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Manufacture of Ras cheese from fresh and recombined milks

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Summary — Ras cheese was made by the traditional process from fresh cow's milk and different recombined milks. The recombined milks were prepared by mixing recombined cream (20% fat) with reconstituted skimmilks obtained from classical low heat and medium heat powders, the latter one added or not with calcium caseinate and also from a new milk powder recently developed under an INRA patented process using membrane microfiltration. Milks, wheys and fresh cheeses were carefully analyzed in order to determine reliable weight and cheese component recoveries. Organoleptic qualities determined through flavour, body and texture scorings were assessed during the 3-month ripening period. The highest weight cheese yields were evidently observed with recombined milks enriched with calcium caseinate and the lowest with recombined milk made from medium heat powder. Satisfactory weight cheese yield and milk component recoveries were achieved with INRA powder recombined milk; they were even higher than those of fresh milk. The ripening changes in composition and in ripening indexes were almost the same in cheeses from different milks. Ras cheese from fresh milk showed the best quality followed by that made with INRA milk powder while that made from medium heat milk powder showed the poorest quality.

Ras cheese / recombined milk / microfiltration / milk powder / ripening

Résumé — Fabrication de fromage Ras à partir de laits frais et recombinés. *La fabrication du fromage Ras d'origine égyptienne à partir de différentes poudres de lait reconstituées a été étudiée par comparaison à une fabrication à partir de lait frais. Les poudres mises en œuvre étaient des poudres «basse et moyenne température», cette dernière étant additionnée ou non de caséinate de calcium, et une nouvelle poudre récemment développée par notre laboratoire avec utilisation de la microfiltration sur membrane. Les laits, les lactosérums et les fromages à l'état frais étaient soigneusement pesés et caractérisés sur le plan analytique dans le but de permettre une comparaison fiable des rendements fromagers en poids et en composants du lait. L'évolution des qualités organoleptiques des fromages durant les 3 mois d'affinage était déterminée par une analyse sensorielle basée sur la flaveur et l'appréciation de la fermeté et de la texture des fromages. Les meilleurs rendements fromagers en poids étaient évidemment observés avec les laits recombinés enrichis en caséinate de calcium et les plus faibles avec les laits reconstitués avec la poudre moyenne température. Les pourcentages de récupération de la matière sèche et des protéines ainsi que le rendement fromager observés avec la*

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poudre INRA reconstituée étaient tout à fait satisfaisants puisqu'ils étaient même supérieurs aux valeurs obtenues avec le lait frais. La qualité organoleptique des fromages s'élevait avec la durée de l'affinage. Les fromages les plus appréciés étaient ceux obtenus à partir de lait frais mais les fromages obtenus à partir de la poudre INRA étaient considérés comme tout à fait satisfaisants, au contraire de ceux obtenus à partir des poudres basse et moyenne température.

fromage Ras / lait recombiné / microfiltration / poudre de lait / affinage

INTRODUCTION

Ras cheese is considered as one of the most popular hard cheeses in Egypt. It is similar to the Greek variety 'Kefalotyri' (Phelan *et al*, 1993). It is manufactured from cow's milk or a mixture of cow's and buffalo's milk. Its production process has been described by Hofi *et al* (1970); it is similar to that for Gouda cheese except that: i) the curd is heated to 44°C in 15 min and held at this temperature for 30 min; and ii) the salting is realized in two stages (Phelan *et al*, 1993).

Because of the shortage of milk supply in Egypt, manufacture of Ras cheese from recombined milk has received quite a lot of interest. While the resulting product appears to be acceptable, it is generally considered as inferior to that made from fresh milk in terms of body texture and flavour (El Ghandour *et al*, 1983). Such defects likely result from the decrease of cheesemaking abilities of the utilized powders due to the heat treatments applied along the spray-drying process of milk. To our knowledge, only low heat powders, *ie* resulting from milk heated to no more than 62°C for 30 min or 80°C for 15 s, and medium heat powders, *ie* resulting from milk heated to no more than 80°C for 10 min or 88°C for 30 s, are considered as suitable for the preparation of recombined cheese milk (Planchet, 1993).

