The Relationships between the Chemical, Dielectric and Sensory Properties of Edam Cheese during Ripening

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Abstract

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Proteolysis, dielectric properties and sensory data were measured during ripening of Edam type cheese (30% and 45% FDM). Cheese of different age (1–25 weeks) was analysed. Dielectric properties were used as a method for assessing proteolysis. Permitivity had significantly similar continuance as pH 4.4 total soluble N, both in opposite to sweet milky taste, during ripening period. This paper offers dielectric properties as useful characteristics for assessing proteolysis in cheese.

Keywords: Edam cheese; proteolysis; dielectric properties; permitivity; sensory analysis; ripening

Proteolysis is a major event in the ripening of most cheese varieties, Edam type cheeses included. Many changes can be perceived during cheese ripening and practically all of them can be measured by any of the available methods. Nitrogen solubility under defined conditions is probably the most widely used criterion of proteolysis (KUCHROO & FOX 1982). MCSWEENEY and FOX (1997) recently published a comprehensive review of methods characterising proteolysis in cheese during ripening. Texture and sensory properties are other important attributes determining cheese quality (JACK *et al.* 1993; HORT *et al*. 1997a). Texture is of primary importance to the consumer as it is often the first attribute to assess quality or to identify the cheese.

Good correlation between quality indicators and consumer acceptability can be obtained within a single cheese variety. ASTON *et al*. (1983) found a very significant correlation between the proteolysis indicators (PTA soluble amino nitrogen and TCA soluble tyrosine levels) and flavour development in Cheddar. Rheological, compositional and sensory measurements were performed by many other authors, e.g. GREEN *et al*. (1985), JACK *et al*. (1993), O'SHEA *et al*. (1996), HORT *et al*. (1997a).

The interaction between the alternating electromagnetic field and cheese enables to elucidate specific properties of this material (KENT 1987). The electric currents are generated inside the sample (TRAN *et al*. 1984). Dielectric properties of cheese can be then analysed, namely using the relative dielectric constant (ε_r) and the dielectric loss tangent (tg δ). The relative dielectric constant of a material shows how many times the force of interaction between the electric charges in the given medium is less than that in a vacuum. The dielectric loss tangent defines the part of the power applied to cheese that is absorbed by the material under the influence of the electric field.

The measurements of interactions between high frequency electromagnetic field (10 GHz) and cheese can be used to monitor technological processes during production (KŘIVÁNEK & BUCHAR 1993). The results suggest future applications of this method for the food quality improvement (BUCHAR *et al*. 1993).

Consequently, for the purpose of this study we mainly investigated the changes in the dielectric properties of Edam type cheese, as related to cheese ripening and to sensory attributes.

MATERIALS AND METHODS

Samples were prepared from commercially manufactured Edam type cheese – with 30% and 45% fat in dry matter

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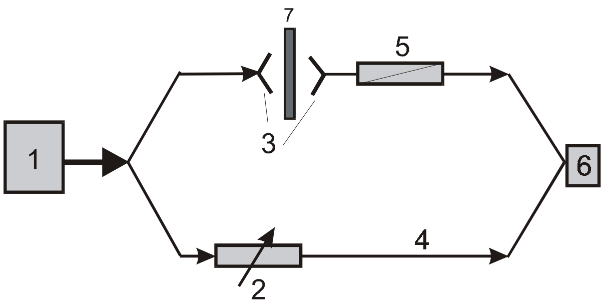
(FDM). The factory processes about 50 000 l of milk a day in a standard manufacturing schedule. Approximately ten lots of 210 Edam blocks are produced. Immediately after salting, six randomly chosen blocks from different batches were cut to thick (about 0.5 kg) slices, five slices each, and vacuum-packed in cryovac foil. Samples were stored at 10°C for future measurements.

Immediately after unwrapping from the foil, a 70 by 70 mm sample, 6 mm thick, was taken from the centre of each slice. A continuous measurement of dielectric properties followed.

Chemical Analysis: All cheeses were analysed for dry matter (DM, expressed in g/100 g of cheese, oven dried at 102°C for 4 hrs), fat (F, g/100g, acidobutyrimetric method according to VAN GULIK, ISO 3433 [1975 – Sýry. Stanovení obsahu tuku v sýrech. Metoda Van Gulik]), tyrosine, tryptophan and total soluble N according to the spectrophotometric method by VAKALERIS and PRICE (1959).

