Determination of emulsifying propertiesof nonmeat proteins.

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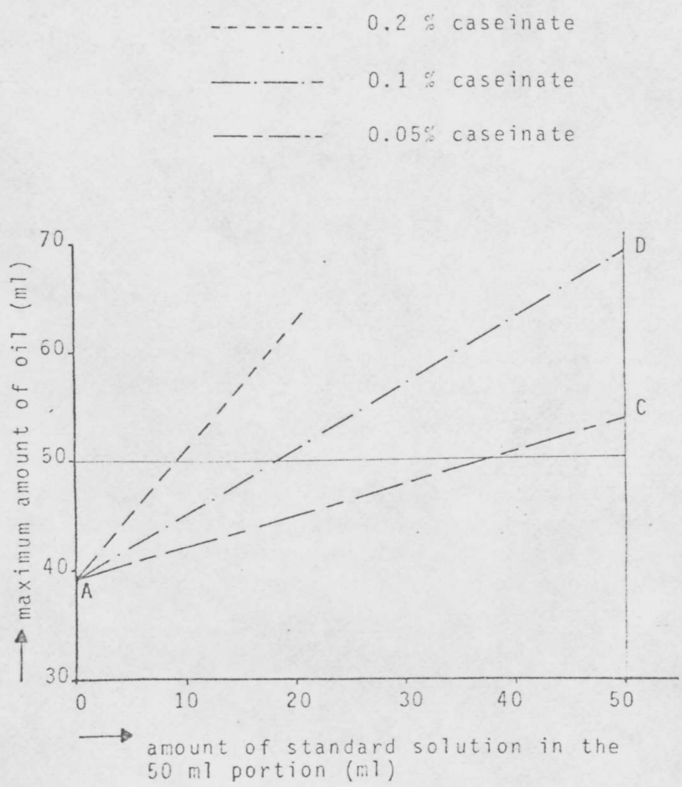
Introduction

It has been stated that the ability of sausage meats to form stable emulsions is connected with the emulsifying properties of meat. Carpenter and Saffle (2) ranked different sausage raw materials according to their emulsifying capacity as determined by the method of Swift et al. (5).

The emulsifying capacity is often expressed as the maximum amount of oil (in ml) which can be emulsified by 100 mg of soluble protein (2) or by one g of sample (1). Moerman (3) carried out the determination with different concentrations of protein; he extrapolated to concentration zero and indicated the intersection with the ordinate as the specific emulsifying capacity (Fig. 1) which is only dependent on the kind of protein. The amount of oil emulsified by 50 ml of protein extract was called effective emulsifying capacity.

Fig. 1. Emulsifying capacity of standard solutions of caseinate of different concentrations. A: specific emulsifying capacity (3) C and D: effective emulsifying capacity (3)



Westerink (6) did not find a relation between one of these parameters for the emulsifying capacity of sausage raw materials to the stability of the sausage emulsions.

The present study was conducted to evaluate the effect of the amount of water on the maximum amount of oil which can be emulsified by a certain amount of protein, and to relate the results to practical circumstances.

Experimental

Protein additives. Well defined non-meat proteins (Table 1) were used as emulsifying agents. These non-meat proteins differ from each other in emulsifying properties so that the results of both methods can be correlated.

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Table 1. Protein content of the non-meat proteins used in the study

Product	Type	Moisture	Protein
Promine D	isolated soy protein	5.6 %	90.1 %
IPSO	isolated soy protein	5.0 %	88.5 %
HV	sodium caseinate (high vicous)	3.6 %	87.5 %
EM 6	sodium caseinate	7.0 %	84.9 %
egg	dried whole egg	4.0 %	47.4 %
blood plasma I	dried	8.1 %	70.8 %
blood plasma II	dried	9.3 %	65.3 %

Emulsifying capacity in concentrated solutions. Peanut oil at 15 °C and anemulsifier were mixed in a 15 l bowl chopper at low speed for one minute (bowl 8 rpm, knives 1500 rpm). After changing over to double speed, water with a temperature of 15 °C was added. The mixture was chopped for 3 minutes, then it was left for 10 minutes without chopping to promote the hydration of the protein and finally it was chopped for another minute.

