H6.

NITRITES AND NITROSAMINES IN PROCESSED MEATS

The influence of the presence of fat on the water-binding properties of meat proteins.

J. SCHUT and F. BROUWER.

Research Laboratory, section meat, DMV, Veghel, The Netherlands.

Summary.

Lean meat, ice, and salt were chopped and the chopping was continued without and with the addition of fat. The resulting lean meat slurries and the meat emulsions were extracted with brine and centrifuged. The fractions observed were, in case of the lean meat slurries: a water layer, containing soluble meat proteins (S), a dense protein fraction, consisting of mainly actomyosin, liberated from the sarcolemna (K), and a residue (R) consisting of fibre pieces and connective tissue particles. For the meat emulsions in addition a fat emulsion fraction (F) was found. The fractions were analysed on protein.
The lean meat slurries, the whole meat emulsions and emulsions made of the protein fractions were heated in cans, in order to determine water and fat exudation. Experiments showed that the "solid" K-fraction (of the experiments without fat) showed a swelling, gradually increasing with chopping time, when fat was present, followed by a rapid swelling. The rapid swelling of the K-fraction appeared to coincide with a sudden increase of extremely fine distributed fat in the K-fraction. At the same time emulsion stability grew to its maximum.
As a possible explanation the orientation of the side chains of the protein in the fat - water interface is suggested. The non-polar groups, being directed towards the fat, give rise to a decrease of inter- and intramolecular and interfilamental hydrophobic bounds, which allow the protein system to swell.
The swelling of the actomyosin seems to be dependent on chopping time rather than on temperature. Prolonged chopping leads to a shrinkage of the swollen actomyosin even at low temperatures.
The sarcoplasmic proteins seemed to interfere undesirably in the water-holding capacity and emulsion stability.
The presence of much fat, particularly beef fat, in an early stage of the chopping process appeared to be unfavourable.
It is suggested that the sarcoplasmic proteins, being the only available emulsifier in the early stage of the chopping process, get denatured.
The denatured sarcoplasmic proteins would possibly be replaced by the salt soluble proteins, in a later stage of the chopping process and could form an insoluble deposite on the myofibrilar proteins, and so interfere unfavourably with the water-holding capacity.

L'influence de la présence de graisse sur le pouvoir liant d'eau des protéines de viande.

J. SCHUT et F. BROUWER.

Laboratoire de recherche, section de viande, DMV, Veghel, Pays - Bas.

Sommaire.

De la viande maigre, de la glace et du sel étaient passés au cutter. Le cutterage était prolongé, soit avec de la graisse soit sans graisse.
Les suspensions de la viande maigre et les émulsions de la viande/eau/graisse étaient extraitées avec de la saumure et centrifugées. Les fractions observées étaient, dans le cas des suspensions de viande maigre: une couche d'eau, contenant des protéines de viande solubilisées (S), une fraction dense de protéines, qui consistait principalement de l'actomyosine, libérée du sarcolemna (K) et un résidu (R) se composant de morceaux de fibre et particules de tissu conjonctif. Pour l'émulsion de la viande une fraction d'émulsion graisseuse a été trouvée en plus. Les fractions ont été analysées pour la teneur en protéine.
Les suspensions de viande maigre, les émulsions de la viande entière, et des émulsions fabriquées à base de fractions des diverses protéines de la viande étaient chauffées dans des boîtes, à fin de déterminer l'exudation d'eau et de graisse. Si de la graisse était présente, des expériences montraient que la fraction solidifiée "K" (des expériments sans sel) se gonflait progressivement avec l'augmentation du temps de cutterage et était suivie par un gonflement rapide. Le gonflement rapide coïncidait avec une augmentation soudaine de la graisse, finement divisée dans la fraction "K".
En même temps la stabilité de l'émulsion atteignait son maximum. Comme explication possible on pourrait suggérer une diminution dans les liens hydrophobes intramoleculaires et intrafilamenteux. Ceci donnerait un gonflement de la fraction "K". Le gonflement de l'actomyosine insoluble semblait dépendre du temps de cutterage plutôt que de la température. Des temps de cutterage prolongés menaient à une diminution de l'actomyosine gonflée, même à basses températures. La présence de beaucoup de graisse, particulièrement de la graisse de boeuf, dans un stade prématuré était défavorable.
Les protéines sarcoplasmatiques semblaient intervenir d'une manière non désirée sur la capacité de rétention d'eau et la stabilité de l'émulsion.

