Composition and Sensory Analysis for Quality Evaluation of a Typical Italian Cheese: Influence of Ripening Period

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Abstract

Papetti P., Carelli A. (**2013**): **Composition and sensory analysis for quality evaluation of a typical Italian cheese: influence of ripening period**. Czech J. Food Sci., **31**: 438–444.

Caciottina massaggiata di Amaseno, a typical dairy product of the Lazio Region prepared from buffalo milk, was analysed for moisture, fat, protein, pH, and acidity content at different storage (0, 3, 6, and 9 months after production). Cheeses were also evaluated for various sensory attributes (taste, flavour, texture, and overall acceptability) during storage. We evaluated the flavour profile and acceptability of Caciottina cheeses of varying maturity using a descriptive analysis. Descriptive sensory profiles of selected cheeses were determined using a trained panel (n = 12) and an established cheese flavour sensory language. In quantitative descriptive analysis a trained panel rated the cheeses for colour, odour, taste and texture. In the affective tests the panellists evaluated the samples for overall quality. The results proved that months of production had significant effects on the sensory quality of the cheeses.

Keywords: buffalo milk cheese; chemical analysis; storage period; sensory profile; flavour

The basic technology for the production of all types of cheese is the same with relatively small changes resulting in significant differences in the final cheese. The art or science of cheese-making comprises five key factors: milk composition, rate and extent of acid development, moisture content, curd manipulation, and ripening conditions (Lucey *et al.* 2003; Walstra *et al.* 2006; Sameen *et al.* 2010). Other factors that may influence the quality of different varieties of cheese are: composition of milk, types of milk, starter cultures and manufacturing technology (Varnam & Sutherland 1994).

Volatiles play an important role in the flavour perception of cheese. Typical cheese aroma is the result of volatiles formed by lipolysis, proteolysis, and metabolism of lactose, lactate, and citrate (McSweeney & Sousa 2000; Smit *et al.* 2000; Marilley & Casey 2004).

During cheese ripening, the enzymatic degradation of amino acids leads to the formation of flavour-impact volatiles (Visser 1993; McSweeney & Sousa 2000; Marilley & Casey 2004); flavour formation in cheese is also importantly influenced by the ripening period. As a result of the destruction of some desirable non-starter lactic acid bacteria during production, cheese made from pasteurised milk ripens more slowly and develops a less intense flavour than buffalo raw milk cheese (Johnson *et al.* 1990; Grappin & Beuvier 1997; Fox *et al.* 1998; Seifu *et al.* 2004).

The aim of this study was to evaluate the flavour profile and acceptability of Caciottina di Amaseno cheeses of varying maturity using a descriptive analysis. Descriptive sensory profiles of selected cheeses were determined using a trained panel (n = 12) and an established cheese flavour sensory language (Heisserer & Chambers 1993).

MATERIALS AND METHODS

Cheese samples. Cheese wheels of Caciottina massaggiata di Amaseno were produced in the cheese factory located in Amaseno (Italy). The product, according to the production protocol, was periodically subjected to manipulations by hand with a mixture of olive oil and wine and to overturning until the end of seasoning, which has a minimum duration of 60 days.

Quality analyses. Chemical analyses were carried out on a total of 23 cheeses. On each cheese wheel 6 slices were cut along the length: two samples (internal part) were obtained from the central slice, two samples (median part) were obtained cutting 2 slices at 2 cm from the central one, the last two samples (external part) were obtained from the remaining part.

These sampling methods were chosen in order to obtain analytical parameters of reference to be used for the evaluation of cheese with unusual fermentations or defects, which frequently occur in limited areas within the whole cheese wheel.

Chemical analysis. The following chemical analyses were performed: dry matter by drying in oven at 102°C (International Standard FIL-IDF 4/A: 1982); fat (ISO 3433:2008); pH by potentiometric measurement by direct insertion of the electrode in the cheese wheel; sodium chloride by titration with $AgNO_3$ (International Standard FIL-IDF 88/A:1988).

Cheese preparation. Cheeses were stored at refrigerator temperature until 15 min before sampling and then allowed to warm to room temperature. The cheeses were sliced into cubes using a wire slicer within 2 h of presentation; they were presented as 5 g cubes in glasses, covered with watch glasses, and assessed in individual booths under diffuse red lighting to minimise differences in appearance. The air temperature and ventilation of the sensory laboratory were also controlled. Assessors rinsed their mouths with de-ionised water between cheeses.

