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Quality and Properties of Low-fat Buffaloes' Kashkaval Cheese

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Abstract: The aim of this study was improving the characteristics of low-fat buffaloes' Kashkaval cheese by using fat replacers. Kashkaval cheese treated with fat replacers namely Simplesse(R) 100 and Dairy-Lo™ contained higher moisture than control cheese when fresh and along the ripening period. Total acidity was not affected by using fat replacers as compared with control cheese when fresh, then decreased up to the end of ripening. Fat and total nitrogen contents were slightly decreased with using fat replacers however, they increased with variable rates during ripening period. Soluble nitrogen, non protein nitrogen, tyrosine and tryptophan contents were not greatly affected by using fat replacers in fresh cheese but they were markedly increased by advancing cheese ripening. Cheese treatment of 0.8% Simplesse(R)100 or 1.6% Dairy-Lo™ ripened for 3 months showed the best organoleptic properties.

Key words: Buffaloes, kashkaval cheese, low fat cheese, Simplesse(R)100, dairy-Lo™, fat replacers, cheese ripening

INTRODUCTION

The cheese known as Kashkaval in the Balcanik countries, especially Greece, Bulgaria, Romania and formerly Yougoslavia regions is a scalded-curd variety prepared formerly only from sheep's milk. It has a semi-hard texture and pliable with small gas holes, whereas its falvour is pleasant, mild, aromatic and slightly sweet or salty (Scott, 1981). At present, the Kashkaval is prepared from cows, buffalo's or goats milk or from a mixture of these milks. In Romania there are known a large varieties of Kashkavals such as: Penteleu, Teleoroman, Fetesti, Dobrogea, Dalia, Vrancea, Rucar, etc. named from the region where they are prepared.

Excessive uptake of fat in the diet has been linked to certain diseases, such as heart disease, cancer, obesity and possibly gall bladder disease and it is associated with high blood cholesterol and increased risk of coronary heart disease (Akoh, 1998).

However, fat is not only of nutritional significant in cheese, but also plays an important role in determining the characteristic body and texture and flavour of cheese. Fat content of cheese affects its microstructure. Full-fat cheese is characterized by a protein matrix interspersed with fat globules of varying shapes and sizes. On contrary, low-fat cheese has less fat globules within the protein matrix and the globules are usually smaller than that of the full fat cheese (Mistry and Anderson, 1993).

Therefore, low-fat cheese made by conventional methods have poor functional properties and sensory defects, such as poor aroma and over-firm or rubbery body and texture as well as appearance of calcium lactate crystals defect. Additionally, low-fat cheese usually excessively dry and possibly grainy (Rodriguez, 1998). Hence, many ingredients and different technological strategies have been developed for enhancing quality of low fat cheese.

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It is important to ascertain the textural characteristics of commercial cheese in the context of developing low-fat cheese using fat replaces in order to achieve similar textural characteristics of full-fat cheese (Bhaskaracharya and Shah, 1999).

The utilization of reduced fat buffaloes' milk in the manufacture of Kashkaval cheese using different types of commercial fat replacers is the aim of this study to improve the quality of the resultant cheese.

MATERIALS AND METHODS

I-Materials

- **Milk:** Fresh raw buffaloes' milk was obtained from the herd of Animal Production Research Station at Sakha, Kafr El-Sheikh Governorate, Egypt, during September to December, 2006.

- **Fat replacers**
  Simplesse(R)100 consists of micro particulates whey protein concentrate was obtained from the NutraSweet Kelco Co., San Diego, Ca, USA.
  Dairy-Lo™ made from denaturated whey proteins was obtained from Cultor Food Science, Ardsley, New York, USA.

- **Coagulants:** Rennilase (*Mucor miehi*) was obtained from Gist-brocades, France.

- **Starter Culture**
  Mesophilic Aromatic culture type, LD-culture CH-N22 multiple mixed strain culture containing *Lactococcus lactis* subsp. *cremoris, Lactococcus lactis* subsp. *Lactis* and *Leuconostoc mesenteriodes* subsp. *cremoris*, were obtained from CHR. HANSEN, Denmark.

