

## SENSORY QUALITY OF COMMERCIAL FULL FAT AND REDUCED FAT CHEESES

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The aim of the present study was to compare the sensory quality of cheeses with different fat content. The samples studied were Polish commercial semi-hard type cheese and its reduced fat version. The sensory quality of cheeses was evaluated by quantitative descriptive analysis (QDA) and as hedonic ratings on day 10, 50 and 80 of their storage under traditional conditions (refrigerator 4°C). The chemical composition of the cheeses was analysed as well. The chemical analysis and sensory evaluation (QDA) proved that the level of fat in cheeses and their storage period had a significant effect ( $p < 0.05$ ) on some chemical parameters of cheese and some sensory attributes. Statistically significant attributes which differentiated the profile of sensory quality of both varieties ( $p < 0.05$ ) of cheeses were: creamy odour, sour odour, yellow colour, salty taste, sweet taste, bitter taste, hardness and dryness. The results obtained with the QDA analysis were confirmed by the PCA analysis. Differentiating the sensory profile of cheeses (QDA) did not influence ( $p < 0.05$ ) their overall quality.

### INTRODUCTION

There is currently much interest in the so-called “light” food products. Obesity has become a major health risk in both the industrial and developing countries. Obesity causes severe health problems, including adult type diabetes, coronary artery disease and breast and colon cancer. People often buy foodstuffs with reduced fat and energy as part of weight-reducing diet. In order to fulfil the expectations of consumers in this field the dairy industry produces various kinds of low fat cheeses. Although, the low fat cheese market is rapidly growing there is still little information which sensory attributes make these products pleasant – or unpleasant for the consumers. So far many studies have been assessed concerning the sensory characteristics of full fat cheeses [Rothe *et al.*, 1978; Heisserer & Chambers, 1993; Moio & Addeo, 1998; Tavarina *et al.*, 2002], but only a few have evaluated the sensory quality of low fat cheeses. In this context, the aim of this work was to compare the sensory quality of Polish commercial semi-hard cheeses with different fat contents and to evaluate the sensorial changes in these products in their shelf life period. The chemical composition of the cheeses was analysed as well.

### MATERIALS AND METHODS

**Materials.** Full fat semi-hard type cheese and its reduced fat version produced from bovine milk were used in this study. Both varieties of cheese originated from the same region (northern-west part of Poland), the same producer and had the same maturation period. After ripening,

the cheeses were stored under traditional conditions (refrigerator 4°C) and then submitted to the sensory analysis and assay of the chemical composition after 10, 50 and 80 days.

**Chemical analyses.** The cheese samples were analysed for dry matter, fat and total nitrogen by AOAC methods [AOAC, 1990]. Proteolysis in cheese during storage was monitored by measuring the water-soluble nitrogen and nitrogen soluble in 12% TCA by FIL-IDF method [FIL-IDF, 1991].

**Sensory evaluation methods.** Quantitative Descriptive Analysis (QDA) was performed to determine the differences in the sensory characteristics of the cheeses [Stone & Sidel, 1993]. The QDA procedure used in the study was in agreement with requirements of the international standard [ISO/DIS 13299:1998]. A comprehensive vocabulary of descriptors for odour, colour, flavour and texture was generated through consensus (Table 1). Intensity of each descriptors was measured on continuous line scale (10 cm), labelled “no intensity” at the left end and “strong intensity” at the right end. The ratings were afterwards converted into number from 0.0 = non intensive to 10.0 = strong intensive.

Overall quality analysis of cheeses was conducted using the same type of scale as above. The quality was expressed as “the general liking” of the sample.

**Sensory panel.** The panel of sensory assessors was trained and monitored according to ISO standards [1993]. Sensory evaluation of the samples was performed by 8 panellists all experienced in discrimination and descriptive tests

TABLE 1. The attributes used in QDA of the cheeses and their definitions and references.

