). Thus, high quality feed proteins including rich amino acids profile and availability of the undegraded protein (Erasmus et al., 1994) may be utilized more efficiently for milk production if large proportions of proteins are less degradable in the rumen.

Sunflower meal (SFM) is a by-product of edible oil industry. It is a rich source of vegetable protein and other nutrient with crude protein (CP): 30.51, ether extract (EE): 0.41, crude fiber (CF): 18.51 and ash: 10.21%. The use of SFM in the ration of lactating cow had a positive effect on solids not fat (SNF) and total solids (TS) of milk, also the cost of milk production was 26.7% less than traditional ration (Jabbar et al., 2008).

Leucaena is a fast growing leguminous tree species that is native to Central America, Mexico and USA. Since its discovery, Leucaena has been distributed throughout many tropical and subtropical areas of the world such as Africa, Australia and India. The CP range for Leucaena is generally accepted to be 20-30% (Gregory, 1996). Leucaena has considerable potential for incorporation into feeding system for dairy cows in the tropics and subtropics. The average increase in milk production obtained from feeding Leucaena was 14% (range of 2-33%). Where recorded, there was usually an increase in fat and protein (Hassan et al., 1989).

Domiati cheese is a soft white salty cheese made primarily in Egypt. It is typically made from buffalo milk, cow milk or mixture milk. It is the most common Egyptian cheese. The yield and composition of cheese vary according to the kind of milk used in cheese making (Abd-El-Aziz et al., 2007).

So, the objective of this study was to evaluate the influence of SFM and LL as a protein source on the yield and composition of milk as well as its resultant Domiati cheese.

2. Materials and Methods:

Animal and rations:

Nine lactating buffaloes in the early lactating season (after 7 days of calving) were used. The animals were randomly assigned into 3 groups of 3 animals each using Latin square design.

Three experimental rations were used in this study. The control diet used (T1) consists of Roughage: concentrate ratio was 30.7% where rice straw composed the basal source of roughage with adding an amount of berseem to adjust crude protein (CP) in the total ration. Sunflower (SFM) meal (T2) and Leucaena (LL) leaves (T3) were used to substitute 30% of the total protein of the concentrate feed mixture (CFM).

The chemical composition of ingredient and rations are shown in Table (1). Animals were feeds twice daily at 6.00 and 16.00 hr. The offered feeds were assesses to cover the requirements for each animal (Kholif and Abd EL-Gawad, 2001).

Analysis of feed samples:

Samples of ingredients and rations were analyzed for Dry matter, ash, crude fiber (CF) CP, Organic matter, ether extract (EE) and nitrogen-free extract, (A.O.A.C, 1995).

Sampling and analysis of milk:

The animals were machine milked twice daily. Milk yield was recorded once every week during the experimental period (90 days, 30 days for each treatment).

At the last 3 days of each experimental period, composite samples were collected from each animal and analyzed for fat, total solids, total protein, non protein nitrogen, acidity and total ash contents were determined as described in IDF standard (1986) and lactose content (Barentte and Abd EL-Tawab, 1957).

Amino acids analysis:

Amino acids composition of milk and cheese samples were determined according to method of Millipore Cooperative (1987) using high pressure liquid chromatographic analysis (HPLC) of amino acids in food using a modification of the PICO-TAG method.

Cheese manufacture

Commercial salt (7%) was added milks and well stirred until dissolved; all treatments were pasteurized at 72°C for 1 min, cooled rapidly to 42°C. Calf rennet (Christian Hansen, Copenhagen, Denmark) was added at 0.1 g/l milk to complete coagulation in 2-3 hr. The curd was scooped into plastic frames lined with cheesecloth and placed over a drainage table and allows draining for 3-4 hr. and pressed to achieve complete drainage in 24 hr. The cheese was cut into blocks and packed in plastic container (500 g), filled with salted whey drained from the same cheese, (EL-Sheikh et al, 2001).

The cheese was stored at room temperature (20 ± 5°C) for 4 months and sampled when fresh and after 1, 2, 3, and 4 months respectively.

Cheese analysis

The samples were first evaluated for their organoleptic properties, homogenized and then stored in the deep freezer until analyze for chemical composition.

Cheese samples were analyzed for moisture, fat and salt as given by A.O.A.C. (1990) and total nitrogen and soluble nitrogen as described in IDF standard (1986). Lactose was determined as described in method of Barnett and Abdel Tawab (1957). Also, Formol and Schilovich (FRI & SRI) ripening indices of cheese were measured according to (Tawab and Hofi, 1966), total volatile fatty acids (TVFA) as described by (Kosikowski, 1978).