Most of the decrease in cheesemaking abilities of medium and high heat milk powders is due to the cumulative effect of heat treatments applied for the sanitation of fresh milk until the final dehydration process. These heat treatments induce modifications of mineral equilibria and formation of a complex between κ-casein and β-lactoglobulin, the main responsible for coagulation and drainage defects (Ferron-Baumy *et al*, 1991). Partial removal of β-lactoglobulin from skimmilk followed by any type of heat treatment was proposed by Quiblier *et al* (1991) for obtaining a new milk powder with improved cheesemaking abilities compared to those of low heat milk powders.

The purpose of this work was to study the cheesemaking ability of this new milk powder for the making of Ras cheese in comparison to fresh milk and four other industrial powders or mixtures currently used by the Egyptian cheese industry. The organoleptic qualities of the different ripened cheeses were also investigated.

MATERIALS AND METHODS

Milk and dairy ingredients

Fresh pasteurized (72°C – 15 s) skimmilk was obtained from an industrial plant (Bridel, L'Hermitage, France). Medium and low heat milk powders were from Besnier-Bridel (Retiers, France). New milk powder called 'INRA powder' was made according to Quiblier *et al* (1991) in ULN pilot plant (Condé-sur-Vire, France). Calcium caseinate was from Eurial (Nantes, France). Anhydrous milk fat was from Besnier-Bridel (Retiers, France).

Preparation of recombined milks

The reconstituted skimmilks were prepared according to Mietton (1988), with water at 20°C, as indicated in table I.

Table I. Composition of reconstituted skimmilks (kg).
Composition des laits écrémés reconstitués (kg).

	INRA powder	*Low heat powder*	*Medium heat powder without Ca caseinate*	*Medium heat powder with Ca caseinate*
Water	9.057	9.057	9.057	9.375
Powder	0.943	0.943	0.943	1.021
Ca caseinate	–	–	–	0.110
PO_4H Ca	–	0.010	0.010	0.010
PO_4H_3 85%	–	–	—	0.0009
Total (kg)	10.0	10.01	10.01	10.517

The reconstituted skimmilks were then aged for 20 h at 4°C and added with reconstituted creams prepared by mixing 2.0 kg of reconstituted skimmilks and 0.5 kg of anhydrous milk fat followed by an homogenization at 100 kg/cm^2 at 50°C. For each recombined milk, 2.25 kg of cream were mixed with 7.75 kg of fresh or reconstituted skimmilks.

Six series (three replicates) of Ras cheeses were made from: 1) fresh milk (control); 2) recombined with low heat powder (LH); 3) recombined with medium heat powder (MH); 4) recombined with medium heat powder added with Ca caseinate (MHCa); 5) recombined with INRA powder (INRA); 6) mixture (1:1) of fresh milk + recombined MHCa (mixture).

Cheese manufacturing

Cheeses were made according to the traditional method (Hofi *et al*, 1970) with slight modifications as follows.

Milk aging

At 35°C, all milks were added with the following starters (for 10 kg): 0.2 g of TA 060 *Lactobacillus thermophilus* (Texel, France); 0.1 g of LD 1 Mesophilic *Lactococcus* (Flora Danica, Denmark); 0.2 g of LH 100 *Lactobacillus helveticus* (Texel, France); and maintained 1 h for control, INRA and mixture milks and only 30 min for LH, MH and MHCa milks.

Renneting

3 ml of rennet extract (520 mg/l chymosin) (Granday, France) were added to each 10 kg batch. Coagulation time was 45 min for control, INRA and mixture milks and 30 min for LH, MH and MHCa milks.

Curd cutting and stirring

As usual, it was realized in two successive steps: 30 min at 35–40°C and 30 min at 40–45°C.

Whey drainage salting and molding

A volume of whey corresponding to 60% of the volume of the milk was removed for all milks, then 120 g of salt were added, the mixture was stirred 15 min, the salted whey was drained and the resulting curds were molded (molds with 13 cm diameter, 10 cm height).

Pressing

As usual, it was realized in two steps: 1 h under 10^5 Pa pressure and 30°C, overnight under 3 10^5 Pa.

Cooling and drying

Cheeses were set for 2 days in a room at 15°C with 85–90% of relative humidity.

Coating

Cheeses were coated with HA-LA Plast (Labo Standa, France) as described by Mohamed *et al* (1992).

