MEAT AND PROTEIN ADDITIVES : AMINO ACID AND MINERAL COMPOSITION

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The research was undertaken to examine the amino acid mineral composition of protein additives used in Lithuania meat industry and evaluate their influence as meat substitutes. Soy concentrate and isolate, sunflower concentrate, sodium caseinate, whey protein concentrate, skimmed milk and buttermilk power, dry lightened blood and dry protein concentrate (50 % blood and 50 % skimmed milk) were analyzed on their amino acid and mineral (Na, K, Ca, Mg, Fe, Zn, Cu, Mn) composition. The pork meat was examined as the reference pattern.

Calculations of the influence of 5 % dash of any mentioned protein additive to amino acid and mineral composition of model meat product revealed the varieties in selected nutrients content depending on the used additive.

Solitary non meat protein additives affect the common meat amino acid and mineral composition. Therefore, the proper selections of meat substitution (especially in dietetic products) require higher accuracy and, on the other hand, well- founded protein mixtures would be far superior to the single protein additive.

• *INTRODUCTION*

Today's consumers want not only products that are convenient and taste good, they also concerned about nutritional value. Non meat protein additives are widely used in meat industry due to their technological, nutritional properties and economy. Each protein, according it's origin, methods of isolation and manufacturing, has unique composition that does or would make that protein can enhance the nutritional properties of the food it is added to [1 - 3] and all daily allowances, also.

The protein additives are used as meat substitutes and there is an important to keep the same level of nutrients which is in meat.

Amino acid composition is mostly used as criteria to asses protein nutrition [4,7]. Since each product together with proteins contains other biological necessary constituents (lipids, carbohydrates, minerals), one of them - minerals -were investigated and analyses on their potential influence on common meat product composition was made, also. The aims of the present study were :

1. Investigate chemical, amino acid and mineral composition of protein additives most commonly used in Lithuania.
2. Calculate possible changes in meat microsubstances due protein additives' employment.
3. Select the best meat substitute according the nutritional value.

• *OBJECTS*

Dry protein additives collected from Lithuania food industry:

- SI - soy isolate Purina 500 E- made in USA,
- SK - soy concentrate Danpro H- made in Denmark,
- SB - sunflower protein- made in Ukraine,
- NK - sodium caseinate -made in Estonia,
- IBK - whey protein concentrate - made in Estonia,
- SP - butter milk - made in Lithuania,
- SNP - skimmed milk - made in Lithuania,

- SNK - dry lightened blood (by using of hydrogen peroxide) - made in Lithuania,
- SBM - dry protein mixture (1 part of lightened blood and 1 part of skimmed milk) - made in Lithuania.

Base on facts that:

- meat has high biological value with good balance of amino acids and almost full complex of essential minerals for human vitally activity,
- science progress changes criteria of nutritional value (FAO/WHO,1973, FAO/WHO/UNU,1984),
- there is is no agreement about necessary in balance of all nutrients in one product

in our research lean pork meat was used as the reference pattern.

- *PROCEDURE*

Proximate composition of these proteins was determined by following procedures:
moisture - drying at 105° C in an oven for 24 h,
ash - mineralization at 550° C,
crude protein - calculated by multiplying the percent nitrogen obtained by half micro Kjeldhal method with the factor 6.25,
crude fat - by Soxhlet extraction with chloroform,
amino acid analyses - on an amino acid analyzer (model T339, Czech), following hydrolyze with 6 N HCl at 110° C for 24 h.
trypthopane - photocolorimetric method (with paradimethilbenzaldehide) following alkaline hydrolyze with 2,5 NaCl at 114° C for 4 h. Photoelectric colorimeter FEK - 60 - Y.42 (Russia),
mineral composition - spectra emission photographic method. Spectrograph ISP - 28 (Russia),
Ca, Mg, Fe, Zn, Cu, Mn - atomic absorption spectrophotometer (model Perkin - Elmer), following mineralization with perchloric acid,
Na, K - after mineralization with perchloric acid with spectrophotometer PFM (Hungary),
P - photocolorimetric method (with ammonia molibdate). Photoelectric colorimeter FEK - 60 - Y.42 (Russia).

All determinations were performed triplicate.

Calculation of the influence of dash of protein additive to amino acid and mineral composition of model meat product was made according formula:

$$\Delta = \frac{K_{1i} - K_{0i}}{K_{0i}} = \frac{0{,}05 \cdot P_{ji} - K_{0i} \cdot \Delta m}{K_{0i}}, \%$$

$$K_{1i} = K_{0i} - K'_{0i} + P'_{ji}; \quad K'_{0i} = K_{0i} \cdot \Delta m; \quad \Delta m \ni B_j$$

K_{0i} - content of i amino acid or mineral in meat;
K_{1i} - content of i amino acid or mineral in combined product with j protein additive;
K_{1i} - content of i amino acid or mineral which is put out with replaced meat;
P_{ji} - content of i amino acid or mineral which is put in with j protein additive;
Δm - content meat which is replaced by j protein additive;
P_{ji} - content of i amino acid or mineral in j protein additive;
B_j - content protein in j protein additive.

- *RESULTS AND DISCUSSION*

1. Chemical composition of protein additives

The chemical composition of examined protein additives is given in Table 1. It was found that the protein additives contain appreciable amount of moisture (5 -9,3%) and fat (0,6 - 1.7%), but were different in ratio of macronutients. The protein content was highest for soy isolate and sodium caseinate (89,1 and 86,8%) and was lowest for whey, butter - milk and non - fat milk (16,9; 33,8 and 35,3% respectively). The ash content of these additives ranged between 3,6 and 10,1%.

Table1. Chemical composition of protein additives

	Moisture	Proteins	Lipids	Minerals	Other
SI	5,43 ± 0,21	89,06 ± 4,51	0,55 ± 0,17	3,60 ± 0,17	9,05 ± 4,07
SK	7,48 ± 0,54	65,79 ± 1,31	0,41 ± 0,10	6,01 ± 0,26	20,31 ±1,10
SB	9,30 ± 0,48	77,46 ± 1,10	1,01 ± 0,28	10,15± 1,03	2,10 ± 1,54
SBM	7,09 ± 0,98	61,27 ± 6,03	0,76 ± 0,27	8,08 ± 0,42	22,83± 4,96
SNK	7,36 ± 0,81	80,12± 1,68	0,46 ± 0,19	7,54 ± 1,54	4,53 ± 1,05
SNP	5,93 ± 1,15	35,26 ± 2,60	1,15 ± 0,28	6,99 ± 0,89	50,18± 1,73
SP	5,07 ± 0,91	33,75 ± 2,81	1,68 ± 0,45	7,12 ± 0,19	52,87± 2,67
NK	5,52 ± 0,80	86,85 ± 3,14	0,52 ± 0,24	3,99 ± 0,26	3,39 ± 3,22
IBK	6,34 ± 1,02	51,42 ± 2,32	1,02 ± 0,21	4,72 ± 0,47	36,50± 2,80

Chemical composition of protein additives varies because of their nature, method's isolation and processing. For example, the high content of ash in sunflower protein currently deals with salt that is used for protein precipitating. Ultrafiltration can decrease the amount of carbohydrates and minerals.

Data of chemical composition are necessary in selecting the appropriate substitutes for several meat products in depending on their aims of use and cost. From economic point of view protein additives with high protein level such soy and sunflower proteins, lighten blood and sodium caseinate are more desirable in combined meat products. Whey protein concentrate or sodium caseinate, free of much of undesirable lactose, are more desirable products for protein fortification and extension of the human diet than non - fat milk, butter - milk or whey. These products are more expensive than last ones and differ in nutritional value (Table 2, Table 3).

2. Amino acid composition

Protein additives can increase protein level and improve nutritional value of products in which they are impact. The nutritional value of proteins (and products) depends on the amino acid composition. The main results of amino acids analyze of protein additives are shown in Table 2.

The tryptophane and methionine were first limiting amino acids in all samples. The methionine content of the FAO reference protein is high (2,2 g/ 100g protein) and in comparison with it many other protein sources, except sodium caseinate with 2,0 g methionine/ 100 g protein, have a low content of this amino acid. The sunflower protein was lower in lysine and isoleucine than the FAO reference protein, too. Both, it and whey protein concentrate, contain nearly trypthopane content to standard protein. Milk proteins contain excessive quantities of isoleucine in which sunflower and blood proteins are deficient. The big differences in amino acid composition of pork protein and additives were found, also. So, a complementary nutritional effect can be achieved in blends that contain different sources of

proteins. These blends are superior to the protein alone. They would not change common meat mineral composition or would improve the nutritional value of products in large level.

Table 2. Amino acid composition of pork and protein additives (g / 100 g protein)

	FAO	Pork	SI	SK	SB	SBM	SNK	NK	IBK	SNP	SP
Ile	4,2	2,92	4,46	3,95	2,81	2,07	0,97	5,1	5,08	5,16	5,02
Leu	4,8	6,76	6,98	6,72	6,26	10,29	10,55	9,47	9,25	9,12	8,19
Lis	4,2	7,04	5,56	5,72	3,64	7,48	7,01	7,59	9,68	5,59	4,53
Met	2,2	1,71	0,97	0,95	1,54	0,86	0,71	1,97	1,08	1,37	1,01
Tir	5,6	3,59	3,25	3,24	2,74	1,55	1,02	4,4	2,41	3,63	3,47
Phe		3,54	4,68	4,77	4,87	5,69	6,61	5,01	2,75	4,25	3,93
Thr	2,8	3,62	2,94	3,3	3,24	3,58	4,51	3,64	6,17	4,19	3,46
Trp	1,4	1,12	0,89	0,99	1,3	0,54	0,33	1,0	1,26	0,82	0,78
Val	4,2	3,51	4,49	4,06	4,96	6,83	7,29	6,39	5,0	5,83	6,03
His		3,08	2,72	2,17	2,75	3,42	3,45	2,85	1,86	2,01	2,43
Arg		5,46	6,09	6,15	7,43	2,97	3,06	3,36	2,13	3,89	2,72
Asp		8,8	10,67	11,22	10,84	9,62	10,11	6,61	10,09	9,52	6,25
Ser		3,85	4,61	4,71	4,37	3,51	3,94	4,04	4,4	4,68	4,0
Glu		15,05	21,11	18,46	20,75	11,4	8,27	20,14	16,95	19,37	17,79
Pro		3,91	6,38	5,19	4,76	4,75	3,59	9,76	6,02	9,38	8,53
Gli		4,19	3,58	4,03	4,54	3,6	3,73	1,81	1,75	1,97	1,91
Ala		5,28	3,96	4,3	4,46	5,91	6,87	2,9	4,85	3,23	3,03

Effect of the addition of 5% of analyzed proteins instead of respectively content of meat (to keep the same level of protein) is given in Figure 1.

The changes that may carry the addition 5% of protein additives are not higher when 25%. The highest differences as shown in Figure 1 are in triptophane content when blood proteins and soy isolate are added. The supplementation of meat may cause increasing only in content of isoleucine (with lighten blood) valine (with blood proteins and sodium caseinate) and phenilalanine (with lighten blood and sunflower protein). In other case - contents of essential amino acids will be than in lean meat.

3. Mineral composition of protein additives

Protein additives contain till 10% of minerals. Minerals are necessary for normal vital activity and their content in meat is important as well as amino acids'. Qualitative analyses of protein additives allowed to concern main mineral, some of which have been found quantity (Table.3).

Table 3. Mineral composition of protein additives (mg / 100 g)

	Na	K	P	Ca	Mg	Fe	Zn	Cu	Mn
Pork	79,3	325,9	198,5	10,7	28,6	3,05	3,19	0,19	0,08
SI	1052,0	86,8	654,5	180,0	37, 5	6,30	1,43	1,04	1,00
SK	89,4	2662,0	653,6	249,6	80,7	5,36	1,81	0,74	4,34
SB	5993,0	285,8	411,8	48,7	44,5	12,39	0,47	3,07	0,35
NK	1140,0	53,8	752,3	112,1	23,8	2,40	1,78	0,19	0,10
IBK	375,9	1796,1	734,2	358,8	61,9	1,09	0,75	0,10	0,10
SNP	536,8	1184,0	813,4	820,9	74,3	1,73	1,67	0,25	0,08
SP	540,0	2471,0	756,3	753,2	56,7	2,01	1,87	0,35	0,11
SBM	1623,0	1797,0	1003,0	483,3	53,6	56,41	1,47	0,31	0,13
SNK	5294,4	241,6	1008,8	33,7	16,1	133,90	0,60	0,32	0,10

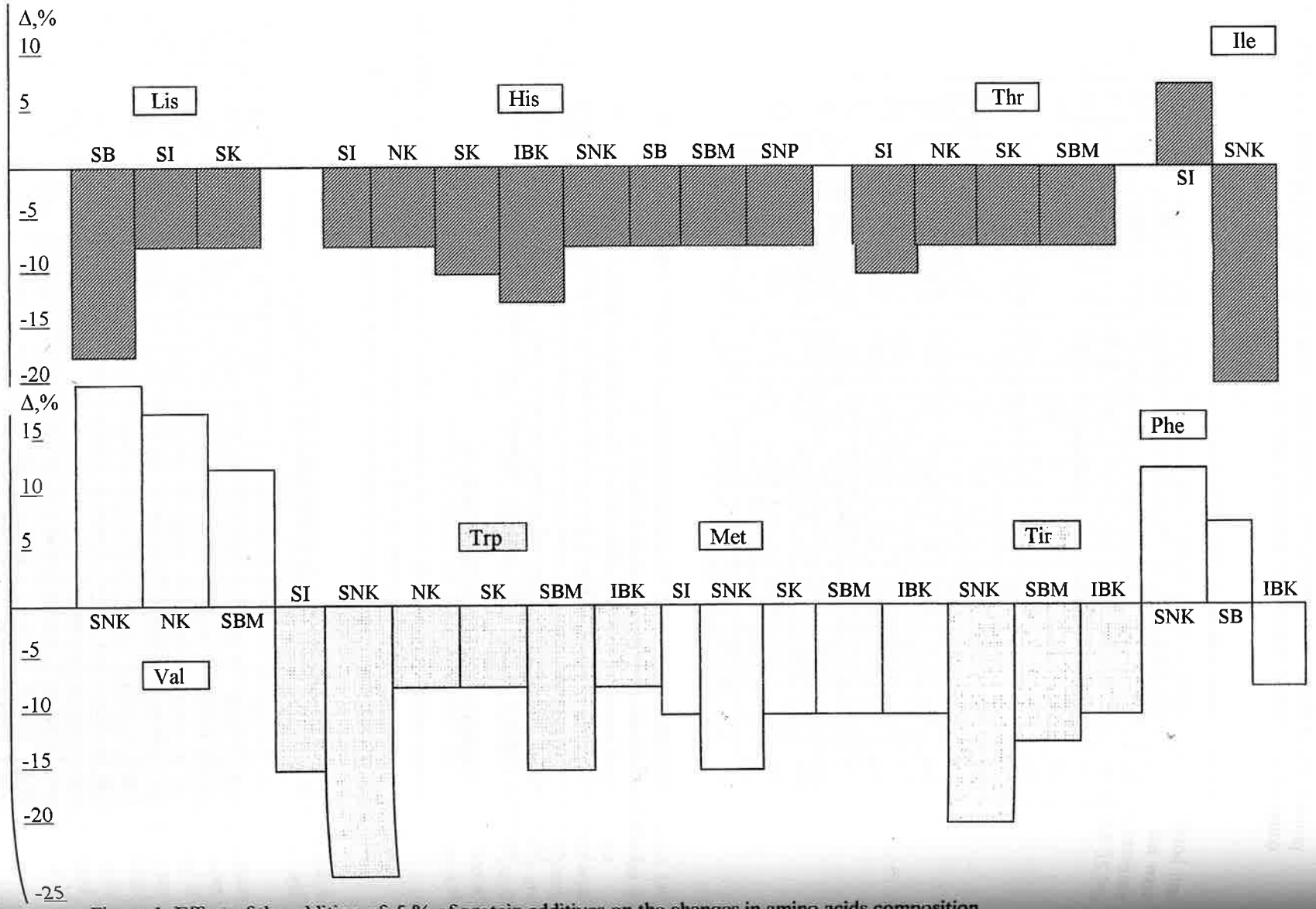

Figure 1. Effect of the addition of 5 % of protein additives on the changes in amino acids composition

Figure 2. Element spectra of protein additives

	Na	K	Ca	P	Mg	Cl	Mn	Fe	Cu	Si	Al	Co	Mo	Sr	Zn
SI, SK, SB															
NK, IBK															
SNP, SP															
SBM, SNK															

Content of Cu in vegetable protein was found higher than in animal origin. Sunflower protein and soy isolate have especially high content of this element (respectively 30,7 and 10,4 mg/kg). In sunflower and soy protein additives 7,5 - 43,4 mg/kg Mn was established. The highest level of this element in milk additives - 1,3 m/kg. The big variations in content of Fe according the protein origin were found, also. Concerning macrominerals big differences of protein additives and reference pattern - meat were found and may be seem very good in Figure 3.

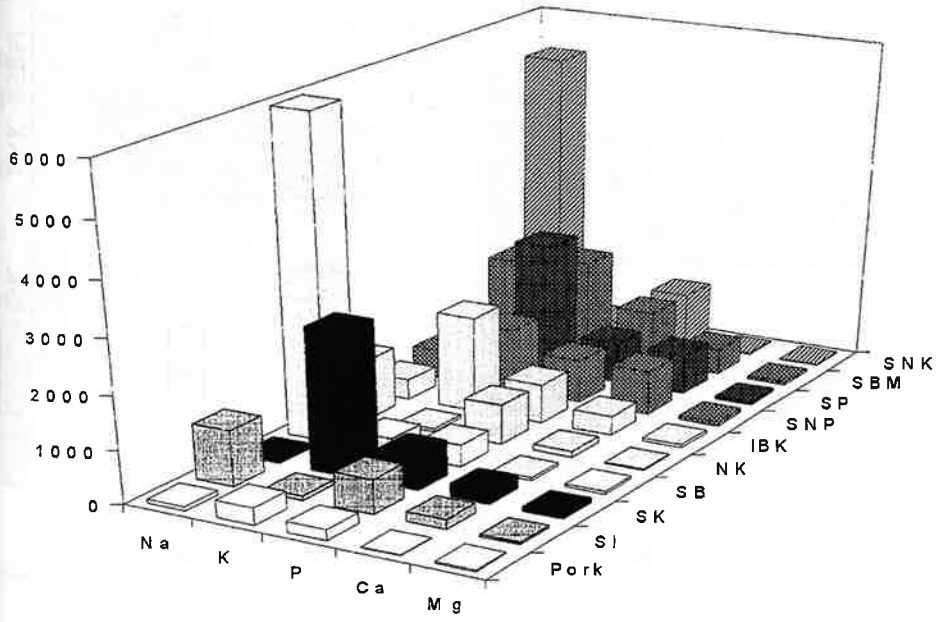

Figure 3. Macromineral composition of pork and protein additives (mg / 100g)

Using of meat substitutes with so high differences in mineral composition may disbalance mineral content of common food.

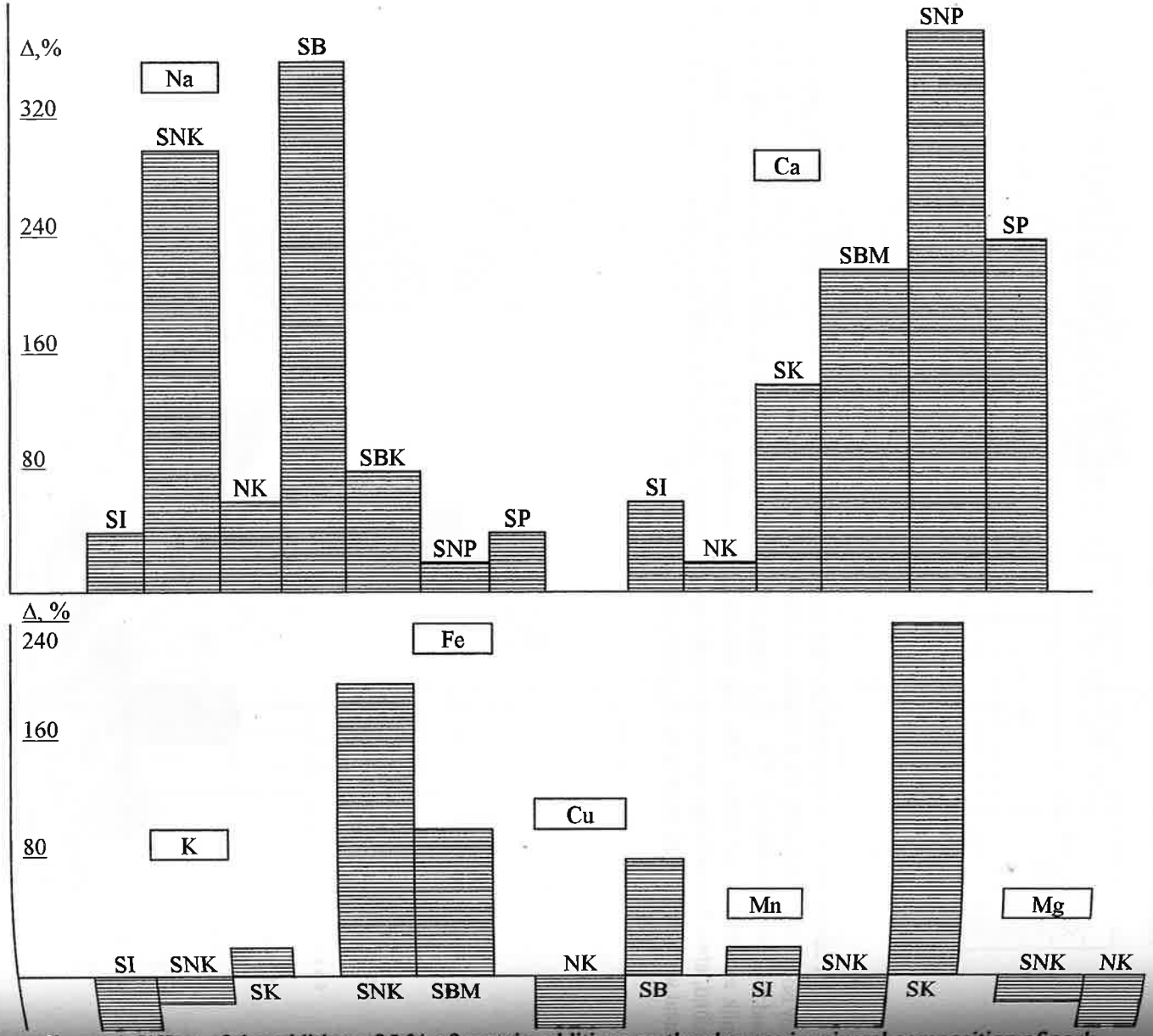

Figure 4. Effect of the addition of 5 % of protein additives on the changes in *mineral composition of pork*

The possible changes with addition 5 % of protein additives are higher than in case of amino acids (from 20 till 380 %). So, mineral composition as well as amino acid composition is necessary criteria to evaluate nutritional value of meat substitutes and to predict possible changes in composition of meat products.

- *CONCLUSION*

1. Analyses of influences on common meat product show quantitative differences in the composition of micro- and macrosubstances of the muscular tissue of the pork and protein additives. Bases on estimation of differences between meat and protein additives in amino acid and mineral composition the best meat substitutes are soy isolate, sodium caseinate and sunflower protein.

2. Whichever of analyzed protein additives in formula of meat products will change usual meat composition. Complementary nutritional effect can be achieved in blends which contain different sources of proteins. The complex proteins blend as substitute will be superior to the protein alone because of minor changes in nutrients. This blend may amend nutritional value of lower quality meat.

- *REFERENCES*

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Table 1. Effects of electrical stimulation on and type of boning on the shear value of chicken breast meat.

VOLTAGE [1]	BONING [2]	SHEAR VALUE (kgf/g)	SE
45		7,4 [bc]	0,5
80		6,3 [ab]	0,5
100		5,9 [a]	0,5
Non stimulated		7,8 [c]	0,5
	Hot boning	8,4 [a]	0,3
	Conventionally	5,3 [b]	0,2

1- Means of 50 measurements / voltage.

2- Means of 100 measurements / boning.

a, b, c - Mean with different letters are statistically different.

Table 2. Combined effect of stunning and electrical stimulation voltage on the shear value and tenderness of breast chicken meat.

TREATMENT	Shear Value (kgf/g)	SE	Tenderness	SE
Conventional				
45	5,8	0,4	6,8	0,2
80	4,7	0,4	7,2	0,2
100	4,2	0,3	8,1	0,3
non stimulated	6,4	0,4	7,1	0,2
Hot Boned				
45	9,0	0,6	4,7	0,7
80	7,8	0,5	4,7	0,6
100	7,7	0,3	5,8	0,2
non stimulated	9,1	0,6	5,3	0,4

Table 3. Nutrients content of hams and shoulders

Nutrient	Unit	Hams		Shoulders	
		Per 55g	% Daily Value*	Per 55g	% Daily Value*
Calories	kcal	50	-	60	-
Calories from	kcal	15	-	20	-
fat	g	1.5	2	2	3
Total fat	g	0.5	2	0.5	2
Saturated fat	mg	25	8	30	10
Cholesterol	g	10	-	10	-
Protein	g	0	-	0	-
Carbohydrate	mg	720	30	720	30
Sodium	mg	180	5	180	5
Potassium	mg	0.4	2	0.4	2
Iron	μg	-	35	-	35
Riboflavin	μg	-	10	-	10
Thiamin			35		35

* Percent of Daily Value are based on 2000 calorie diet.

Fig. 1. Frequency distribution of protein values in hams

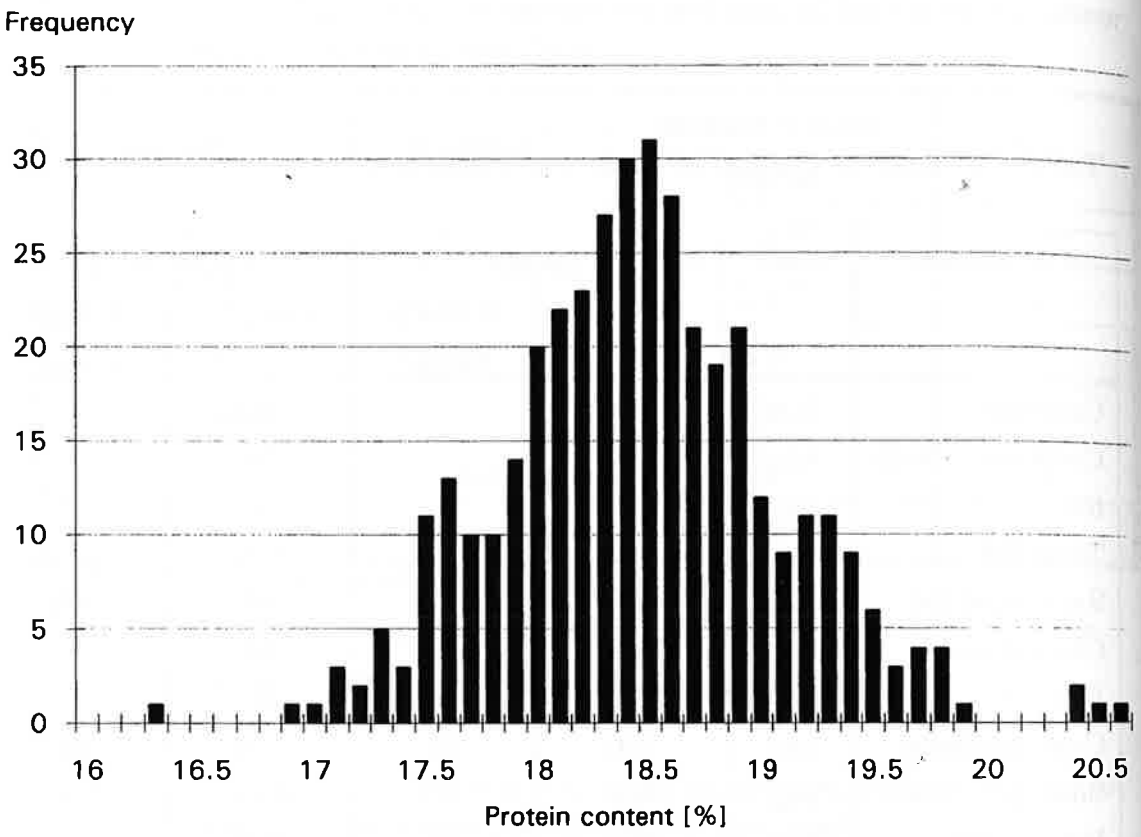


Fig. 2. Frequency distribution of cholesterol content in hams

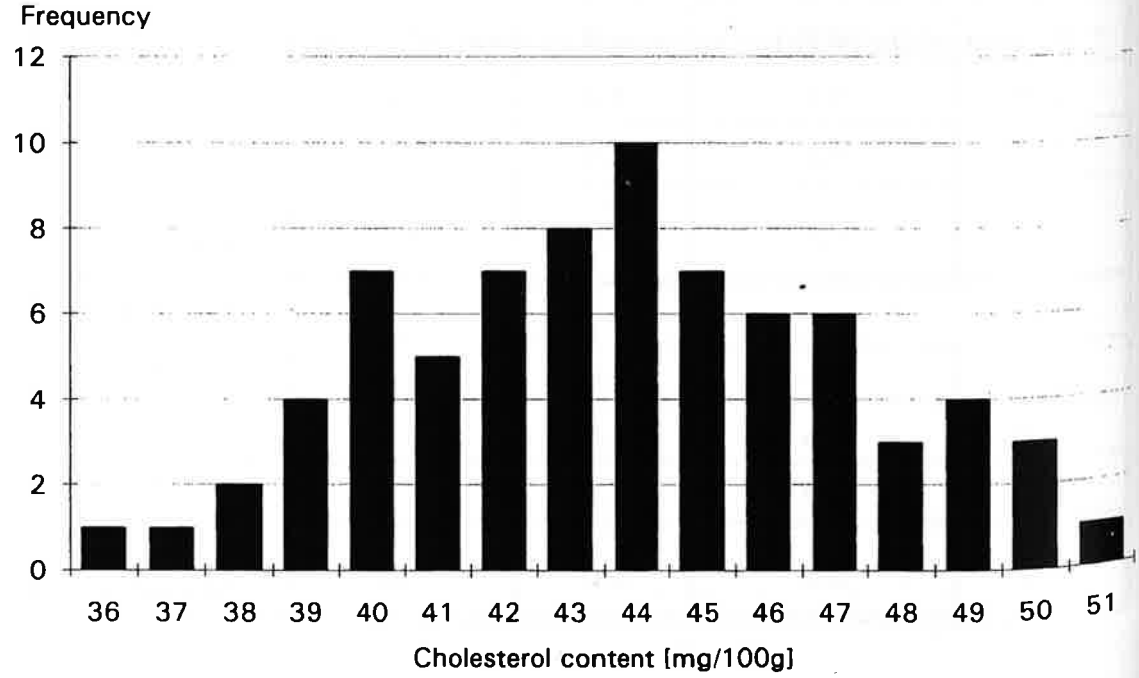


Table 1. Proximate analysis for four experimental sausage products and two commercial sausages.

Sample	% Dry Matter	% Fat	% Ash	% Crude Protein
1	32.9	10.6	3.0	16.4
2	33.0	11.1	3.1	16.3
3	33.7	12.4	2.8	17.5
4	33.8	11.5	3.3	16.1
5-low-fat[a]	38.1	20.4	1.8	15.1
6-regular[a]	52.4	36.8	2.0	12.6

[a] Designates commercial sausage.

Table 2. Color evaluation for six sausage products held at 1°C for four weeks.

	Color			
Sample	Week 1	Week 2	Week 3	Week 4
1	3.0	3.5	4.0	4.0
2	3.0	3.5	4.0	4.0
3	3.0	3.5	4.0	4.0
4	3.0	3.5	4.0	4.0
5-low-fat[b]	3.0	3.0	3.5	4.0
6-regular[b]	3.0	3.0	3.5	4.0

[a] Color scale of 3 = grayish pink and 4 = moderately dark.
[b] Designates commercial sausage.

Table 3. Sensory scores for six sausage products rated by cm of deviation from a zero just right scale of 15 cm.

Number		Juiciness		Greasy	
Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
1	5	-1.73[b]	-.26[a]	.80[a]	-.93[b]
2	6	-1.16[ab]	.01[a]	.53[ab]	.20[a]
3	3	-1.19[ab]	-1.41[b]	.57[ab]	.53[a]
4	4	-.67[a]	-1.71[b]	.19[b]	.61[a]

[ab] Items in a column with different small superscript letters are different (P<.05).

Table 4. Sensory scores for six sausage products rated by cm of deviation from a zero just right scale of 15 cm.

Number		Saltiness		Texture	
Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
1	5	.43[a]	-.35[b]	-1.28[a]	1.77[a]
2	6	.32[a]	-.37[b]	-1.06[a]	-2.17[b]
3	3	.59[a]	.25[a]	-1.20[a]	-2.29[b]
4	4	.38[a]	.16[a]	-.84[a]	-3.77[c]

[ab] Items in a column with different small superscript letters are different (P<.05)

Figure 1: Total saturated, mono and polyunsaturated fatty acid in beef cuts

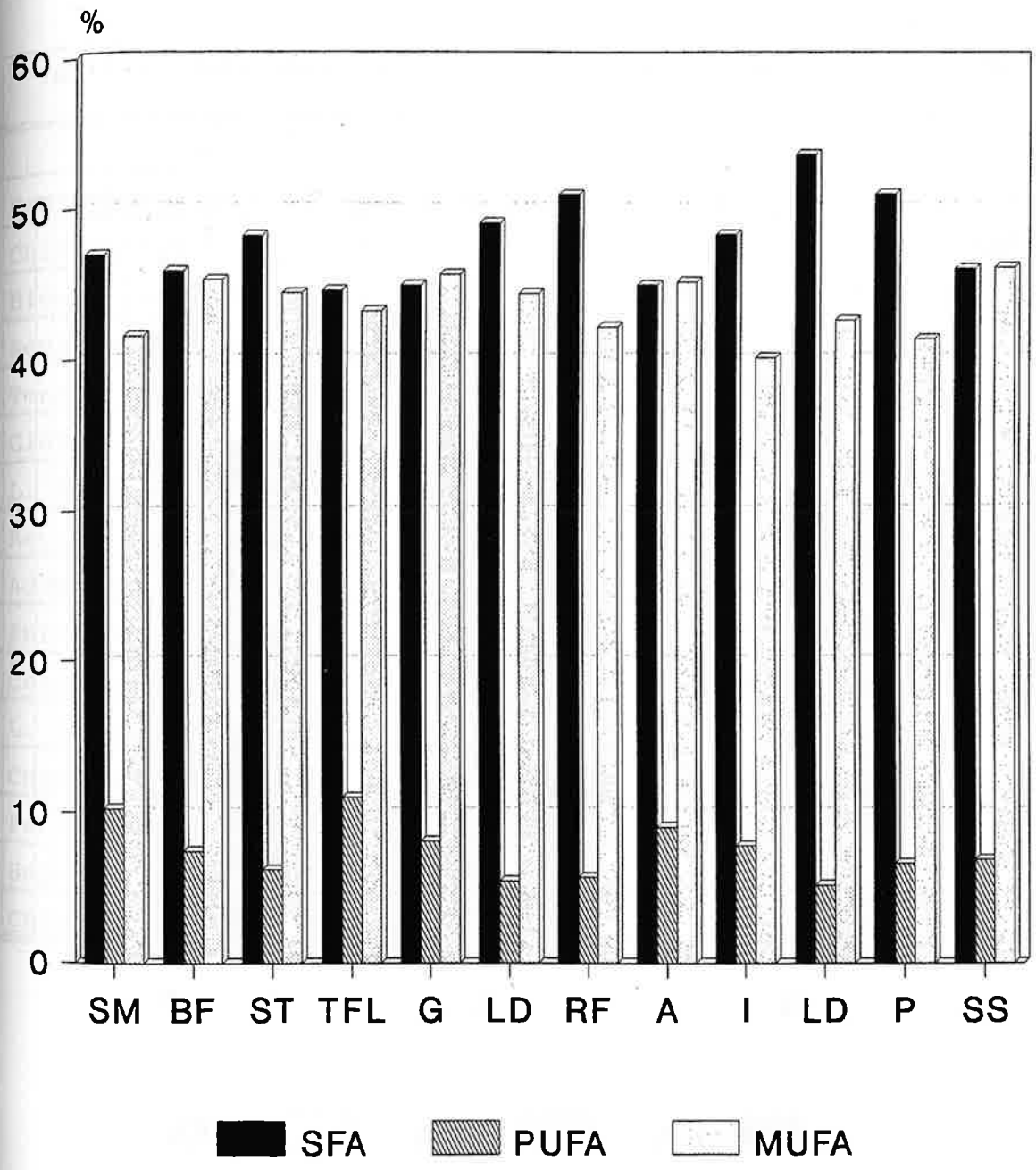


Figure 2: Total saturated, mono and poly unsaturated fatty acid in poultry meats

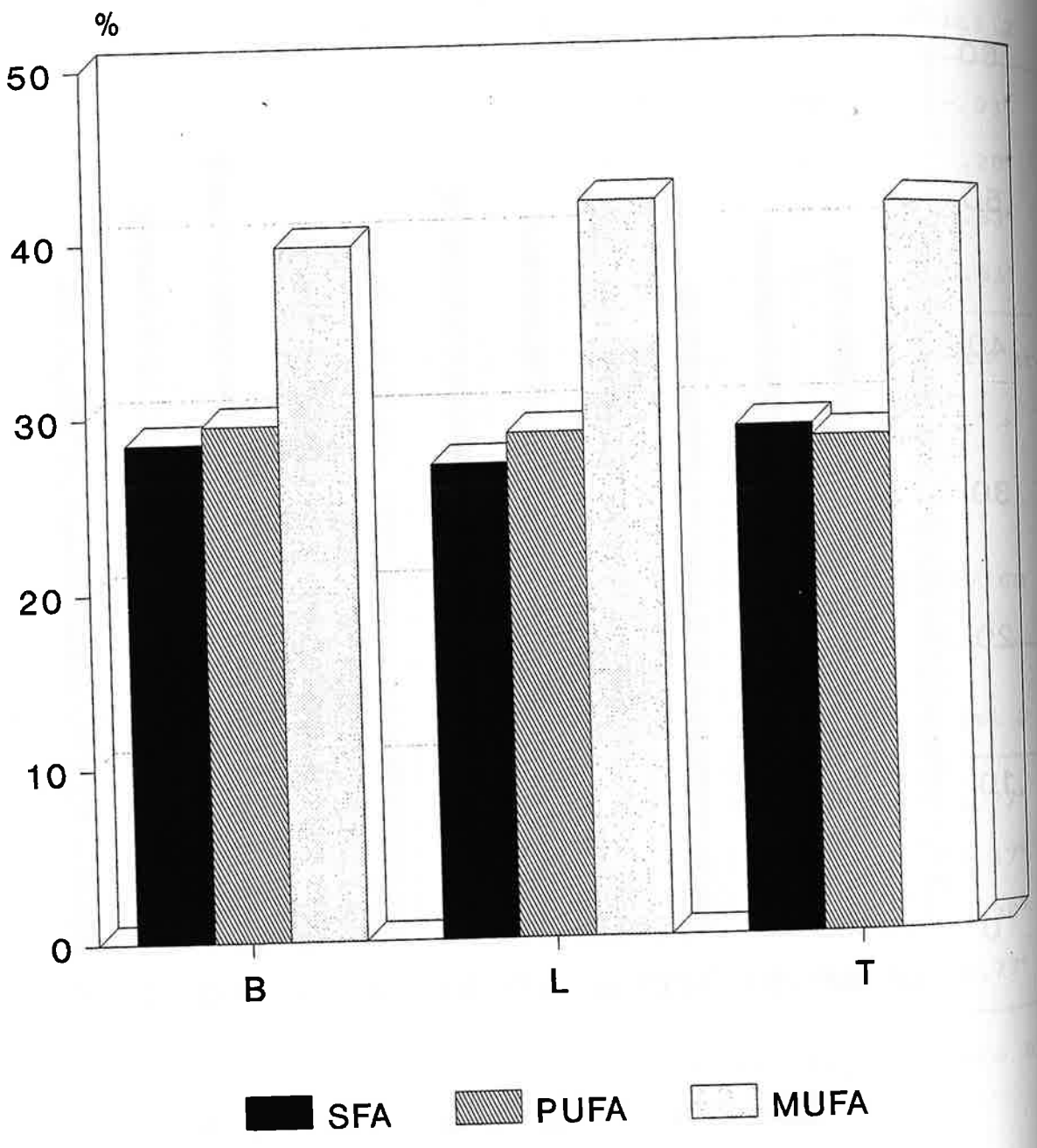


Table 1: Intramuscular fat (%) in the different meats

Meat	Mean	SD	CV %
Semimembranosus	1.0	0.3	30
Chicken breast	1.0	0.3	30
Biceps femoris	1.1	0.3	27
Semitendinosus	1.6	0.6	37
Tensor fascia latae	1.9	0.6	31
Gluteous	2.2	0.6	27
L. dorsi 12-12a rib	2.4	0.7	29
Rectus femoris	2.6	0.9	34
Adductor	3.0	0.6	20
Infraspinatus	3.6	1.1	30
Chicken thigh	3.6	0.8	22
L. dorsi	3.8	1.1	28
Chicken leg	3.8	1.2	31
Psoas major	3.8	1.1	28
Supraspinatus	4.6	1.1	23
Chicken breast with skin	9.5	3.6	38

Table 2 : Cholesterol content in the different meats (mg/100g)

Meat	Mean	SD	CV %
Chicken breast	42	8.5	20
Semitendinosus	45	11.0	24
Adductor	46	8.2	18
Rectus femoris	48	8.8	18
Biceps femoris	49	9.5	19
Chicken breast with skin	50	9.8	19
Semimembranosus	51	7.1	14
Tensor fascia latae	51	10.4	20
L. dorsi 10-12th	51	4.5	9
L. dorsi 4-5th	52	5.0	10
Supraspinatus	53	9.9	19
Psoas major	54	5.4	10
Infraspinatus	56	14.4	26
Chicken leg	64	3.8	6
Chicken thigh	65	8.5	13

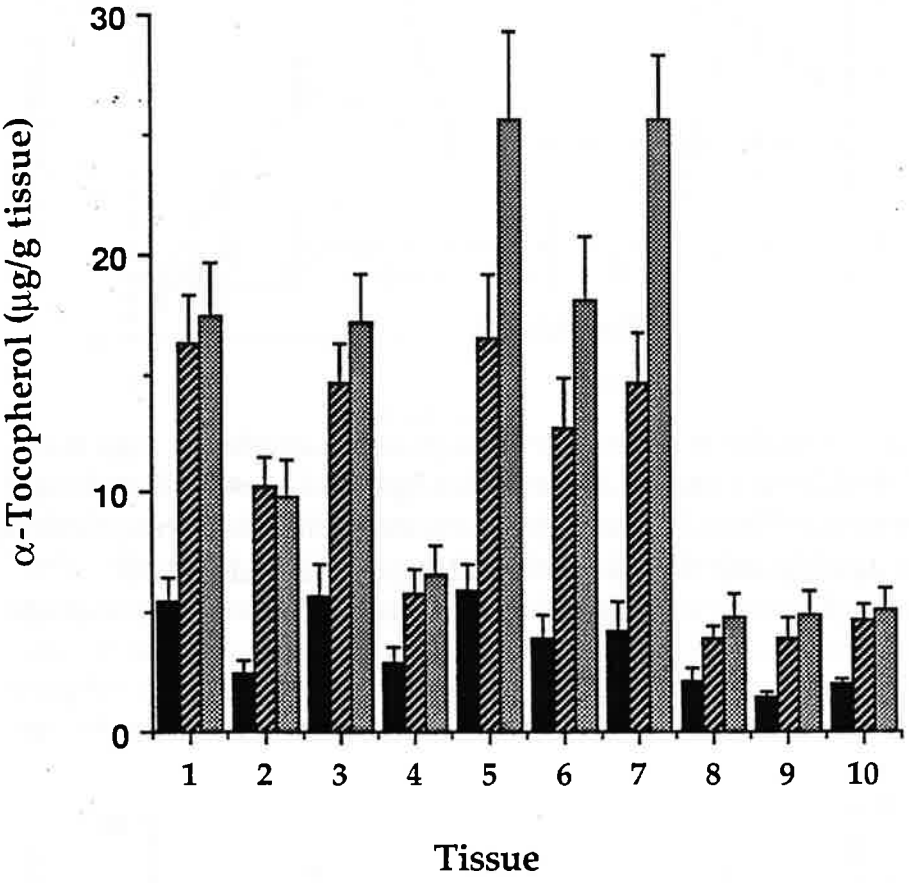


Figure 1. Mean α-tocopherol content of plasma and tissue samples of pigs fed a basal diet, ■ , a basal diet for 91 days followed by supplementation with α-tocopheryl acetate for 35 days, ▧ , or a diet supplemented with α-tocopheryl acetate for 126 days, ▩ .
1, Liver, 2, Heart, 3, Lung, 4, Kidney, 5, Subcutaneous fat, lower layer, 6, Subcutaneous fat, upper layer, 7, Kidney fat, 8, Muscle, 9, Brain, 10, Plasma.

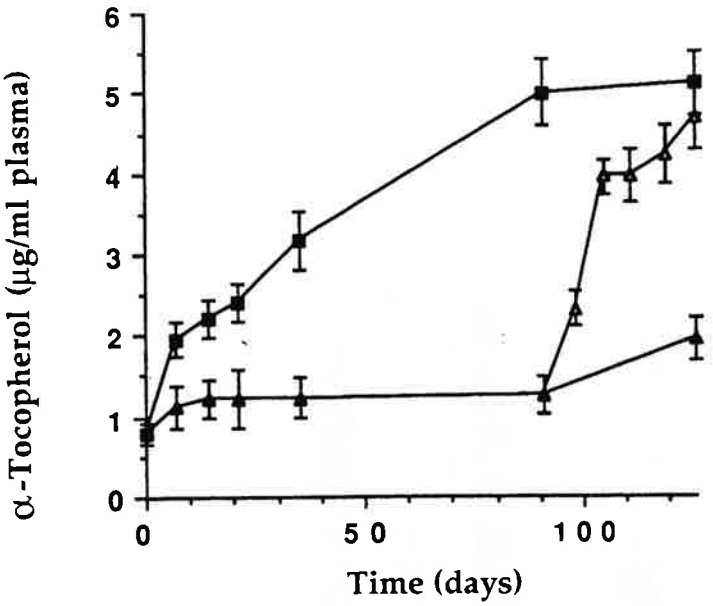


Figure 2. Uptake of α-tocopherol in plasma samples of pigs fed a basal diet from weaning to slaughter (group A), ▲, a basal diet for 91 days followed by supplementation with α-tocopheryl acetate for 35 days (group B), △, or a diet supplemented with α-tocopheryl acetate from weaning to slaughter (126 days, group C), ■.

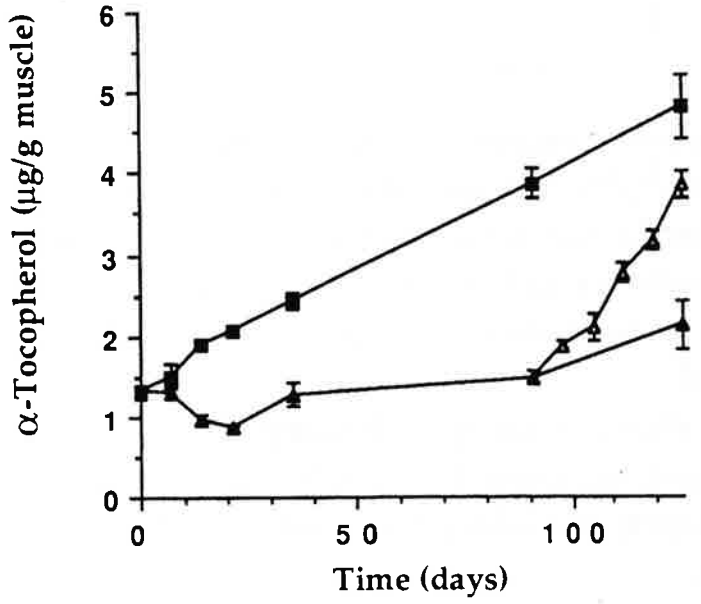


Figure 3. Uptake of α-tocopherol in *Longissimus dorsi* muscle samples of pigs fed a basal diet from weaning to slaughter (group A), ▲, a basal diet for 91 days followed by supplementation with α-tocopheryl acetate for 35 days (group B), △, or a diet supplemented with α-tocopheryl acetate from weaning to slaughter (126 days, group C), ■.

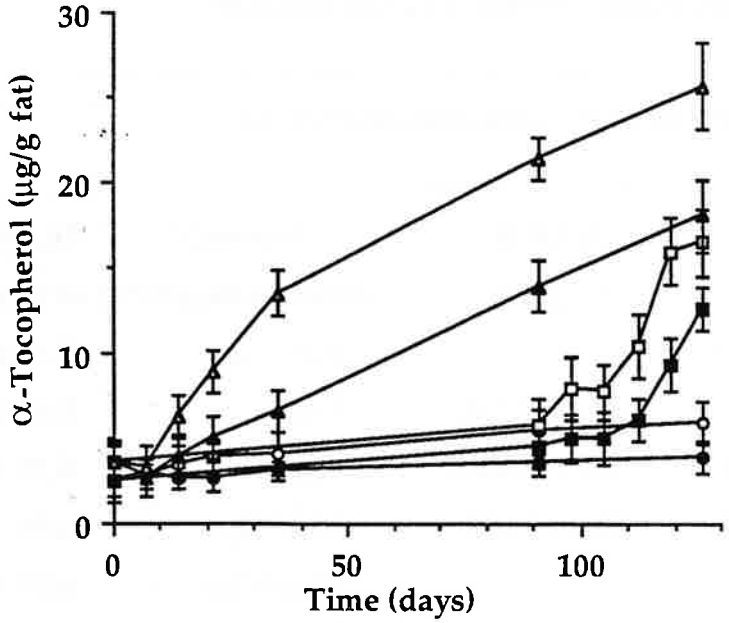


Figure 4. Uptake of α-tocopherol in subcutaneous fat layers of pigs fed a basal diet from weaning to slaughter (group A), -○- , inner layer; -●-, outer layer, a basal diet for 91 days followed by supplementation with α-tocopheryl acetate for 35 days (group B), -□- , inner layer; -■- outer layer or a diet supplemented with α-tocopheryl acetate from weaning to slaughter (126 d, group C), -△- , inner layer; -▲- outer layer.

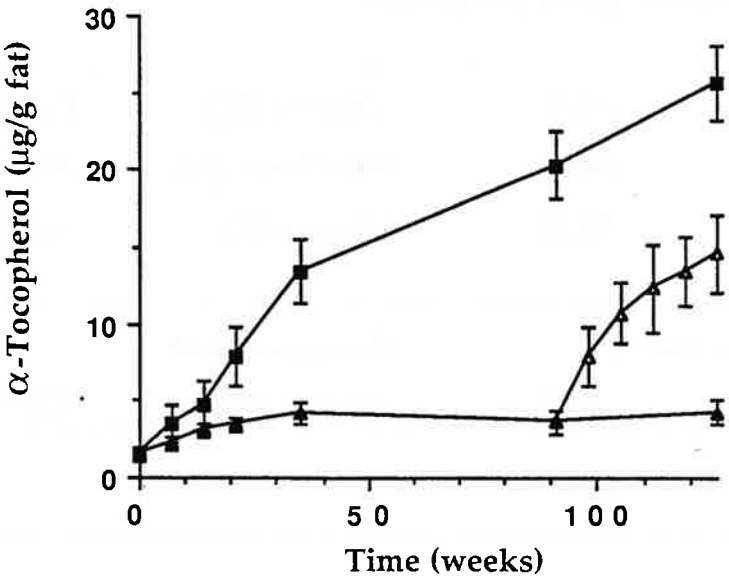


Figure 5. Uptake of α-tocopherol in kidney fat of pigs fed a basal diet from weaning to slaughter (group A), -▲- , a basal diet for 91 days followed by supplementation with α-tocopheryl acetate for 35 days (group B), -△- , or a diet supplemented with α-tocopheryl acetate from weaning to slaughter (126 d, group C), -■- .