Descriptor	Definition
<b>Odour</b>	
creamy odour	smell of market cream (30%)
acid odour	typical note of fermented milk products such as yoghurt
<b>Appearance</b>	
yellow colour	visual estimation of intensity
<b>Taste</b>	
salty taste	basic taste typical of sodium chloride as diluted in water (0.2%)
sweet taste	basic taste illustrated by sucrose diluted in water (1–5%)
acid taste	taste of fermented milk products
bitter taste	basic taste typical of caffeine in water (0.5%)
aftertaste	after-taste which continued after the removal of sample
<b>Texture</b>	
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 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 – nonintensive very intensive; \* - low - high

on different food products. Prior to their participation in the experiments, the subjects were trained to rate the perceived intensity of the following different sensations: sourness, bitterness saltiness and sweetness, using aqueous solutions of different concentration of citric acid, quinine sulphate, caffeine, NaCl, sucrose. Further, they were instructed to chew cheese and use their tongues to push the sample against the palate to perceive the flavour and texture.

#### Preparation of samples and evaluation conditions.

Cheeses were cut into 2.0 cm<sup>3</sup> samples and placed in plastic

cups covered with a plastic lid. The cheeses were served at 21°C (room temperature) because of its optimal flavour [Heisserer & Chambers, 1993]. Three-digit random numbers were used to code the samples and the descriptive analysis of the cheeses was evaluated in two replications. Unsalted crackers and spring water were provided in between samples for cleaning the panellists' palates. The analysis was performed in a standardised test room [ISO 8589:1998] and with the computerised system ANALSENS for data collection and processing [Baryłko-Pikielna, 1992].

**Statistical analysis.** The results of the sensory analysis (factors: fat content/sensory attribute, time storage/sensory attribute) and chemical analysis (factors: fat content/chemical composition, time storage/chemical composition) were analysed by ANOVA. Statistically significant differences ( $p < 0.05$ ) in the results were tested by Fisher's protected least significant difference (LSD) test ( $p \leq 0.05$ ). Principal component analysis (PCA) was applied for general assessment of similarity-dissimilarity of the evaluated samples and describing their attributes. Statistical analyses were gained by Statgraphics Plus 5.1 (Statistical Graphics corp., USA, 2001) and Senstat for Windows (Deltaworks software, 1996, The Netherlands).

## RESULTS AND DISCUSSION

### Chemical analyses

The summary of the results is presented in Table 2. The full fat cheese was different from the reduced fat cheese with respect to its contents of fat, dry matter, total nitrogen, nitrogen soluble in water, non-protein nitrogen and pH ( $p < 0.05$ ). The fat content of full fat cheese ranged from 43.80% (10-day-old) to 46.11% (50-day-old) and that of the reduced fat from 26.49% (50-day-old) to 27.84% (10-day-old). It is well known that fat content plays an important role in the sensory quality of cheeses [de Ross, 1997; Plug & Haring, 1993; Schirle-Keller *et al.*, 1994]. A preference for higher fat content cheese was found in the study of Vickers & Mullan [1997], where consumption and liking of full fat processed cheese were higher than those of a fat-free version. Apart from fat, the fractions of nitrogen have a significant impact on sensory quality of cheese. According to the lecture of Engel *et al.* [2002], cheese is a complex product

TABLE 2. Chemical composition of the experimental cheeses stored for 10, 50 and 80 days.

Chemical components	Storage period (days)					
	10		50		80	
	full fat	reduced fat	full fat	reduced fat	full fat	reduced fat
Dry matter (%)	59.25±0.51bC	49.89±0.27aA	58.78±0.08bB	49.79±0.23aA	58.37±0.02bA	49.64±0.04aA
Fat (%)	43.80±3.42bA	27.84±0.30aB	46.11±0.01bA	26.49±0.11aA	45.50±0.50bA	27.06±0.14aAB
pH	5.12±0.01aA	5.06±0.00bB	5.23±0.01aA	5.08±0.01bA	5.20±0.01bB	5.14±0.01aA
Total nitrogen (% DM)	7.18±0.01aA	9.70±0.01bA	7.67±0.39aA	9.62±0.17bA	7.54±0.09aA	9.87±0.46bA
Nitrogen soluble in water (% in total nitrogen)	9.96±0.04aB	12.96±0.02bA	12.90±0.06aA	15.74±0.07bB	15.51±0.05aA	19.21±0.01bC
Non-protein nitrogen (% in total nitrogen)	5.66±0.00aA	3.57±0.01aA	5.32±0.01aA	6.01±0.03bB	6.29±0.00aB	6.87±0.01bC