Der Einfluss der Fettanwesenheit auf der Wasserbindung des Fleischeiweisses.

J. SCHUT und F. BROUWER.

Forschungslabor, Abteilung Fleisch, DMV, Veghel, Niederlande.

Kurzfassung.

Magerfleisch, Eis und Salz wurden feinzerkleinert und anschliessend ohne und mit Fett weiter gekuttert. Die entstandenen Magerbräte und Wurstbräte wurden mit einer Lake versetzt und sofort zentrifugiert. Nach der Zentrifugierung wurden drei bzw. vier Fraktionen gefunden, und zwar eine wässerige Schicht (S), die lösliches Eiweiss enthält, eine kompakte Eiweisschicht (K), hauptsächlich aus von Sarkolemm befreiten Aktomyosin bestehend und ein Residu (R), dass zerkleinerte Faserbruchstücken und Bindegewebe enthält. Für das Wurstbrät wurde zusetzlich eine Fettemulsionschicht gefunden. Die Fraktionen sind auf Eiweissgehalt analysiert worden. Die Magerbräte, Wurstbräte und Emulsionen aus den originellen Fraktionen der Magerbräte (nach verschiedener Kutterzeit) sind in Dosen abgefüllt und sterilisiert worden, wonach die Absatzwerten ermittelt worden sind. Die Versuche haben erbracht, dass die unlösliche K-Fraktion (der Magerbräte) in Anwesenheit von Fett erst langsam quellt mit der Kutterzeit und bei fortschreitender Zerkleinerung eine rasche Quellung zeigt. Die rasche Quellung ist mit einer erheblichen Zunahme von feinstzerkleinertem Fett in der K-Fraktion verbunden. In gleicher Zeit erreicht die abgesetzte Menge Gelee (bei der Erhitzung) ein Minimum. Als mögliche Erklärung wird auf die Orientierung der Seitenketten der Eiweissmolekulen hingewiesen. Die apolare Gruppen werden an die Fett - Wasser Grenzfläche adsorbiert und könnten eine Schwächung der inter- und intramolekularen und interfilamentaren hydrophoben Bindungen zufolge haben. Damit wäre eine Quellung des Eiweissnetzwerkes ermöglicht. Die Quellung des Aktomyosins erscheint kutterzeitabhängig zu sein und kaum von der Kuttertemperatur beeinflusst zu werden. Längere Kutterzeit führt zu einer Verringerung des gequollenen Aktomyosins, auch bei verhältnismässig niedrigen Temperaturen.
Es ist weiter gefunden worden, dass die Anwesenheit der Sarkoplasma-Eiweisse sich nachteilig auswirkt auf der Emulsionstabilität. Auch die Anwesenheit von viel Fett, am Anfang des Kutterprozesses, insbesonderes Rindfett, hat sich ungünstig erwiesen. Es wird in dieser Beziehung darauf hingewiesen, dass die Sarkoplasma-Eiweisse im Anfang der Zerkleinerung im Grenzflächenbereich denaturiert werden könnten. Spätere Verdrängung durch die freigesetzten salzlöslichen Eiweisse könnte dazu führen, das die denaturierten Sarkoplasma-Eiweisse eine ungünstige Auswirkung auf der Wasserbindung der myofibrillaren Eiweisse ausüben.

Влияние присутствия жира на водосвязывающие свойства мясных белков.