Table 1

Quality indices of gerodietetic product VITASTIMULIN

Mass quotas of macronutrients and their components			
Moisture, %	73,7±1,8	Protein,%	10,1±0,7
Fat, %	7,3±0,5	Amino acids, g/100 g of protein	
Fatty acids, % to fat		Iso	4,15-4,27
saturated	35,70-35,82	Leu	8,45-8,65
monounsaturated	52,56-52,67	Lys	6,15-6,28
polyunsaturated	11,52-11,64	Met+Cys	3,56-3,60
Carbohydrates, %		Phen+Tyr	6,83-6,97
total	9,1±0,4	Tre	3,61-3,67
hydrolyzed	8,21±0,38	Trp	0,94-0,96
Ballast matters	0,91±0,02	Val	5,39-5,48
Minerals, %	1,7±0,1	Coefficient of amino	
Sodium chloride, %	0,8±0,03	acid correspondence	K=0,61
Mass quotas of vitamins, µg/100 g of product*			
Vitamin A	16,0	Thiamin (B_1)	42,0
Vitamin C	192,0	Riboflavin (B_2)	6,0
Tocopherol (E)	980,0	Niacin (PP)	164,0
Protein digestion "in vitro", % to tyrosin	79,5	Energy value of 100 g of product kJ	635±10

* Were determined by calculating (with regard for coefficients of thermodegradation) according to recommendations of Nutrition Institute of the Russian Academy of Medical Sciences

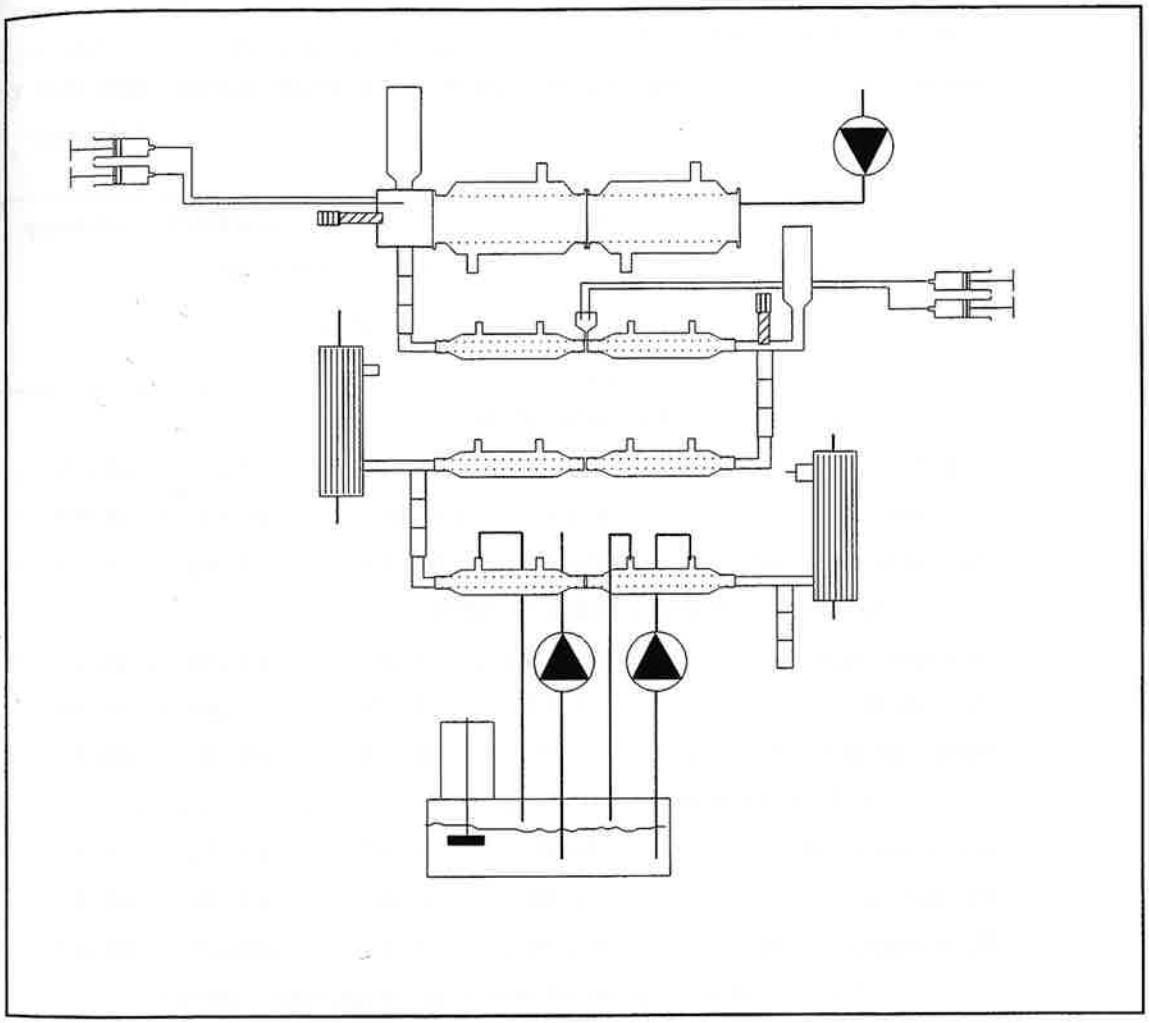


fig. 1. Schematic drawing of the TNO gastro- Intestinal Model (TIM)

Table 1

Digestion of Protein-containing raw material

Protein-containing raw material and type of preliminary processing	mg of tyrosine/g of protein			Percent to tyrosin
	Under action of pepsine	Under action of trypsine	Summary	Summary
Soya protein isolate (SPI)				
Non-hydrated	5.17	5.54	10.71	25.75
Hydrated	8.27	8.65.	16.92	42.84
Thermoprocessed	10.40	11.05	21.45	54.31
Cotton protein isolate (CPI)				
Non-hydrated	5.71	6.09	11.79	37.91
Hydrated	7.63	9.76	17.39	55.92
Thermoprocessed	9.19	10.31	20.50	65.92
Sodium caseinate				
Non-hydrated	6.92	7.60	14.52	23.01
Hydrated	8.54	11.61	20.15	31.93
Thermoprocessed	12.29	14.32	26.61	42.17
Diafiltration skimmed milk concentrate (DSMC)				
Non-hydrated	5.79	6.20	11.99	21.00
Hydrated	7.41	7.57	14.98	26.23
Thermoprocessed	9.67	10.10	19.77	34.62
Bone protein isolate (BPI)				
Non-hydrated	2.33	3.88	6.21	55.95
Thermoprocessed	3.37	4.28	7.65	68.92
Micellial mass of Polyporus fungus				
Non-hydrated	7.99	7.56	15.55	53.81
Hydrated	12.20	9.86	22.06	76.37
Thermoprocessed	12.74	10.55	23.20	80.59

Table 2

Digestion of protein contained in animal material

Protein-containing raw material and type of preliminary processing	Digestion			
	mg of tyrosine/g of protein			Percent to tyrosine
	Under action of pepsine	Under action of trypsine	Summary	Summary
Blood plasma				
Raw	7.69	9.41	17.10	32.20
Thermoprocessed	17.85	9.86	27.71	52.18
Blood				
Raw	7.63	9.55	17.18	47.33
Thermoprocessed	10.67	12.96	23.63	65.10
Tripe				
Raw	5.27	5.90	11.17	39.33
Thermoprocessed	7.90	8.79	16.69	66.48
Meat trimmings				
Raw trimmed	6.96	6.06	13.02	41.46
Trimmed fermented	7.53	6.89	14.42	45.92
Trimmed thermoprocessed	12.34	10.49	22.83	72.71
Fermented thermoprocessed	13.98	12.62	26.60	84.71
Beef thermoprocessed (muscle)	16.59	16.00	32.59	88.08
Pork thermoprocessed (muscle)	15.84	15.45	31.29	91.76

Table 3

Digestion of proteins of binary systems

Components and mass quota in binary mixtures				Digestion	
Terms	Quota	Terms	Quota	mg of tyrosine/g of protein	Percent to tyrosine
				pepsin-trypsin	Summary
Plasma	0.9	+ SPI hydrated	0.1	14.72	32.60
Plasma	0.1	+ SPI hydrated	0.9	13.27	33.75
Plasma	0.9	+ CPI hydrated	o.1	11.62	39.22
Plasma	0.7	+ CPI hydrated	0.3	8.63	49.04
Cooked tripe	0.2	+ Pork thermo-processed	0.8	28.59	89.65
Cooked tripe	0.8	+ Pork thermo-processed	0.2	21.13	-
SPI thermo-processed	0.25	+ Beef thermo-processed	0.75	25.81	67.00
SPI thermo-processed	0.1	+ Beef thermo-processed	0.9	26.89	74.06
SPI thermo-processed	0.1	+ Pork thermo-processed	0.9	28.59	77.75

Table 4

Digestion of protein in three-component system

Componet and its mass quota		Digestion of three-component system				
		mg of tyrosine/g of protein				
		under action of pepsine	under action of trypsine	Factural	Calcu-lated	Relative deviat-ion
Sodium caseinate	0.43	10.46	13.56	24.02	25.107	-4.53
SPI	0.07					
POlyporus	0.50					
Sodium caseinate	0.06					
SPI	0.16	10.10	14.11	24.21	23.104	-4.57
Polyporus	0.78					
Sodium caseinate	0.07					
SPI	0.42	8.37	12.91	21.28	22.507	-5.77
Polyporus	0.51					
Sodium caseinate	0.10					
SPI	0.30	10.51	12.14	22.65	22.935	-1.26
Polyporus	0.60					
Sodium caseinate	0.50					
SPI	0.10	12.22	13.76	25.98	25.197	+3.01
Polyporus	0.40					

Table 1. Essential amino acid content of samples (g/16g N) and suggested pattern

Essential amino acids	FAO/WHO/UNU Pre-school Child (2-5 years)	Rainbow trout raw	broiled	smoked
His	1.9	3.32	3.09	3.12
Lys	5.8	7.03	6.76	6.78
Met+Cys	2.5	4.04	3.24	3.18
Thr	3.4	4.16	3.95	3.58
Iso	2.8	4.75	4.13	4.65
Leu	6.6	6.90	6.82	6.80
Val	3.5	5.85	4.69	4.75
Phe+Tyr	6.3	7.46	7.10	6.50
Trp	1.1	1.01	0.89	0.91

Table 2. Protein Digestibility , AAS and PDCAAS values of samples

	Rainbow trout		
	raw	broiled	smoked
In Vitro Protein Digestibility (%)			
3 enzyme pH-drop	87.07	84.00	83.40
4 enzyme pH-drop	84.73	81.43	80.82
3 enzyme pH-stat	95.51	93.95	91.20
AAS (%)	100.00	100.00	100.00
PDCAAS (%)	99.81	97.05	93.94

Table 3. Correlations between estimates of digestibility in all in vitro methods

Method	Regression Equation	Regression Coefficient
x=3 enzyme pH-drop y=4 enzyme pH- drop	y=-11.686437+1.109988.x	r = 0.989
x=3 enzyme p-H drop y=3 enzyme p-H stat	y=10.357538+0.980099.x	r = 0.876
x=4 enzyme p-H drop y=3 enzyme p-H stat	y=20.857694+0.880746.x	r = 0.883

Table 1. Macrophage Stimulating Activities of Water Extracts from Beef and Cattle Organs

Part	Concentration of extract (mg/ml)	Nitrite formation (nmol/10^6cells)
Meat	20.0	–*
Reticurolumen	20.0	43.9
	2.0	6.9
	0.2	–
Heart	20.0	–
Liver	20.0	–
Kidney	20.0	–
Spleen	20.0	–
Adrenal grand	20.0	–
Bile	20.0	–
Pancreas	20.0	–
Lung	20.0	–
Large intestine	20.0	–
Small intestine	20.0	–
Uterine	20.0	–
Cerebrum	20.0	19.1
	2.0	3.7
	0.2	–
Cerebellum	20.0	–
Eyeball	20.0	–
Udder	20.0	–

* Not detected

Table 2. Macrophage Stimulating Activities of Water Extracts from Pork and Swine Organs

Part	Concentration of extract (mg/ml)	Nitrite formation (nmol/10^6cells)
Meat	20.0	-*
Stomach	20.0	32.1
	2.0	19.5
	0.2	3.7
Heart	20.0	-
Liver	20.0	-
Kidney	20.0	-
Spleen	20.0	-
Adrenal grand	20.0	-
Bile	20.0	-
Pancreas	20.0	-
Large intestine	20.0	-
Small intestine	20.0	-
Uterine	20.0	14.0
	2.0	-
Cerebrum	20.0	38.9
	2.0	-
Cerebellum	20.0	18.1
	2.0	-
Tongue	20.0	32.1
	2.0	19.2
	0.2	-
Eyeball	20.0	28.0
	2.0	-

* Not detected

Table 3. Macrophage Stimulating Activities of Water Extracts from Chicken and Chicken Organs

Part	Concentration of extract (mg/ml)	Nitrite formation (nmol/10^6cells)
Meat	20.0	68.2
	2.0	42.6
	0.2	11.4
Gizzard	20.0	53.1
	2.0	6.7
	0.2	– *
Heart	20.0	–
Liver	20.0	–
Kidney	20.0	–

* Not detected

Table 4. Stimulating Activity of Non-diffusible Fraction

	Concentration of extract (mg/ml)	Nitrite formation (nmol/10^6cells)
Cattle		
Cerebrum	20.0	– a
Reticulorumen	20.0	+ b
	2.0	11.9
	0.2	–
Swine		
Cerebrum	20.0	31.6
	2.0	37.3
	0.2	24.4
Cerebellum	20.0	29.0
	2.0	25.9
	0.2	–
Eyeball	20.0	–
Tongue	20.0	+ c
	2.0	9.3
Stomach	20.0	32.1
	2.0	19.2
	0.2	–
Uterine	20.0	–
Chicken		
Chicken	20.0	42.6
	2.0	58.5
	0.2	19.3
Gizzard	20.0	42.3
	2.0	13.9
	0.2	–

a : Not detected.

b : Detected. Absorption could not determined because of turbidity.

c : Detected. Absorption could not determined because the sample had red colour.

Table 1
Summary of Observations from Visits to Participating Countries

	Portugal	Italy	Belgium	Germany	Holland	UK	Denmark
Regulations	no	yes	yes	recommend.	yes	yes	yes
Live pig* imports	none	~1,000,000	minimal	162,461	208,217	none	none
Live pig* export	none	minimal	~700,000	1,872,279	2,878,000	minimal	127,852
Pig population	mixed	stress –	stress +	stress +	stress –	stress –	stress –
Transport Mortality	0.16%	0.10%	0.30%	0.50%	0.16%	0.09%	0.03%
m^2/pig (100 kg)	0.36–0.38	0.37–0.40	0.38–0.39	0.36–0.46	0.32–0.35	0.37–0.49	0.34–0.36
Price DKK/pig	16.0(200 km)	11.7–15.6	8.7–13.6	12.3–20.5	14.45	15.5	15.0
Loading device	–	–	vertical	–	vertical	mainly –	+ tail gate
Tiers	fixed	mobile	fixed	mobile	fixed/mobile	fixed/mobile	mobile
No. of Tiers	1 – 2	3	2 – 3	1 – 2	2 – 3	2 (3)	1 – 2
Tier Heights (m) 1–tier 2–tiers 3–tiers	 1.70 0.80–1.1/1.2	 2.00 – 0.90	 – 1.00–1.20 0.80–0.85 old 0.90 new	 1.90–2.00 1.00–1.20 –	 – 1.05–1.30 0.90–0.95	 – 0.95–1.30	 1.80–2.00 1.10 –
Compartment Sizes	7 – 9	15 – 30 (no mixing)	10 – 20	10 – 20	15 – 20	20	15 – 20
Roofing	–	+	+	+	+	+	+
Material – Walls – Floor	Al./steel/wood Al./wood	Al. Al.	Al./steel Al./acrylic	Al./plywood Al./wood	Al. Al./acrylic	Al./plywood Al./wood	Al./plywood Al./rubber
Ventilation	natural	natural	natural/mech.	natural	natural	natural	natural/mech.
Bedding	–	–	+	+	+	+	+

* Slaughter pigs

Figure 1
Transport & Lairage Mortality for all Danish Slaughter Pigs

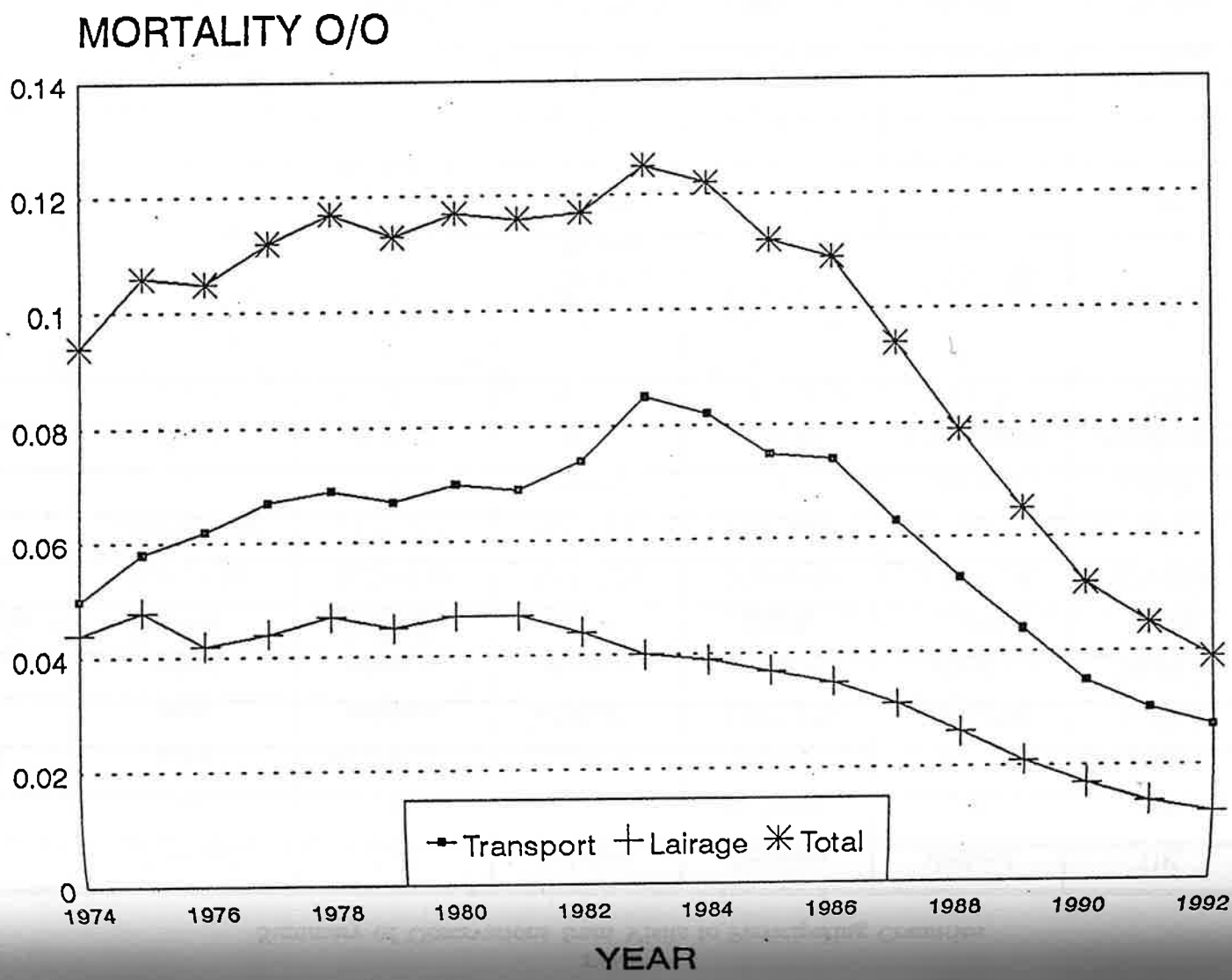


Table 1. Chemical composition (g/kg) of rabbit meat

	Age (A)			Sex (S)		Transportation (T)		Significance level			RSD
	77d	84d	91d	M	F	NO	YES	A[(1)] L	A[(1)] Q	S	T	
Rabbits, no.	20	20	20	30	30	30	30					
Hindleg muscles:												
- water	728	729	724	726	728	728	726					7
- protein	224	222	225	225	223	224	225		*			4
- fat	35	36	38	36	36	36	36					7
- ash	13	13	13	13	13	13	13					1
M. *longissimus dorsi:*												
- water	747	752	750	749	751	750	749		**			5
- protein	230	226	226	227	226	226	228	**	**		*	4
- fat	10	10	11	11	10	11	10				*	2
- ash	13	12	13	13	13	13	13		*			1

***: P<0.001; **: P<0.01; *: P<0.05

(1) Linear (L) and quadratic (Q) components of variance.

Table 2. Physical and chemical traits

	Age (A)			Sex (S)		Transportation (T)		Significance level				RSD
	77d	84d	91d	M	F	NO	YES	A(1)		S	T	
								L	Q			
Average pH_u(2)	5.78	5.77	5.81	5.81	5.76	5.71	5.86			*	***	0.10
Cooking losses (%):												
- Hindleg muscles	20.3	18.2	18.1	18.6	19.1	20.4	17.3				**	3.5
- M. *l. dorsi pars lumbalis*	22.3	22.2	21.3	21.9	22.0	22.8	21.0				***	1.8
Average colour(3):												
- L^*value (lightness)	56.9	54.4	53.3	54.5	55.2	56.8	52.9	***			***	2.3
- a^*value (redness)	2.72	3.31	2.49	2.98	2.70	3.44	2.24		**		***	0.91
- b^*value (yellowness)(4)	1.15	1.28	0.96	1.09	1.16	1.78	0.48				***	0.85
- C^*value (chroma)	3.49	4.18	3.41	3.82	3.56	4.34	3.05		*		***	1.02

***: P<0.001; **: P<0.01; *: P<0.05

(1)Linear (L) and quadratic (Q) components of variance. (2)Average pH of the following muscles: *biceps femoris* (BFE), *tensor fasciae latae, semimembranosus accessorius, longissimus dorsi pars lumbalis* (LDL). (3)Average colour of BFE and LDL. (4)A x T interaction: P< 0.05.

Table 3. Mechanical and sensory properties of meat

	Age (A)			Sex (S)		Transportation (T)		Significance level				RSD
	77d	84d	91d	M	F	NO	YES	A(1)		S	T	
								L	Q			
Warner-Bratzler shear force (kg/cm^2):												
- Hindleg muscles	2.19	1.97	2.08	2.04	2.11	2.38	1.77				**	0.70
- M. *l. dorsi pars lumbalis*	1.97	2.39	2.19	2.13	2.24	2.40	1.97		*		**	0.57
Sensory toughness(2):												
- Hindleg muscles(3)	3.80	3.45	3.25	3.23	3.77	3.77	3.23					1.66
- M. *l. dorsi pars lumbalis*	2.90	3.85	3.75	3.63	3.37	4.23	2.77				***	1.55
Hindleg muscle flavour(4)	3.40	2.95	4.15	3.10	3.90	3.57	3.43					1.71

***: P<0.001; **: P<0.01; *: P<0.05

(1)Linear (L) and quadratic (Q) components of variance. (2)Score 1 (the least tough sample) to 6 (the most tough sample). (3)A x S interaction: P<0.05. (4)Score 1 (the least flavoured sample) to 6 (the most flavoured sample).

Table 4. Fatty acid concentration (% total FA) and lipid quality of perirenal fat

	Age (A)			Sex (S)		Transportation (T)		Significance level				RSD
	77d	84d	91d	M	F	NO	YES	A[1]		S	T	
								L	Q			
Samples, no.	10	10	10	15	15	15	15					
Fatty acids:												
C12:0	0.3	0.3	0.2	0.3	0.3	0.3	0.2					0.1
C14:0	2.9	3.0	3.0	3.0	2.9	3.0	2.9					0.4
C16:0	28.1	28.8	23.8	27.2	26.6	26.2	27.6	***	**			2.2
C18:0	6.1	6.4	6.1	6.0	6.4	6.2	6.2			**		0.4
Other saturated[2]	1.7	1.6	1.5	1.6	1.6	1.6	1.7					0.2
Total saturated (SFA)	39.1	40.1	34.6	38.1	37.8	37.3	38.6	***	**			2.3
C14:1	0.2	0.2	0.3	0.3	0.2	0.2	0.2					0.1
C16:1	4.0	4.0	4.0	3.9	4.1	4.1	3.9					0.9
C18:1	28.4	28.3	29.7	29.4	28.0	29.1	28.4					2.0
Other monounsaturated[3]	1.3	1.3	1.4	1.4	1.3	1.4	1.3	*		**		0.2
Total monounsaturated	33.9	33.8	35.4	35.0	33.6	34.8	33.8					2.4
C18:2 n-6	22.4	22.0	25.1	22.5	23.9	23.3	23.1	*				2.4
C18:3 n-3	4.6	4.1	4.9	4.4	4.7	4.6	4.5		**			0.5
Total polyunsatur. (PUFA)	27.0	26.1	30.0	26.9	28.6	27.9	27.6	*	*			2.8
PUFA/SFA	0.69	0.65	0.87	0.71	0.76	0.75	0.72	***	**			0.08
n-3/n-6	0.21	0.19	0.20	0.20	0.20	0.20	0.19					0.14
PCL-FA/PCE-FA[4]	1.40	1.34	1.77	1.46	1.52	1.54	1.45					0.19
Iodine number	83.4	81.1	90.2	83.8	86.0	85.7	84.1	**	**			4.4

***: $P<0.001$; **: $P<0.01$; *: $P<0.05$

[1]Linear (L) and quadratic (Q) components of variance. [2]C10:0 + C15:0 + C17:0. [3]C17:1 + C20:1. [4]Plasma cholesterol lowering FA (polyunsaturated FA + 1/2 monounsaturated FA) to plasma cholesterol elevating FA (C12:0+C14:0+C16:0) ratio (Reiser and Shorland, 1990).

Table 1: Treatment of Groups 1, 2a and 2b

Treatment	1	2a	2b
Fasting period	0 hours	min. 12 hours	min. 12 hours
Delivery from Farm	From the pen	From collecting pen	From collecting pen
Handling	Normal	Careful	Careful
Transportation	½ – 1 hour	½ – 1 hour	½ – 1 hour
Lairage at Abattoir	0 hours	2 hours	18–24 hours
Lairage overnight	No	No	Yes + feeding
Showering	No	½ – 1 hour	½ – 1 hour
No. of pigs	636	602	657

Table 2: Slaughterweight of all pigs in this experiment

	Group 1	Group 2a	Group 2b	All
No. of pigs	630	599	657	1,886
Slaughterweight	75.3[a]	75.8[a]	74.5[b]	74.8

Table 3a: pH_u and water holding capacity (MQM) measured day after slaughter, average per group (exclusive of pigs from Producer No. 3) (values marked with different letters vary significantly $p>0.05$)

	Group 1 No fast	Group 2a Fast	Group 2b Lairage overnight
pH_u – Biceps femoris	5.59[a]	5.62[b]	5.66[c]
pH_u – Semimembranosus	5.59[a]	5.62[b]	5.65[c]
pH_u – Longissimus Dorsi	5.62[a]	5.66[b]	5.67[b]
pH_u – Semispinalis Capitis	5.92[a]	6.02[b]	6.14[c]
Water – Biceps femoris	0.174[a]	0.175[b]	0.176[a]
Water – Semispinalis capitis	0.186[a]	0.186[a]	0.182[b]

Table 3b: pH_u and water holding capacity (MQM) measured day after slaughter, average per group – Producer No. 3 only (values marked with different letters vary significantly p>0.05).

	Group 1 No fast	Group 2a Fast	Group 2b Lairage overnight
pH_u – Biceps femoris	5.60[a]	5.81[b]	5.72[c]
pH_u – Semimembranosus	5.60[a]	5.82[b]	5.73[c]
pH_u – Longissimus Dorsi	5.69[a]	5.89[b]	5.73[b]
pH_u – Semispinalis Capitis	5.95[a]	6.32[b]	6.21[c]
Water – Biceps femoris	0.175[a]	0.182[b]	0.176[a]
Water – Semispinalis capitis	0.187[a]	0.190[a]	0.187[b]

Table 4: Frequency (%) of varying meat quality with all pigs

	Group 1	Group 2a	Group 2b
DFD Biceps femoris pH_u >6.10	0.3	1.8	1.5
DFD Sememembranosus pH_u >6.10	0.6	1.7	2.0
DFD Longissimus dorsi pH_u >6.10	0.3	2.0	1.7
DFD Semispinalis Capitis pH_u >6.50	0.8	7.4	9.2
PSE Biceps femoris, WHC <0.150	0.8	0.5	0
PSE Longissimus dorsi, WHC <0.150	0.3	0.7	2.8

Table 1

General losses of produce as depended on distance of delivery

№ of group	Distance of delivery, km	Losses, %			Yield of liver, % to live weight	Yield of carcass, %	Weight losses of carcass during chilling, %
		general	due to feces	mass of body			
1	0	-	-	-	2.21	60.0	1.5
2	50	1.3	0.4	0.9	1.47	58.5	2.1
3	100	1.6	0.41	1.2	1.36	57.0	2.6

Table 2

Physical and chemical indices of M. long. dorsi, n = 5

№ of group	Distance of delivery, km	Intensity of colour, units	Water-holding capacity, %	pH value	
				pH_1	pH_{24}
1	0	120.0	89.4	6.3	5.5
2	50	100.5	75.2	6.0	5.8
3	100	98.0	72.8	5.9	6.0

Table 3

Influence of distance of transportation on functional composition of protein of muscular tissue, n = 5

№ of group	Distance of transportation, km	Total protein, %	Sarcoplasmic proteins, %	Myofibrillar proteins, %	Proteins of stroma, %	Quality index of protein
1	0	19.4	5.0	7.8	6.6	2.0
2	50	17.9	4.4	7.0	6.5	1.8
3	100	19.3	4.2	7.1	8.0	1.4

Table 4

Influence of pre-slaughter keeping period on slaughter characteristics of pigs

№ of group	Pre-slaughter keeping time, h	Losses, %			Carcass yield, %	Yield of liver, % to live weight
		total	due to feces	mass of body		
1	"from wheels"	-	-	-	54.3	1.3
2	6	0.97	0.39	0.58	54.3	1.44
3	24	2.9	1.54	1.36	53.6	1.2

Table 5

Technological properties of pork animals, kept for different time period before slaughter, n = 5

№ of group	Time before slaughter, h	pH value		Water-holding capacity, %	Intensity of colour, units
		pH_1	pH_2		
1	"from wheels"	6.3	5.6	78.4	82.5
2	6	5.7	5.5	69.7	65.0
3	24	5.3	5.4	63.5	62.5

Table 6

Influence of pre-slaughter keeping time on fractional composition of muscular proteins, n = 5

№ of group	Pre-slaughter keeping time, h	Fractions of proteins, %			Quality index of proteins
		sarco-plasmic	myofib-rillar	proteins of stroma	
1	"from wheels"	4.4	8.1	7.2	1.7
2	6	4.6	7.9	7.1	1.8
3	24	3.3	6.3	9.2	1.0

Table 1: Mean value and Coefficient of variability for analysed meat characteristics

	n	mean	coefficient of variability %
pH	418	5.41	4
FOP	444	34.48	25
L	382	39.87	8
a	382	22.40	8
b	382	12.13	11

Table 2: Influence of transport duration on meat pH and colour

	Transport duration		p values
	up to 1h	from 4 do 7h	
	n	n	
pH	935.45	325 5.40	.081
FOP	9333.3	351 35.4	.156
L	5538.8	327 40.3	.061
a	5521.0	327 23.2	.001
b	5511.3	327 12.8	.001

Table 3: Influence of the waiting period from arrival to slaughter on meat pH and colour

	Waiting period			p values between		
	up to 2h (1)	17 to 20h (2)	64h (3)	1-2	1-3	2-3
	n	n	n			
pH	2205.36	1765.50	225.42	.000	.077	.069
FOP	22035.0	20231.9	2236.2	.089	.508	.099
L	19241.4	16836.8	2240.5	.000	.247	.006
a	19222.7	16819.9	2223.8	.001	.067	.000
b	19212.7	16810.0	2213.5	.000	.053	.000

Table 4: Influence of heifers origin on meat pH and colour

	Farms		Co-operatives		p
	n		n		values
pH	2265.29		192	5.57	.000
FOP	22635.8		218	33.0	.038
L	22340.3		159	38.8	.005
a	22323.5		159	20.8	.000
b	22313.0		159	11.1	.000

Table 5: Correlation coefficients between some meat characteristics

	FOP	L	a	b
pH	-.34	-.33	-.34	-.34
FOP		.50	.54	.58
L			.33	.58
a				.90

All correlation coefficients are significant ($p<0.01$)

Table 1. Spearman rank correlation coefficients (r_s) between resting time and skin damage and density and skin damage (df = 40).

	r_s	
skin damage	resting time - skin damage	density - skin damage
front	0.3875**	0.0506
middle	0.4075**	0.4315**
hind	0.3766**	0.3920**

** significant at $p < 0.01$

Table 2. Spearman rank correlation coefficients (r_s) between total frequency of being attacked and skin damage in the front region and total duration of received aggression and skin damage in the front region for three abattoirs.

abattoir	frequency being attacked - skin damage	duration of being attacked - skin damage
A	0.14	0.28**
B	0.36***	0.35***
C	0.15	0.16

** significant at $P < 0.01$

*** significant at $P < 0.001$

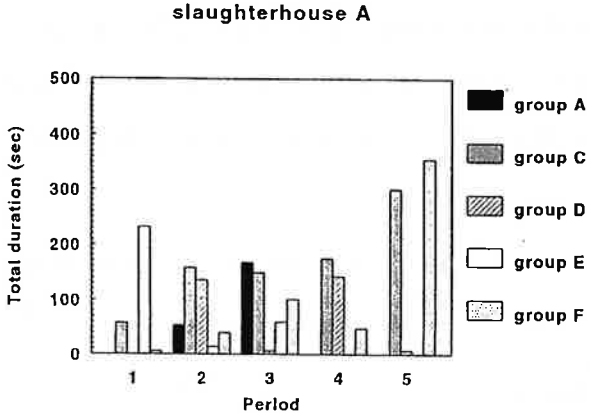


Fig. 1a. Group A and E were slaughtered after the third period.

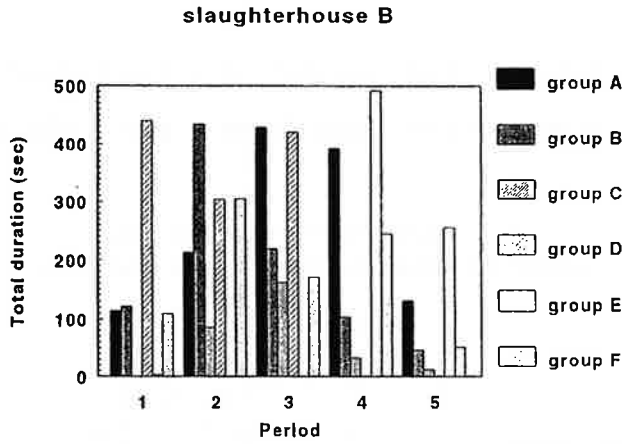


Fig. 1b. Group D was slaughtered after the third period.

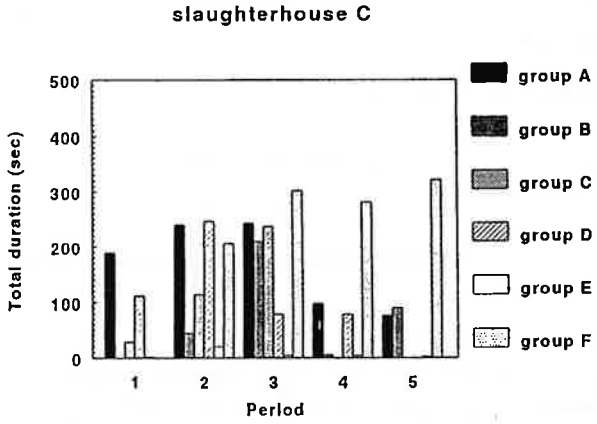


Fig. 1c. Group C was slaughtered after the third period and group D was slaughtered after the fourth period.

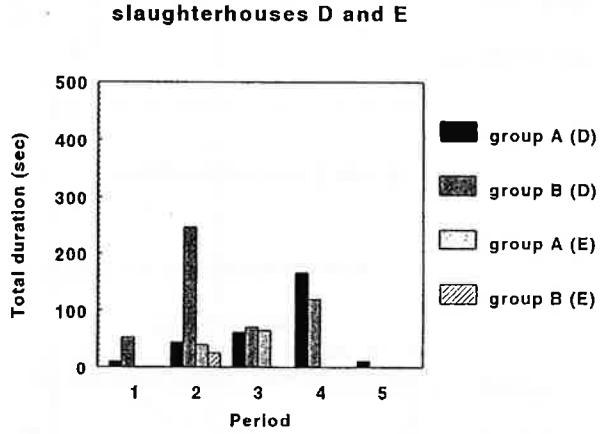


Fig. 1d. Group B (slaughterhouse D) was slaughtered after the fourth period, group A (slaughterhouse E) after the third and group B (slaughterhouse E) after the second period.

Fig. 1. Total duration of agonistic interactions during 10-minute bouts in lairage. Visits to slaughterhouse A, B and C were repeated twice. Each day, two groups were observed (first day: *group A and B; second day: group C and D; third day:* group E and F). Slaughterhouse D and E were visited once.

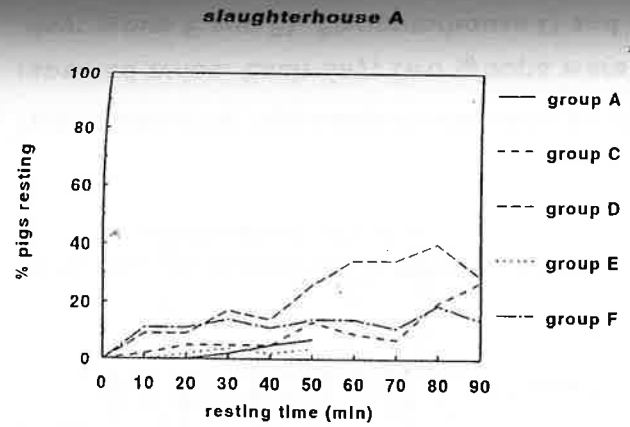


Fig. 2a. Group A and E were slaughtered prematurely.

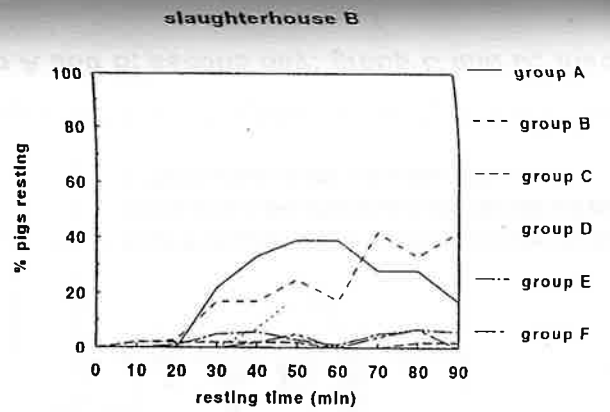


Fig. 2b. Group D was slaughtered prematurely.

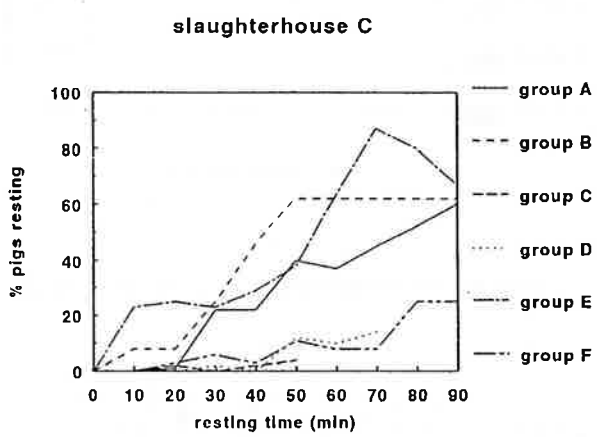


Fig. 2c. Group C and D were slaughtered permaturely.

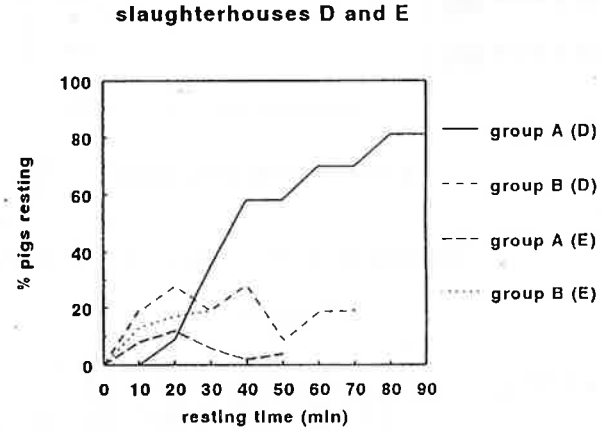


Fig. 2d. Group B (slaughterhouse D) and group A and B (slaughterhouse E) were slaughtered prematurely.

Fig. 2. Percentage of resting animals (sitting of lying) during resting time in lairage. Visits to slaughterhouse A, B and C were repeated twice. Each day two groups were observed (first day: group A and B; second day: group C and D; third day: group E and F). Slaughterhouse D and E were visited once.

Table 1. Mean values and standard deviations (SD) of meat quality characteristics from pigs of different halothane genotype (nn, Nn and NN) that were slaughtered after a 45-minute period of anesthesia during which one part of the pigs was stimulated to exercise for 15 minutes before slaughter

Variables	Genotype											
	NN (n = 8)				Nn (n = 8)				nn (n = 8)			
	Control		Exercised		Control		Exercised		Control		Exercised	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Live wt, kg	88.0	20.4			82.6	3.7			76.4	16.5		
pH45 LD	6.65[a]	.11	6.52[a,b]	.11	6.38[b]	.14	6.27[c]	.18	6.08[c]	.36	5.90[d]	.24
pH18h LD	5.59[a,b]	.13	5.61[a]	.12	5.46[b,c]	.12	5.59[a]	.21	5.44[c]	.11	5.52[a,b]	.18
T45 LD, °C	38.8	1.3	38.7	1.2	38.9	.9	38.7	.8	39.1	1.3	39.1	1.4
T18h LD, °C	5.4[a]	1.1	5.5[a]	.8	5.0[a,b]	1.3	5.0[a,b]	1.3	4.7[b]	1.3	4.8[b]	1.3
WHC, mg	21.8[a]	6.6	61.4[b,c]	16.6	25.5[a]	7.7	71.1[b,c]	17.8	58.1[b]	23.4	76.1[c]	25.6
Drip loss in %	3.8[a]	1.3	7.7[b]	3.2	3.7[a]	1.1	7.5[b]	3.2	8.1[b]	3.3	9.5[b]	2.2
Hunter L*-value	55.83[a]	3.70	58.66[b,c]	3.31	58.67[b]	2.43	59.59[b,c]	1.82	57.95[a,b]	3.12	59.53[c]	2.19
PSE samples	0		3		1		5		4		6	

[a,b,c,d] Means within a row lacking a common superscript letter differ significantly between combinations of genotype and treatment ($P < .05$).

Table 2. Mean values and standard deviations (SD) of temperature measurements and meat quality characteristics from pigs of different halothane genotype (nn, Nn and NN) that were slaughtered after a 45-min period of anesthesia during which the pigs were decreased (low) or increased (high) in body temperature.

Variables	Genotype											
	NN				Nn				nn			
	Low (n=7)		High (n=9)		Low (n=7)		High (n=7)		Low (n=8)		High (n=9)	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Live wt ,kg	103.6	10.7	97.1	19.5	110.6	19.4	113.1	22.7	94.9	23.8	99.1	23.8
Rectal T at the start, °C	38.2	.7	38.3	.4	38.6	.5	38.2	1.1	38.1	1.1	38.1	.6
Rectal T after treatment, °C	36.9[a]	.7	38.8[b]	.6	37.5[a]	.8	39.2[b]	1.2	37.0[a]	1.4	39.0[b]	.9
T in LD at the start, °C	38.2	.6	38.3	.6	38.8	.6	38.7	.8	38.5	.8	38.5	.6
T in LD after treatment, °C	37.2[a]	.7	38.9[b]	.6	37.8[a]	.5	39.6[b]	.9	37.6[a]	1.1	39.4[b]	.8
T45 LD, °C	37.8[a]	.6	39.9[b]	.9	38.2[a]	.8	41.0[c]	1.4	38.5[a]	1.4	40.7[c]	1.0
T18h LD, °C	6.8	2.9	6.7	2.4	7.1	1.7	5.8	2.5	7.1	1.3	7.0	2.6
pH45 LD	6.69[a]	.12	6.63[a]	.11	6.65[a]	.18	6.24[b,c]	.43	6.30[b]	.28	6.00[c]	.26
pH18h LD	5.49	.14	5.48	.06	5.47	.14	5.48	.17	5.44	.09	5.47	.07
WHC, mg	15.7[a]	5.1	24.6[a]	17.4	39.9[a,b]	20.2	69.7[c]	32.3	50.8[b,c]	27.0	91.7[d]	21.4
Drip loss in %	2.8[a]	.9	3.6[a]	.9	4.2[a,b]	1.4	6.6[c]	2.6	5.9[b,c]	2.8	8.4[d]	3.0
Hunter L*-value	54.80	2.77	56.56	4.20	54.59	2.14	58.22	5.46	57.48	2.96	58.07	4.41
PSE samples	0		1		0		2		1		4	

[a,b,c,d]Means within a row lacking a common superscript letter differ significantly between combinations of genotype and treatment ($P < .05$).

Table 1. Stunner settings and actual current and voltage readings at some of the plants monitored.

PLANT	STUNNER SETTINGS		TESTER READING (AMPS)	ACT VOLTS (VOLTS)
	NUMBER	VOLTAGE		
ABATTOIR I	3	200	1.26	233
	4	300	1.63	302
ABATTOIR II	1	100	0.78	144
	2	200	1.15	213
	3	300	1.57	290
	*	400	2.10	388
ABATTOIR III	1	350	1.99	368
	2	325	1.83	339
	3	300	1.70	314
	4	275	1.54	285
	5	250	1.40	259
ABATTOIR IV	1	*	1.72	318
	2	*	1.46	270
	3	*	1.21	224
ABATTOIR V	1	*	1.14	211
	2	260	1.35	250
	3	280	1.45	268
	4	300	1.55	287
	5	320	1.66	307
ABATTOIR VI	1	*	1.67	309
	2	*	1.37	250
	3	*	1.14	211
ABATTOIR IX	1	200	1.04	192
	2	300	1.56	289
	3	400	2.11	390
ABATTOIR X	1	350	1.93	357
	2	325	1.74	324
	3	300	1.64	303
	4	275	1.44	266
	5	250	1.33	246
ABATTOIR XI	1	100	0.53	98
	2	200	1.08	200
	3	300	1.62	300
	4	400	2.16	400

Table 2. Summary of stunning procedures at various plants.

ABATTOIR	RESTRAINT	STUNNER	HANDPIECE	MEAN CURRENT (amp)	PERCENTAGE ≥ 1.3 amp	DURATION (sec)
1	V	V	P	1.9	100	7
2	V	V	Y	1.0	30	<1
3	V	V	T	2.7	100	4-7
4	V	C	HB	1.7	96	4.5
5	Pen	V	T	2.4	100	2.5
6	V	C	HB	1.1	0	3
7	V	C	HB	1.2	0	4
8	V	C	HB	1.4	99	3
9	V	V	P	2.0	90	3
10	V	V	T	3.5	100	4
11	V	V	P	1.8	90	16
12	V	V	HB	1.2	20	3
13	Pen	V	P	1.8	90	3
14	V	V	HB	1.02	0	5
15	V	C	T	2.5	95	6
16	V	V	P	1.14	10	15
17	V	V	P	1.71	98	2

KEY TO TABLE - SUMMARY OF STUNNING PROCEDURES

Abattoir - Number of Abattoirs involved in the Survey

Restraint - **V:** V-Restrainer **Pen:** Pen Restraint

Stunner - **V:** Constant Voltage **C:** Constant Current

Handpiece - **P:** Two Probes **Y:** Y Shaped **T:** Tongs
HB: Head-to-Back

Mean Current - Mean current obtained from chart recordings

Percentage ≥ 1.3 amp - Percentage of chart recording currents ≥1.3 amp

Duration - Duration of stun current

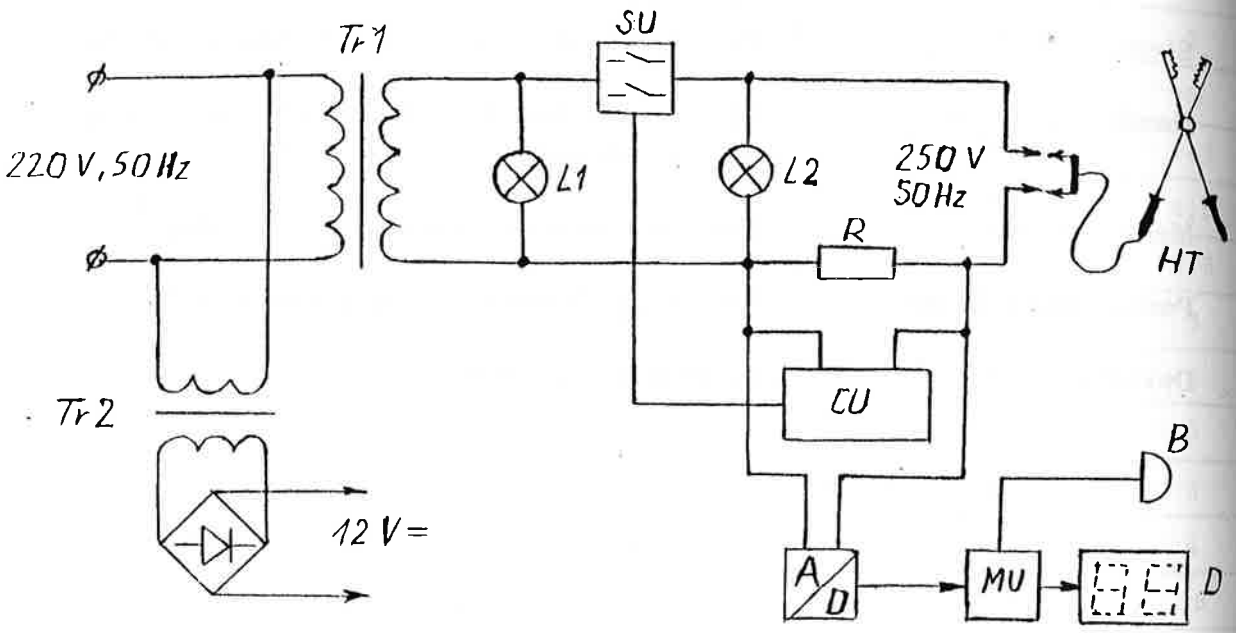


Fig.1. Simplified circuit diagram of the new stunning device (Tr1, Tr2 - transformers, L1, L2 - signal lamps, SU - switching unit, R - calibrated resistor, CU - control unit, A/D - - analog/digital converter, MU - multiplying unit, D - charge digital display, B - bell, HT - hand tongs)

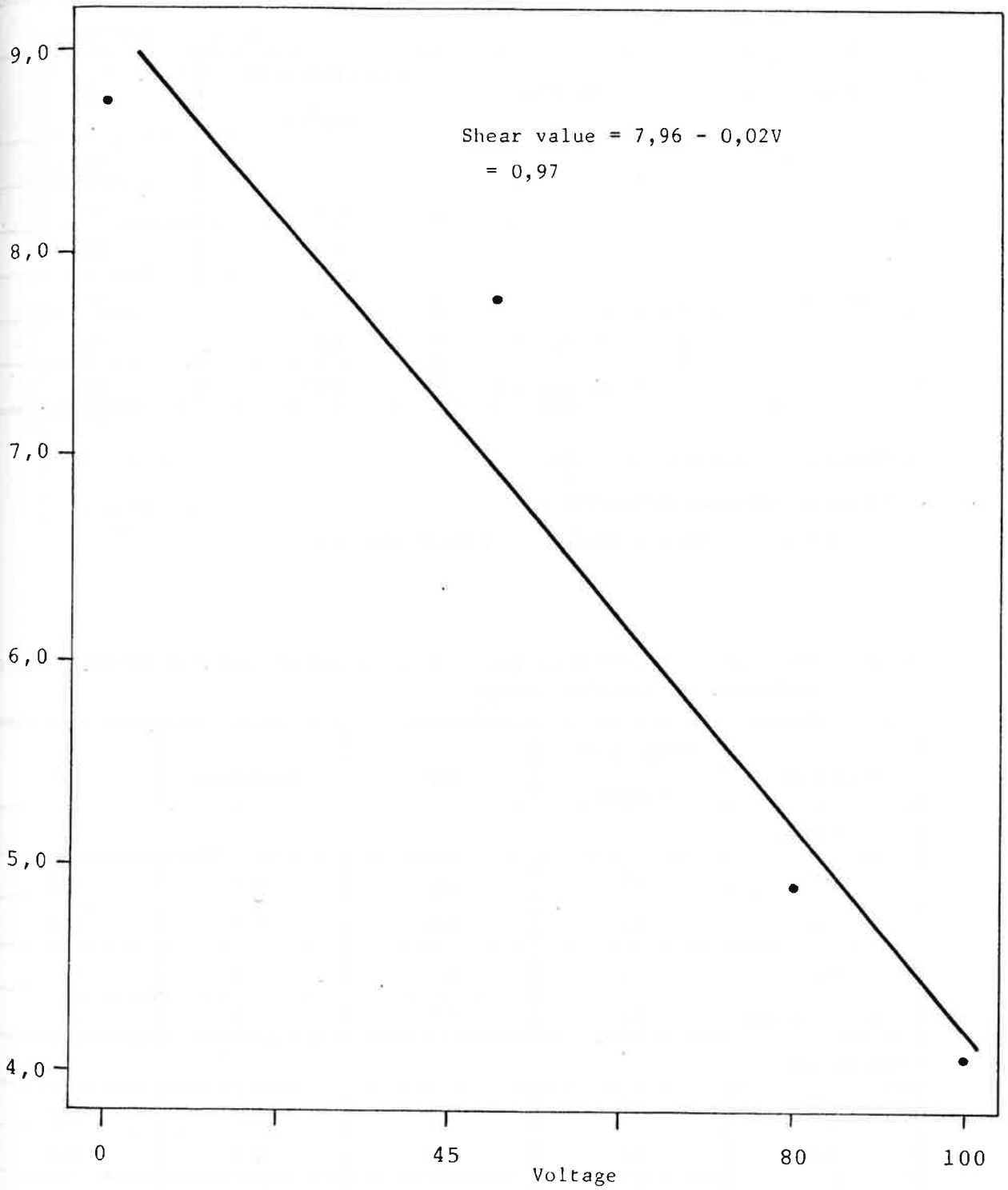


Figure 1. Correlation between electrical stimulation voltage and shear value.

Table 1. Effects of voltage of electrical stimulation and type of boning on the shear value of chicken breast meat.

VOLTAGE [1]	BONING [2]	SHEAR VALUE (kgf/g)	SE
45		7,4 [bc]	0,3
80		6,3 [ab]	0,3
100		5,9 [a]	0,3
Non stimulated		7,8 [c]	0,3
	Hot boning	8,4 [a]	0,2
	Conventionally	5,3 [b]	0,2

1- Means of 50 measurements / voltage.

2- Means of 100 measurements / boning.

a, b, c - Mean with different letters are statistically different.

Table 2. Combined effect of stunning and electrical stimulation voltage on the shear value and tenderness of breast chicken meat.

TREATMENT	Shear Value (kgf/g)	SE	Tendemess	SE
Conventional				
45	5,8	0,5	6,8	0,3
80	4,7	0,5	7,2	0,3
100	4,2	0,5	8,1	0,3
non stimulated	6,4	0,5	7,1	0,3
Hot Boned				
45	9,0	0,5	4,7	0,3
80	7,8	0,5	4,7	0,3
100	7,7	0,5	5,8	0,3
non stimulated	9,1	0,5	5,3	0,3

Table 3. Effects of electrical stimulation voltage and type of boning juiciness and overall quality of chicken breast meat.