Ripening

Cheeses were ripened 3 months at 15°C with relative humidity adjusted to 85–90%.

Analytical measurements

Total solids (TS) and fat were determined as described by Ling (1963), total nitrogen was by macro Kjeldahl equipment (Humeau, France), casein according to Aschaffenburg and Drewry (1959), calcium by atomic absorption spectrometry according to Brulé *et al* (1974), lactose according to Acton (1977), salt by chlorurometry by using the Corning 926 equipment (Humeau, France), soluble proteins according to Ling (1963), cheese ripening indexes (Shilovich Ripening Index) (SRI) according to Tawab and Hofi (1966) and total volatile free fatty acids as described by Kosikowski (1978).

Cheeses were scored for flavour (60 points), body and texture (40 points) at 30, 60 and 90 days by a tasting panel of 10 Egyptian students living in Rennes according to the usual method used by Hofi *et al* (1970).

RESULTS AND DISCUSSION

Composition of the different milks and wheys

Table II shows the composition of the 6 cheese milks used and the resulting wheys. Protein contents of LH, MH, INRA and control cheese milks were in the normal range of variation (30.4 to 32.7 g/kg); casein/protein ratios in milks varied from 78–79% (control, LH, MH) to 86.8% (MHCa, INRA) and fat/casein ratios from 1.35 (MHCa) to 1.83 (MH and LH), representing a slightly broader variation than for the fat/protein ratios: 1.17 for MHCa to1.47 for LH milk. Addition of the phosphoric acid-calcium phosphate mixture decreased the milk pH of MHCa recombined milk to 6.12 and only to 6.4 for MH and LH recombined milks.

In all cheese manufactures, whey 1 represented 60% of the weight of the cheese milks, wheys 2 (salted wheys) were respectively 26, 24.5, 27, 22, 28.5 and 28% of the weight of control, mixture, INRA, MHCa, LH and MH cheese milks. Wheys 3 obtained during pressing were respectively 1.7, 1.6, 1.7, 2.7, 0.9 and 1.5% for the same manufactured cheese milks.

Calculations of the weighted mean of the different whey components showed that the highest fat losses were observed in control, LH and MH wheys (around 10 g/kg) in contrast to the three other wheys (only around 4 g/kg). Protein contents ranged from 8 g/kg for INRA whey to 10.3 g/kg for mixture and MHCa wheys.

Composition of the fresh Ras cheeses and milk components recovery

Table III gathers average weight and composition of the six different fresh 'Ras cheeses' obtained from control and recombined milks. Measurements were made after the overnight pressing step. Fat/TS ratios varied from 52.7% (MHCa) to 56% (MH). Moisture in non-fat cheese values ranged from 60.6% (INRA) to 64.2% (mixture and MHCa). Salt content (not shown) was close to 2% (w/w) for all cheeses. Lactose contents were respectively 1.33, 1.19, 0.98, 1.06, 1.33 and 1.27% for control, mixture, INRA, MHCa, LH and MH Ras cheeses. Such contents are in the range of the usual compositions described for Egyptian Ras cheeses made from fresh milk or pasteurized milks (Hofi *et al,* 1970). However, pHs observed for INRA and MHCa cheeses were similar to the values described for cheeses made from raw milk, in contrast to other cheeses' pHs which were close to the values described for cheeses made from pasteurized and recombined milks (Hofi *et al,* 1970; El Ghandour *et al,* 1983).

Careful check of the weight, total solids, fat and protein balances between cheese milks plus added salt on one side and cheeses plus wheys on the other showed unexplained differences of approximately ±1% for weight, ±2% for total solids, −2% to −9% for fat and −1% for proteins. Consequently, recovery calculations or yields are reliable for weight, total solids and proteins (Vandeweghe and Maubois, 1987).

As expected, the highest gross cheese yields in weight were obtained with recombined milks enriched with calcium caseinate (MHCa and mixture). This highest yielding capacity of MHCa and mixture recombined milks is evidently also found in TS recoveries but much less in protein recoveries. INRA recombined milk led to a protein yielding capacity very close to that observed for MHCa. Comparison of non-calcium

Table II. Gross composition (g/kg) and pH of milks and wheys from fresh and recombined milks.
Composition (g/kg) et pH du lait de départ et des lactosérums correspondant aux différents laits frais ou recombinés.