means marked in each row with the same letters do not have significant differences (LSD test,  $p < 0.05$ ); small letters describe comparison between full and reduced fat cheese in each day of storage; capital letters describe comparison between days of storage in each variety of cheese

which can be considered as consisting of two portions: a matrix which is a network of protein and fat and water-soluble fraction (minerals cation, amino acids, peptides and low weight molecular proteins). In order to investigate cheese taste, the water-soluble fraction has been extensively studied because it is considered by numerous authors to be mainly responsible for this gustatory property [McSweeney, 1997; Engel *et al.*, 2000]. Our results indicate that the contents of nitrogen soluble in water (% in total nitrogen) were higher in the reduced fat cheese than in the full fat cheese and ranged from 12.96% (10-day-old) to 19.21% (80 days old) and from 9.96% (10-day-old) to 15.51% (80-day-old), respectively. The results were in agreement with the study of Tungjaroenchai *et al.* [2001], where proteolysis was found to occur more rapidly in reduced fat cheeses. Moreover, the contents of non-protein nitrogen in both varieties of cheeses were similar except the 10-day-old reduced fat cheese.

### Sensory analysis

For sensory evaluation, the quantitative descriptive analysis was used (QDA), which is often applied to study a variety of products including cheese [Lawless & Heymann, 1999; Stone & Sidel, 1993]. Using QDA method 13 attributes for the investigated products describing odour, appearance, taste and texture were selected and defined in (Table 1). Table 3 shows the results of sensory evaluation for QDA analysis and overall quality in two factors: fat level and storage time (the mean values of intensity of these attributes are presented). The results show that among 13 attributes only the intensity of three of them (acid odour, salty taste and dryness) was statistically significant for cheeses stored for 10 days, whereas in the 50-day-old cheeses significant differences ( $p < 0.05$ ) were observed in the intensity of such attributes as: salty taste, sweet taste, bitter taste, hardness and dryness. In 80-day-old cheeses significant differences ( $p < 0.05$ ) were noted in such attributes as: creamy odour, yellow colour, salty taste and sweet taste. In order to observe the

above differences in the products analysed more clearly, sensory profiles of full fat cheese (80-day-old) and reduced fat cheese (50-day-old) which obtained the highest scores of overall quality were displayed as spider diagrams in Figure 1. At the first glance one could see that the profile of reduced fat cheese differs profoundly from that of the full fat cheese. These differences mainly applied to the colour, and the attributes of texture and taste. The results of the overall quality of the investigated samples demonstrate that full fat cheese and reduced fat cheese stored for 10 days obtained the lowest scores – 5.11 units and 4.87 units, respectively. The reduced fat cheese stored for 50 days obtained the highest scores – 6.18 units and full fat cheese stored for 80 days – 5.99 units (Figure 2). Although prolonging the storage period affected the overall quality of scores, they were statistically insignificant ( $p < 0.05$ ).