FACTOR	JUICINESS	SE	OVERALL QUALITY	SE
Voltage				
45	6.2^{a}	0.2	6.2^{a}	0.6
80	6.1^{a}	0.5	6.6^{a}	0.4
100	5.6^{a}	0.3	6.9^{c}	0.4
non-stimulated	5.7^{a}	0.4	6.8^{bc}	0.4
Boning				
hot boning	5.4^{a}	0.2	5.9^{a}	0.2
conventional	6.3^{b}	0.2	7.3^{b}	0.1

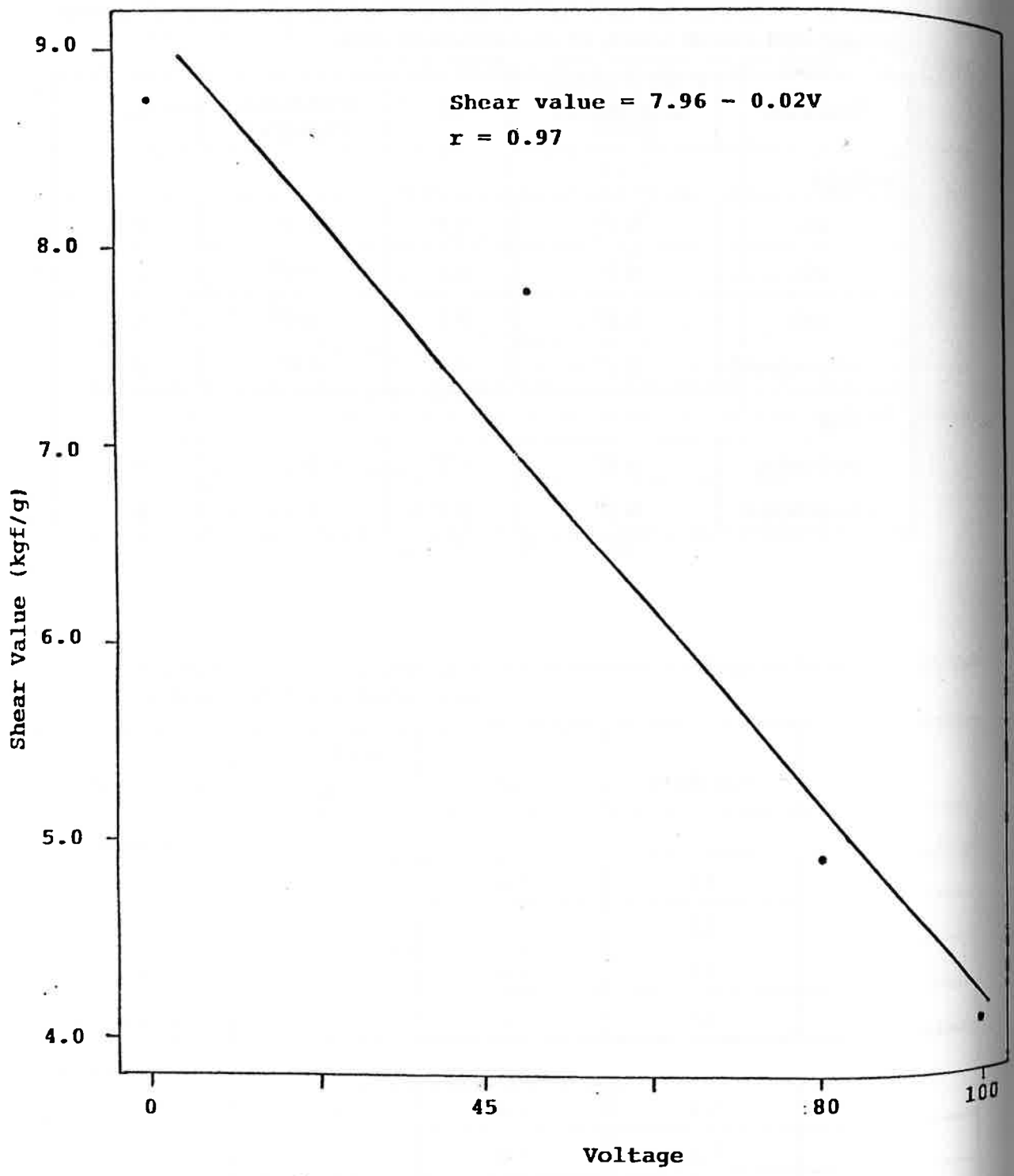


Figure 1. Correlation between electrical stimulation voltage and shear value

Table 3. Effects of electrical stimulation voltage and type of boning juiciness and overall quality of chicken breast meat.

FACTOR	JUICINESS	SE	OVERALL QUALITY	SE
Voltage				
45	6.2[a]	0.2	6.2[a]	0.1
80	6.1[a]	0.2	6.6[a]	0.1
100	5.6[a]	0.2	6.9[c]	0.1
non-stimulated	5.7[a]	0.2	6.8[bc]	0.1
Boning				
hot boning	5.4[a]	0.1	5.9[a]	0.04
conventional	6.3[b]	0.1	7.3[b]	0.04

Table 1. Mean values (mean) and standard deviations (SD) of meat quality traits at 1 day post mortem of whole-body (200 Hz AC, 100 V, 4s; n=30) and head-only (200 Hz AC, 25 V, 4 s; n=30) electrically stunned broilers.

		Stunning method			
		Whole-body		Head-only	
		Mean	SD	Mean	SD
pH,					
breast		5.7	0.1	5.8	0.1
thigh		6.0	0.1	6.0	0.1
Haemorrhaging-scores,					
breast		3.1[y]	1.2	3.2	1.2
thigh		2.9*	1.1	1.8*	1.0
wings		1.6[z]	0.8	1.8	0.8
Colour,					
breast	L*	55.8**	2.2	53.3**	1.6
	a*	9.4**	1.0	10.1**	0.8
	b*	16.1**	1.6	15.2**	1.6
thigh,					
M. iliotibialis cranialis	L*	50.7	1.7	51.2	1.6
	a*	11.4	1.0	11.1	0.9
	b*	16.7	1.2	16.9	1.2
M. flexor cruris medialis	L*	52.7	2.0	53.0	2.4
	a*	8.6*	0.9	8.0*	1.1
	b*	15.8	1.1	15.8	1.2

* significant difference, $p \leq 0.05$ for stunning method.
** significant difference, $p \leq 0.01$ for stunning method.
y Haemorrhages in breast and thigh muscles were classified in 5 categories by a visual grading system. Category 1 through 5 indicate increasing prevalence of haemorrhages. The score is presented as a mean value of the scores of 3 persons.
z Haemorrhaging in the wings was classified in 3 categories (1=no, 2=medium, 3=severe).

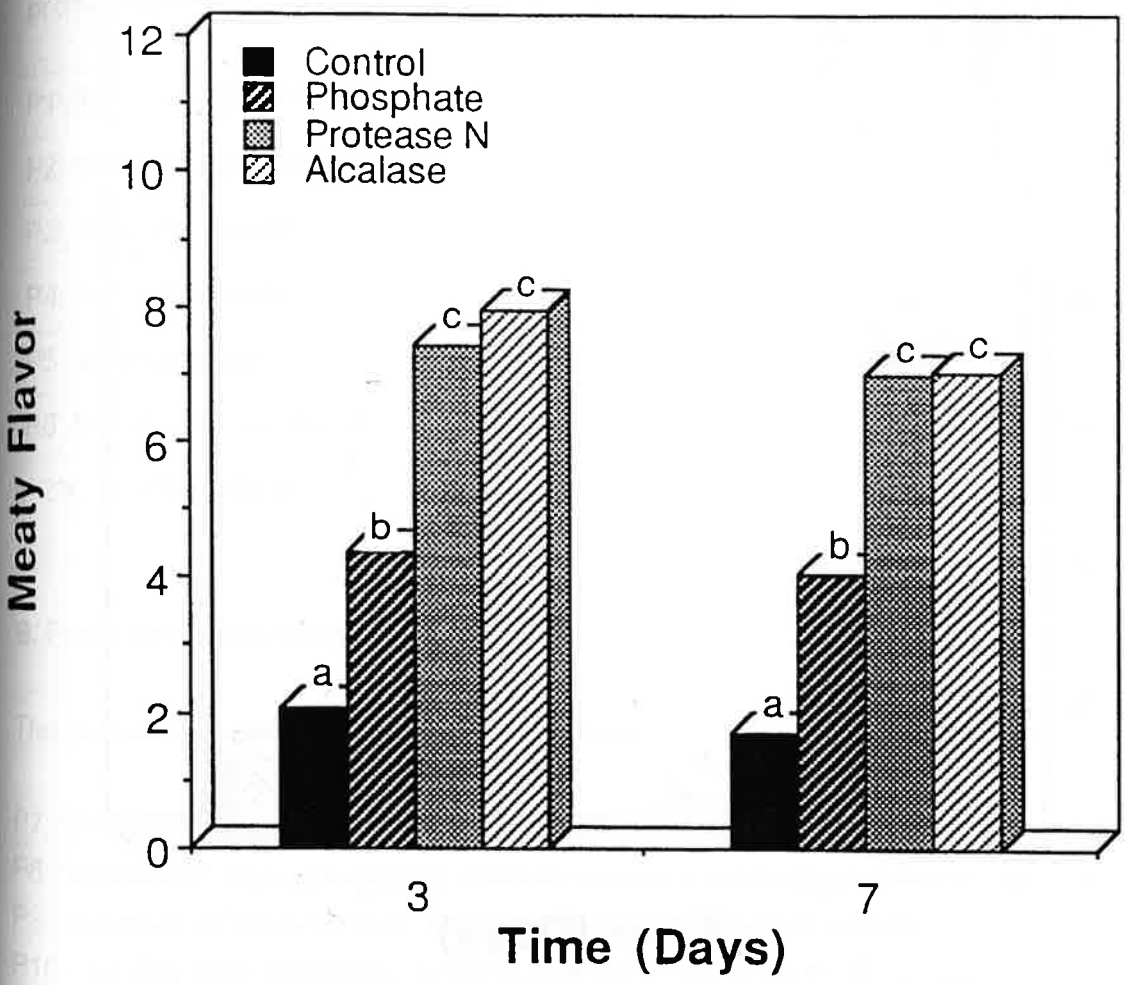


Figure 1. Effect of antioxidants on meaty flavor of precooked vacuum-packaged chopped beef steak during storage of 4°C.
abc Means within a time period with different letters are significantly different ($p<.05$) (N = 2)
Meaty score: 0 = none, 10 = intense
Control = 0.5% NaCl, 2% water; phosphate = 0.5% NaCl, 0.4% STP, 2% water; protease N = 0.5% NaCL, 0.4% STP, 2% SMF made of beef protein hydrolysate (BPH) digested with protease N (0.2%) and peptidase A (0.4%); Alcalase = 0.5% NaCl, 0.4% STP, 2% SMF made of BPH digested with alcalase (0.2%) and fungal protease (0.6%)

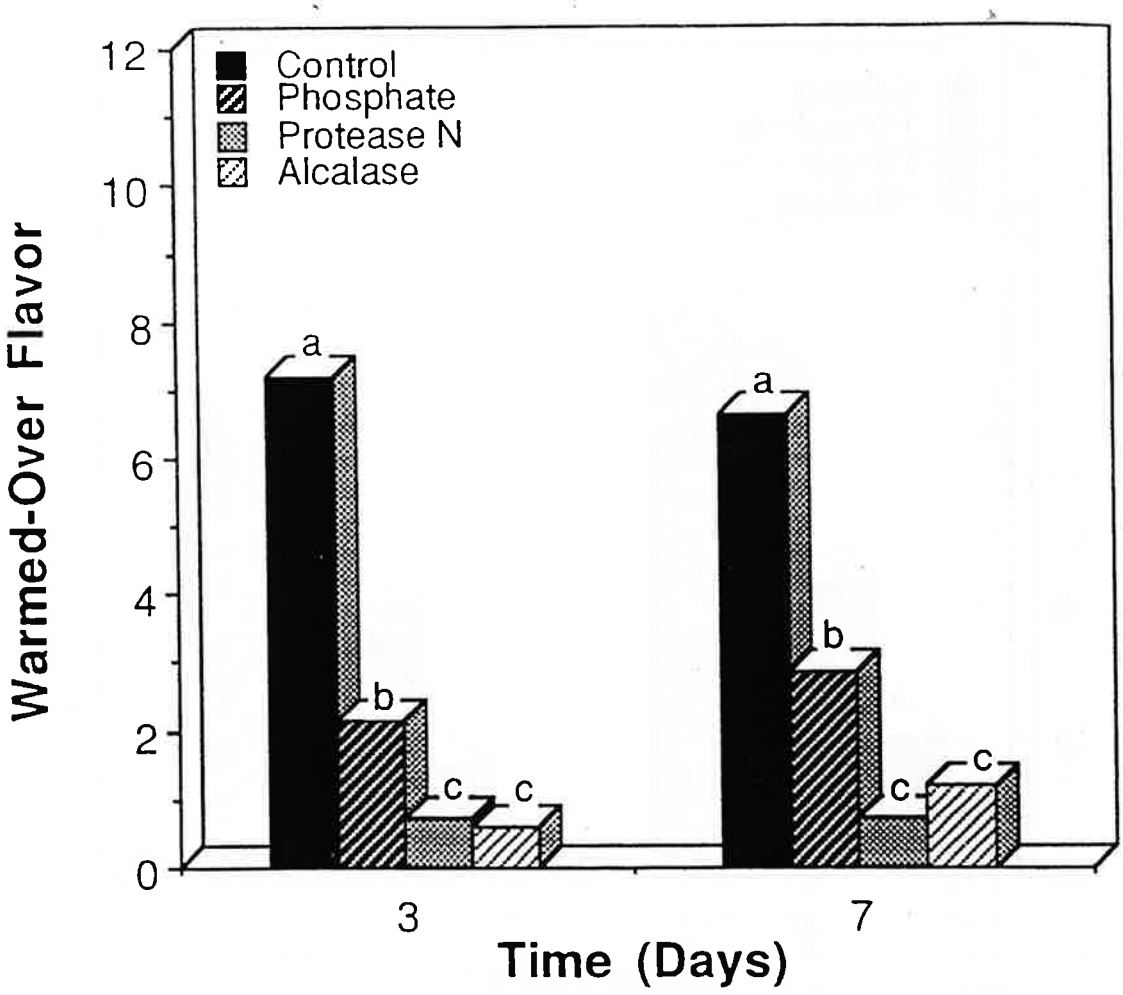


Figure 2. Effect of antioxidants on WOF of precooked vacuum-packaged chopped beef steak during storage at 4°C.
[abc] Means within a time period with different letters are significantly different ($p<.05$) (N = 2)
WOF score: 0 = none, 10 = intense
Control = 0.5% NaCl, 2% water; phosphate = 0.5% NaCL, 0.4% STP, 2% water; protease N = 0.5% NaCL, 0.4% STP, 2% SMF made of beef protein hydrolysate (BPH) digested with protease N (0.2%) and peptidase A (0.4%); Alcalsase = 0.5% NaCl, 0.4% STP, 2% SMF made of BPH digested with alcalase (0.2%) and fungal protease (0.6%)

Table 1: Avaluation of meat products and ready-to-eat meals prepared with addition of collagen hydrolysates (Gelita-Sol, Collagel*); frequency of positive evaluation:
+ >50%, ++ ≥75%, +++ = 100%

product tested	taste, flavour	colour	lowering of consistency (%)
P1: liversausage in casing	+		15.5
P2: liversausage sterilized	+	++	23.2
P3: liver pâté baked	++	++	14.1
P4: liver pâté fresh*			a: 28.3; b: 68.4
P5: spreading paste	+++		
P6: turkey pâté sterilized	+++	+++	13.3

a: 2%, b: 3% Collagel

B. Frankfurter (scalded) sausage type

The products investigated under this headline are characterized as follows:

P7: "Bratwurst" (frying sausage), finely comminuted, scalded, in natural casings
P8: "Bratwurst" (frying sausage) medium coarse (minced), scalded, in natural casings
P9: meatloaf ("Fleischkäse"), finely comminuted, baked in molds
P10: hot dog-type sausages, canned and sterilized, in peel-off casings
P11: wieners, fresh product, scalded, in collagen casings
P12: luncheon meat, canned and sterilized
P13: ham-sausage ("Bierschinken"), scalded, in natural casings

All products (P7-P13) contained an addition of 2% Gelita-Sol. The results of the sensory tests and of measuring the product's consistency are listed in Table 2.

The addition of 2% Gelita-Sol has a positive effect on the taste and flavour of hot dogs, wieners and luncheon meat (see Table 2). First of all the meat aroma has been intensified, and the colour and colour stability of meatloaf, wieners and ham-sausage have been improved.

Table 2: Avaluation of frying sausage and frankfurter sausage type containing 2% collagen hydrolysate (definition of positive evaluation see legend to Table 1)

product tested	taste, flavour	colour	changes in consistency (%)
P7: "Bratwurst", fine			+19.9
P8: "Bratwurst", medium			+15.2
P9: meatloaf		+++	+20.0
P10: hot dog	++		+19.8
P11: wieners	++	+++	
P12: luncheon meat	+		+38.1
P13: ham-sausage		+++	

Also, a stabilization of emulsion binding properties (not shown in Table 2) with a resultant improved cutting firmness and a generally firmer consistency were in evidence in these Gelita-Sole containing product samples. In addition, a reduction in frying and grilling losses in a magnitude of 10 to 30 per cent could be determined as a substantially favourable calculatory factor. The lowering of the water activity also effectuated in these products by the use of the added collagen hydrolysate, brought about improved product keepability expressed as longer product shelf-life.

C. Ready-to-eat-dishes

A third group of meat products, so-called ready-to-eat-dishes, were represented by the following (wet and canned) products:

P14: liver dumplings in broth
P15: meat patties in sauce
P16: meat balls in caper sauce
P17: meat dumplings in hunter-style sauce
P18: "Maultaschen" (Swabian style ravioli, filling including ground meat) in broth
P19: goulasch soup, canned
P20: ragout fine with champignons in white cream sauce
P21: ravioli in tomato sauce

he examination of the sensory and technological effects obtained by adding Gelita-Sol r, respectively, Gelita-Collagel, both at a two per cent dosage level, to the wet, canned ategory leaded to the results listed in Table 3.

able 3: Evaluation of taste, flavour and consistency obtained from gelatin products (GS Gelita-Sol, CG = Collagel; to products not specially assigned GS was added); equency of positive evaluation: - < 50%, + >50%, ++ ≥75%

product tested	taste, flavour	colour	consistency changes (%)	
			Gelita-Sol	Collagel
P14: liver dumplings	++	++	-21.2	+2.8
P15: meat patties	++	++		
P16: meat balls			-20.3	+6.5
P17: meat dumplings			-15.3	+3.0
P18: "Maultaschen"			-20.1	-12.0
P19: goulasch soup	++	++		
P20: ragout fine	GS: - / CG: ++	GS: + / CG: -		

he addition of Gelita-Sol has produced clearly a positive effect on the product's taste, avour and colour. A point which stands out with the "ragout fine" is the fact, in this articular case, the sample made with Collagel turned out to be the one on which ositive evaluations dominated.

he change in consistency of the insert materials made from basic product mixes shows at, for samples containing Gelita-Sol, a softer consistency was observed, while those ontaining an equal concentration of Collagel (two per cent) the consistency was firmer. addition, for all samples, including ravioli (not listed in Table 3), the net insert weight early rose during storage to a higher extent than the "control" samples.

general the results show that the following possibilities of quality improvement and ontrollability of product properties emerge:

a) improvement of taste and product-specific flavours, such as the typical aromas of eat or liver, for instance,
b) more beautiful, stronger product colour and improved colour rentention,
c) ability to improve the consistency of insert materials in "wet" products,

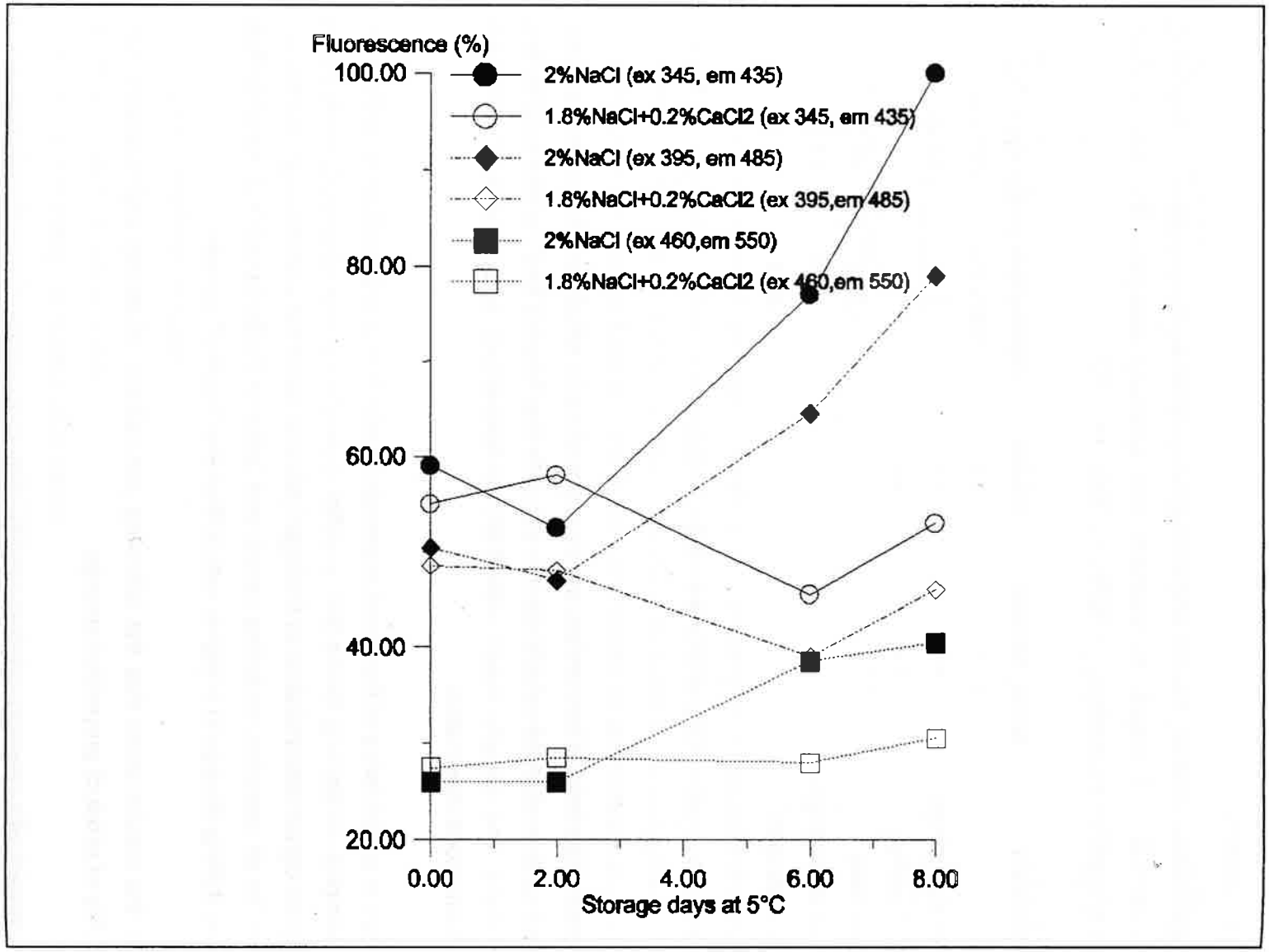


Fig. 1. Fluorescence at different $\lambda_{ex/em}$ of samples with NaCl and NaCl+$CaCl_2$.

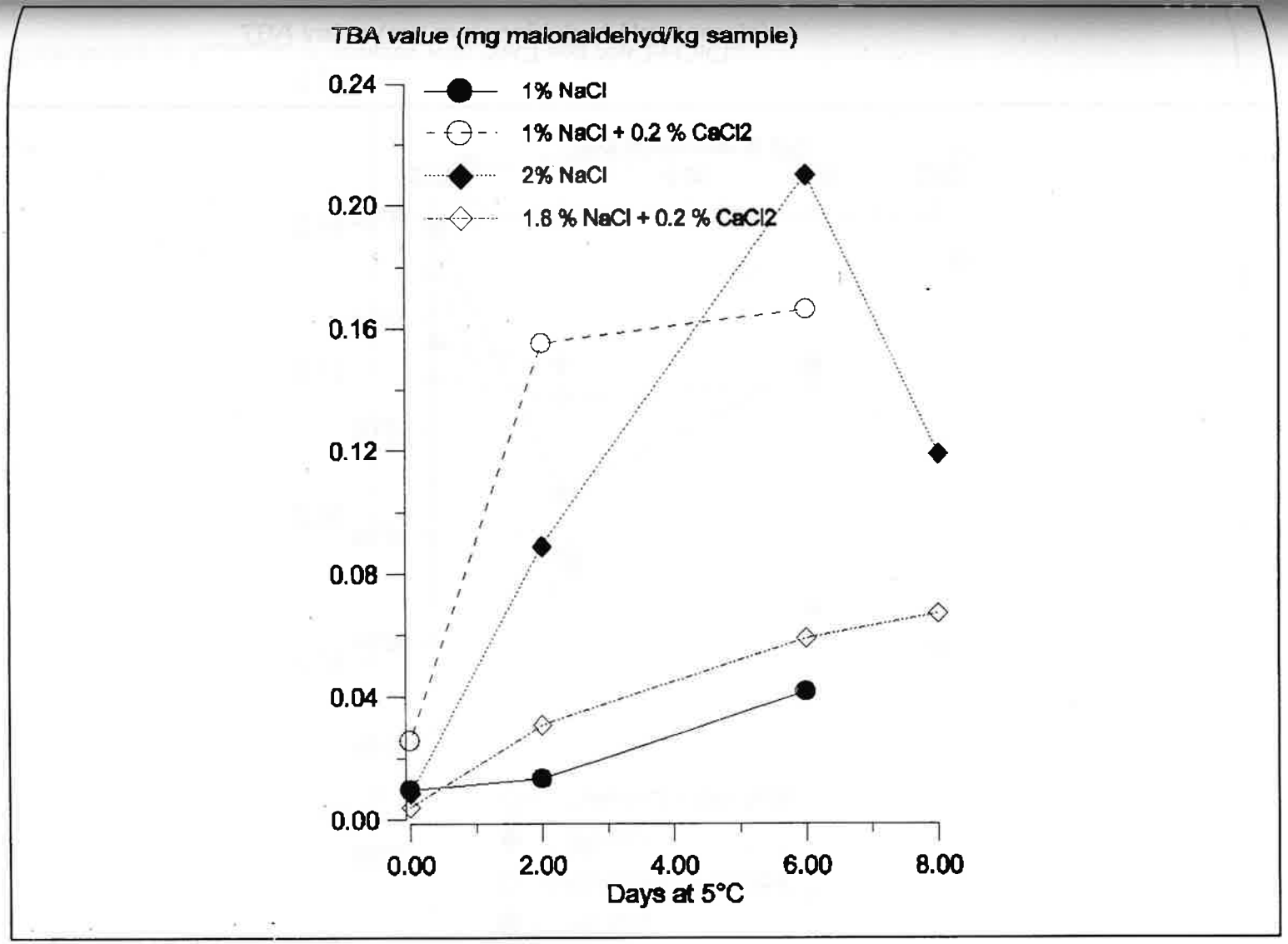


Fig. 2. TBA values of samples with NaCl and NaCl+$CaCl_2$.

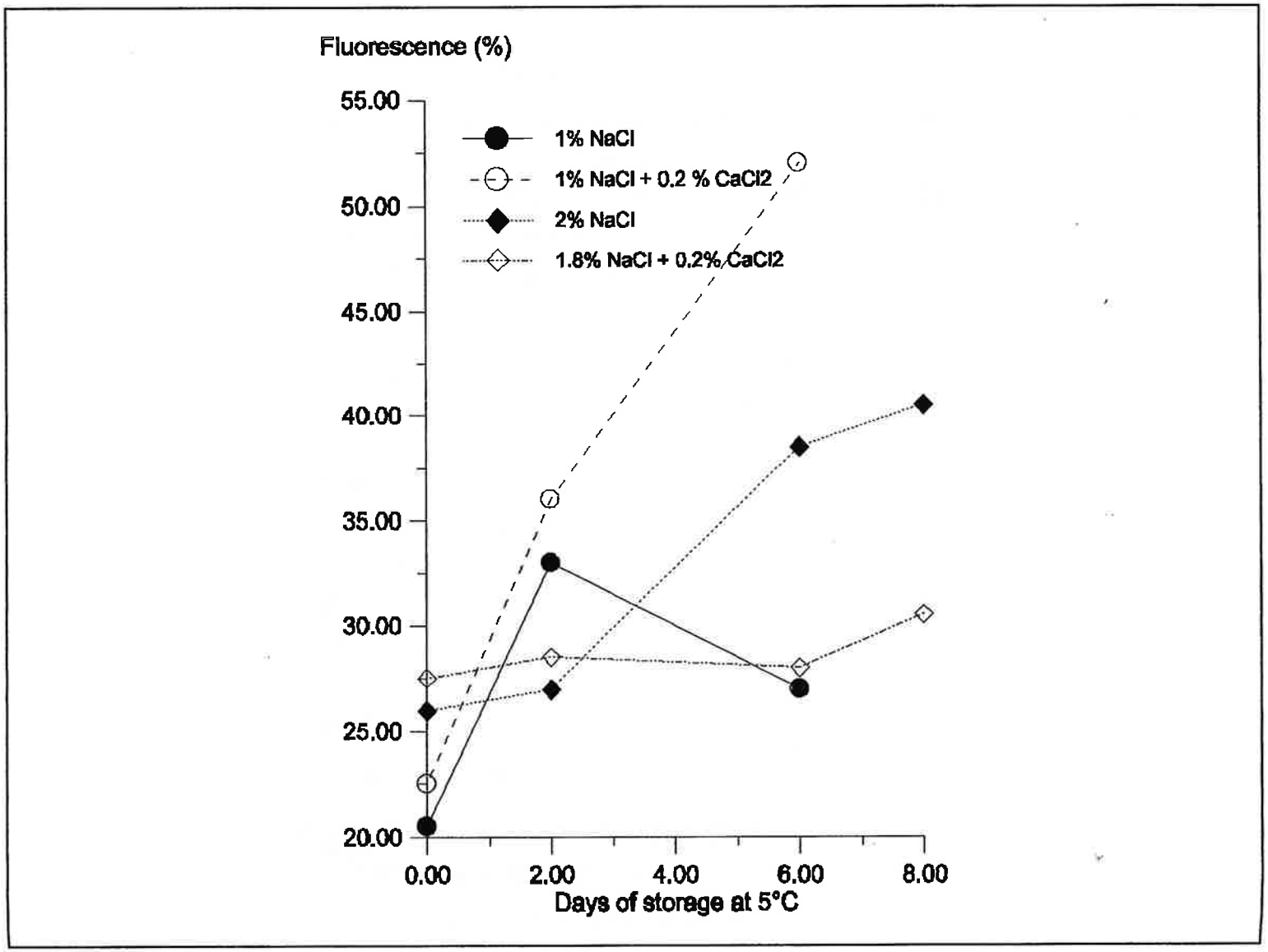


Fig. 3. Fluorescence at $\lambda_{ex460/em550}$ of samples with NaCl and NaCl+$CaCl_2$.

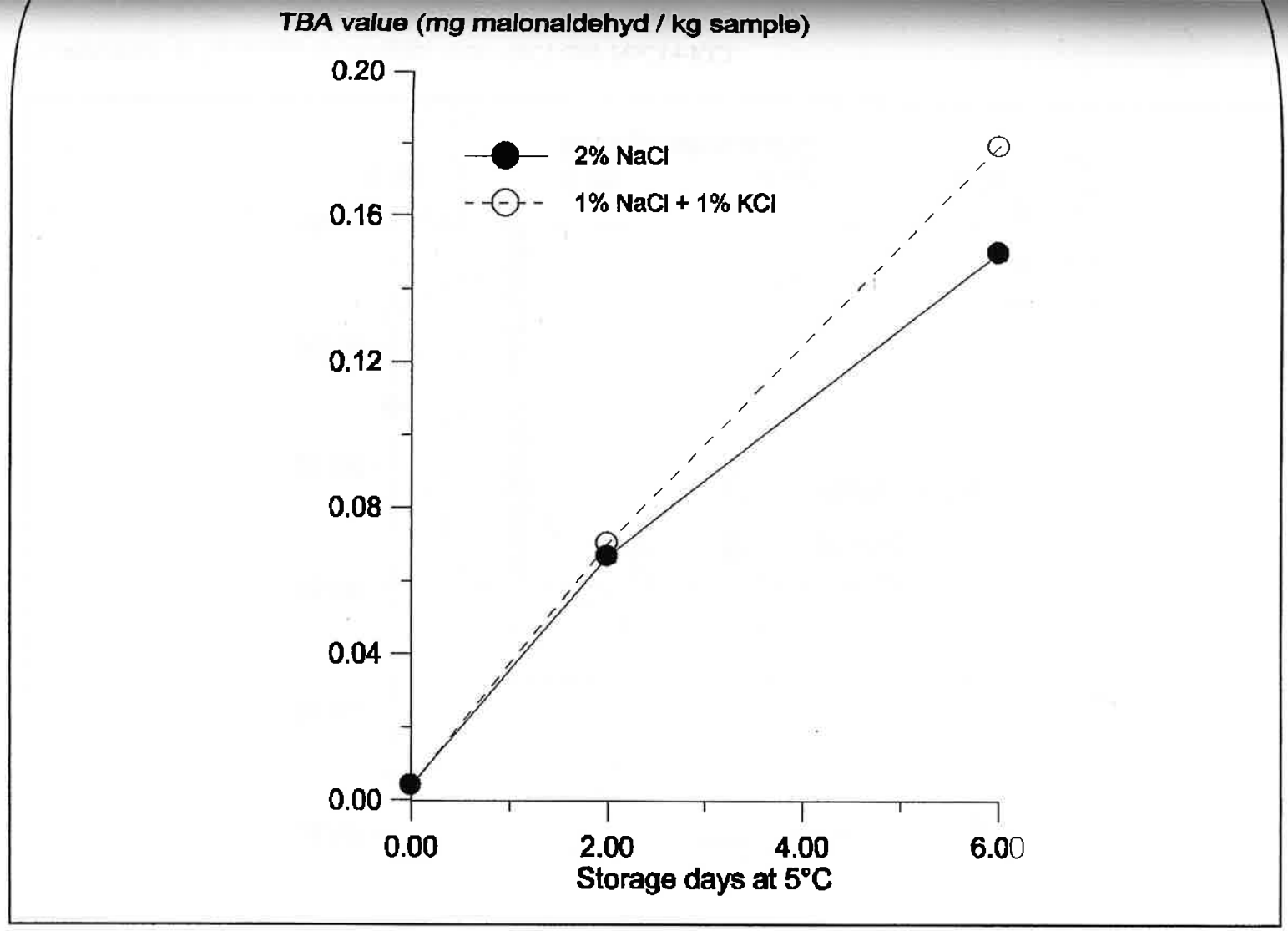


Fig. 4. TBA values of samples with NaCl and NaCl+KCl.

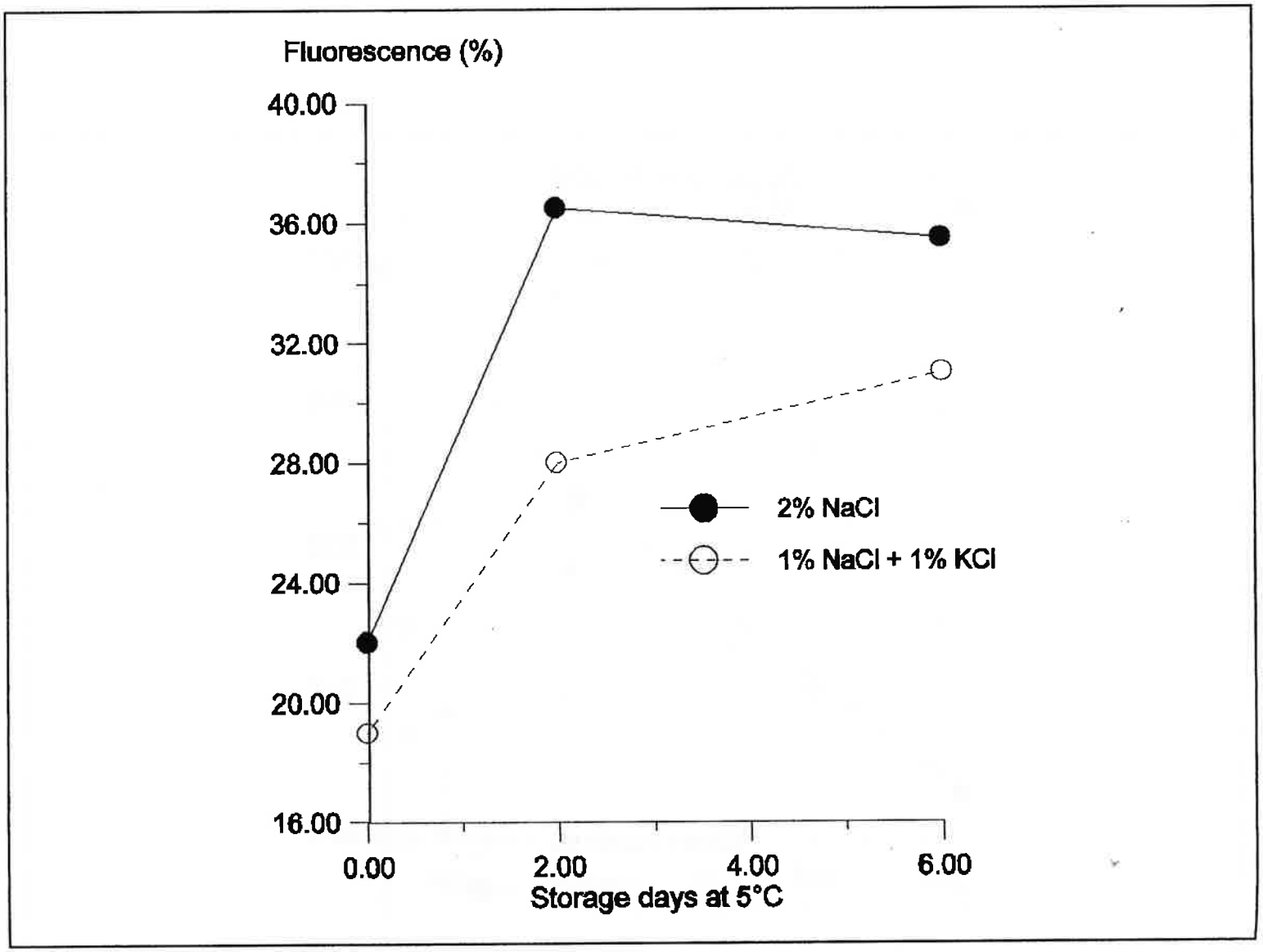
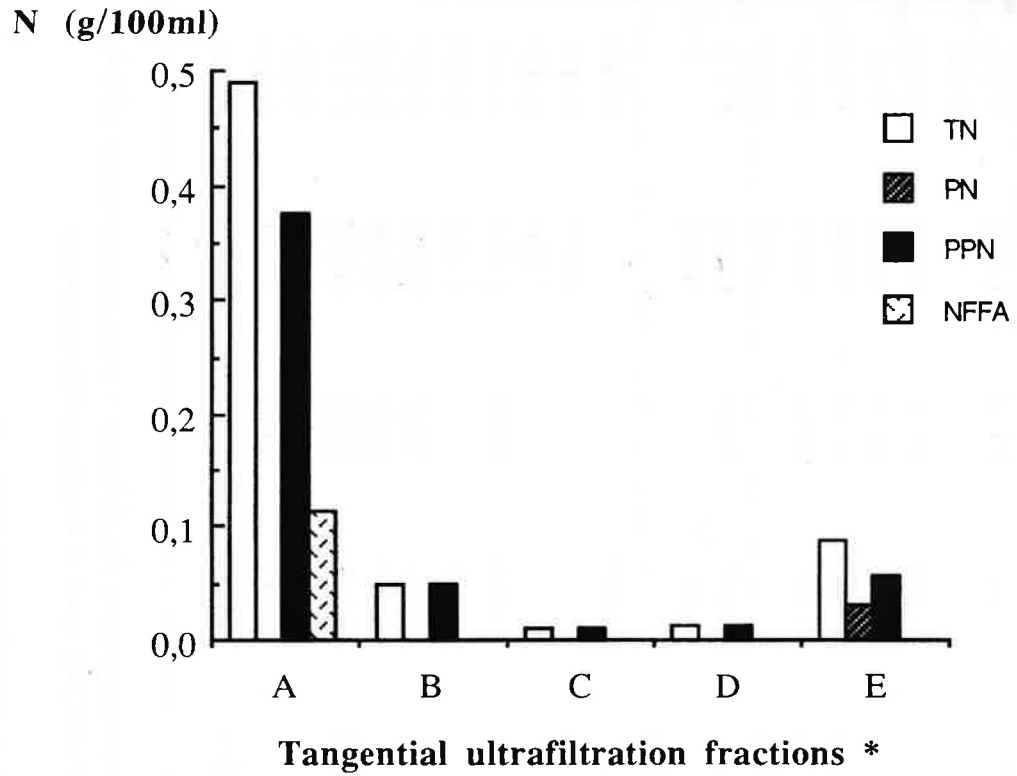


Fig. 5. Fluorescence at $\lambda_{ex460/em550}$ of samples with NaCl and NaCl+KCl.



*** A < 1KDa**
B between 1 and 3 KDa
C between 3 and 5 KDa
D between 5 and 8 KDa
E > 8 KDA

Figure 1. Total nitrogen (TN), protein nitrogen (PN), peptidic nitrogen (PPN) and nitrogen content of free amino acids (NFFA) of tangential ultrafiltration fractions of beef broths.

	Tangential Ultrafiltration Fractions**					
	A		B	C	D	E
Amino acid	FAA	PAA	PAA	PAA	PAA	PAA
ASP	0.121	0.152	0.014	0.005	0.004	0.184
GLU	0.133	0.381	0.017	0.008	0.004	0.004
ASN						0.011
SER	0.041		0.001	0.002	0.002	0.023
GLY/GLN	0.519		0.018	0.004	0.008	0.165
ß-ALA	0.003	0.664	0.016	0.004	0.008	0.018
HIS/TAU	0.221	0.767	0.001	0.011	0.013	0.072
THR	0.027	0.005			0.002	0.247
ALA	0.284		0.011	0.003	0.006	0.151
PRO	0.068		0.003		0.004	
ARG	0.005	0.001				
CYS	0.214		0.003			0.008
TYR	0.013				0.002	0.031
VAL	0.034				0.001	0.023
MET	0.027		0.009	0.004	0.004	0.051
L-CYS	0.028		0.002		0.001	0.003
ILE	0.017		0.002	0.002	0.002	0.024
LEU	0.034		0.005	0.001	0.006	0.067
M-HIS	0.118	14,67	0.115	0.036	0.042	0.437
PHE	0.061			0.006	0.002	0.025
TRP/ORN	0.088		0.011	0.001	0.011	0.012
LYS	0.026	0.013	0.003	0.001	0.004	0.146

Table 1. Concentration (µmol/100ml) of free amino acids before (FAA) and after hydrolysis (PAA)* in tangential ultrafiltration fractions of beef broth **.

* Potential amino acids were estimated from the differences between the values of FAA after fractions hydrolysis with 6N HCl and FAA without this treatment

** Values in table are the means of duplicate samples

*** A < 1 KDa, B between 1and 3 KDa, C between 3 and 5 KDa, D between 5 and 8 KDa and 8 > KDa.

Table. 1. Distribution of consumers for sex and age

	FEMALE		MALE		TOTAL	
Age	N.	%	N.	%	N.	%
< 20	7	8.3	5	7.3	12	7.9
20÷34	36	42.9	25	36.8	61	40.1
35÷49	19	22.6	11	16.2	30	19.7
> 50	22	26.2	27	39.7	49	32.2
Total *	84		68		152	

* The age of 3 females and 2 males is unknown

Table 2. Data concerning comparisons, consumers, answers.

Comparisons		Consumers		Answers					
		Female:	Male:	Prefer (1)		Prefer (2)		No preference	
Type	N.	number	number	Total	female	Total	female	Total	female
(1) vs (2)		age	age		male		male		male
H vs HxF	11	15	15	15	7	13	6	2	2
		20÷52	12÷59		8		7		0
H vs N	12	19	12	8	4	20	13	3	2
		14÷60	12÷72		4		7		1
H vs F	11	13	17	12	8	15	4	3	1
		9÷62	16÷67		4		11		2
HxF vs N	12	16	13	14	8	12	5	3	3
		19÷72	21÷69		6		7		0
Hxf vs F	9	13	6	9	5	9	7	1	1
		8÷67	20÷63		4		2		0
N vsF	7	11	7	10	7	4	2	4	2
		19÷82	20÷64		3		2		2
Total	62	87	70						

Meat	Trial	C_6	C_8	C_{10}
Goat	1	1328	3679	17927
	2	523	827	12296
	3	785	936	17373
	4	643	897	15692
	5	671	893	16946
	6	1311	2577	14402
	7	1223	2108	13976
	8	842	1977	14018
	9	446	—	13392
	10	1061	1321	15441
Pork	1	1175	2102	6831
	2	1052	2779	5927
	3	557	1164	5316
	4	634	1351	5817
	5	1288	2464	5474
	6	656	1237	5875
	7	1413	2044	6480
	8	1336	1928	5219

Table2 Ratio of Average C_6:C_8:C_{10} Peak Areas in Goat Meat and Pork

Meat	Trial	C_6	C_8	C_{10}	Ratio
Goat	10	883.3	1690.5	15146.3	0.5:1:9
Pork	8	1013.8	1883.6	5867.4	0.5:1:3

Table 3 Effects of C^{10} Concentration on Park Sausage Flavour

C_{10}(ppm) Addition	Non-specific Flavoar	Slightly Muttony Flavour	Rancid Flavoar	Muttony Flavour	Soapy Flavour	Note
1	—					
2	—					
3	—	—				
4	—		—	—		
5	—		—	—	—	Slightly Spicey flavour
6	—		—		—	*Unacceptable flavour*

All samples were heated to 50–60℃ for 72 hours and then boiled

Table 4 Effect of C_6, C_8 and C_{10} (0.5:1:8) on Muttony Flavour in Pork Sausages

Group	Amount added (ml/250g Pork Mince)			Flavour	Note
	C_6	C_8	C_{10}		
1	0.0343	0.06742	0.5	Slightly muttony	
2	0.0515	0.1011	0.75	Muttony	
3	0.0687	0.1348	1	Distinctly muttony	Slight flavour

All sample were heated a to 50–60℃ for 72 hours and then boiled.

Table 5 **Values of C_{10} in Demuttony Goat Sausage and Goat Mince**

	Trial	Peak area of C_{10}	Decrease of C_{10}(%)	Taste result
Test Ⅱ	3	11357	29.81	Not muttony
Test Ⅲ	3	10727	33.75	Not muttony
Control	3	15930	1.50	Muttony
Raw Mince	3	16179	0.00	Muttony

All samples nere roasted and fermented for 4 weeks, then boiled and tasted

Table 6 **Results of C_{10} Content in Different Cuts of Meat from a Male Goat**

Part	Back Leg	Front Leg	Shoulder	Belly
Value*	13392	16564	12638	11403

* All values are averages of eight independent tests of two parallel groups.

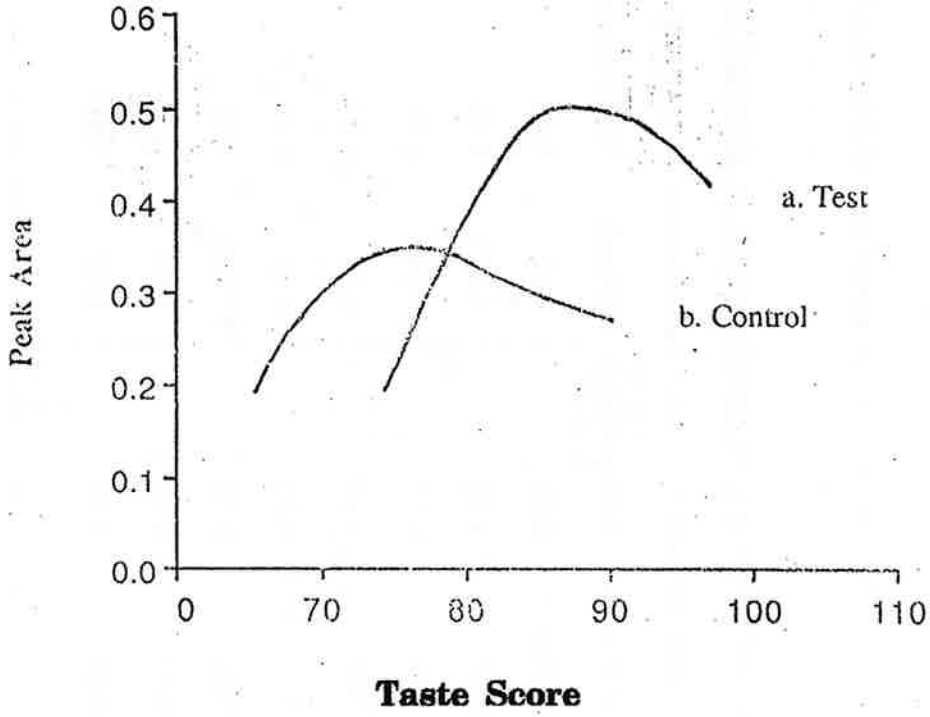


Figure 1 Taste Score Fuzzy Mathematics Relationship Between Peak Area and Taste Score

Table1. Mean scores and results of ANOVA by group for the sensory evaluation of off-flavour in shoulder butts, n=54 samples, 2 replicates, 12 assessors.

Attribute	Males skatole < 0.20ppm	Males skatole ≥ 0.20ppm	Gilts	p-value
Off-flavour meat	4.4^{a}	4.8^{b}	3.4^{ab}	0.000
Off-flavour fat	3.7^{a}	4.2^{ab}	2.9^{b}	0.000

Means within a row followed by the same letter are sign. different ($p \leq 0.05$) by Tukey's test

Table 2. The results, in the form of p-values, of multiple regression analysis according to the model: y = skatole + androstenone + skatole *androstenone, n=54 samples, 2 repl., 12 ass.

Attribute	Tot.p-value	Androstenone	Skatole	Androstenone*Skatole	R^2
Off-flavour meat	0.000	0.09	0.02	0.48	0.45
Off-flavour fat	0.000	0.05	0.014	0.44	0.48
Paint/terp	0.016	0.79	0.64	0.09	0.38
Naftaline	0.003	0.40	0.51	0.13	0.36
Pig	0.099	0.85	0.29	0.49	0.19
Manure	0.003	0.44	0.007	0.61	0.47
Stable	0.027	0.90	0.04	0.59	0.35
Urine	0.001	0.01	0.02	0.06	0.53

Table 3. The average percentage of consumers that did not approve of the aroma or the flavour of the meat and the results of ANOVA by group, n= 27 samples, 50 consumers.

% of consumers not approving.	Males skatole<0.20ppm	Males skatole≥0.20ppm	Gilts	p-value
Aroma	12,0[a]	21.1[b]	7.5[ab]	0.002
Flavour	19.5[a]	24.7[b]	13.3[ab]	0.013
Overall acceptability	20.2[a]	26.7[b]	13.8[ab]	0.020

Means within a row followed by the same letter are sign. different ($p \leq 0.05$) by Tukey's test

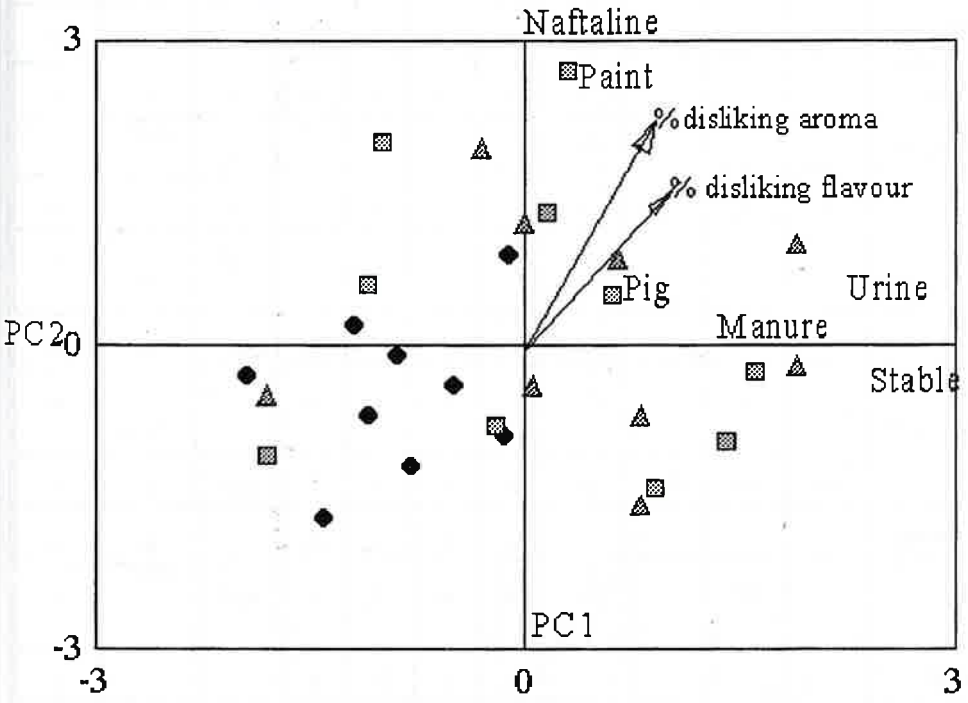


Figure 1.PCA scores for PC1 and PC2 for the sensory profile on shoulder butt samples, average of two replicates and 12 assessors. □, males with skatole content <0.20 ppm; Δ, males with skatole content ≥0.20 ppm; O, gilts. The arrow directions show the relationship between consumer and sensory profiling attributes, n=27 samples, 50 consumers.

Table 1. Identified volatiles from various meat starter cultures.