Dielectric Measurements: Samples were analysed at storing temperature 10°C. Fig. 1 represents a schematic diagram of the measuring instrument.

The generator produces standard microwave signal with frequency 10 GHz. The phase of the signal in the measuring section is changed when passing through cheese sample. The alternation of the phase is measured in the phase move and changes the phase to the original. The amplitude of the signal passing through the sample is lowered. It is therefore necessary to decrease the level of the signal by discriminating attenuator in order to get the difference in measuring and comparative line equal to zero (TORGOVNIKOV 1993).



1 – generator; 2 – discriminating attenuator on ferrite valve; 3 – measuring line; 4 – comparative line; 5 – phase move; 6 – microampermetr; 7– sample of cheese

Fig. 1. The measuring instrument

The result of the solution of the Maxwell equations is the relative dielectric constant ε_r, the dielectric loss tangent tg δ and the high frequency specific conductivity σ (HOŠEK 1963).

$$\varepsilon_r = [1 + \Delta\varphi * \lambda/360\delta]^2$$

$$\text{tg } \delta = \lambda * b_D/8.686\varepsilon_r^{1/2}$$

$$\sigma = 2\Pi * f * \varepsilon_r * \varepsilon_0 * \text{tg } \delta$$

where: $\Delta\varphi$ – alternation of the phase [grad]
λ – wave length [m]
d – thickness of sample [m]
b_D – attenuation of the signal [dB/m]
ε_0 – permitivity of vacuum $\varepsilon_0 = 8.854*10^{-12}$ F/m
f – frequency of the generator

Sensory Evaluation: Four sensory panellists, familiar with Edam cheese properties, performed the appraisal of sensory characteristics. Middle of the sliced piece was taken for sensory assessment. Colour, sour and milk smells, texture characteristics elasticity and deformability and flavour descriptors salt, bitter, sour, sweet and nutty were graded. All characteristics were graded zero to seven (integers only). The scores presented are the means of grading by all panellists.

RESULTS AND DISCUSSION

Basic parameters (dry matter and fat), which characterise the tested Edam cheese more closely, are summarised in Table 1. These parameters do not change during the ripening process because of the presence of foil on cheese surface, so they were not measured again.

As can be seen from our results, the methods used offer sufficient distinguishing among given samples of different age (Table 2). Each value is a mean of six measurements. The results show an increase of soluble tyrosine, tryptophan and also of total soluble N with prolonged ripening period. Their amounts also correlate very closely (VAKALERIS & PRICE 1959). This is logical and in full agreement with many other authors (e.g. MCSWEENEY & FOX 1997). Only between the 4th and 7th weeks of ripening (30% FDM) there was no difference among total N values – maybe due to small change in age or lower resolution of the method used. However, the measurement of tyrosine content of different medium-soluble extracts is a well-established, easy and quick traditional method for assessing proteolysis (FOX 1989).

Table 1. Basic characteristics of tested cheese

	DM	Fat	FDM
30%			
Mean	53.4	16.8	31.5
sd	1.6	0.7	0.6
45%			
Mean	57.1	25.8	45.1
sd	0.7	0.5	0.4

Dielectric properties were measured after the first month of ripening of 30% FDM cheese. It has been proved that

Table 2. Dielectric and proteolytic characteristics (30% and 45% FDM cheese) during ripening

