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Original article

Effect of forage type and cow breed on the characteristics of matured Saint-Nectaire cheeses

I Verdier [1], JB Coulon [2], P Pradel [3], JL Berdagué [4]

[1] *Laboratoire de recherches fromagères, INRA, 36, rue de Salers, 15000 Aurillac;*
[2] *Laboratoire d'adaptation des herbivores aux milieux, INRA, Theix, 63122 Saint-Genès-Champanelle;*
[3] *Domaine de la Borie, INRA, 15190 Marcenat;*
[4] *Station de recherche sur la viande, INRA, Theix, 63122 Saint-Genès-Champanelle, France*

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Summary — Dairy cows belonging to 3 different genetic types (Holstein, Montbéliarde and Tarentaise) were fed, according to a 3 x 3 latin square experimental design, 3 different types of forage (ryegrass silage, cocksfoot regrowths and maize silage). The proportion of concentrate in the diet, and the energy and nitrogen contents were similar between all 3 feeding treatments. The milk yielded by these cows was used in the manufacture of Saint-Nectaire cheeses, under controlled technology manufacturing conditions which were identical from one production to another. Cheeses manufactured from grass silage milk have a more yellow curd than cheeses made from cocksfoot regrowth or maize silage milk. Cocksfoot regrowth milk cheeses are more sticky and less firm than the others; they achieve a global score which is 0.6 to 1 point higher ($P < 0.05$) than those of other cheese types. Cheeses manufactured from milk yielded by Montbéliarde and Tarentaise cows were better rated than those made from Holstein milk. The various reasons for these differences are discussed in relation to the chemical composition of the feeds.

cheese / Saint-Nectaire / cow breed / forage type / sensory characteristic

Résumé — **Effet de la nature de la ration de base et du type de vache sur les caractéristiques des fromages de Saint-Nectaire affinés.** *Des vaches laitières de 3 types génétiques différents (Holstein, Montbéliarde et Tarentaise) ont reçu, selon un dispositif expérimental en carré latin 3 x 3, 3 natures de fourrage différentes (ensilage de ray-grass anglais, foin de seconde coupe de dactyle et ensilage de maïs). La part de concentré dans la ration, et le niveau des apports énergétiques et azotés ont été semblables dans les 3 traitements alimentaires. Le lait de ces vaches a été transformé en fromages de Saint-Nectaire, dans des conditions technologiques de fabrications contrôlées et identiques d'une fabrication à l'autre. Les fromages réalisés avec du lait d'ensilage d'herbe présentent une pâte plus jaune que celle des fromages réalisés avec du lait de foin de seconde coupe ou d'ensilage de maïs. Les fromages au lait de foin de seconde coupe se différencient des autres par leur caractère collant et* *leur moindre fermeté ; ils obtiennent une note globale supérieure de 0,6 à 1 point (P < 0,05) à celles des autres types de fromages. Les fromages réalisés à partir du lait de vaches Montbéliardes et Tarentaises ont été mieux notés que ceux réalisés à partir du lait de vaches Holstein. Les différentes origines de ces écarts sont discutées en relation avec la composition chimique des aliments.*

fromage / Saint-Nectaire / race de vache / nature des fourrages / caractéristique sensorielle

