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Retention of sulfur flavours by food matrix and determination of sensorial data independent of the medium composition

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Abstract

Interactions between food matrix and sulfur compounds (thioesters, sulfides, disulfides, pentanethiol and 2-ethoxythiazole) were studied in a real food system composed of fresh cheese, triolein or inulin, and water. Results obtained with the lipidic medium confirm that 10% of triolein is enough to significantly affect flavour perception. The lipophilicity index, log k_W, appears as an interesting physicochemical property allowing assessment of the aroma retention intensity. Results obtained with inulin indicate how different the retention will be when a polysaccharide is used as a fat-mimic. Formulation of dietetic products has to take that discrepancy into account. GC-odour port evaluation of diluted solutions appears as an interesting method for easy acquisition of best estimated GC-lower amounts detected by sniffing (BE-GC-LOADS), threshold values independent of the medium composition.

Keywords: Flavour; Sulfur; Lipophilicity; Lipids; Inulin; Odour threshold

1. Introduction

In food flavour acceptability, not only are the nature and the concentration of the aroma compounds essential but also their interactions with non-volatile macromolecules such as sugars and hydrocolloids (Goubet, Quere & Voilley, 1998; Nuessli, Sigg, Conde-Petit & Escher, 1997; Yven, Guichard, Giboreau & Roberts, 1998), proteins (Pelletier, Sostmann & Guichard, 1998), and lipids.

Of all food ingredients, lipids probably have the strongest sensory impact. Ebeler, Pangborn and Jennings (1988), studying menthone and isoamyl acetate in soybean oil, as well as Guyot, Bonnafont, Lesschaeve, Issanchou, Voilley and Spinnler (1996) using model emulsions of δ-decalactone, found lipids to significantly reduce the headspace aroma concentration and hence the perceived flavour intensity. Opposite results were obtained for diacetyl and butyric acid (Guyot et al., 1996). Earlier, Buttery, Guadagni and Ling (1973) found that the air–oil partition coefficients determined for a series of aliphatic aldehydes and ketones decreased as the molecular weight of the flavouring compound increased. Sensorial and analytical experiments indicate that parameters, such as fat composition and concentration, emulsion characteristics, pH, and temperature significantly modify interactions between lipids and small molecules (Guyot et al., 1996; Kieckbusch & King, 1979; Land, 1978; Lee, 1986; Linssen, Janssens, Reitsma, Bredie & Roozen, 1993; Salvador, Bakker, Langley, Potjewijd, Martin & Elmore, 1994; Schirle-Keller, Reineccius & Hatchwell, 1994). Most of the above-mentioned experiments involved simple model systems. More recently, some of us have shown similar results on a real fat-containing food system composed of fresh cheese, triolein, and water (Piraprez, Hérent & Collin, 1998a). As shown for methylketones, esters, and aldehydes, the aroma retention by lipids was proportional to the aroma lipophilicity.

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Sulfur compounds play a significant role in the flavour of dairy products, as in many other foods (Cuer, Dauphin, Kergomard, Roger, Dumont & Adda, 1979). Sulfides and polysulfides have been identified in Gruyère, Cheddar and Domiati cheeses (Collin, Osman, Delcambre, El-Zayat & Dufour, 1993; Cuer, 1982) while thioesters are probably the main contributors to the characteristic aroma of matured cheeses such as Camembert (Khan et al., 1999). That is why, in the present work, lipophilicity and flavour retention were investigated in a large set of sulfur compounds including thioesters, polysulfides, sulfides, thiols and thiazoles. The impact of the use of inulin as a fat-mimic was also considered. As flavour retention (and related flavour threshold) proves to be drastically variable, according to the matrix, a matrix-independent measure of relative