Cheese Manufacture

Kashkaval cheese was manufactured from low-fat buffaloes' milk according to the method described by Scott (1981).

Sixth part (1/6) of buffaloes' milk was served as full-fat control cheese and the remainder milk portion was standardized to 1.5% fat, heat treated at 72°C for 15 sec and cooled to 30°C. The heat treated milk was divided into five parts. The first part was manufactured without any fat replacers and served as low-fat control. Quantities of 0.8 and 1.6% of Simplesse(R)100 and Dairy-Lo™ were added to the other four parts, respectively, then the manufacture steps were completed. The cheese was ripened for three months and samples were analyzed when fresh and after 1, 2 and 3 months.

II-Methods

Cheese samples were chemically analyzed for total and soluble nitrogen contents by Kjeldahel method (IDF, 1993). The fat content, moisture, non protein nitrogen and titratable acidity contents of cheese as described by Ling (1963). The Soluble tyrosine and tryptophan contents of cheese were determined according to Vakaleris and Price (1959), while total volatile fatty acids content was determined as described by Kosikowski (1966).

Organoleptic Evaluation of Cheese

The cheese samples were organoleptically scored according to the score card suggested by Nelson and Trout (1956). Samples were judged by 12 persons of the colleague staff members.

Statistical Analysis

The obtained data were statistically analyzed according to SAS (1996).Analysis data as indicated by the following model:

$$Yij = \mu+Ti+Eij$$

Where:

Yijk : Is the observation on the ith treatment.
μ : Common effect to represent the population mean.
Ti : A common effect to treatments.
Eij : Is a randomized error.

RESULTS AND DISCUSSION

The commercial fat replacers Simplesse(R)100 and Dairy-Lo™ were used to improve the quality of low-fat Kashkaval cheese made from buffaloes' milk. Chemical composition and organoleptic properties of the controls and treated cheeses when fresh and during ripening were determined.

Cheese Chemical Composition

Moisture content: Data of moisture content in Table 1 show that the average moisture content of fresh cheese was affected significantly by adding different fat replacers. Where cheeses made with fat replacers contained higher moisture content than cheese without fat replacer (low-fat control II and full-fat control I) and this increase was significant to the ratio of added fat replacers. These results are in agreement with those of Lucey and Gorry (1993) and McMahon *et al*. (1996) who found that low-fat cheese made with the whey-based fat replacers had higher moisture contents than control cheese. The latter one mentioned that the differences in moisture content may reflect the quantity of fat replacers used in the cheese manufacture.

The data also indicate that the kind of fat replacers had a significant effect on the moisture content as Simplesse(R)100 showed higher moisture content compared with Dairy-Lo™. These results are in agreement with the finding of McMahon *et al*. (1996) who mentioned that Simplesse(R) was observed as micro particles embedded within the casein matrix, which may allow greater moisture retention than does Dairy-Lo™ which was present as smaller particles. The increased moisture content of low fat cheese made by using fat replacers explains that curd syneresis decrease during cheese making, which

can occur as a result of water being bound directly to the fat replacers, or fat replacers may interfere with shrinkage of the casein matrix, thus lowering the driving force involved in expelling water from the curd particles.

All experimental cheese treatments showed a continuous decrease in moisture content as the ripening period progressed up to three months.

Table 1: Effect of using fat repalcers on moisture content (%) of low-fat buffaloes Kashkaval cheese during ripening

Storage period (month)	Control		Simplesse (R) 100		Dairy-LoTM		Average of storage period±SE
	Full-fat	Low-fat	0.8%	1.6%	0.8%	1.6%	
Fresh	41.401^{Ab}	38.796^{Aa}	48.810^{Ade}	49.561^{Ace}	45.516^{Ac}	47.304^{Ad}	45.23±0.06
1	36.455^{Ba}	34.589^{ABa}	47.923^{Bd}	48.315^{Bd}	44.232^{Bb}	46.157^{Bc}	42.945±0.05
2	35.065^{Ca}	34.231^{Ba}	46.973^{Cc}	47.977^{Cd}	43.661^{Cb}	45.925^{Cb}	42.31±0.04
3	34.828^{Ca}	33.963^{Ba}	46.825^{Cd}	47.793^{Cd}	43.117^{Cb}	45.628^{Cc}	42.03±0.04
Average of treatments±SE	36.94±0.09	35.40±0.08	47.633±0.10	48.413±0.11	44.133±0.12	46.25±0.11	-