	Control	*Mixture*	*INRA*	*MHCa*	*LH*	*MH*
Milk						
TS	129.2 ± 1.3	136.4 ± 0.9	133.3 ± 1.4	142.4 ± 1.1	127.3 ± 0.0	130.3 ± 0.7
Fat	44.8 ± 0.4	46.8 ± 0.5	45.6 ± 0.1	47.3 ± 0.6	44.8 ± 0.02	45.2 ± 0.4
Protein[a]	31.6 ± 0.6	37.0 ± 0.2	32.7 ± 0.3	40.3 ± 0.4	30.4 ± 0.03	31.6 ± 0.5
Casein	24.6 ± 1.0	29.8 ± 0.2	28.4 ± 0.3	35.0 ± 0.2	24.3 ± 0.05	24.7 ± 0.4
Lactose	46.0 ± 0.3	46.0 ± 0.6	45.8 ± 0.5	45.3 ± 0.4	45.3 ± 0.03	46.1 ± 0.4
Ca^{2+}	1.23 ± 0.02	1.33 ± 0.02	1.27 ± 0.02	1.46 ± 0.0	1.16 ± 0.02	1.12 ± 0.02
NaCl	1.85 ± 0.02	2.0 ± 0.07	1.85 ± 0.05	2.5 ± 0.1	2.35 ± 0.04	2.0 ± 0.06
pH	6.68 ± 0.01	6.49 ± 0.02	6.62 ± 0.02	6.34 ± 0.02	6.39 ± 0.01	6.36 ± 0.01
Whey 1						
TS	77.1 ± 0.18	68.5 ± 1.1	67.0 ± 0.4	70.9 ± 1.7	75.7 ± 0.8	71.3 ± 0.8
Fat	10.5 ± 0.07	3.0 ± 0.1	1.2 ± 0.06	3.0 ± 0.15	9.8 ± 0.1	10.0 ± 0.3
Protein[a]	8.4 ± 0.05	9.8 ± 0.04	6.5 ± 0.04	9.7 ± 0.2	8.1 ± 0.07	8.9 ± 0.2
Casein	0.4 ± 0.02	0.6 ± 0.01	0.3 ± 0.01	0.8 ± 0.03	0.7 ± 0.03	0.9 ± 0.02
Lactose	47.3 ± 0.4	47.7 ± 0.1	47.9 ± 0.06	47.7 ± 0.2	46.9 ± 0.2	47.7 ± 0.4
Ca^{2+}	0.48 ± 0.02	0.52 ± 0.1	0.51 ± 0.01	0.53 ± 0.02	0.49 ± 0.01	0.46 ± 0.01
NaCl	2.0 ± 0.02	2.5 ± 0.1	2.0 ± 0.06	0.3 ± 0.05	2.5 ± 0.06	2.0 ± 0.03
pH	6.3 ± 0.01	6.18 ± 0.05	6.02 ± 0.02	5.95 ± 0.02	6.02 ± 0.03	5.97 ± 0.06
Whey 2						
TS	108.6 ± 1.5	109.6 ± 1.5	125.0 ± 1.7	115.3 ± 1.7	112.3 ± 0.43	127.2 ± 1.8
Fat	10.7 ± 0.3	6.5 ± 0.17	9.8 ± 0.20	10.5 ± 0.36	11.0 ± 0.15	11.2 ± 0.03
Protein[a]	8.0 ± 0.20	11.6 ± 0.17	11.2 ± 0.16	11.8 ± 0.27	10.2 ± 0.05	10.1 ± 0.17
Casein	0.7 ± 0.05	1.6 ± 0.06	0.6 ± 0.05	2.0 ± 0.05	1.7 ± 0.05	2.7 ± 0.05
Lactose	44.3 ± 0.35	45.5 ± 0.38	43.8 ± 0.38	44.4 ± 0.27	46.7 ± 0.27	43.6 ± 0.14
Ca^{2+}	0.61 ± 0.01	0.63 ± 0.01	0.64 ± 0.01	0.73 ± 0.02	0.63 ± 0.004	0.71 ± 0.04
NaCl	37.3 ± 0.55	35.9 ± 0.58	36.0 ± 0.51	34.0 ± 0.68	35.8 ± 0.35	37.3 ± 0.55
pH	6.1 ± 0.03	6.05 ± 0.02	5.91 ± 0.03	5.76 ± 0.16	5.88 ± 0.02	5.82 ± 0.05
Whey 3						
TS	89.25 ± 1.25	85.8 ± 0.98	101.7 ± 1.2	88.20 ± 1.4	101.5 ± 1.1	98.6 ± 1.15
Fat	0.6 ± 0.02	1.0 ± 0.06	0.9 ± 0.06	1.4 ± 0.03	8.5 ± 0.15	5.0 ± 0.1
Protein[a]	8.2 ± 0.16	9.1 ± 0.22	10.2 ± 0.12	9.2 ± 0.18	13.4 ± 0.11	13.1 ± 0.15
Casein	0.6 ± 0.06	1.2 ± 0.05	0.4 ± 0.03	1.3 ± 0.04	1.2 ± 0.06	2.0 ± 0.06
Lactose	35.2 ± 0.29	37.6 ± 0.56	34.8 ± 0.42	35.3 ± 0.07	36.2 ± 0.33	35.0 ± 0.57
Ca^{2+}	1.05 ± 0.04	1.09 ± 0.05	1.4 ± 0.05	1.2 ± 0.03	1.2 ± 0.04	1.1 ± 0.04
NaCl	35.3 ± 0.52	33.6 ± 0.44	33.8 ± 0.41	32.2 ± 0.23	33.6 ± 0.54	33.3 ± 0.54
pH	5.75 ± 0.03	5.25 ± 0.05	5.51 ± 0.04	5.42 ± 0.04	5.25 ± 0.04	5.20 ± 0.04

