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Physico-chemical characterization of cheese : application to French Emmental

(summary of the lecture given by M SCHMITT, ITFF, at CECALAIT's Annual General Meeting 2001)

French Emmental is the largest french cheese : its weight can be over 75 kg, its production was over 240 000 t in 2000 *ie* more than 12% of the milk collection and more than 24% of the french production of ripened cheese. It is very frequently used in restaurants or the food industry and about 95% of consumers use it directly or for cooking. It represents 1% of the food sales in mass distribution, but with various brands and presentations. Therefore, there is a need for identification and characterization of the product. Its composition has thus been carefully examined in order to build a database.

The studies were launched a few years ago by the LARF, (laboratoire d'analyse alimentaire et de recherche fromagère de l'ITFF, the former ITG - *see abbreviations in La Lettre de CECALAIT n° 39)* and are still in progress. The work is divided into three parts :

- characterization of french Emmental among other hard cheeses,
- characterization of Emmental in processed cheese,
- definition of Emmental in the Codex.

Emmental and other hard cheeses

The aim of this work was to reveal the characteristics of Emmental among neigbouring cheeses, which could be mistaken for it, especially when grated. Many of these cheeses were thus characterized in order to build a database to give discriminating criteria.

➢ CHARACTERIZATION METHODS

Studies were carried out on samples taken from cheese plants, but also bought in retail stores. When possible, former work was also used. Characterization was done :

- on the one hand, by using "classical" physico-chemical methods in order to determine dry matter (DM), fat, nitrogen, calcium, salt…and also volatil fatty acids….
- on the other hand, by studying the proteic fraction

Indeed, proteolysis is very important in cheese technology. Two different types of analysis were chosen to follow this process : analysis of primary proteolysis and for further steps, the analysis of the water-soluble peptidic fraction.

- Primary proteolysis was followed by polyacrylamide gel electrophoresis of casein (PAGE), under different conditions. The degradation products of the caseins can be shown and quantified by densitometry and/or image analysis.
- the peptidic patterns of the water-soluble fraction of cheeses - representing only part of the proteolysis products- were obtained using a reverse phase high performance liquid chromatographic method (HPLC), allowing identification and quantification.

Firstly, a lot of French Emmentals were analysed in order to get an array of peptidic patterns, corresponding to different geographic origins, to different production methods, to the season…

Fig. 1 gives an example of such a peptidic pattern. (taken from the article by CHOPARD M.A., SCHMITT M., PERREARD E. et J.F CHAMBA : Aspect qualitatif de l'activité protéolytique des lactobacilles thermophiles utilisés en fabrication de fromages à pâte pressée cuite. Lait, 2001, V. 81, p. 183-194).

Fig 1 : Schematic representation of average peptidic patterns of water-soluble fraction of French Emmental (n=253) *see Lettre de CECALAIT n° 39, page 2*

➢ DISCRIMINATING CRITERIA

All the results obtained using the above methods (except HPLC) with numerous hard cheeses and French Emmentals were put together and examined.

Some criteria, already specified in the definition of Emmental, could indeed be considered as discriminating criteria. It is the case for the dry matter, one of the two basic analytical criteria for Emmental, *ie* :

dry matter ≥ 60% and "fat/dry" ≥ 45% .

Likewise, two of the important definition criteria of "French Emmental Selection" (as specified by professionals) revealed themselves as discriminating criteria. These are the calcium content and the ratio between α_{S1} and β caseins :

- **calcium content > 850 mg/100 g of cheese.**
- **ratiot α_{S1}/β caseins > 0.6.**

However, the important criteria of propionic fermentation did not need to be considered here.

Finally, hard cheeses that might be mistaken for Emmental could be split into several groups, according to the scheme described in Fig. 2. *see Lettre de CECALAIT n° 39, page 3*

Fig 2. shows that some cheeses are very close to Emmental and actually very difficult to identify. For these, all the available analytical criteria were used for a multiparametric statistical analysis : principal component analysis (PCA). So it was for French Emmentals. Finally, these could be clearly distinguished from the other products, even very close.

Moreover, it seems, from preliminary work, that peptidic patterns could also be used to distinguish French Emmental from other close hard cheeses, including Maasdams.

➢ CHARACTERIZATION OF EMMENTAL IN PROCESSED CHEESE

It is a special case linked to processed cheese trade. Indeed, GATT had specified lower import taxes on processed cheese made with Emmental. But, until now there was no method to check if Emmental had been used in the process or not. So, the LARF launched work which could later help the Customs laboratories in the development of a control method.

Experimental cheeses were manufactured with mixtures of cheddar and French Emmental, using a very denaturating process. The cheeses were then analysed by the characterization methods described above : physico-chemical methods, casein electrophoresis and HPLC of the water-soluble peptidic fraction.

Manufacturing conditions : STEPHAN pilot 24 kg, 300 to 3000 rpm, 118°C maximum. Experimental cheeses manufactured : simple processed cheeses, only made from raw cheese material, butter for fat standardization, processing salts and water, with expected dry matter around 50%. 4 types of raw cheese material were used :

- Emmental only : processed cheese named below, 100E,
- Cheddar only : processed cheese named below 100C,
- Emmental - Cheddar mixtures, with 75% Emmental, 25% Cheddar and inversely : processed cheese named below, 75E and 75C respectively.

Table 1, page 4 of La Lettre de CECALAIT n°39, gives the main compositional characteristics of the raw materials used (at the same ripening stage) and of the experimental processed cheeses made from them.

These results show that the main initial characteristics of Emmental and Cheddar, especially the ratio of caseins α_{S1}/β, are found again in the processed cheeses 100E and 100C.
But, in the processed cheeses made from mixtures, the obtained values are intermediate between the initial values of the raw materials.

Likewise, the HPLC patterns of water-soluble peptides "keep" specific peaks of the two raw materials in the processed cheeses. Thus, **the same peaks, at the same retention times**, are observed for Emmental as a raw material and for processed cheeses containing Emmental. Quantification of the initial proportions of the mixture can even be considered.

In conclusion, applying the same methods to more sophisticated process might be considered.

➢ DEFINITION OF FRENCH EMMENTAL

The need for characterization of cheese is also very important during Codex talks about standard C9 concerning the definition of Emmental. For example, to justify the importance of the specifications they defend, French (and other "traditional") Emmental manufacturers need a complete characterization of their products, but also of similar and/or competing products.

So, the ITFF launched new work to complete the results already obtained with French Emmental.

It aims at :

- characterizing Emmentals from other countries and comparing the results to those of French Emmentals.
- fully characterizing Maasdams, in order to determine the specifications for this type of cheese
- fully characterizing experimental cheeses where size and/or heating temperature of the curd are significantly different from the present French specifications.

Most of this work is still in progress. Some of the discriminating criteria determined for French Emmental may still work with other Emmentals, some might need a revision…Anyhow, the aim remains to propose an international "definition" of Emmental in the CODEX C9 talks, allowing in particular, to distinguish them clearly from Maasdam type cheeses.

In conclusion

The characterization of hard cheeses, including Emmentals, implies building databases with the detailed physico-chemical composition of these cheeses and using multiparametric statistical analysis in order to discriminate close, but different groups.

The list of abbreviations and bibliographic references are in « La Lettre de CECALAIT »