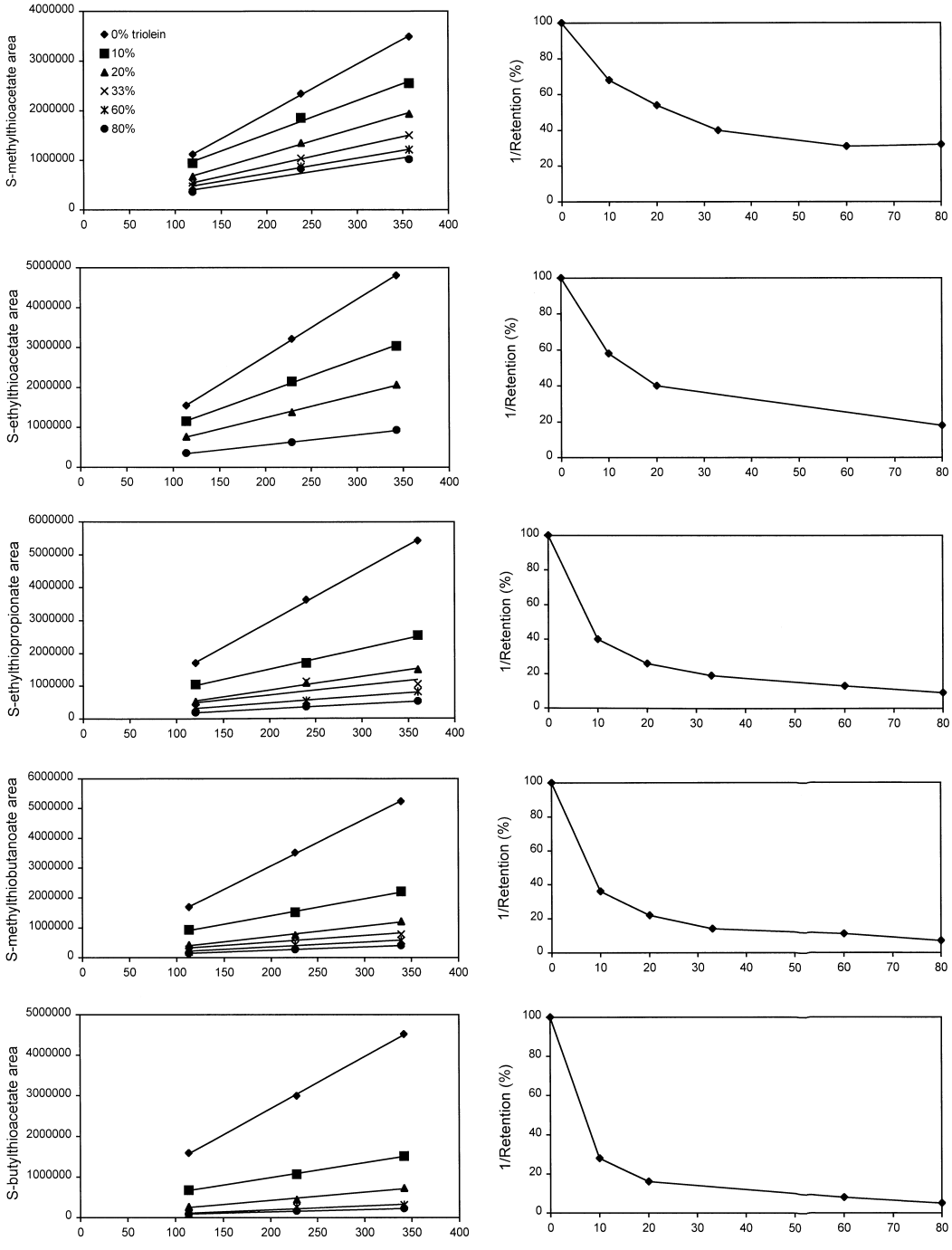


Fig. 1. (a) Linear relationships between chromatographic areas and thioester concentrations at different percentages of triolein. (b) Relationship between the inverse of the relative aroma retention (%) and the percentage of triolein (%).

odour threshold values is here given, allowing rapid prediction in a large range of foods.

2. Materials and methods

2.1. Materials

2.1.1. Lipids

Triolein [1,2,3-Tris(*cis*-9-octadecenoyl)glycerol] (98% pure) was purchased from Aldrich Chemicals (Belgium) and purified twice by percolating it through a column packed with magnesium silicate ($MgO:SiO_2 \sim 15:85$) of particle size 0.150–0.250 mm (60–100 mesh ASTM) (Florisil; Merck, Darmstadt, Germany) (Gaonkar, 1989; Landy, Courthaudon, Dubois & Voilley, 1996). Deodorised triolein was obtained by keeping it for 3 h at 80°C and 60 mm Hg, in the presence of helium. It was then stored at 4°C until used in the headspace experiments.

2.1.2. Inulin

A polydisperse very slightly β (2→6) branched β (2→1) fructan molecule (DeLeenheer & Hoebregs, 1994) issued from chicory roots, was furnished by a local industry. It is a long chain (LC) type inulin, free of oligosaccharides.

2.1.3. Cheese

Fresh cheese samples with a low lipid content (1%) were purchased from a local market and stored at 4°C.

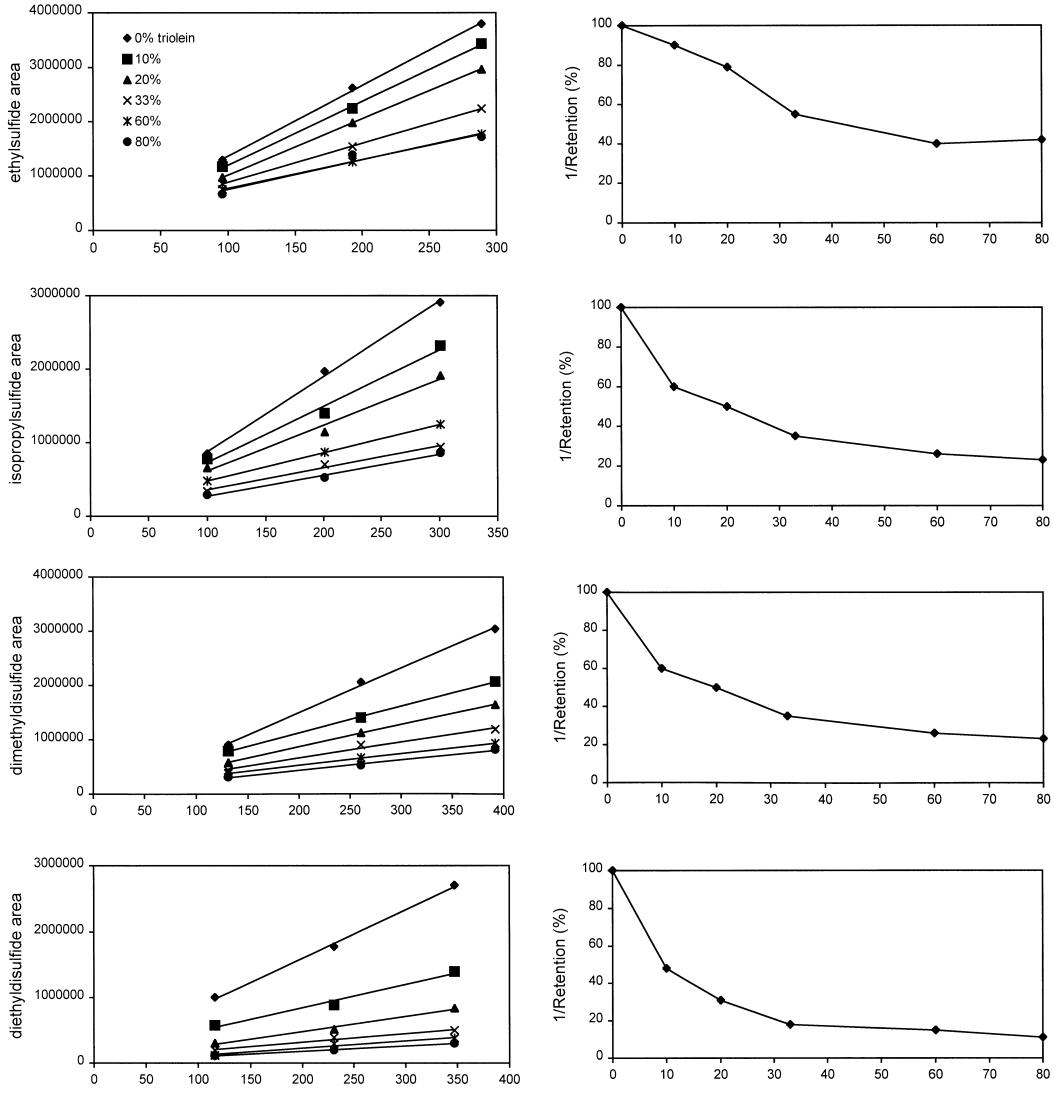


Fig. 2. (a) Linear relationships between chromatographic areas and sulfide and disulfide concentrations at different percentages of triolein. (b) Relationship between the inverse of the relative aroma retention (%) and the percentage of triolein (%).

