POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES

www.pan.olsztyn.pl/journal/
e-mail: joan@pan.olsztyn.pl

Pol. J. Food Nutr. Sci.
2007, Vol. 57, No. 1, pp. 31–38

CHANGES OF SELECTED QUALITY ATTRIBUTES OF EDAM CHEESE WITH VARIOUS FAT CONTENTS DURING STORAGE

Małgorzata Jasińska, Izabela Dmytrów, Adrian Stradomski

Dairy Technology Department, Agricultural University, Szczecin

Key words: fat content, Edam cheese, acidity, nitrogen compounds, storage, quality

Changes of selected quality attributes of Edam cheese with different fat contents were analysed during its six-week storage at 5±1°C. The subject of the analysis was reduced-fat (28% of fat in dry matter) and full-fat (50% of fat in dry matter) Edam cheese produced by a domestic manufacturer. The sensory assessment of the experimental cheese was performed and the following attributes were determined: total water and fat content, titratable acidity, pH, and total nitrogen content, water soluble nitrogen and amino acid nitrogen contents. It was shown that the full-fat Edam cheese had more intensive colour, tenderer consistence and definitely better taste than the reduced-fat cheese. Also, it was proved that fat content did not have any significant influence on titratable acidity nor pH of the cheese analysed, but it significantly differentiated cheeses with respect to contents of water soluble nitrogen. The full-fat Edam cheese had higher contents of this form of nitrogen. The content of amino acid nitrogen was not dependent on fat content.

Abbreviations: FDM – fat in dry matter, WSN – water-soluble nitrogen, AAN – amino acid nitrogen

INTRODUCTION

Fat content in food has recently become one of the most important features influencing consumers' choice. Increasing consumers' demands and the situation on the market makes cheese producers extend and improve the attractiveness of the assortment of products, also by reducing fat content. It is well-known that there exists connection between an increased consumption of animal fat and health condition [Banks *et al.,* 1989; Fenelon & Guinee, 2000]. Consequently, much attention is focused on the reduction of fat content of renneted cheese in order to persuade consumers to increase cheese consumption. Fat plays an important role in determining functional properties, texture, taste and aroma of cheese [Rudan *et al.,* 1999]. The modification of chemical composition of renneted cheese was observed to deteriorate its quality [Fife *et al.,* 1996; Merrill *et al.,* 1994; Tunick *et al.,* 1993]. The reduction of fat content could have an influence on deterioration of sensory characteristics of cheese, and also could cause a lower cheese yield and slower ripening [Rodriguez, 1998].

Changes in proteolysis and texture related to maturation of full-fat cheese have been extensively investigated and reviewed [Prentice & Gilles, 1993]. Only few of those studies consider cheeses with reduced fat content and, besides this fact, they focus mainly on the influence of other than fat content factors, *i.a.* the composition, additional microflora [Ardö *et al.,* 1989; Banks *et al.,* 1989], fat substitutes [Fenelon & Guinee, 1999] or cheese processing conditions [Guinee *et al.,* 1997] on proteolysis and texture of a reduced-fat cheese. Comparatively few works refer to comparison of qualitative features of one-brand cheese, but with different fat content [Madsen & Ardö, 2001]. In available literature the analyses referring to Dutch cheese, to which group of cheeses Edam can be included, have not been met. Tunick *et al.* [1993] stated that Mozzarella cheese with 10% fat content, made of homogenised milk, was harder and less fusible than both full-fat cheese and cheese with the same fat content but made of non-homogenised milk. Similar unfavourable changes of quality attributes of cheese were observed by Paulson *et al.* [1998], who described Mozzarella cheese with a reduced fat content as hard, gummy and less fusible. Worse features of reduced-fat cheese are unfortunately connected not only with its texture, but also with taste, aroma and colour. Cheese ripening - as a complex process - consists of several changes and biochemical reactions which lead to cheese flavour and texture development [Tungjaroenchai *et al.,* 2001]. Every disturbance of balance between particular cheese chemical components may result in the appearance of atypical sensory features of the final product.

The aim of this study was to observe changes in selected quality attributes of Edam cheese with various fat contents during its storage.

MATERIAL AND METHODS

The subjects of the analysis were two types of domestic Edam cheese with different fat contents (28% and 50% FDM). Samples of cheese were obtained from the dairy plant specialising in the production of this kind of cheese. Both types of cheese were obtained from the same materials and with maintaining identical technological parameters

Author's address for correspondence: Izabela Dmytrów, Dairy Technology Department, Agricultural University, ul. Papieża Pawła VI/3, 71–459 Szczecin, Poland; tel.: (48 91) 425 04 13; fax: (48 91) 425 04 32; e-mail: dmytrow@interia.pl

while processing. Samples of cheese were prepared in 300-g blocks (on need of the Dairy Technology Department) using the traditional technology as a part of the normal production scheme. The cheeses ripened for 4 weeks under appropriate conditions for Edam cheese. Analyses were performed on matured cheeses in one-week intervals beginning with 7th day after ending of the ripening process. Cheeses were stored at 5°C±1°C for 6 weeks. Both variants of the Edam cheese were packaged in thermo-shrinkable foil of the cryovac type. Forty eight blocks of cheese were stored altogether. After performing panel sensory assessment of the cheese samples weighing 300g each, 5 mm of external layer was removed and the remaining part was grated on a grater with 6-mm mesh diameter and was designed for chemical analyses.