To establish the heat stability of the emulsions, a cooking test was performed by heating the emulsions in cans of 200 g at 120 °C for 60 minutes. By increasing the amount of oil (x) in the ratio oil:water:protein = x:5:1, the maximum amount of oil, which gave a stable emulsion, was determined. The effect of addition of 2 % NaCl at the beginning of the process also was investigated.

Effect of varying amounts of water. A water/protein ratio of about 5/1 is often used for preparing emulsions. To confirm that the water/protein ratio had a major effect on the emulsifying capacity in concentrated solutions, a series of runs was made with the emulsifiers EM 6, Promine D, HV and dried plasma at water/protein ratios of $\frac{4}{1}$, $\frac{5}{1}$ and $\frac{6}{1}$.

Evaluation of emulsions with beef. To investigate the usefulness of the model system in concentrated solutions, emulsions were made with lean beef tissue as emulsifier at a water/protein ratio of 5/1. The meat was comminuted by chopping for 4 minutes before the oil was added. The emulsifying capacity and the stability of the emulsions with and without polyphosphates was evaluated.

Effect of the amount of water in a sausage emulsion. The effect of the amount of water on the stability of a sausage emulsion was studied by preparing emulsions of the following compositions:

beef	49 %	44 %	41 %	37 %	34 %
water	0 %	10 %	16 %	24 %	30 %
pork fat	49 %	44 %	41 %	37 %	34 %
salt	2 %	2 %	2 %	2 %	2 %

The amount of fat released after cooking was determined by weighing.

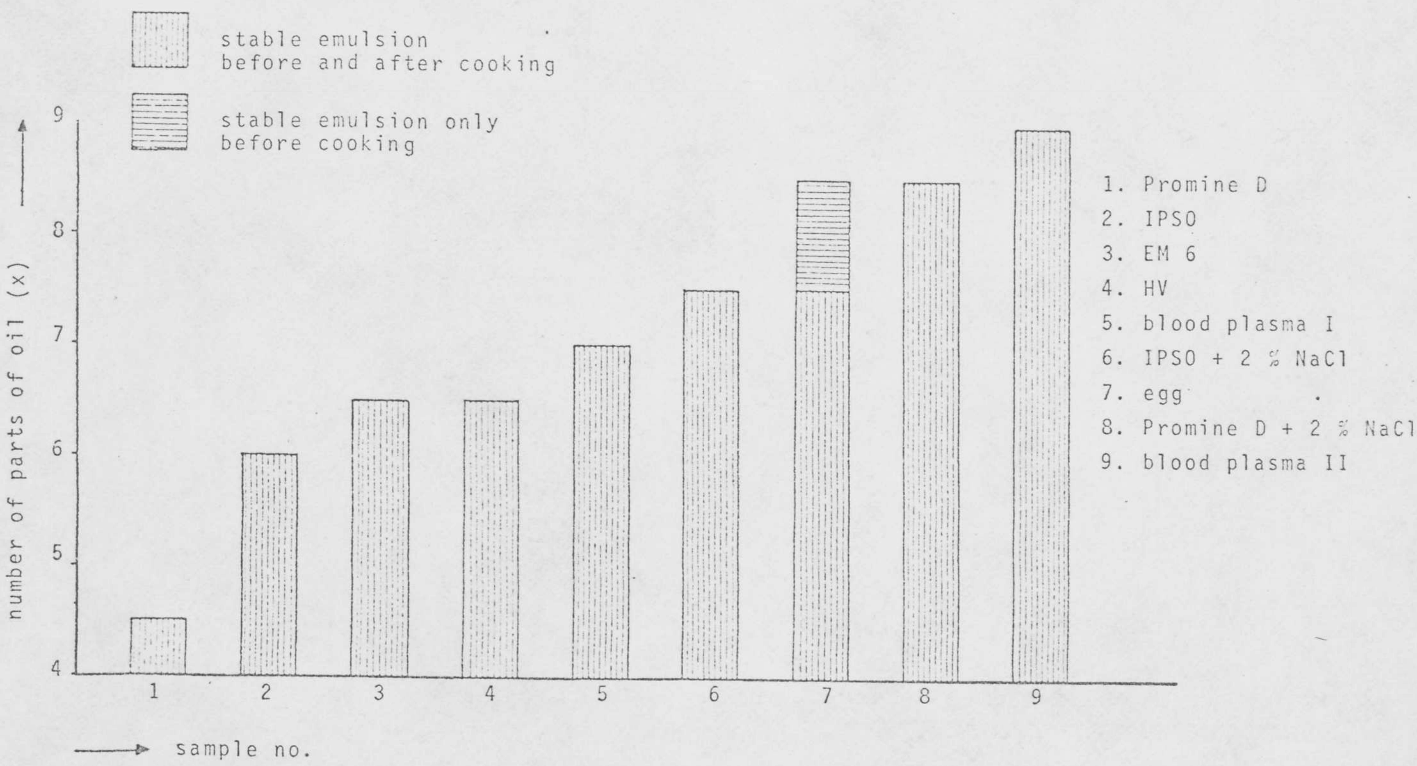
Emulsifying capacity in dilute solutions. The method of Swift et al. (5) for the determination of the emulsifying capacity in dilute solutions (water/protein ratio about 1000) was used with some modifications.