Измельчали нежирное мясо со льдом и солью, и продолжали измельчение с добавлением жира и без него. Полученные нежирные мясные каши и мясные эмульсии экстрагировались рассолом и центрифугировались. В случае нежирных каш замечались следующие фракции: водяной слой, содержащий растворимые мясные белки (S), густая белковая фракция, состоящая главным образом из актомиозина, освобожденного из саркоолемны (K), и остаток (R) из кусков волокна и частиц соединительной ткани. В случае мясных эмульсий добавочно обнаружили фракцию жировой эмульсии(F). На фракции проводили анализ белков.
Нежирные мясные каши, цельномясные эмулсии и эмульсии,состоящие из белковых фракций нагревали в банках, чтобы определить эксудацию воды и жира. Опыты показали, что так называемая твердая К-фракция - в опытах без жира - в присутствии жира показывала набухание, увеличивающееся постепенно длительностью измельчения и потом быстрое набухание. Это быстрое набухание К-фракции видимому совпадало с внезапным увеличением мельчайшей жировой дисперсии в К-фракции. В то же время стабильность эмульсии достигла максимума.
В качестве возможного обьяснения предполагается ориентация боковых цепей белка на границе жира и воды. Неполярные группы, направленные к жиру, обуславливают уменьшение меж- и внутримолекулярных и междунитьевых гидрофобных связей, что позволяет белковой системе разбухать.
Набухание актомиозина повидимому скорее зависит от длительности измельчения чем от температуры. Продолжительное измельчение приводит к сжатию распухшего актомиозина, даже при низких температурах.
Саркоплазмовые белки, -казалось, нежелательно действовали на водоудерживающую способность и стабильность эмульсии.
Присутствие большого количества жира, особенно говяжьего, в ранней стадии измельчения оказалось неблагоприятным.
Предполагается, что у саркоплазмовых белков, являющихся единственно действующим эмульсификатором в начальной стадии измельчения потеряется растворимость, т.е. происходит денатурация.
Денатурированные саркоплазмовые белки в поздней стадии, возможно, могли бы быть замещены растворимыми в рассоле белками и могли бы образовать нерастворимый осадок на миофибрилярных белках, и таким образом воздействовать неблагоприятно на водоудерживающую способность.

Й. СХУТ и Ф. БРАУВЕР

Исследовательская лаборатория, отделение Мясо, DMV, Вэхель, Нидерланды.

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J. SCHUT and F. BROUWER.

Research Laboratory, section meat, DMV, Veghel, The Netherlands.

I. Introduction.

It is a known fact, that meat fibres are able to take up water under favourable conditions, this being accompanied by swelling of the tissue. As long as meat fibres are still intact, the swelling is limited by the sarcolemna. When meat is comminuted and both the sarcolemna and the meat fibres are disintegrated, the latter fall apart more or less completely into myosin and actin filaments. The resulting filament slurry is capable to practically unbound swelling when the attraction forces between myosin and actin molecules and between filaments are weakened. By increasing pH and addition of salt and phosphates, the loose protein network of the filament slurry swells, resulting in an increase of intermolecular and interfilamental spaces and an increased uptake of water. These forces, of which the weakening or strengthening has such a considerable influence on the water-holding capacity (WHC) and swelling of the meat, are of electrostatic nature. It was found (1,2,3), however, that also the presence of fat has a considerable influence on the WHC of meat. It was the aim of the underlying work to investigate the mechanism behind this phenomenon.

II. Experimental.

1) Chopping procedure.

Post-rigor lean meat is chopped for ½ minute with 4 % salt and then 2½ minutes with 60 % ice. From this point chopping is continued with and without added fat, under strict temperature control. After heating in cans, 45 min./110°C, and subsequent chilling, the water and fat separation is determined.

2) Quantitative determination of protein fractions.