The yield of cheese was calculated as kg of fresh cheese per 100 kg of milk, EL-Sheikh et al., (2001). The corrected yield on the basis of 60% moisture was calculated as follows:

Corrected yield = 60% ÷ fresh moisture x calculated yield

Taste panel of 8 persons for National Research Centre (NRC) staff evaluated the organoleptic properties of cheese samples. The panelists scored the cheese for flavour (out of 60 points), body & texture (30 points) and appearance (10 points).

Statistical analysis:

Data obtained from this study were statistically analyzed according to procedures measured by Snedecor and Cochran (1982), Duncan's Multiple Range Test (1955) was used for testing the significant differences between means.

3. Results and Discussion:

Composition of rations:

Table (1), shows the chemical composition of the three experimental treatments. No clear differences between treatments for crude protein (CP), dry and organic matter. Crude fiber (CF) was less when we use LL while nitrogen free extract was higher than control and SFM.

The precentage of the removal of aromatics content is 50%, of sulfur content is 63wt% and nitrogen content is 80.48%.The Refining process decreases mostly the aromatic hydrocarbons in the form of di-and polycyclic aromatics while the monocyclic aromatics are not affected to a big extent as given in Table (1). It is observed that the polycyclic aromatics are completely removed. The refining process removes 80% of dicyclic aromatics.

Table (1): Chemical composition of the three experimental rations (% on dry matter basis).

Item	(T1)	(T2)	(T3)
Dry matter	90.13	90.33	90.21
Organic matter	89.87	90.44	90.82
Crude protein (CP)	13.72	13.53	13.57
Crude fiber (CF)	20.26	18.22	15.24
Ether extract EE)	3.78	3.22	3.52
Nitrogen free extract	52.11	55.47	58.49
Ash	10.13	9.56	9.18

T1 = Control
T2 = Sunflower meal (30%)
T3 = Leucaena (30%)

Milk yield and composition:

The use of Sunflower (SFM) meal (T2) and Leucaena (LL) leaves (T3) increased milk and 4% fat corrected milk (FCM) yield (P > 0.05, P <0.05) than control (T1). The use of LL had a relative improvement in milk production, this may be attributed to leucaena had a lower nitrogen solubility than concentrate feed mixture (CFM) and SFM. Similar results were obtained by Grummer and Clark (1982), Khattab et al., (1998). Moreover, LL contains tannins which may be important in the protection of protein from degradation, Jones (1979).

Data of milk composition (Table2) indicated that averages of milk fat, TS, SNF and total protein (TP) were insignificant higher (P > 0.05) in LL than those of control and SFM, in addition lactose content of milk was increased significantly (P < 0.01) in LL than those of control and SFM. However the mean values of ash content of milk was lower for SFM and LL than that of control. Non-protein nitrogen (NPN) content of milk showed insignificant differences among treatments. The mean values of milk acidity were higher in the evening than that in the morning milking.

Table (2): Composition of buffaloes milk from different treatment used in Domiati cheese manufacture.

Item	T1	T. 2	T. 3	SD
Milk yield kg/day	7.62	8.24	8.58	± 1.75
Total solids	16.00	16.18	16.53	± 0.22
Fat corrected milk	10.34^{bc}	11.26^{ac}	11.77^{a}	± 2.05
Fat	6.30	6.41	6.67	± 0.16
Solids not fat	9.70	9.77	9.86	± 0.007
Total protein	4.00	4.31	4.46	± 0.19
Non protein nitrogen	0.039	0.035	0.033	± 2.49
Ash	0.85	0.77	0.72	± 0.05
Lactose	4.36^{b}	4.40^{b}	4.78^{a}	± 0.19
Acidity morning	0180	0.189	0.186	± 0.004
evening	0.179	0.191	0.187	± 0.005

T1 = Control
T2 = Sunflower meal (30%)
T3 = Leucaena (30%)

- Means of 3 samples for each treatment
- Significant different, according to Duncan's (P ≤ 0.05)
- A, b and c or (P < 0.01) between means are indicated by dissimilar superscripts.

Amino acids content of milk:

Data in Table (3) showed that the milk of buffaloes fed CFM (T1) contained the lowest concentration of most essential amino acids. MILK OF (T3) was the highest in histidine, lysine, methionine and phenylalanine, while (T2) was the highest in arginine and threonine. The control (T1) was the highest in leucine, isoleucine and valine. In addition, data of Table (3) showed that the total essential amino acids of milk were higher in T3 (58.67) g/100 g milk protein than those of T1 (49.72) g/100 g milk protein and T2 (57.15) g/100 g milk protein. This may be due to the lower degradation of protein of leucaena treatment.