2.1.4. Flavours

2-Methylbutanal (98%), methylsulfide (98%), ethylmethylsulfide (99%), isopropylsulfide (99%), methyldisulfide (99%), ethyldisulfide (99%), allylsulfide (97%), allyldisulfide (80%), thiazole (99%), 4-methyl-5-vinylthiazole (99%), 2,4,5-trimethylthiazole (98 + %), 2-methylpropanethiol (95%), pentanethiol (98%), ethylsulfide (98%) and *S*-methylthiobutanoate (98%) were purchased from Aldrich Chemicals (Belgium). Ethylenesulfide (> 97%) and *tert*-butylsulfide (> 98%) were obtained from Fluka Chemika (Belgium). *S*-Methylthioacetate (98 + %), *S*-ethylthioacetate (97%), *S*-*n*-propylthioacetate (98 + %), *S*-*n*-butylthioacetate and *S*-ethylthiopropionate (97%) were supplied by Lancaster (France). Methional (95%) and methionol (98%) were purchased from Acros (Belgium). Methyltetrasulfide, (methtylthio)methyldisulfide, bis(methylthio)methane and *S*-methyl-2-methylthiobutanoate were synthesized by J. Khan and E.N. Vulfson (Institute of Food Research, Reading, UK).

For the aroma retention experiments, an aqueous solution of aroma compounds (± 10 ppm) was prepared in volatile-free deionized water (Milli-Q water purification system, Millipore, Bedford, MA).

2.2. Quantification of flavour retention

2.2.1. Preparation of the samples containing triolein

Blends of fresh cheese (20% w/w), triolein, and ultrapure water were prepared with increasing amounts of lipid and accordingly decreasing quantities of water. We thus prepared a "light" system without triolein, called "0% triolein" and a "high-fat" system without water, called "80% triolein". Four intermediate compositions were also tested: 10, 20, 33 and 60% triolein. For each triolein content, volatile compounds were added at increasing concentrations (between 40 and 400 ppb according to the flavouring compound). An internal standard (2-methylbutanal) was also added to each sample just to monitor the reproducibility of our injections, for the same lipid content. Prior to dynamic headspace analysis, 60 µl of a 10 ppm aqueous solution of 2-methylbutanal and 30, 60 or 90 µl of a diluted aroma compound solution (final concentration between 40 and 400 ppb) were added to 7 g of the blend of fresh cheese, triolein, and water, then mixed with an Ultra-Turrax® (Janke & Kunkel Gmbh, Ika-Labortechnik, Ultra-Turrax® T25; 9500 rpm) for 30 s at 4°C. Portions of this mixture (5 g) were finally poured into the 25 ml purge vessel (surface area = 4.2 cm^2) for dynamic headspace extraction.

2.2.2. Preparation of the samples containing inulin

Blends of fresh cheese (20% w/w), ultrapure water and inulin were prepared with increasing amounts of polysaccharide and accordingly decreasing quantities of water. Four percentages of inulin were tested: 1, 3, 5 and 10% (w/w). With a mixer working at 1000 rpm, inulin powder was first blended with water for 2 min at 4°C, then mixed with an Ultra-Turrax® (24,000 rpm), again for 2 min at 4°C. The fresh cheese (20% w/w) was finally added to the solution and mixed twice according to the same protocol. The blend was then stored at 4°C until used in the headspace experiments. Ten minutes before the dynamic headspace analysis, the aroma compounds (60 µl of a 10 ppm aqueous solution of

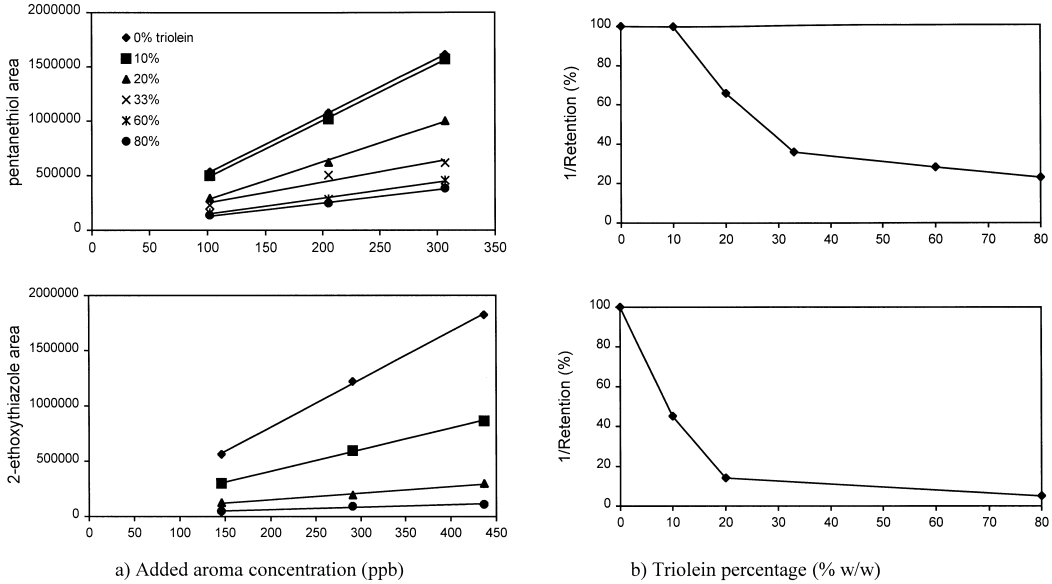


Fig. 3. (a) Linear relationships between chromatographic areas and pentanethiol and 2-ethoxythiazole concentrations at different percentages of triolein. (b) Relationship between the inverse of the relative aroma retention (%) and the percentage of triolein (%).

2-methylbutanal and 30, 60 or 90 μl of a diluted aroma compound solution (final concentration between 40 and 400 ppb)) were added to 7 g of the sample; 5 g of the mixture were analysed.