Both the lean meat slurries and the meat emulsions are chilled at 4°C, gently stirred with brine (2,8 % salt) and immediately centrifuged, resulting in three and four fractions respectively:

Lean meat slurries:	Meat emulsions	
-	a) Emulsion layer	: fat, water, proteins.
b) Water layer	b) Water layer	: sarcoplasm proteins (WSP) and a soluble part of the myofibrillar proteins (SSP).
c) K-fraction	c) K-fraction	: actomyosin, liberated from the sarcolemna (4).
d) Residue	d) Residue	: meat fibre pieces and connective tissue.

Both the K-fraction and the residue (R) are washed and centrifuged twice. All the fractions were weighted and analysed on protein. In some cases the WSP are extracted with 0,02 M KCl previous to the chopping with salt and ice.
The influence of the chopping time and temperature, of various kinds of fat and meat and the role of the various meat protein fractions are investigated.

III. Results and discussion.

In accordance with the followed procedure the amounts of the protein fractions found in the lean meat - salt - water slurry, and calculated in percentage of the total protein, are a quite constant quantity of WSP of 24 to 25 %, 8-10 % of SSP (beef fore hand) to 3-4,5 % (beef head meat) and of the K-fraction and the residue ranging from 27-43 % and 40 - 23 % respectively (beef fore hand).
For frozen meat a slight increase in the amount of WSP has been found, whereas the quantity of SSP has been observed to decline slightly. The influence of freezing on the amounts of K-fraction and residue was varying.
It is interesting to note that the amount of K-fraction found after simultaneous extraction of WSP and SSP (chopping lean meat with salt and ice) is considerably less than after separate extraction of WSP and SSP (16-18 % compared to 30-40 %). Apparently, the presence of WSP inhibits the formation of K-fraction to some extent. The K-fraction is found as a distinct and more or less swollen layer, which is easily to distinguish and to separate from the water layer and the residue.
When fat is chopped into the lean meat slurry, the K-fraction gradually swells with chopping time and takes up considerable amounts of water, (table I, W_s and W_k), whereas in the same time the exudation at heating decreases (table I). This is not, in the first place, a matter of time of chopping the lean meat slurry, but merely due to the presence and the degree of disintegration of the fat (oil). In most cases the water layer and the swollen K-fraction unite almost completely and no accurate separation of the two is anymore possible. They form a more or less viscous colloidal solution, showing some turbidity, which means that the K-fraction is not really dissolved.
Table I also shows, that the amount of residue falls off with chopping time much faster when fat is present; in the same time the amount of protein in the fat emulsion layer increases. Apparently, the presence of fat promotes a shift of the meat proteins from the residue to the more swollen condition.
Analysis of fat in the K-fraction shows a slow increase in the beginning and a sudden steep rise at a certain chopping time. This dramatic increase coincides with the sudden swelling of the K-fraction (table I). These phenomena suggest that the fat plays an important part in the swelling of the actomyosin (K-fraction), and could be explained by the orientation of the side chains of the protein molecules of the K-fraction. The non-polar groups, being directed towards the fat, give rise to a decrease of inter- and intramolecular and interfilamental hydrophobic bonds, which allows the protein molecules to swell.
At a prolonged chopping time the swollen actomyosin shrinks again. The swelling and shrinkage of the actomyosin depends on chopping time, rather than on temperature, although these phenomena seem to occur earlier when chopping temperature is lower. The temperature, particularly of the lean meat slurry, is of extreme importance for the emulsion stability (table III). Provided the lean meat slurry is prepared at a low temperature, a temperature increase during the chopping with fat has only a minor influence on emulsion stability, unless the temperature exceeds approximately 23°C (table II and III) or the chopping time is extraordinary long (table II). The first effect is suggested to be caused by a sudden decrease in elasticity of the interfacial protein films, resulting in coalescense of the fat particles (5). The latter phenomenon could be due to a progressive protein denaturation at prolonged chopping time (4,5).
The presence of much fat at the beginning of the chopping process is shown to be unfavourable, particularly in the case of beef fat (table IV).