	ε_r	sd	tg δ	sd	σ	sd	sol. N	sd	Tyr	sd	Trp	sd
30%												
1 week	x	x	x	x	x	x	5.79	0.26	0.030	0.002	0.015	0.001
4 weeks	x	x	x	x	x	x	8.36	0.56	0.053	0.005	0.020	0.001
7 weeks	19.0	1.0	0.170	0.009	1.83	0.07	8.30	0.46	0.052	0.004	0.020	0.001
11 weeks	21.0	1.2	0.129	0.014	1.50	0.08	10.21	0.65	0.069	0.006	0.022	0.002
25 weeks	22.5	0.7	0.111	0.010	1.39	0.09	15.33	0.46	0.115	0.004	0.031	0.001
45%												
1 week	19.0	0.9	0.174	0.012	1.83	0.10	5.62	0.36	0.028	0.003	0.016	0.001
5 weeks	21.5	0.4	0.127	0.011	1.52	0.11	8.38	0.39	0.053	0.003	0.020	0.002
11 weeks	22.1	0.4	0.110	0.014	1.35	0.16	10.04	0.41	0.068	0.004	0.023	0.001
19 weeks	23.0	0.7	0.113	0.023	1.44	0.25	11.98	0.37	0.085	0.003	0.026	0.001
25 weeks	23.1	1.7	0.109	0.015	1.40	0.07	13.27	0.29	0.097	0.003	0.026	0.001

x – not measured; ε_r – permitivity; tg δ – dielectric loss (grad); σ – high frequency specific conductivity (S/m); sol. N – % of total N; Tyr, Trp – g of tyrosin or tryptophan in 100g of cheese

while the curve of the real part of relative permitivity (ε_r) is steadily increasing (Table 2) during the process of cheese ripening (in both, 30 and 45% FDM cheeses), specific conductivity (σ) is gradually decreasing (KŘIVÁNEK & BUCHAR 1993). After the process of salting, the NaCl diffusion through the whole body of cheese occurs and unbound water loss follows. It certainly influences ε_r and σ, similarly as proteolysis – all dielectric characteristics correlate significantly with tyrosine and total soluble N values and very significantly with tryptophan values.

Sensory characteristics are summarised in Tables 3. We did not find any conspicuous change in smells, only slight decrease of intensity of milk smell in both 30% and 45% FDM cheeses. Colour was also gently changing (limits were white, milky and yellow). As for taste, bitter taste developed only after longer period of ripening in both cases, sour taste did not change very much except that it was reduced at the end of ripening. Salty taste changed rapidly in the first stages of ripening and through the rest of ripening was well balanced – this was due to the buffering changes of salt content in cheese after brining. The most pronounced changes were found in the sweet (milky) taste, which was vanishing through the ripening period (less in 45% FDM, more in 30% FDM cheese).

Table 3. Sensory characteristics (30% and 45% FDM cheese) during ripening

	30% FDM					45% FDM				
	week									
	1	4	7	11	25	1	5	11	19	25
Smell										
Sour	0	0	1	0	0	0	0	0	0	0
Milky	4,5	4	3	3	3	4.5	4.5	3.5	3	3
Colour	2.5	3.5	4	4.5	3.5	2.5	3	3.5	3.5	3.5
Taste										
Bitter	0	0	1	1	2.5	0	0	0.5	1.5	2
Sour	3	3	3	3.5	1.5	2.5	3.5	2.5	2	1.5
Salt	1	4	2	2	1.5	1	4	3	2.5	2.5
Sweet	6	5	4	3	1.5	4.5	4.5	2.5	1.5	1.5
Nutty	0	0	0	1	2	0	0	1.5	2.5	2.5
Elasticity	2	2.5	3	3	2.5	4	3	4.5	5.5	5.5
Deformability	2	3.5	2.5	3	1.5	4	3	4.5	5.5	5.5