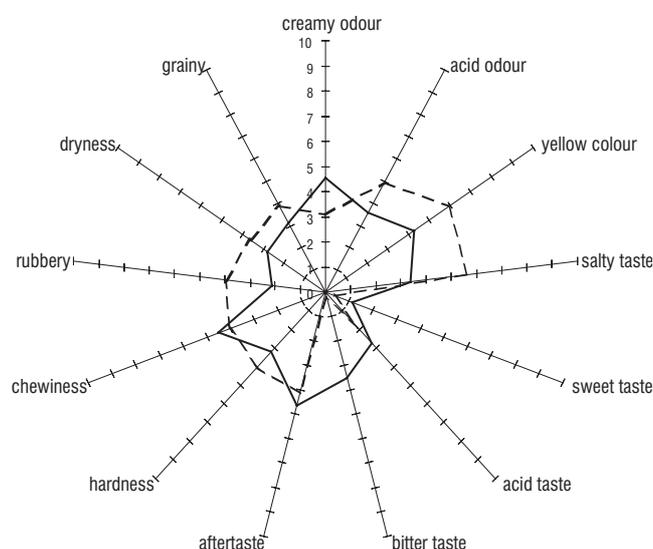


FIGURE 1. Graphical chart of the sensory profile (QDA) of products: — 80-day-old full fat cheese, - - - - 50-day-old reduced fat cheese.

TABLE 3. Quantitative descriptive analysis of cheeses stored at 10, 50 and 80 days.

Attribute	Storage period (days)					
	10		50		80	
	full fat	reduced fat	full fat	reduced fat	full fat	reduced fat
Creamy odour	4.14aA	3.15aA	4.54aA	3.09aA	4.55bA	2.11aA
Acid odour	4.13bB	2.20aA	4.52aA	4.93aA	3.56aA	4.46aA
Yellow colour	4.91aA	5.36aAB	5.71aA	5.95aB	4.24aA	6.11bA
Salty taste	1.88aB	3.08bA	2.78aA	5.61bAB	3.38aA	6.10bB
Sweet taste	1.07aA	0.69aA	0.84bA	0.35aA	1.11bA	0.49aA
Acid taste	1.53aA	1.40aA	1.49aA	1.93aA	2.73aB	3.71aB
Bitter taste	1.49aAB	1.28aA	0.78bA	0.21aA	3.52aB	2.06aB
Aftertaste	4.50aA	4.58aA	4.52aA	4.12aA	4.67aA	4.36aA
Hardness	3.54aA	4.51aA	2.74aA	4.04bA	3.20aB	2.38aA
Chewiness	4.26aA	4.96aA	3.14aA	4.04aA	4.51aA	3.71aA
Rubbery	3.63aA	3.91aA	3.49aA	3.96aA	2.09aA	3.23aA
Dryness	3.18aB	5.06bA	2.33aAB	3.64bA	2.79aA	2.78aA
Grainy	3.36aB	4.29aA	3.11aAB	3.90aA	3.14aA	2.44aA
Overall quality	5.11aA	4.84aA	5.87aA	6.18aA	5.99aA	5.51aA

means marked in each row with the same letters do not have significant differences (LSD test,  $p < 0.05$ ); small letters describe comparison between full and reduced fat cheese in each day of storage; capital letters describe comparison between days of storage in each variety of cheese

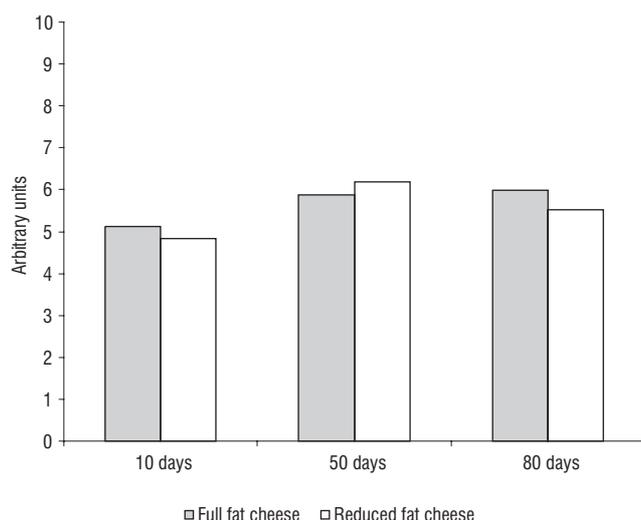


FIGURE 2. Overall quality of the products investigated.