This could possibly be due to an interfacial denaturation of the WSP, being the only available protein in the early stage of the chopping process. Since it has been found previously that SSP is preferentially adsorbed at the interface (4), it is not to be excluded, that the SSP take the place of the WSP in the fat - water interface in a later stage of the chopping process. The denatured WSP could possibly form an insoluble deposite on the myofibrillar proteins and so interfere with their water-holding capacity. Table V seems to confirm the unfavourable influence of the WSP fraction. From this table it can be seen, that a meat emulsion is more heat-stable and the amounts of fat and water, bound per gram of protein are higher in the absence of WSP, in spite of a lower protein content. A combination of SSP and K-fraction, representing the major part of the myofibrillar proteins, shows the highest water- and fat-binding effect. Also here the results are less favourable in the presence of WSP.
The soluble protein fractions (WSP and SSP) show a very high water- (and fat-) binding capacity as can be seen from table VI, last column. The heated product deviates considerably from a normal sausage structure; it is an extremely swollen weak gel, and very much sensitive to mechanical stress. At the slighest stress, the gel breaks, releasing substantial amounts of water. This seems to be mainly due to the presence of WSP, which unlike pure SSP, show the same behaviour in a pronounced form, if heated alone. At prolonged chopping of the soluble proteins (WSP + SSP extracts) with fat an increasing amount of insoluble protein is observed (column K), which has been identified as actomyosin (4). The quantity of soluble proteins in the fat-emulsion layer is almost negligible.
The K-fraction is the next best in water- and fat-binding capacity; the total exudation at heating is of the same order as from the "whole meat sausage", inspite of the much lower protein content of the former. Also here, the amount of protein absorbed in the fat-emulsion layer is low.
The lowest part of table VI suggest a shift of protein from the residue to the swollen and soluble form, with chopping time. Apparently, a substantial part of the protein of the residue is absorbed in the fat-emulsion layer. The exudation at heating the "meat emulsion", made of the residue with fat, is highest of all; the texture, however, is most similar to that of a sausage.
The general picture resulting from these experiments is that the presence of comminuted fat helps the K-fraction to swell and contributes to emulsion stability. The results further suggest that the function of the soluble proteins partly is to prevent coalescence of the fat particles during chopping. An other important role seems to be to support the matrix during the heat treatment by means of forming a solid gel, together with the swollen K-fraction. These properties must mainly be put on the credit of the SSP-fraction. The presence of WSP appeares to influence emulsion stability in an unfavourable way. There is evidence that the SSP used as emulsifier get denatured in the interface (4) and are not able anymore to jellify at heating. This is supported by the observation that a meat emulsion made with liquid oil, resulting in an extreme large interface, fails to built up a coherent structure at heating (5). The protein (particles) of the residue show a great affinity for the fat fraction and are most important for the body of the sausage.

Legends.

C_t = chopping time in minutes
AC_t = additional chopping time in minutes
T = temperature in °C at the end of the chopping process
S_f = fat separation after heating in % of initial product weight
S_w = water separation after heating in % of initial product weight
S_t = total separation of water and fat, after heating in % of initial product weight
W = water distribution over the various fractions after centrifuging in % of total water:
W_e = in emulsion layer
W_s = in soluble protein layer
W_k = in K-fraction
W_r = in residue
P = protein distribution over the various fractions after centrifuging in % of total protein:
P_e = in emulsion layer
P_s = in soluble protein layer
P_k = in K-fraction
P_r = in residue
F_k = fat in K-fraction in % of total K-fraction weight
F/P = grams of fat bound per gram of protein
W/P = grams of water bound per gram of protein
P_{fe} = % meat protein in fat-emulsion layer in % of total meat protein
C = composition of the meat emulsion
C_p = % protein in the meat emulsion
C_w = % water in the meat emulsion
C_f = % fat in the meat emulsion
F_a = fat addition

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Table I

Meat emulsion with and without fat and oil: Water and protein distribution over the various fractions after dilution with brine and subsequent centrifuging, and the water and fat separation of the products after cooking.