INTRODUCTION

The characteristics of matured cheeses depend upon a great many factors linked, on the one hand, to the technology employed and, on the other hand, to the original characteristics of the milk. The majority of studies conducted over the past few years on the influence of milk production factors on cheese characteristics, concerned the effect of genetic factors (lactoprotein variants) on cheese chemical composition (Schaar *et al*, 1985; Marziali and Ng-Kwai-Hang, 1986; Rahali and Ménard, 1991; Nuyts-Petit *et al*, 1991; Remeuf, 1993; Delacroix-Buchet and Marie, 1994). Only a few studies revealed the presence of a relationship between milk protein genetic variants and the sensory characteristics of cheeses (Marziali and Ng-Kwai-Hang, 1986; Nuyts-Petit, 1991; Marie and Delacroix-Buchet, 1994; Vassal *et al*, 1994). The influence of diet on milk chemical composition (Hoden *et al*, 1985; Sutton, 1989; Grummer, 1991; Hoden and Coulon, 1991) and its rheological characteristics (Grandison *et al*, 1984, 1985a; Vertès and Hoden, 1989; Laurent *et al*, 1992; Colin *et al*, 1993; Macheboeuf *et al*, 1993) has been studied extensively. But most studies failed to approach the characteristics of the corresponding matured cheeses, or only did so partially (Grandison *et al*, 1985b; Garel and Coulon, 1990). Some authors have, however, recently displayed a specific interest in the sensory characterization of cheeses (Berdagué *et al*, 1988, 1990; Paléari *et al*, 1993; Chamba *et al*, 1994). Elsewhere, numerous empirical observations have been made associating differences in cheese quality with variations in farming practices (Urbach, 1990), and recent studies (Martin and Coulon, 1995) have provided explanatory factors. The relative lack of experimental data surrounding this topic is mainly linked to the difficulty in correctly differentiating the particular effects of upstream factors from those linked to cheese manufacturing itself. This approach is, however, of utmost importance in the case of "Appellation d'Origine Contrôlée"-labelled cheeses for which modifications of original milk characteristics upon cheese manufacturing are generally highly limited if not forbidden.

The aim of this study was to describe and analyse the organoleptic characteristics of Saint-Nectaire cheeses manufactured from milk yielded by cows belonging to 3 different breeds fed 3 types of forage (hay, grass silage and maize silage) in a 3 x 3 latin square design. This study is a direct extension of the work published by Coulon *et al* (1995) concerning the effect of type of forage on the chemical composition and clotting ability of milks, the latter having been used in the manufacturing of the Saint-Nectaire cheeses studied in this paper.

MATERIALS AND METHODS

Experimental design

The cheeses studied were manufactured from 9 different batches of milk yielded by animals of 3 genetic types (Holstein [HO], Montbéliarde [MO], Tarentaise [TA]), fed a diet based on cocksfoot regrowths (R), ryegrass silage (GS) or maize silage (MS). A total of 54 multiparous cows (18 per genetic type) in mid lactation (the mean lactation stage at the beginning of the first experimental period was 10 weeks) were used. The experiment was conducted according to a 3 x 3 latin square design over 3 experimental periods (each of 3 weeks) during which each group of cows was successively fed the 3 types of forage. The 9 groups (3 groups per breed) were formed on the basis of production performances during a pre-experimental period and of the genetic variant of the κ casein. The quantities of forage and concentrate (mixture of barley, soya-bean meal and urea) fed, were calculated so that energy and nitrogen contents were similar between all 3 diet treatments. On average, forage represented between 67 (group MS) and 72% (group R) of total dry matter (DM) intake. The data concerning the setting up of the groups and the diets of the animals have been explained in detail elsewhere (Coulon *et al*, 1995).

Manufacturing technology

The cheese transformations were carried out in an experimental mini-cheese dairy equipped with 2 vats having a maximal capacity of 40 l, on the Tuesdays, Wednesdays and Thursdays of the last 2 weeks of each period. In each vat, 34 kg of milk were used, allowing the manufacturing of 2 actual-size Saint-Nectaire cheeses per batch. Saint-Nectaire cheese was selected as the model for our study as it is an Auvergne cheese which carries the "Appellation d'Origine Contrôlée" and is small in size (21 cm in diameter, around 5 cm thick). It is manufactured exclusively with cows' milk originating from the area possessing the Appellation (a few communes of the Puy de Dôme and the Cantal). The cheese has a semi-hard, pressed, salty curd with a moulded rind. In each period, 12 vats were transformed, that is, 24 cheeses manufactured: each period therefore allowed the repetition of 3 of the 9 batches.