2.2.3. Dynamic headspace operating conditions

A Chrompack purge and trap injector (PTI) was used. Samples were injected into the chromatographic column in three steps as follows: (1) precooling of the cold trap (CP-SIL 8 CB capillary column, 0.53 mm i.d.; film thickness, 5 μm): the trap was cooled for 1 min in a stream of liquid nitrogen; (2) purging of the sample: the temperature of the purge vessel was set at 60°C. The sample was purged with helium gas (12 ml/min) for 15 min. The gas stream was passed through a condenser kept at −15°C by means of a cryostat (Colora WK 15)

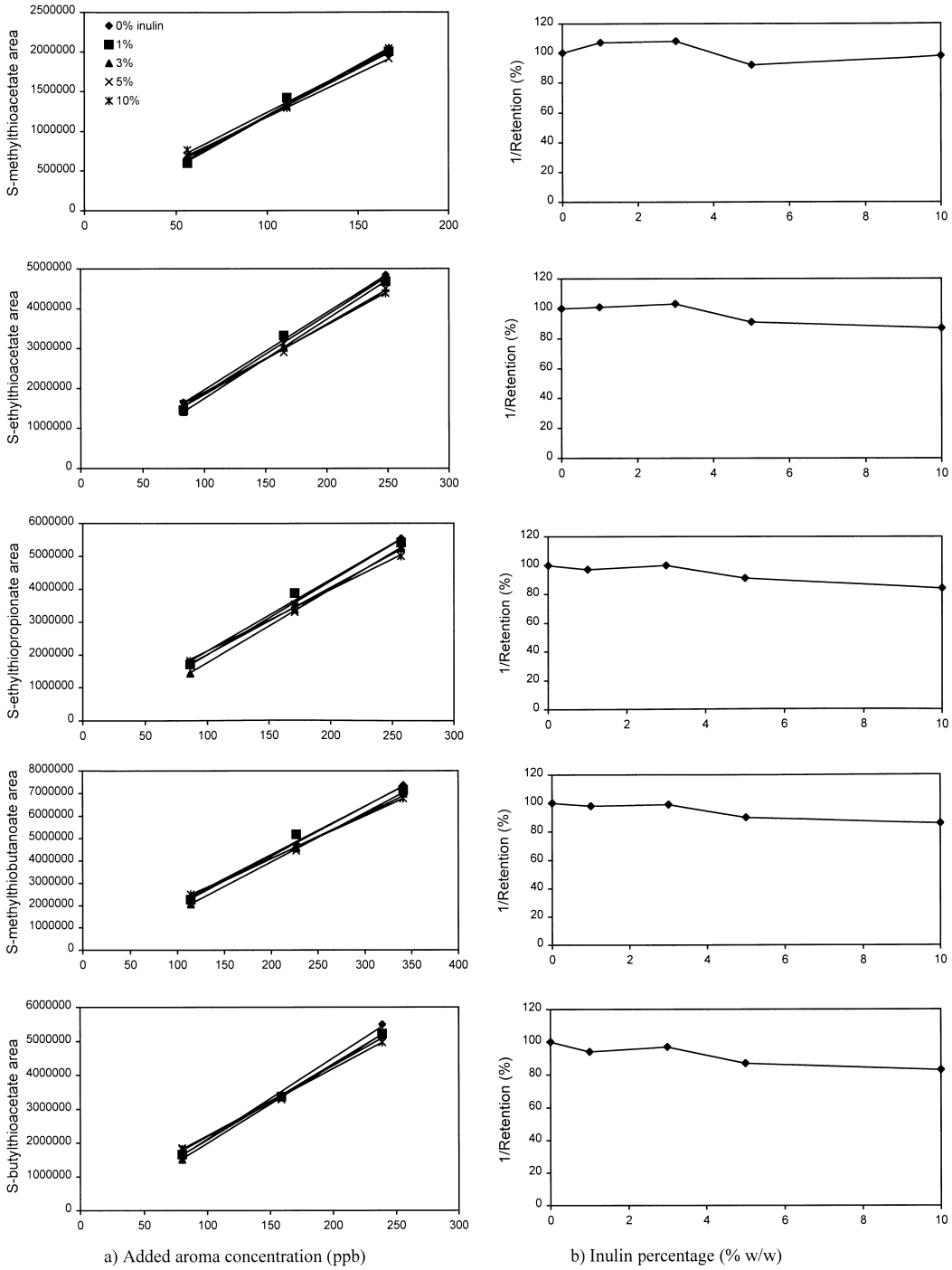


Fig. 4. (a) Linear relationships between chromatographic areas and thioester concentrations at different percentages of inulin. (b) Relationship between the inverse of the relative aroma retention (%) and the percentage of inulin (%).

to remove water vapour and then through an oven at 200°C. The volatiles were finally concentrated in the cold trap maintained at −95°C (liquid nitrogen); (3) desorption of the volatiles: cooling was stopped, and the surrounding metal capillary was rapidly heated to 220°C for 5 min. The carrier gas swept the trapped compounds into the analytical column.

2.2.4. Gas chromatographic analytical conditions

A Hewlett–Packard Model 5890 gas chromatograph equipped with a flame ionization detector and an integrator (Shimadzu C-R1A) was used. Analysis of volatile compounds was carried out on a 50 m×0.32 mm, wall-coated open tubular (WCOT) apolar CP-SIL 5 CB capillary column (film thickness, 1.2 μm). Oven temperature, initially kept at 33°C for 16.5 min, was programmed to rise from 33 to 160°C at 2°C/min and, thereafter, from 160 to 200°C at 20°C/min, remaining at the maximum temperature for 9 min. Helium carrier gas was used at a flow rate of 1.0 ml/min. Injection and detection temperatures were 200 and 220°C, respectively. The minimum peak area for data acquisition was set at 5000 μV/s. Assessment of the technique's reproducibility has been previously described (coefficients of variation under 10% for five analyses of the same standard mixture; Collin et al., 1993).

2.3. Viscosity measurements

An Haake-Rotovisco RV20 viscosimeter (CV 20, ME 30 sensors, Karlsruhe, Germany) with a coaxial cylinder geometry ($D_i = 27.83$ mm, $D_0 = 30.00$ mm) was used for shear flow measurements. The viscosity was determined, at 25°C, at a shear rate of 200 s^{-1}.