During sensory testing, the panellists were seated in individual booths in a sensorial room of University of Cassino's Laboratory, and data was recorded on a computer.

Four cheeses were presented each day and the order of tasting was balanced between days and within days to account for first order, carry over and day elects (MacFie *et al*. 1989).

Sensory panel. A panel of twelve assessors, 7 males and 5 females, took part in the Descriptive Sensory Analysis. All were members of an established sensory panel at University of Cassino. The panel was recruited and screened according to the accepted international standards (ISO 8586-1: 1993, ISO 8589:1998, ISO/DIS 13299:1998). This experienced trained panel had a high level of discrimination, sensitivity, and consistency in measurement (Land & Shepherd 1988). All assessors were trained to carry out descriptive analysis and were involved in developing the descriptive vocabulary for cheese.

The development of a full descriptive vocabulary, to describe the sensory characteristics of the cheeses, was carried out over two group discussions for each product category, and the panel of assessors evaluated the products for flavour, texture and mouth feel, appearance and odour (Lawless & Heymann 2010). The lexicon was modified from that previously developed for Cheddar cheese (Murray & Delahunty 2000).

The quantity of each descriptive attribute perceived was scored on a 10 cm continuous line scale.

Methodology. Descriptive sensory assessment of the samples was carried out using the terms and standard references developed. During each sensory session four different samples were evaluated for all the attributes, organised so that three replicates were obtained for all the assessors for every sample. The experimental design used to eliminate carryover and order of tasting bias is described in detail in Muir and Hunter (1992, 1995a,b, 1996). Using the QDA method 16 attributes for the investigated cheeses were selected and thoroughly defined for profiling (Table 1): colour, odour (creamy, acid, buttery, fruits), taste (salty, acid, sweet, bitter, aftertaste), and texture (hardness, chewiness, rubbery, dryness, grainy). The attribute intensities were rated on continuous unstructured graphical scales. The scales were 10 cm in length and verbally anchored at each end, the left side of the scale corresponding to the lowest intensity (value 0) and the right side to the highest intensity (value 10) of the attribute. Overall quality of cheeses was assessed using the same type of scale as above anchored at both ends: unlinking (0)–extremely linking (10).

Statistical analysis. The panel mean scores of the quantitative descriptive data were analysed by ANOVA. Statistically significant differences in the results were tested by Fisher's protected least significant difference (*LSD*) test.

RESULTS AND DISCUSSION

Chemical analysis

Table 2 shows the mean values for the chemical parameters (pH, moisture, chlorides and fat content) of the internal, median and external cheese

Table 1. Definitions of attributes for profiling of the Caciottina cheese

Descriptor	Definition
Colour	visual estimation of intensity
Creamy odour	smell of market cream (30%)
Acid odour	typical note of fermented milk products such as yoghurt
Buttery	flavour associated with butter
Flowers/fruits	the aromatic blend of different fruity identities, like pineapple, ripe apple, zest and red berries. May also include the aromatics associated with sweetened cultured dairy products such as fruit yoghurts
Salty	taste, basic taste typical of sodium chloride as diluted in water (0.2%)
Sweet	fundamental taste sensation of which sucrose is typical
Acid	taste of fermented milk products
Bitter	taste, basic taste typical of caffeine in water (0.5%)
Aftertaste	aftertaste which continued after the removal of the sample
Hardness*	the force needed by the jaws to bite the sample into two pieces
Chewiness	time and multiplicity of chewing the product to prepare it to swallow
Rubbery	the ability of the sample to regain shape after pulling
Dryness (moisture)	moisture that exists in the sample, mouthfeel after 4, 5 chews
Grainy	the ability of the sample to break into pieces
Overall quality	overall sensation determined in terms like and dislike

Anchoring points: non-intensive–very intensive; *low–high

wheel parts during 9 months. For the maturation time results, all the parameters (pH, moisture, chloride and fat content) presented during the cheese maturation, a moisture decrease by evaporation led to a progressive weight decline and afterwards there was a progressive dehydration during the following maturation phase of 35–40% (Papetti *et al.* 2012). The moisture content decreased in all cheeses throughout the storage period (Aly & Galal 2002). It might be attributed to degradation of proteins and fats (Zaki *et al.* 1974).

Statistically significant differences between all the maturation classes ($P < 0.05$) are shown in Table 3.