Compound	Bl_0	Bl_{10}	Sx_0	Sx_{10}	Sc	La	Lp	Ls	Pp	Identification	
										FID	MS
2,3-butanedione			(x)	x		x	x	x	x	x	x
furan compound	(x)	(x)	x	x							x
ethylacetat						x	x	x		x	
2-butanol						x		x		x	
3-me-butanal						x	x	x			x
2-me-butanal	(x)		(x)		x	x	x	x			x
acetic acid			(x)	x	x				x	x	
butan-1-ol	x	x	x	x	x	x	x	x	x	x	x
2,3-pentanedione				x		x	x	x		x	x
3-me-1-butanol ?				x	x	x	x	x			x
3-hydroxy-2-butanone (acetoin)				x	x	x	x	x	x	x	x
2,5-dihydro-furan				x					x		x
hexanal	x	x	x	x	x	x	x	x	x	x	x
2-me-propanoic acid				x					(x)		x
butanoic acid				x					x	x	x
2-furan-carbox-aldehyd (furfural)	x	x	x			x	x	x	x		x
heptanal	(x)	(x)	(x)	(x)	x	x	x	x	(x)	x	x
methyl-hexanoate					x	x	x	x		x	x
2,5-dimethyl-pyrazine		(x)	x	x	x	x	x	x	(x)		x
2,4-nonadienal				x	x	x	x	x			x
methyl-branched alkanes				x	x	x	x	x			x
3-me-butanoic acid				x		x	x	x	x		x
2-me-butanoic acid				x			x	x	x	x	
benzaldehyde	x	x	x	(x)		x	x	x	x		x
octanal	(x)	(x)	x	(x)					(x)		x
nonanal	x	x	x	x	x	x	x	x	x	x	x

Legend: FID: retension times compared to known standards. MS: NIST library identification and comparison with KI of known standards. Bl_0 and Bl_{10}: Blind incubated 0 and 10 days respectively. (x) indicates very low level. Sx_0 and Sx_{10} S. xylosus incubated 0 and 10 days respectively.

Figure 1. Chromatogram of volatiles produced by *S. xylosus*.

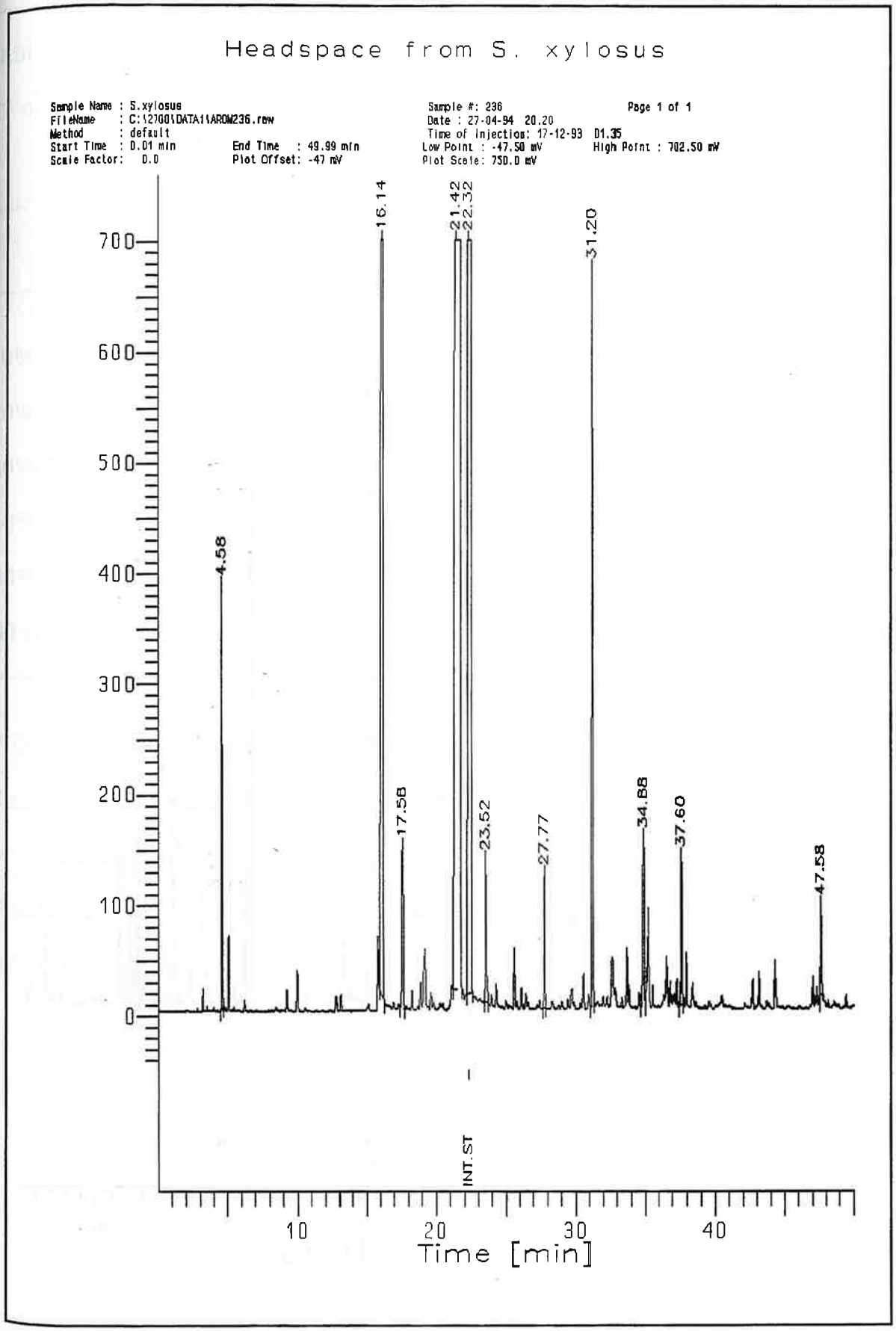


Figure 2. Chromatogram of volatiles produced by *L.sake*.

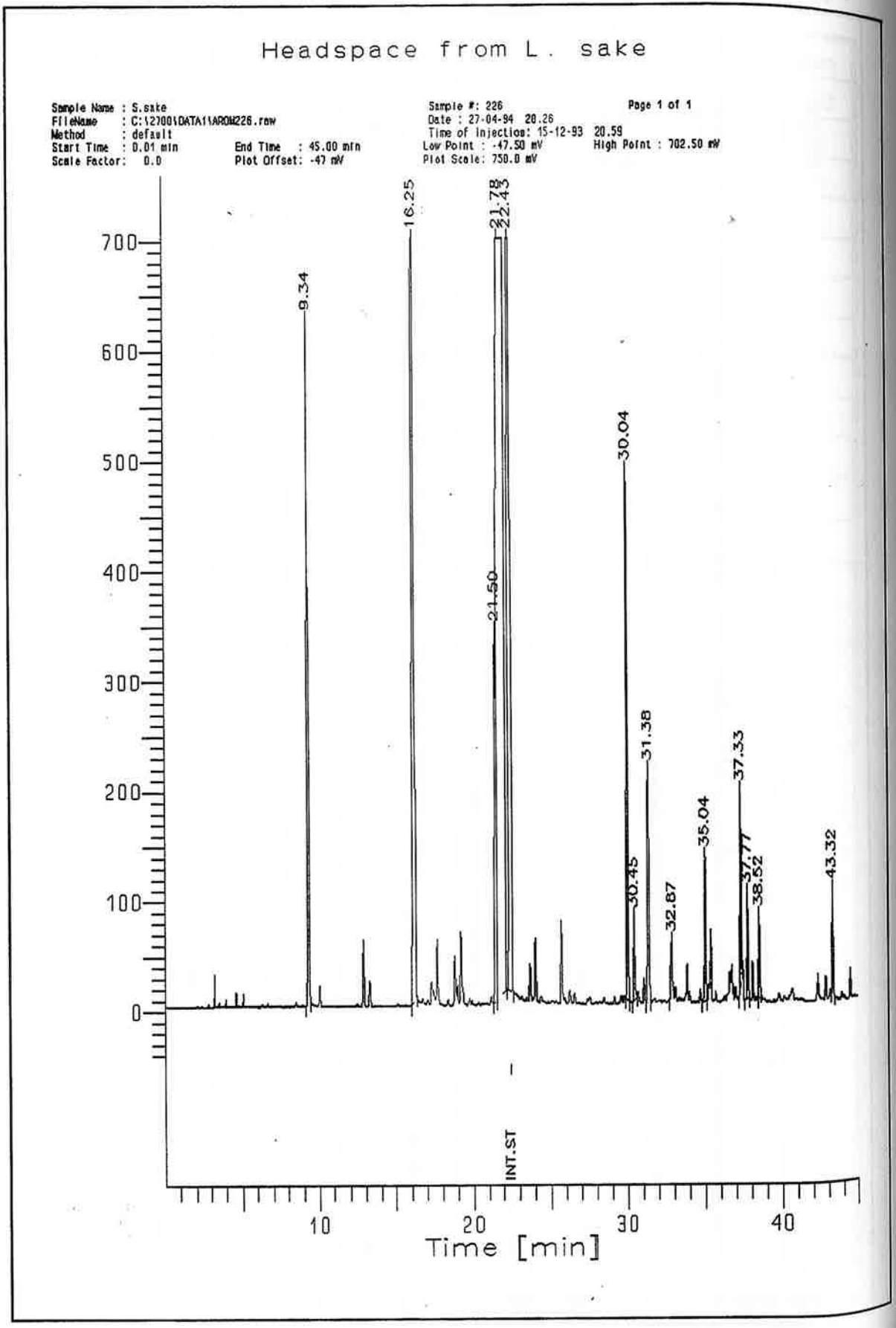


TABLE 1. Differences of KCl substitutions (10% to 60%) with respect to the control (C) on Texture Profile Analysis and on flavour in fermented sausages.

	SPRI	COHE	CHEW	ACID	SALT	BITT
10%-C	0,87	-0,59	-0,75	-0,18	0,23	-0,10
20%-C	2,31	0,22	-0,12	-0,02	0,01	0,36
30%-C	2,69	1,01	0,06	-0,44	-0,43	1,11 *
40%-C	1,81	-0,72	-0,19	0,08	-0,31	1,37 *
50%-C	-2,59	-2,45	-0,36	-0,43	-0,90 *	3,28 *
60%-C	-0,82	0,85	-0,29	-0,49	-1,02 *	3,84 *

* Difference significative ($p < 0,05$).

Texture Profile Analysis: SPRI = springiness (%), COHE = cohesiveness (%), CHEW = chewiness (kg).

Flavour: ACID = acid taste, SALT = saltiness, BITT = bitterness (0 = low intensity, 10 = high intensity).

TABLE 2. Differences of potassium lactate substitutions (10% to 100%) with respect to the control (C) on Texture Profile Analysis and on flavour in fermented sausages.

	SPRI	COHE	CHEW	ACID	SALT	LACT
10%-C	3,30	2,86	-0,45 *	0,29	-0,36	0,04
20%-C	0,23	2,04	-0,52 *	-0,39	-0,66 *	0,42
30%-C	-3,20	0,19	-0,86 *	-1,18 *	-1,10 *	1,24 *
40%-C	-5,67 *	-2,13	-1,29 *	-1,47 *	-1,22 *	1,33 *
50%-C	-3,73 *	-1,13	-1,22 *	-1,75 *	-1,61 *	2,92 *
60%-C	-5,88 *	-3,07 *	-1,59 *	-2,08 *	-2,00 *	3,79 *
70%-C	-7,37 *	-4,51 *	-1,92 *	-1,89 *	-2,05 *	4,39 *
80%-C	-10,43 *	-7,83 *	-2,00 *	-2,25 *	-2,49 *	4,50 *
90%-C	-11,88 *	-8,42 *	-2,07 *	-1,94 *	-2,27 *	5,75 *
100%-C	-15,15 *	-11,57 *	-2,32 *	-2,40 *	-3,86 *	7,02 *

* Difference significative ($p < 0,05$).

Texture Profile Analysis: SPRI = springiness (%), COHE = cohesiveness (%), CHEW = chewiness (kg).

Flavour: ACID = acid taste, SALT = saltiness, LACT = lactate taste (0 = low intensity, 10 = high intensity).

BLE 3. Differences of glycine substitutions (10% to 100%) with respect to the trol (C) on Texture Profile Analysis and on flavour in fermented sausages.

	SPRI	COHE	CHEW	ACID	SALT	SWEE
%-C	-4,07 *	-1,74	0,03	-0,15	-0,20	0,33
%-C	-5,35 *	-3,84 *	-0,33 *	-0,97 *	-0,65 *	0,60
%-C	-7,10 *	-3,82 *	-0,38 *	-0,94 *	-1,19 *	1,68 *
%-C	-9,07 *	-5,82 *	-0,80 *	-1,07 *	-0,99 *	1,98 *
%-C	-8,65 *	-8,62 *	-0,91 *	-1,90 *	-1,97 *	3,03 *
%-C	-11,09 *	-8,66 *	-1,24 *	-2,79 *	-2,29 *	3,45 *
%-C	-12,81 *	-10,94 *	-1,31 *	-2,30 *	-2,55 *	2,96 *
%-C	-14,40 *	-13,12 *	-1,42 *	-2,62 *	-2,67 *	4,13 *
%-C	-12,15 *	-13,69 *	-1,73 *	-3,12 *	-3,51 *	4,32 *
0%-C	-13,94 *	-15,21 *	-1,91 *	-3,36 *	-3,49 *	4,23 *

Difference significative ($p < 0,05$).

xture Profile Analysis: SPRI = springiness (%), COHE = cohesiveness (%), CHEW chewiness (kg).

avour: ACID = acid taste, SALT = saltiness, SWEE = sweetness (0 = low tensity, 10 = high intensity).

TABLE 1. Differences of KCl substitutions (10% to 60%) with respect to the control (C) on Texture Profile Analysis and on flavour in dry cured loin.

	SPRI	COHE	CHEW	SALT	BITT
10%-C	2,31	-0,56	-0,66	0,51	-0,19
20%-C	-0,45	0,28	-0,66	-0,18	0,35
30%-C	-1,77	-2,81	-0,44	0,50	1,52
40%-C	0,39	0,33	0,23	-0,36	1,35
50%-C	-3,11 *	-1,23	-0,11	0,40	2,28 *
60%-C	-4,06 *	-1,98	-0,28	-0,32	3,81 *

* Difference significative ($p < 0,05$).

Texture Profile Analysis: SPRI = springiness (%), COHE = cohesiveness (%), CHEW = chewiness (kg).

Flavour: SALT = saltiness, BITT = bitterness (0 = low intensity, 10 = high intensity).

TABLE 2. Differences of potassium lactate substitutions (10% to 100%) with respect to the control (C) on Texture Profile Analysis and on flavour in dry cured loin.

	SPRI	COHE	CHEW	SALT	LACT
10%-C	-3,65	-2,83	-0,35	-0,11	0,08
20%-C	-8,85 *	-5,11 *	-1,50	-0,77 *	0,35
30%-C	-7,02 *	-7,60 *	-0,46	-0,50 *	-0,04
40%-C	-7,69 *	-6,96 *	-1,78	-0,92 *	0,79
50%-C	-11,96 *	-6,45 *	-0,78	-1,27 *	3,72 *
60%-C	-14,91 *	-6,10 *	-1,46	-1,67 *	3,41 *
70%-C	-10,67 *	-8,12 *	-1,06	-2,30 *	3,59 *
80%-C	-17,16 *	-8,91 *	-1,22	-2,43 *	5,24 *
90%-C	-16,80 *	-9,97 *	-0,70	-3,17 *	6,16 *
100%-C	-15,33 *	-10,15 *	-1,64	-3,43 *	6,82 *

* Difference significative ($p < 0,05$).

Texture Profile Analysis: SPRI = springiness (%), COHE = cohesiveness (%), CHEW = chewiness (kg).

Flavour: SALT = saltiness, LACT = lactate taste (0 = low intensity, 10 = high intensity).

TABLE 3. Differences of glycine substitutions (10% to 100%) with respect to the control (C) on Texture Profile Analysis and on flavour in dry cured loin.

	SPRI	COHE	CHEW	SALT	SWEE
10%-C	0,81	-0,60	0,00	-0,42	0,26
20%-C	-7,72	-4,78	-0,41	-0,94 *	1,28
30%-C	1,12	-3,46	-0,17	-1,22 *	1,15
40%-C	-9,64 *	-4,23	-0,61	-1,85 *	2,91 *
50%-C	-9,63 *	-8,24 *	-0,58	-2,05 *	2,97 *
60%-C	-16,10 *	-11,80 *	-0,87 *	-2,55 *	3,04 *
70%-C	-13,74 *	-11,22 *	-0,86 *	-2,69 *	4,66 *
80%-C	-18,68 *	-13,19 *	-1,11 *	-3,51 *	5,19 *
90%-C	-16,12 *	-14,64 *	-1,03 *	-3,68 *	6,03 *
100%-C	-19,81 *	-14,01 *	-1,21 *	-4,23 *	7,18 *

* Difference significative ($p < 0,05$).

Texture Profile Analysis: SPRI = springiness (%), COHE = cohesiveness (%), CHEW = chewiness (kg).

Flavour: SALT = saltiness, SWEE = sweetness (0 = low intensity, 10 = high intensity).

Table 1: The Impact of Smelling Substances

Smelling Substance	RSD
Androstenone	1.30
Skatole	1.18
Skatole+androstenone	1.11

Table 2: Androstenone Contents, Danish Entire Male Pigs

Carcass weight	Androstenone (ppm)					
	Qty.	Ave. *	sd	< 0.5 (%)	0.5–1.0 (%)	> 1.0 (%)
< 70 kg	547	0.52	0.56	68	22	10
70 – 80 kg	848	0.63	0.75	62	22	16
> 80 kg	513	0.72	0.67	48	31	21

* Arithmetic average.

Table 3: Odour Score relative to Slaughter Weight

Slaughter Weight	Expected Average Odour Score
< 70 kg	4.3
70 – 80 kg	4.2
> 80 kg	4.2

Table 4: Classification Accuracy

Classification criteria	Approved, smelly		Rejection, %
	%	Confidence interval	
Skatole, 0.25 ppm	1.2	0.8 – 2.1	4
Skatole + Androstenone	1.0	0.2 – 1.1	4
Skatole, 0.20 ppm	0.8	0.4 – 1.6	6
Androstenone 0.5 ppm	1.2	0.6 – 2.2	48

Table 1 Means, standard deviation and the ranges for variables from the fresh and cooked fillet steaks

Variables	Mean	Standard Deviation	Range	
			Minimum	Maximum
Fresh				
Fresh weight (g)	126.06	3.16	120	130
Thickness (mm)	38.76	5.75	30	50
Diameter (mm)	58.88	5.13	48	73
pH	5.76	0.22	5.44	6.37
Marbling %	1.34	0.88	0	3.8
Thaw loss %	7.11	5.20	-2.36	26.26
Cooked				
Doneness (1-6)	3.02	1.21	1	5
Cooked Temperature (°C)	63.41	6.67	49	78
Taste Panel Scores				
Tenderness (1-6)	3.27	0.89	1.75	6.0
Taste (1-6)	3.31	0.87	1.0	5.75
Juiciness (1-6)	3.57	0.80	2.0	5.0
Cooking Loss%	21.91	3.81	14.16	32.23
Colour dimensions				
L*	46.69	3.53	39.93	56.08
a*	20.33	4.30	9.38	29.82
b*	10.37	1.18	7.41	12.89

Table 2 Regression coefficients (±SE) and coefficients of determination (R^2) for the effects of pH, fresh steak weight, thickness, and cooked temperature on degree of doneness and eating quality.

Independent Variables	Dependent Variables			
		Eating quality		
	Doneness	Tenderness	Juiciness	Flavour
Constant	-0.97 (3.99)	0.85 (2.77)	2.20 (2.51)	6.40 (2.82)
pH	-1.77 (0.38)	0.75 (0.47)	0.52 (0.43)	-0.37 (0.48)
Fresh wt	0.06 (0.02)	-	-	-
Thickness	-0.05 (0.01)	-	-	-
Cooked Temperature	0.13 (0.01)	-0.03 (0.01)	-0.03 (0.01)	-0.01 (0.01)
R^2	0.70	0.12	0.10	0.04

Table 3 Regression coefficients (±SE) and coefficients of determination (R^2) for the effects of pH, and cooked internal temperature on thaw loss %, cooked loss % and colour dimensions (L*a*b*).

Independent Variables	Dependent Variables				
	Thaw loss %	Cooking loss %	Colour dimensions		
			L*	a*	b*
Constant	53.76 (12.69)	34.03 (7.77)	66.66 (9.85)	19.62 (12.26)	10.68 (4.01)
pH	-8.21 (2.20)	-6.60 (1.28)	-6.05 (1.62)	3.81 (2.02)	-0.16 (0.66)
Cooked temperature	-	0.41 (0.04)	0.23 (0.05)	-0.33 (0.07)	-0.01 (0.01)
R^2	0.18	0.64	0.33	0.30	0.04

Table 1. Color values with postmortem, exposure and display times.

	Ground beef patties			Loin steaks		
Postmortem[a]	L	a	b	L	a	b
½	35.54[b]	14.26[c]	8.79[b]	35.50[b]	17.03	8.90[b]
48	34.91[bc]	15.04[b]	8.58[bc]	33.62[c]	16.94	8.49[c]
96	34.33[c]	15.30[b]	8.46[c]	34.43[c]	16.68	8.57[c]
s.e.m.	0.25	0.17	0.10	0.34	0.44	0.10

Exp.[a]	Disp.[a]	L	a	b	Exp.[a]	Disp.[a]	L	a	b
0	4	35.62[bc]	14.86[bcd]	8.73[bc]	0	0	33.07[d]	15.87[c]	7.66[f]
	8	36.23[b]	14.27[de]	8.83[b]		6	31.72[d]	19.01[b]	8.56[de]
5	4	34.11[cde]	14.93[bcde]	8.37[bc]		24	32.63[d]	18.23[b]	8.55[de]
	8	34.82[bcde]	14.64[cde]	8.94[b]	15	0	33.24[d]	15.30[cd]	7.67[f]
10	4	35.43[bcd]	15.30[bcd]	8.84[b]		6	32.12[d]	19.28[b]	8.72[cd]
	8	35.98[b]	14.48[de]	8.61[bc]		24	32.67[d]	17.63[bc]	8.17[cf]
20	4	34.32[cde]	15.81[b]	8.36[bc]	30	0	47.82[b]	9.19[e]	10.21[b]
	8	34.32[cde]	14.50[de]	8.15[c]		6	32.46[d]	18.96[b]	8.74[cd]
60	4	34.04[de]	15.69[bc]	8.76[bc]		24	32.54[d]	18.61[b]	8.67[de]
	8	36.05[b]	14.04[e]	8.52[bc]	60	0	42.42[c]	12.31[de]	9.52[bc]
120	4	33.35[e]	15.05[bcde]	8.55[bc]		6	31.87[d]	19.21[b]	8.72[cd]
	8	34.85[bcde]	14.76[bcde]	8.66[bc]		24	31.66[d]	18.99[b]	8.68[de]
s.e.m.		0.49	0.34	0.20			0.62	0.80	0.19

[a]Postmortem, air exposure, and display times in hr.

[bcde]Least squares means in column with same superscripts are not different ($p<0.05$).

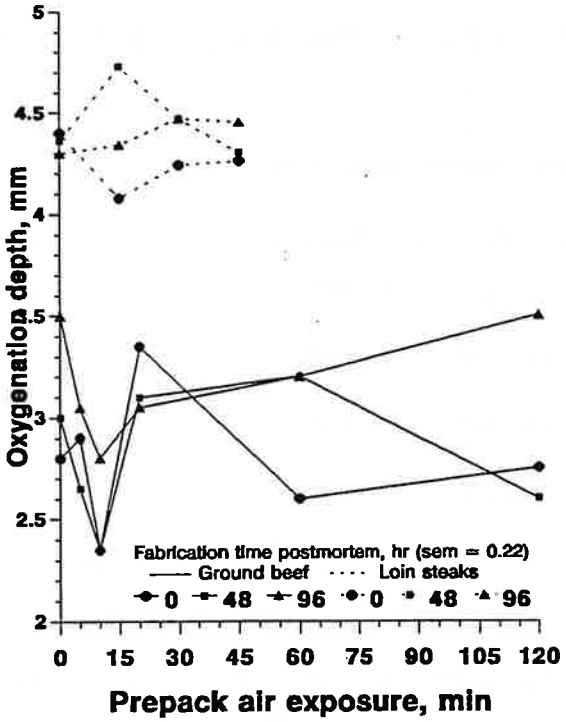


Figure 1. Oxygenation of beef with postmortem and air exposure time.

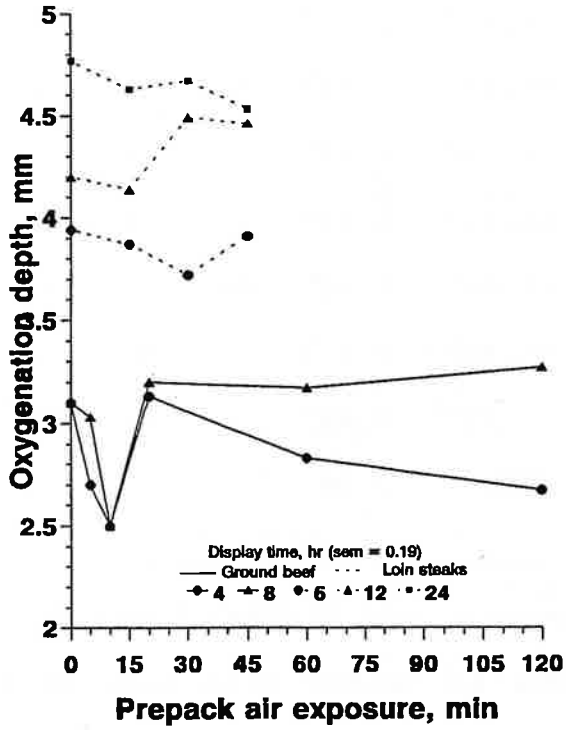
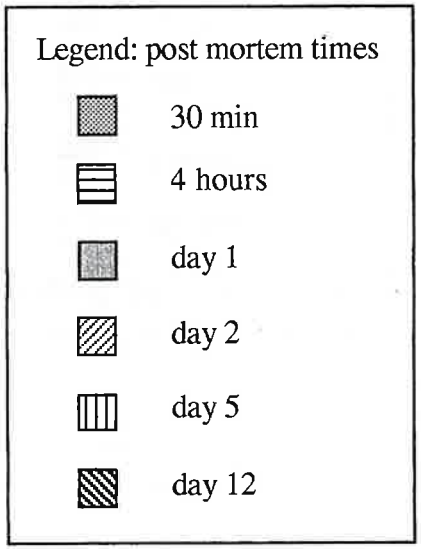


Figure 2. Oxygenation of beef with air exposure and display time.



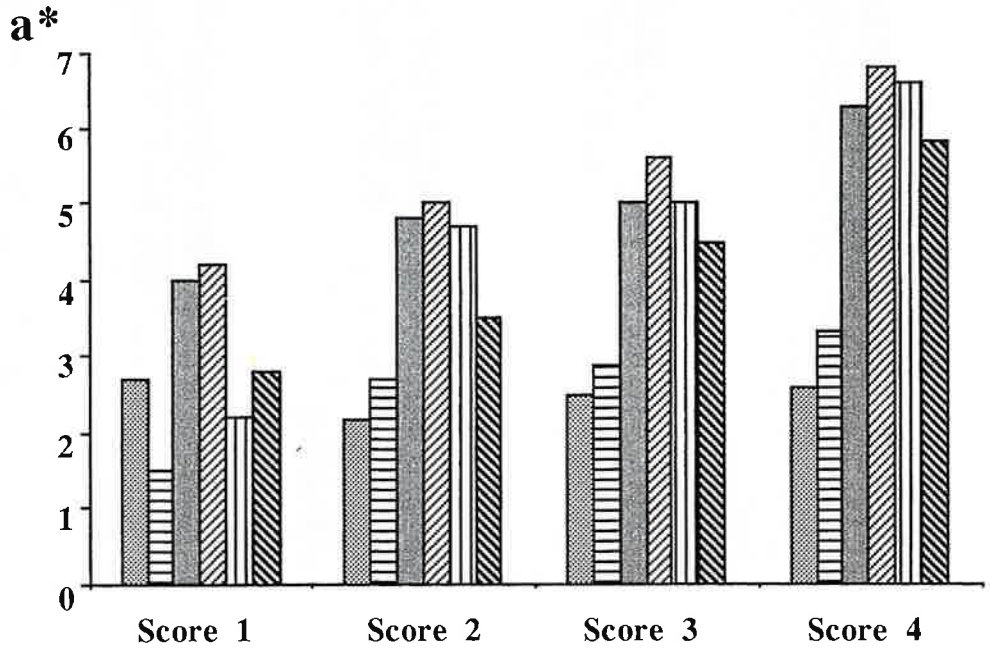


Figure 1 : Evolution of redness a* during storage for the four colour scores

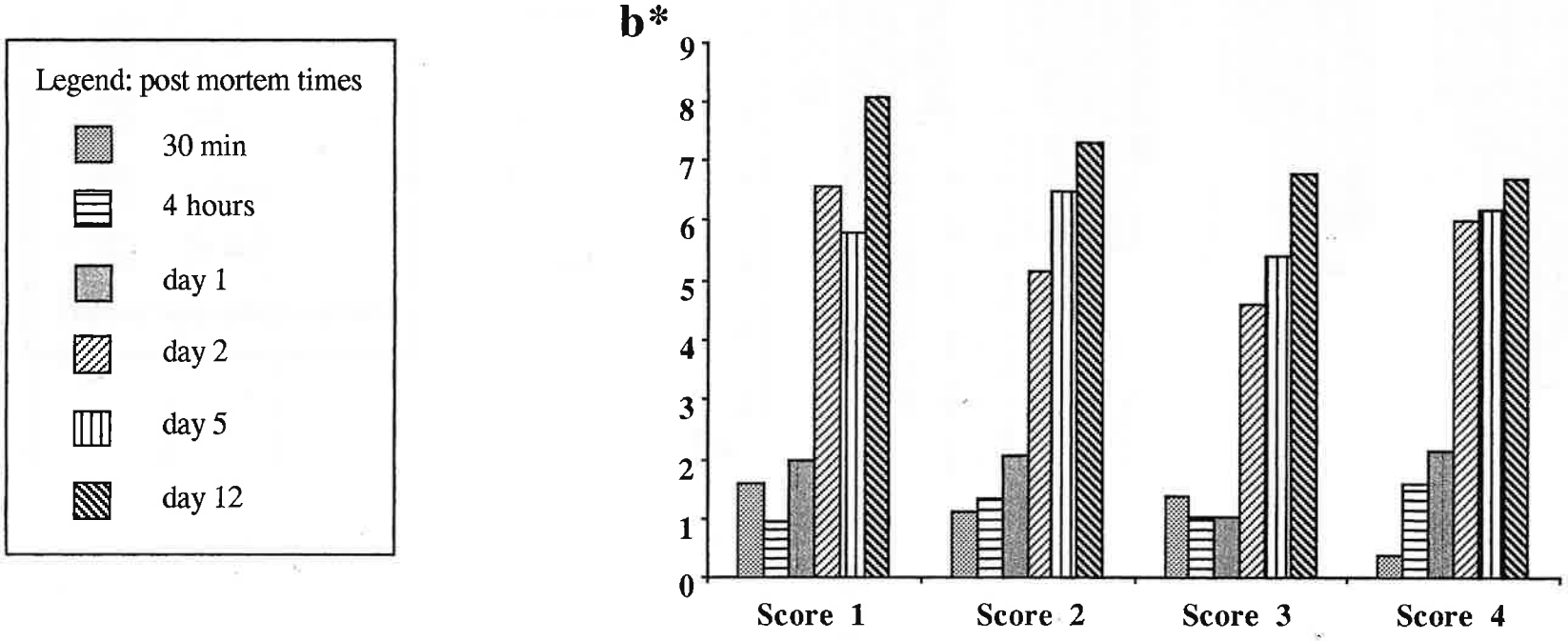


Figure 2 : Evolution of yellowness b* during storage for the four colour scores

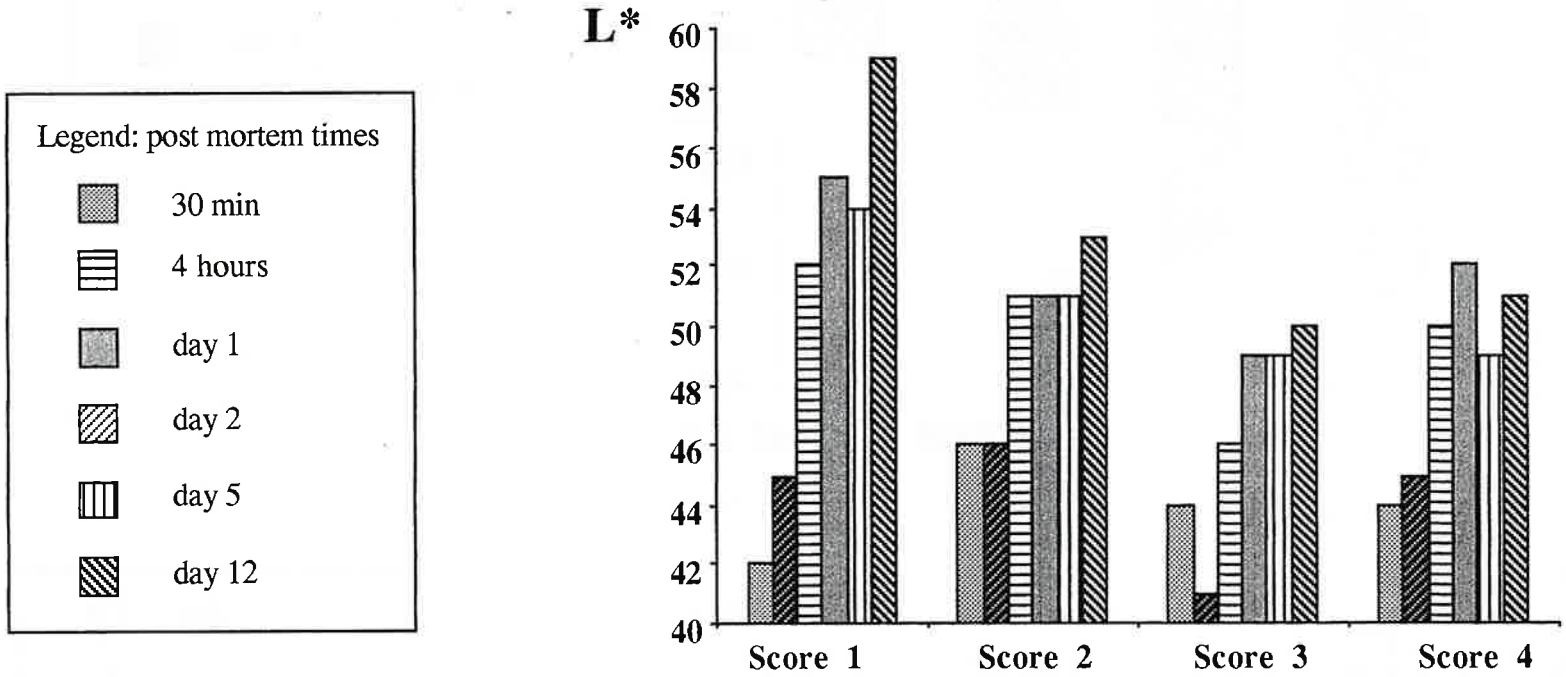
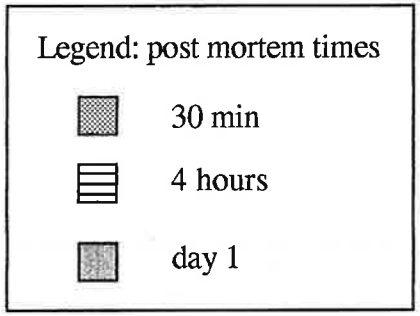


Figure 3 : Evolution of lightness L* during storage for the four colour scores



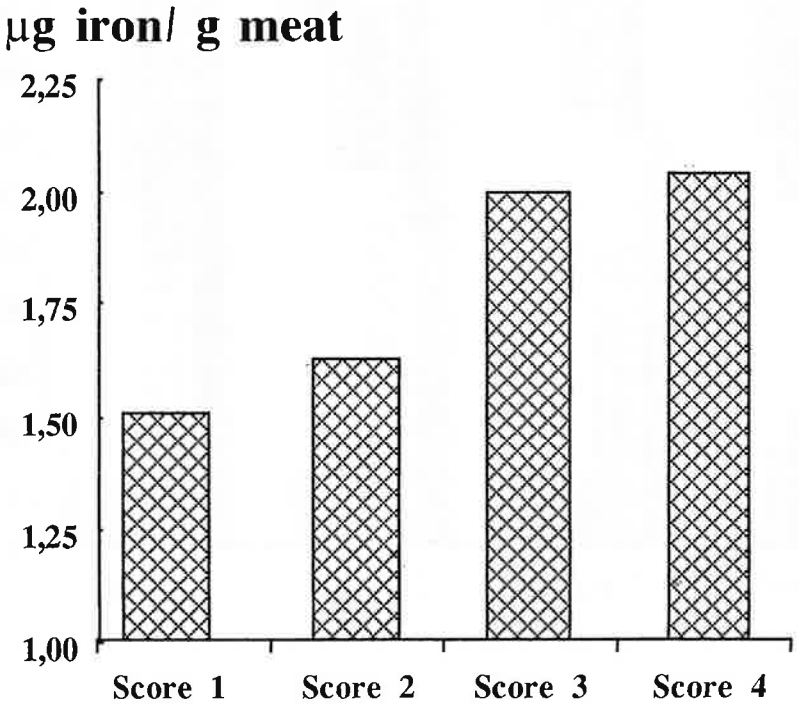


Figure 4 : myoglobin concentration of the four colour scores

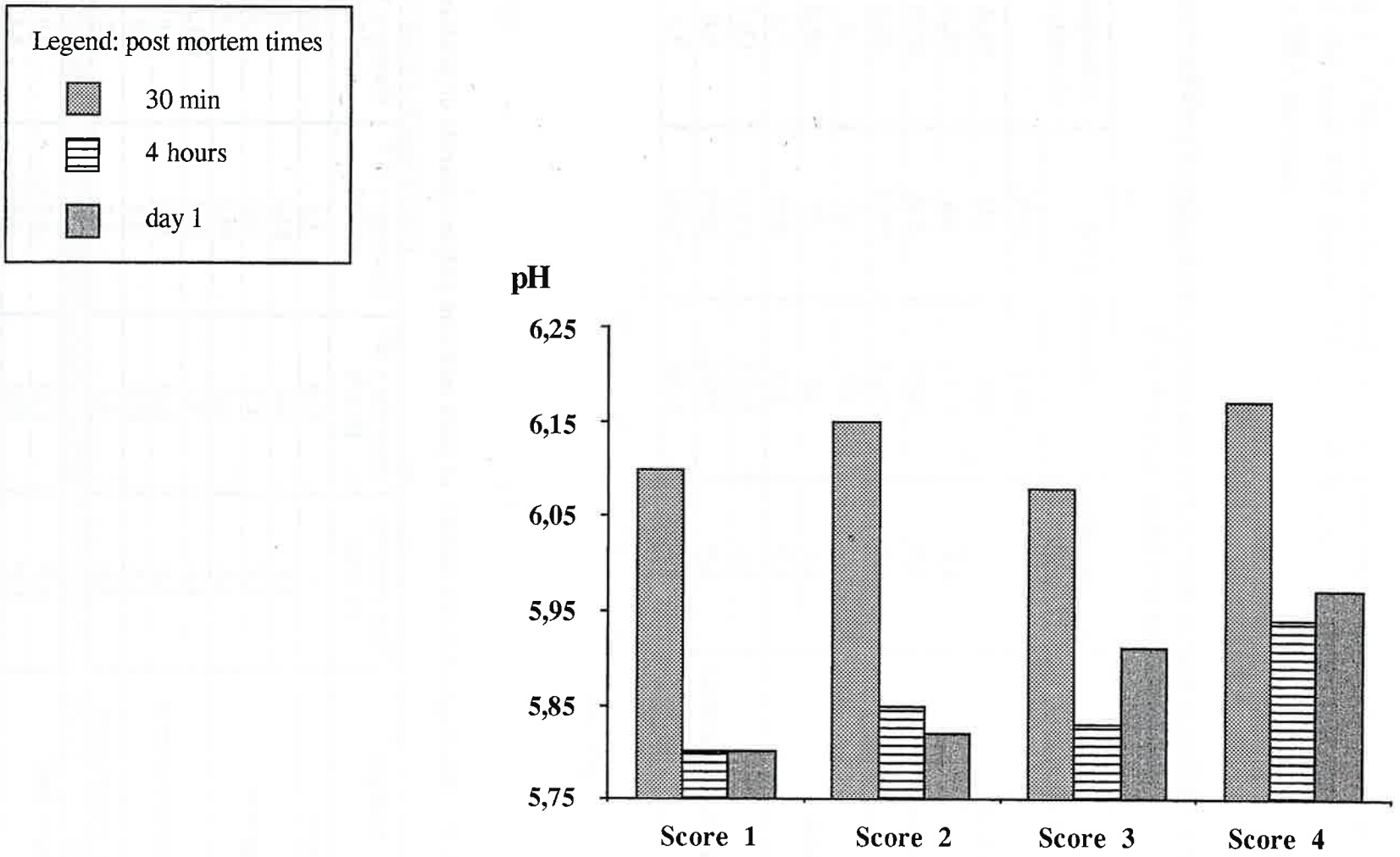


Figure 5 : pH development during storage in the four colour scores

Table 1 Effect of temperature and concentration on viscosity of pork lard and polysaccharide gels (shear rate 9,00 s^{-1})

Sample	Concentration [% w/w]	Viscosity [cPs]		Changes of viscosity [%]
		20°C	37°C	
pork lard	-	9067	744	91,8
carrageenan	0,6	3711	66	98,2
	1,0	2600	833	67,9
	1,5	3544	1922	45,8
xanthan	0,1	67	67	0
	0,6	62	50	19,3
	1,0	933	867	7,1
carrageenan/xanthan	0,6	1677	1467	13,5
	1,0	3922	3656	6,8
	1,5	6122	5567	9,1

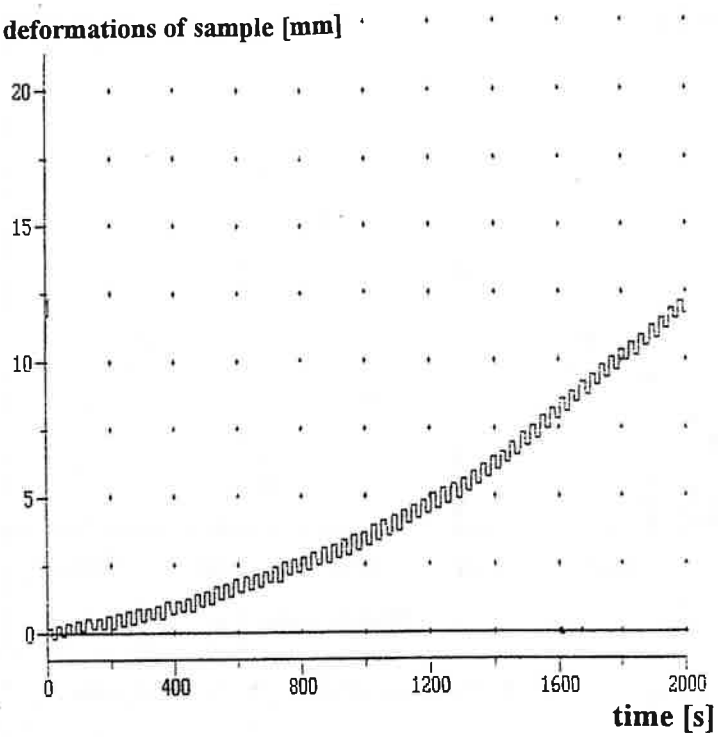
Table 2 Rheological characteristic of pork lard and polysaccharide or protein gels

Sample	Concentration [% w/w]	Plasticity x 10^3 [N/m^2]	Elasticity x 10^{-6} [m^2/N]	Fluidity x 10^{-7} [m^2/Ns]
pork lard	-	13,0	3,4	24,5
carrageenan	0,6	2,0	83,4	20,4
	1,0	2,7	75,2	16,2
	1,5	6,5	28,7	19,8
carrageenan/xanthan	0,6	2,5	50,1	181,3
	1,0	12,0	16,7	7,0
	1,5	27,0	8,5	0,4
locust bean /xanthan	0,6	4,5	4,3	5,2
ISP Supro 500E	1:5*	17,0	8,7	7,0
	1:4*	28,2	4,8	4,4
ISP Supro 595	1:5*	8,2	6,7	7,2
	1:4*	16,7	4,9	4,6

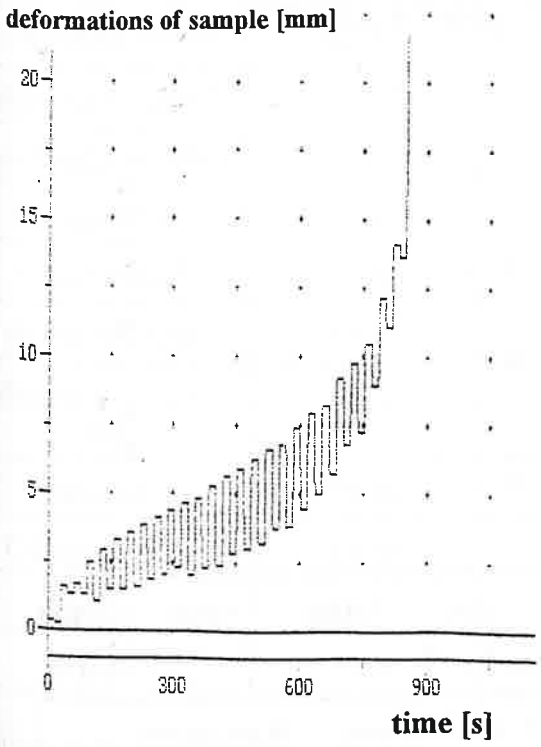
* hydration ratio

Fig 1 Characterictic rheograms of pork lard (a), 1,5% carrageenan gel (b) and ISP Supro 595 in 1:4 hydration ratio (c) obtained by CASRA method

a)



b)



c)

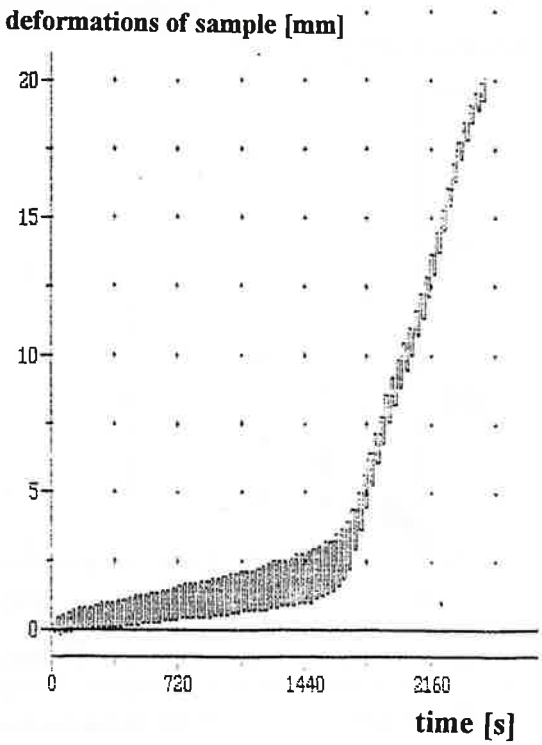


Fig. 2 Flow curves of pork lard and polysaccharide gels at 20°C

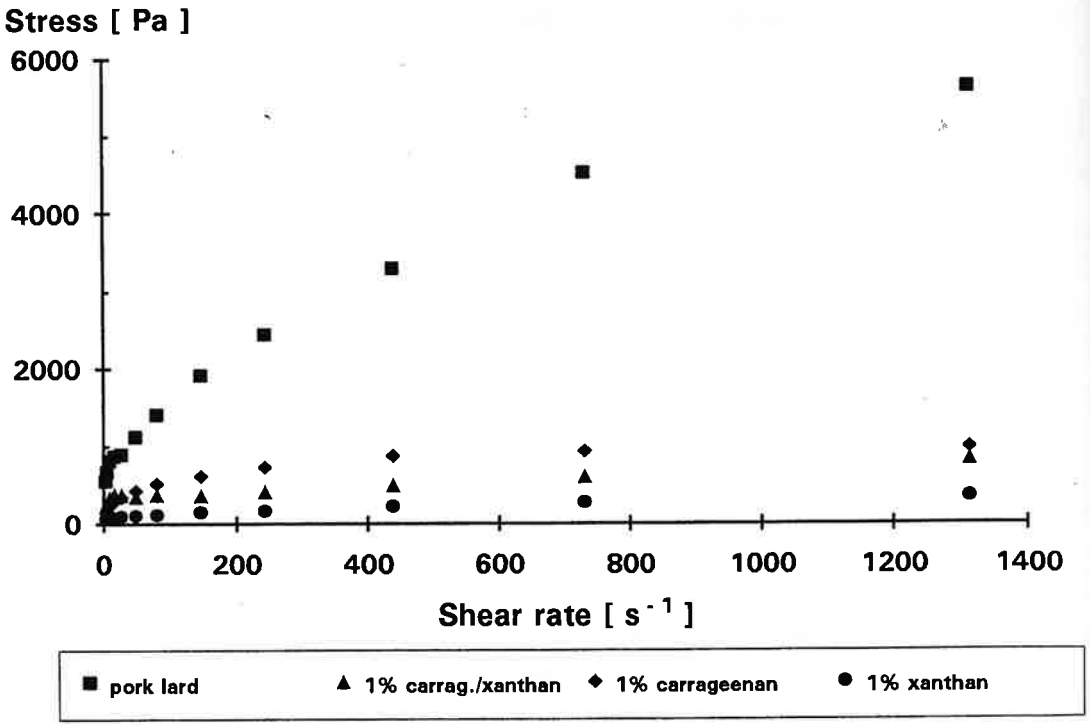
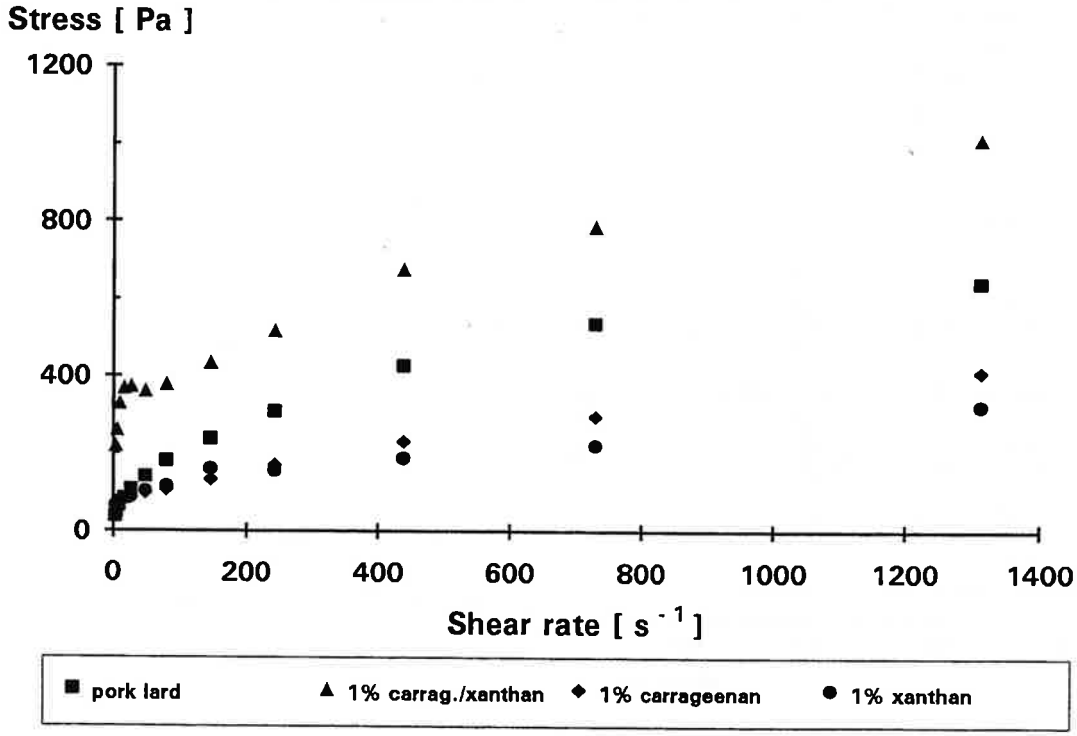


Fig. 3 Flow curves of pork lard and polysaccharide gels at 37°C



able 1. Cooking characteristics for low fat beefburgers

Ingredient	%Cook Yield	% W.H.C.	%Reduction in diam.	%Reduction in thick.
Full Fat Control	61.25	30.12	20.7	9.0
Low Fat Control	59.59	36.12	21.4	0.0
Danagel GB1	60.89	39.12	22.1	6.7
Genugel MG11	63.63	40.74	18.8	3.3
Maltrin MO40	54.79	28.62	24.2	7.2
Leanbind	61.24	40.22	18.3	10.0
Tapiocaline EX533	64.38	42.40	19.1	6.9
Soyamin 70	57.47	35.91	21.1	7.1
Soyamin 90	56.74	30.82	21.2	14.3
Carbelac 35	63.56	34.36	17.2	2.9
Alacen 152	61.65	35.91	17.3	3.3
Alanate 195	63.92	39.59	19.4	6.3
MPC 195	63.32	40.77	22.4	3.1
Plasmapowder U70	63.25	41.03	21.4	0.0
Protoplus U70	62.23	39.93	18.8	6.5
Adv. Oat Fibre	66.48	34.53	21.0	-3.3
Fat Replacer #786	64.93	33.05	23.4	3.1
Manugel\CaL	73.96	46.85	15.9	-3.3
Avicel PH101	61.98	35.07	21.4	6.3
Avicel RCN30	60.93	27.04	17.5	11.4
MicroQuick WC-595	57.64	31.34	22.5	7.1
Slendid	59.38	25.43	22.6	7.1
Collagen Fibre	63.08	36.87	19.1	6.3
Inulin	60.27	31.34	21.1	12.0
S.E.D.*	7.87	1.39	1.70	4.46

Standard Error of Difference

TABLE 2. Sensory panel ratings for low fat beefburgers

	SENSORY TRAITS[1]								
INGREDIENT	**T**	**C**	**M\J**	**MF**	**FF**	**MEF**	**OF**	**OA**	**OT**
Full Fat Control	4.8	4.9	4.9	4.6	2.8	4.9	3.2	3.6	3.3
Low Fat Control	4.5	4.7	4.4	4.7	3.2	5.1	3.3	3.7	3.2
Danagel GB1	5.6	4.7	4.9	4.9	3.3	5.0	3.9	4.1	3.6
Genugel MG 11	5.7	4.4	4.8	4.5	3.0	5.1	3.7	4.1	3.4
Maltrin MO40	4.2	4.6	4.9	4.6	3.0	4.7	2.8	3.3	3.0
Leanbind	5.1	4.5	4.4	4.9	2.7	5.0	3.3	3.8	3.5
Tapiocaline EX533	6.4	5.3	6.3	4.9	2.6	5.2	3.5	3.9	3.7
Soyamin 70	4.8	5.1	4.2	4.8	3.5	4.9	3.0	3.8	3.4
Soyamin 90	5.0	4.6	4.8	3.9	3.2	4.8	3.3	3.6	3.3
Carbelac 35	5.5	5.7	6.0	4.7	2.7	5.1	3.9	3.9	3.8
Alacen 152	4.9	4.9	5.1	4.3	3.1	4.8	3.5	3.8	3.3
Alanate 195	4.9	4.8	4.8	4.8	3.1	4.9	3.5	3.9	3.2
MPC 195	4.5	4.6	4.5	5.0	3.5	4.7	3.3	3.8	3.3
Plasmapowder U7	4.5	4.5	5.0	3.9	2.7	2.8	2.0	2.2	2.8
Protoplus U70	5.7	4.7	5.9	4.8	2.7	4.3	3.1	3.7	3.8
Adv. Oat Fibre	5.2	5.0	4.9	4.9	3.1	5.0	3.7	4.2	3.8
Fat Replacer #786	7.3	5.4	6.3	4.6	2.9	3.8	3.0	3.1	2.9
Manugel\CaL	6.6	5.0	6.3	4.7	2.9	4.6	3.1	3.6	3.8
Avicel PH101	5.1	4.8	4.7	4.4	3.3	5.0	3.3	3.7	3.7
Avicel RCN-30	5.3	5.4	5.2	5.8	2.8	5.5	3.7	4.0	3.4
MicroQuick WC-595	4.8	5.2	4.5	4.3	2.8	5.2	3.1	3.8	3.3
Slendid	5.6	4.9	5.5	5.2	3.3	5.3	3.8	4.2	3.8
Collagen Fibre	6.3	4.3	5.4	3.9	2.9	4.6	3.2	3.4	3.7
Inulin	5.7	4.5	5.1	4.3	3.4	4.9	3.1	3.6	3.6
S.E.D.[2]	.40	.41	.38	.43	.27	.38	.29	.32	.25

[1]T=tenderness, C=crumbliness, M\J=moistness\juiciness, MF=meaty flavour, FF=fatty flavour, MEF=musty\earthy(non-burger flavour), OF=overall flavour, OA=overall acceptability, OT=overall texture.