A panel of five assessors, who were experienced in rating cheese, evaluated the Edam cheeses after each week of storage for external appearance (shape, jacket), consistence, colour, ocellation, taste and aroma. Panelists evaluated each characteristic using a 6-point scale [PN-ISO 6658; PN-ISO 4121; Kurpisz, 1984]. All analyses were done in a separate sensory laboratory equipped with individual testing booths. Assessors were supplied with water to rinse their mouths between samples. The order of presentation of samples was randomised. External appearance attributes were assessed first. The knife was used to notch a cheese's side in order to evaluate aroma. Colour and ocellation were evaluated after cutting the cheese and observation of sections, while kneading and tripsis helped in evaluation of consistence.

In the analysed full-fat and reduced-fat cheese total water content was evaluated by drying according to PN-73/A-86232 standard, fat content was evaluated butyrometrically (Gerber's method), titratable acidity (°SH), pH, total nitrogen content and water soluble nitrogen content were determined with the Kjeldahl's method and amino acid nitrogen content with the Pope & Stevens's method [Dziuba & Kostyra, 1992]. Grated cheese (12.5 g) was ground with 50 mL of distilled water at 40°C and the resultant suspension was transferred to a measuring flask (250 mL). Then several drops of formaldehyde were added and the suspension was cooled to a room temperature. The measuring flask was moderately stirred for 5 min with 10-min stops. Stirring was stopped after 1 h. Then the mixture was left to stand for 1.5 h at 4°C. The fatty layer was removed and supernatant liquid (100 mL) was filtered through paper filter. The content of water soluble nitrogen (WSN) was determined using a sample of the filtrate (25 mL) with the Kjeldahl method after mineralisation. Forty mL of 15% TCA (w/v) solution was added to 10 mL of cheese filtrate. The mixture was left to stand for 20 min at a room temperature and then was filtered through paper filter. The extract obtained was used to determine the content of amino acid nitrogen by means of Pope & Stevens's method. All chemical analyses were performed in five replicates.

All results were analysed statistically. First, the normality of distribution of all analysed attributes was tested by means of the Shapiro-Wilk test. Then, the significance of differences between mean levels of analyzed coefficients was verified by means of Student's *t* test or Cochrane-Cox tests. All tests were performed at a significance level of $\alpha=0.05$. The aims of statistical analysis were: (i) to verify the hypothesis that fat reduction in renneted ripening cheese resulted in differences in titratable acidity, water soluble nitrogen and amino acid nitrogen contents, and (ii) to verify the hypothesis that fat reduction resulted in significant differences in the rate of conversion of nitrogen compounds.

RESULTS AND DISCUSSION

Proximate chemical composition of Edam cheese

All analysed cheeses were classified as hard cheeses with respect to water content, while with respect to fat content – as reduced-fat and full-fat cheeses (Table 1). However, the manufacturer offered the analysed cheeses as low-fat ("light") and full-fat. Table 1 shows fat content, total water and protein content in the analysed renneted cheeses.

Sensory assessment

TABLE 1. Fat, water and protein contents in the Edam cheese.

Cheese	FDM (%)	Water (%)	Protein (%)
Edam reduced-fat	27.87	44.38	32.14
Edam full-fat	50.09	39.81	26.31

Sensory assessment demonstrated the influence of fat content on organoleptic traits of Edam cheese. All panelists recognised full-fat Edam cheese as more desirable. It was characterised by more intensive colour, softer and more elastic consistence and definitely better taste and aroma (Figure 1). The cheeses under study showed proper organoleptic quality and the biggest differences were found to be in the case of taste and aroma. Whole, more typical taste after the first week of storage was the characteristic feature of

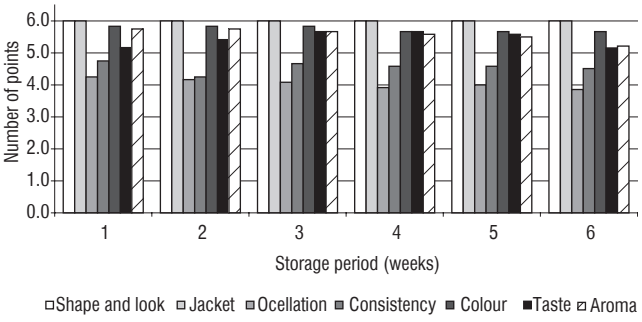

FIGURE 1. Results of sensory assesment of full-fat Edam cheese during storage (6-point scale).