Moisture content decreased in a statistically significant way in the first maturation time, until the sixth month, while, later, a moisture decrease was less relevant in percentage. pH reached a maximum level around the third month, while afterwards equilibrium was established, as a result of the opposed proteolysis effect from which ammonia is produced and lipolysis leads to a fatty acid release.

A similar increase in the acidity of cheese was reported previously by Bilal (2000) and Warsama *et al.* (2006). It is probably due to the growth of lactic acid bacteria in cheese (Warsama *et al.* 2006). The lactic acid not only contributes to the taste of fresh cheese but also improves the cheese structure and protects it against a kind of microbiological spoilage (Ceylan *et al.* 2003).

Table 2. Results of chemical and nutritional analysis performed on 23 cheese samples (mean ± standard deviation)

Months	pH			Moisture (%)			Chlorides (g/100 g DM)			Fat (g/100 g DM)		
	external	median	central	external	median	central	external	median	central	external	median	central
0	5.22 ± 0.09	5.12 ± 0.14	5.07 ± 0.27	58.70 ± 5.41	53.06 ± 5.29	53.04 ± 6.70	1.37 ± 0.09	1.29 ± 0.011	1.22 ± 0.09	21.09 ± 0.91	19.23 ± 0.12	18.35 ± 0.18
3	5.59 ± 0.82	5.58 ± 0.63	5.52 ± 0.15	39.42 ± 3.22	38.86 ± 3.05	38.36 ± 3.11	2.12 ± 0.19	1.56 ± 0.12	1.47 ± 0.013	18.83 ± 1.11	18.53 ± 1.01	19.83 ± 0.99
6	5.42 ± 0.61	5.35 ± 1.01	5.39 ± 0.73	29.79 ± 2.02	30.42 ± 0.44	26.76 ± 0.95	1.64 ± 0.12	1.56 ± 0.016	1.52 ± 0.12	21.67 ± 1.91	21.00 ± 1.01	22.33 ± 1.21
9	5.12 ± 0.23	5.18 ± 0.09	5.18 ± 0.45	27.20 ± 1.84	29.60 ± 2.34	29.60 ± 0.94	1.41 ± 0.012	1.36 ± 0.09	1.36 ± 0.09	24.10 ± 0.53	23.90 ± 0.95	23.90 ± 1.34

Table 3. Mean values, ANOVA, and *LSD* multicomparison between factors

Month	Position significance*	External a*	Median a	Internal a	2-way ANOVA source	df	mean sq.	prob > F
pH								
0	a	5.218	5.116	5.066	month	3	0.62338	0.031923
3	b	5.592	5.584	5.52	position	2	0.011852	0.94126
6	ab	5.422	5.346	5.394	month position	6	0.013005	0.99874
9	a	5.122	5.176	5.184	error	48	0.19554	
Moisture								
		a*	a	a				
0	a	58.704	53.056	53.036	month	3	2265.8	0
3	b	39.416	38.862	38.364	position	2	17.007	0.25641
6	c	29.792	30.424	26.758	month position	6	22.176	0.11386
9	c	27.204	29.602	29.604	error	48	12.145	
Chlorides								
		a*	b	b				
0	a	1.366	1.286	1.216	month	3	0.56134	0
3	b	2.116	1.562	1.472	position	2	0.31923	1.0224E-10
6	c	1.636	1.56	1.52	month position	6	0.11275	5.8162E-09
9	d	1.404	1.356	1.356	error	48	0.008273	
Fat								
		a*	b	ab				
0	a	21.092	19.23	18.352	month	3	75.279	0
3	a	18.826	18.526	19.826	position	2	2.9004	0.064135
6	b	21.666	20.996	22.328	month position	6	3.8298	0.0032924
9	c	24.098	23.896	23.898	error	48	0.99666	
					Total	59		

*different letters indicate significant differences for $P < 0.05$

Sensory analysis

For sensory evaluation, the quantitative descriptive analysis (QDA) was used, which is often applied to study a variety of products including cheese (Stone & Sidel 1993; Lawless & Heymann 2010). Mean intensity ratings of descriptive attributes and the analysis of variance are documented in Table 4. ANOVA showed that there were significant ($P < 0.05$) differences in the intensity of attributes such as colour, salty taste, bitter taste aftertaste, hardness, chewiness, rubbery, dryness, and grainy caused by the maturation time.