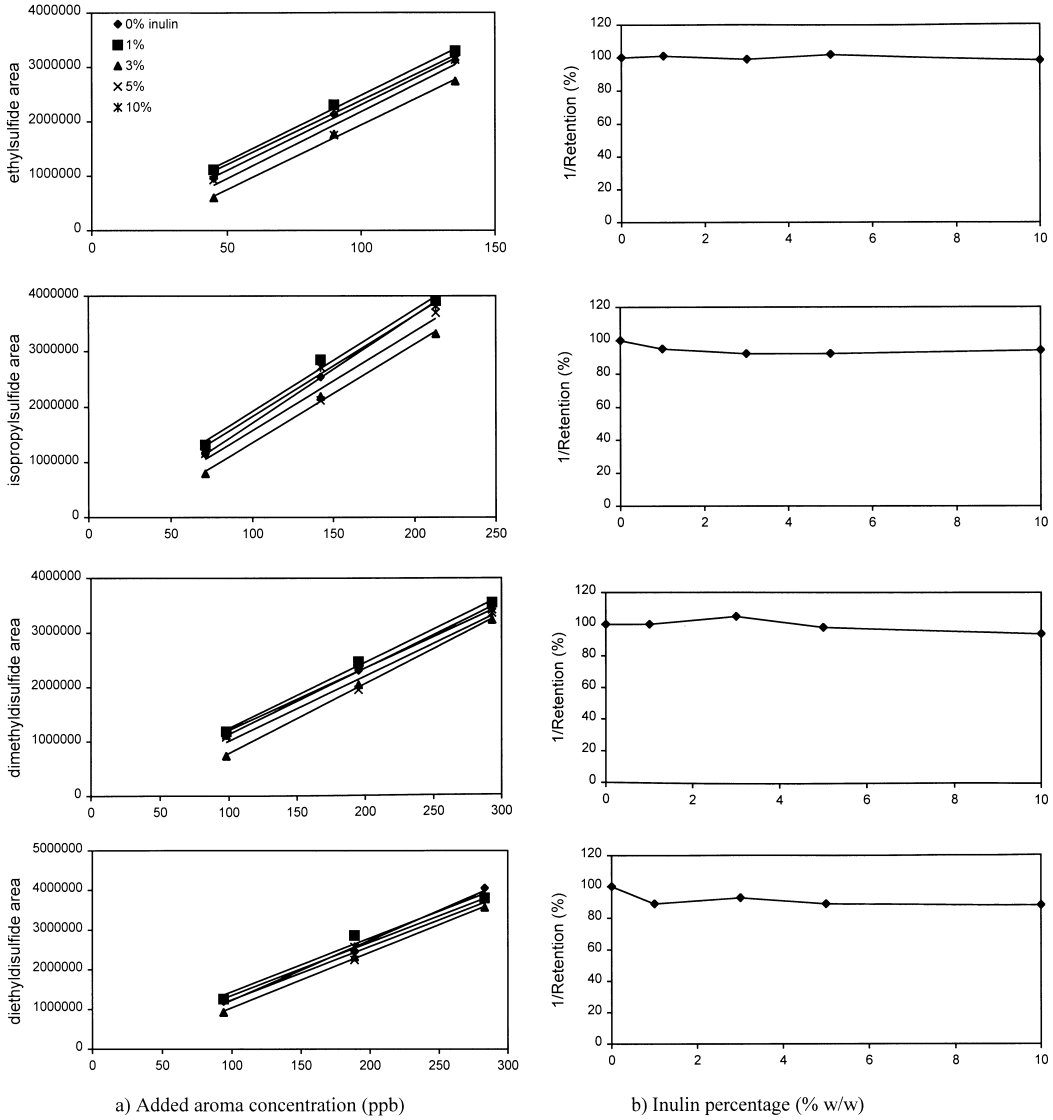
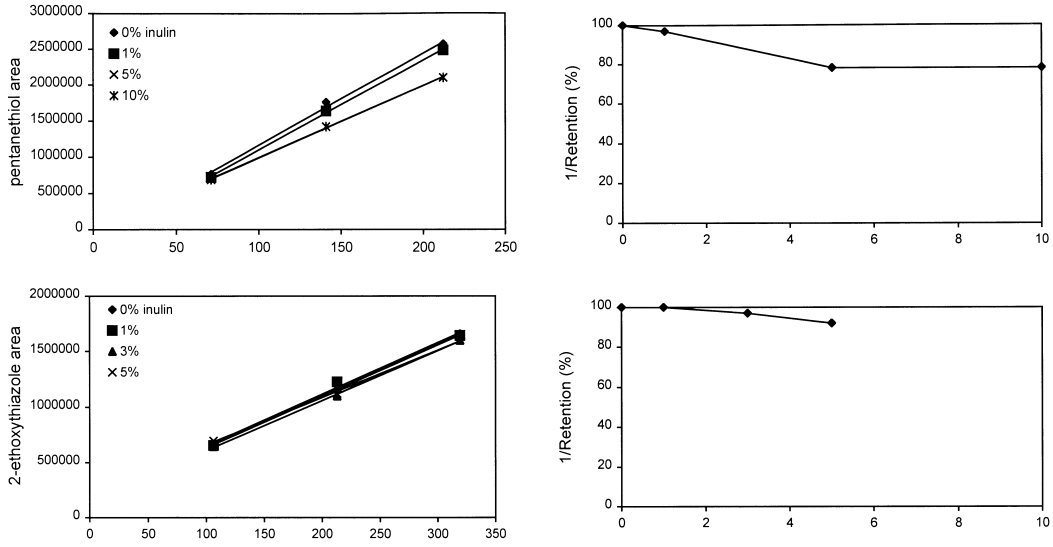


Fig. 5. (a) Linear relationships between chromatographic areas and sulfide and disulfide concentrations at different percentages of inulin. (b) Relationship between the inverse of the relative aroma retention (%) and the percentage of inulin (%).



a) Added aroma concentration (ppb) b) Inulin percentage (% w/w)

Fig. 6. (a) Linear relationships between chromatographic areas and pentanethiol and 2-ethoxythiazole concentrations at different percentages of inulin. (b) Relationship between the inverse of the relative aroma retention (%) and the percentage of inulin (%).