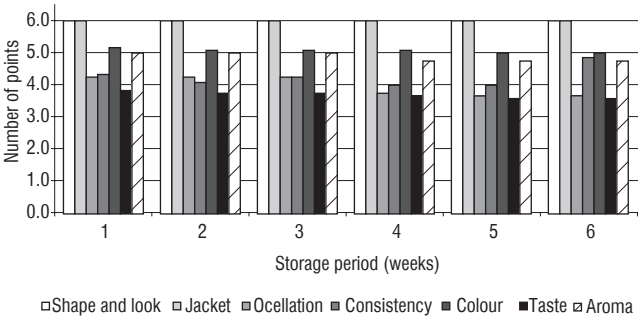

FIGURE 2. Results of sensory assesment of reduced-fat Edam cheese during storage (6-point scale).

full-fat Edam cheese and it received 5.2 points. At the same period of time, the taste of reduced-fat cheese, described as untypical, less distinguishable, was rated significantly lower (3.8 points). Also, after further analyses the taste of full-fat cheese was assessed very high (5.2 to 5.7 points), whilst the ratings for taste of reduced-fat cheese were within the range from 3.6 to 3.8 points (Figure 2). The samples differed in aroma and also in this case full-fat cheese received higher scores (5.2–5.8 points). The assessing panel characterised this type of cheese as aromatic, pleasant and typical of renneted cheeses. That feature, however, in reduced-fat cheese was assessed to be slightly worse (4.8–5.0 points) due to a lack of typical cheese aroma. Full-fat cheese was evaluated higher also for its consistency (4.3–4.8 points), ocellation (3.9–4.3 points) and colour (5.7–5.8 points). The differences between the appearance were not observed. In both cases, cheeses had the shapes of a block with slightly rounded edges and convex sides. The jacket of cheeses was soft and smooth. In this case both types of cheeses received the maximum score (6 points). The results are not surprising because it was noticed many times that the interference into chemical composition of renneted cheese leads to deterioration of its quality [Fife *et al.,* 1996; Merrill *et al.,* 1994; Tunick *et al.,* 1993]. It was also stated that decreasing of fat content is connected with worsening of cheese colour and that a small number of fat globules results in "whiteness" of renneted cheese [Paulson *et al.,* 1998; Mc Mahon *et al.,* 1993]. Explicit differences in colour of cheese with different fat contents were also observed by Rudan *et al.* [1999]. They confirmed lighter colour in the case of cheese with reduced fat content. Unfavourable changes of texture of cheeses with reduced fat content were also observed by Emmons *et al.* [1995]. Madsen & Ardö [2001] showed deterioration of texture and taste of Danbo cheese along with reducing fat content. The performed sensory and instrumental analysis confirmed that the low-fat cheese had harder and less elastic consistence than

TABLE 2. Results of statistical analysis of chemical indices contents analysed in the Edam cheese during storage.

	Titratable acidity (°SH)		Water soluble nitrogen (%)		Amino acid nitrogen (mg%)		pH	
	full-fat	reduced-fat	full-fat	reduced-fat	full-fat	reduced-fat	full-fat	reduced-fat
After 1st week of storage								
$\bar{x}$	48.75	40	2.3750	1.8650	142.10	140.00	5.43	5.65
S^2	15.69	2.00	0.0019	0.0017	895.23	588.00	0.0014	0.0043
Test	Student's t		Student's t		Student's t		Student's t	
Conclusion	+		+		–		+	
After 2nd week of storage								
$\bar{x}$	43.75	43.50	3.5900	2.7625	183.40	214.90	5.78	5.54
S^2	56.19	1.25	0.0609	0.0541	883.96	130.83	0.0002	0.0009
Test	Cochrane-Cox		Student's t		Cochrane-Cox		Student's t	
Conclusion	–		+		–		+	
After 3rd week of storage								
$\bar{x}$	44.25	43.00	3.6750	2.5100	175.00	221.20	5.52	5.47
S^2	50.19	13.00	0.0002	0.0002	648.76	15.68	0.0074	0.0059
Test	Student's t		Student's t		Cochrane-Cox		Student's t	
Conclusion	–		+		+		–	
After 4th week of storage								
$\bar{x}$	47.00	43.50	3.3450	2.7950	197.30	219.80	5.44	5.29
S^2	3.50	26.75	0.0051	0.0172	483.31	586.04	0.0110	0.0042
Test	Student's t		Student's t		Student's t		Student's t	
Conclusion	–		+		–		–	
After 5th week of storage								
$\bar{x}$	46.25	43.25	3.3875	2.8900	217.70	231.00	5.21	5.28
S^2	6.19	0.69	0.0007	0.0008	79.87	56.84	0.0056	0.0058
Test	Student's t		Student's t		Student's t		Student's t	
Conclusion	–		+		–		–	
After 6th week of storage								
$\bar{x}$	47.00	49.00	5.4400	4.6150	226.10	231.00	5.18	5.10
S^2	21.00	11.50	0.0198	0.0009	9.31	96.04	0.0029	0.0040
Test	Student's t		Cochrane-Cox		Cochrane-Cox		Student's t	
Conclusion	–		+		–		–	