The data obtained from the profile analysis (QDA) were subjected to PCA employing statistical software. Two principal components, PC1 and PC2, were extracted which accounted for 75% of total data variance (Figure 3). The projection of data points ascribes to the samples and to input attributes on the plane reflects a comprehension of graphical manner of the similarities and dissimilarities among them. It can be seen that all studied samples of cheeses are located next to each other and near the overall quality. It indicates that there is a similar sensory character of the assayed samples in the hedonic context. Moreover, the sensory attributes describing the texture of these samples were situated close to each other. It indicates that the samples studied were similar. The attributes of flavour such as acid taste, sweet taste, and bitter taste, which significantly differentiated the cheeses under study, were located on the opposite side of the chart.

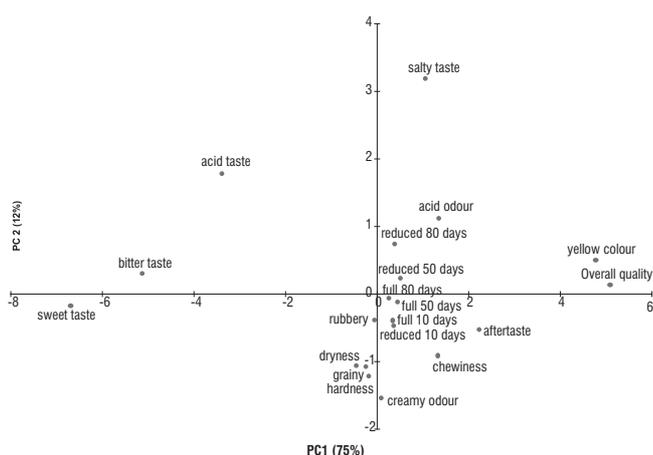


FIGURE 3. PCA plot of sensory profiling results of the products investigated and their descriptors.

## CONCLUSIONS

In conclusion, we found that the content of fat in cheeses and storage time had a significant effect on some chemical parameters and sensory attributes of cheese. Significantly differentiating attributes of sensory profiles of full fat and

reduced fat cheeses were: creamy odour, sour odour, yellow colour, salty taste, sweet taste, bitter taste, hardness and dryness. The sensory differentiation of sample profiles (QDA) did have any statistically significant effect on the overall quality of the cheeses ( $p < 0.05$ ). This is probably due to the fact that in the QDA analysis individual attributes of the samples are evaluated, whereas in the overall quality this is the consumers' liking that plays the key role.

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## OCENA SENSORYCZNA SERÓW HANDLOWYCH PEŁNOTŁUSTYCH I O ZREDUKOWANEJ ZAWARTOŚCI TŁUSZCZU

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Zainteresowanie konsumentów żywnością niskotłuszczową szybko wzrasta ze względów zdrowotnych. Przemysł mleczarski chcąc sprostać oczekiwaniom konsumentów, produkuje coraz więcej różnego rodzaju produkty o obniżonej zawartości tłuszczu w tym również sery. Jakość sensoryczna serów pełnotłustych była przedmiotem wielu badań, natomiast mało jest prac dotyczących serów niskotłuszczowych. Celem pracy było porównanie jakości sensorycznej handlowych serów tego samego typu, wyprodukowanych przez tego samego producenta, różniących się zawartością tłuszczu. Sery obu odmian (pełnotłusty i o obniżonej zawartości tłuszczu) były poddane ocenie sensorycznej (analiza QDA) oraz analizie chemicznej po 10, 50 i 80 dniach przechowywania. Stwierdzono zróżnicowanie jakości sensorycznej badanych produktów, na co miał wpływ zarówno poziom tłuszczu jak i czas przechowywania. Wyróżnikami istotnie różnicującymi ( $p < 0,05$ ) profile jakości sensorycznej serów były: zapach kremowy, zapach produktów fermentowanych, barwa, smak słony, smak słodki, smak gorzki oraz cechy tekstury: twardość i suchość. Analiza chemiczna produktów wskazuje, że proteoliza w serach o obniżonej zawartości tłuszczu przebiegała intensywniej niż w serach pełnotłustych.