2.4. Lipophilicity measurements

Lipophilicity was measured by RP-HPLC (Piraprez et al., 1998b) with a chromatograph equipped with a Waters model 510 isocratic pump and a Waters WISP 710 B autosampler. The detector was a Perkin–Elmer LC 75 operating at 215 nm for thiols, sulfides, and disulfides, at 230 nm for thioesters and at 245 nm for thiazole derivatives. The Guard-Pak insert was packed with μBondapak™ C18, particle size 10 μm (Waters). The column (25 cm×4 mm ID) was prepacked with LiChrosorbRP-18, particle size 10 μm (Merck). A Digital 380 PC equipped with the Waters 840 acquisition program (version 6.0) was used as an integrator for peak recording and to calculate retention times. The mobile phase was made up volumetrically from various combinations (30–70%) of methanol (analytical grade, LabScan), and a solution containing MOPS (3-morpholinopropane sulphonic acid, Sigma) buffer (0.01 M) and *n*-decylamine (Sigma, Belgium) (0.2% v/v). MOPS buffer was chosen to avoid ion-pair formation and *n*-decylamine was used as a masking agent to eliminate silanophilic interactions (El Tayar, Van de Waterbeemd & Testa, 1985b). The pH of the aqueous solution was adjusted beforehand to 7.4 by addition of HCl. The methanol/aqueous solution mixture was filtered with a Millipore HAWP filter (0.45 μM). The concentration of the standards is around 10 ppm. Retention times (t_r) were measured at room temperature with a 1.5 ml/min flow rate. The column dead time (t_0) was determined with uracil. The capacity factor was defined as $k = (t_r - t_0)/t_0$. Log k for 100% water (log k_w) was linearly extrapolated from results obtained for different mobile phase compositions (El Tayar et al., 1985a,b).

2.5. Flavour quality and relative threshold measurements

A Chrompack CP 9001 gas chromatograph equipped with a splitless injector maintained at 250°C and opened after 0.5 min was used. Sulfur compounds were analyzed using a 50 m×0.32 mm, wall-coated open tubular (WCOT) apolar CP-SIL 5 CB capillary column (film thickness, 1.2 μm). An initial oven temperature of 40°C was maintained for 4 min and then programmed to rise from 40 to 132°C at 2°C/min followed by 132–250°C at 10°C/min. The final temperature was then held for 15 min. Helium carrier gas was used at a flow rate of 1 ml/min. A T-junction was used at the end of the capillary column. Fifty percent of the eluent was sent to a FID detector maintained at 250°C and connected to a Shimadzu C-R3A integrator, while the other part was directed to a GC-odour port at 250°C. In the latter case, the eluent was diluted with a large volume of air (20 ml/min) previously humidified in an aqueous copper (II) sulphate solution. For each compound, 2 μl of a 5000 ppm standard solution in dichloromethane were injected to determine their flavour quality. As recently described by Berger et al. (1999), the best estimated GC-lower amount detected by sniffing (BE-GC-LOADS) is defined as the geometric mean between the lowest mass of compound perceived at the outlet of the GC-odour port and the highest undetected amount injected onto the column. Experiments were performed using independent measurements of a dichotomized dilution of a given compound as follows: a standard solution (C0) and 50%, 25% of this initial concentration was injected onto the GC until a dilution ($Cn = C0/2^n$) was no longer perceived at the odour port. This was then followed by injection of a mid-dilution between Cn-1 and Cn until the compound was no longer detected at two

consecutive dilutions. Sensory analysis was performed by three judges working independently and a verbal description of the odour was obtained at the same time.

3. Results and discussion

The dynamic headspace method was used to quantify triolein or inulin-aroma compound interactions in a fresh cheese system (20% w/w). Five thioesters (*S*-methylthioacetate, *S*-ethylthioacetate, *S*-ethylthiopropionate, *S*-methylthiobutanoate and *S*-butylthioacetate), two sulfides (ethylsulfide and isopropylsulfide), two disulfides (methyldisulfide and ethyldisulfide), pentanethiol and 2-ethoxythiazole were selected. For each triolein content (0, 10, 20, 33, 60 and 80% w/w) or each inulin content (0, 1, 3, 5 and 10% w/w), increasing amounts of these flavouring substances were added prior to GC-analysis.

The linear relationship between the measured chromatographic area of each substance and the aroma concentration was plotted for each triolein [Figs. 1–3(a)] or inulin ratio [Figs. 4–6(a)].

For each considered medium, the calibration slope includes both the detector response coefficient and the aroma recovery factor. From these results, the inverse of the relative aroma retention was calculated by dividing the slope of the straight line obtained for the blend containing added lipids or polysaccharides by the slope of the "0%" samples. These data were plotted on the one hand versus the triolein content [Figs. 1–3(b)] and, on the other hand, versus the inulin content [Figs. 4–6(b)] (Piraprez et al., 1998a).

For the five investigated thioesters, the higher the fat content the lesser the slope of the calibration curve. Similar results were obtained for sulfides, disulfides, pentanethiol and 2-ethoxythiazole. Very small quantities of triolein were sufficient to considerably increase the interaction with the matrix ($P < 0.01$ for all comparisons between 0 and other concentrations of triolein, whatever the compound; *F*-tests for equality of slopes of several regression lines were executed in the SAS system; Sokal & Rohlf, 1969).

As suggested by Fig. 7, the higher the molecular weight of the flavouring compound, the stronger the aroma-lipid interaction. Both the lipid ratio in the dairy product and aroma structure thus proved essential.

As depicted in Figs. 4–6, increasing the inulin content has no influence on the behaviour of sulfur compounds within the fresh cheese matrix, in spite of the increasing viscosity (Table 1) (Harrison, Hills, Bakker & Clothier, 1997; Roberts, Elmore, Langley & Bakker, 1996). Even at 10% (w/w) inulin, the calibration curves are not significantly different. Indeed, by the *F*-tests described above, we have shown that $P > 0.05$ in all cases, except for pentanethiol ($P = 0.01$ between the 0% and the 5 or 10% of inulin and $P = 0.02$ between the 1% and the 5 or 10% of inulin). This suggests that it takes smaller amounts of flavouring compounds to

Table 1
Dynamic viscosity of fresh cheese, water and triolein or inulin samples

Sample	Viscosity (mPa s)
Fresh cheese and water without inulin or triolein	4.5
Triolein 10%	4.7
Triolein 20%	10.8
Triolein 33%	14.5
Triolein 60%	105.0
Triolein 80%	83.0
Inulin 1%	2.8
Inulin 3%	5.1
Inulin 5%	5.3
Inulin 10%	16.9