$\bar{x}$ – mean value of the analysed indicator, S^2 – variance of the analysed indicator, + – on the basis of appropriate test rejection of null hypothesis (on significance level α), – – on the basis of appropriate test lack of basis for rejection of null hypothesis (on significance level α)

the full-fat cheese. In addition, they observed the appearance of the bitter peptide being a symptom of unequal ripening. Denser consistence and an increase in fracture stress along with reduction of cheese lipid fraction was also reported by Fenelon & Guinee [2000]. Tunick *et al.* [1993] and Paulson *et al.* [1998] stated that Mozzarella cheese with a reduced fat content was harder and less fusible in comparison with full-fat cheese. According to them, the reduction of fat content led to quicker formation of jacket and semi-transparent, translucent colour. They explained these changes by the fact that fat globules act as a filler between protein fibres which are formed during hot stretching of the cheese curd, thus, reducing the interactions among proteins within the protein matrix. Consequently, low-fat cheese, because of the increased protein concentration and increased interactions between proteins, would require more energy to melt when heated than the full-fat cheese.

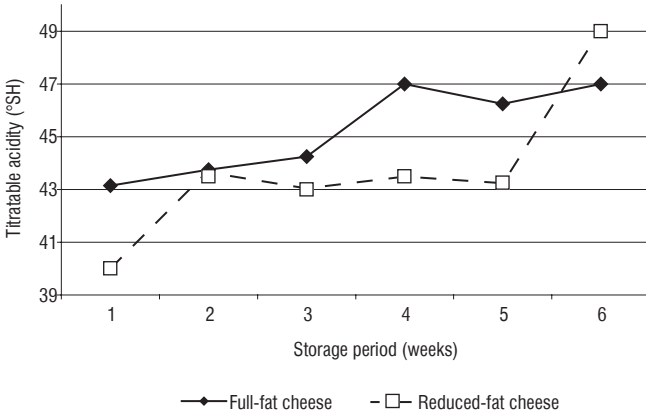

FIGURE 3. Influence of time of storage on titratable acidity of the Edam cheese with various fat content.

The formation of chemical properties of Edam cheese during storage

The performed analyses showed a lack of a significant influence of fat content on the formation of titratable acidity of the renneted cheeses analysed. In both types of Edam cheese this index showed an increasing trend in almost the whole period of analysis and the rate of growth of this change was statistically significant (Figure 3, Tabele 2). The models' fit to empirical data was hardly visible for full-fat cheese (R^2=0.2%) and pretty significant for reduced-fat cheese (R^2=67.2%). These models had low random variability (up to 4.54%) (Tabele 3). During 6 weeks of storage certain differences were observed in the formation of the titratable acidity of the analysed cheeses. Initial acidity of full-fat cheese was higher by *ca*. 3°SH than acidity of reduced-fat cheese. For the next 5 weeks of analyses full-fat cheese had higher acidity. Its acidity during this period increased by *ca*. 7% and the acidity of reduced-fat cheese – by *ca*. 8%. In full-fat cheese the highest increase of acidity was reported after 4 weeks, whilst in reduced-fat cheese – after 6 weeks of storage.

The analyses proved the increasing trend of pH of both types of the Edam cheese during storage period. Generally higher pH was observed in full-fat cheese. However, the differences noticed were generally statistically insignificant. Only after the 1st and the 5th week was pH in reduced-fat cheese higher (by 4.05% and 1.34%, respectively) (Figure 4). In the entire storage period (6 weeks), the decrease in pH for full-fat cheese was 4.6% and for reduced-fat cheese – 9.7%. The analysis of pH changes showed its significance only in the case of reduced-fat cheese. For full-fat cheese, directional coefficient (α_1) was statistically insignificant. In the case of reduced-fat cheese pH was decreasing on average by 0.106 percent points per week, while in the case of full-fat cheese – only by 0.005 percent points per week (Table 3).

The results are confirmed in the literature since a constant increase of titratable acidity has already been proved many times by other scientists. Increasing titratable acidity was observed, among others, for Cheddar cheese [Lau *et al.,* 1991] and Edam cheese [Cichosz *et al.,* 1995]. However, in available literature there is a little distinguished information referring to changes of compounds of ripe cheese during storage. Ardö [1993], while analysing ripening of low-fat and

TABLE 3. Results of dynamics analysis of the changes of chemical indices contents in the Edam cheese during storage.