[2]Standard Error of Difference

Table 3. Instrumental compression values for low fat beefburgers

Ingredient	Resistance to deformation (N\cm)	Compressive strength ($N\backslash m^2$) $\times 10^4$	Residual strength ($N\backslash m^2$) $\times 10^4$
Full Fat Control	78.67	6.51	8.34
Low Fat control	69.32	5.90	8.33
Danagel GB1	66.71	5.13	7.81
Genugel MG11	70.40	5.80	7.45
Maltrin MO40	76.88	6.51	7.38
Leanbind	63.78	5.03	4.62
Tapiocaline EX533	49.11	2.83	2.88
Soyamin 70	75.03	7.02	8.04
Soyamin 90	76.15	6.76	8.14
Carbelac 35	71.38	5.90	7.60
Alacen 152	78.43	7.15	7.56
Alanate 195	61.60	5.13	5.46
MPC 195	80.96	7.00	6.54
Plasmapowder U7	85.01	7.01	6.03
Protoplus U70	84.92	6.54	5.94
Adv. Oat Fibre	67.27	5.91	5.84
Fat Replacer #786	39.36	2.55	3.64
Manugel\CaL	61.15	3.08	4.23
Avicel PH101	66.13	5.10	6.51
Avicel RCN30	49.36	4.09	6.56
MicroQuick WC-595	62.08	5.55	8.19
Slendid	63.56	5.34	9.11
Collagen Fibre	57.65	4.24	6.36
Inulin	73.29	5.62	8.89
S.E.D.*	4.90	0.35	0.68

*Standard Error of Difference

Table 1 Effect of punch size on rheological parameters

Punch size [mm]	Plasticity [x 10^5 N/m^2]	Elasticity [x 10^{-6} m^2/N]	Fluidity [x 10^{-8} m^2/Ns]
2 x 4	2,2*	0,9*	4,1*
2 x 6	1,7	1,2	4,0*
2 x 8	1,8	1,3	5,8
2 x 10	1,9	1,2	6,4
2 x 12	1,9	1,2	6,2
2 x 14	1,6	1,4	7,3
2 x 16	1,8	1,2	7,1
2 x 18	1,8	1,3	6,9
2 x 20	2,0	1,2	5,7

* significantly different

Table 2 Precision of CASRA method

Parameters	Precision S	Coefficient of variability
Plasticity	3,00 x 10^4 N/m^2	14,8%
Elasticity	1,45 x 10^{-7} m^2/N	9,7%
Fluidity	4,27 x 10^{-9} m^2/Ns	8,8%

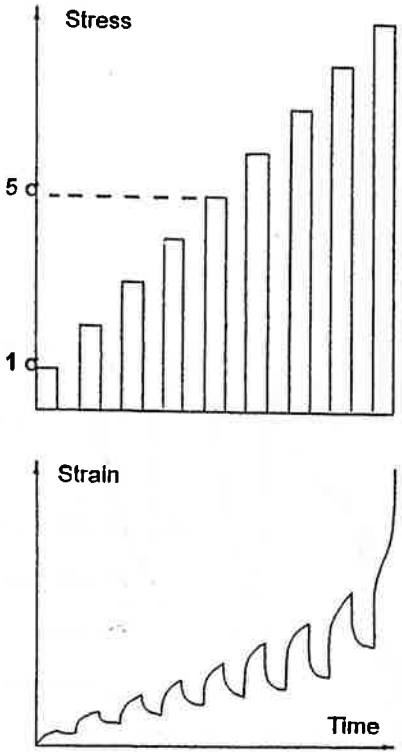


Fig. 1 Stress and strain distribution during test

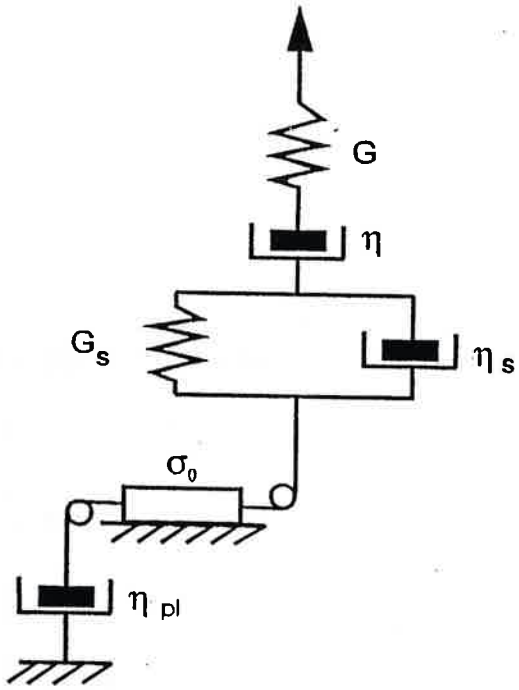


Fig. 2 Rheological model for homogenously structured meat product

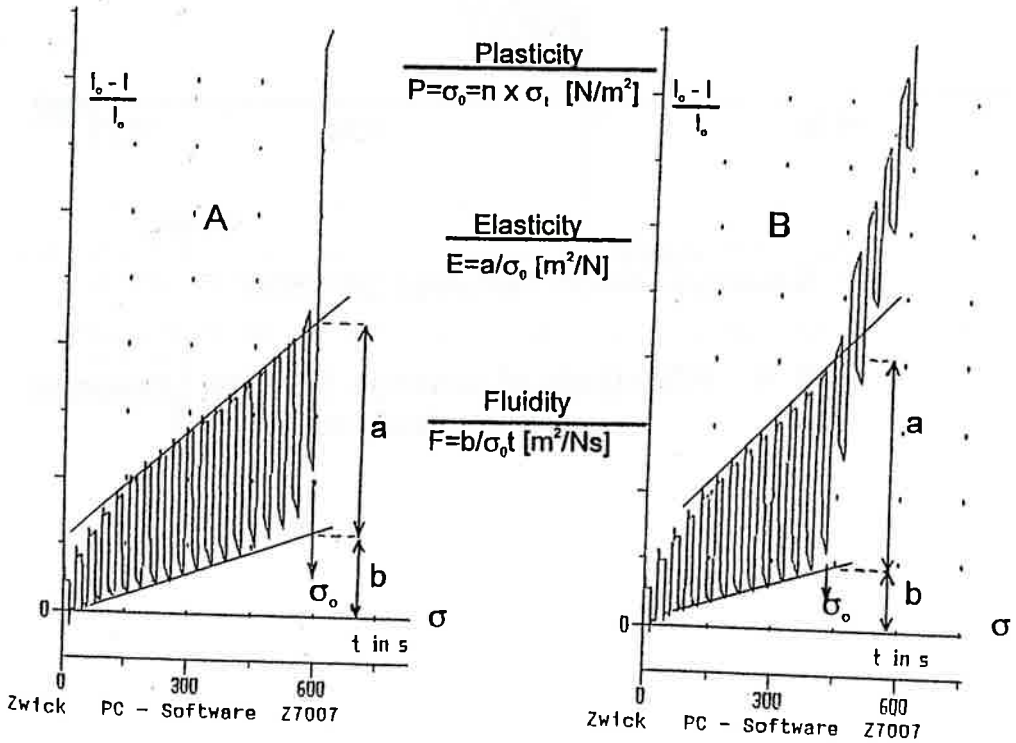


Fig. 3 Methods of obtaining the values of plasticity P, elasticity E and fluidity F. Symbols: height of samples l_o- initial height of sample, σ–stress, t-duration time of the bit.

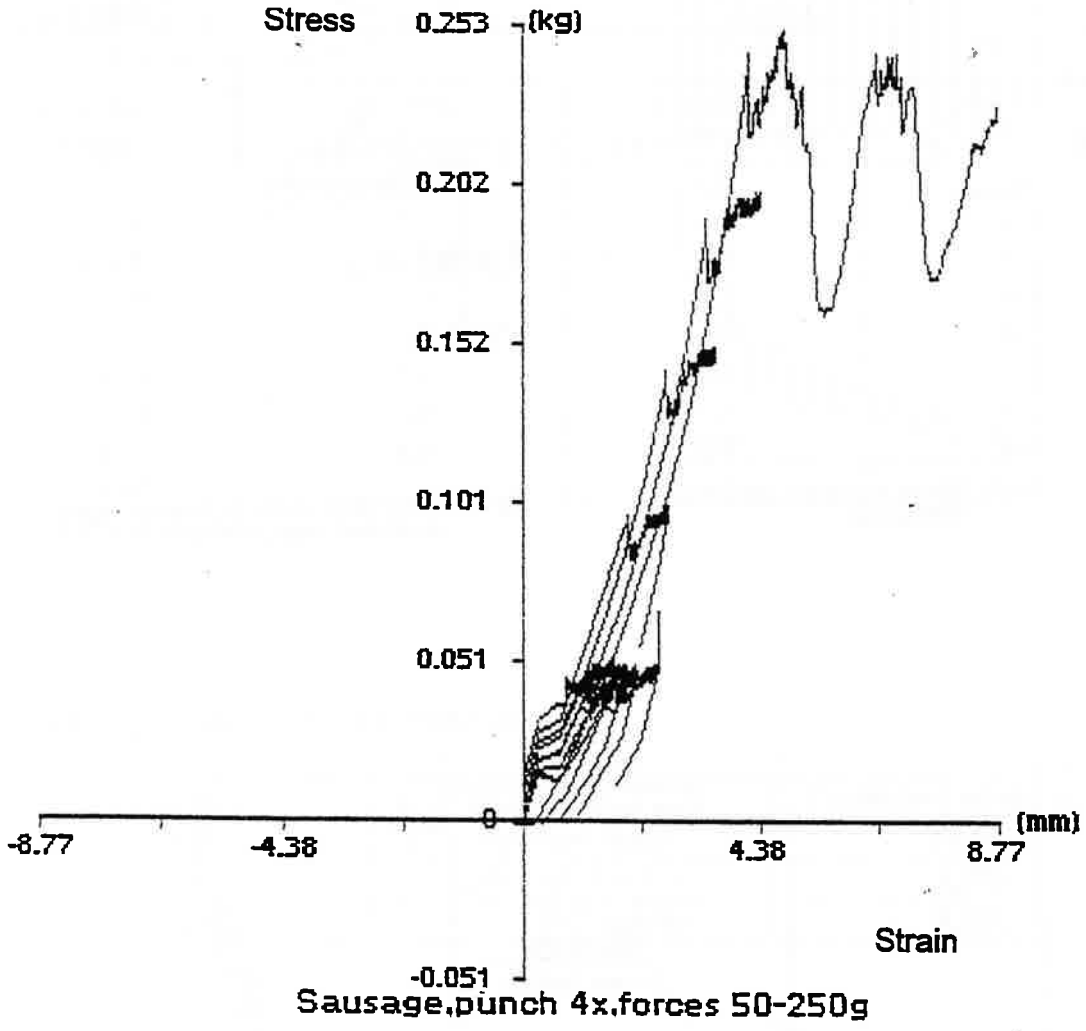


Fig. 4 Rheogram of sausage from the Universal Texture Analyzer TA-XT2

Table 1.
Characteristics of
Tendercut (TC) Treated Pork *Longissimus* Muscle.

Trait[a]	Treatment		S.E.
	Control	TC	
Cooked Pork Chop			
Warner-Bratzler			
Peak force (kg)	4.62[b]	3.96[c]	0.13
Lee-Kramer			
Total energy (kg*mm)	224.1[b]	187.9[c]	9.57
Shear force (kg)	35.2[b]	30.1[c]	1.12
Raw Pork			
Sarcomere length (μm)	1.58[c]	1.88[b]	0.02
Fat (%)	3.80[b]	3.74[b]	0.17
Moisture (%)	72.9[b]	72.8[b]	0.15

[a]Trait: The following traits had significant ($P<0.05$) treatment by location interactions: Warner-Bratzler peak force and sarcomere length.

[b,c] Means bearing unlike superscripts within each trait are different ($P<0.05$).

Table 2.
Effect of Location[a] on
Tendercut (TC) Treated Pork *Longissimus* Muscle.

	LOCATION						
	1		2		3		S.E.
	Control	TC	Control	TC	Control	TC	
Cooked Pork Chop							
Warner-Bratzler Peak Force (kg)	4.40[b]	3.79[c]	4.81[b]	4.02[c]	4.65[b]	4.07[c]	0.24
Lee-Kramer							
Peak Force (kg)	35.04[b]	29.04[c]	34.81[b]	32.66[b]	35.68[b]	28.56[c]	2.43
Total Energy (kg*mm)	222.8[b]	174.9[c]	220.4[b]	197.4[b]	229.0[b]	191.4[b]	15.8
Raw Pork							
Sarcomere Length (μm)	1.58[c]	1.99[b]	1.58[c]	1.89[b]	1.59[c]	1.78[b]	0.05

[a] *Longissimus* muscles were removed between the 9th thoracic and 4th lumbar vertebra, and divided into three equal sections (Location 1, 2, 3; anterior to posterior).

[b,c] Row means bearing unlike superscripts within each location are different ($P<0.05$).

Table 1

Coefficient correlations between EMG (sum area) or sensory values (hardness) and mechanical measurements (n = 6, shaded values for $p < 0.05$)

Subject	Compression Compression modulus (L, K = 0.2)		Shear Force (L, destructive)		Viscoelasticity Phase angle (A)	
	Sum area	Hardness	Sum area	Hardness	Sum area	Hardness
1	0.79	0.78	0.92	0.94	-0.78	-0.77
2	0.76	0.52	0.80	0.66	-0.76	-0.71
3	0.89	0.63	0.65	0.79	-0.77	-0.36
4	0.77	0.81	0.88	0.85	-0.66	-0.79
5	0.73	0.95	0.70	0.81	-0.91	-0.88
6	0.83	0.73	0.90	0.88	-0.87	-0.73
7	0.87	0.81	0.78	0.49	-0.88	-0.92
8	0.30	0.60	0.49	0.50	-0.51	-0.83
9	0.83	0.78	0.86	0.74	-0.80	-0.84
10	0.89	0.81	0.51	0.36	-0.90	-0.96
11	0.33	0.54	0.57	0.86	-0.11	-0.30
12	0.93	0.86	0.56	0.66	-0.84	-0.88
13	0.35	0.85	0.13	0.67	-0.44	-0.87
14	0.88	0.55	0.95	0.87	-0.84	-0.64

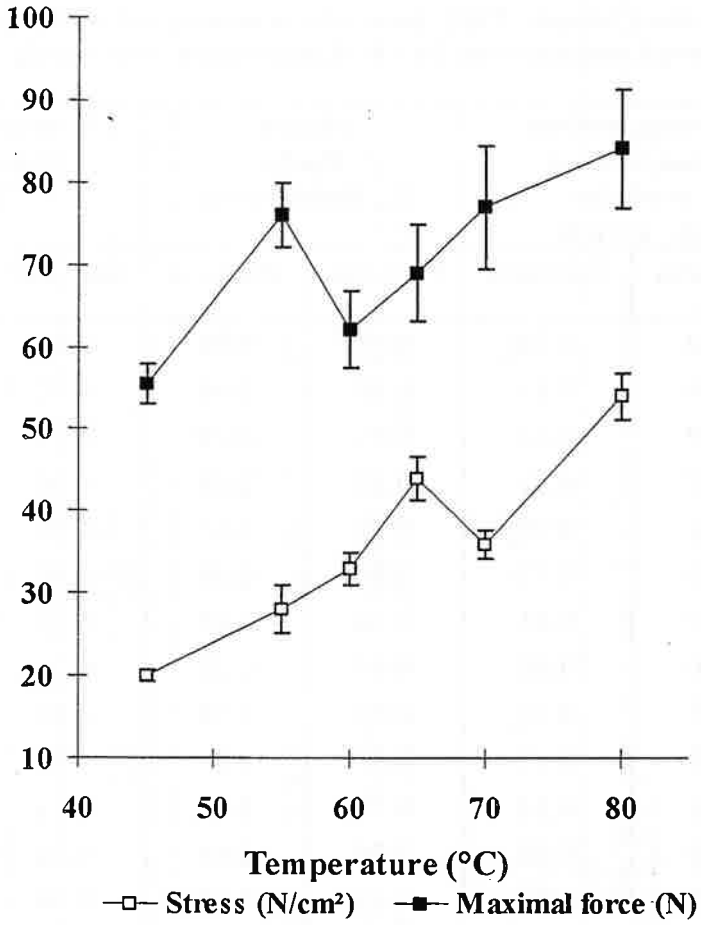


Figure 1: Mechanical parameters versus cooking temperature. Compression stress in longitudinal configuration to 20% deformation and shear maximal force in longitudinal configuration respectively. Bars representing SEM (ten replicates).

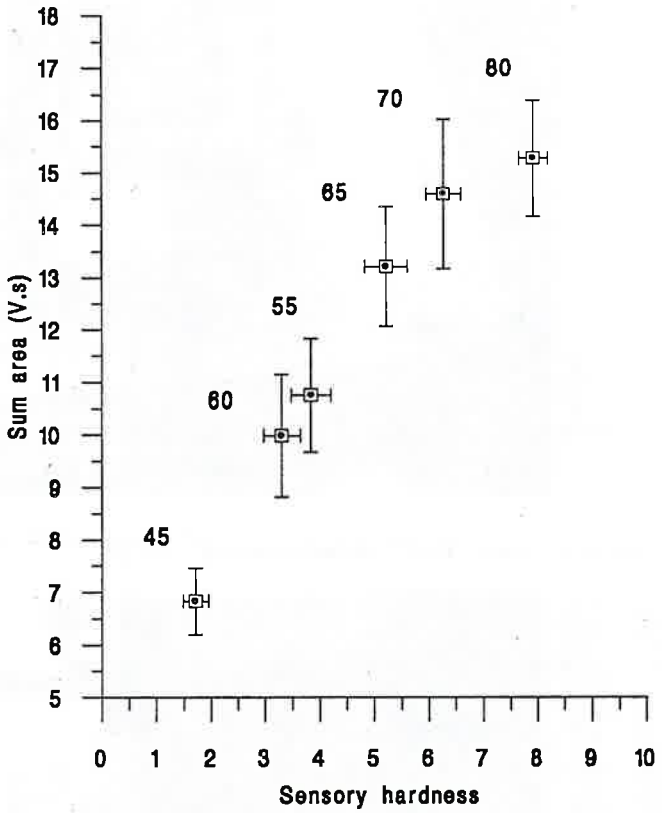
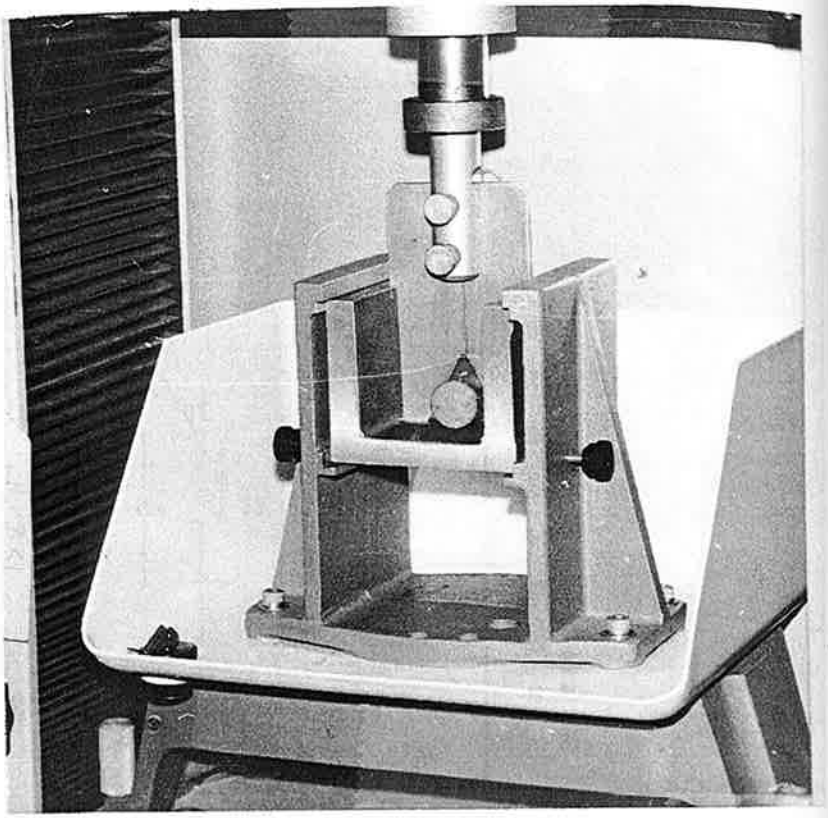
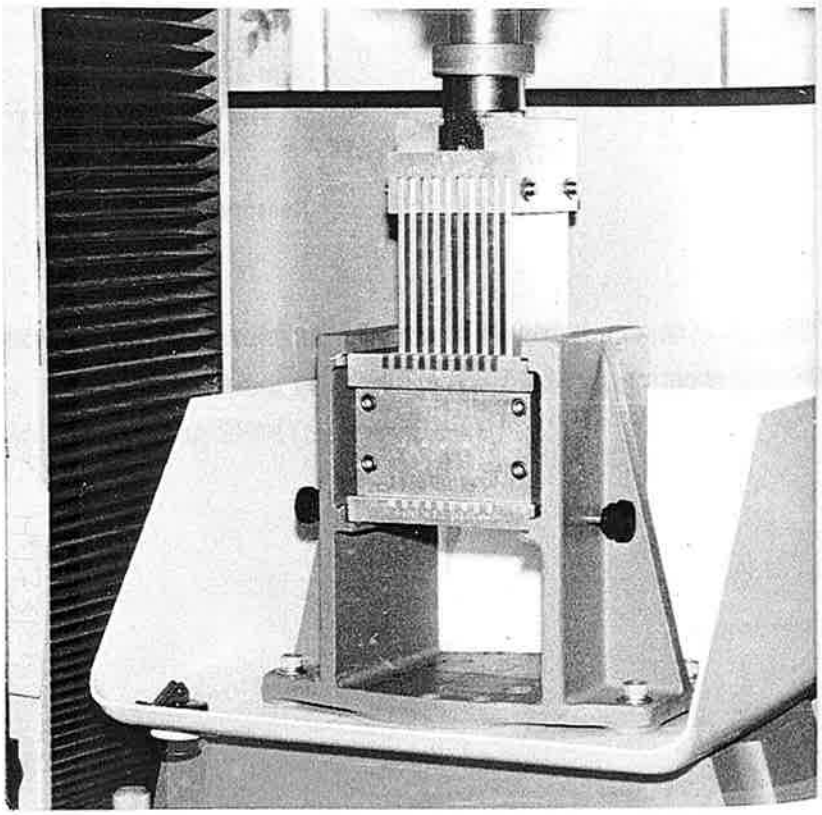


Figure 2: Sensory hardness versus EMG sum area for complete masticatory sequence, with bars representing SEM (three replicates by fourteen subjects).

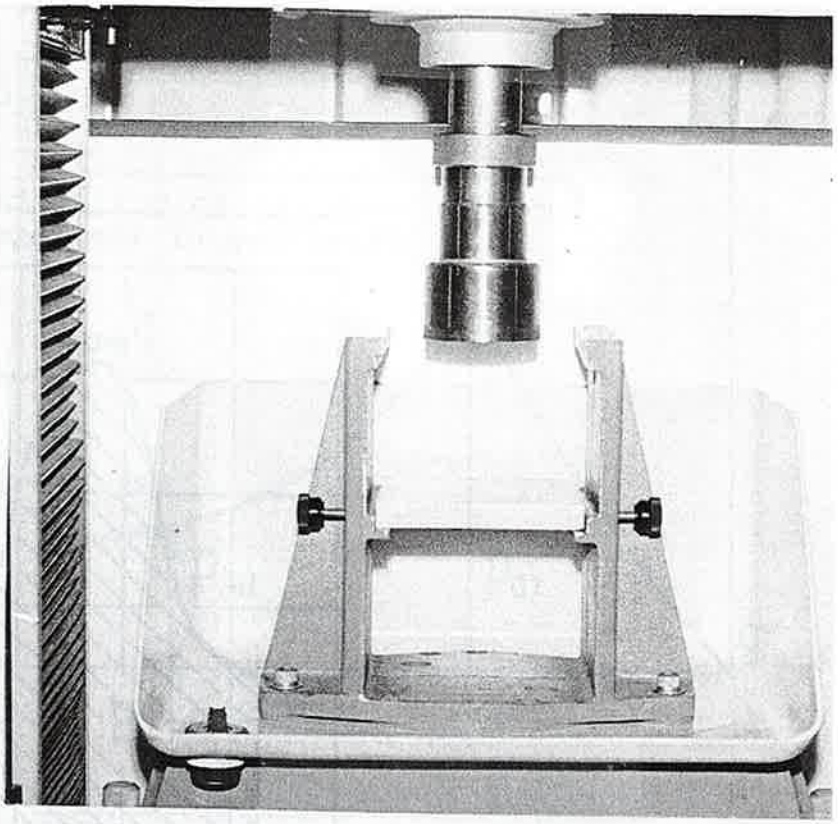
Fig. 1 Changeable appliances for "Instron" universal testing device:



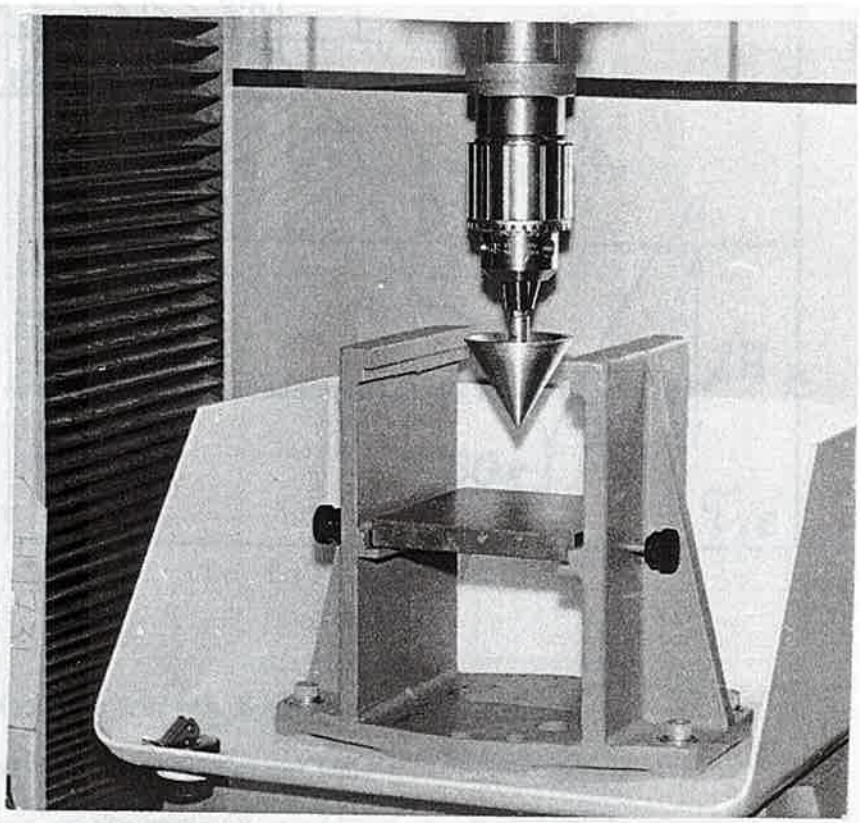
a - "Warner-Bratzler" measurement cell;



b - "Kramer Shear Press" measurement cell;



c - "Magness-Taylor" appliance;



d - conic indentor.

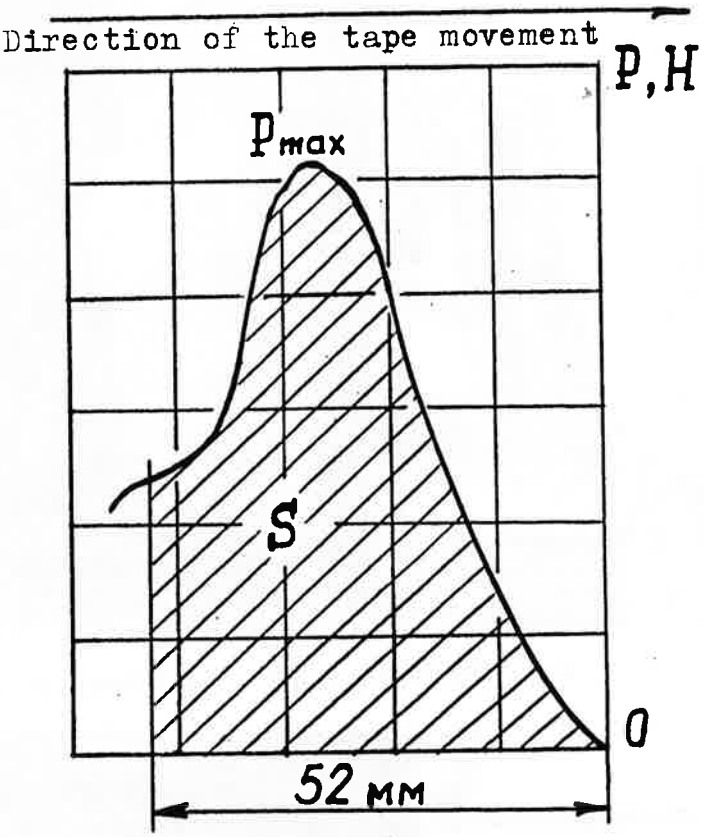
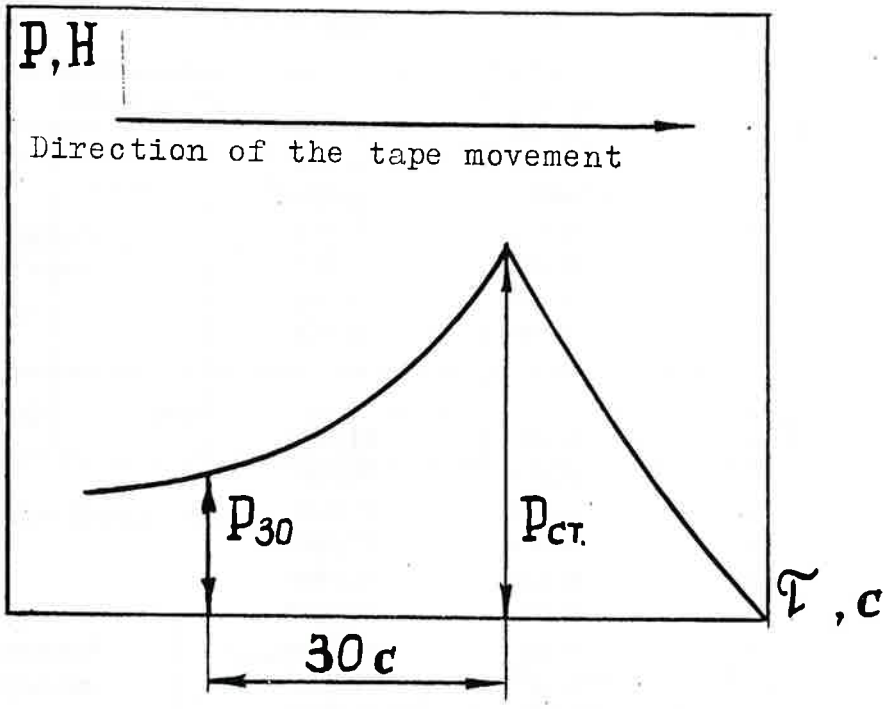


Fig. 2. Geometric interpretation of the shear cut.



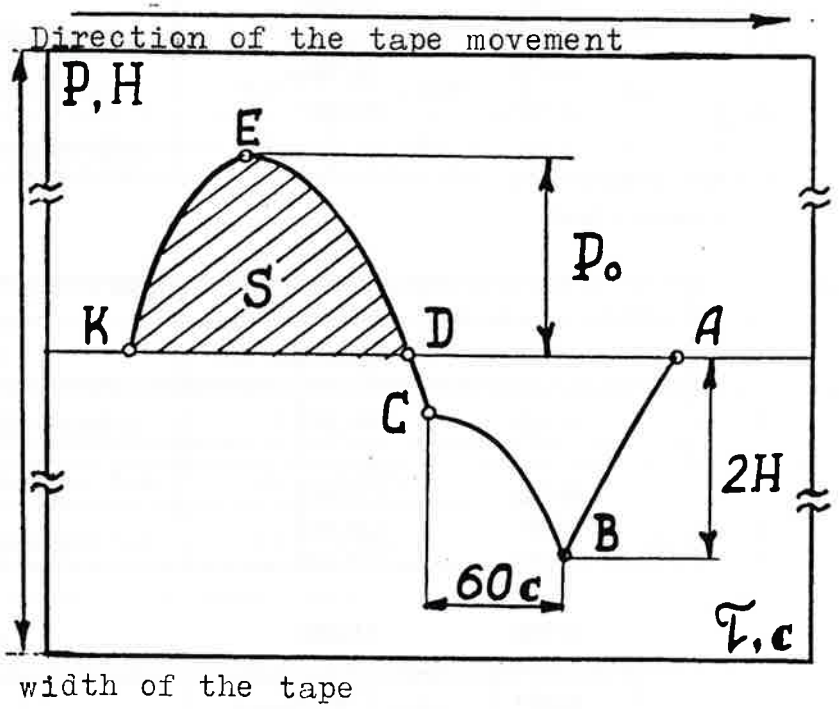


Fig. 3. Characteristics curves by determining:

a - stress of standard penetration;

b - adhesion-cohesion strength and specific adhesion-cohesion work.

Table 1: Relative Mobility (Rf) and Molecular Weights of Sarcoplasmic Proteins of Ayami.

Band	Rf	Molecular Wt.	Washing Effect
1.	0.023	230,000	
2.	0.046	205,000	
3.	0.061	160,000	
4.	0.114	155,000	Increase in
5.	0.136	140,000	intensity (Visual observation)
6.	0.159	125,000	
7.	0.189	110,000	
8.	0.231	94,000*	
9.	0.247	90,000	
10.	0.264	82,000	
11.	0.297	72,000	
12.	0.364	55,000#	
13.	0.405	45,000#	
14.	0.455	40,000#	Decrease in
15.	0.504	37,000#	intensity (Visual observation)
16.	0.537	35,000*	
17.	0.636	30,000	
18.	0.652	29,500#	
19.	0.678	28,500#	
20.	0.727	27,500	

* Only in Spent Hen
\# Decrease Clearly

Table 2: Relative Mobility (Rf) and Molecular Weights of Myofibrillar Proteins of Ayami.

Band	Rf	Molecular Wt.	Components
1.	0.045	205,000	Myosin
2.	0.116	155,000	
3.	0.134	140,000	Actinin &
4.	0.170	120,000	M-protein
5.	0.430	41,000	Actin
6.	0.509	37,000	Tropomyosin
7.	0.536	34,000	
8.	0.598	31,500	
9.	0.652	29,500	
10.	0.741	27,000	Troponin &
11.	0.777	25,500	myosin subunit
12.	0.911	22,000	
13.	0.946	21,000	

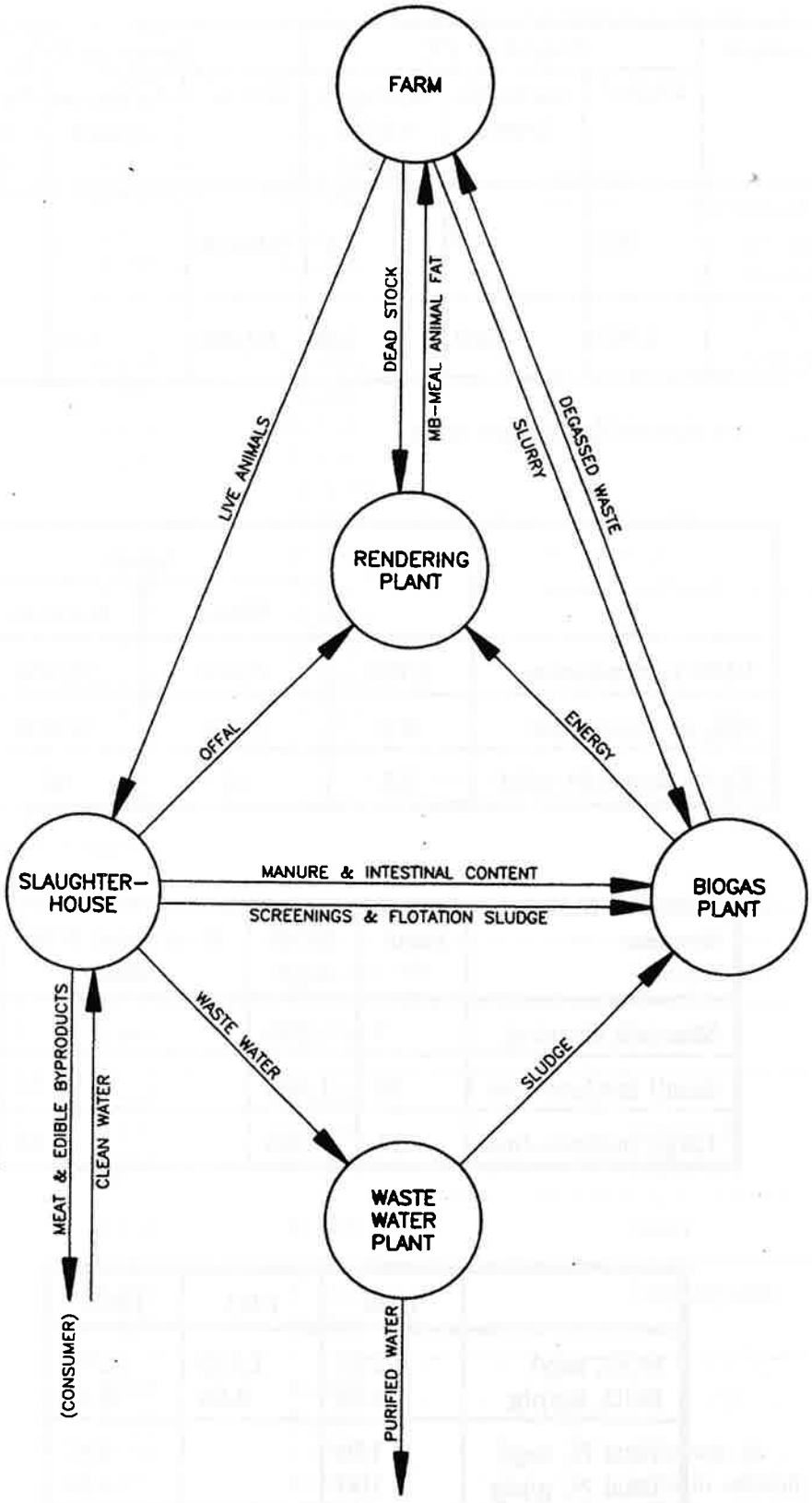
Sample	Stored at 4°C			Stored at 30°C		
	OU/m^3	Ammonia (ppm)	Hydrogen sulfide (ppm)	OU/m^3	Ammonia (ppm)	Hydrogen sulfide (ppm)
Above stored blood	700	nd[1)]	nd[1)]	300,000	2	380
Dryer gasses	1,000	200	200	60,000	675	300

1) n.d. = not detectable (Dräger tubes)

	Fresh	Aged	
		Winter	Summer
COD in condensate	2,700	10,000	50,000
NH_3 in condensate	500	2,000	10,000
Kg 0_2 demand/t offal	3.2	12	60

Process	**l/unit**	**BOD mg/l**	**% of total BOD load**
Stomach cleaning	7	500	3
Small instines–line	28	1,600	31
Large instines–line	11	6,300	66

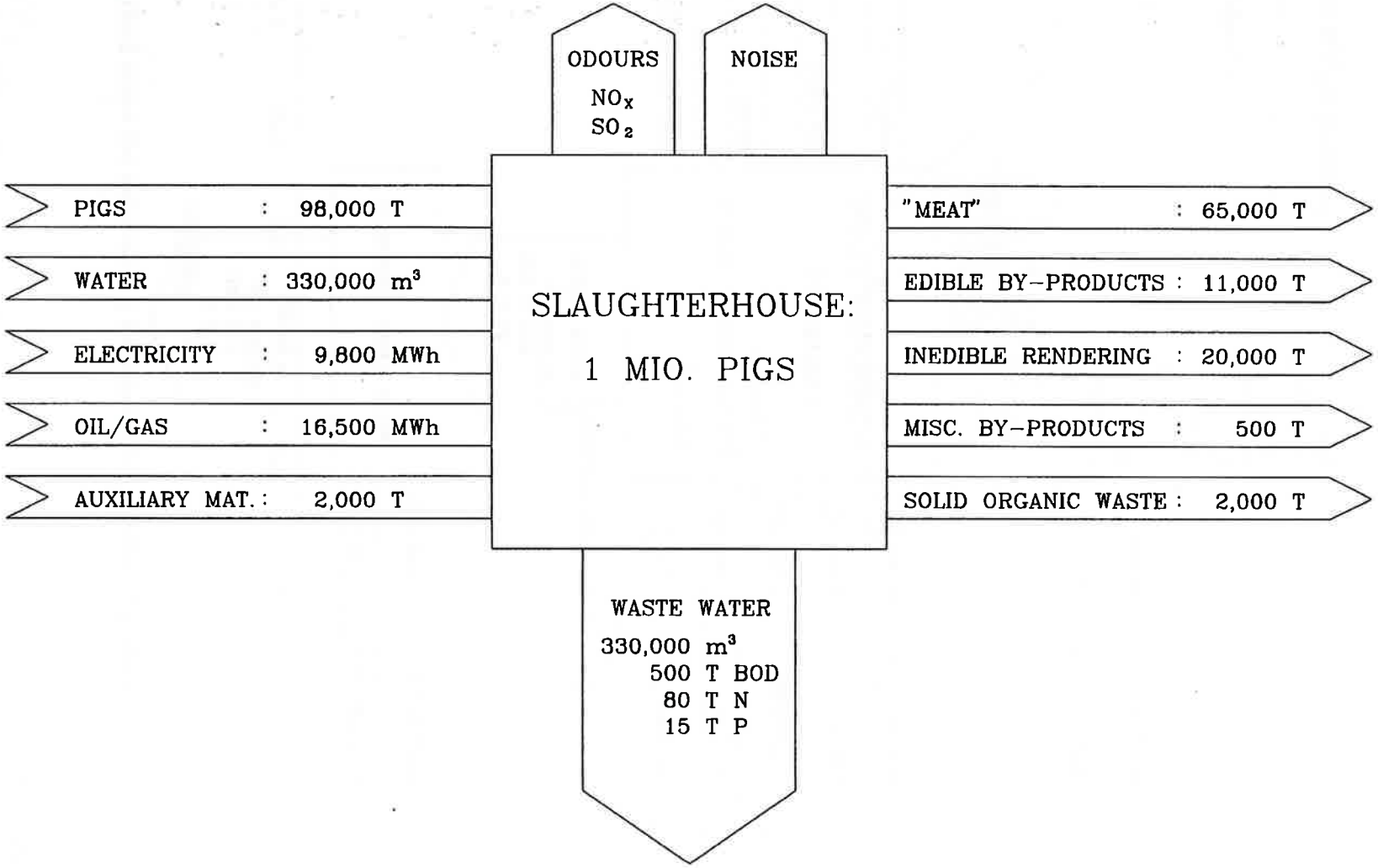
	1986	**1991**	**1993**
BOD, mg/l BOD, kg/pig	1,250 0.80	1,535 0.66	1,575 0.48
Total N, mg/l Total N, g/pig	150 100		235 80
Total P, mg/l Total P, g/pig	25 16		40 14



Figures 1. Recycling of by-products (2)

FIG. 2

SIMPLIFIED BLOCK DIAGRAM OF ENVIRONMENTAL IMPACT OF SLAUGHTERING



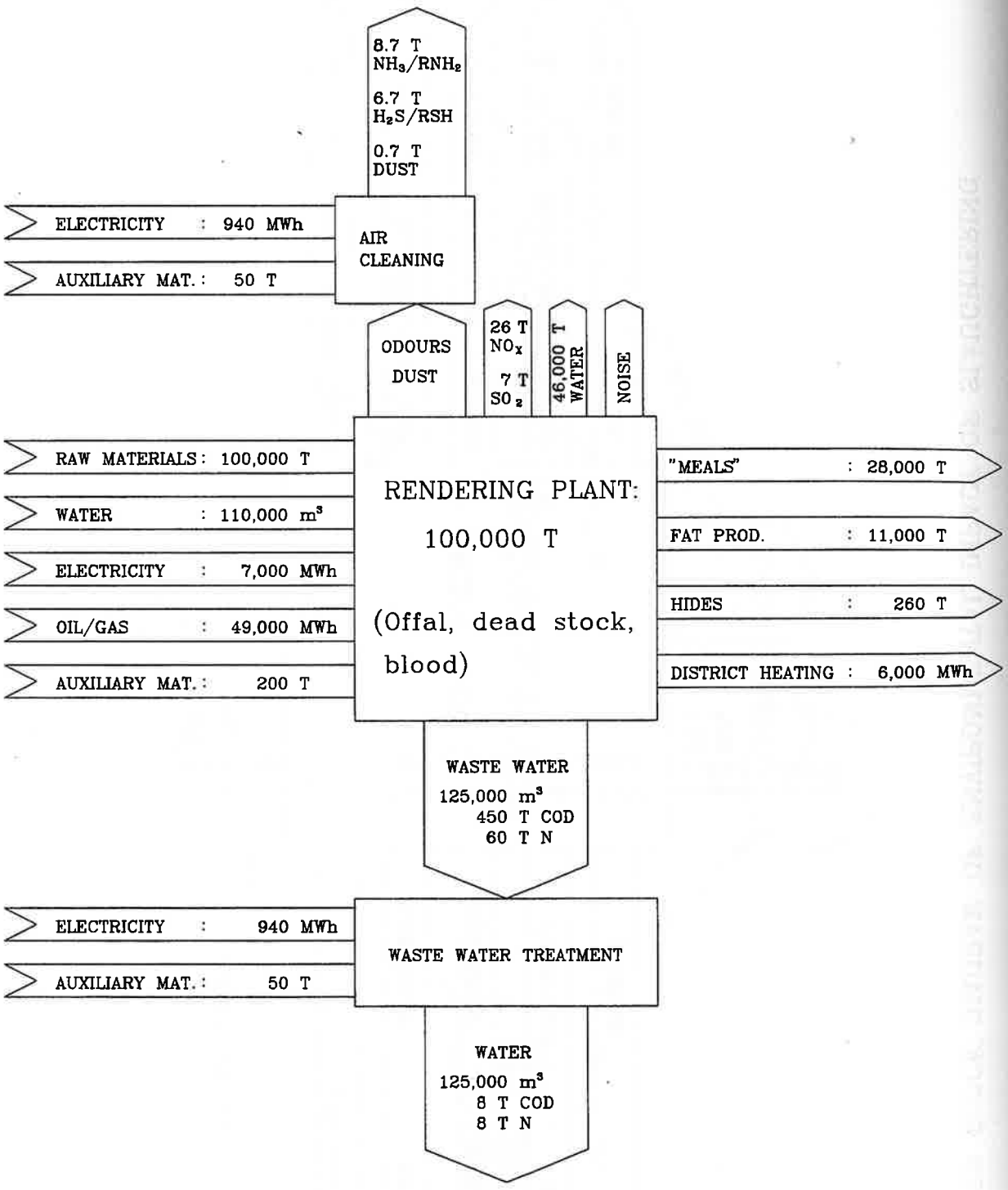


FIG. 3
SIMPLIFIED BLOCK DIAGRAM OF ENVIRONMENTAL IMPACT OF RENDERING

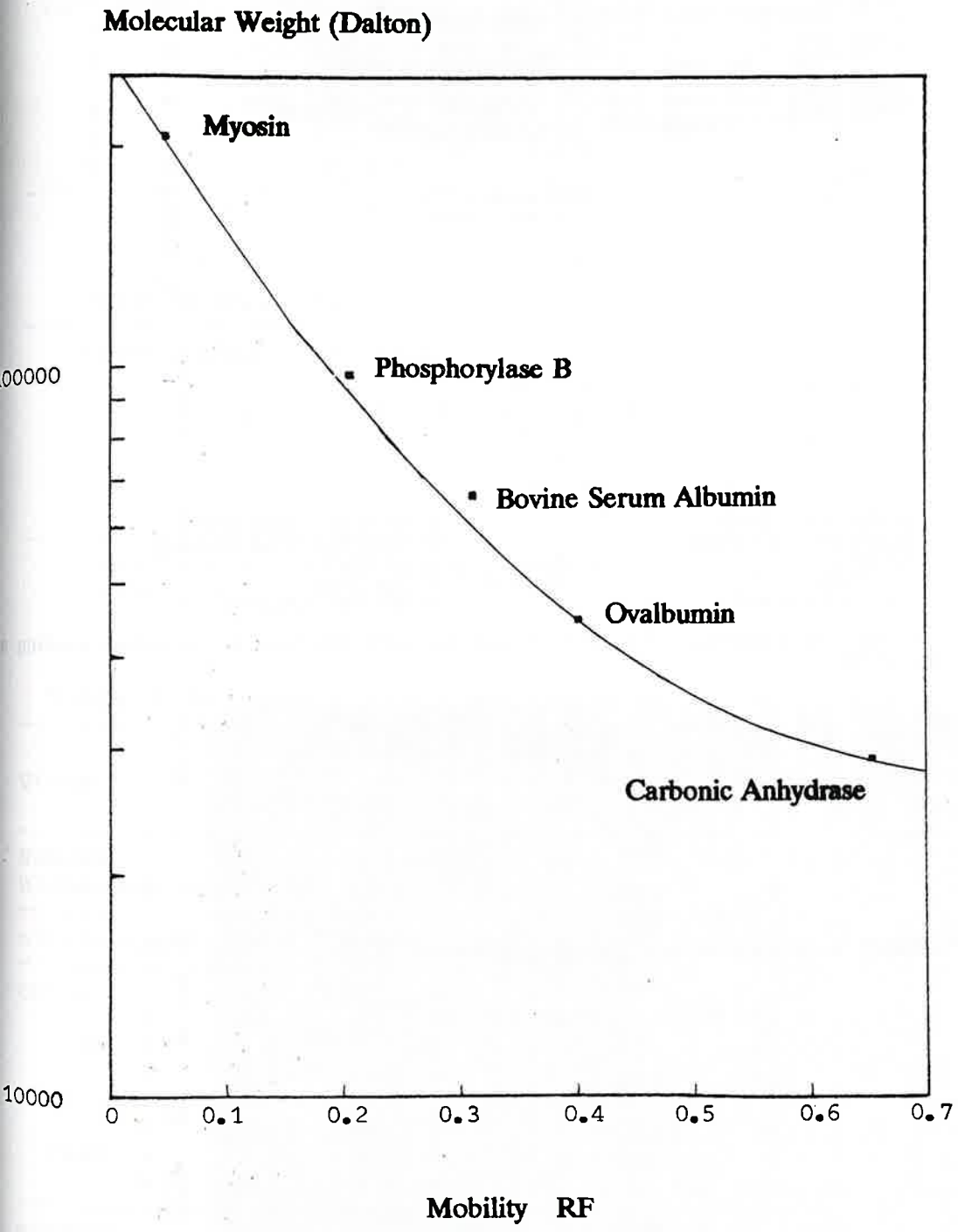


Figure 1 : Standard curve for determining the molecular weights of proteins.