Chemical qualities of the cheeses have a significant effect on flavour (Barlow *et al.* 1989; Aly & Galal 2002; Guler & Uraz 2004).The scores of sensory parameters (Table 4) such as rubbery and grainy decreased with the ripening, while scores for hardness increased. The chewiness of the cheese samples increased with the progressive ripening days and it was a highly desirable sensory attribute especially for cheese. The increase in chewiness might be due to a change in the average size of fat globules, distance between fat globules and variation in the size of globules (Richardson & Booth 1993).

It can be seen that, in the sensory profiles of cheeses, the improvement in colour from month zero to months 9 agreed with the findings of Tarakci and Kucukoner (2006), who reported that colour score increased generally during ripening. In order to observe the above differences in the analysed samples more clearly, the sensory profiles of cheeses were displayed as spider diagrams in Figure 1.

Flavour of all samples improved with storage months because during ripening the metabolic processes are responsible for the basic flavour and texture changes (Smit *et al.* 2005). When biochemi-

Table 4. Quantitative descriptive analysis of cheeses stored for 0, 3, 6, and 9 months

	Month			
	0	3	6	9
Yellow colour	3.2[a]	5.2[a]	5.9[b]	6.11[a]
Flavour	7.5[a]	8.5[b]	6.0[ab]	5.8[a]
Acid odour	4.1[b]	4.5[a]	4.9[a]	4.46[a]
Buttery	1.2[a]	6.0[a]	6.6[a]	5.4[ab]
Creamy odour	5.1[a]	4.5[a]	4.0[b]	2.1[a]
Flowers/fruits	0.0	6.2[a]	4.0[a]	1.0[a]
Salty taste	4.4[a]	3.1[a]	2.8[a]	1.9[b]
Sweet taste	1.0[a]	0.8[a]	1.2[a]	0.5[a]
Acid taste	1.5[a]	1.5[a]	2.7[b]	3.7[b]
Bitter taste	1.5[ab]	0.8[a]	0.21[a]	3.6[b]
Hardness	2.4[a]	2.4[a]	4.2[b]	5.5[a]
Chewiness	2.8[a]	4.7[a]	7.9[b]	8.0[ab]
Rubbery	6.3[a]	6.9[a]	5.4[a]	4.0[b]
Dryness	5.2[b]	3.3[ab]	2.9[a]	2.8[a]
Grainy	7.6[b]	4.2[a]	3.8[a]	3.2[a]
Overall quality	5.01[a]	6.3[a]	6.1[a]	5.9[a]

Letters describe a comparison between years in each variety of cheese; means marked with the same letters in each row do not show significant differences (*LSD* test, $P < 0.05$)

cal reactions continued for the breakdown of fat and protein by the activity of microbial and residual rennet (McSweeney 1997), more flavouring compounds were produced in cheeses and casein was hydrolysed, which gives a smooth texture

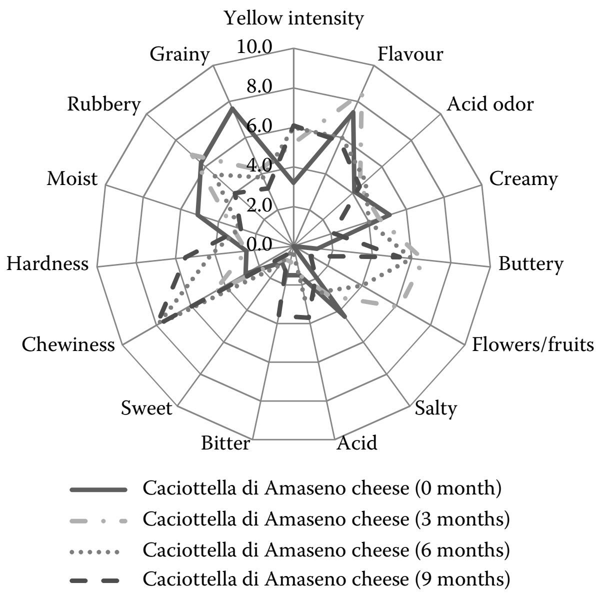

Figure 1. Spider diagrams

(Barbano *et al.* 1994). The improvement in texture from month zero to month nine indicates clearly the effect of storage time. This agrees with Aly and Galal (2002) and Topcu and Saldamli (2006), who reported that the textural attributes of white cheese were significantly ($P < 0.05$) affected by the ripening period.

The improvement in flavour was probably attributed to the effect of lactic acid development which controls the growth of undesirable organisms (Kosikowski 1997). The improvement in flavour might be due to the natural flora initially present in buffalo milk which participates in flavour production.