Dissimilar superscripts at the same row (for treatments) and at the same coloum (for storage periods) are significantly differed ($p<0.05$). Each value is a mean of 3 replicates

Fat Content

Cheese fat content of fresh samples was slight lower in the various treatments than low-fat control (Table 2) and lower than full-fat control. Also, the fat content slightly decreased as the quality of fat replacers increased which may be due to that addition of fat replacers to cheese milk which led to relatively higher moisture retention in the resultant cheese.

It was also noticeable that during the ripening period there was a significant increase in cheese fat content of all samples. This could be attributed to the reduction of its moisture content throughout the ripening period.

Titratable Acidity

The titratable acidity of cheese treatment did not affected significantly by using the different fat repalcers as compared with the controls (Table 3). Also, it can be seen from the same table that the titratable acidity of all cheese samples had the same trend, as it increased significantly with variable rates during ripening period. These results are in agreement with those reported by Katsiari and Voutsinas, (1994) and Romeih *et al*. (2002) for low-fat cheese.

Total Nitrogen (TN)

The TN (total nitrogen) content of the different treatments were slightly lower than the low-fat control while had a significant difference than full-fat control cheese (Table 4).

The TN contents were inversely proportional to the rate of adding fat replacers, Simplesse$^{(R)}$100 but the opposite trend was noticed with Dairy-Lo^{TM}.

The TN contents of all cheese samples were significantly increased with variable rates during ripening. This increase might be due to loss of cheese moisture content. Similar results were reported by Abdel-Gawad (1998), Rudan *et al*. (1998), Zammar, (2000) and Romeih *et al*. (2002) with Mozzarella and low fat white cheese.

Soluble Nitrogen: Total Nitrogen Ratio (SN/TN)

The effects of fat replacers added to low-fat cheese on its SN/TN are shown in Table 4. It is worth mentioned that SN/TN had similar trends as they did not affected significantly by the fat replacers in fresh cheese and markedly increased significantly by advancing cheese ripening.

Table 2: Effect of using fat replacers on fat percentage of low fat buffaloes Kashkaval cheese during ripening

Storage period	Control		Simplesse$^{(R)}$100		Dairy-Lo^{TM}		Average of storage
(month)	Full-fat	Low-fat	0.8%	1.6%	0.8%	1.6%	period±SE
Fresh	25^{Aa}	12^{Ab}	11.0^{Ab}	10.5^{Ab}	11.3^{Ab}	10.4^{Ab}	13.37±0.06
1	27^{Bb}	13^{Bb}	12.1^{Bb}	11.1^{Bb}	12.2^{Bb}	11.3^{Bb}	14.45±0.07
2	29^{Cb}	14^{Cb}	12.8^{Cb}	11.7^{Cb}	13.0^{Cb}	12.1^{Cb}	15.433±0.08
3	30^{Db}	15^{Db}	13.2^{Db}	12.6^{Db}	13.5^{Db}	12.8^{Db}	16.18±0.09
Average of treatments±SE	27.75±0.11	13.5±0.09	12.28±0.12	11.48±0.08	12.5±0.09	11.65±0.12	-

Dissimilar superscripts at the same row (for treatments) and at the same colum (for storage periods) are significantly differed ($p<0.05$). Each value is a mean of 3 replicates

Table 3: Effect of using fat replacers on titratable acidity % of low fat buffaloe's Kashkaval cheese during ripening