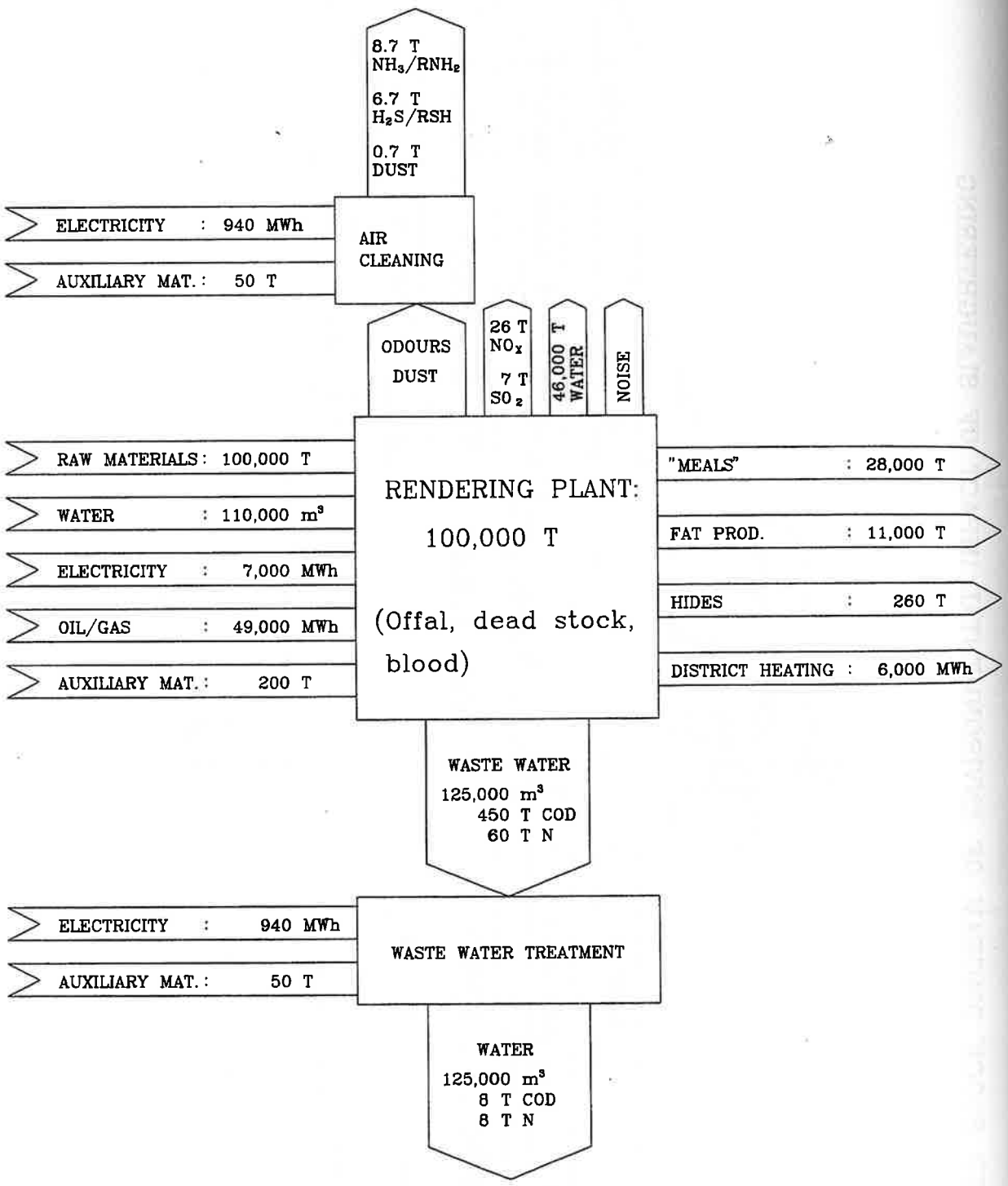


FIG. 3
SIMPLIFIED BLOCK DIAGRAM OF ENVIRONMENTAL IMPACT OF RENDERING

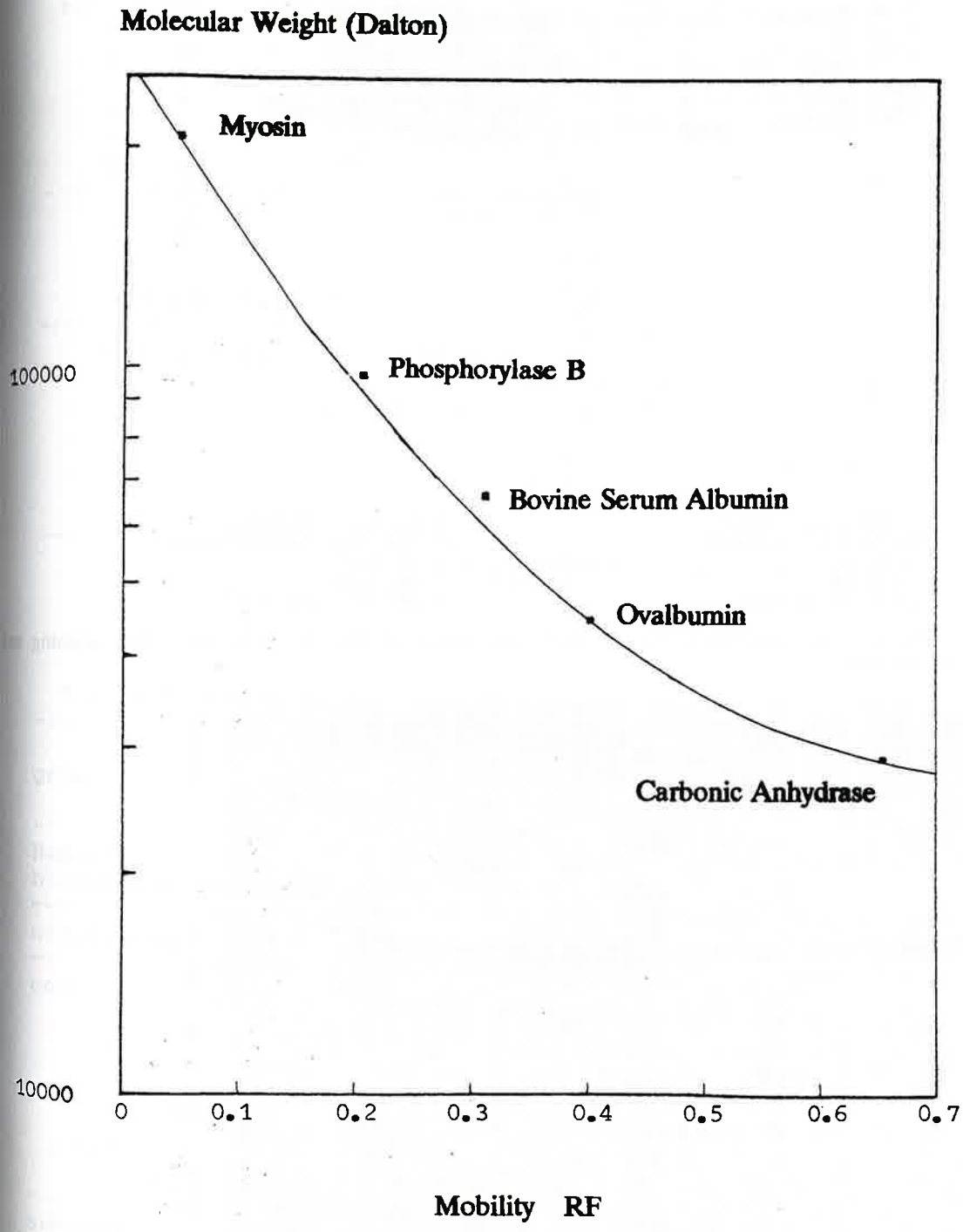
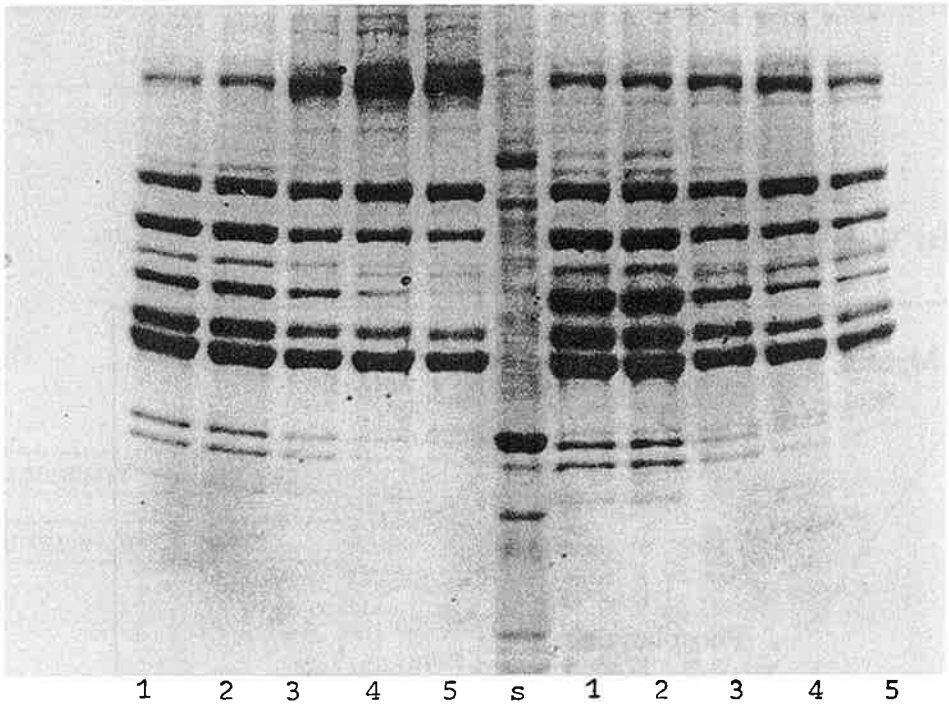


Figure 1 : Standard curve for determining the molecular weights of proteins.

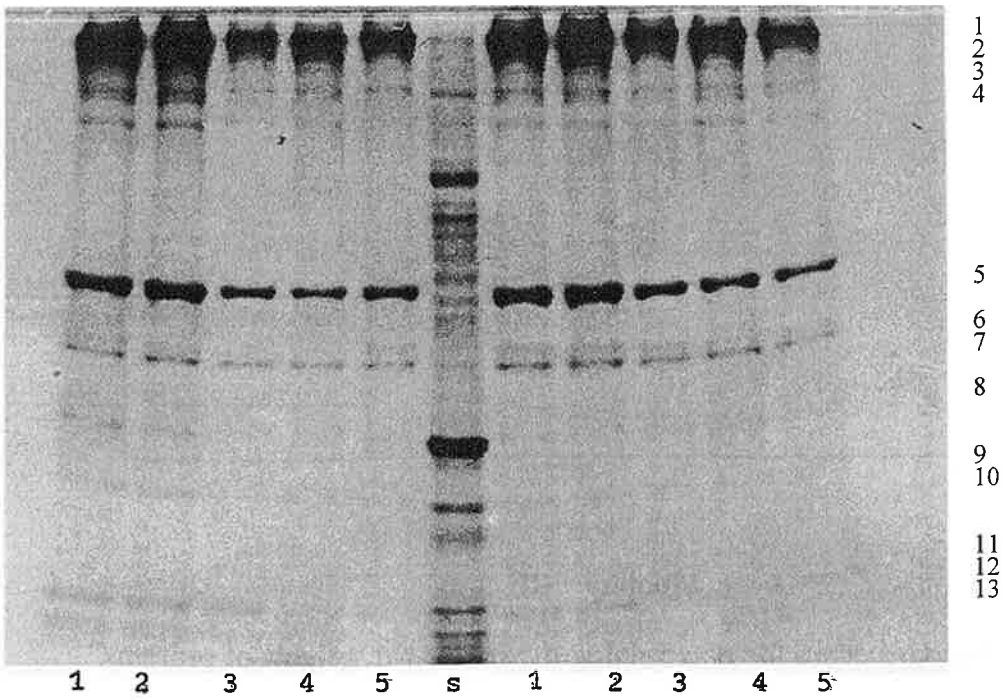


1 Broiler Meat (Raw)
2 Broiler Meat (Ground)
3 1st Wash
4 2nd Wash
5 3rd Wash (Ayami)

s = Protein Standard

1 Spent Hen Meat (Raw)
2 Spent Hen Meat (Ground)
3 1st Wash
4 2nd Wash
5 3rd Wash (Ayami)

Figure 2: Changes in Sarcoplasmic Proteins of Broiler and Spent Hen Meat due to various washing and processing procedure.



1 Broiler Meat (Raw)
2 Broiler Meat (Ground)
3 1st Wash
4 2nd Wash
5 3rd Wash (Ayami)

s = Protein Standard

1 Spent Hen Meat (Raw)
2 Spent Hen Meat (Ground)
3 1st Wash
4 2nd Wash
5 3rd Wash (Ayami)

Figure 3: Changes in Myofibrillar Proteins of Broiler and Spent Hen Meat due to various washing and processing procedure.

Table 1. Adding NaNO2, Vc and its relation with color
(unit: %)

test number	NaNO2	Vc	sensory analysis
1	0.20	0.5	light red
2	0.20	0.8	red
3	0.20	1.0	deep red
4	0.20	1.0	deep red
5	0.25	0.8	deep red
6	0.25	0.5	dull red

Table 2 Relation of color and hydrolysing time

hydrolyzing time (hrs)	color change
4	L=7.00 a=6.63 b=2.24
6	L=6.81 a=6.59 b=2.27
8	L=6.43 a=6.51 b=2.54
10	L=8.34 a=8.53 b=1.65
12	L=7.33 a=5.03 b=1.00
14	L=7.57 a=4.52 b=1.33

* Addition of nitrite and Vc: 0.25g/100g respectively
Addition of pancrea paste: 5%

Table 3. Relation between BRP amount and color in sausage.

roup		control	Test I			TestII			Test III		
			I1	I2	I3	II1	II2	II3	III1	III2	III3
aNO2%			0.46	0.46	0.46	0.37	0.37	0.37	0.28	0.28	0.28
lood-red pigment%			2	3	4	2	3	4	2	3	4
itrite(ppm)		16.4	19.1	24.3	27.0	17.1	20.4	24.2	8.3	12.8	18.7
olor											
	L	64.1	55.8	58.9	54.0	58.0	58.2	53.9	58.0	58.4	56.3
CSA	a	8.1	9.5	10.0	11.1	10.8	10.6	11.8	10.2	9.3	9.7
	b	7.7	8.1	9.2	8.1	8.6	8.8	8.2	8.2	8.2	8.6
	L	61.2	51.7	57.8	50.0	54.5	55.5	50.3	55.4	55.8	53.6
CSA*	a	7.3	9.1	9.2	12.0	11.5	10.3	10.6	9.1	9.1	9.3
	b	8.7	9.3	9.6	9.0	9.9	9.5	9.1	9.2	9.4	9.1
ensory		1.2	1.4	1.6	0.6	1.3	1.1	0.8	1.4	1.4	1.2

Footmark: color is indicated as "L, a, b" tristimulus

CSA stand for cut surface
CSA* stand for cur surface area after an hour

Table 4 Ratio of production (unit:g,%)

group	control	Test I			Test II			Test III		
		I1	I2	I3	II1	II2	II3	III1	III2	III3
Material wight(g)	140	140	140	140	140	140	140	140	140	140
Product wight(g)	152	153	158	151	150	161	155	149	157	151
ratio of production (%)	109	110	113	108	107	115	111	106	112	108

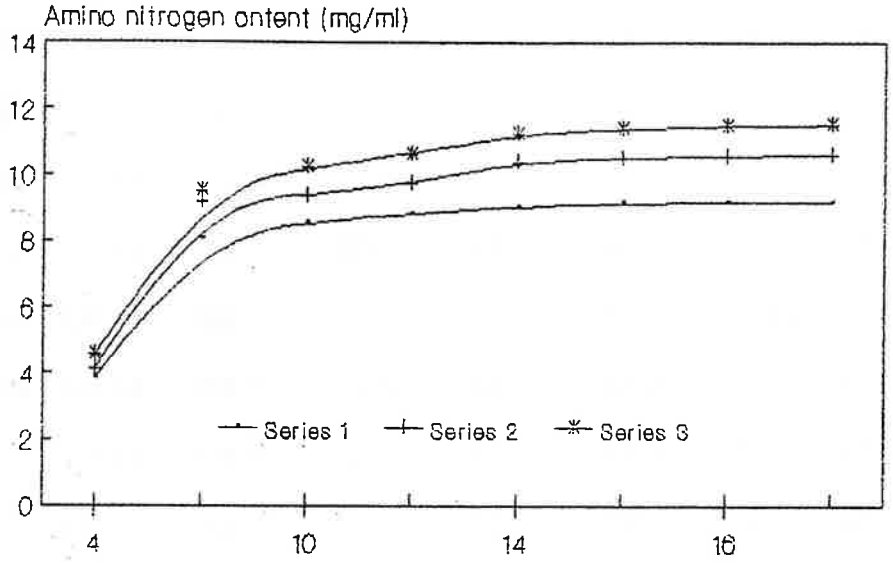
Table 5 Relation of pancrea adding and protein recovery (unit %)

group	I(20%)	II(20%)	III(30%)
erythrocyte	22.67	33.03	33.41
DPP	17.72	24.40	28.98
protein recovery	64.41	65.60	66.46

Table 6 Amino acid content of DPP (unit: 100%)

Amino acid	content	Amino acid	content
Asp	6.00	Leu	10.45
Thr	0.59	Tyr	1.69
Ser	1.05	Phe	4.83
Glu	9.41	Lys	7.63
Gly	5.22	Ammonia	1.36
Ala	7.71	His	6.47
Cys	0.48	Arg	0.30
Val	8.73	Pro	2.69
Met	0.49	Trp	?
Ile	1.09		

Fig 1. Variation of Amino acid content based on hydrolysis time



1.Ratios of pancreas addition: 1,10%; 2, 20%; 3,30%.
2.Temperature:45 C, pH 8.

TABLE 1: Bacteriological quality of pigblood collected under GMP conditions immediately after slaughter through a semi open blood collecting system. n=2 for code 2, 3, 4, 5, 6,7 and 8. n=3 for code 1.

Total aerobic plate count and Enterobacteriaceae in log CFU/ml and pH

Code[a)]	1	2	3	4	5	6	7	8
pH								
day 1	7.6		7.6	7.6	7.6	8.5		
day 2	7.5		7.5			8.6	7.7	
day 3	7.4		7.4	7.5		8.2	7.4	
day 4	7.6	7.6	7.7	7.5		8.2		
day 5	7.6	7.7	7.8	7.7		8.4	7.8	
day 10	7.6	7.8	7.6	7.7		8.4	7.7	
day 18	7.7	7.5	7.6	7.7		8.5		7.7
dag 24	7.7	7.6	7.8	7.7		8.4		7.7
Total aerobic plate count								
day 1	4.0		3.6	4.7	4.6	<1.8		
day 2	3.9		3.5			<1.8	4.4	
day 3	3.9		3.5	4.2		<1.8	4.2	
day 4	4.1	4.0	4.0	4.4		<1.8		
day 5	2.9	3.6	3.6	4.1		<1.8	3.6	
day 10	3.3	4.2	3.9	3.9		<1.8	4.4	
day 18	3.7	4.2	4.2	4.2		<1.8		3.6
day 24	3.7	3.9	3.3	4.7		<1.8		5.5

Code[a)]	1	2	3	4	5	6	7	8
Enterobacteriaceae								
day 1	<1.8		<1.8	2.4	<1.8	<1.8		
day 2	<1.8		<1.8			<1.8	<1.8	
day 3	<1.8		<1.8	<1.8		<1.8	<1.8	
day 4	<1.8	<1.8	<1.8	<1.8		<1.8		
day 5	<1.8	<1.8	<1.8	2.0		<1.8	<1.8	
day 10	<1.8	<1.8	<1.8	<1.8		<1.8	<1.8	
day 18	<1.8	<1.8	<1.8	<1.8		<1.8		<1.8
day 24	2.7	<1.8	<1.8	2.9		<1.8		4.3

a) Explanation of the codes:

1. first blood of the day, identification vessel;
2. just before lunch break, identification vessel;
3. just after lunch break, identification vessel;
4. end of the day, storage vessel 1 from the top;
5. end of the day, storage vessel 2 from the top;
6. start of the day, anticoagulant agent;
7. blood from dirty looking pigs, identification vessel;
8. end of the day, storage vessel 1 from the bottom.

Time of hydrolysis (h)	Amount of enzyme (ml) per 100 g of red cells	Efficiency of hydrolysis (%)	Extinction by 540 nm	Protein fractionation (kD)		
				< 5	5-20	>20
6	5.0	23.3	0.29	7.7	14.7	77.6
	10.0	44.4	0.25	11.5	19.8	68.7
	20.0	57.0	0.13	12.8	18.4	68.8
18	5.0	44.3	0.08	14.3	21.3	64.4
	10.0	59.0	0.05	16.7	20.2	63.1
	20.0	64.4	0.06	17.4	21.2	61.4
48	5.0	49.5	0.04	16.9	20.3	62.8
	10.0	54.9	0.03	22.0	19.7	58.3
	20.0	64.9	0.02	24.8	19.2	56.0

Table 1 Selected properties of examined red cell hydrolysates

Preparation	Protein content (%) (N x 6.25)	NSI (%)	Emulsifying properties		Foaming properties	
			EC (ml of oil)	ES (%)	FA (ml)	FS (30 min) (ml)
freeze dried red cells	70.6	65.6	32.5	57.0	20.0	4.0
PROTEOPOL-trated red cells	70.0	91.0	96.5	60.6	169.0	36.0
spray dried blood plasma	72.0	98.4	62.9	61.4	130.0	15.0
spray dried Na caseinate	88.7 (N x 6.38)	89.2	47.5	62.0	148.0	24.0

Table 2 Some functional characteristics of examined protein preparations

Table 1. Chemical composition of plasma, Retentate I and II and Permeate I and II

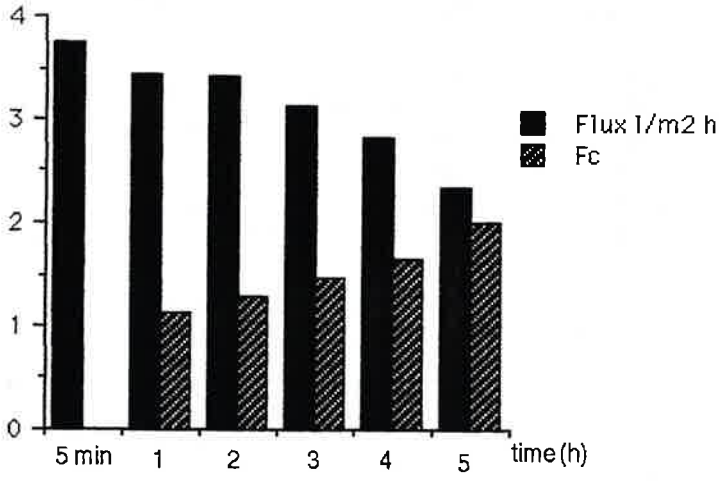
	Content of (%)		
	Water	Proteins	Ash
Plasma	90.85	6.9	2.16
Retentate I	83.00	14.42	3.22
Permeate I	97.52	0.37	1.97
Retentate II	78.88	17.70	2.76
Permeate II	97.57	0.31	2.05

Table 2. Amount of separated fat and liquid in model systems (%)

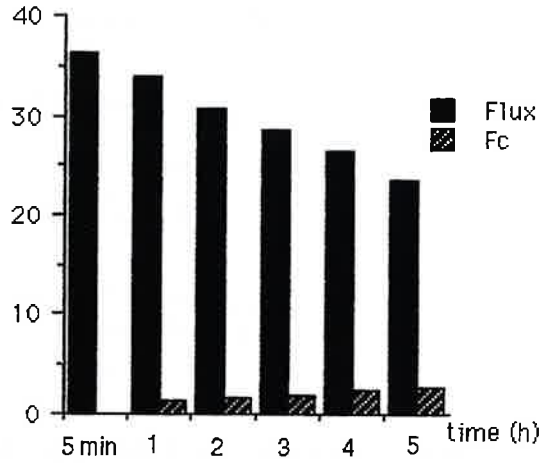
Emulsifier	Dispersed system fat:emulsifier:water			
	4:1:4	5:1:5	6:1:6	7:1:7
Plasma	-	-	8.46	14.20
Retentate I	-	-	15.20	21.35
Retentate II	-	-	20.85	24.10

Table 3. Sensory evaluation of colour and consistency of model systems

	Ratio			
	4:1:4	5:1:5	6:1:6	7:1:7
Plasma Colour	light-yellowish	yellowish	greyish	greyish
Plasma Consistency	firm-elastic	firm-elastic	firm	firm
Retentate I Colour	greyish-pink	greyish-pink	greyish-pink	greyish-pink
Retentate I Consistency	firm	firm	firm, hard	firm, hard
Retentate II Colour	greyish-pink	greyish-pink	greyish-pink	greyish-pink
Retentate II Consistency	firm	firm	firm, hard	firm, hard



Graph 1. Flux and F_c during UF of plasma at 35C in the function of time



Graph 2. Flux and F_c during UF of plasma at 45C in the function of time

Values for Graph 1

τ (h)	Flux l/m^{2}h	F_c
5 min	3.75	0
1	3.43	1.12
2	3.41	1.28
3	3.12	1.45
4	2.81	1.63
5	2.34	23

Values for Graph 2

τ (h)	Flux l/m^{2}h	F_c
5 min	6.37	0
1	33.75	1.22
2	30.56	1.48
3	28.62	1.85
4	26.39	2.28
4	23.5	2.7

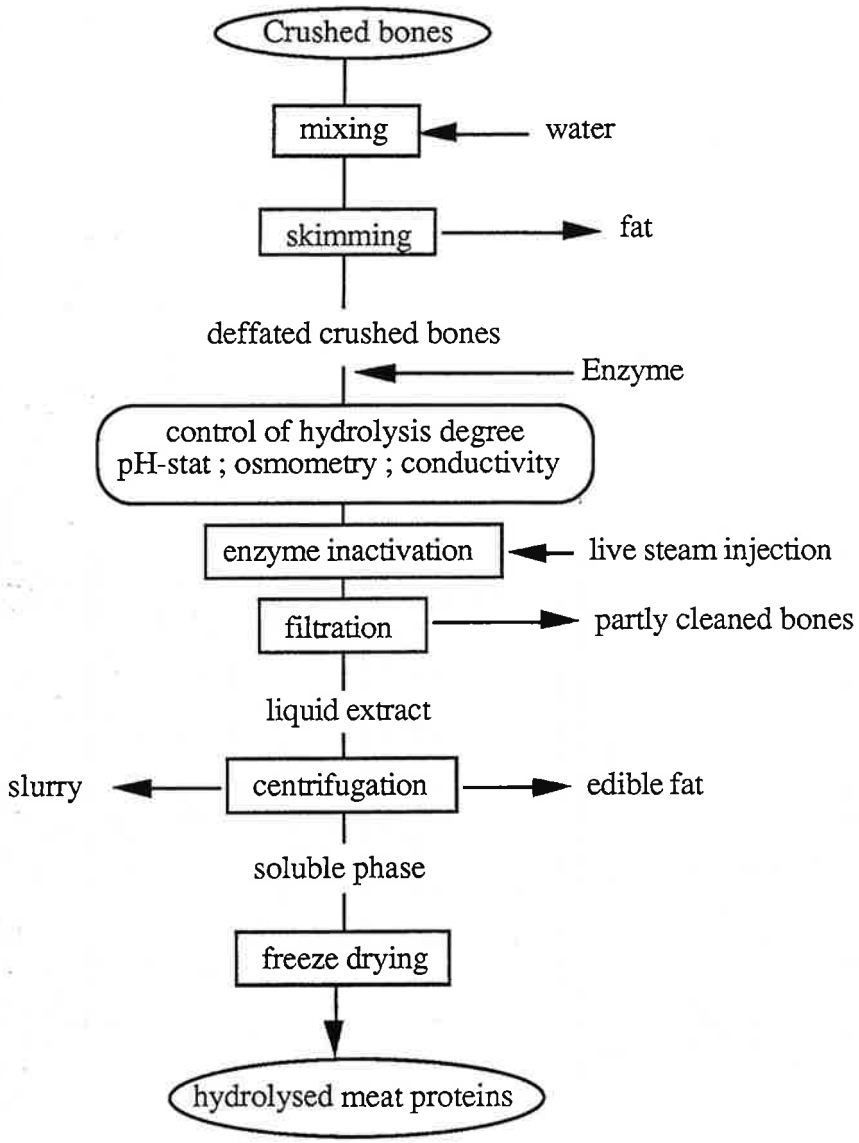


Figure 1 : Meat Bone Proteins recovery process.

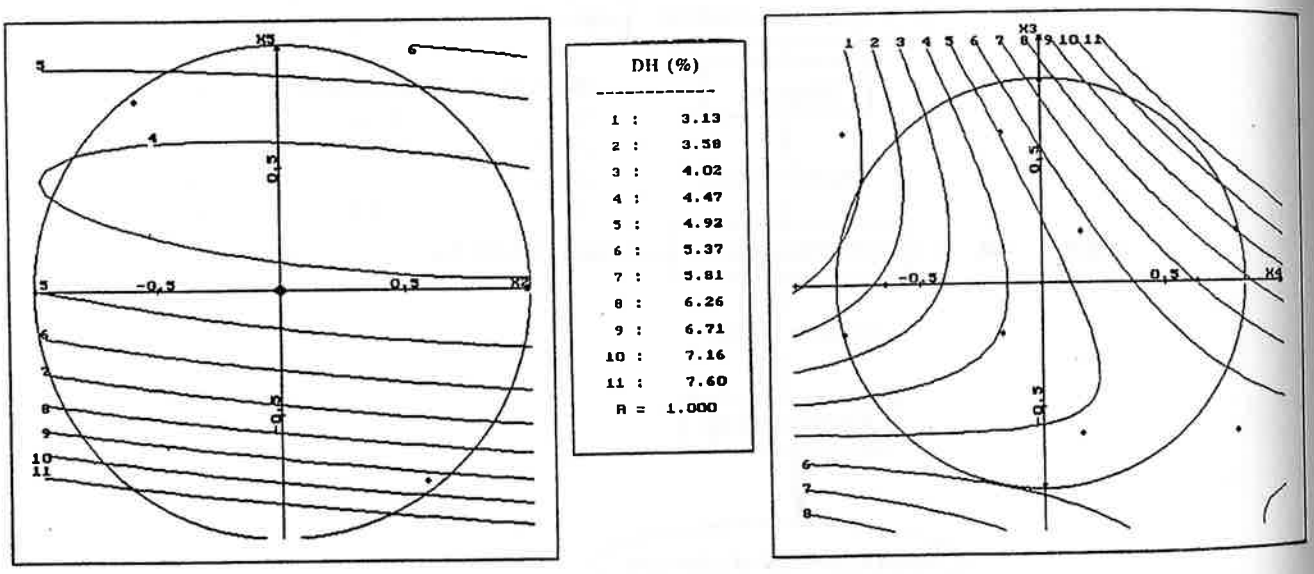
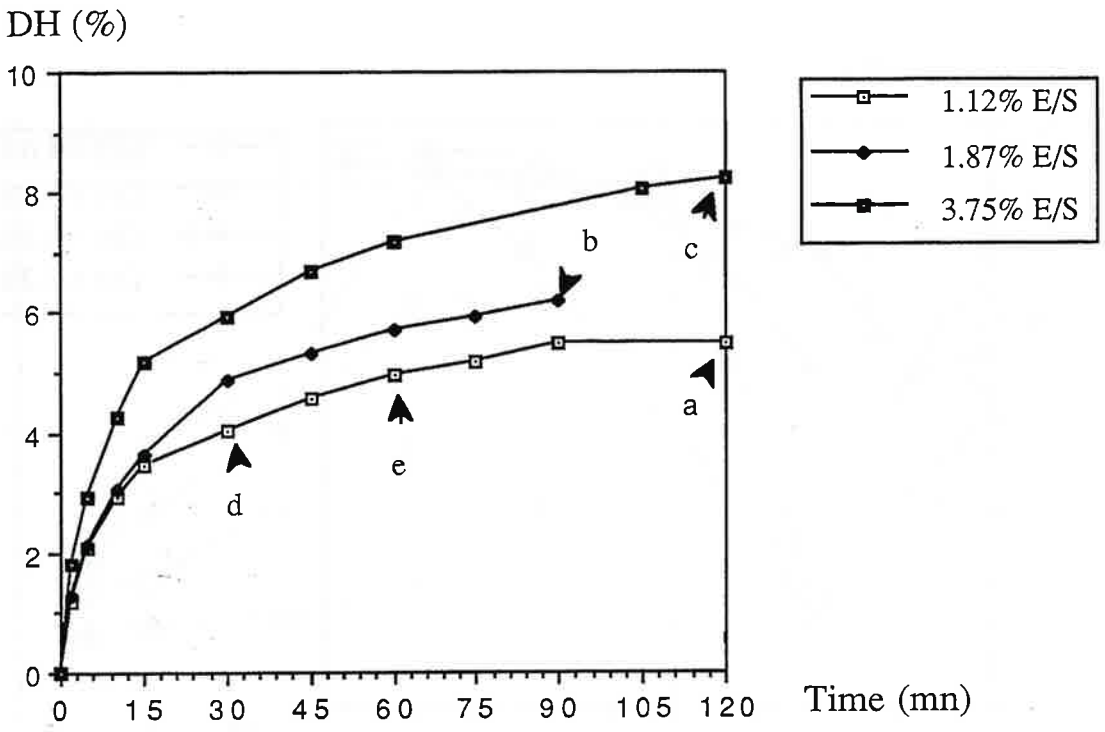
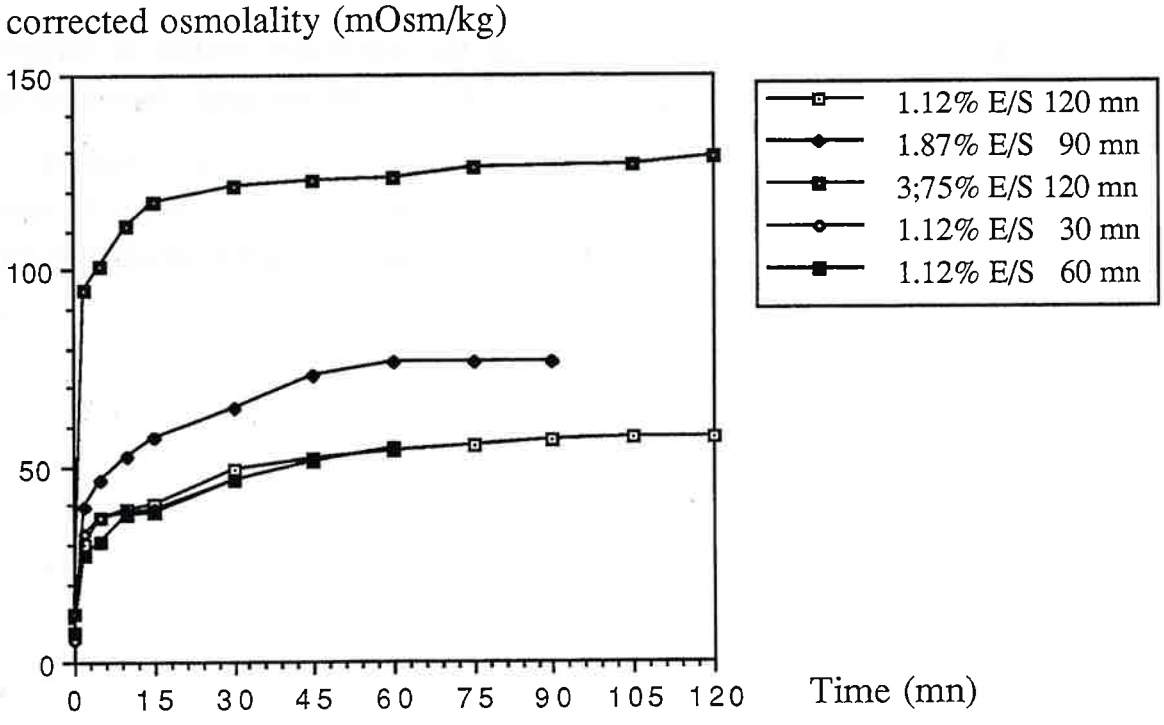


Figure 2 : Responses surface contours for protein yield and DH as a function of temperature (X1), pH (X2), enzyme (X3), time (X4) and protein concentration (X5) as plotted for two variables with other three variables fixed at 0 coded levels. Data were computed using the NEMROD program.





ıre 3 : The degree of hydrolysis (DH) and corrected osmolality (mOsm/kg) as a ction of time (a, d, e) or enzyme/substrate ratio (a, d, e) for the digestion of ıt Bone Proteins at 55°C with Neutrase 0.5L, pH 7.0, 7.5% protein centration.

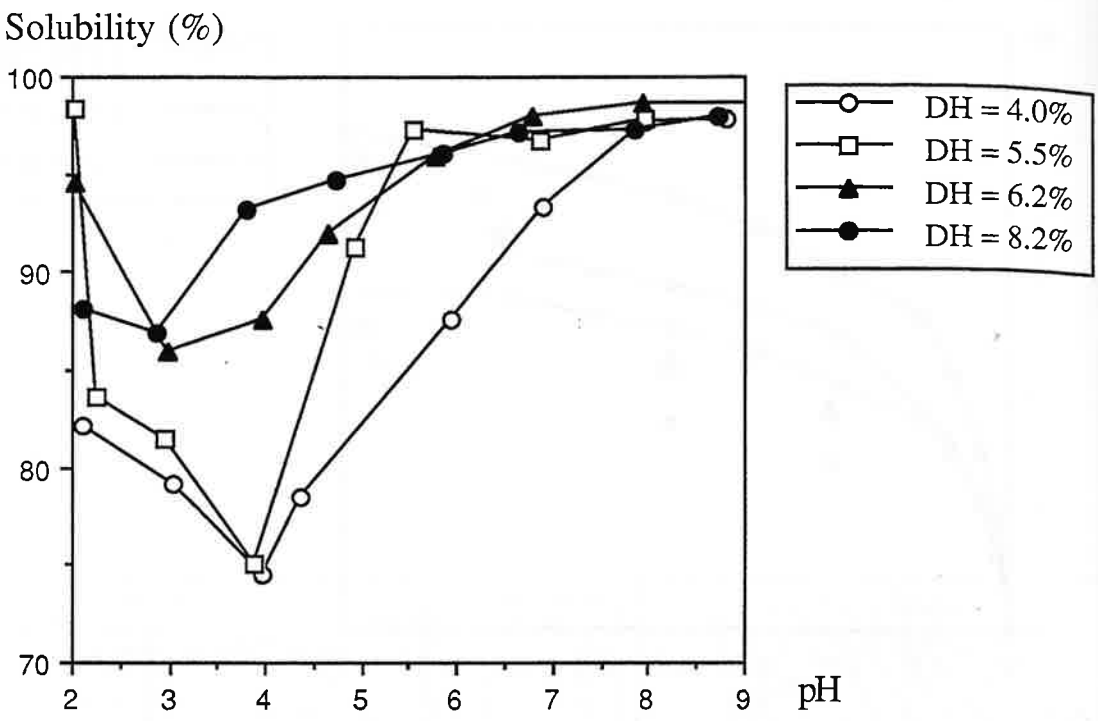
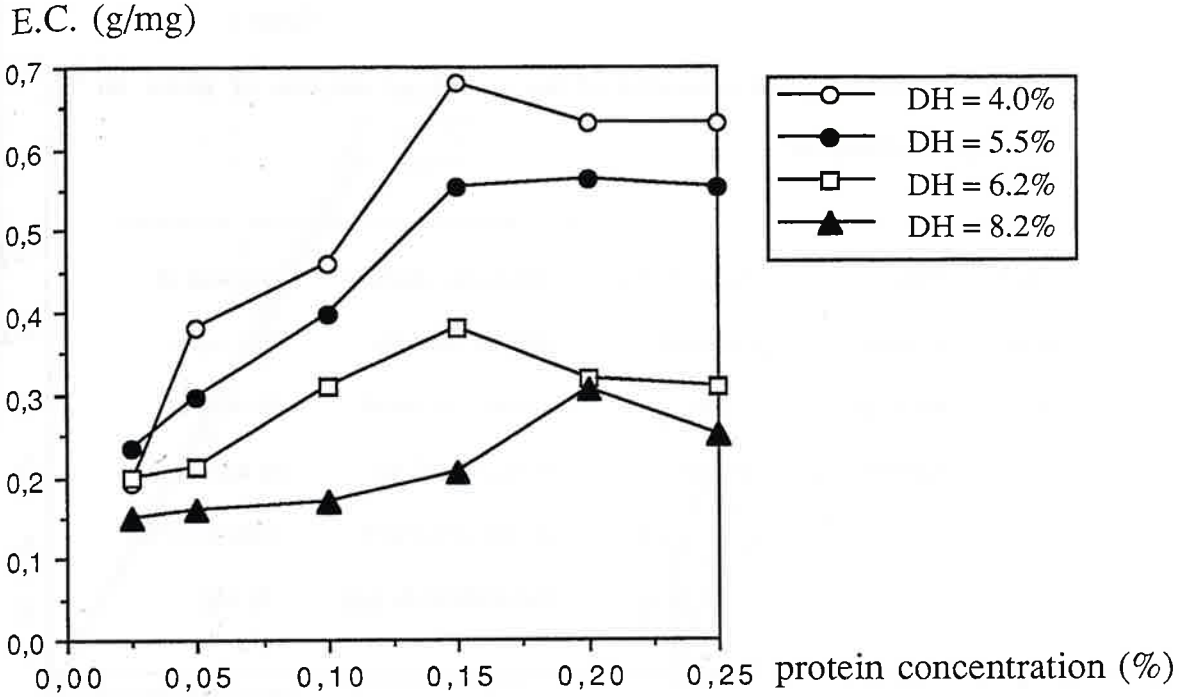


Figure 4 : Effect of the hydrolysis degree on the solubility profile of different Meat Bone Hydrolysate (Neutrase 0.5L, pH 7.0, 55°C, 7.5% protein concentration in the reactor).



ure 5: Effect of protein concentration on the emulsifying capacity of different at Bone Hydrolysates. EC is expressed as the amount of oil emulsified minus a nk (30.8g), divided by the amount of protein. Each value is a mean of triplicate lysis.

Table 1

Kinetic and sorption characteristics of the process of sorption of globin on carboxymethylcellulose

Temperature, °C	Rate of protein sorption, mg/min	Energy of the process activation, kJ/mole	Constant, characterising protein concentration at its filling of all active centers of the sorbent A, g/g	Content of the equilibrium of the adsorption process B, l/g
10	8.1±0.20	-	0.357±0.01	1.334±0.08
20	10.0±0.24	22.15±0.48	0.625±0.03	1.066±0.11
30	14.2±0.32	-	0.869±0.03	1.150±0.09

Table 2

Quality characteristica of globin

Moisture, %	8.9±1.5
Ash, %	19.1±2.3
Protein, %	70.2±2.5
Hydrogen index, pH	3.2±0.1
Solubility, %	98.9±0.4

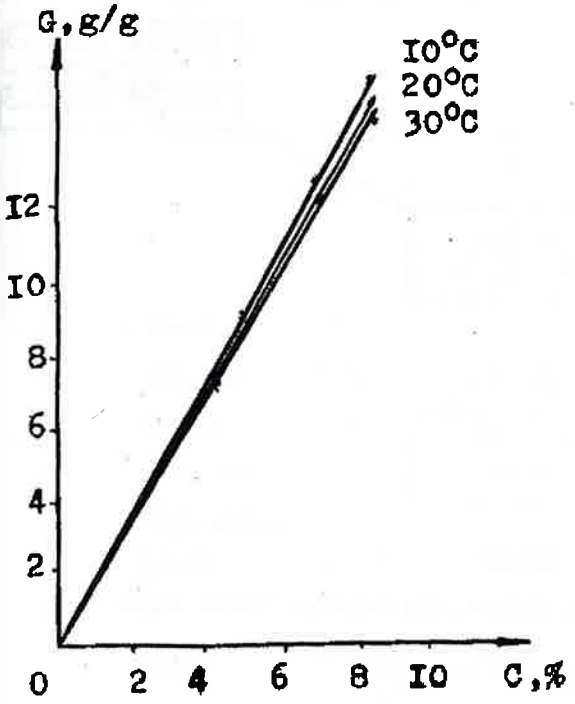


Fig. 1. Dependence of the hemin sorption value on its concentration in the solution

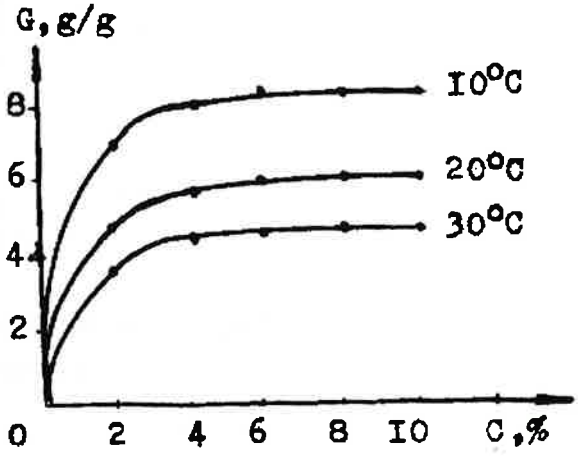


Fig. 2. Dependence of the globin sorption value on its concentration in the solution

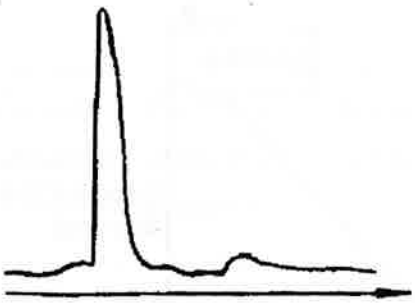


Fig. 3. Densitogram of globin (M.M = 15 kD)

Fig. 4. The scheme of separation of hemin and globin

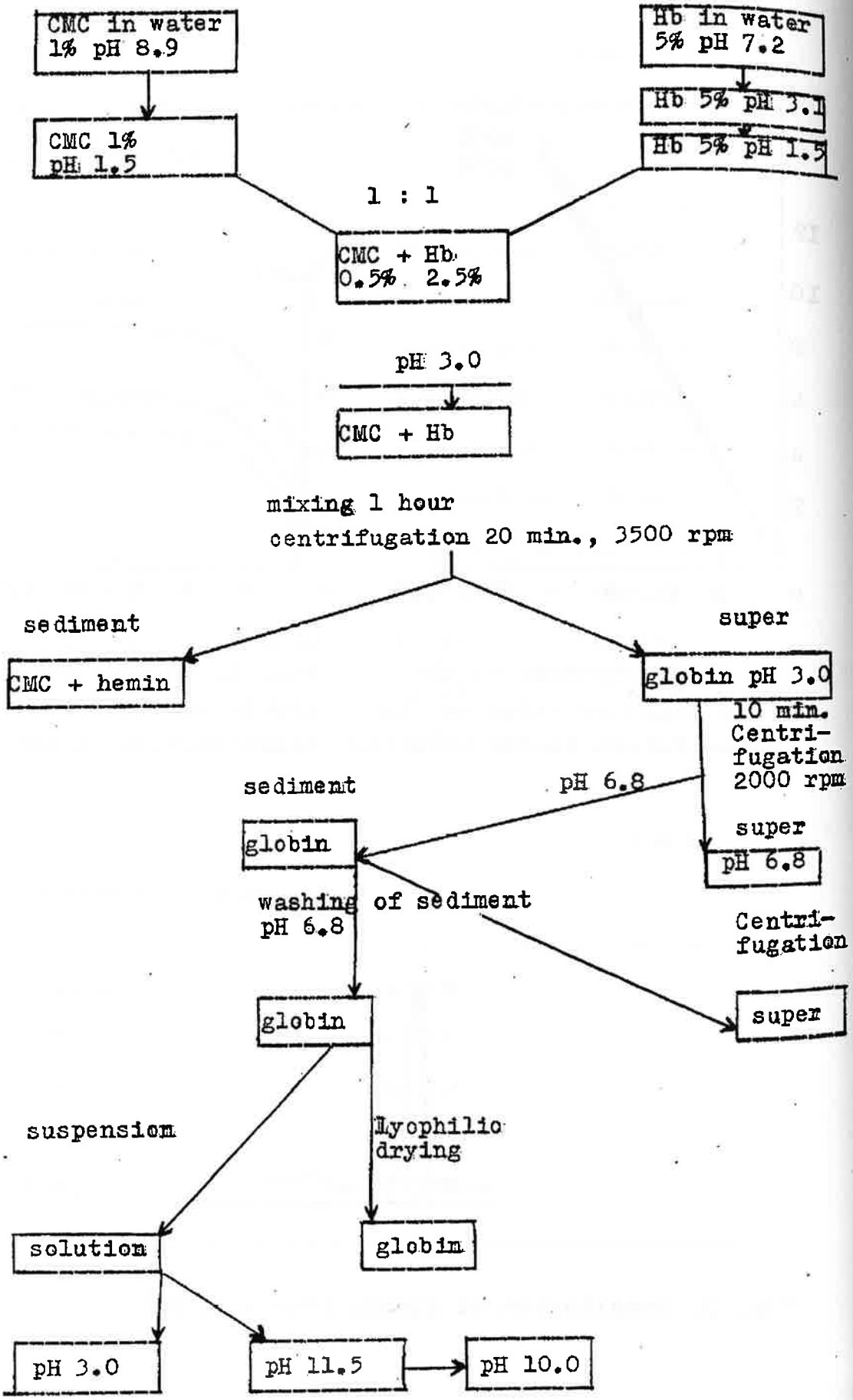


Table 1

Kinetic constants of hydrolysis of protein substrates by pancreatin at 50°C.