Data in Table (3) showed that T2 and T3 recorded nearly similar values of total non-essential amino acids and were lower than T1. Same results were obtained by Khattab et al., (1998).

Table (3): Effect of protein source in rations of lactating buffaloes on amino acids composition of milk (g/100 g milk protein).

Amino acids	T1	T. 2	T. 3	SD
Essential				
Arg	4.68	10.08	8.51	± 2.27
His	1.06	1.31	1.65	± 0.24
Ile	8.09	6.31	5.97	± 0.93
Leu	8.83	6.71	6.89	± 0.96
Lys	8.23	14.75	15.47	± 3.26
Met	2.18	2.29	3.92	± 0.79
Phe	5.65	6.10	6.93	± 0.53
Thr	3.59	4.68	6.86	± 1.2
Val	7.41	4.92	5.47	± 1.07
Total essential	49.72	57.15	58.67	
Non-essential				
Ala	1.66	1.55	1.31	± 0.15
Asp	7.27	6.87	6.72	± 0.23
Cys	1.93	2.30	1.86	± 0.19
Glu	13.03	13.66	13.74	± 0.32
Gly	1.99	2.24	2.17	± 0.11
Pro	1.27	1.63	1.86	± 0.24
Ser	2.27	1.95	1.71	± 0.23
Tyr	10.51	6.75	6.22	± 1.91
Total non-essential	39.93	36.92	35.59	

T1 = Control
T2 = Sunflower meal (30%)
T3 = Leucaena (30%)

Cheese yield:

Table (4): Yield of Domiati cheese made from different treatments.

	T1	T2	T3
Fresh yield	30.25	30.46	32.12
Corrected yield	29.67	29.93	32.73

T1 = Control
T2 = Sunflower meal (30%)
T3 = Leucaena (30%)

Table (4), shows the fresh and calculated yield based on 60% moisture of Domiati cheese from different treatments. LL cheese gave the highest fresh and corrected yield than SFM and control treatments.

It is shown in Table (5), that the moisture content of Domiati cheese decreased gradually as ripening progresses in all treatments. Similar results were reported by EL-Sheikh et al., (2001).

Also, data in Table (5) shows that the F/DM values gradually increase with increasing ripening period. However, T3 showed the highest value (52.32%) at the end of ripening, same trend were also noted for total nitrogen content. However, control cheese showed lowest total nitrogen content (2.54%) at the end of ripening. Salt/DM % showed gradually decreased for all treatments during ripening, T3 showed lowest value (10.03%) at the end of ripening period.

The acidity of cheese increased gradually for all treatments and the cheese resultant from T3 showed the lowest acidity (1.90%) at the end of ripening period.

Data in table (6) showed that T3 contained the highest concentration of essential amino acids (416.81 mg/100g) at the end of ripening period.

Gross composition of cheese:

Table (5) : Gross composition of Domiati cheese from different treatments.

	Moisture %	F/DM %	T. N %	Salt/DM %	Acidity %
Fresh T1	61.17 ± 0.372	40.68 ± 0.676	2.21 ± 0.046	14.19 ± 0.306	0.330 ± 0.009
T2	61.07 ± 0.463	44.85 ± 0.606	2.36 ± 0.030	13.59 ± 0.265	0.347 ± 0.014
T3	58.88 ± 0.462	44.32 ± 0.232	2.42 ± 0.019	12.50 ± 0.165	0.273 ± 0.019
1 month T1	59.75 ± 0.207	42.90 ± 0.672	2.31 ± 0.035	12.42 ± 0.236	0.808 ± 0.022
T2	59.20 ± 0.456	46.70 ± 0.405	2.49 ± 031	11.91 ± 0.067	0.817 ± 0.023
T3	57.45 ± 0.302	46.26 ± 0.163	2.55 ± 0.015	11.04 ± 0.070	0.735 ± 0.021
2 months T1	58.42 ± 0.306	45.68 ± 0.319	2.40 ± 0.095	11.90 ± 0.119	1.23 ± 0.032
T2	57.65 ± 0.460	48.26 ± 0.150	2.58 ± 0.041	10.98 ± 0.213	1.27 ± 0.039
T3	56.13 ± 0.458	48.40 ± 0.261	2.63 ± 0.066	10.55 ± 0.148	1.15 ± 0.024
3 months T1	57.35 ± 0.288	47.50 ± 0.654	2.47 ± 0.020	11.23 ± 0.558	1.63 ± 0.030
T2	56.45 ± 0.517	49.58 ± 0.117	2.65 ± 0.014	10.70 ± 0.271	1.55 ± 0.029
T3	55.50 ± 0.600	50.40 ± 0.20	2.69 ± 0.050	10.25 ± 0.366	1.39 ± 0.021
4 months T1	56.10 ± 0.126	49.40 ± 0.245	2.54 ± 0.028	10.62 ± 0.638	2.09 ± 0.062
T2	55.90 ± 0.482	51.47 ± 0.103	2.70 ± 0.029	10.25 ± 0.095	2.07 ± 0.067
T3	54.72 ± 0.343	52.32 ± 0.223	2.74 ± 0.025	10.03 ± 0.095	1.90 ± 0.056