	Titratable acidity (°SH)		pH		Water soluble nitrogen (%)		Amino acid nitrogen (mg%)	
	full-fat	reduced-fat	full-fat	reduced-fat	full-fat	reduced-fat	full-fat	reduced-fat
$\hat{\alpha}_0$	46.017	39.233	5.541	5.759	2.197	1.465	135.747	159.460
$\hat{\alpha}_1$	0.043	1.279	-0.005	-0.106	0.411	0.412	15.577	14.340
$t_{\hat{\alpha}_0}$	23.597	22.572	24.789	159.030	3.306	2.843	13.903	6.952
$t_{\hat{\alpha}_1}$	0.086	2.865	-0.095	-11.399	2.409	3.114	6.213	2.435
R^2	0.002	0.672	0.002	0.970	0.592	0.708	0.906	0.597
S_e	2.095	1.867	0.240	0.039	0.714	0.553	10.488	24.638
V_s	4.54%	4.27%	4.35%	0.72%	19.63%	19.04%	5.51%	11.75%
$t_{\hat{\alpha}_{11}-\hat{\alpha}_{12}}$					0.00397		0.193272	
t_α					2.306		2.306	
Conclusion					–		–	

$\hat{\alpha}_0$ – intercept's estimator, $\hat{\alpha}_1$ – slope coefficient's estimator, $t_{\hat{\alpha}_0}$ –value of Student's t statistics for intercept, $t_{\hat{\alpha}_1}$ – value of Student's t statistics for slope coefficient, R^2 – multiple correlation coefficient, S_e – standard error of estimate, V_s – coefficient of random variability, $t_{\hat{\alpha}_{11}-\hat{\alpha}_{12}}$ – value of Student's t statistics for differences between slope coefficients, t_α – critical value for significance level α and $n_1 + n_2 - 4$ degrees of freedom, + – on the basis of appropriate test rejection of null hypothesis (on significance level α), − – on the basis of appropriate test lack of basis for rejection of null hypothesis (on significance level α)

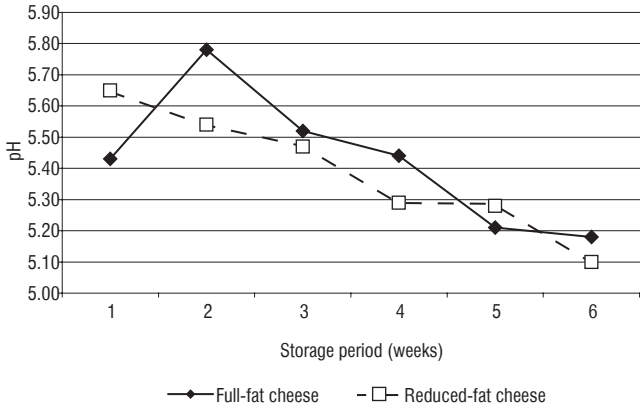

FIGURE 4. Influence of time of storage on pH of the Edam cheese with various fat content.

reduced-fat cheeses, reported that among four cheeses differing in fat content, lower pH during the whole analysed period was observed in cheese with the highest fat content. In the case of all analysed cheeses pH was rather constant during the whole analytical period. Mistry & Kasperson [1998] analysed the influence of NaCl on the quality of the Cheddar cheese with reduced fat content and reported that pH of all analysed cheeses, in spite of fat and salt content, increased during ripening. This increase was explained by the formation of alkaline nitrogen compounds. The increase of pH in the Cheddar cheese, observed during cheese ripening, according to Fenelon & Guinee [2000] was connected with a decrease in the proportion of lactate to protein. A constant level of pH was also reported by Shakeel-Ur-Rehman *et al.* [2003], who analysed the influence of standardisation of milk by milk powder on yield and ripening of the Cheddar cheese with reduced fat content. Different results were obtained by Madsen & Ardö [2001]. They analysed proteolytic changes, reological and sensory features of the Danbo cheese with various fat contents. In this case, cheese with the highest fat content had also the highest pH, which was also observed in authors' own researches.

The amount of water-soluble nitrogen (WSN), containing low-molecular proteins, peptides and amino-acids, is commonly used as a ripening index. In both analysed cheeses, a constant increase of WSN was observed and the dynamics of this change, similar for both types of cheeses, was statistically significant (Figure 5, Tabele 2). During the entire analysed period full-fat Edam cheese had higher content of this form of nitrogen and the existing differences were in most cases statistically significant. The statistical analysis of trend's directional coefficient showed that the level of this form of nitrogen was increasing weekly on average by 0.412 percentage points for reduced-fat cheese and by 0.411 percentage points for full-fat cheese. The models of trends describing changes of WSN contents were characterised by considerable random variability (in both types of cheeses more than 19%) and were fit to the empirical data significantly (R^2=59.2% for full-fat cheese and 70.8% for reduced-fat cheese). Thus in the case of WSN, an explicit influence of fat content in cheese on the formation of this form of nitrogen was observed. Analysing the course of changes of WSN contents in the full-fat Edam cheese, periods of increase and small decrease of this form of nitrogen can be distinguished (Figure 5). The first three weeks of storage resulted in almost 55% increase of contents of water-soluble nitrogen, while in the next three weeks its level decreased by *ca.* 8%. The most distinct increase of WSN contents (by about 60.6%) was observed in the last week of analyses.

Reduced-fat cheese with 21.5% lower initial WSN contents as compared to the full-fat cheese, was characterised by an almost constant increase of this form of nitrogen. The exception was the 3rd week of storage. In this period the contents of WSN decreased by *ca*. 9% in relation to its contents in the previous week (Figure 5). Similarly as in the case of full-fat Edam cheese, the highest increase of WSN was observed in the 6th (the last) week of storage – by about 59%.