[a] Protein = total nitrogen x 6.38.

Table III . Composition of fresh cheeses and gross recoveries of milk components
Composition des fromages Ras frais et récupération des constituants du lait.

	Cheese					*Recovery(%)*				
	Weight (kg)	*TS (%)*	*Fat (%)*	*Protein (%)*	*pH*	*Weight*	*TS*	*Fat*	*Protein*	*Casein*
Control	1.16	56.0	30.0	20.84	5.66	11.62	47.27	77.68	76.96	98.24
Mixture	1.39	55.06	30.3	20.21	5.42	13.90	53.30	89.10	76.03	97.40
INRA	1.17	59.68	32.5	21.56	5.23	11.70	48.05	83.38	78.30	98.75
MHCa	1.49	54.12	28.5	20.80	5.28	14.90	54.47	89.78	78.56	97.44
LH	1.03	58.77	33.10	21.82	5.56	10.30	43.78	75.87	74.12	96.32
MH	1.02	58.09	32.5	22.28	5.52	10.2	43.90	73.34	73.09	94.56

caseinate enriched recombined milk *ie* control, LH, MH and INRA shows gross yielding capacities increasing as follows: for weight: MH < LH < control < INRA; for protein: MH < LH < control < INRA.

Comparison of weight cheese yields requires, as demonstrated by Maubois and Mocquot (1967), calculations of corrected yields with adjustment of TS contents of cheeses to the reference value, *ie* 56% in this study. Calcium caseinate enriched recombined milks: MHCa and mixture respectively led to an increase in yield of 23.2% and 17.2%. Non-enriched recombined milks led to the following values: –6.0% for LH; –8.2% for MH; and +7.5% for INRA.

Protein recovery values, and increase in cheese yielding capacity confirm the high cheese making ability of the INRA powder as claimed by Quiblier *et al* (1991). In addition to a renneting time close to that of original raw milk, it appears that partial removal of whey proteins before spray drying allows to keep a cheese curd with high firmness properties. Casein contents of the three successive wheys are the lowest for those issued from recombined INRA powder. Casein fines losses appear lowered by a selective increase in native micellar casein of the recombined milk. More studies on the making of other cheese varieties are requested to confirm this hypothesis.