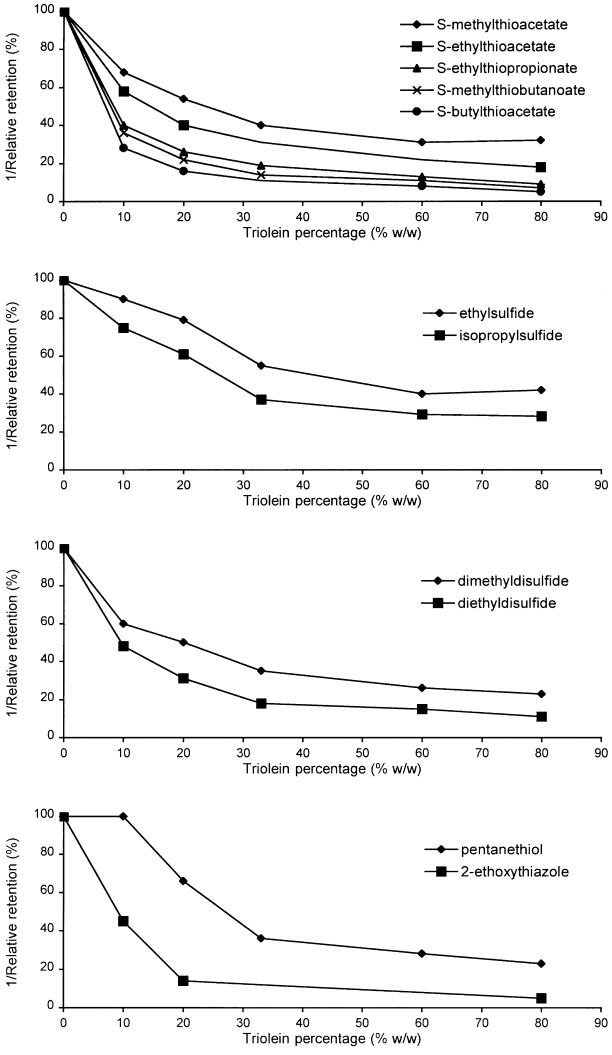


Fig. 7. Aroma retention by triolein in fresh cheese.

produce a given level of perception in a dietetic product containing inulin.

As previously suggested by Piraprez and coworkers (1998a), lipophilicity measurements could be used in an analogue series to mathematically predict aroma retention in lipid-containing media. The present RP-HPLC data (experimental log k_w values chosen here as lipophilicity index) obtained for thioesters confirm that a linear relationship exists between lipophilicity and aroma retention for each percentage of triolein (Table 2). The slopes appear, however, much lower than the ones previously obtained for aldehydes, ketones and esters (Piraprez et al., 1998a), leading to relatively moderate thioester retention despite their very high lipophilicity. In comparison, and taking into account their capacity factor (k_w), sulfides, disulfides and pentanethiol are still less retained at a given percentage of triolein, while 2-ethoxythiazole is very similar to thioesters.

Table 2
Linear relationships between the capacity factor (k_w) and aroma retention of thioesters according to the percentage of triolein in the fresh cheese samples (r^2: determination coefficient, $n = 5$)

	r^2
Retention (10% triolein) = 0.0611 k_w + 1.4587	0.909
Retention (20% triolein) = 0.1306 k_w + 1.7758	0.943
Retention (33% triolein) = 0.3258 k_w + 1.3260	0.909
Retention (60% triolein) = 0.2808 k_w + 3.4286	0.906
Retention (80% triolein) = 0.5507 k_w + 2.5815	0.945

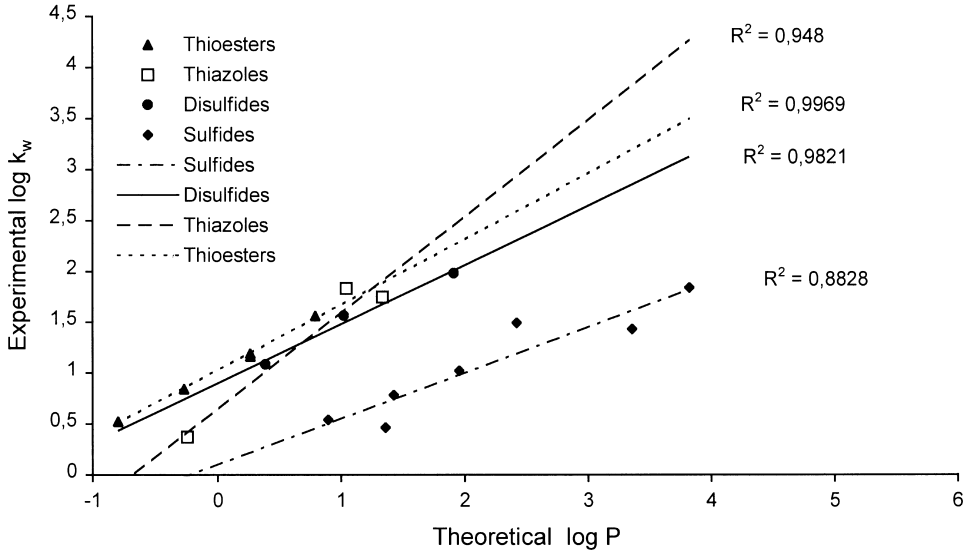


Fig. 8. Correlation trials between calculated log P and experimental log k_w values.

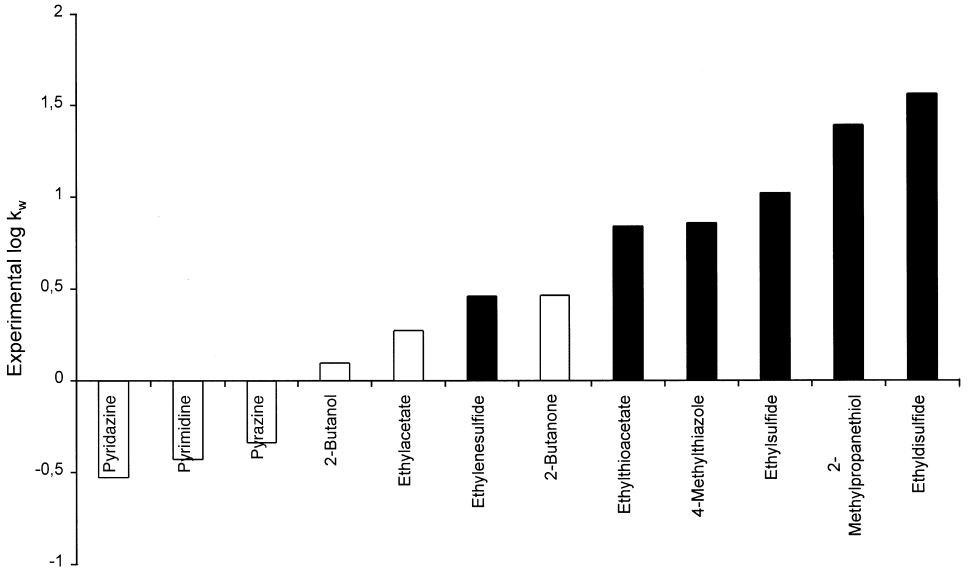


Fig. 9. Experimental lipophilicity of molecules with 4 carbon atoms.