				separation in % of initial product weight		water distribution after centrifuging in % of total water					protein distribution after centrifuging in % of total protein			
No.	AC_t	fat/oil	T	S_f	S_w	W_e	W_s	W_k	W_r	F_k	P_e	P_s+P_k	P_r	P_{fe}
1	0	-	-2	-	24,7	-	69,7	11,0	19,3	-	-	44,6	55,4	-
2	1	-	-1	-	21,4	-	61,6	18,6	19,8	-	-	=	=	-
3	2	-	2	-	21,1	-	58,6	19,9	21,5	-	-	51,3	48,7	-
4	3	-	4	-	20,6	-	54,8	22,8	22,4	-	-	=	=	-
5	5	-	6	-	20,5	-	61,3	21,1	17,6	-	-	61,2	38,8	-
6	7	-	8½	-	21,0	-	60,8	22,0	17,2	-	-	65,5	34,5	-
		+fat												
7=1	0	-	-2	-	25,4 16,9**	-	69,3	11,8	18,9	0,1	-	47,0	53,0	-
8	1	+	-1	3,9	11,6	6,3	61,6	17,8	14,3	0,3	1,8*	59,4	38,8	0
9	2	+	1½	1,1	9,6	6,7	65,0	16,3	12,0	0,3	9,9*	62,0	28,1	0,3
10	3	+	6	0,6	10,3	7,6	9,1	75,2	8,1	1,2	13,0*	67,0	19,9	0,5
11	5	+	8	0,2	9,6	8,1	9,4	77,3	5,2	1,5	13,8*	73,3	12,9	0,6
12	7	+	11	0,1	8,8	9,0	9,1	76,8	5,1	1,5	15,0*	70,9	14,1	0,7
		+oil												
13=1	0	-	-2	-	25,6 16,9**	-	69,2	11,8	19,0	0,1	-	43,0	57,0	-
14	1	+	2		50,4	9,0	69,6	5,3	16,1	0,3	=	=	=	=
15	2	+	4		37,8	13,6	60,5	12,5	13,4	0,5	16,8	43,9	39,2	0,9
16	3	+	7	-	12,1	11,5	0	75,7	12,8	2,7	16,3	52,1	31,6	0,9
17	5	+	9	-	9,3	12,8	0	77,2	10,0	5,0	19,0	56,1	24,9	1,0
18	7	+	11	-	9,3	14,7	0	76,6	8,7	5,2	23,2	54,0	22,8	1,3

*) protein from fat tissue excluded.
**) water separation calculated on the lean slurry part of the meat emulsion.

Recipe: beef meat: 40,7 %
salt : 1,6 %
ice : 24,4 %
fat/oil : 33,3 %

Table II

Meat emulsion with and without fat: Water and fat separation in % of total product and water absorbed by K-fraction (W_k) after dilution with brine and subsequent centrifuging in % of total water. Relation with chopping time and temperature with and without intermediate chilling.

without intermediate chilling:							with intermediate chilling:						
					separation %							separation %	
No.	AC_t	T	F_a	W_k	S_f	S_w	No.	AC_t	T	F_a	W_k	S_f	S_w
1	0	-2	0	13,0	-	17,9							
2	1½	-1	+	80,8	0,3	9,1							
3	4½	7	+	80,1	-	6,9							
4	8½	14	+	70,7	-	7,5	9	8½	-2	+	67,9	-	8,0
5	14	18	+	42,7	-	9,7	10	14	-3	+	41,4	-	9,4
6	24	24	+	26,8	7,8	26,6	11	24	16	+	25,2	-	11,7

Recipe: beef meat: 40,7 %
salt : 1,6 %
ice : 24,4 %
fat : 33,3 %

Table III

Meat emulsions with fat: Water and fat separation in % of total product and water absorbed by the K-fraction after dilution with brine and centrifugation, in % of total water. Relation with chopping temperature of the lean base (meat - salt - water).