Storage period	Control		Simplesse$^{(R)}$100		Dairy-Lo^{TM}		Average of storage
(month)	Full-fat	Low-fat	0.8%	1.6%	0.8%	1.6%	period±SE
Fresh	0.63^{Aa}	0.61^{Aa}	0.72^{Aa}	0.73^{Aa}	0.71^{Aa}	0.72^{Aa}	0.69±0.002
1	0.79^{ABa}	0.76^{Ba}	0.85^{ABa}	0.89^{Ba}	0.83^{ABa}	0.87^{ABa}	0.83±0.003
2	0.91^{Ba}	0.89^{Ba}	1.26^{Ba}	1.29^{BCa}	1.21^{Ba}	1.24^{Ba}	1.13±0.004
3	1.42^{Ca}	1.37^{Ca}	1.49^{Ca}	1.58^{Ca}	1.46^{Ca}	1.52^{Ca}	1.47±0.006
Average of treatments±SE	0.938±0.02	0.908±0.03	1.08±0.04	1.123±0.03	1.05±0.02	1.09±0.03	

Dissimilar superscripts at the same row (for treatments) and at the same colum (for storage periods) are significantly differed ($p<0.05$). Each value is a mean of 3 replicates

Table 4: Effect of using fat replacers on total nitrogen, soluble nitrogen/total nitrogen and non protein nitrogen/total nitrogen contents of low fat buffaloes' Kashkaval cheese during ripening

Storage period (month)	Control		Simplesse(R)100		Dairy-Lo™		Average of storage period±SE
	Full-fat	Low-fat	0.8%	1.6%	0.8%	1.6%	
T N (%)							
Fresh	2.82^{Aa}	4.81^{Ad}	4.24^{Abc}	4.17^{Ab}	4.35^{Abc}	4.42^{Ac}	4.14±00.004
1	3.04^{ABa}	5.09^{Abd}	4.46^{ABbc}	4.39^{ABb}	4.68^{C}	4.81^{ABc}	4.412±0.003
2	3.21^{Ba}	5.27^{Bd}	4.62^{Bbc}	4.66^{Bb}	4.79^{Bc}	4.87^{Bc}	4.57±00.002
3	3.44^{BCa}	5.48^{Bd}	4.84^{BCbc}	4.79^{BCb}	5.01^{BCc}	5.13^{BCc}	4.78±00.004
Average of treatments±SE	3.13±0.007	5.163±0.008	4.54±0.12	4.503±0.11	4.71±0.12	4.81±0.11	
SN/TN (%)							
Fresh	6.79^{Aa}	6.82^{Aa}	6.820^{Aa}	6.77^{Aa}	6.96^{Aa}	6.81^{Aa}	6.83±0.004
1	7.55^{Ba}	6.99^{ABa}	7.16^{ABa}	7.14^{ABa}	7.17^{Aa}	7.09^{Aa}	7.18±0.005
2	10.31^{Ca}	10.40^{Ca}	10.73^{Ca}	10.33^{Ca}	10.39^{Ca}	10.31^{Ca}	10.412±0.006
3	10.79^{CDa}	10.66^{CDa}	10.81^{Ca}	10.46^{Ca}	10.50^{Ca}	10.52^{Ca}	10.623±0.007
Average of treatments±SE	8.86±0.11	8.718±0.12	8.88±0.11	8.68±0.113	8.76±0.11	8.68±0.13	
NPN/TN (%)							
Fresh	2.730^{Aa}	2.975^{Ab}	2.77^{Aa}	2.87^{Ab}	2.65^{Aa}	2.72^{Aa}	2.79±00.004
1	3.605^{Bb}	3.143^{Ba}	3.01^{Ba}	3.09^{Ba}	2.98^{Ba}	3.03^{Ba}	3.143±0.005
2	4.090^{Cc}	3.373^{Cb}	3.22^{Ca}	3.31^{Ca}	3.17^{Ca}	3.25^{Ca}	3.143±0.006
3	4.291^{Db}	3.741^{Da}	3.69^{Da}	3.71^{Da}	3.66^{Da}	3.72^{Da}	3.80±00.007
Average of treatments±SE	3.68±0.12	3.31±0.11	3.17±0.13	3.25±0.11	3.12±0.12	3.18±0.13	

Dissimilar superscripts at the same row (for treatments) and at the same colum (for storage periods) are significantly differed ($p<0.05$). Each value is a mean of 3 replicates

Non-protein Nitrogen: Total Nitrogen Ratio (NPN/TN)

The changes occurred in NPN/TN of low fat buffaloes' Kashkaval cheese made with fat replacers during ripening (Table 4). As ripening period progressed, NPN/TN of all samples gradually increased significantly up 3 months. These results are in agreement with those reported by Mostafa *et al*. (2002) for semi-hard cheese.

