CHARACTERIZATION OF NON-MEAT PROTEIN PREPARATIONS BY EMULSION STABILITY CURVES

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SUMMARY

This study is directed to the assessment emulsifying properties of commercial milk protein preparations proposed for meat processing purposes by using of newly designed flow cell apparatus. As reference material a commercial spray dried porcine blood plasma was used.

Whereas the emulsifying capacity of low viscosity sodium caseinate and of blood plasma protein were comparable under the chosen analytical conditions (0.15 % protein solution, w/v, pH=6.0, 0.4 M NaCl, 20° C),the other milk proteins exhibited significantly ($p > 0.05$) lower emulsifying capacity.

Since the developed method allowed continuous collection of emulsion samples with increasing oil fraction, emulsion stability curves were prepared for all examined protein preparations. It has been shown that their emulsion stability values varied markedly depending on the percentage of oil required to cause emulsion collapse.

Instead of measuring emulsion stability at one protein to oil ratio, these results indicate that it is preferrable to measure it over a broad range with increasing oil fraction. The flow cell apparatus in this study offers many advantages over methods previously used for such characterization.

Introduction

According to Patel and Kilara (1990), emulsyfing properties of protein preparations are usually described by: (a) emulsifying capacity, which denotes the maximum amount of oil that can be emulsified by a protein dispersion, and (b) emulsion stability, which reflects the ability of a protein to impart strength to emulsion for resistance to stress.

Standarized methods to measure these properties have not been developed, although different methods have been used by various investigators: Swift et al.(1961), Webb et al.(1970), Pearce and Kinsella (1978), Kato et al. (1985).

Extensive reviews are available on the emulsifying properties of milk proteins: Morr (1979), Lorenzen (1983), Langley et al.(1988). Since emulsifying properties of protein are affected by the processing conditions e.g. the rate of oil addition, the speed of homogenization, the protein concentration, the temperature during emulsification and the amount of air incorporated in the emulsion Lorenzen (1983), Britten and Giroux (1990), no valid comparison of the results for milk proteins from various studies can be made.

A flow cell system designed by Britten and Giroux (1990), offers many advantages over methods previously used to measure emulsifying properties of proteins. In particular, it facilitates the characterization of the emulsion in the pre-collapse region.

In the present study, a similar, constant volume flow cell system, developed in our laboratory, was used to compare emulsifying properties of different commercial milk proteins under the same analytical conditions.

Materials and Methods

Eight commercial milk proteins manufactured by DMV, Veghel, Holland and one commercial grade Na caseinate manufactured in Poland were obtained for this study. A spray dried porcine blood plasma was purchased from Harimex b.v., Loenen, Holland and used as reference material (Table 1).

Solutions of 0.15 % protein, w/v, in deionized water containing 0.4 M NaCl and adjusted to pH 6.0 using dropwise addition of 1 N HCl or NaOH, were prepared to determine emulsifying properties. Emulsions were formed by a constant volume (100 ml) flow cell apparatus, according to the principle described by Britten and Giroux (1990) (Figure 1).

Homogenization power was provided by a Silverson homogenizer (type: 0L4R). Two vessels containing the protein solution and the oil (soya oil from Remia b.v., Holland) were connected to a flow cell. Two peristaltic pumps (Watson-Marlow, type 501U) were used to introduce oil and protein solution into the cell. A pair of electrodes (Philips conductivity cell, type 9553/60, Flow PT 100) and a recorder were used to record the conductivity of the emulsion output from the cell. To operate the system, the flow cell was completely filled with the protein solution and then the oil was introduced. The homogenizer was switched on and the speed adjusted to maximal value (about 50000 rpm). Oil flow rate was increased step by step until emulsion collapsed. This moment was associated with a sudden drop in the conductivity to zero. Emulsifying capacity was calculated from the ratio of the oil fraction and protein fraction at collapse point and expressed in g oil per mg of protein.

To determine the emulsion stability the same flow cell system was used. Emulsions were made between 50 and 90% of the volume of oil required to cause emulsion collapse (EC) and treated according to the method reported by Porteous (1979).The emulsions were collected with increasing oil fraction and weighted portions of these emulsions were heated at 78 C in a water bath for 30 min, then cooled in a water bath (20° C) for 60 min and subsequently centrifuged at 3000 rpm for 2 min (Beckman Centrifuge, Modell TJ-6). Any separated oil was decanted and the weight of the remaining emulsion was determined.The emulsion stability was expressed as the amount of bound oil (%).

Results and discussion

The values given in Table 1 correspond well to literature data, however, the polish Na caseinate obtained for this study demonstrated a considerably lower pH-value (after solubilization in water) than other commercial milk preparations . This caseinate was found more dusty in comparison to similar dutch milk preparation (NaDMV) (210 g/l and 350 g/l, respectively).

In this study,emulsifying capacity of the protein preparations was determined by a flow cell apparatus. The homogenization conditions in such constant volume system remain the same, irrespective of the amount of added oil. In addition, the results are not affected by foaming of the protein solution, since air particles are not present in emulsion formed using the closed cell (Britten and Giroux (1990)). In the experiments carried out here, the homogenizer was supplied with a medium emulsor screen during preparation of emulsions to ensure uniform size of emulsion droplets and to avoid the influence of this variable on final results (Leman and Kinsella (1989)).

Most of the milk protein preparations exhibited comparable emulsifying capacities in the range of 3.85 to 4.78 g oil per mg of protein. Whereas no significant difference ($p > 0.05$) was observed between reference blood plasma powder (4.84 g oil per mg of protein) and low viscosity caseinate (EMLV) (4.78 g oil per mg of protein), high viscosity caseinate (EMHV) and calcium caseinate showed lower EC values (3.88 and 3.85 g oil per mg of protein, respectively).

In the present study emulsion stability was determined by a method similar to that described by Carpenter and Saffle, (1964) and modified by Porteous (1979).Whereas they made only emulsions for the stability test using 80 % of the volume of oil required to cause emulsion collapse, we collected contineously from the flow system emulsion samples in the range from about 50 to 90% of EC value. It was, therefore, possible to illustrate that emulsion stability of the protein preparations varied markedly depending on percentage of the volume of oil required to cause emulsion collapse.

The differences in the emulsion stability of the milk protein/oil emulsions and the dependence of the emulsion stability upon the amount of added oil are shown in detail in Figures 2 and 3. High emulsion stabilities of low viscosity caseinate (EMLV) and reference blood plasma was observed over the whole range of 50 to 90 % of the volume of oil required to cause emulsion collapse. The EMLV protein differed from all other preparations.

Conclusion

It is concluded that the commercial milk protein preparations can vary considerably in their emulsifying properties. Depending of the type of protein and processing conditions is possible to affect both emulsifying capacity as well as emulsion stability.

Emulsion stability values obtained in this study indicate the critical character of this parameter for evaluation of the milk protein preparations in aquaeous solutions. In stead of measuring this parameter at one protein to oil ratio, these results indicate that it is preferrable to measure it over a broad range with increasing oil fraction. The flow cell apparatus in this study offers many advantages over apparatus previously used for such characterization.

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Table 1 Physico-chemical properties of the protein preparations

Figure 1 Schematic diagram of flow cell apparatus for emulsifying and collapse point detection

Figure 2 Emulsion stability curves of protein preparations (a)

Figure 3 Emulsion stability curves of protein preparations (b)