The Saint-Nectaire cheeses were manufactured according to a technology used in the making of dairy Saint-Nectaire with raw milk; the milks used were from the prior evening milking, refrigerated in tanks and maintained at 4°C until transformation. The milks were first heated in the vats to 32°C, by allowing the hot water fluid at regulate temperature to flow in the jacket, then their fat content was standardized by total skimming of a partial volume, so as to obtain a fat content/protein content ratio close to 1.15. They were next enriched with $CaCl_2$ (0.15 g/kg) to compensate Ca losses consecutive to chilling, and inoculated with a 1% culture with mesophilic lyophilized starters (Flora Danica Direct, Sochal, St Etienne de Chomeil, France) revitalized on 10% sterile reconstituted skimmed milk. The milks were then renneted at 32°C with a 520 mg active chymosin proof rennet (Gand-gassiot, Granday Laboratory, Beaune, France), 36 g of which were added per 100 kg of milk. Clotting time was assessed visually. Twenty-five min after renneting, the curd was cut for 5 min, then stirred for 40 min after extracting a part of whey. It was then left to drain in a pre-pressing tray until it reached a pH close to 6.20. Two cheeses per vat were then formed in cloth moulds and pressed until a pH between 5.30 and 5.40 was attained. Once this pH had been reached, the cheeses, identified by numbering on a casein plate, were removed from hoops and brine salted for 7 h at 10°C. They were then placed in a ripening cellar for 8 weeks. Temperature in the cellar was between 10 and 12°C and relative humidity between 97 and 98%.

Physicochemical analyses

The pH was measured by introducing an Ingold electrode into some ground-up cheese, the temperature of which had first been brought up to 20°C. Dry matter content was determined by dessication at 103°C for 24 h. The fat content of the cheeses was measured by butyrometric method (FIL-IDF standard 152:1991). The yellow index of the cheese curds was determined using a spectrophotometer equipped with an integrating sphere (Renerre, 1981), on both faces of a disk cut from the center of the cheeses.

Sensory analyses

The characteristics of the cheeses were assessed in 2 steps, using 2 very different methods.

1) All of the matured cheeses were submitted to a tasting panel of 8 assessors belonging to the INRA laboratory of Aurillac. The quality of the cheeses was assessed according to the criteria issued by the Commission de Contrôle du Syndicat du Saint-Nectaire: members of the panel gave a score for the appearance of the cheese (/5), the curd (/5) and the taste (/10).

2) In addition, a cheese from each batch was submitted for tasting to a sensory analysis group comprising 10 subjects, all volunteers, trained to recognize primary tastes (AFNOR standard 1988) and familiar with sensory analysis and its tools. This panel had initially been required to assess various characteristics (appearance, odour, taste, texture) of retail Saint-Nectaire. A product profile was subsequently established by the free generation of attributes whose numbers were reduced with the agreement of the tasting panel (AFNOR standard 1990; Barthélémy, 1990). The subjects were trained to assess the intensity of each of the attributes included in the final profile. Scoring was done on a structured scale from 0 to 10. The profile comprised 2 parts of 15 attributes each: 1 involved the "by mouth" description of the product, the other concerned the "by appearance" description of the cheese. The assessors always began with the actual tasting: the cheese samples, with rinds removed, were coded and presented simultaneously to all tasters in a random order which was different for each person. Cheese appearance was assessed on a quarter of a cheese (different code from the former part): all cheeses were presented simultaneously to all assessors.

Analysis of volatile compounds

A total of 20 g of cheese were used to analyse the volatile compounds of 2 cheeses, chosen in the 2 most different groups according to sensory analysis. This analysis was performed by gas chromatography-mass spectrometry, as described in Berdagué *et al* (1993), and used to detect differences in the concentration of substances which play a role in the flavour of cheeses (Bosset *et al*, 1994), and to put forward chemical and biochemical hypotheses as to the origin of these substances.

Statistical analysis

Results were analysed using the mean scores of both methods of assessment (tasting and sensory analysis). The data were processed by analysis of variance (SAS, 1987), whilst including in the model the forage type, breed, batch, the number of the cheeses in the vat and the period, as well as breed x treatment interaction.

RESULTS

For each group of animals, 2 cheeses were manufactured, analysed and tasted. For all parameters studied, these 2 cheeses were identical.

Effect of type of basal ration

The cheeses made from milk of animals fed regrowths (R cheeses) differed in certain aspects from cheeses made from grass silage milk (GS cheeses) (table I). The maize silage milk cheeses (MS cheeses) generally showed intermediate characteristics. Cheese yield was higher, but not significantly, in MS cheeses than in GS and R cheeses. This is linked to the fat and protein concentrations of the milks used in cheesemaking, which were slightly higher in the MS group. R cheeses were less dry than GS and MS cheeses (-1.1 points of dry matter, $P < 0.05$). Their yellow index was significantly lower than that of GS cheeses, but higher than that of MS cheeses ($P < 0.01$). On tasting, their overall score was higher by, respectively, 0.6 ($P < 0.05$) and 0.3 points ($P < 0.05$) than those of GS and MS cheeses.