Soluble Tyrosine and Tryptophan

Tyrosine and tryptophan contents of fresh samples did not significantly affected by using fat replacers, while they were affected significantly during storage period for all samples (Table 5). Fat replacers produced an increase in tyrosine and tryptophan contents during ripening period in comparison with the control samples and also increased with increasing the added ratio of fat replacers. Using Simplesse(R)100 gave higher contents of tyrosine and tryptophan as compared with using Dairy-Lo™ at the same added ratio. These results are in agreement with the finding of El-Sissi (2003) for buffaloes' Kashkaval cheese.

Total Volatile Fatty Acids

It is clear from (Table 6) that TVFA contents were affected significantly with fat content, where control sample from full-fat milk had the highest TVFA content than all other treatments at fresh and during storage periods. However, the data indicate that all samples showed significant increase in TVFA contents during storage period. These results are in agreement with the finding of Hassan (2005) for low-fat Edam buffaloes' cheese.

2-Organoleptic Properties

When fat is partially removed, as in low fat cheese, casein plays a greater role in curd texture development. In low fat variants there is inadequate breakdown of casein and therefore, the cheese

Table 5: Effect of using fat replacers on soluble tyrosine and tryptophan contents (mg/100 g cheese) of low-fat buffaloes' Kashkaval cheese during ripening

Storage period (month)	Control		Simplesse(R)100		Dairy-Lo™		Average of storage period±SE
	Full-fat	Low-fat	0.8%	1.6%	0.8%	1.6%	
Tyrosine							
Fresh	45.46^{Aa}	44.00^{Aa}	45.81^{Aa}	46.22^{Aa}	45.92^{Aa}	46.33^{Aa}	45.623±0.05
1	179.34^{Bb}	167.41^{Ba}	188.26^{Bc}	191.42^{Bcd}	182.61^{Bb}	189.21^{Bc}	183.042±0.06
2	263.21^{Cb}	244.05^{Ca}	272.51^{Cc}	274.31^{Cc}	269.83^{Cb}	271.31^{Cb}	265.87±0.04
3	322.54^{Dc}	299.52^{Da}	319.62^{Db}	315.69^{Db}	313.52^{Db}	315.81^{Db}	314.45±0.07
Average of treatments±SE	202.64±0.12	188.75±0.11	206.55±0.13	206.91±0.15	202.97±0.17	205.67±0.16	
Tryptophan							
Fresh	53.41^{Aa}	55.31^{Aa}	55.21^{Aa}	56.00^{Aa}	54.22^{Aa}	55.71^{Aa}	54.98±0.05
1	62.85^{Ba}	63.26^{Ba}	68.43^{Bb}	74.41^{Bc}	63.51^{Ba}	67.43^{Bc}	66.65±0.07
2	71.23^{Ca}	70.21^{Ca}	75.2^{Cb}	78.62^{Cc}	72.66^{Cb}	75.62^{Cb}	73.92±0.06
3	79.25^{Db}	73.62^{Da}	80.3^{Db}	84.61^{Dc}	76.25^{Dab}	79.27^{Db}	78.88±0.07
Average of treatments±SE	66.69±0.11	65.6±0.12	69.79±0.10	73.41±0.13	66.66±0.12	69.51±0.14	

Dissimilar superscripts at the same row (for treatments) and at the same colum (for storage periods) are significantly differed ($p<0.05$). Each value is a mean of 3 replicates

Table 6: Effect of using fat replacers on total volatile fatty acids (mL 0.1 N NaOH/100 g cheese) of low-fat buffaloes' Kashkaval cheese during ripening