T1 = Control
T2 = Sunflower meal (30%)
T3 = Leucaena (30%)

Ripening indices:

Fig (1) referred that T3 cheese showed higher value of SN/TN at the end of storage. While, control cheese as shown in fig (2) showed higher value of total volatile fatty acids.

Fig (3&4) shows the values of FRI and SRI, these values were increased with increasing storage period. However, T3 showed higher value at the end of storage.

Organoleptic properties:

Table (7), shows the sensory evaluation of Domiati cheese during storage. T3 cheese was ranked the highest total score (65/100) when fresh. Also, T3 cheese ranked the highest total score (95/100) at the end of storage period (4 months).

Table (6): Effect of protein source in rations of lactating buffaloes on amino acids composition of Domiati cheese (mg/100 g).

Amino acids	T1		T2		T3	
Essential	**Fresh**	**4 months**	**Fresh**	**4 Months**	**Fresh**	**4 months**
Arg	1.93	Trace	0.62	0.51	7.45	345.4
His	0.75	1.23	3.63	1.57	3.15	0.85
Ile	1.08	3.08	1.17	3.31	2.84	4.76
Leu	Trace	Trace	Trace	5.16	6.41	Trace
Lys	2.35	2.28	9.95	2.74	1.23	59.30
Met	11.46	7.38	2.20	13.80	1.75	0.80
Phe	Trace	100.8	5.76	3.93	8.11	4.08
Thr	0.71	91.38	1.50	Trace	Trace	1.22
Val	0.30	0.71	3.21	26.40	5.84	0.42
Total	**18.58**	**206.86**	**38.04**	**57.42**	**36.78**	**416.81**
Non-essential						
Ala	3.14	14.35	3.89	0.72	Trace	66.51
Asp	0.40	64.54	13.22	20.8	2.28	42.13
Cys	1.48	10.38	9.05	23.94	55.81	11.16
Glu	6.43	1.69	2.90	1.33	4.03	1.33
Gly	1.94	9.49	3.86	4.29	0.97	0.52
Pro	1.53	1.87	7.95	18.86	Trace	399.8
Ser	0.34	0.22	0.24	37.09	1.32	4.23
Tyr	7.48	13.23	9.64	97.5	3.18	12.37
Total	**22.7**	**115.77**	**50.75**	**204.53**	**67.59**	**538.05**

T1 = Control
T2 = Sunflower meal (30%)
T3 = Leucaena (30%)

Table (7): Sensory evaluation of Domiati cheese from different treatments (average of three replicates).

Item		Flavour 60	Appearance 10	Body & texture 30	Total score 100
Fresh					
	T1	30	9	19	58
	T. 2	35	7	16	58
	T. 3	35	10	20	65
1 month					
	T1	35	8	18	61
	T. 2	35	7	17	59
	T. 3	40	10	20	70
2 months					
	T1	45	7	21	73
	T. 2	48	6	20	74
	T. 3	56	8	25	89
3 months					
	T1	47	7	22	76
	T. 2	50	6	20	76
	T. 3	58	8	27	93
4 months					
	l T1	51	7	23	81
	T. 2	55	6	20	81
	T. 3	59	8	28	95

T1 = Control
T2 = Sunflower meal (30%)
T3 = Leucaena (30%)

4. Conclusion:

Using of Sunflower meal and Leucaena leaves as a source of 30% of protein requirements in the feeding system of dairy buffaloes increased total solids, fat, protein and essential amino acids of milk than control one. Leucaena leaves improved the quality of Domiati cheese, so its uses in the feeding system of dairy buffaloes are recommended.