By mouth, 2 attributes differed significantly ($P < 0.01$): R cheeses were more sticky and less firm than MS and above all GS cheeses. Overall acceptability score for R cheeses was greater by 1 point ($P < 0.05$) to that of GS cheeses and by 0.6 points ($P > 0.05$) to that of MS cheeses.

Effect of breed

The cheeses manufactured from the milk of all 3 breeds of cow showed similar physicochemical characteristics (curd colour, dry matter, pH) (table I). The fat in dry matter of the cheeses done on Tarentaises milk

Table I. Effect of forage and animal breed on cheese characteristics.
Effet de la nature du fourrage et de la race sur les caractéristiques du fromage.

	Diet [1]			*Breed* [2]			*RSD* [3]
	GS	*R*	*MS*	*HO*	*MO*	*TA*	
Milk concentration [4]							
Fat (g/kg)	35.4^{a}	35.1^{a}	36.8^{b}	35.7	35.9	35.7	1.0
Protein (g/kg)	33.3^{a}	33.1^{a}	34.5^{b}	34.0	33.9	33.1	0.8
Cheese yield [5]	51.6	51.3	52.2	52.2	51.5	51.4	1.6
Appearance (A)	3.19	3.35	3.30	3.11^{a}	3.32^{b}	3.40^{b}	0.37
Texture (Tx)	3.03	3.15	3.08	2.91^{a}	3.19^{b}	3.16^{b}	0.32
Taste (T)	6.37	6.65	6.46	6.31^{a}	6.68^{b}	6.49^{ab}	0.48
Total (A+Tx+T)	12.59^{a}	13.15^{b}	12.84^{ab}	12.32^{a}	13.20^{b}	13.06^{b}	0.85
Dry matter (%)	55.3^{a}	54.2^{b}	55.3^{a}	55.3	55.0	55.4	1.6
Fat in dry matter	50.4	51.3	51.6	51.7^{a}	51.6^{a}	50.0^{b}	2.1
Solids not fat (%)	38.0	36.5	37.6	37.5	37.2	37.4	2.4
Yellow index	23.8^{a}	22.1^{b}	19.1^{c}	21.7	21.4	22.0	1.1
Visual attributes							
Rind	6.00	6.20	6.12	5.82	6.05	6.45	0.63
Rind homogeneity	5.87	5.96	5.76	5.63	5.68	6.28	0.94
Curd colour intensity	6.53^{a}	5.91^{b}	4.62^{b}	5.55	5.62	5.89	0.45
Opening number	4.91	5.54	5.31	5.43	5.00	5.33	1.44
Elastic texture	5.15	5.30	4.98	4.96	5.03	5.43	0.61
Firm texture	5.35^{a}	4.91^{b}	5.46^{a}	5.19^{a}	5.53^{ab}	5.00^{b}	0.57
By mouth attributes							
Odour intensity	4.09	4.16	4.00	4.23	4.08	3.93	0.67
Sticky texture	2.07^{a}	3.26^{b}	2.40^{c}	2.71	2.65	2.36	0.75
Melting texture	3.44	3.82	3.35	3.20^{a}	3.67^{b}	3.75^{b}	0.62
Firm texture	5.11^{a}	4.30^{b}	5.33^{a}	5.08	4.86	4.80	0.72
Gritty texture	1.24	1.15	1.66	1.40	1.24	1.42	0.69
Taste intensity	5.19	4.91	4.83	5.00	5.02	4.92	0.73
Acid taste	1.58	1.47	1.44	1.53	1.48	1.48	0.68
Persistence	5.16	5.17	4.92	5.17	5.16	4.93	0.63
Acceptability	3.93^{a}	4.92^{b}	4.36^{ab}	4.18^{a}	4.43^{b}	4.60^{b}	0.63

[1] GS: ryegrass silage; R: cocksfoot 2nd cut hay; MS: maize silage. [2] HO: Holstein; MO: Montbéliarde; TA: Tarentaise. [3] Residual standard deviation. [4] After partial skimming. [5] 100 x [(curd weight x curd DM)/(milk weight x milk DM)].
[abc] Within diet or breed, values with different superscripts within row differ significantly ($P < 0.05$).
[1] GS : ensilage de ray grass anglais ; R : foin de dactyle de seconde coupe ; MS : ensilage de maïs. [2] HO : Holstein ; MO : Montbéliarde ; TA : Tarentaise. [3]Écart type résiduel. [4] Après écrémage partiel. [5] 100 x [(poids de caillé x teneur en MS du caillé)/(poids de lait x teneur en MS du lait)].
[abc] À l'intérieur de la race ou du régime, les valeurs suivies d'une lettre différente sont significativement différentes (P < 0,05).