Storage period (month)	Control		Simplesse(R)100		Dairy-Lo™		Average of storage period±SE
	Full-fat	Low-fat	0.8%	1.6%	0.8%	1.6%	
Fresh	10.5^{AC}	4.5^{Aa}	5.2^{Ab}	5.6^{Ab}	5.3^{Ab}	5.6^{Ab}	6.12±0.005
1	18.6^{Bc}	10.8^{Ba}	14.6^{Bb}	14.6^{Bb}	14.4^{Bb}	14.5^{Bb}	14.58±0.006
2	27.8^{Cb}	20.0^{Ca}	21.6^{Ca}	22.2^{Ca}	22.0^{Ca}	22.6^{Ca}	22.70±0.005
3	38.5^{Dc}	23.4^{Da}	26.4^{Db}	26.8^{Db}	27.1^{Db}	27.3^{Db}	28.25±0.007
Average of treatments±SE	23.85±0.03	14.68±0.02	16.95±0.03	17.30±0.02	17.2±0.04	17.5±0.03	

Dissimilar superscripts at the same row (for treatments) and at the same colum (for storage periods) are significantly differed ($p<0.05$). Each value is a mean of 3 replicates

appears to have a relatively firm texture. It is well known that milk fat provides a range of functional properties in cheese, contributing to the sensory, structure and texture attributes of the product. Fat breaks up to protein matrix and plays the role of lubricant to provide smoothness and softer texture. In low fat cheese due to the dominating role of milk proteins, the product becomes hard and rubbery. These results are in agreement with the finding of El-Sissi (2003) and Anderson and Mistry (1994).

Data presented in Table 7 show that fat replacers fresh cheese treatments have nearly the same appearance score like control full-fat cheese, while low-fat control cheese obtained the lowest scores when fresh and during ripening periods. From the same Table 7 it could be said that using fat replacers improved body and texture of low fat buffalo's Kashkaval cheese as compared with low-fat control cheese when fresh. Addition of fat replacers Simplesse(R)100 at 0.8% and Dairy-Lo™ at 1.6% were effective in improving body and texture of low-fat cheese. From the obtained results it was evident that as ripening period progressed there was gradual improvement in body and texture until the third month of ripening for all cheese samples. However, using 1.6% of Simplsse(R)100 gave a soagy body and texture, while low-fat control cheese had a hard body and texture.

Also, the same Table 7 showed that flavour of low-fat Kashkaval cheese had nearly the same scores as full-fat control cheese when fresh. During ripening period there were obvious increases in flavour scores for different treatments. However, Simplesse(R)100 at 0.8% level gained the highest flavour score being 58 point.

Table 7: Effect of using fat replacers on the organoleptic properties of low-fat buffaloe's Kashkaval cheese during ripening

	Storage	Control		Simplesse(R)100		Dairy-Lo™	
Properties	period (month)	Full-fat	Low-fat	0.8%	1.6%	0.8%	1.6%
Appearance (10)	Fresh	8	6	8	8	8	8
	1	8	6	8	8	8	8
	2	9	6	9	9	9	9
	3	9	7	9	9	9	9
Body of Texture (30)	Fresh	22 compact	16 hard	24 smooth compact	20 soagy	22 compact	24 compact
	1	24 compact	17 hard	25 smooth compact	21 soagy	23 compact	25 compact
	2	25 compact	18 slight opened	27 smooth compact	22 soagy	24 compact	26 smooth compact
	3	27 compact	20 slight opened	28 compact smooth	23 soagy	25 compact	27 compact smooth
Flavour (60)	Fresh	35 flat	18 flat	36 flat	36 flat	33 flat	35 flat
	1	42 slightly developed	22 flat	45 slightly developed	46 slightly developed	40 slightly developed	41 slightly developed
	2	52 slightly developed	29 flat	54 ripened	54 ripened	50 ripened	51 ripened
	3	55 ripened developed	33 slightly	58 ripened	58 ripened	51 ripened	53 ripened
Total (100)	Fresh	65	40	68	64	63	67
	1	74	45	78	75	71	75
	2	86	53	91	90	83	87
	3	91	60	95	90	93	89

Samples were judged by 12 persons of the colleague staff members

The total scores are recorded in Table 7, It could be noticed that using fat replacers greatly enhanced the total score of the low-fat cheese which improved by increasing the added ratio for Dairy-Lo™ and at the lowest ratio for Simplesse(R)100 when fresh and during storage period. Adding 0.8% Simplesse(R)100 gained the highest score at the end of ripening period being 95 point. Low-fat control cheese gained the lowest score when fresh and during ripening period.