Ripening of Ras cheeses and organoleptic evaluation

Figure 1 shows the main variations in the characteristic parameters of Ras cheeses issued from the six different cheese milks during 3-month ripening. Moisture decreases (fig 1a) were approximately 3–4% for control and mixture cheeses and in the 5.5–7% range for the four other ones. Lactose decreases (fig 1d) were similar for control, MH and LH cheeses on one side and faster for MHCa, mixture and INRA cheeses on the other, but all cheeses were lactose-free when they were 3 months old. General proteolysis evolution appeared similar for all types of cheeses (fig 1c) as for lipolysis (fig 2a). As natural milk lipase is inactivated by heat treatment applied to fresh milk and during spray-drying, observed lipolysis came mostly from lipolytic activity of the added dairy starters. Differences observed in the free fatty acids contents (fig 2a) during ripening of the six cheeses types could result from a difference in bacterial lipase accessibility due to a likely varying protein composition of recombined fat globules. Further

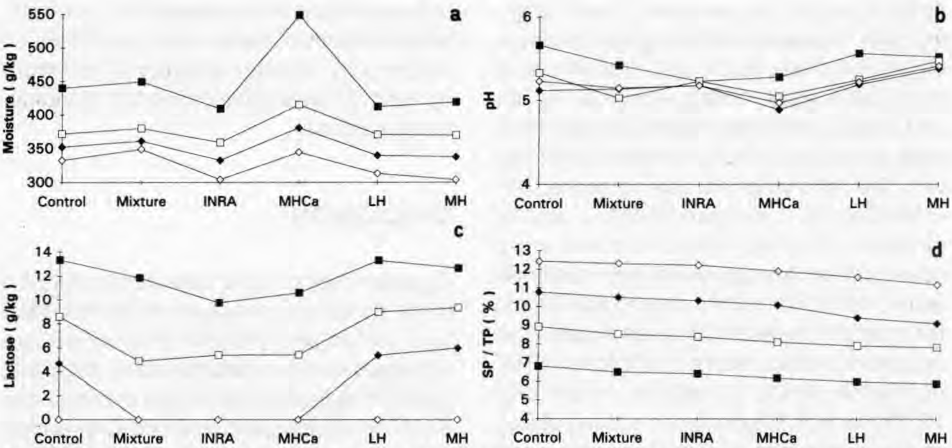

Fig 1 . Moisture content (**a**), pH values (**b**), soluble proteins/total proteins ratios (**c**) and lactose content (**d**) of Ras cheese made from fresh cow's and recombined milks during ripening. ■ : fresh; ❑: 1 month; ◆: 2 months; ◊: 3 months.

*Taux d'humidité (**a**), pH (**b**), rapport protéines solubles/protéines totales (**c**) et teneur en lactose (**d**) du fromage Ras fait à partir de laits de vache frais et recombinés, au cours de l'affinage. ■ Frais ; ❑1 mois; ◆ 2 mois ; ◊ 3 mois.*

work is requested for confirming this hypothesis.

Except for INRA cheese which has the lowest moisture content, there was a gradual decrease in pH value of all cheeses during the first two months of ripening, probably due to lactose, protein and lipids hydrolysis; this pH decrease is followed in the third month of ripening by a slight increase, probably due to the degradation of hydrolysis products, in good agreement with the results described by Hofi *et al* (1970). Evolution of SRI (fig 2b), used for following protein degradation in Ras cheese (Tawab and Hofi, 1966), varies according to the cheese type. Increase of SRI appears as strongly correlated with the moisture content of the fresh cheese. MHCa, mixture and control cheeses with a TS content between 54 to 56% show relatively rapid and high protein degradation in contrast with the three other cheeses with a TS content between 58 to 59% which show a much smaller proteolysis.

Figure 3 summarizes data of organoleptic tastings realized during the 3-month

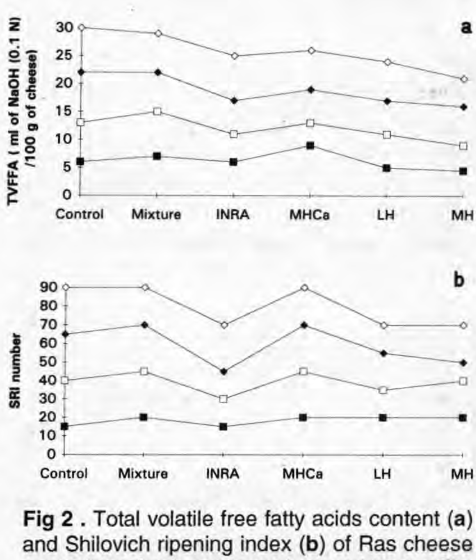

Fig 2 . Total volatile free fatty acids content (**a**) and Shilovich ripening index (**b**) of Ras cheese made from fresh cow's and recombined milks during ripening. ■ : fresh ; ❑ 1 month; ◆ : 2 months ; ◊ : 3 months.