Substrate	$V_{max} \cdot 10^3$, mg/ml·min	$K_1 \cdot 10^2$ min^{-1}	K_m mg/ml	E_a kJ/mol
	"Rapid" step			
Blood	9,9±0,4	3,61±0,23	0,33±0,05	54,5±0,8
Albumin	6,7±0,5	4,25±0,34	0,29±0,04	103,1±0,9
Globin	14,6±0,8	5,15±0,22	0,55±0,04	70,7±0,9
Soya isolate	8,0±0,3	2,65±0,54	0,63±0,07	58,2±0,7
Soya isolate+ blood	9,7±0,5	1,35±0,12	0,87±0,04	27,4±0,4
	"Slow" step			
Blood	5,5±0,6	1,27±0,61	0,55±0,03	37,4±0,9
Albumin	3,3±0,1	1,12±0,15	0,58±0,02	60,7±0,8
Globin	5,0±0,5	1,27±0,44	0,51±0,06	38,8±0,2
Soya isolate	4,0±0,4	0,90±0,34	0,37±0,05	37,4±0,4
Soya isolate+ blood	5,2±0,3	0,95±0,32	0,88±0,03	13,3±0,5

Table 2

Indices of biological value of blood hydrolyzates and their mixes with soya isolate

Product	Increase in weight, g/day	Coefficient of efficiency of protein	Net utilization of protein
Dry blood	0,64±0,08	0,13±0,02	43,0±2,4
Soya isolate	1,36±0,14	2,34±0,02	72,6±2,0
Soya isolate + blood (hydrolyzed by pancreatin)	1,42±0,18	2,68±0,20	78,6±1,8

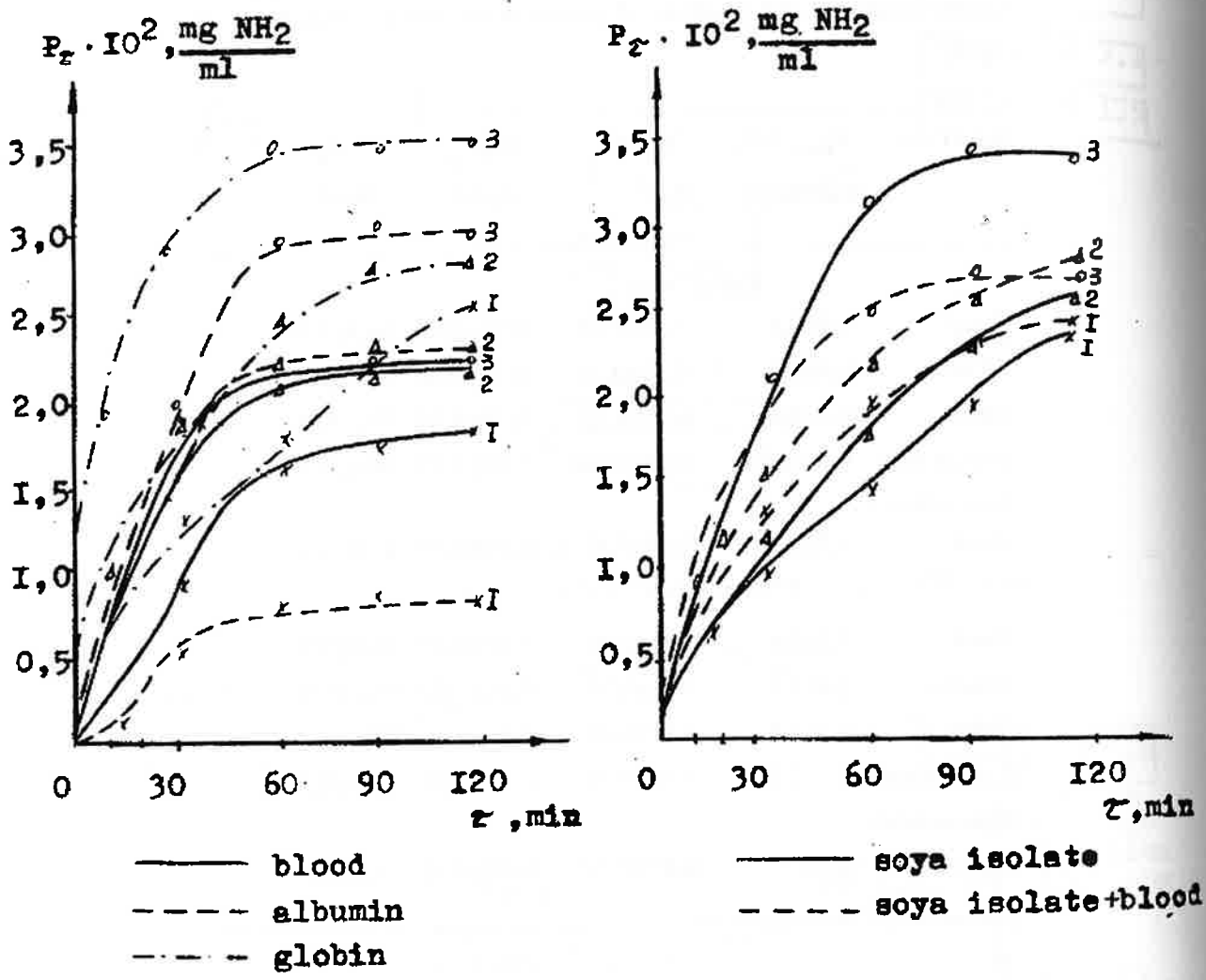


Fig 1. Dependence of yield of hydrolysis product of protein substrates by pancreatin from time at different temperatures: 1 - 40; 2 - 50; 3 - 60°C

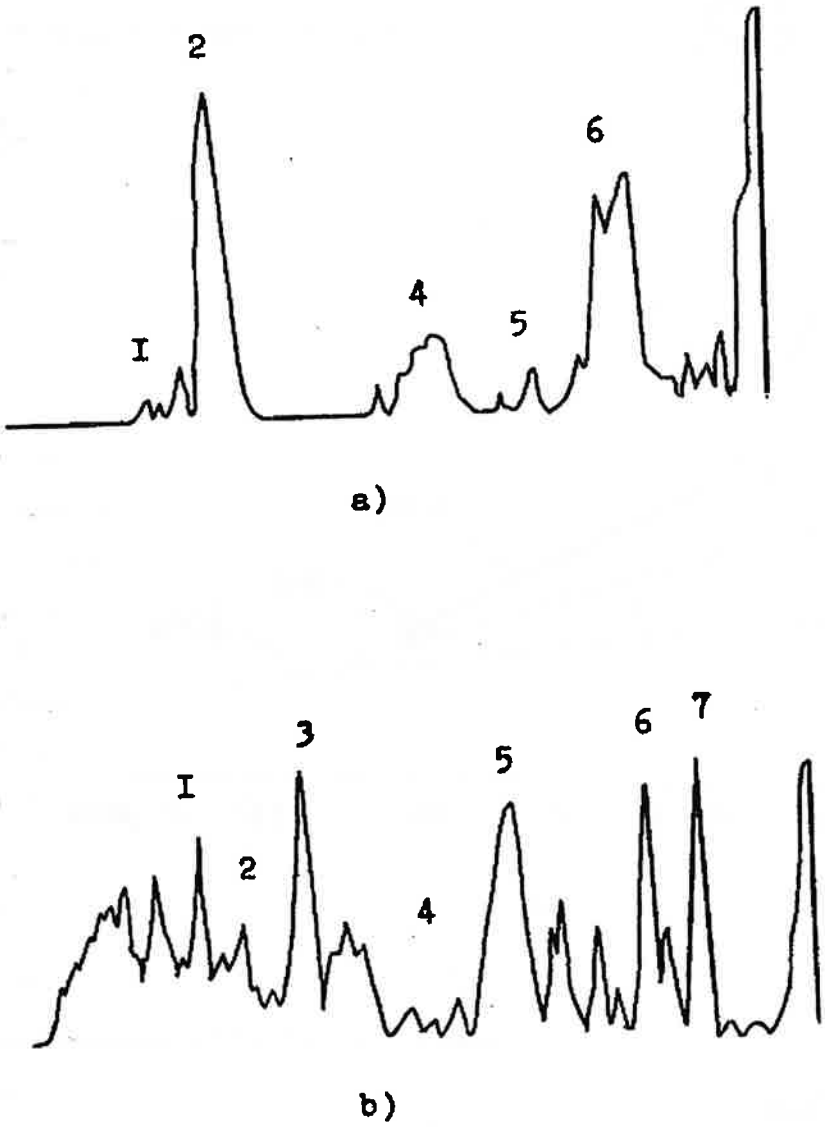
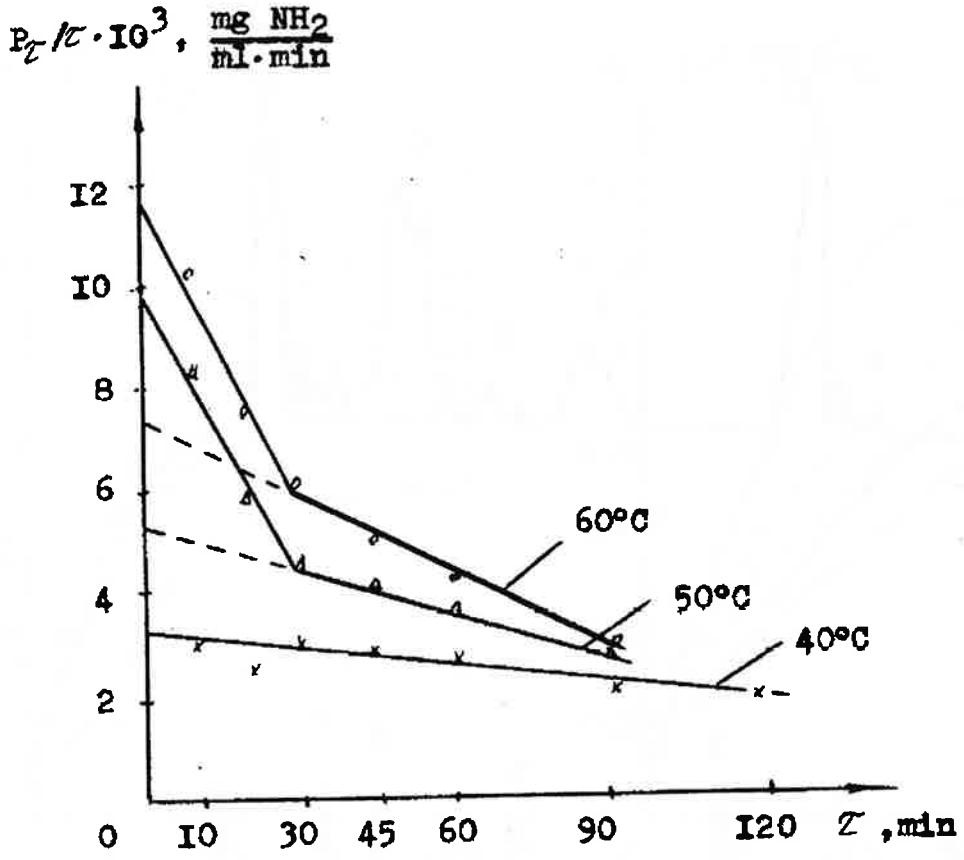
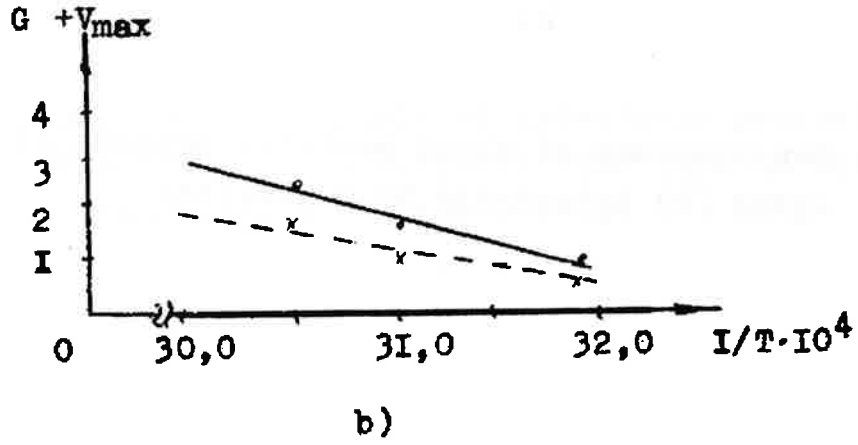


Fig. 2. Densitograms of blood proteins before (a) and after (b) hydrolysis by pancreatin



a)



b)

Fig. 3. Graphic determination of maximum apparent rates (a) and energy of activation (b) of hydrolysis process of the whole blood by pancreatin

Table 1

The Main Chemical Characteristics of Protein Components Derived from Bones of Slaughter Animals by Different Methods

Indices	Method of extraction		
	hydrothermal	hydrothermal with a catalyst	of the Lensfield Products Ltd. company (Great Britain)
Content, %			
Moisture	4.7±0.4	7.3±0.6	5.0±0.4
Nitrogen	13.6±1.1	14.9±1.2	15.5±0.7
Fat	3.8±0.2	3.5±0.2	3.5±0.1
Minerals	2.7±0.3	3.8±0.3	2.0±0.2
Active acidity of a 10% water solution (pH)	6.0	6.2	5.0-7.0
Solubility	99.0	99.0	99.0

Table 2

Functional Properties of Bone Protein Components

Indices	Method of protein component extraction	
	hydrothermal	hydrothermal with a catalyst
Fat-binding ability, %	140-250	180-230
Emulsifying ability, %	65-100	100
Water binding ability, %	Do not posses	
Gel-forming ability, g protein/100cm^3	Do not posses	
Emulsion stability	49-100	53-83
Dispersibility of protein	92.7	94.0

Table 3

Biological Value of Bone Protein Components

Amino Acids	Protein component, extracted by a hydrothermal method	
	Score, %	Difference of the amino acid score, %
Isoleucine	36	10
Leucine	56	30
Lysine	57	31
Methyonine + Cystine	26	0
Phenilalanine + Tyrosine	56	30
Threonine	50	24
Tryptophane	46	20
Valine	48	32

Table 4

Chemical Composition and the Meat Physico-Chemical Indices of broths Containing Bone Protein Components

Indices	"Estonian" broth	"Russian" broth	"Summer" broth
Content, %			
Moisture	Not more than 8		
Fat	24	19	24
Protein	18	20	18
Active acidity of a 2.5% water solution (pH)	6.05	6.05	6.05
Stuffing density, kg/m^3	650-700	650-700	650-700
Energy value, Cal	250	215	250
Calcium: Phosphorus ratio	1.2 : 1	1.2 : 1	1.2 : 1
Ratio of indispensable and dispensable amino acids	1 : 4.4	1 : 4.5	1 : 4.4
Sum of sulphur-containing amino acids	1.28	1.43	1.42

Table 5

Nutritional and Energetic Value of Soup Concentrates Containing Dry Protein Component of Bones

Name of the Product	Content, %			Energetic value, Cal
	Protein	Fat	Carbohydrates	
Soup with pasta and broth	14.1	5.2	53.8	322
Soup with mashed potatoes & broth	12.9	4.7	58.6	328
Broth - based soup with pearl barley	12.8	5.1	53.7	316
Borsch with broth	11.2	9.0	40.4	295

Table 6

Chemical Composition and Energetc Value of the Extruded Products

Initial raw material	Content, %			Energetic value, Cal
	Protein	Fat	Carbohydrates	
Semolina and dry broth	10.4-10.6	2.5-3.0	63.1	323-326
Corn cereal and dry broth	8.1-8.3	2.9-3.4	64.2	321-324

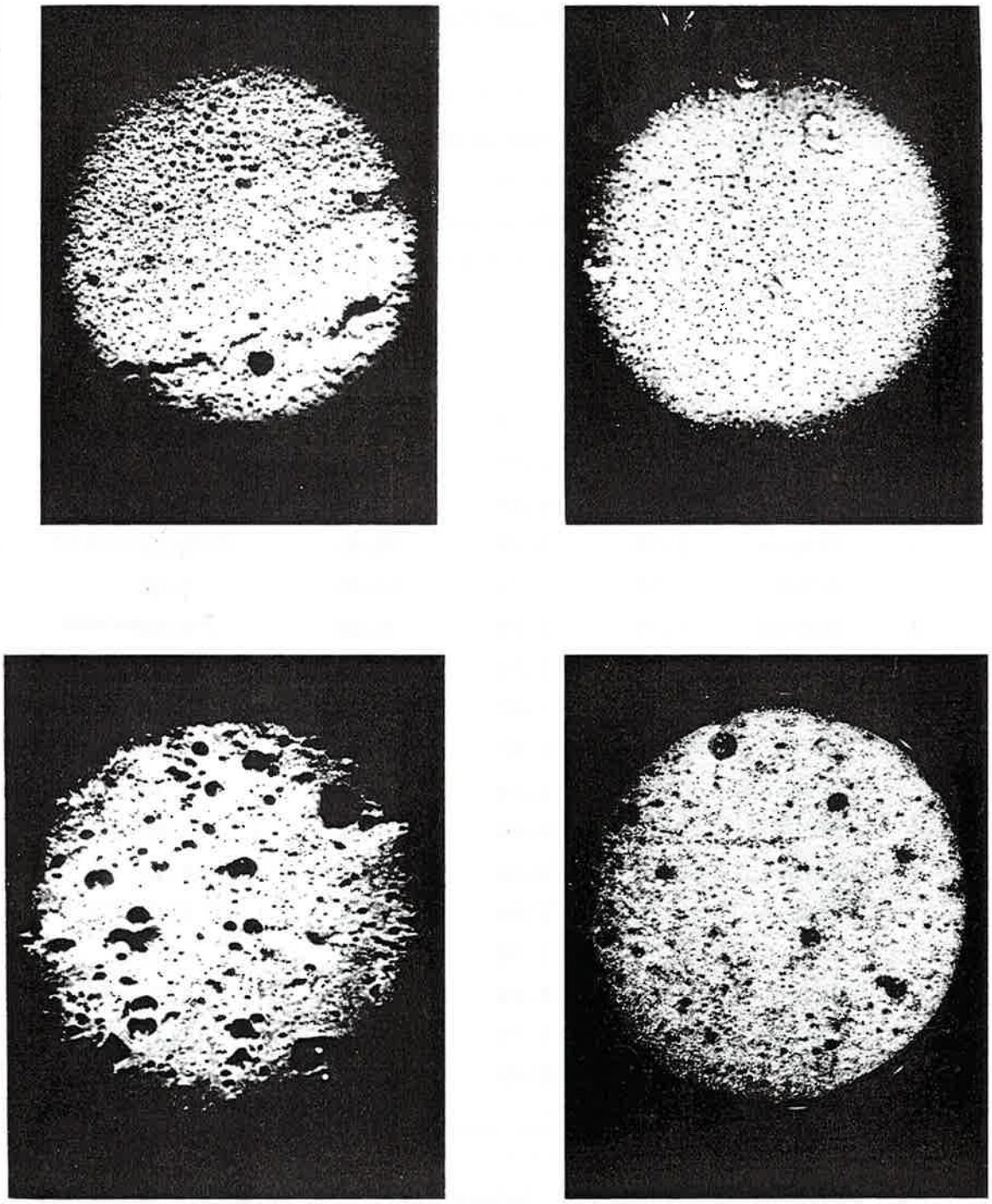


Fig. 1. Macrostructure of thermally processed structured protein products based on blood plasma:

a - with sodium caseinate; b - with bone protein isolate;

c - with micellial micomass of the Polyporus fungus;

d - with cotton protein isolate

Table 1

Structural and mechanical characteristics of structured protein products based on blood plasma

Type of SPP	SPP before and after thermal processing	Structural and mechanical characteristics of SPP: Shear stress x 10^{-4}, Pa	Shear cut x 10^{-2}, j/m^2	Specific shear stress x10^{-5}, Pa/kg	Specific shear cut x 10^{-3} j/m^2*kg
1	Before	-	-	-	-
	After	3.39	1.98	8.83	5.16
2	Before	2.76	1.59	7.46	4.30
	After	4.96	2.89	13.27	7.43
3	Before	1.10	0.80	6.93	5.28
	After	1.89	1.44	12.45	9.45
4	Before	1.79	1.29	5.36	3.86
	After	3.58	2.55	10.69	7.74
5	Before	1.85	1.33	5.66	4.00
	After	1.54	2.55	10.59	7.65
6	Before	1.65	1.18	4.61	3.32
	After	3.02	2.18	8.44	6.08
7	Before	1.95	1.42	5.70	4.20
	After	3.79	2.76	11.11	8.16
8	Before	1.56	1.09	4.84	3.37
	After	2.91	2.04	9.04	6.50
9	Before	3.19	1.74	9.27	5.07
	After	4.92	2.69	14.48	7.81

1 - plasma; 2 - plasma (sCa=3.12); 3 - plasma (sCa=3.11) aerated; 4 - plasma + soya protein isolate (sCa=3.13); 5 - plasma + cotton protein isolate (sCa=3.12); 6 - plasma + sodium caseinate (sCa=3.11); 7 - plasma + skimmed milk diafiltration concentrate (sCa=3.13); 8 - plasma + bone protein isolate (sCa=3.12); 9 - plasma + Polyporus (sCa=3.10)

Table 2

Structural and mechanical characteristics of finely minced thermoprocessed meat

Type of meat raw materials	sCa	Structural and mechanical characteristics			
		Shear stress x 10^{-4}, Pa	Shear cut x 10^{-2}, j/m^2	Specific shear stress x 10^{-5}, Pa/kg	Specific shear cut x 10^{-3} j/m^2*kg
Minced pork, fat	I	2.92	1.37	12.63	5.65
	II	2.84	1.36	12.35	5.58
Average value		2.88	1.37	12.49	5.62
Minced pork, semi-fat	I	3.95	2.07	14.76	8.23
	II	4.03	2.15	14.75	8.35
Average value		3.99	2.10	14.76	8.29
Minced beef	I	4.17	2.74	15.27	10.47
	II	4.23	2.84	15.49	10.24
Average value		4.20	2.79	15.38	10.35
Minced beef + minc ed pork, semi-fat	I	4.05	2.65	14.96	8.67
	II	3.94	2.60	14.80	8.55
Average value		4.00	2.62	14.88	8.61

I - sCa=3.10 - 3.15; II - sCa=3.05 - 3.10

Table 1 Means, standard deviation and the ranges for variables from the fresh and cooked fillet steaks

Variables	Mean	Standard Deviation	Range	
			Minimum	Maximum
Fresh				
Fresh weight (g)	126.06	3.16	120	130
Thickness (mm)	38.76	5.75	30	50
Diameter (mm)	58.88	5.13	48	73
pH	5.76	0.22	5.44	6.37
Marbling %	1.34	0.88	0	3.8
Thaw loss %	7.11	5.20	-2.36	26.26
Cooked				
Doneness (1-6)	3.02	1.21	1	5
Cooked Temperature (°C)	63.41	6.67	49	78
Taste Panel Scores				
Tenderness (1-6)	3.27	0.89	1.75	6.0
Taste (1-6)	3.31	0.87	1.0	5.75
Juiciness (1-6)	3.57	0.80	2.0	5.0
Cooking Loss%	21.91	3.81	14.16	32.23
Colour dimensions				
L*	46.69	3.53	39.93	56.08
a*	20.33	4.30	9.38	29.82
b*	10.37	1.18	7.41	12.89

Table 2 Regression coefficients (±SE) and coefficients of determination (R^2) for the effects of pH, fresh steak weight, thickness, and cooked temperature on degree of doneness and eating quality.

Independent Variables	Dependent Variables			
		Eating quality		
	Doneness	Tenderness	Juiciness	Flavour
Constant	-0.97 (3.99)	0.85 (2.77)	2.20 (2.51)	6.40 (2.82)
pH	-1.77 (0.38)	0.75 (0.47)	0.52 (0.43)	-0.37 (0.48)
Fresh wt	0.06 (0.02)	-	-	-
Thickness	-0.05 (0.01)	-	-	-
Cooked Temperature	0.13 (0.01)	-0.03 (0.01)	-0.03 (0.01)	-0.01 (0.01)
R^2	0.70	0.12	0.10	0.04

Table 3 Regression coefficients (±SE) and coefficients of determination (R^2) for the effects of pH, and cooked internal temperature on thaw loss %, cooked loss % and colour dimensions (L*a*b*).

Independent Variables	Dependent Variables				
	Thaw loss %	Cooking loss %	Colour dimensions		
			L*	a*	b*
Constant	53.76 (12.69)	34.03 (7.77)	66.66 (9.85)	19.62 (12.26)	10.68 (4.01)
pH	-8.21 (2.20)	-6.60 (1.28)	-6.05 (1.62)	3.81 (2.02)	-0.16 (0.66)
Cooked temperature	-	0.41 (0.04)	0.23 (0.05)	-0.33 (0.07)	-0.01 (0.01)
R^2	0.18	0.64	0.33	0.30	0.04

Table 1. Change of pH value during storage of acidulated, and fermented poultry viscera combined with different amounts of carbohydrates.

days	Acidulated	Fermented							
		3%S	3%CM	5%S	5%CM	7%S	7%CM	10%S	10%CM
0	2.55	6.05	6.05	6.05	6.05	6.05	6.05	6.05	6.05
1	3.00	4.07	5.30	3.96	4.75	3.96	4.54	3.91	4.15
4	3.28	4.20	5.65	3.98	5.10	3.98	4.80	3.98	4.21
7	3.55	4.30	5.65	3.98	5.35	4.00	4.95	4.00	4.45
14	4.20	4.51	5.65	4.15	5.60	4.05	5.00	4.05	4.40
18	5.80	---	---	---	---	---	---	---	---
21	---	4.55	6.00	4.15	5.50	4.10	5.30	4.10	4.50
28	---	4.70	6.25	4.25	5.70	4.15	5.50	4.05	4.60

S: Sucrose, CM: Corn meal
The samples were stored at room temperature (22-25°C) for 28 days

Table 2. Energy of poultry viscera products

Kinds	crude protein(%)	crude fat%	energy MEn Kcal/kg
Fresh PV(dry)	28.47	65.27	6031.29
(wet)	8.27	18.36	1698.41
Rendered PV(dry)	48.46	36.31	4367.00
(powder)	47.20	35.37	4253.46
Acidulated PV(dry)	27.22	57.69	5394.03
(wet)	7.98	17.40	1626.84
Fermented PV(dry)	23.26	53.82	4966.31
(wet)	7.56	17.49	1614.05

MEn Kcal/kg= (31.02 x crude protein) + (78.87 x crude fat)
PV: Poultry viscera

Table 3. The chemical contents of poultry viscera products

Contents Kinds	Crude protein%	Crude fat%	Moisture%	Ash%
Fresh PV	8.27±0.65	18.36±0.34	71.87±1.04	0.99±0.07
Rendered PV	47.20±1.05	35.37±0.67	2.59±0.22	4.90±0.18
Acidulated PV	7.98±0.54	17.40±0.31	69.85±0.80	1.52±0.07
Fermented PV	7.56±0.61	17.49±0.31	67.46±0.89	1.10±0.06

PV: poultry viscera
Mean ± SD

Table 4 Analysis of amino acid contents of poultry viscera products

Contents	Rendered	Acidulated	Fermented
Asp	9.42	8.36	7.84
Glu	14.33	13.07	12.84
Ser	4.55	2.60	2.92
Gly	6.26	5.44	5.68
His	2.49	1.93	1.62
Arg	11.35	10.91	9.43
Thr	4.55	0.63	1.71
Ala	4.75	2.21	2.55
Pro	5.06	8.02	9.43
Tyr	3.48	2.27	2.31
Val	5.49	4.69	4.99
Met	2.54	1.92	1.99
Ile	4.81	4.09	4.07
Leu	8.69	5.93	6.33
Phe	4.60	3.73	3.64
Lys	7.12	6.86	6.83

Expressed as a percentage of dry matter

Table 5 Minerals analysis of poultry viscera products

Contents	Rendered	Fermented	Acidulated
%			
P	0.93	0.66	1.28
K	0.99	0.72	0.38
Ca	0.23	0.18	0.02
Mg	0.16	0.12	0.03
Na	0.34	0.26	0.13
ug/g			
Fe	158.80	108.00	87.20
Cu	14.72	56.20	3.45
Zn	98.76	48.70	36.90
Mn	13.28	24.00	2.09

%= Expressed as a percentage of dry matter
ug/g= Expressed as a microgram/gram of dry matter

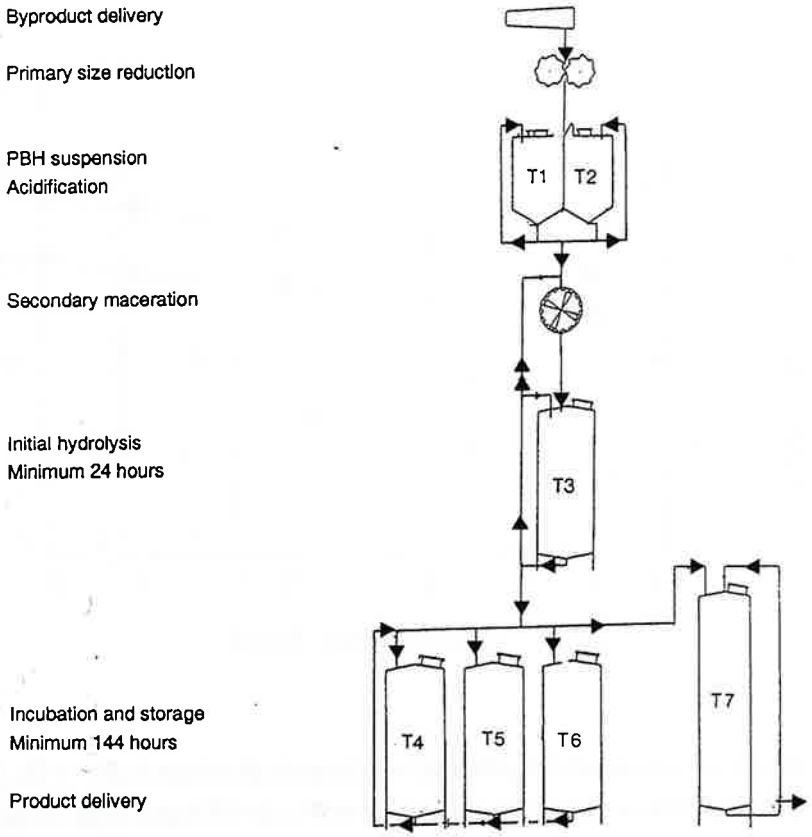


Figure 1. Diagrammatic representation of poultry byproduct hydrolysate plant (▶ indicates direction of flow).

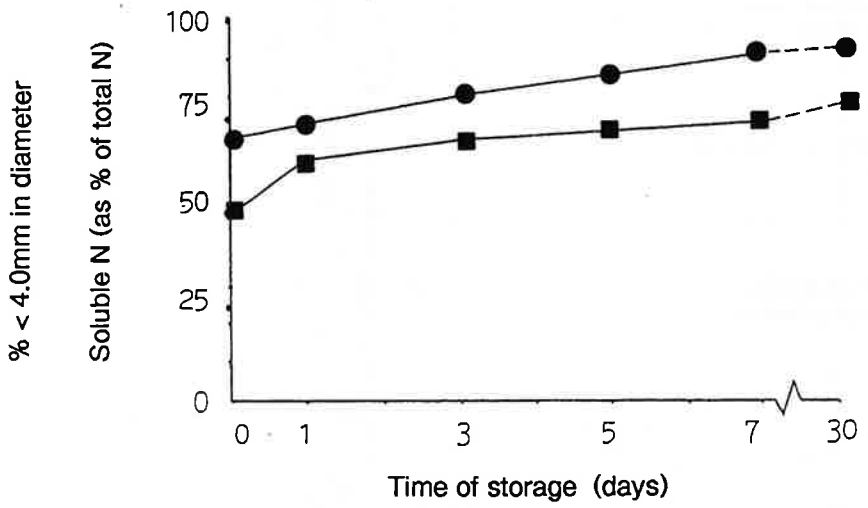


Figure 2. Increase in % material < 4.0 mm in diameter (●——●) and increase in % soluble nitrogen (■——■) in PBH over time (days).

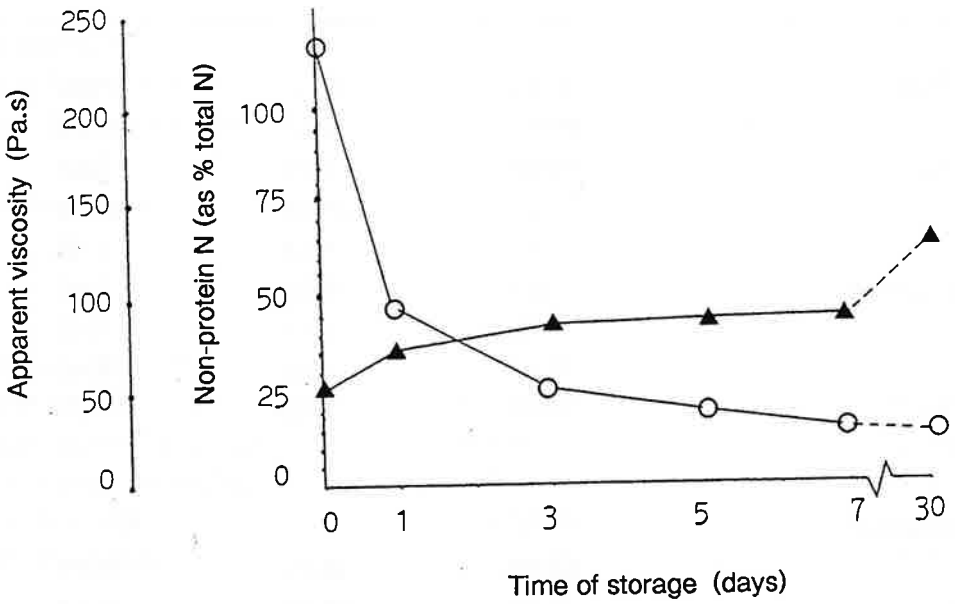


Figure 3. Decrease in apparent viscosity - Pa.s (O——O) and increase in % soluble non-protein nitrogen (▲——▲) in PBH over time (days).

Table 1. Composition of grower diets for pigs fed PBH (as % of dry matter).

	Pig Grower	PBH - 1 month	PBH - 18 month
Ingredients			
PBH (dry matter)	0.00	28.57	25.26
Maize	65.94	31.70	33.25
Soyabean meal (44% CP)	20.60	3.69	3.87
Wheat feed	10.07	32.51	34.02
Limestone	0.92	1.43	1.49
Dicalcium phosphate	1.60	0.53	0.55
Salt (NaCl)	0.46	0.15	0.15
Lysine	0.16	0.15	0.15
Premix (Vit/min)[1]	0.26	1.20	1.25
Calculated analysis			
Crude protein	16.29	18.40	18.71
Ether extract	3.10	14.10	13.04
Crude fibre	4.00	3.87	4.05
Digestible energy (MJ/kg)	14.40	16.49	16.41
Lysine	0.96	0.92	0.93
Methionine + cystine	0.55	0.67	0.67
Calcium	1.00	1.16	1.21
Phosphorus	0.62	0.67	0.70
Salt (NaCl)	0.46	0.29	0.30
Dry matter	89.00	89.00	89.00

Note 1. Vitamin and mineral premix: Vitamin A 102270 IU; Vitamin D3 22730 IU; Vitamin E 260IU; Vitamin K 50 mg; Riboflavin 115 mg; Choline 4550 mg; Pantothenic acid 275 mg; Niacin 795 mg; Vitamin B12 545 mg; Iron 1600 mg; Copper 225 mg; Cobalt 415 mg; Manganese 10 mg; Zinc 1590 mg; Iodine 60 mg; Selenium 2.25 mg; Antioxidant 795 mg.

Table 2. Physical and chemical characteristics of PBH products used in feeding trial.

	PBH-1 month[1]	PBH- 18 month
1. Particle size[2]		
i. % > 4.0 mm in diameter	7.2 (0.22)	1.9 (0.26)
ii. % < 1.4 mm in diameter	76.2 (0.33)	93.3 (0.05)
2. Viscosity (Pa.s)	26.8 (6.78)	6.8 (0.14)
3. pH	3.78	4.31[3]
4. Composition		
a. Dry matter (%)	34.8 (1.42)	29.4 (0.14)
b. Crude protein (% of DM)	35.5 (1.92)	39.7 (2.05)
c. Ether extract (% of DM)	46.0 (2.15)	47.0 (0.71)
d. Ash (% of DM)	4.8 (0.33)	5.8 (0.16)
e. NFE (% of DM)	13.8 (1.71)	7.5 (0.93)
5. Nitrogen solubility		
a. Soluble N (as % of total N)	82.4 (0.71)	93.9 (0.78)
b. Non-protein N (as % of total N)	68.7 (2.83)	90.2 (4.14)

Notes 1. Age relates to age at commencement of trial.
2. Mean (SD); determined where n=4 unit batches (500 kg offal + 100 kg PBH).
3. pH before correction to pH 3.9 (addition of 0.5% m/m formic acid) prior to commencement of feeding trial.

Table 3. Summary of growth performance and carcase data of pig groups.

	Pig Grower	PBH - 1 month	PBH - 18 month
1. Initial liveweight[1] (kg)	34.0 (11.04)	34.0 (6.91)	34.4 (7.04)
2. Final liveweight (kg)	73.8 (15.45)	76.8 (11.11)	79.3 (15.08)
3. Days on trial	74	69	82
4. Average daily gain (kg/day)			
a. Male	0.54	0.61	0.52
b. Female	0.53	0.63	0.57
5. Average group FCE[2]			
a. As fed	3.32	4.40	4.92
b. Dry matter basis	2.89	2.73	2.92
6. Carcase data			
a. Carcase wt (kg)	59.7 (12.10)	62.4 (9.33)	61.1 (12.59)
b. Kill out %	80.4^{a} (2.43)	80.9^{a} (0.84)	76.9^{b} (2.48)
c. Red offal (liver, lungs) kg	1.94^{a} (0.58)	1.84^{a} (0.46)	2.44^{b} (0.39)
d. Processor value[3]	96.5 (8.75)	97.8 (7.51)	97.3 (7.18)
e. Loin area[4] (cm^2)	37.5 (4.56)	36.4 (6.45)	37.5 (7.19)
f. P1 + P3 depth (mm)	30.4 (10.93)	35.4 (8.38)	35.4 (8.38)
g. Fat depth ratio[5]	3.58 (1.17)	3.09 (0.98)	2.86 (0.47)

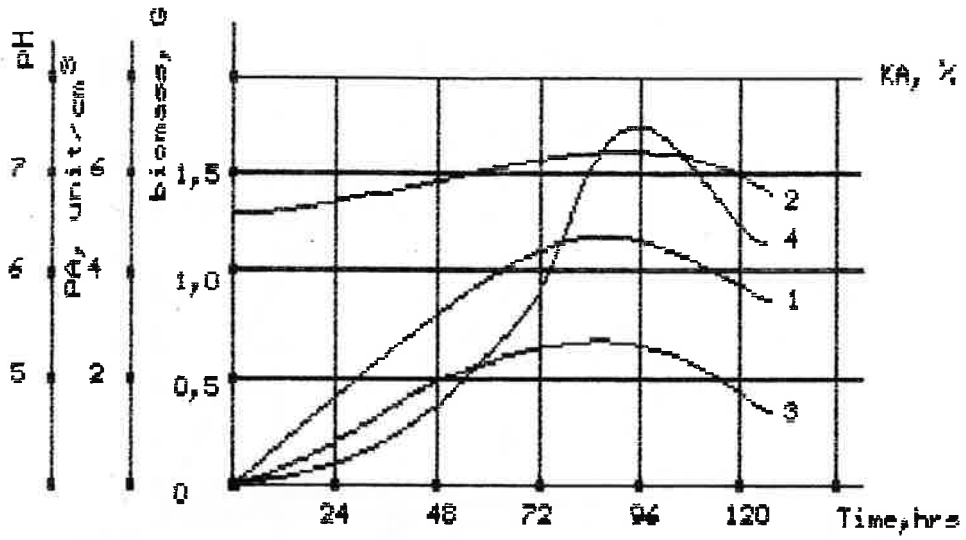
Notes. 1. Mean (SD); n=10 (5 males [castrates] + 5 females).
2. FCE: Feed conversion effiency as feed fed/wt gain.
3. Processor value adapted from Canadian system where 100% value reflects best price for 59-63 kg carcase with additive shoulder and backfat thicknesses of 69 mm.
4. Loin area and P1, P3 were determined at 10th rib.
5. Loin muscle to fat depth ratio at maximum loin depth 10th rib.
6. Values with no or same letter superscript do not differ at p=0.05 level;(n=12), paired t test.

Table 1
Physico-chemical features of proteolitic ferments

Denomination of fractions	Molecular mass	Optimum of influence on substrata		Stability aeria	
		acid (pH)	thermal (°C)	acid	thermal
protheinaza I	34500	7.0-7.2	55-60	6-9	20-60
protheinaza II	20800	10.0-10.5	40-42	8-11	20-40

Table 2
Characteristics of proteolitic features of P.Wortmanii BKM 2091 ferments preparation

Source of ferments	Proteolitic activity of preparations		
	General with standard substratum unit/hour	collagenous unit of opt.sq./h	keratinous unit/hour
P.Wortmanii BKM 2091	230	0.60	1200
B.Subtilic (neutral)	100	0.16	180



1 - PA
2 - pH
3 - biomass
4 - KA (% of maximum value)

Figure 1

Mechanisms of growth and biosynthesis of proteases P.Wortmanii.

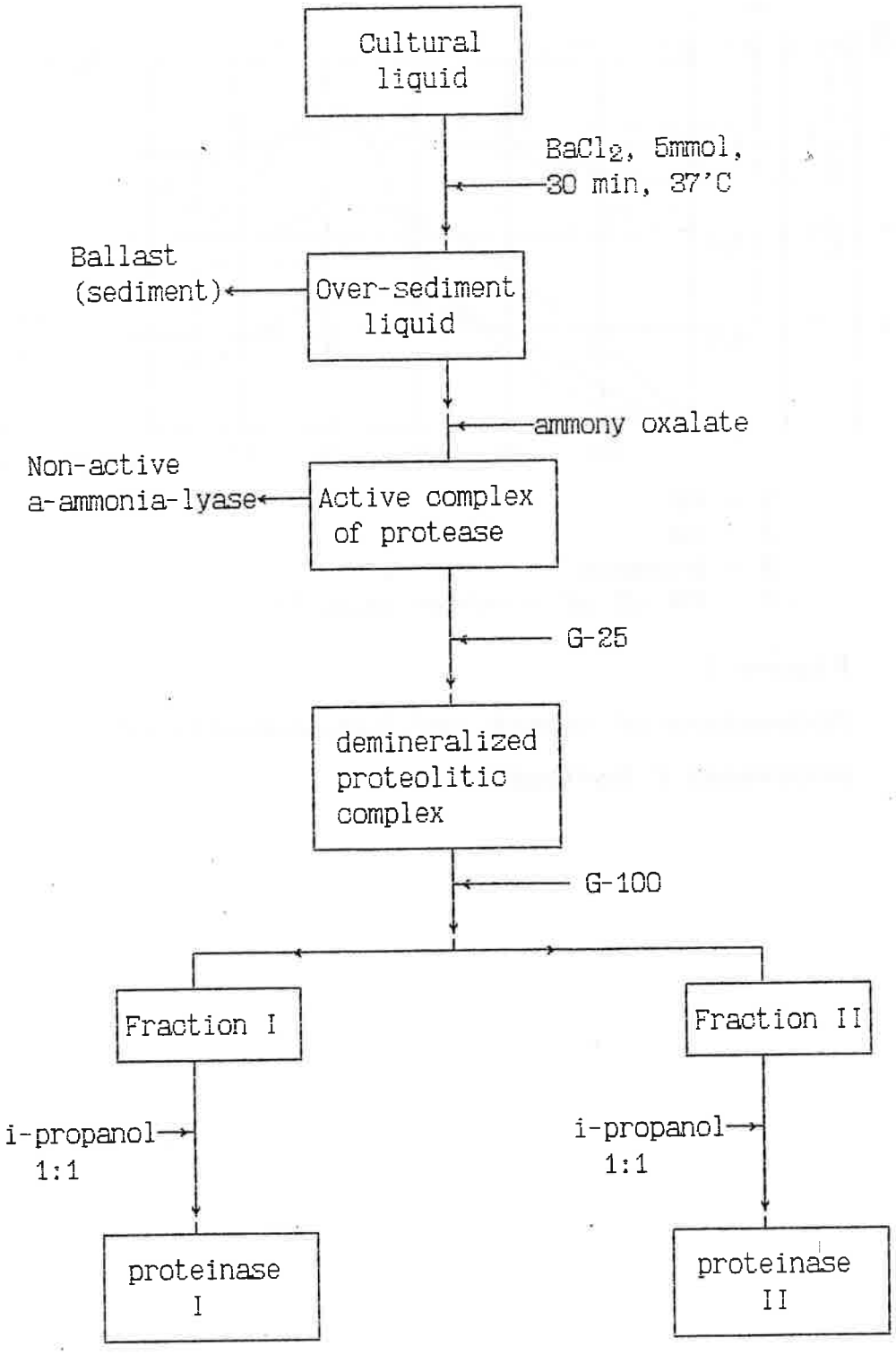
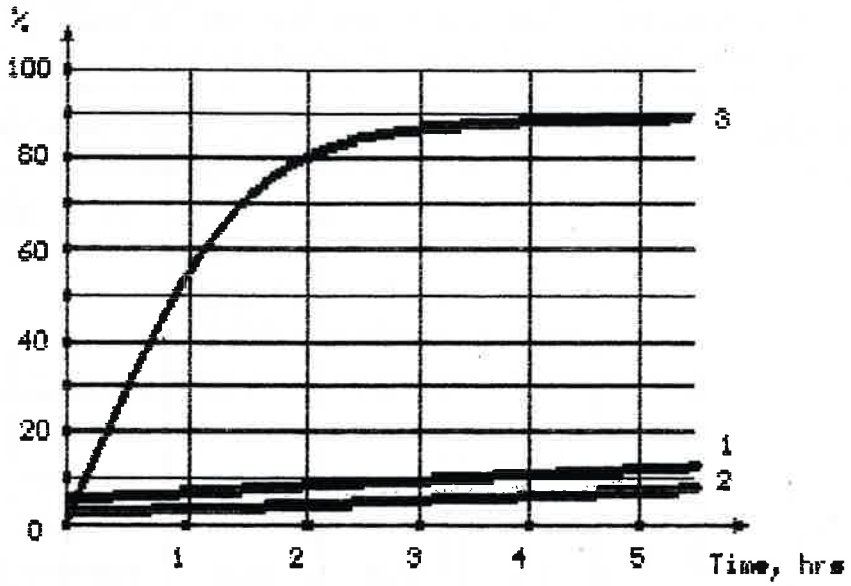


Figure 2.

Basic diagram of obtaining neutral Penicillium wortmanii BKM 2091 protheasis preparations with different purity degrees.



1 - water soluble albumens
2 - peptids
3 - amino acids

Figure 3

Accumulation of keratin hydrolysis by preparation (% per 100ml of hydrolysate)

Table 1. Total chemical composition and content of main protein fractions in some by-products of meat production

Samples name	Mass content of components, % to raw materials mass						
	protein				fat	ash	moisture
	total	water soluble	salt soluble	alkaline soluble			
Group 1: Blend of hide raw materials by-products (cattle)	22.3	1.9	6.8	11.2	1.4	1.3	77.0
Swine hide	29.6	1.0	2.9	25.7	17.8	1.2	50.6
Tendons (cattle)	37.8	2.5	2.4	32.9	6.0	1.7	54.5
Blend of veins and tendons	33.0	5.6	7.4	20.0	26.4	1.1	39.5
By-products of guts raw material (cattle):							
great guts	19.2	2.2	3.7	13.3	4.5	1.0	75.2
little guts	16.2	4.8	4.4	7.0	1.2	1.2	80.8
bladder	17.0	3.8	2.5	10.7	1.5	1.2	80.4
Cattlehide split (control)	23.4	0.1	0.2	23.1	1.1	0.9	74.6
Group 2: By-products (cattle):							
tripe	14.8	0.9	7.1	6.8	4.2	0.5	80.0
lung	12.1	5.8	1.8	4.5			
spleen	10.1	6.2	1.4	2.5			
Group 3: Poultry heads (homogenate)	15.7	4.2	3.4	8.1	5.7	1.2	77.4
Poultry legs (homogenate)	25.0	8.1	5.4	11.5	7.0	1.3	84.5
Beef tankage (homogenate)	7.3	2.5	0.3	4.5	2.2	1.0	89.5

Table 2. Physico-chemical characterics of enzyme complexes of preparations

Name	Source	Activity			Action optimum		Stability region	
		total proteolutic at pH 7.0, units/g	collagenaze units of optical density/g	lipolitic, units/g	acid, pH units	thermal, oC	acid, pH units	thermal, oC
Protofulvoviridine	Streptomyces fulvoviridis RDM Ac-161	230.0	0.28	--	7.2	60	5.5-7.0	30-50
Protochromogenine	Streptomyces chromogenes graecus 0832	253.3	0.38	--	7.2	58-60	5.8-7.2	30-50
Protovortmenine	Penicillium wortmannii RDM F-2091 (neutral)	216.0	0.58	--				
proteinaze I					7.0-7.2	55-60	6.0-9.0	20-60
proteinaze II					10.0-10.5	40-42	8.0-11.0	20-40
Liporisine	Rhizopus oryzae	traces	---	550000	7.0	40	5.0-9.0	20-40

Table 3. Chemical composition of collagen pastes from various sources

Sources name	Mass content of components, % to raw materials mass						
	protein				fat	ash	moisture
	total	water soluble	salt soluble	alkaline soluble			
According to suggested technology: blend of fibers and tendons,	19.90	0.00	0.00	19.90	0.4	1.10	78.60
offals of pigs small guts,	11.76	0.00	0.06	11.70	0.8	1.04	86.40
offals blend of pigs hide raw materials.	29.22	0.00	2.38	24.84	3.8	0.80	66.17
According to the traditional technology: cattlehide split	32.4	0.00	1.55	30.85	0.4	0.20	67.00

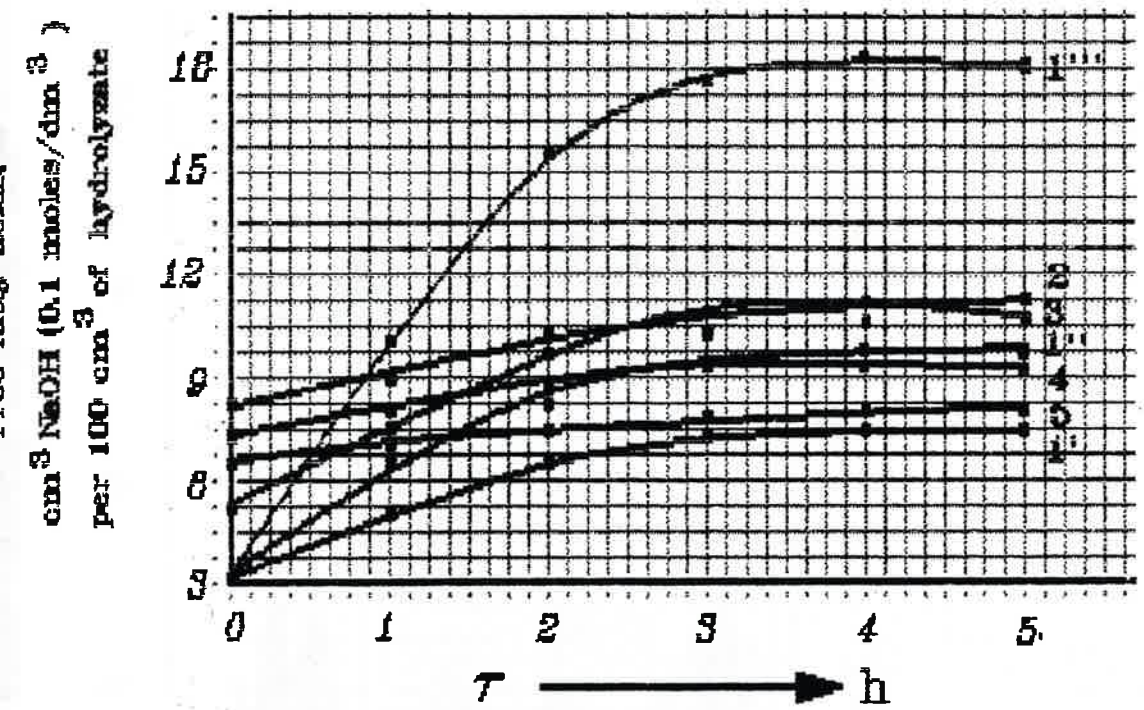


Figure 1. Accumulation dynamics of free fatty acids in hydrolyzates of collagen containing raw materials under the action of liberizidine

1 – blend of hide raw material offals ; 2 – tripe ; 3 – bladder ; 4 – little guts ; 5 – great guts .

Mass content of enzymes in solution : 1' – 0.5 % ; 1'' – 1.0 % ; 1''' – 5.0 % .

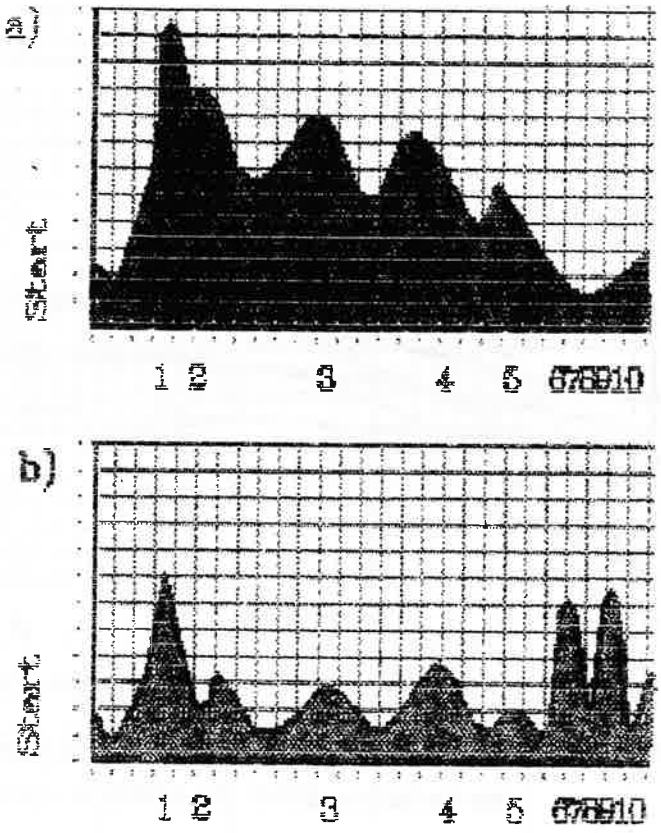


Figure 2. Densitygramme of PAAG at proteins analysis:
a) initial collagen containing raw material;
b) hydrolyzate.

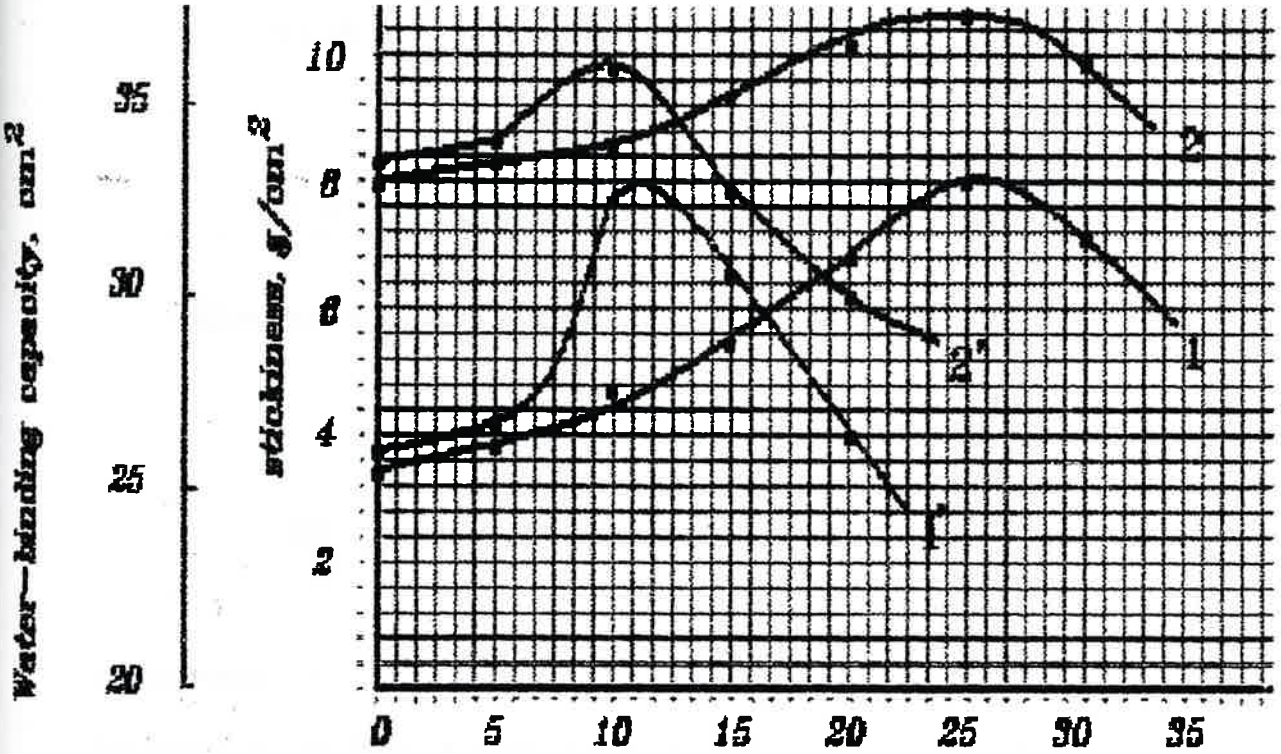


Figure 3.