			separation %						separation %		
AC_t	T	W_k	S_f	S_w	S_t		T	W_k	S_f	S_w	S_t
0	-1	14,5	-	-	-		6	11,7	-	-	-
1½	7	78,4	0,3	17,0	17,3		13	12,7	0,7	20,9	21,6
3	11	81,2	0	11,8	11,8		16	81,8	0,3	15,4	15,7
4½	14	81,9	0	11,5	11,5		18	81,6	0,3	14,0	14,3
6½	15	84,0	0	9,4	9,4		20	83,4	0,2	13,0	13,2
8½	17	82,1	0	10,5	10,5		22	80,7	0,3	14,9	15,2
11	19	78,7	0	12,9	12,9		23	81,3	0,3	16,4	16,7
0	12	9,3	-	-	-		19	10,3	-	-	-
1½	17	12,7	3,3	26,0	29,3		21	11,7	3,4	27,2	30,6
3	20	12,4	1,0	19,4	20,4		24	13,1	3,3	26,4	29,7
4½	22	83,1	1,1	19,1	20,2		25	82,1	8,2	29,3	37,5
6½	23	84,6	1,4	21,0	22,4		26	84,2	10,7	28,7	39,4
8½	24	84,5	9,2	28,5	37,7		27	84,3	10,6	28,2	38,8
11	25	85,4	8,3	27,5	35,8		27	84,5	10,0	29,8	39,8

Recipe: beef meat: 40,7 % ice: 24,4 %
salt : 1,6 % fat: 33,3 %

Table IV

Meat emulsions made of different kinds of meat containing various initial amounts of fat: (Fat contents of meat emulsion ranging from 24-27%) Fat and water separation.

	% fat on lean	separation in %			% fat on lean	separation in %			% fat on lean	separation in %		
		S_f	S_w			S_f	S_w			S_f	S_w	AC_t
Beef	21,0	12,6	26,0	beef fore	2,6	2,4	14,4	pork	25,7	3,0	21,1	1½
head		11,5	26,9	hand (1)		0,1	8,8	head		1,0	18,8	4½
meat		14,3	26,2	frozen		0,1	9,0	meat		0,7	20,0	8½
Beef	6,6	7,8	25,8	beef fore	19,2		13,9	pork	12,6	2,6	18,6	1½
head meat		4,2	24,0	hand + add.		0,1	9,1	head		0,2	9,5	4½
defatted		7,1	27,8	pork fat		0,-	9,5	meat defatted		0,3	11,3	8½
Beef fore	2,6	2,0	14,8	beef fore	6,5	1,4	20,8	pork	6,1	1,0	14,7	1½
hand (1)		0,-	7,5	hand (2)		0,-	13,1	shoulder		0,-	7,8	4½
		0,-	9,7			0,1	17,6			0,1	9,8	8½
Beef fore	15,2	0,7	22,7	beef fore	2,1	3,8	16,4					1½
hand (1) with		0,4	22,5	hand (2)		0,-	6,3					4½
extra beef fat		1,2	27,8	defatted		0,-	7,7					8½

Table V

Emulsions made from various meat protein fractions: Fat and water separation.

	emulsion composition %			70°C		110°C		g. water and fat bound / g. protein	
	C_p	C_w	C_f	S_f	S_w	S_f	S_w	F/P	W/P
Whole meat	9,8	59,7	28,0	0	9,0	0	16,8	2,8	4,4
Meat - WSP	7,7	61,8	28,0	0	5,3	0	12,6	3,6	6,4
SSP + K	3,5	64,5	29,5	0	17,0	1,5	24,5	8,0	11,4
WSP + SSP + K	4,0	64,0	29,5	0,7	15,3	1,4	21,4	7,0	10,7
Residue 1*	4,2	64,8	28,5	0	24,4	3,4	36,7	6,0	6,7
Residue 2*	4,1	64,9	28,5	2,1	28,5	13,5	44,6	3,6	5,0
Whole meat	8,9	56,5	32,1	0	7,4	0	15,4	3,6	4,6
Meat - WSP	6,8	58,6	32,1	0	3,1	0	11,7	4,7	6,9
SSP + K	2,5	61,1	33,9	0	1,2	0	26,1	13,5	16,0
WSP + SSP + K	3,1	60,5	33,9	0	14,9	0	25,7	10,9	11,2
Residue 1*	3,3	61,4	32,6	0	13,3	0	28,5	9,9	9,9
Residue 2*	3,2	61,5	32,6	0	28,5	0	38,0	10,0	7,3

*Residue 1 is not washed, residue 2 is washed with brine.