(TA cheeses) was, nevertheless, lower by 1.6 points ($P < 0.01$) than those of HO and MO cheeses. However, HO cheeses were significantly different ($P < 0.01$) from the cheeses of the 2 other breeds (MO and TA cheeses) in all tasting criteria (appearence, texture, taste). The total score was lower by nearly 1 point for HO as compared to MO and TA.

In the sensory analysis, no differences between the 3 cheese types appeared significant, apart from the more melting character of MO and TA cheeses ($P < 0.05$), but the tendances observed confirmed the disparities highlighted by the panel of assessors. Global acceptability was therefore greater by 0.2 and 0.5 points, respectively, for MO and TA cheeses comparatively to HO cheeses.

The disparities in cheese characteristics between breeds were noticeably different according to the diet fed ($P < 0.01$). In particular, MO cheeses achieved their best taste score (13.9) with the regrowth diet whereas TA cheeses achieved this (13.5) with the maize silage-based diet. The grass silage-based diet resulted in the smallest differences between breeds. Finally, the difference in taste score reached almost 2 points between the cheeses made with Montbéliarde cows and cocksfoot regrowths and those made with Holstein cows and ryegrass silage. The qualities differentiating these 2 groups of cheeses were essentially opening number, firmness and gritty texture of the curd (fig 1). The volatile compounds distribution was analysed on 1 cheese of each of these 2 groups (MO/R and HO/GS).

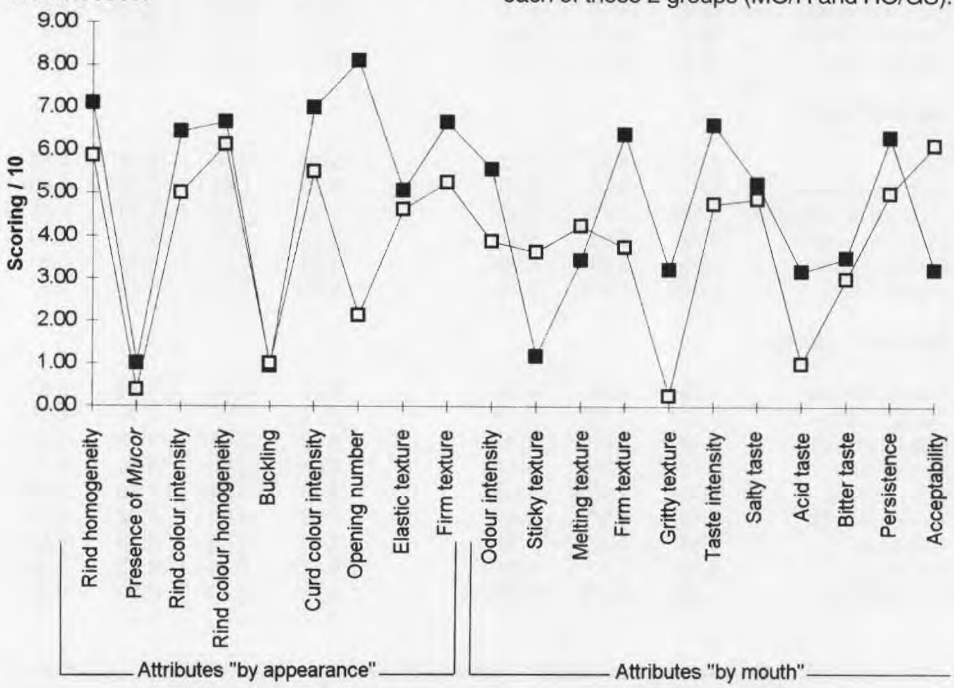

Fig 1. Sensory characteristics of cheeses according to type of forage and cow breed. ■ HO/GS; ❑ MO/R.
Caractéristiques sensorielles des fromages selon la nature du fourrage et la race. ■ Holstein/ensilage de ray-grass anglais ; ❑ Montbéliarde/foin de dactyle de seconde coupe.