CONCLUSION

From the foregoing results it could be concluded that Kashkaval cheese can be made from low fat buffalo's milk by using 0.8% Simplesse(R)100 or 1.6% Dairy-Lo™ with good quality attributes as compared with full-fat cheese.

REFERENCES

Abdel-Gawad, M.A.M., 1998. Manufacture and properties of Mozzarella cheese from buffaloes' milk. Ph.D. Thesis, Cairo University, Egypt.

Akoh, C., 1998. Fat Replacers. Food Tech., 52: 47-53.

Anderson, D.L. and V.V. Mistry, 1994. Reduced fat cheddar cheese from condensed milk. 2-Microstructure. J. Dairy Sci., 77: 7.

Bhaskaracharya, R.K. and N.P. Shah, 1999. Texture evaluation of commercial Mozzarella cheese. Aust. J. Dairy Tech., 54: 36-40.

El-Sissi, M.G.M., 2003. Improvement of the quality of Kashkaval cheese made from buffaloes' milk. Egypt. J. Dairy Sci., 31: 147-158.

Hassan, S.A.M., 2005. Improving the quality and microstructure of low fat Edam cheese made from buffaloes' milk. MS.D. Thesis, Cairo University, Egypt.

IDF., 1993. Milk determination of nitrogen content. IDF Standard 2/B. International Dairy Federation.

Katsiari, M.C. and L.P. Voutsinas, 1994. Manufacture of low-fat Kefalagroviera cheese Int. Dairy. J., 4: 533-553.

Kosikowski, F.V., 1966. Cheese and Fermented Milk. Foods. 2nd Printing. Edward Brothers. Inc., Ann. Arbor., Mi., USA.

Ling, E.R., 1963. A Text Book of Dairy Chemistry. Vol. 2, Practical. 3rd Edn., Chapman and Hall, Ltd., London.

Lucey, J.A. and C. Gorry, 1993. Effect of Simplesse(R)100 on the manufacture of low-fat Cheddar cheese. Page 439 in cheese yield and factors affecting its content. Int. Diary Fed. Seminar. Int. Dairy Fed., Brussels, Belgium, pp: 439.

McMahon, D.J., M.C. Alleyne, R.L. Fife and C.J. Oberg, 1996. Use of fat replacers in low fat Mozzarella cheese. J. Dairy Sci., 79: 1911-1921.

Mistry, V.V. and D.L. Anderson, 1993. Composition and microstructure of commercial full fat and low-fat cheese. J. Food Struct., 55: 8514.

Mostafa, M.B.M., A. Sonia, Metwaly and M. E. El-Demerdash, 2002. Effect of using heat and freeze shocked starter on the quality and ripening of UF Edam cheese. J. Agric. Sci. Mansoura Univ., 27: 449-458.

Nelson, J.A. and G.M. Trout, 1956. Judging Dairy Products. 4th Edn., The Olsen Pub. Co. Milwaukee, 12, Wis., USA.

Rodriguez, J., 1998. Recent advances in the development of low-fat cheese. Trends Food Sci. Technol., 9:249-254.

Romeih, E.A., A. Michaelidou, C.G. Biliaderis and G.K. Zerfiridis 2002. Low-fat white-brined cheese made from bovine milk and two commercial fat mimetics: Chemical, Physical and Sensory Attributes. Int. Dairy. J., 12: 525-540.

Rudan, M.A., D.M. Barbano and P.S. Kindstedt, 1998. Effect of fat replacers (Salatrim) (R) on chemical composition, proteolysis, functionality, appearance and yield of reduced fat Mozzarella cheese. J. Dairy Sci., 81: 2077-2088.

SAS, 1996. Statistical Analysis System. SAS User's Guide statistics. SAS Institute Inc. Editors, Cary, NC, USA.

Scott, R., 1981. Cheese Making Practice. Applied Science Publishers Ltd., London.

Vakaleris, D.G. and W.W. Price, 1959. A rapid spectrophotomertic method for measuring cheese ripening. J. Dairy Sci., 32: 264.

Zammar, O.A., 2000. Technological studies on Mozzarella cheese Ph.D. Thesis, Ain Shams Univ., Egypt.