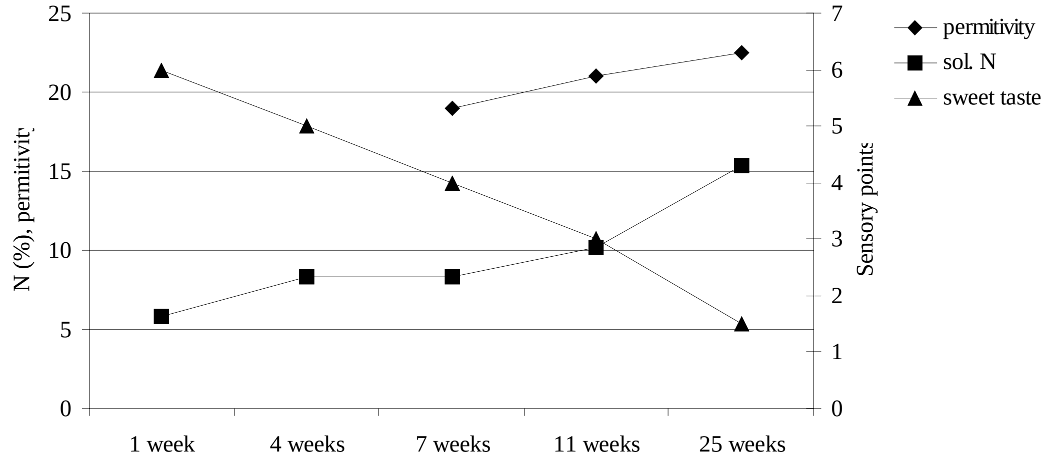


Fig. 2. Dielectric, proteolytic and sensory characteristics and its changes (30% FDM cheese) during ripening

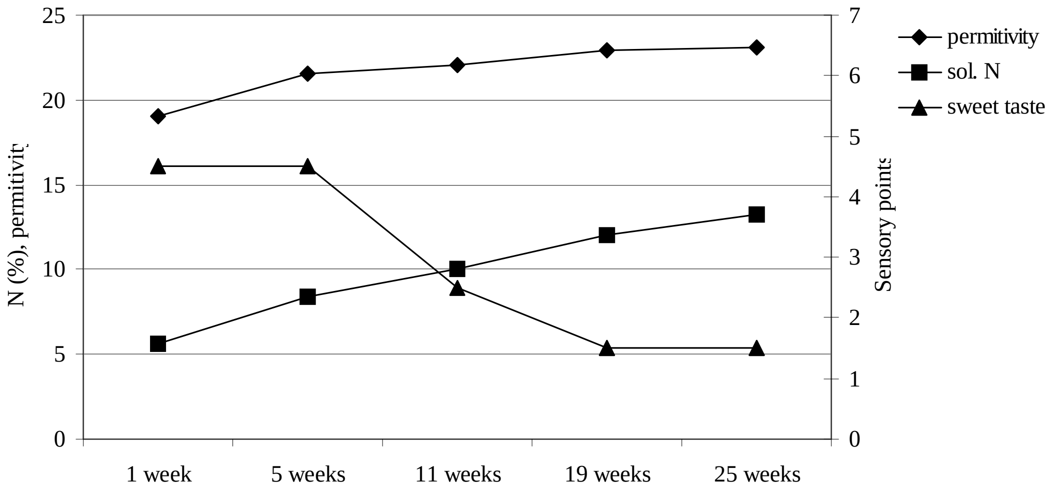


Fig. 3. Dielectric, proteolytic and sensory characteristics and its changes (45% FDM cheese) during ripening

Nutty taste was found in the late ripening (more 45%, less 30% FDM). Texture characteristics, elasticity and deformability, showed similar results without any significant change, only at the end of ripening both characteristics decreased in 30% FDM cheese because of the harder nature of cheese in this period. This is in agreement with HORT *et al.* (1997b), who found older Cheddar cheese less springy and creamier. On the other hand, 45% FDM cheeses were getting softer with the increased age.

The main characteristics and their mutual relationships are emphasised in Figs. 2 and 3. Based on our results, we consider the dielectric properties to be other possible indices for the assessment of the level of cheese ripening.

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Souhrn

KUBIŠ I., KŘIVÁNEK I., GAJDŮŠEK S. (2001): **Vzájemné vztahy mezi chemickými, dielektrickými a senzorickými vlastnostmi sýra v průběhu zrání**. Czech J. Food Sci., **19**: 85–89.

U sýrů eidamského typu (30 a 45 % tvs) byla v průběhu zrání měřena proteolýza, dielektrické a senzorické vlastnosti. Byly analyzovány sýry různé zralosti (1–25 týdnů). Dielektrické charakteristiky byly ověřovány jako ukazatelé proteolýzy. V průběhu zrání měla permitivita podobný trend nárůstu intenzity jako obsah rozpustného dusíku (pH 4,4), naopak sladká mléčná chuť měla průběh opačný. Dielektrické vlastnosti sýrů mohou být využity při hodnocení stupně zralosti sýrů.

Klíčová slova: eidamský sýr; protelolýza; dielektrické vlastnosti; permitivita; senzorické vlastnosti; zrání

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