Volatile compounds

Forty-two molecules were identified by GC-MS measurements (table II). Most of these compounds belonged to the following chemical families: alkanes or alkenes (10), aldehydes (4), ketones (6), alcohols (5), esters (7) and aromatic hydrocarbons (3). The comparison between the chromatographic profiles of HO/GS and MO/R cheeses revealed a desorption 5 times superior in HO/GS cheese. The differences between the 2 cheeses lay essentially in the sulphur compounds whose contents were very low or indeterminable in MO/R cheese. These compounds, which present very low thresholds of olfactory perception and whose impact on cheese sensory characteristics is important, originate probably from an advanced microbial sulphur-amino acid catabolism during the ripening phase (Hemme *et al*, 1982). Esters, some of which are able to contribute to a "fruity" note of the product, the 2-3 butanedione, which is a typical compound of glucidic catabolism with a butter odour, and many 2-methyl-ketones were identified in more important quantities in the HO/GS cheese. In contrast, the MO/R cheese distinguished itself by a more important quantity of cyclic-alkenes. The oxidation degree of the 2 cheeses was limited as shown by the low desorption of aldehydes, alcohols and unramified aliphatic alkanes.

DISCUSSION

One of the difficulties in studying the actual effects of production factors on the quality of matured cheeses lies in the control of the cheesemaking technology employed. In this study, all precautions were taken to ensure that variations of technological order from one production to another were as slight as possible (use of identical vats, regular monitoring of pH leading to a placing in mould and end of pressing conducted under similar conditions between productions). Moreover, the latin square experimental design allowed the random distribution between treatments of possible variations caused by noncontrolled modifications in the technology.

Effect of the type of forage

One of the main effects of the type of diet concerned the colour of the cheese curd. As already observed by Garel and Coulon (1990), grass silage results in a more yellow curd than regrowth or maize silage. The yellow colour of the cheese curd is due to certain milk carotenoids originating from foodstuffs and more or less absorbed within the rumen depending on cell wall fat content (Hay, 1993). The positive effect of grass silage is due both to the type of forage (maize displaying lower carotenoid contents than grasses [Knigh and Waghorn, 1993]) and, comparatively to regrowths, to its method of harvesting which avoids long exposure to light, a major cause of carotenoid destruction (Britton and Goodwin, 1973).

From a sensory point of view, cocksfoot regrowth led to cheeses which were more sticky and less firm than the others. This is no doubt partially linked to their lower dry matter, and to the slightly lower useful matter content of the milks used in manufacturing. However, Grandison *et al* (1985b), in Cheshire technology, observed no effect of milk chemical composition on cheeses and their texture. Regrowth cheeses were generally better rated and globally more satisfying than GS and MS products. It is most likely that the observed disparities were due to minor components which were either specific or present to a greater or lesser extent in each forage (sesquiterpenes, lactones, dimethyl sulphyde) as already suggested by certain authors concerning milk (Forss, 1993; Visser, 1993; Wilson, 1993)

Table II. Volatile compounds of 2 extreme cheeses.
Composés volatils de 2 fromages extrêmes.