To 50 ml protein solution of 25 °C peanut oil was added by means of a motor driven burette at a dosing speed of 0.46 ml/sec. The speed of the mixer was calibrated with a stroboscope at 12.000 rpm. A rheostat was used to provide variable speeds of the motor. The formation and collapse of the emulsion was observed by change of the electric conductivity of the mixture (3). Standard solutions of the proteins with a concentration of 0.1 % (0.2 % for the soy proteins) were diluted with 5 % saline by varying the amounts of standard solution in the 50 ml portion.

Results and discussion

Emulsifying capacity in concentrated solutions. The investigated emulsifiers differed considerably in their emulsifying capacities (Fig. 2).

Fig. 2. Emulsifying capacity of the non-meat proteins determined in concentrated solutions. Oil:water:protein = x:5:1

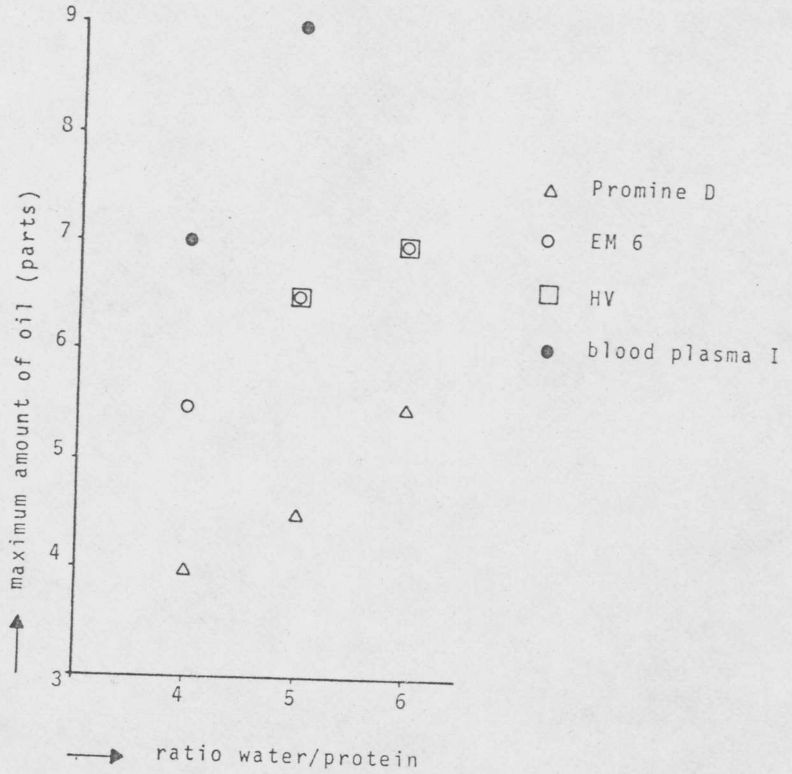


After sterilization all emulsions (except those with sodium caseinate) were qua consistency somewhat comparable with a luncheon meat type product.

Remarkable was that after heating, only the emulsions with whole egg powder had some separation of oil in the composition to which maximum amount of oil was added. All other emulsions were completely intact after heating. Consequently the emulsifying capacity appeared to be a more critical parameter for the evaluation of an emulsion than the stability during heating. The emulsifying capacity of the isolated soy proteins increase considerably by the addition of sodium chloride, but salt did not influence the emulsifying capacity of other proteins.