It is to conclude that the storage period significantly affected the weight loss, chemical composition and sensory characteristics of "Caciottina romana" cheese.

CONCLUSION

In this study, the flavour evolution during ripening of the investigated cheese was evaluated; these results indicate that Caciottina di Amaseno cheese is characterised by a complex sensory profile depending mainly on the heterogeneity of buffalo milk microflora and of natural starter. Due to these own peculiar characteristics of this cheese, to date it is possible to define the typical sensory profile of the cheese.

Therefore, the study of traditional products, such as Caciottina Romana cheese, can be of considerable benefit to the rural economy by improving the incomes of farmers and by retaining the rural population in these areas. Moreover, the use of the sensory profile may help to preserve the identity of "Caciottina Romana" cheese by means of sensory quality certification.

References

Aly S.A., Galal E.A. (2002): Effect of milk pretreatment on the keeping quality of Domiati cheese. Pakistan Journal of Nutrition, **1**: 132–136.

Barbano D.M., Yun J.J., Kindstedt P.S. (1994): Mozzarella cheese making by a stirred curd, no brine procedure. Journal of Dairy Science, **77**: 2687–2694.

Barlow I., Lloyd G.T., Ramshaw E.H., Miller A J., McCabe G.P., McCabe L. (1989): Correlations and changes in flavour and chemical parameters of Cheddar cheeses during maturation. Australian Journal of DairyTechnology, **44**: 7–18.

Bilal A.M. (2000): Effect of partial substitution of soymilk on the chemical composition and sensory characteristics of white soft cheese. [M.Sc. Thesis.] University of Khartoum, Sudan.

Ceylan Z.G., Turkoglu H., Dayisoylu S. (2003): The microbiological and chemical quality of Skima cheese produced in Turkey. Pakistan Journal of Nutrition, **2**: 95–97.

Fox P.F., McSweeney P.L.H., Lynch C.M. (1998): Significance of non-starter lactic acid bacteria in Cheddar cheese. Australian Journal of Dairy Technology, **53**: 5383–5389.

Grappin R., Beuvier E. (1997): Possible implications of milk pasteurization on the manufacture and sensory quality of ripened cheese. International Dairy Journal, **7**: 751–761,

Güler Z., Uraz Ü. (2004) : Relationships between proteolytic and lipolytic activity and sensory properties (taste–odour) of traditional Turkish white cheese. International Journal of Dairy Technology. **57** 237–242,

Heisserer D.M., Chambers E. IV (1993): Determination of the sensory flavour attributes of aged natural cheese. Journal of Sensory Studies, **2**: 121–132.

ISO 3433 (2008): Determination of fat content – van Gulik method. International Organization for Standardization, Geneva.

ISO 8586-1:1993. Sensory analysis – General guidance for the selection, training and monitoring of assessors – Part 1: Selected Assessors. International Organization for Standardization, Geneva.

ISO 8589:1998. Sensory analysis – General guidance for the design of test rooms. International Organization for Standardization, Geneva.

ISO/DIS 13299:1998. Sensory analysis – Methodology – General guidance for establishing a sensory profile. International Organization for Standardization, Geneva.

Johnson E.A., Nelson J.H., Johnson M. (1990): Microbiological safety of cheese made from heat-treated milk, Journal of Food Protection, **53**, 519–540.

Kosikowski F.V., Mistry V.V. (1997): Bacterial surface ripened chees. In: Kosikowski F.V.: Cheese and Fermented Milk Foods. Vol. 1. 3rd Ed. LLC, Westport: 266–271..

Land D.G., Shepherd R. (1988): Scaling and ranking methods. In: Piggott J.R. (ed): Sensory Analysis of Foods. 2nd Ed. Elsevier Science Publishers, London: 155–185.

Lawless H.T., Heymann H. (2010): Sensory Evaluation of Food: Principles and Practices. Chapman and Hall, New York.

Lucey J.A., Johnson M.E., Horne. D.S, (2003): Invited review: Perspectives on the basis of the rheology and texture properties of cheese. Journal of Dairy Science, **86**: 2725–2743.

MacFie H.J., Bratchell N., Greenhoff K., Vallis L.V. (1989): Designs to balance the affect of order of presentation and first-order carry-over effects in hall tests. Journal of Sensory Studies, **4**: 129.