Fig (1): SN/TN % of Domiati cheese made from different treatments.

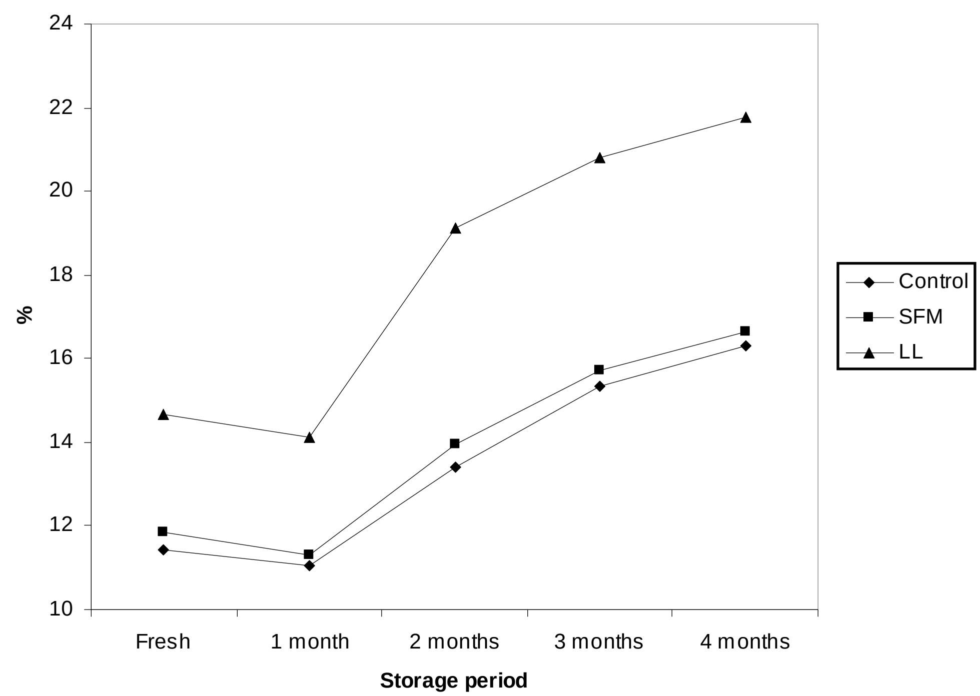


Fig (2): Total volatile fatty acids of Domiati cheese made from different treatments.

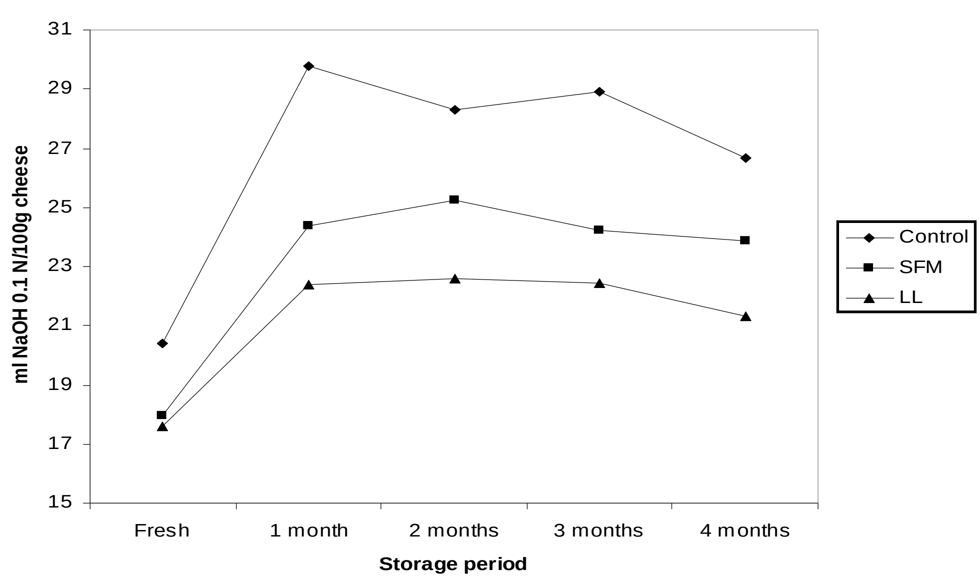


Fig (3): Formol ripening index (FRI) of Domiati cheese made from different treatments