*Teneur en acides gras libres volatils totaux (**a**) et indice Shilovich d'affinage (**b**) du fromage Ras fait à partir de laits de vache frais et recombinés, au cours de l'affinage. ■ Frais ; ❑ 1 mois ; ◆ 2 mois ; ◊ 3 mois.*

ripening period. As expected, flavour scoring data increased with progress in ripening for all cheeses (fig 3a). Variations in body and texture scoring were low (fig 3b) and cheeses rankings observed at the fresh state were kept in the whole ripening period with the following increasing score: MH < MHCa; LH < mixture; INRA < control cheeses. Highest global scores were observed for cheeses made from fresh milk alone: 88/100 for control cheese and 84/100 for mixture cheese. Cheeses made from recombined milks reached 83/100 for INRA, 80/100 for MHCa, 77/100 for LH and only 72/100 for MH. Organoleptic scoring of Ras cheeses made in this study was in good agreement with those of El Ghandour *et al* (1983) for both cheese series made from fresh and recombined LH and MH powders. Scoring of INRA cheese was reasonably satisfactory compared to that of fresh milk. It was nevertheless the highest one in the

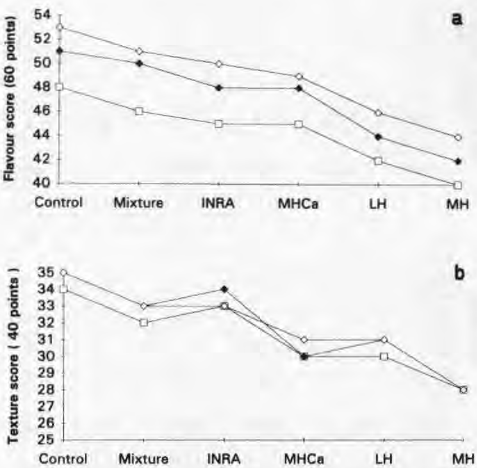

Fig 3 . Flavour (**a**) and texture (**b**) scores of Ras cheese made from fresh cow's and recombined milks during ripening. ❑ 1 month ; ◆ : 2 months ; ◊ : 3 months.

*Scores de flaveur (**a**) et de texture (**b**) du fromage Ras fait à partir de laits de vache frais et recombinés, au cours de l'affinage;* ❑ *1 mois ;* ◆ *2 mois;* ◊ *3 mois.*

cheeses made from recombined powders. Improvements of the scoring could likely be reached by a better mastery of moisture content of that cheese during the manufacturing process.

CONCLUSION

Egyptian Ras cheese can successfully be made by using recombined milks. Satisfactory yields and protein recoveries are observed when reconstitution is done with powders selectively enriched in caseinate. Such an enrichment realized with partial removal of whey proteins as proposed by Quiblier *et al* (1991) appears very interesting as it leads to significant cheese yield increase (+ 7.5%), decrease in whey losses in casein fines and its utilization does not require addition of chemical additives (phosphoric acid and calcium phosphate). However, although cheeses made from INRA recombined powder have the highest organoleptic tasting scores amongst the cheeses made from only milk powder, some adaptations of the cheesemaking parameters have to be done for obtaining texture and flavour similar to those obtained with fresh milk, the first one being to manage time, temperature and rate of acidification during the drainage step in order to reach a total solid content in the fresh cheese identical to that obtained with fresh milk. Such adaptations are easily feasible.

Specific enrichment in native casein as proposed by Quiblier *et al* (1991) will perhaps represent the first approach of a new generation of milk powder especially devoted to cheesemaking in countries suffering as Egypt of a shortage in milk supply. However, on the other hand, use of such powders could be generalized only if the supplementary cost of casein enrichment is largely counterbalanced by their technological properties: cheese yield increase and ease of use.

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