Marilley L., Casey M.G. (2004): Flavours of cheese products: metabolic pathways, analytical tools and identification of producing strains. International Journal of Food Microbiology, **90**: 139–159.

McSweency P.L.H. (1997): The flavour of milk and dairy products: III. Cheese: taste. International Journal of Dairy Technology, **50**: 123–128.

McSweeney P.L.H., Sousa M.J. (2000): Biochemical pathways for the production of flavor compounds in cheese during ripening: a review. Lait, **80**: 293–324.

Muir D.D., Hunter E.A. (1992): Sensory evaluation of Cheddar cheese: the relation of sensory properties to perception of maturity. Journal of the Society of Dairy Technology, **45**: 23–29.

Muir D.D., Hunter E.A., Watson M. (1995a): Aroma of cheese. 1. Sensory characterization. Milchwissen, **50**: 499–503.

Muir D.D., Hunter E.A., Banks J.M., Horne D.S. (1995b): Sensory properties of hard cheese: identification of key attributes. International Dairy Journal, **5**: 157–177.

Muir D.D., Hunter E.A., Banks J.M., Horne D.S. (1996): Sensory properties of Cheddar cheese: changes during maturation. Food Research International, **28**: 561–568.

Murray J.M., Delahunty C.M. (2000): Selection of standards to reference terms in a Cheddar-type cheese flavour language. Journal of Sensory Studies, **15**: 179–199.

Papetti P., Costa C., Antonucci F., Figorilli S., Solaini S., Menesatti P. (2012): A RFID web-based infotracing system for the artisanal Italian cheese quality traceability. Food Control, **27**: 234–241.

Richardson N.J., Booth D.A. (1993): Multiple physical patterns in judgements of the creamy texture of milks and creams. Acta Psychologica, **84**: 93–101.

Sameen A., Anjum F.M., Huma N., Nawaz H. (2010): Chemical composition and sensory evaluation of mozzarella cheese: influence by milk sources, fat levels, starter cultures and ripening period. Pakistan Journal of Agricultural Sciences, **47**: 26–31.

Seifu E., Buys E.M., Donkin E.F., Petzer I.M. (2004): Antibacterial activity of the lactoperoxidase system foodborne against pathogens in Saanen and South African Indigenous goat milk. Food Control, **15:** 447–452

Smit G., Verheul A., van Kranenburg R., Ayad E., Siezen R., Engels W. (2000): Cheese flavour development by enzymatic conversions of peptides and amino acids. Food Research International, **33**: 153–160.

Smit B.A., Engels W.J.M., Alewijn M., Lommerse G.T.C.A., Kippersluijs E., Wouters J.T.M., Smit G. (2004): Chemical conversion of alpha-keto acids in relation to flavor formation in fermented foods. Journal of Agricultural and Food Chemistry, **52**: 1263–1268.

Smit G., Smit B.A., Wim J.M., Engels J.M. (2005): Flavour formation by lactic acid bacteria and biochemical flavor profiling of cheese products. FEMS Microbiology Review, **29**: 591–610.

Stone H., Sidel J.L. (1993): Sensory Evaluation Practices. 2nd Ed. Academic Press, San Diego.

Tarakci Z., Kucukoner E. (2006): Changes on physicochemical, lipolysis and proteolysis of vacuum packed Turkish Kasar cheese during ripening. Journal of Central European Agriculture, **7**: 459–464.

Topcu A., Saldamli L. (2006): Chemical, textural and sensorial changes during ripening of Turkish white cheese made of pasteurized cow's milk. International Journal of Food Engneering, **9**: 665–678.

Varnam A.H., Sutherland J.P. (1994): Milk Products-1. Chapman and Hall, New York.

Visser S. (1993): Proteolytic enzymes and their relation to cheese ripening and flavor: an overview. Journal of Dairy Science, **76**: 329–350.

Walstra P., Wouters J.T.M., Geurts T.J. (2006): Dairy Science and Technology. 2nd Ed. Taylor and Francis Group, Boca Raton-London.

Warsama L.M., Elzubeir I.E.M., El Owni O.A.O. (2006): Composition and hygienic quality of Sudanese white cheese in Khartoum North markets (Sudan). International Journal of Dairy Science, **1**: 36–43.

Zaki M.H., Metawally N.H., Koussy L.A. (1974): Domiati cheese stored at room temperature as affected by heat treatment of milk and different salting levels. Agriculture Research Review, **52**: 217–231.

Received for publication November 9, 2012
Accepted after corrections March 4, 2013

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