During storage a constant, statistically significant increase of amino acid nitrogen (AAN) in both types of the Edam cheese was observed. A higher content of this form of nitrogen was in reduced-fat Edam cheese almost during the whole storage period (Figure 6). Only after the 1st week of storage had both kinds of cheese almost identical amount of AAN (*ca* 140 mg%). Curves describing changes of levels of this form of nitrogen had a similar course. Total increase of contents of AAN was 60% for full-fat Edam cheese and 65% for reduced-fat cheese. The models' fit to the empirical data was fairly high for reduced-fat cheese (R^2=59.7%) and high for the full-fat cheese (R^2=90.6 %). Models had random variability ranging from 11.75% to 5.51%, respectively (Tabele 3).

The increase of contents of nitrogen compounds dur-

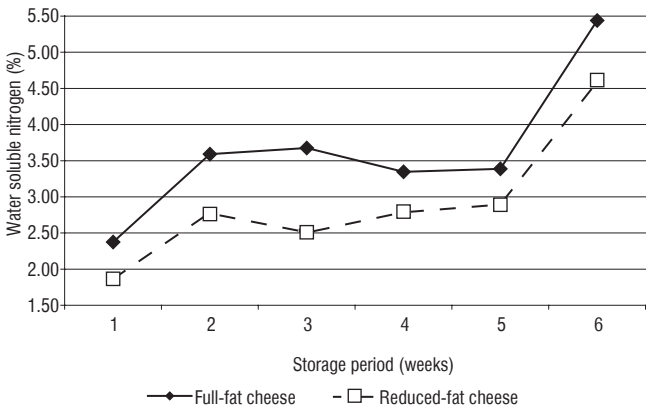

FIGURE 5. Influence of time of storage on contents of water soluble nitrogen of the Edam cheese with various fat content.

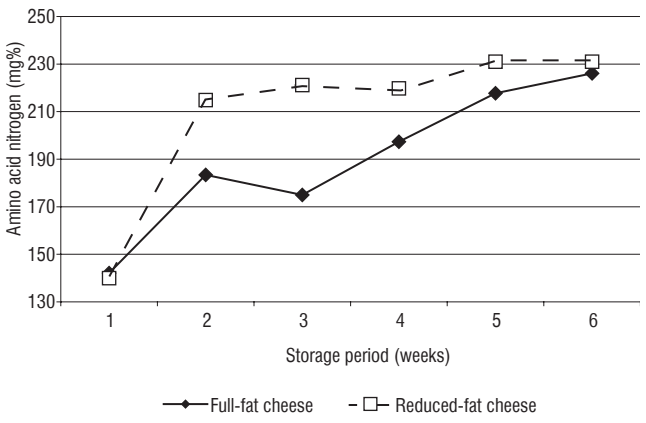

FIGURE 6. Influence of time of storage on contents of amino acid nitrogen of the Edam cheese with various fat content.

ing degradation of proteins is widely known and confirmed. Farkye *et al.* [1991], on the basis of contents and dynamics of increase of various forms of nitrogen in the Mozzarella cheese, observed the extensive proteolysis in cheese stored at cooling temperatures. The results of our analyses are consistent with the results obtained by Mayer *et al.* [1998], who analysed Grana Padano and Parmezan cheeses originating from various producers, and they confirmed a constant increase of AAN contents. Similar observations were made by Rudan *et al.* [1999] who analysed the influence of a decrease in fat content on the chemical composition, proteolysis and functional properties of Mozzarella cheese stored at 4°C. Apart from the constant increase of this form of nitrogen, they reported that its level was significantly influenced by fat content. In this case the highest level of AAN had cheese with the highest fat content. The influence of varying fat content on microbiological quality and proteolysis of the Cheddar cheese was analysed by Fenelon *et al.* [2000a]. They observed a constant increase of AAN contents during storage period and a decrease of its amount together with a decrease in fat content in cheese. They justified this change partly by simultaneous increase of water content, differences in retention of rennet and its activity in relation to casein. The decrease of the amount of WSN and AAN together with the decrease of FDM in the Cheddar cheese was also confirmed by Guinee *et al.* [2000]. Altemueller & Rosenberg [1996] and Fenelon *et al.* [2000b] showed that full-fat Cheddar cheese reached higher contents of WSN in comparison with the same cheese, but with lower fat content. Guo & Kindstedt [1995], analysing changes of water content in low-fat Mozzarella cheese during storage at 4°C, observed a significant increase of WSN and AAN contents over the entire analysed period. Similarly, Jaros *et al.* [1997], analysing the influence of water addition on the composition and tenderness of the Emmental cheese, reported a significant increase of WSN and AAN contents regardless of the quantity of water used. A rapid increase of WSN and AAN contents in renneted cheese was also confirmed by Ardö *et al.* [1989]. However Rudan *et al.* [1999], observing the influence of fat content reduction on the chemical composition, proteolysis, functional properties and yield of the Mozzarella cheese, noted the decrease of contents of all analysed forms of nitrogen (water soluble, non-protein and amino acid nitrogen) together with the decrease of fat content in cheese. However, they emphasised that the age of cheese had the greatest influence on WSN content. Moreover, there was a significant relationship between fat content and decrease of WSN contents. Also Fenelon *et al.* [2000a] observed a lack of any significant influence of fat content reduction on mean levels reached by water-soluble, non-protein and amino acid nitrogen in the analysed Cheddar cheese.