Table VI

Emulsions made from various meat protein fractions with and without fat. Water and fat separation, water absorbed by the K-fraction and protein distribution over the various fractions.

		emulsion composition in %			protein distribution after centrifuging in % of total protein					separation in % of total product		g. water and oil per g. protein	
	C_t T	C_p	C_w	C_f	P_e	P_s	P_k	P_r	W_k	S_f	S_w	F/p	W/p
Beef meat													
	0	13,6	81,1	2,3	0	41,5	11,9	46,6	17,6	0	25,6	-	4,0
	1 13	10,6	61,2	25,8	8,5	38,6	22,1	30,8	69,2	4,8	17,2	2,0	4,1
	2 14	10,6	61,2	25,8	11,5	39,6	22,7	26,2	70,4	1,0	14,5	2,3	4,4
	3½ 15	10,6	61,2	25,8	11,5	38,4	28,3	21,8	72,5	0,5	14,3	2,4	4,4
	5½ 16	10,6	61,2	25,8	11,4	38,2	32,4	18,0	73,5	0,2	11,3	2,4	4,7
	7½ 17	10,6	61,2	25,8	13,2	37,3	35,1	14,4	71,5	1,0	11,9	2,3	4,7
K-fraction													
	0	5,0	92,2	0	0	48,8*	51,2	0	34,8	0	45,5	-	9,3
	1 15	4,2	70,8	22,5	5,1	58,8	32,2	3,9	41,8	6,3	21,8	3,8	11,7
	2 15	4,2	70,8	22,5	5,0	55,4	31,7	6,9	84,5	0	14,0	5,4	13,7
	3½ 15	4,2	70,8	22,5	4,9	54,2	33,6	7,3	85,9	0	11,2	5,4	14,2
	5½ 16	4,2	70,8	22,5	=	=	=	=	85,2	0	13,8	5,4	13,5
	7½ 16	4,2	70,8	22,5	5,5	51,3	35,9	7,3	85,7	0	13,8	5,4	13,5
WSP + SSP													
	0	2,8	94,4	0	0	87,5	12,5	0	19,2	0	21,3	-	26,1
	2 14	2,5	72,2	22,5	0,3	86,5	13,2	0	29,3	0	1,5	9,-	28,3
	5½ 14	2,5	72,2	22,5	3,8	81,5	14,7	0	39,2	0	1,8	9,-	28,2
	7½ 15	2,5	72,2	22,5	=	63,6	31,4	0	53,9	0,6	21,9	8,7	20,1
Residue													
	0	8,8	89,2	0	0	24,6	10,7	64,7	13,4	0	51,3	-	4,3
	1 14	7,0	66,2	24,8	14,0	31,3	13,0	41,7	18,9	14,6	36,4	1,4	4,3
	2 14	7,0	66,2	24,8	17,2	30,1	17,8	34,9	34,8	2,7	28,3	3,1	5,4
	3½ 14	7,0	66,2	24,8	17,1	27,5	24,2	32,2	59,0	2,6	27,8	3,2	5,5
	5½ 15	7,0	66,2	24,8	20,6	25,2	28,2	26,0	61,7	1,8	24,8	3,3	5,9
	7½ 15	7,0	66,2	24,8	19,2	25,8	30,4	24,6	46,5	2,3	23,4	3,1	6,1

*) no exact separation of the water soluble protein and K-fractions possible.