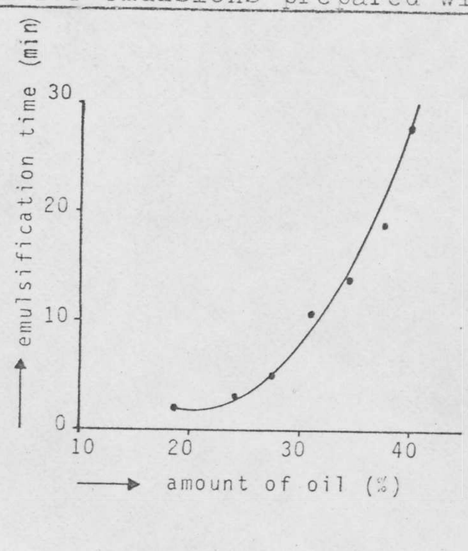
Effect of varying amounts of water. The emulsifying capacity increases when more water is added (Fig. 3). Moreover, the emulsion is formed quicker; the amount of water is, therefore, clearly a limiting factor at these concentrations. For the standard procedure a water/protein ratio of 5 is chosen.

Fig. 3. Effect of variation in ratio of water/protein on the emulsifying capacity



Evaluation of emulsions with beef. During the preparation of emulsions with beef the chopping time appeared to be a very important factor. In comparison with the procedure for the non-meat proteins it took much more time before a good emulsion was formed. This emulsification time was dependent on the amount of oil (Fig. 4) and accurate to determine (± 15 sec.). After sterilization the emulsions did not show any release of oil, not even after a chopping time of 30 minutes, during which the temperature was raised to 25 °C.

Fig. 4. Effect of varying amounts of oil on the emulsification time for emulsions prepared with beef



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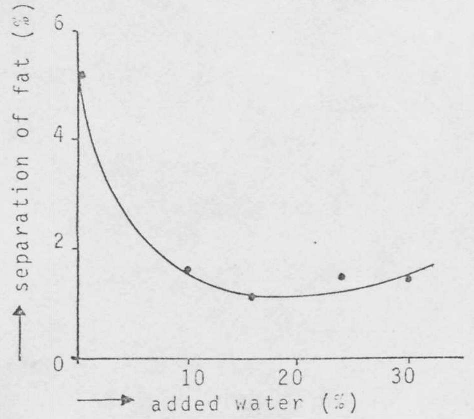
Though the amount of water again appeared to be a limiting factor during the chopping, all emulsions showed some release of jelly after sterilization. Addition of polyphosphates reduced the emulsification time approx. 16 %. In other words: at a chosen, constant emulsification time the emulsifying capacity increased by addition of polyphosphates. This well known fact, that the emulsifying properties of meat are promoted by polyphosphates could not be demonstrated by determination of the emulsifying capacity in dilute solutions. The water/protein ratio, therefore, seems to be very important for the effect of polyphosphates.