Peak	*identification*	*KI* [1]	*Cheese* HO/GS Abundance (10^{-6})	MO/R	*Reliability of identification* [2]
1	methanethiol		56.4	0.0	c
2	SO_2		21.3	0.0	c
3	ethanol		0.00	4.8	b
5	2-propanone		44.3	8.0	a
7	pentane + 2-propanol	500	0.0	6.9	ab
8	1,3-pentadiene	508	0.0	0.7	b
9	ethanethiol	518	6.9	1.8	c
11	carbon disulfide	536	0.0	0.9	b
12	propanol	555	90.5	48.5	b
14	2,3-butanedione	584	21.2	6.1	b
15	butanal	590	0.0	2.4	b
16	2-butanone	595	78.1	11.6	b
17	2-butanol	601	36.8	11.6	b
18	ethyl acetate	613	6.0	1.6	b
20	2-methylpropanal	624	0.0	2.7	b
21	tetrahydrofuran	627	5.9	4.5	c
22	3-methylbutanal	650	2.6	9.8	b
23	butyl formate	659	15.1	4.1	c
26	1-methoxy-2-propanol	674	4.4	0.7	c
27	2-pentanone	684	18.4	6.0	b
29	heptane	700	0.0	3.1	a
30	S-methyl thioacetate	700	49.8	0.0	c
31	ethyl propanoate	710	3.8	0.6	b
32	propyl acetate	712	7.7	0.5	b
33	3-methylbutanol	731	3.5	7.6	b
35	4-methyl-2-pentanone	738	0.8	1.1	c
36	dimethyl disulfide	746	937.4	31.1	b
38	toluene	769	1.2	1.7	b
39	1-octene	791	0.0	1.1	c
40	hexanal	798	0.0	3.2	b
41	octane	800	8.0	8.9	a
42	methyl,2-methylbutanoate	800	1.2	0.0	c
44	2-octene	815	0.0	0.5	b
45	cyclooctene	826	0.0	18.7	d
46	cyclooctene isomer	828	0.0	3.3	d
47	ethyl cyclohexene	853	0.0	1.3	d
48	ethyl cyclohexene isomer	854	0.0	0.8	d
49	p-xylene	866	1.3	1.6	b
50	m-xylene	874	2.7	2.2	b
51	2-heptanone	888	4.8	2.6	b
52	propyl butanoate	895	1.6	0.0	b
53	dimethyl trisulfide		16.1	0.0	c
Total area (10^6)			1 510	294	

[1] Measured Kovats indices. [2] The reliability of the identification is indicated by the following symbols: a: mass spectrum and retention time identical with those of an authentic sample; b: mass spectrum and Kovats indices in agreement with the corresponding literature data; c: mass spectrum consistent with spectra found in the literature; d: tentative identification by mass spectrum.

[1] Indices de Kovats mesurés. [2] La validité de l'identification est précisée par les symboles suivants : a = spectre de masse et temps de rétention identiques à ceux d'un échantillon de référence ; b = spectre de masse et indices de Kovats en accord avec les données de la littérature ; c = spectre de masse voisin de ceux observés dans la littérature ; d = essai d'identification à partir du spectre de masse.

or cheese (Dumont and Adda, 1978; Dumont *et al,* 1981; Bosset *et al,* 1994). This study does not enable us, however, to specify whether these components were originally in the forages or linked to their method of conservation in the form of silage. Indeed, the latter can lead, in certain cases, to the development of distinctive flavours in cheese (Urbach, 1990; Forss, 1993).

Effect of animal breed

In this trial, the Montbéliarde breed led to the most favourable cheese characteristics, especially in comparison with Holstein. These differences must be interpreted with caution. On the one hand, they can be due to feed effects. Indeed, considering the experimental protocol, all animals received complements as required, which means that the greater the production level of the animals, the more concentrated feed they were given. The cows belonging to group HO were thus fed a diet comprising 40% of concentrate against, respectively, 28 and 21% for MO and TA animals. On the other hand, these disparities cannot be generalized to all animals of a breed, because our sample was low and not representative. Our results simply show that differences in cheese quality can be due to intrinsic animal characteristics. This type of observation has recently been made for Beaufort type cheeses or traditional caprine cheeses according to the milk β or α_{s1} casein variants (Marie and Delacroix-Buchet, 1994; Vassal *et al,* 1994). Along the same lines, differences in colour and flavour according to breed (Friesian *vs* Jersey herds) have also been noted (Keen and Wilson, 1993).

CONCLUSION

This study is original in the fact that it was conducted under controlled conditions of milk production and cheesemaking. It has revealed certain differences in cheese characteristics depending on type of forage and animal breed, and thus confirms the numerous empirical observations made on this subject (Urbach, 1990). These results should, however, be confirmed by complementary studies before being made general, in particular for breed effects. The differences observed were obtained within the context of a particular technology. As interactions exist between the effects of production factors and manufacturing technology employed (Martin and Coulon 1995), it is possible that the effects of production factors might have been limited by the technology used in this study (relatively rapid acidification of the curd). Moreover, this study did not allow the separation of the effect of the floristic type of forage itself from that of its method of conservation. Work is presently underway to analyse the respective specific effects of these 2 factors.

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