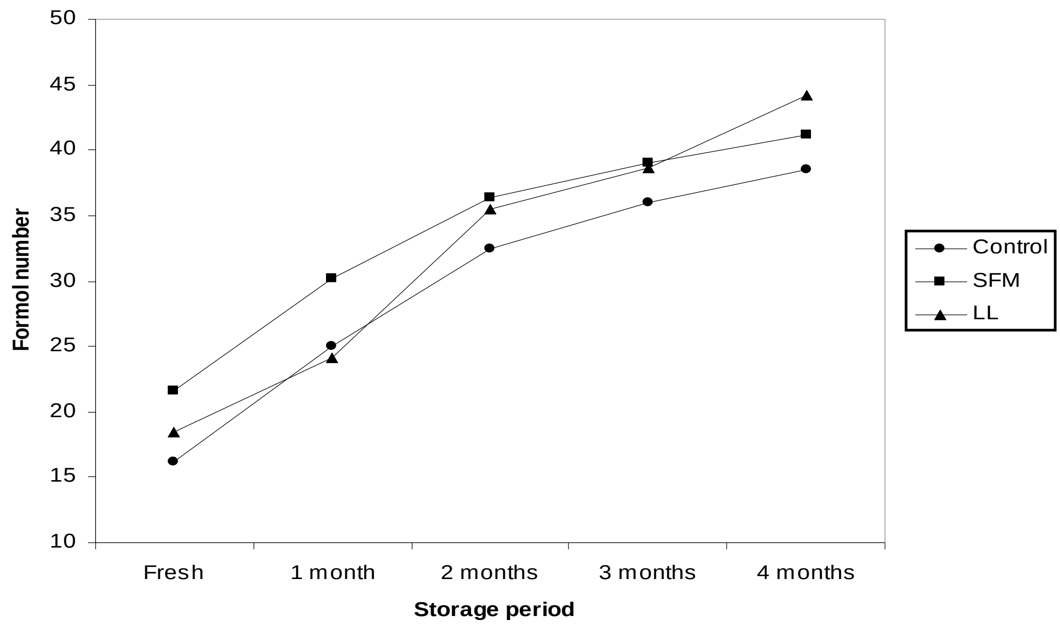
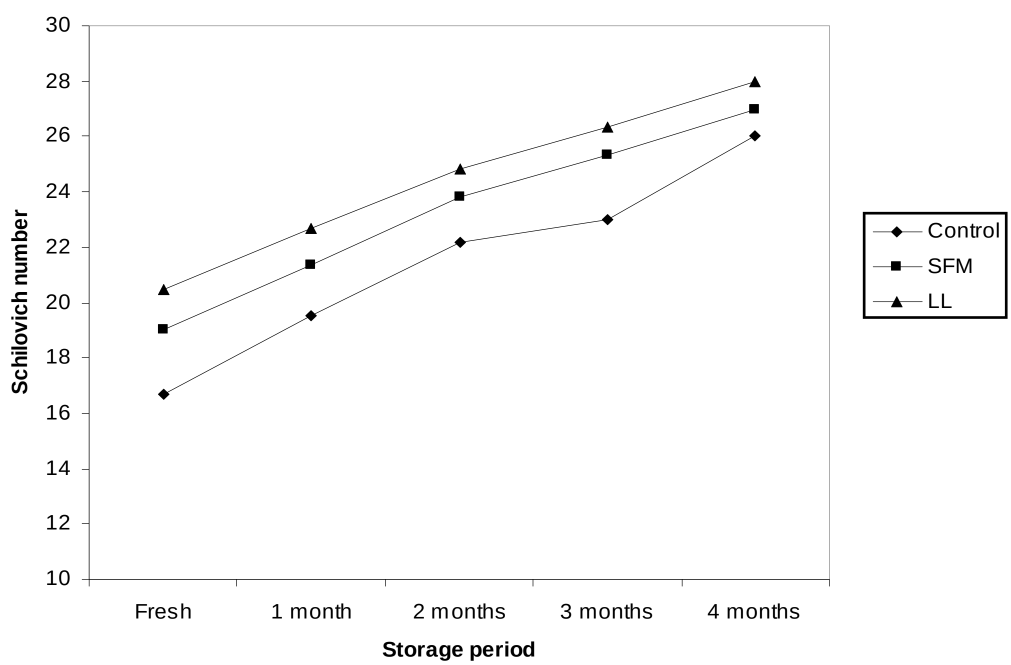


Fig (4): Schilovich ripening index (SRI) of Domiati cheese made from different treatments.



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12/1/2010