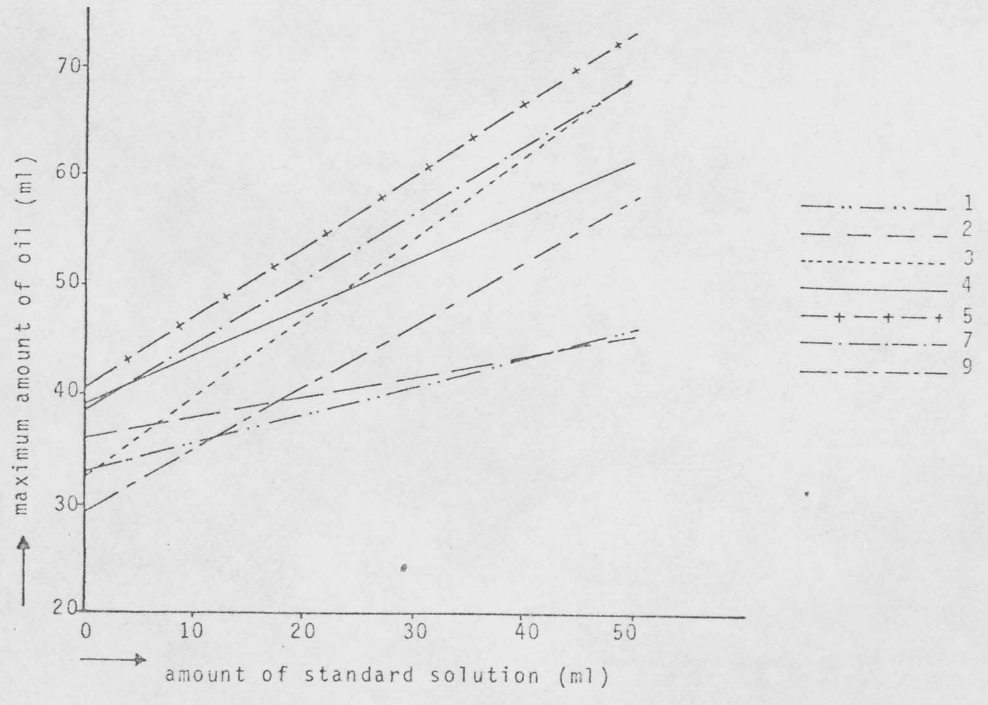
Effect of the amount of water in sausage emulsions. To obtain more information about the practical use of the model system, the effect of the amount of water was investigated with sausage emulsions. The results revealed that the amount of water can be a limiting factor for the emulsification of fat (Fig. 5). After having added approx. 16 % of water, the maximum stability concerning fat separation was obtained. The results found agreed with those of Schut (4).

Fig. 5. Effect of varying amounts of water in a sausage emulsion on the separation of fat



Emulsifying capacity in dilute solutions. The emulsifying capacities of the different non-meat proteins for standard solutions of 0.1 % are shown in Fig. 6. The correlation coefficient between ml of standard solution and ml of oil emulsified was 0.957-0.990. This means that the line of dilution can be rendered by the equation $y = A + Bx$, with x = ml of standard solution and y = ml of oil.

Fig. 6. Emulsifying capacity in dilute solutions of 0.1 % of the samples 1, 2, 3, 4, 5, 7 and 9 (see explanation Fig. 2)



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The coefficient B is indicating the slope of the line and is dependent on the protein concentration, while A (intersection with the ordinate) is independent on the concentration (Fig. 1). Therefore, different emulsifiers can be compared, though the concentrations of the standard solutions are not the same (3).

The emulsifying capacity can be expressed by one of the following parameters (Fig. 1): the specific emulsifying capacity, the effective emulsifying capacity and the slope of the line. These parameters were calculated for all the emulsifiers (Table 2).

Table 2. Emulsifying capacity of the non-meat proteins in dilute solutions of 0.1 %

Product	Specific em.cap.	Effective em.cap.	Slope
blood plasma I	40.3	72.8	0.65
HV	39.1	61.6	0.45
EM 6	38.4	69.4	0.62
IPSC	35.9	44.9	0.18
Promine D	33.1	46.1	0.26
egg	32.2	69.7	0.73
blood plasma II	29.2	58.7	0.59

For a comparison of these emulsifiers preferably a parameter has to be chosen, which is independent on the concentration, namely the specific emulsifying capacity. The slope of the lines can also be compared, provided that the results have the same concentration for all emulsifiers. It is less correct to express the emulsifying capacity in ml of oil pro mg of protein, because this measure is depending on the concentration.

Correlation between emulsifying capacities in concentrated and in diluted solutions. To compare the results of both model systems, the correlation coefficients between the emulsifying capacity of the non-meat proteins in concentrated solutions (with 2 % NaCl) and the different parameters for the emulsifying capacity in diluted solutions, were calculated (Table 3). It seems probable that the deficiency of a positive correlation is caused by the different water/protein ratios.

Table 3. Correlation coefficients between the emulsifying capacities as determined in concentrated and dilute solutions

Parameter	Correlation coefficients
Specific emulsifying capacity	- 0.880
Effective emulsifying capacity	- 0.206
Slope	- 0.510

Conclusion

The determination of the emulsifying capacity in a chopper with oil is a model system, which showed certain relation with practice. Especially the water/protein ratio appeared very important.

No correlation was found between the determination of emulsifying capacity in concentrated and in diluted solutions.

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