The results presented show that fat content in cheese had the most significant influence on WSN content and its sensory attributes. Therefore, while producing cheeses with reduced fat content one must consider the fact that these kinds of cheeses can be subject to less widespread proteolysis and obtain worse taste and aroma attributes. It may cause that, despite health advantages, consumers will rarely buy these products.

CONCLUSIONS

On the basis of the results obtained, it was found that full-fat Edam cheese was characterised by more intensive colour, softer consistence and definitely better taste than the reduced-fat cheese. Fat content had no impact on forming titratable acidity and pH in the cheeses analysed. Titratable acidity of both reduced-fat and full-fat cheese increased over the entire storage period and its change rate was statistically significant. pH of both types of Edam cheese was decreasing during the entire storage period and generally a higher level of this parameter was characteristic for full-fat cheese. In both kinds of cheeses a constant, statistically significant increase of amino acid and water-soluble nitrogen was observed. Fat content significantly differentiated cheeses with respect to contents of water-soluble nitrogen and a higher level of this parameter in the entire analysed period was in full-fat Edam cheese. The content of amino acid nitrogen was not dependant on fat content in the Edam cheese.

REFERENCES

1. Altemueller A.G., Rosenberg M., Monitoring proteolysis during ripening of full-fat and low-fat Cheddar cheese by reverse-phase HPLC. J. Food Sci., 1996, 61, 295–298.
2. Ardö Y., Characterizing ripening in low-fat, semi-hard cheese made with undefined mesophilic DL - starter. Int. Dairy J., 1993, 3, 343–357.
3. Ardö Y., Larsson P., Mansson L., Hedelberg A., Studies on peptidolysis during early maturation and its influence on low-fat cheese quality. Milchwissenschaft, 1989, 44, 485–490.
4. Banks J.M., Brechany Y.E., Christie W.W., The production of low fat Cheddar cheese. Int. J. Soc. Dairy Technol., 1989, 42, 6–9.
5. Cichosz G., Rymaszewski J., Kujawski M., Metabolism of lactose during production of Edam cheese. Acta Acad. Agricult. Tech. Olsztyn, Technologia Alimentarium, 1995, 27, 61–69 (in Polish).
6. Dziuba J., Kostyra H., Biochemia żywności. Ćwiczenia i metody. 1992. ART. Olsztyn, pp. 89-90 (in Polish).
7. Emmons D.B., Kalab M., Larmond E., Lowrie R.J., Milk gel structure. X. Texture and microstructure in Cheddar cheese made from whole milk and from homogenized low – fat milk. J. Texture Stud., 1995, 11, 15–34.
8. Farkye N.Y., Kiely L.J., Allshouse D.R., Kindstedt P.S., Proteolysis in Mozzarella cheese during refrigerated storage. J. Dairy Sci., 1991, 74, 1433–1438.
9. Fenelon M.A., Connor P.O., Guinee T.P., The effect of fat content on the microbiology and proteolysis in cheddar cheese during ripening. J. Dairy Sci., 2000a, 83, 2173–2183.
10. Fenelon M.A., Guinee T.P., Delahunty C., Murray J., Crowe F., Composition and sensory attributes of retail Cheddar cheese with different fat contents. J. Food Comp. Anal., 2000b, 13, 13–26.
11. Fenelon M.A., Guinee T.P., The effect of milk fat on Cheddar yield and its prediction using modifications of the van Slyke cheese formula. J. Dairy Sci., 1999, 82, 1–13.
12. Fenelon M.A., Guinee T.P., Primary proteolysis and textural changes during ripening in Cheddar cheeses manufactured to different fat content. Int. Dairy J., 2000, 10, 3,151–158.
13. Fife R.L., Mc Mahon D.J., Oberg C.J., Functionality of low fat Mozzarella cheese. J. Dairy Sci., 1996, 79, 1903–1910.
14. Guinee T.P, Auty M.A.E., Fenelon M.A., The effect of fat content on the rheology, microstructure and heat-induced functional characteristics of Cheddar cheese. Int. Dairy J., 2000, 10, 4, 277–288.