Table 3
Retention index (CP-SIL 5 CB), lipophilicity (experimental log k_w values and corresponding r^2), flavour descriptors (> = odour becomes ... at the maximum peak intensity), best estimated GC-lower amount detected by sniffing (BE-GC-LOADS) and published flavour thresholds (Thr) of sulfur compounds

Compounds	Retention index (CP-SIL 5 CB)	Log k_w	r^2	Flavour descriptors at the sniffing port	BE-GC-LOADS (ng)	Thr (ppb)
Ethylenesulfide	606	0.46	0.990	Old onions, vegetable	219	
Ethylmethylsulfide	611	0.79	0.982	Onion, shallot, garlic, DMS, sulfur	2.2	
Ethylsulfide	698	1.02	0.990	Leek, chives, onion	2.2	0.92[a]; 1.2[b]; 3[c]
Methyldisulfide	734	1.08	0.982	Cabbage, brussels sprouts, vegetable	82	3–50[a]; 29[a]
Isopropylsulfide	778	1.43	0.990	Fructed (melon), violet	0.7	20[b]
Allylsulfide	848	1.49	0.997	Burnt rubber, onion, old garlic	7	
Methional	862	0.53	0.997	Potato, wort	6	250[b]; 1.7[i]; 0.05[i*]
(Methylthio)methyldisulfide	872			Garlic	10	
tert-Butylsulfide	905	1.84	0.980	Cabbage	32	
Ethyldisulfide	910	1.56	0.986	Poultry, cabbage, Brussels sprouts	9	0.4–30[d]
Methionol	950	0.44	0.997	Radish	171	2000[b]
Methyltrisulfide	952	1.46	0.997	Onion	1.4	0.1[h]
Allyldisulfide	1071	1.98	0.999	Fresh garlic	7	
Bis(methylthio)methane	1109			Onion	9	
Methyltetrasulfide	1208			Boiled poultry meat, onion	13	0.1[d]
S-Methylthioacetate	683	0.52	0.990	Rotten egg, well matured cheese	23	300[d], 5[h]
S-Ethylthioacetate	749	0.84	0.985	Well matured cheese, cabbage, petrol	14	0.8–3.5[d]
S-*n*-Propylthioacetate	848	1.19	0.984	Shallot, garlic	14	
S-Ethylthiopropionate	846	1.16	0.999	Well matured cheese > Ether > Smoked	7	
S-Methylthiobutanoate	869	1.19	0.998	Rancid butter	14	200[h]
S-Methyl-2-methylthiobutanoate	925	1.55	0.994	Truffle	11	
S-*n*-Butylthioacetate	951	1.56	0.998	Varnish	12	
Thiazole	740	0.37	0.988	Rubber, leek	515	23,000[e,f]
2-Ethoxythiazole	959	1.57	0.988	Coffee		
2,4,5-Trimethylthiazole	1028	1.75	0.999	Mould, hazel-nut	2.2	
4-Methyl-5-vinylthiazole	1056	1.83	0.996	Hospital	30	
2-Methyl-1-propanethiol	658	1.39	0.969	Fresh onion, fresh shallot	0.2	
Pentanethiol	819	1.15	0.868	Painting, pharmacy, smoked	0.07	0.8[g]

[a] Rauhut (1993) (in wine).
[b] Meilgaard (1975) (in beer).
[c] Fazzalari (1978).
[d] Soltoft (1988) (in beer).
[e] Maga (1975).
[f] Buttery, Guadagni and Lundin (1976).
[g] Maga (1976).
[h] Cuer (1982) (in dairy media).
[i] Grosch (1994) (in water).
[i*] Grosch (1994) (in sunflower oil).

Although reasonably good for very similar compounds, the calculated theoretical log *P* values (defined as the partition coefficients; Rekker method; Rekker, 1979) cannot be used to estimate the hydrophobicity of sulfur-containing molecules (Fig. 8). Our experimental data suggest (see log k_w in Table 3 and Fig. 9) that, as a general rule, lipophilicity decreases among sulfur-containing analogs in the order: disulfide > thiol > sulfide > thiazole > thioester.

From the above results, it appears that published experimental odour/flavour thresholds must be used very carefully when several food matrices are considered. As determining such thresholds is, moreover, very tedious, we here apply a new strategy for comparing, very rapidly, the aromatic power of a large series of sulfur compounds (Berger et al., 1999). Best estimated GC-lower amounts detected by sniffing (BE-GC-LOADS) are determined at the GC-sniffing port by testing various dilutions of a standard solution until no odour is perceived (Table 3). As explained above, such data are logically not correlated with usual threshold values since they are independent of the food matrix. However, very interesting comparisons can be deduced from BE-GC-LOADS data. For instance, thiols, 2,4,5-trimethylthiazole, *S*-ethylthiopropionate, ethylmethyl-, ethyl-, isopropyl- and allyl-sulfide and methional emerge here as the most sensorially potent compounds (BE-GC-LOADS $\leqslant$ 7 ng). A very good knowledge of the mechanisms of aroma retention by macromolecules will obviously be essential in order to predict sensory properties from BE-GC-LOADS in a real food system.

4. Conclusion

As shown by dynamic headspace experiments, aroma retention by lipids is very significant for sulfur compounds, even when only 10% triolein is considered. Yet this phenomenon is highly influenced by aroma compound structure, as demonstrated by the RP-HPLC lipophilicity data of thioesters. Contrasting with triolein, inulin does not modify the aroma behaviour, even when high inulin content systems are considered. Such aroma retention discrepancies will have to be corrected when fat-mimics will be used.

GC-odour port evaluation of a series of diluted solutions (BE-GC-LOADS) appears as an interesting method to easily obtain a sensorial value independent of the medium composition.

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