15. Guinee T.P, Fenelon M.A., Mulholland E.O., O'Kennedy B.T., O'Brien N., Reville W.J., The influence of milk pasteurization temperature and pH at curd milling on the composition, texture and maturation of reduced fat Cheddar cheese. Int. J. Soc. Dairy Technol., 1997, 50, 1–10.
16. Guo M.R., Kindstedt P.S., Age-related changes in the water phase of Mozzarella cheese. J. Dairy Sci., 1995, 78, 2099–2107.
17. Jaros D., Ginzinger W., Tschager E., Mayer H.K., Rohm H., Effects of water addition on composition and fracture properties of Emmental cheese. Lait, 1997, 77, 467–477.
18. Kurpisz W., Organoleptic assessment of dairy products. 1984, Wyd. Spół., Warszawa, pp. 52–65, 103–134 (in Polish).
19. Lau K.Y., Barbano D.M., Rasmussen R.R., Influence of pasteurization of milk on protein breakdown in Cheddar cheese during aging. J. Dairy Sci., 1991, 74, 727–740.
20. Madsen J.S., Ardö Y., Exploratory study of proteolysis, rheology and sensory properties of Danbo cheese with different fat content. Int. Dairy J., 2001, 11, 423–431.
21. Mayer H.K., Rockenbauer Ch., Mlcak H., Evaluation of proteolysis in Parmesan cheese using electrophoresis and HPLC. Lait, 1998, 48, 425–438.
22. Mc Mahon D.J., Oberg C.J., Mc Manus W., Functionality of Mozzarella cheese. Austr. J. Dairy Technol., 1993, 48, 99–104.
23. Merrill R.K., Oberg C.J., Mc Mahon D.J., A method for manufacturing reduced fat Mozzarella cheese. J. Dairy Sci., 1994, 77, 1783–1788.
24. Mistry V.V., Kasperson M., Influence of salt on the quality of reduced fat cheddar cheese. J. Dairy Sci., 1998, 81, 1214–1221.
25. Paulson B., Mc Mahon D.J., Oberg C.J., Influence of NaCl on appearance, functionality and protein arrangements in non-fat Mozzarella cheese. J. Dairy Sci., 1998, 81, 2053–2064.
26. Polish Standard PN-73/A-86232, Milk and dairy products. Cheeses. Methods of analyses 1973 (in Polish).
27. Polish Standard PN-ISO 6658, Sensory assessment. Methodology. General guidelines, 1998 (in Polish).
28. Polish Standard PN-ISO 4121, Sensory assessment. Methodology. Assessment of food products by means of scaling methods, 1998 (in Polish).
29. Prentice J.H., Gilles J., Composition and grade of cheddar cheese manufactured over three seasons. New Zeal. J. Dairy Sci. Technol., 1993, 14, 63–71.
30. Rodriguez J., Recent advances in the development of low-fat cheeses. Trends Food Sci. Technol., 1998, 9, 249–254.
31. Rudan M.A., Barbano D.M., Yun J.J., Kindstadt P.S., Effect of fat reduction on composition, proteolysis, functionality and yield of mozzarella cheese. J. Dairy Sci., 1999, 82, 661–672.
32. Shakeel-Ur-Rehman, Farkye N.Y., Considine T., Schaffner A., Drake M.A., Effects of standardization of whole milk with dry protein concentrate on the yield and ripening of reduced-fat cheddar cheese. J. Dairy Sci., 2003, 86,1608–1615.
33. Tungjaroenchai W., Drake M.A., White C.H., Influence of adjunct cultures on ripening of reduced fat Edam cheeses. J. Dairy Sci., 2001, 84, 2117–2124.
34. Tunick M.H., Mackey K.L, Shieh J.J., Smith P.W.P., Cooke P., Malin E.L., Rheology and microstructure of low-fat Mozzarella cheese. Int. Dairy J., 1993, 3, 649–662.

Received November 2005. Revision received July and accepted December 2006.

ZMIANY WYBRANYCH CECH JAKOŚCIOWYCH SERA EDAM O RÓŻNEJ ZAWARTOŚCI TŁUSZCZU W CZASIE JEGO PRZECHOWYWANIA

Małgorzata Jasińska, Izabela Dmytrów, Adrian Stradomski

Zakład Technologii Mleczarskiej, Akademia Rolnicza, Szczecin

Przebadano średniotłusty (28% tłuszczu w Sm) i pełnotłusty (50% tłuszczu w Sm) ser Edam podczas 6 tygodni przechowywania w temp. 5°C±1°C. Ser poddano ocenie organoleptycznej oraz oznaczono w nim zawartość wody, tłuszczu, kwasowość miareczkową, pH oraz zawartość azotu ogólnego, rozpuszczalnego i aminowego. Stwierdzono, że ser Edam pełnotłusty charakteryzował się intensywniejszą barwą, bardziej miękką konsystencją oraz zdecydowanie lepszym smakiem niż ser średniotłusty. Wykazano, że zawartość tłuszczu nie miała istotnego wpływu na kształtowanie się kwasowości potencjalnej i pH analizowanych serów. Stwierdzono również, że zawartość tłuszczu istotnie różnicowała sery pod względem zawartosci azotu rozpuszczalnego a wyższą jego zawartość w całym okresie badawczym wykazywał ser Edam pełnotłusty. Zawartość azotu aminowego nie była zależna od udziału tłuszczu w serze.