Function qualities of sample force—meats at the substitution of the principal raw material by food additives: (1, 2) – on the base of tankage; (1', 2') – on the base of poultry heads and legs; 1 – stickiness; 2 – water –binding capacity

$$E = \frac{C}{M}\int_{t0}^{tf} T.V.dt \quad (1)$$

$$E = \frac{C.Vm}{M}\int_{t0}^{tf} T.dt \quad (2)$$

The term $\int_{t0}^{tf} T.dt$ is estimated graphically from the torque profile.

$$dE = -K.\frac{dD}{D^a} \quad (3)$$

where K and a are constants.

$$E = K_r\left(\frac{1}{D_2} - \frac{1}{D_1}\right) \quad (4)$$

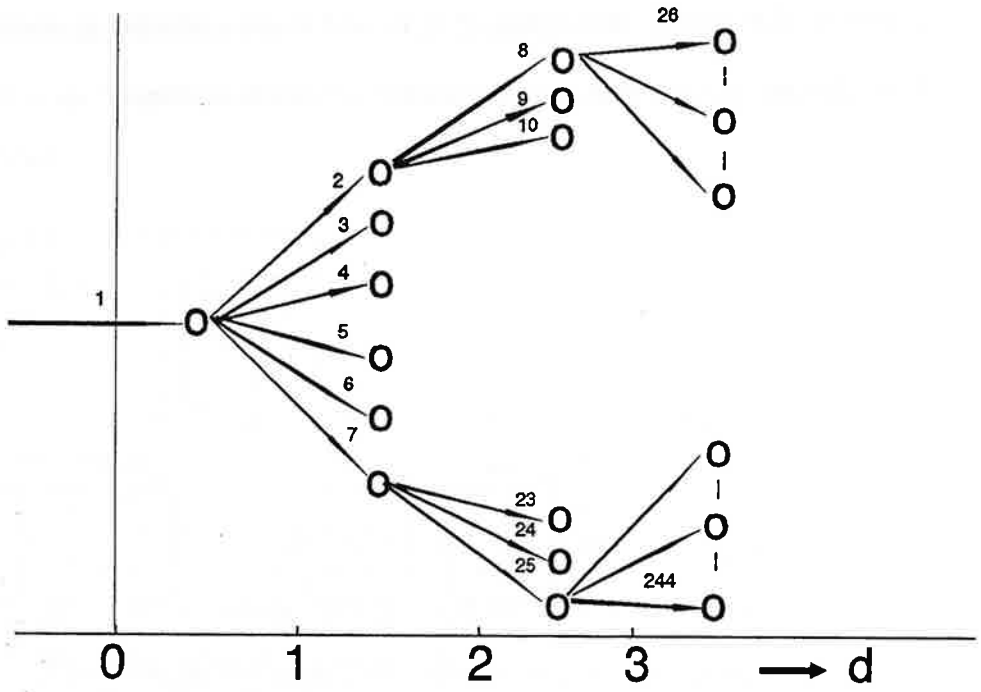
$$E = K_k.\log\left(\frac{D_1}{D_2}\right) \quad (5)$$

$$\frac{E}{W_i} = \sqrt{\frac{100}{D_2}} - \sqrt{\frac{100}{D_1}} \quad (6)$$

$$E = A_1.\log\left(1+\frac{D_1}{D_2}\right) + B_1 \quad (7)$$

$$E = A_2.\log\left(1+\frac{D_1}{D_2}\right) + B_2.K_w + C \quad (8)$$

FIGURE 1 Decision tree.



2.2 Modeloptions

The mixed integer linear programming model (see figure 1) is based on a decision tree containing three decision moments (indicated by d=1,2,3):

d=1: way of sorting the by-products (raw materials) after slaughtering

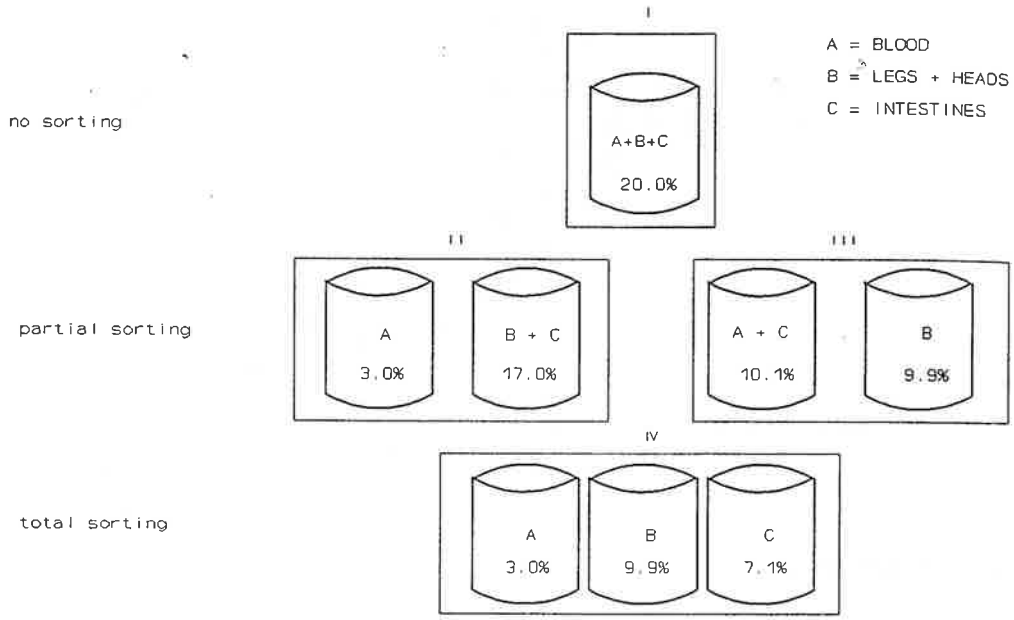
d=2: way of storage

d=3: way of processing (both central and decentral processing)

d=1: *Sorting raw materials*

At decision moment 1 can be chosen in which way three kinds of poultry and pork slaughter by-products A, B and C will be sorted. Possibilities are given in figure 2. So it is suggested to sort the slaughter by-products in four ways so-called sorting groups. These sorting groups result in six different raw-material combinations. Because of incomparability the combination A+B is not considered.

FIGURE 2. The four sorting groups (I to IV) in the model for poultry slaughter by-products. Different combinations of A, B, and C are collected in containers. Also the mass percentage in relation to live weight has been displayed.



d=2: *Storage*

After the release of slaughter by-products some way of buffering is necessary. The following options are considered:

(i) Unconditioned storage: this storage is interesting for the sorting groups with a relatively low spoilage rate and a short time lag between release and processing.

(ii) Cooled storage: this storage is interesting for the sorting groups with a relative high spoilage rate and/or a long time lag between release and processing.

(iii) Frozen storage: this storage is interesting for the sorting groups with a relative high spoilage rate and/or a very long time lag between

Table

Results of determination of activity (A, thousand of conventional units) of rennet enzyme as dependent on conditions of vibration treatment (τ, f) at the first stage of extraction at different concentration (c) of the extracting solution

c, %	f, Hz	Duration of stage, s						
		60	360	960	1560	2160	2766	3360
6	10	100.62	183.16	404.00	601.70	758.60	840.50	861.00
	16	103.18	190.40	422.20	650.00	822.00	999.40	1024.00
	25	114.76	192.30	452.90	678.00	882.30	1050.20	1070.00
	38	114.52	189.40	432.80	690.00	883.10	1048.80	1068.20
8	10	96.26	160.00	352.10	499.20	652.30	760.60	779.80
	16	97.02	183.20	383.70	551.90	720.50	914.10	940.20
	25	103.00	190.80	401.60	601.80	800.00	1007.00	1030.60
	38	102.10	189.10	400.70	600.90	802.00	1003.00	1031.10
10	10	90.95	130.10	301.60	421.10	551.20	662.20	680.20
	16	92.52	157.60	343.20	500.80	640.90	820.00	851.90
	25	96.74	133.90	352.10	502.60	741.50	980.00	1002.40
	38	95.90	131.20	353.20	500.60	743.20	981.90	1003.10

Standard deviation throughout all the experiments S = 4.382

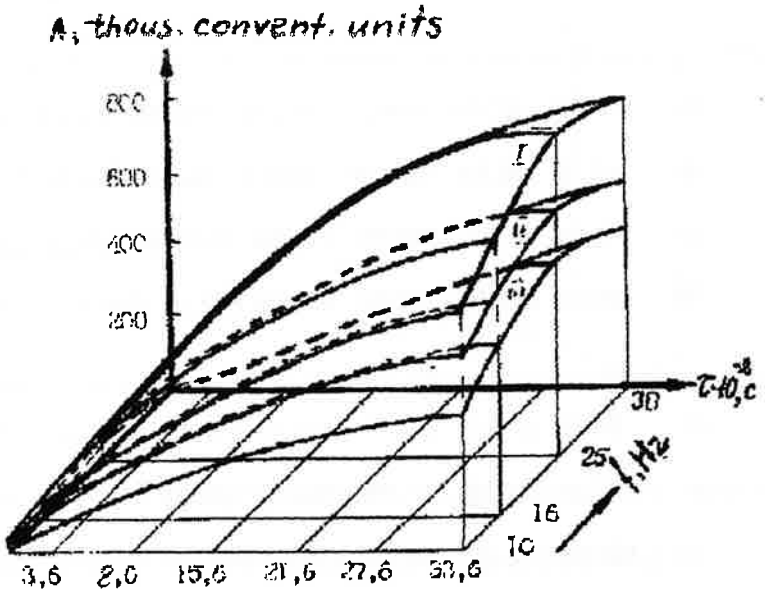


Fig. 1. Dependence of activity (A) of ready enzyme preparation on conditions of vibration extraction (τ, f)

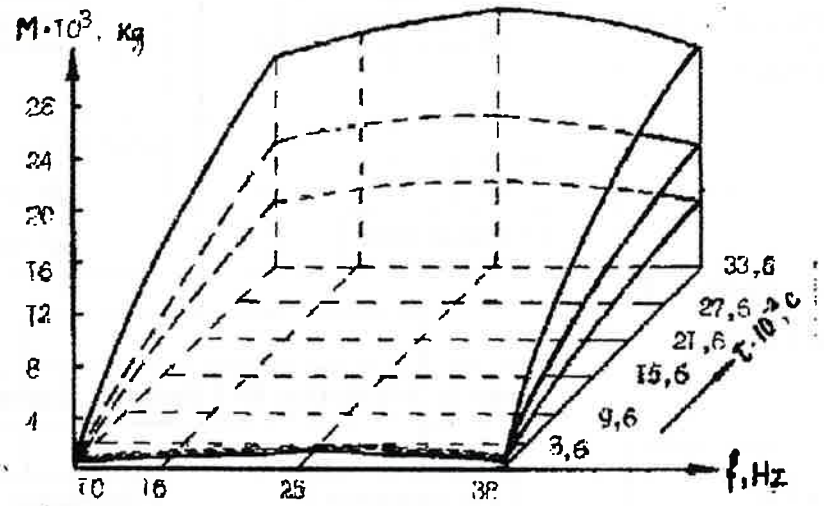
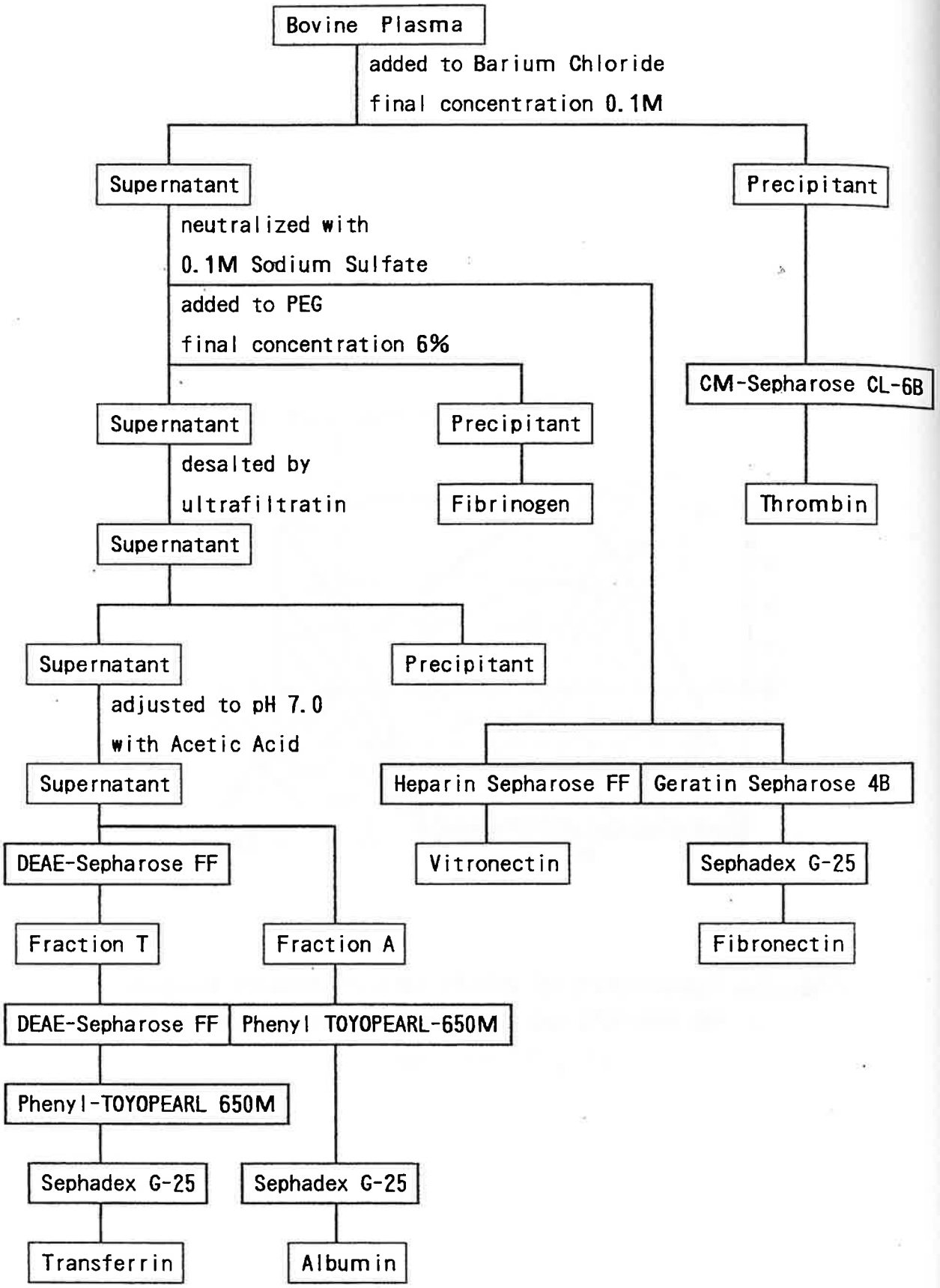


Fig. 2. Dependence of yield (M) of rennet enzyme on conditions of vibration extraction (τ, f)



Scheme 1. Separation of useful proteins from the supernatant of bovine plasma containing 0.1M barium chloride.

Table 1. The yield of bovine plasma proteins by column chromatography

Starting Material	Proteins			
	Albumin	Transferrin	Vitronectin	Fibronectin
	Yield (%)			
Native Plasma	66	50	25	48
Supernatant of plasma containing 0.1M barium chloride	60	50	23	28

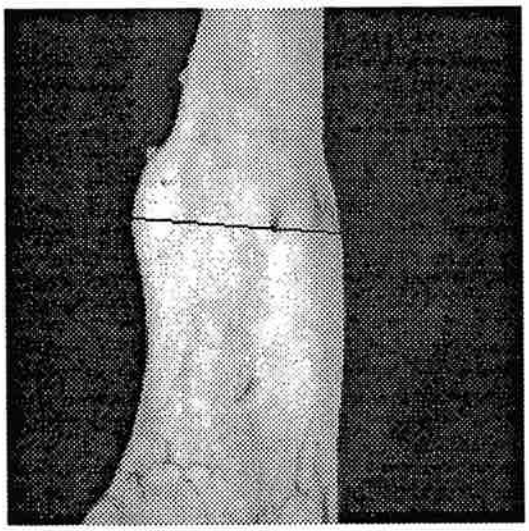


figure 1 : patterns of the trotter cut

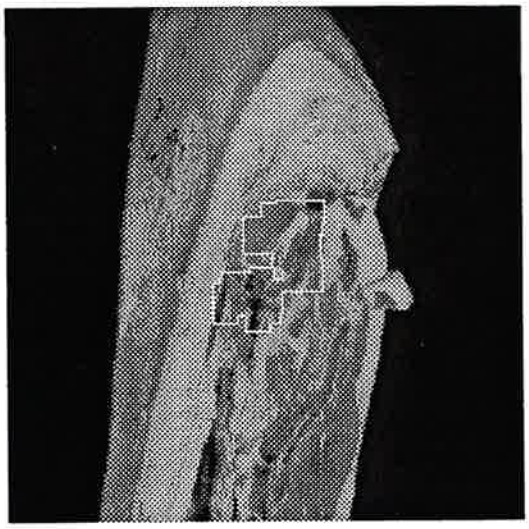


figure 2 : patterns of the leg cut

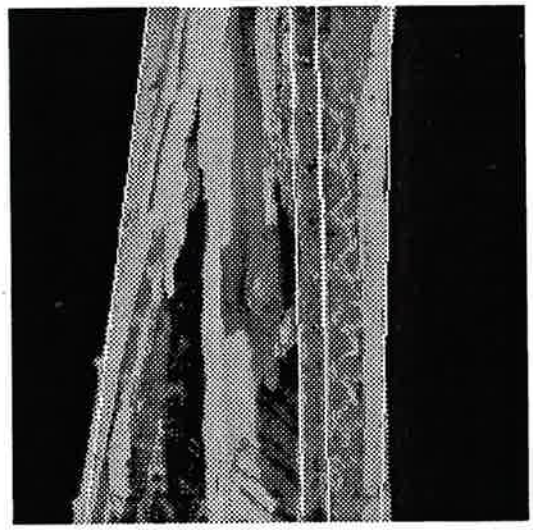


figure 3 : patterns of the backbone

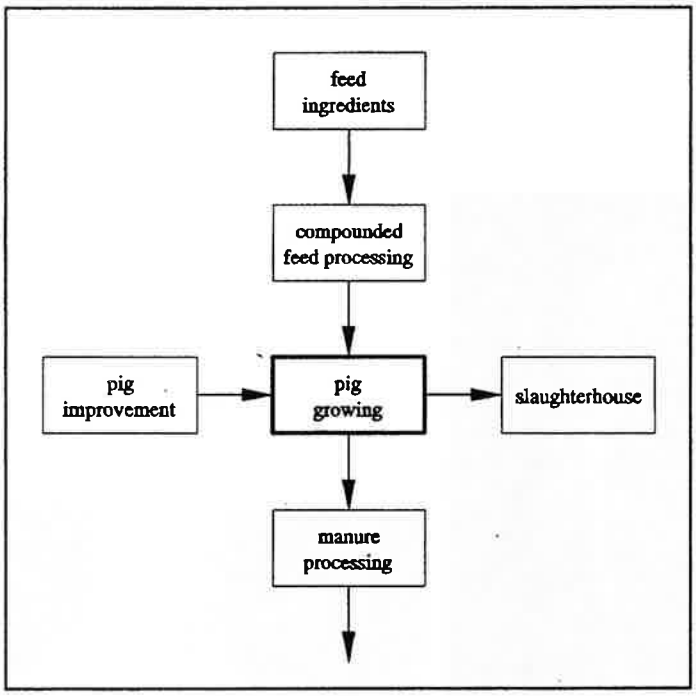


Fig. 1. Two crossing chains in pork production.

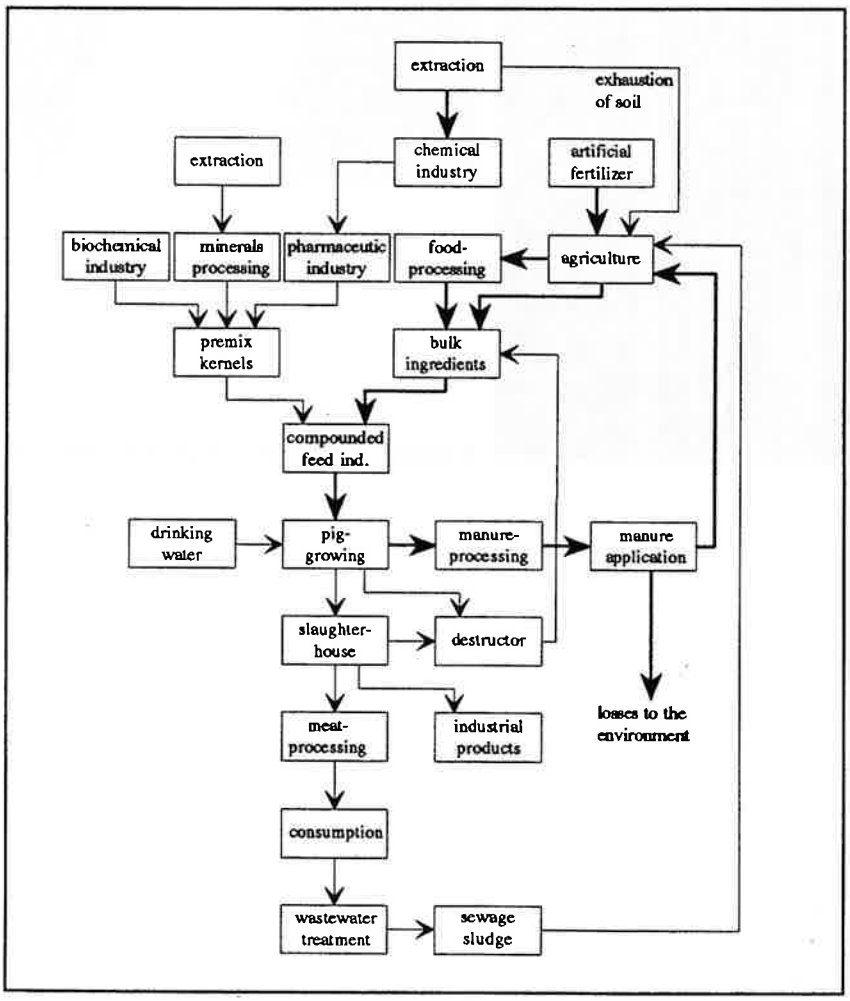


Fig. 2. Simplified pork production chain [8].

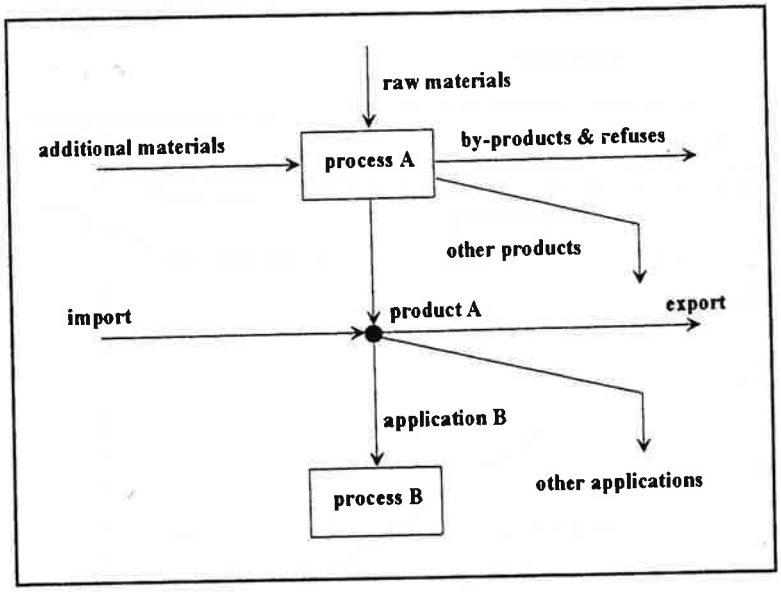


Fig. 3. Processes and products in the chain [8].

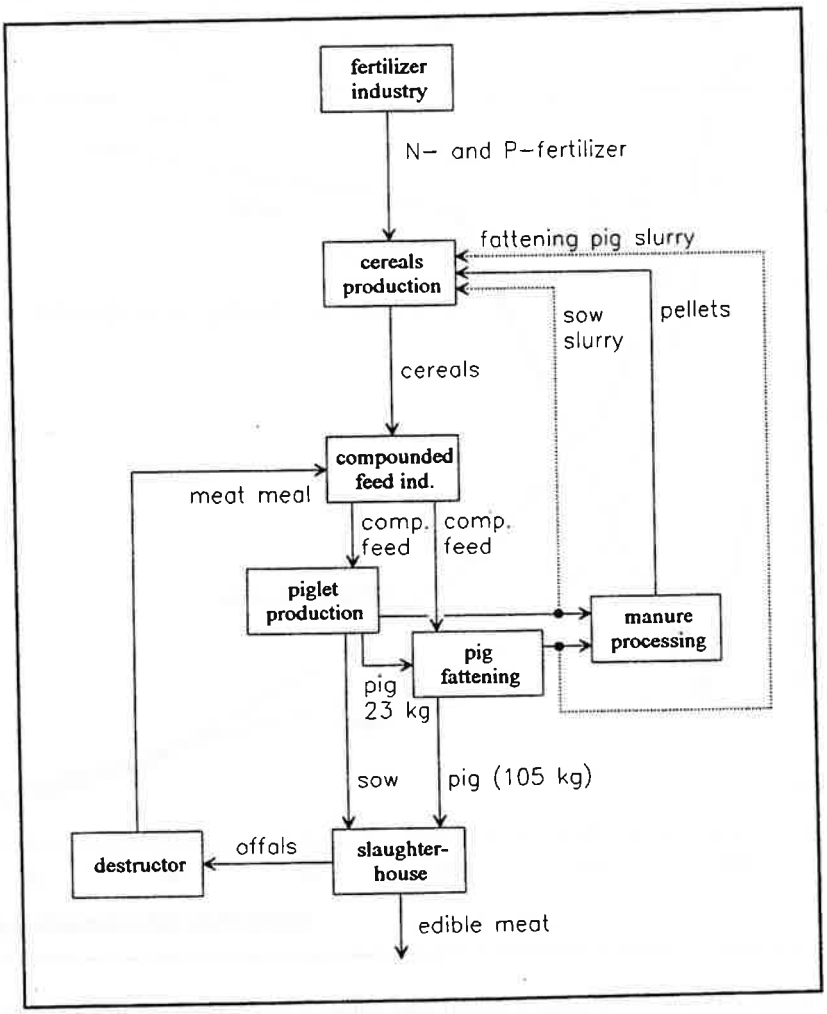


Fig. 4. Partial model of pork production.

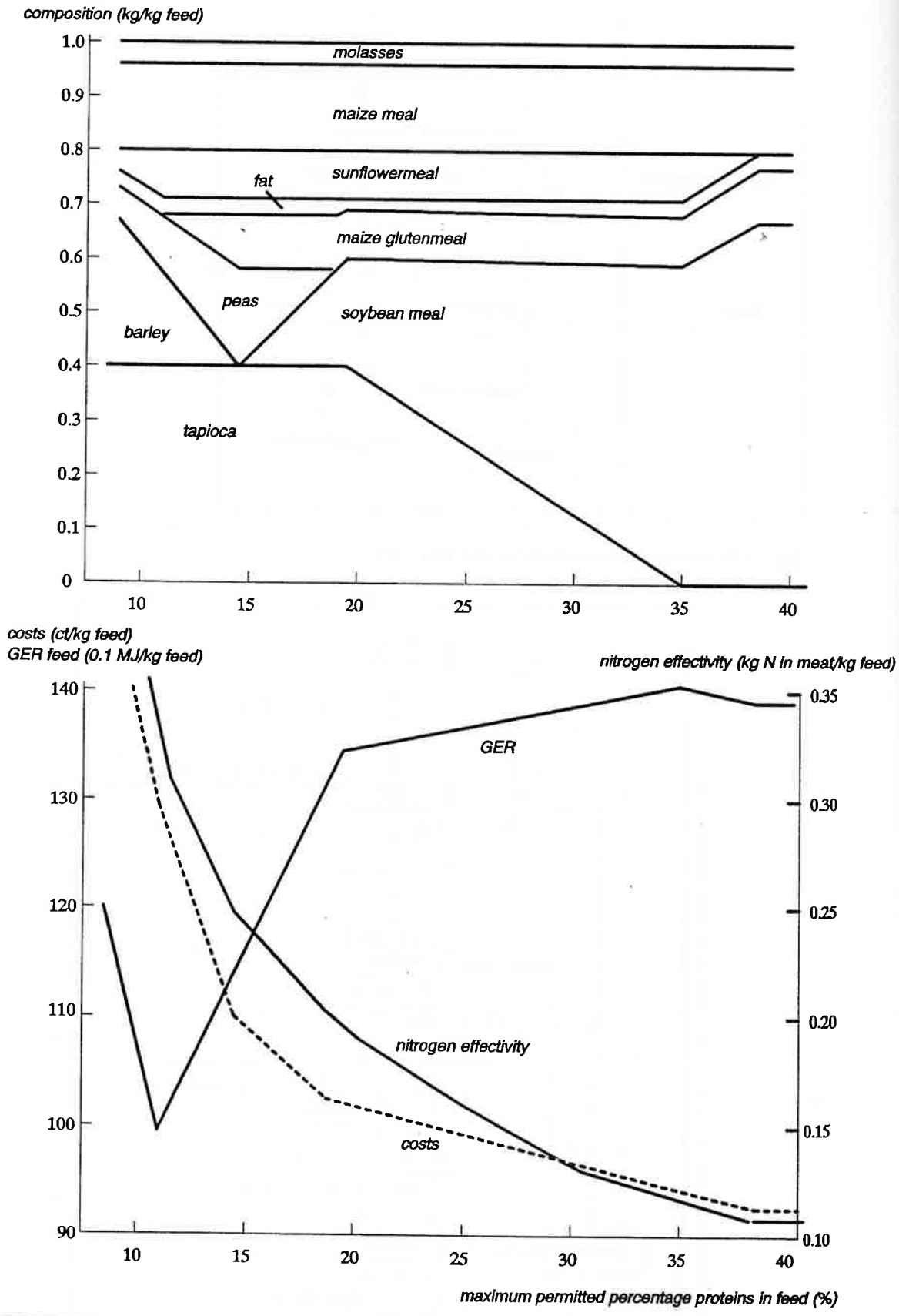


Fig. 5. Dependence of feed composition and some feed characteristics on maximum permitted protein content.

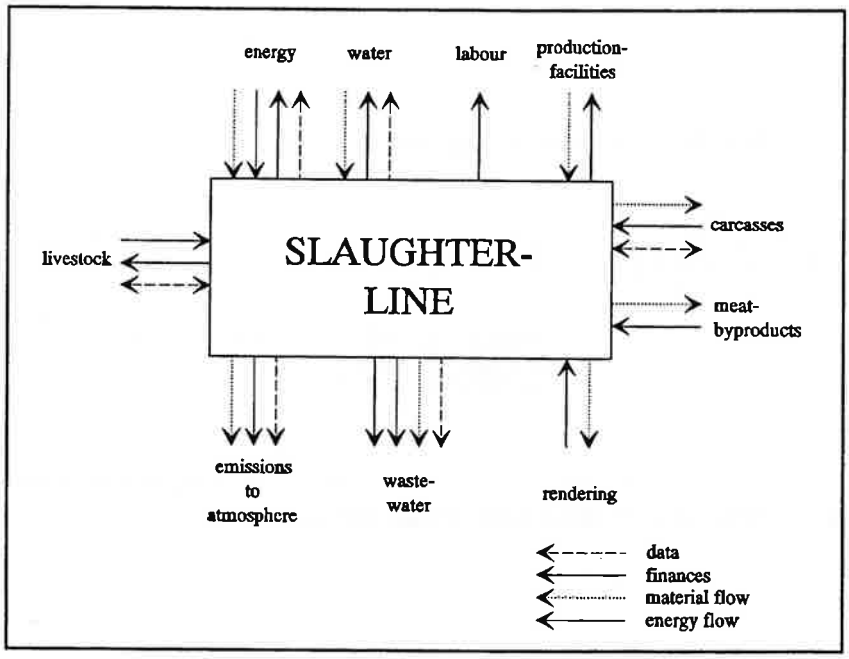


Fig. 6. Management optimisation model for pig slaughterlines.

Figures.

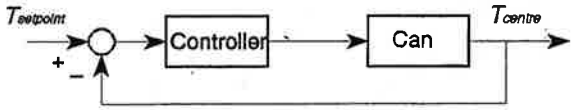


Figure 1. Feedback control of can temperature.

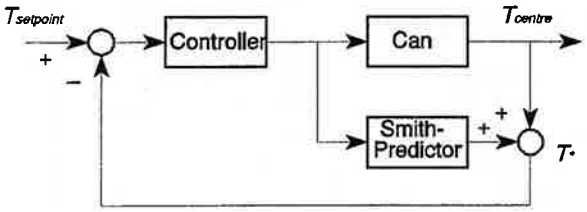


Figure 2. Feedback control with Smith-predictor.

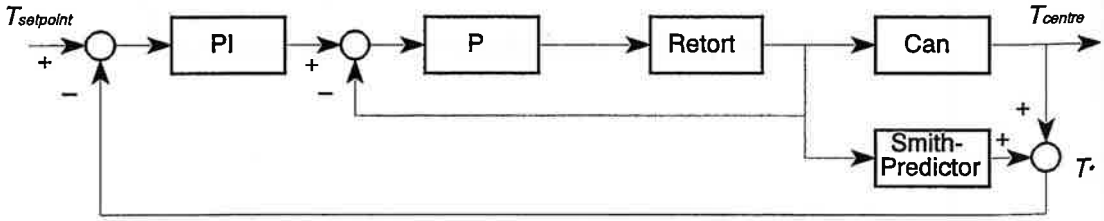


Figure 3. Cascade control with Smith-predictor.

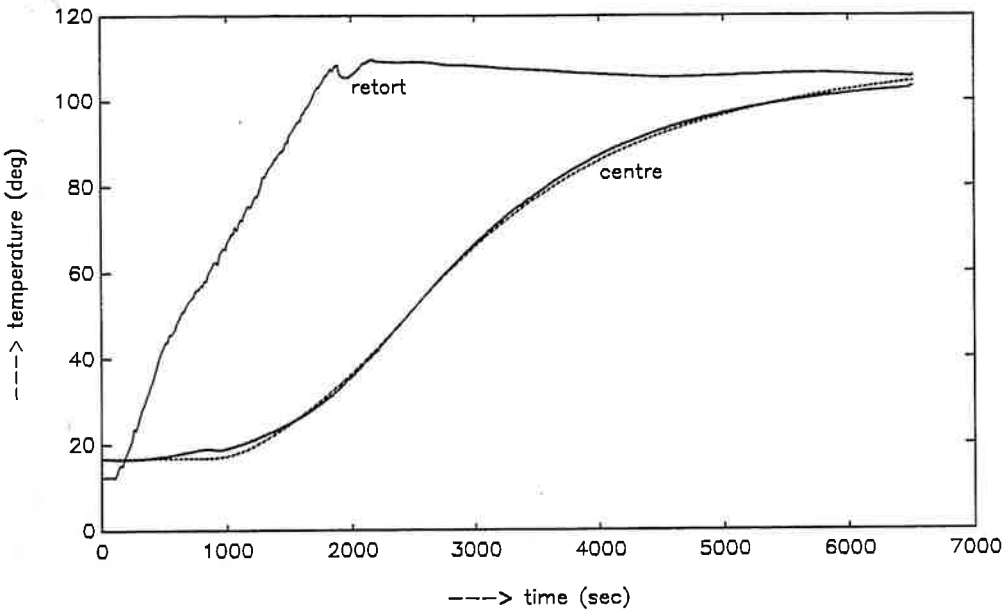


Figure 4. Measured and fitted centre temperatures. (—) measured temperature, (--) fitted temperature.

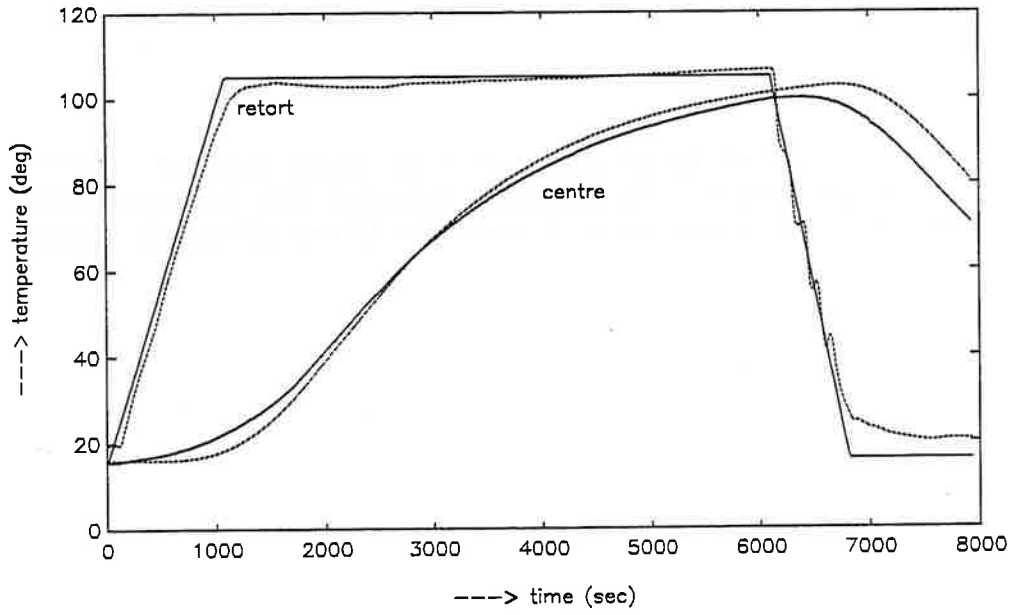


Figure 5. Measured centre temperatures (the moment to start the cooling phase being applied as an additional control variable). Retort: (—) temperature setpoint, (--) measured temperature. Centre: (—) measured temperature, (--) calculated temperature.

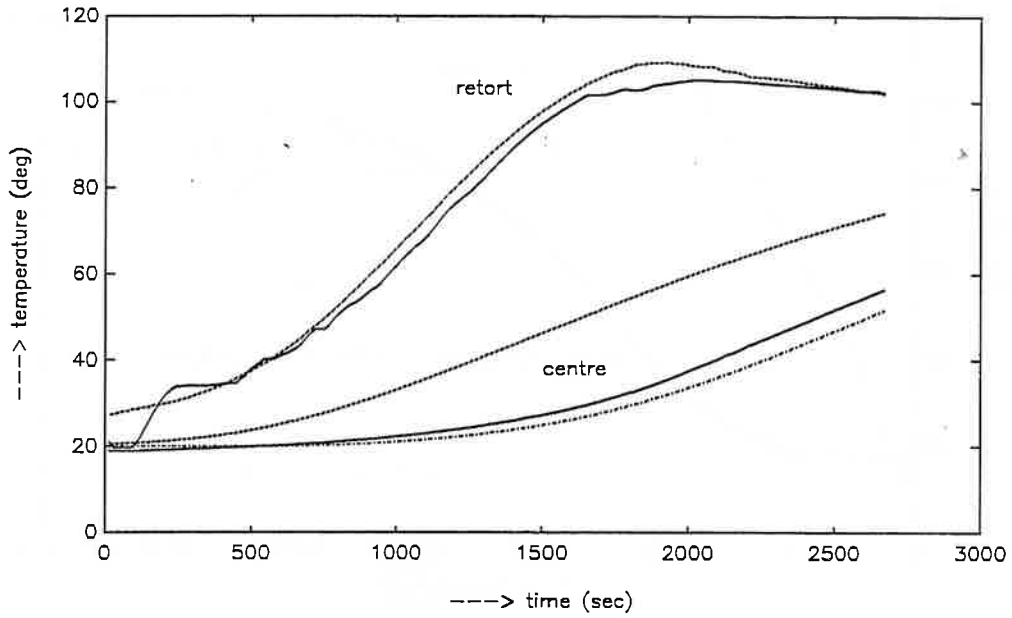


Figure 6. Measured centre temperatures (Cascade control with Smith-predictor applied). Retort: (—) measured temperature, (--) setpoint determined by the primary controller. Centre: (—) measured temperature, (--) setpoint, (-·) calculated temperature.

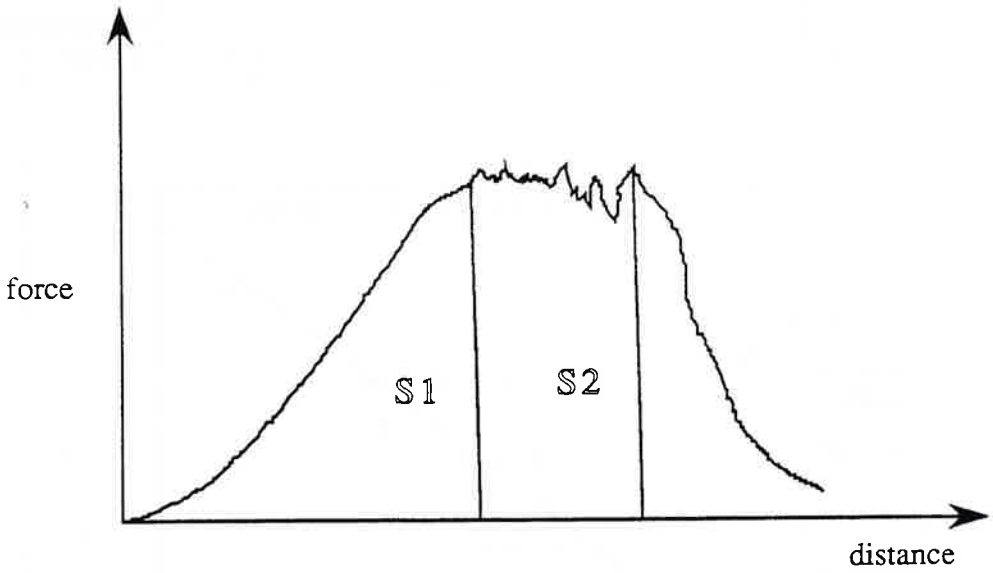


figure 1. A typical profile of a force /distance graph for Warner-Bratzler test. The texture index Kw is defined as the ratio between shear and extension energy S2, and the sum S2+S1, where S1 represents compression energy.

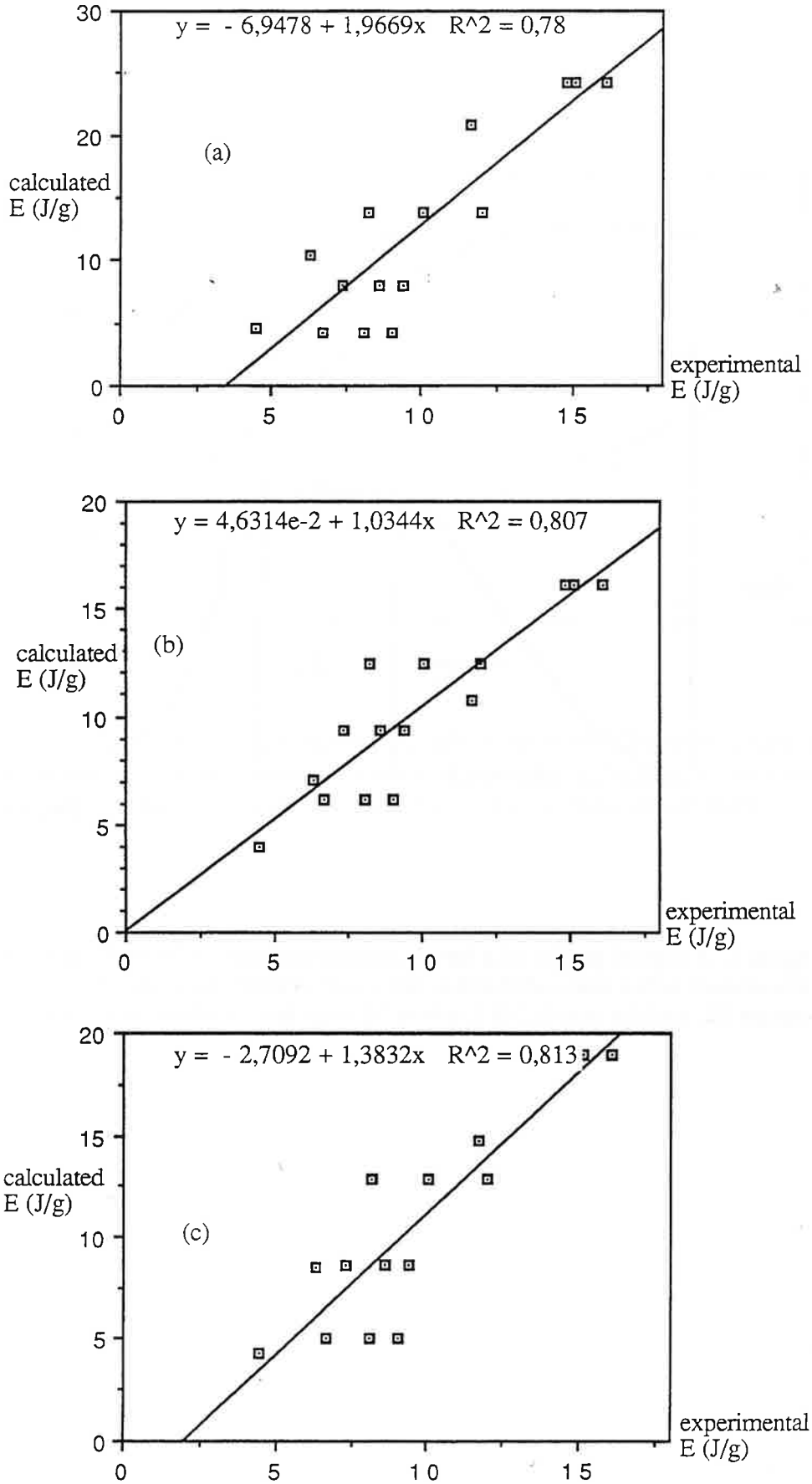


figure 2. Correlations between experimental E and calculated E from the equations of a) Rittinger, b) Kick and c) Bond.

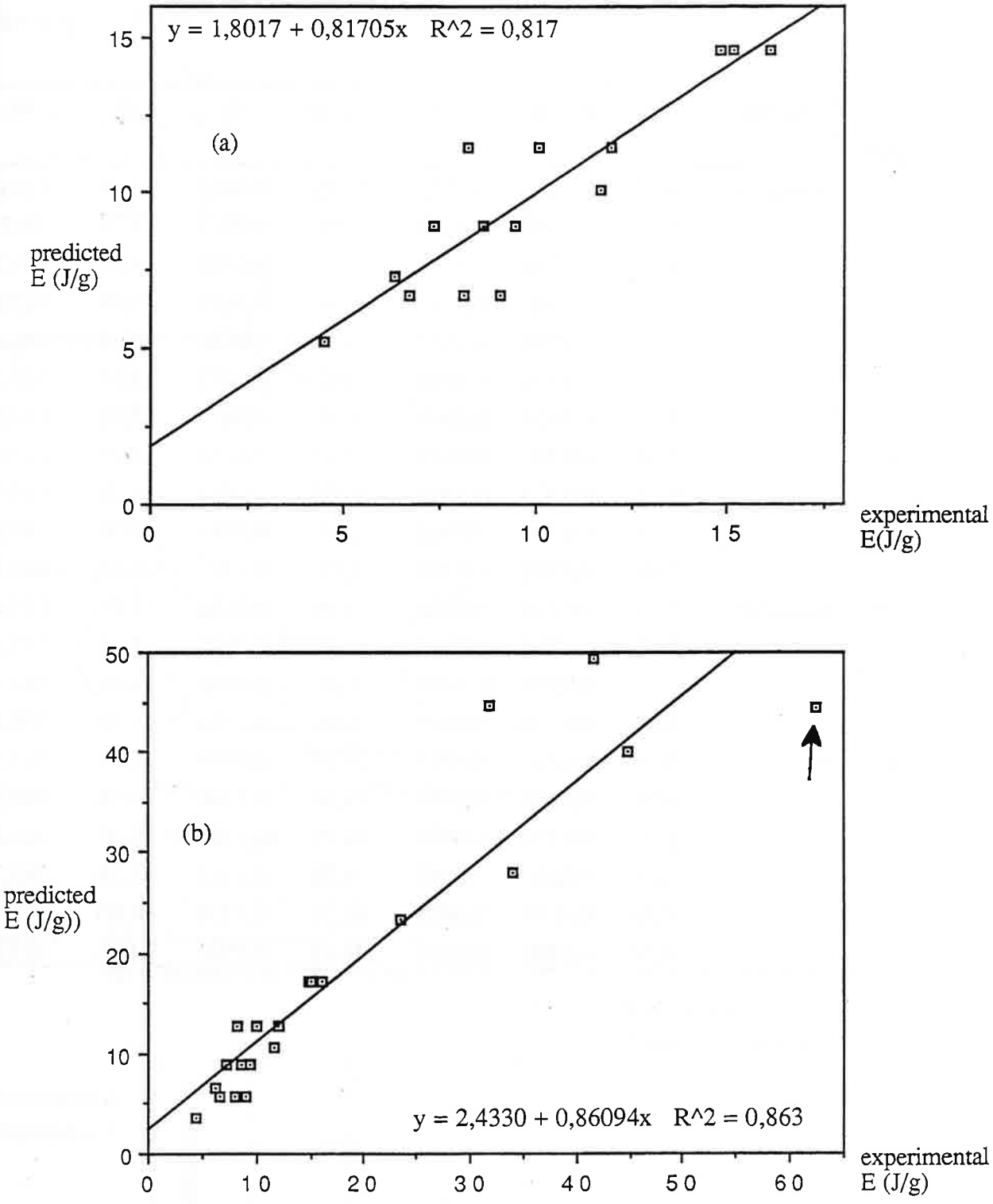
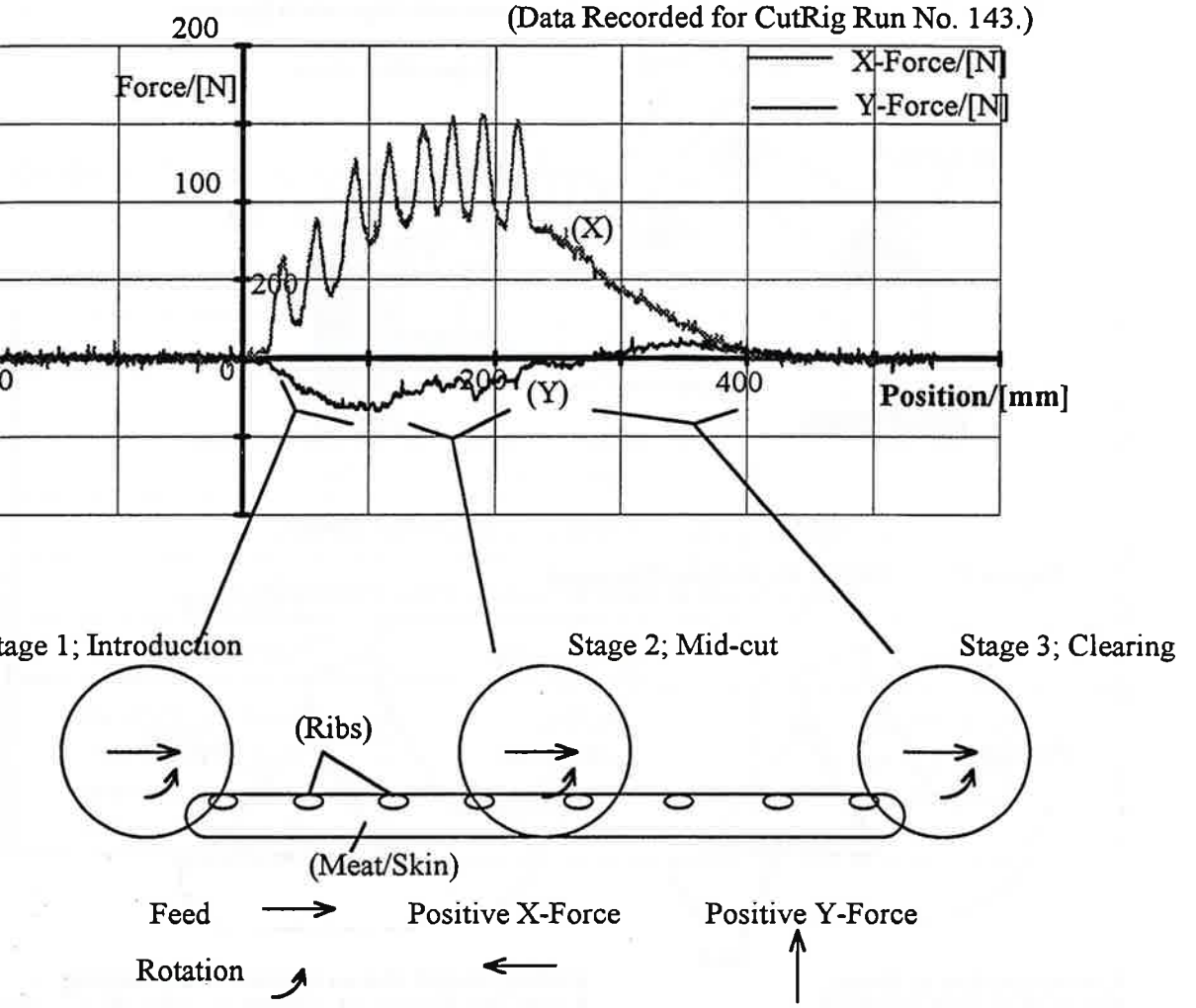


figure 3. Correlations between experimental E and predicted E from a) equation (7), b) equation (8).

V (r.p.m)	meat state	Kw	D1 (m)	D2 (m)	E (J/g)	Kr	Kk	Wi
60	unheated	0,47	0,0200	0,0025	14,82	0,0423	16,41	114,6
		0,47	0,0200	0,0040	8,21	0,0411	11,75	93,9
		0,47	0,0200	0,0060	7,34	0,0629	14,04	125,7
		0,47	0,0200	0,0090	6,69	0,1095	19,29	192,8
		0,47	0,0100	0,0025	11,66	0,0389	19,37	116,6
		0,47	0,0100	0,0040	6,32	0,0421	15,88	108,8
		0,47	0,0100	0,0060	4,48	0,0672	20,19	154,0
90	unheated	0,47	0,0200	0,0025	15,13	0,0432	16,75	117,0
		0,47	0,0200	0,0040	10,04	0,0502	14,36	114,9
		0,47	0,0200	0,0060	8,63	0,0740	16,50	147,8
		0,47	0,0200	0,0090	8,10	0,1325	23,36	233,4
120	unheated	0,47	0,0200	0,0025	16,09	0,0460	17,82	124,4
		0,47	0,0200	0,0040	11,99	0,0600	17,15	137,2
		0,47	0,0200	0,0060	9,42	0,0807	18,02	161,3
		0,47	0,0200	0,0090	9,05	0,1481	26,10	260,8
60	heated	0,56	0,0200	0,0025	34,10	0,0974	37,76	263,7
		0,56	0,0200	0,0040	23,60	0,1180	33,76	270,0
		0,74	0,0200	0,0025	41,70	0,1191	46,17	322,5
		0,74	0,0200	0,0040	31,70	0,1585	45,35	362,7
		0,70	0,0200	0,0025	62,31	0,1780	69,00	481,9
		0,70	0,0200	0,0040	44,84	0,2242	64,15	513,0

Table 1. Characteristic constants of Rittinger, Kick and Bond's equations, calculated from the experimental values of E.

re 4; Typical Force Plot Characteristics.



e 5; Output from Fast-Fourier Transform Signal Processing of X-Force Data.

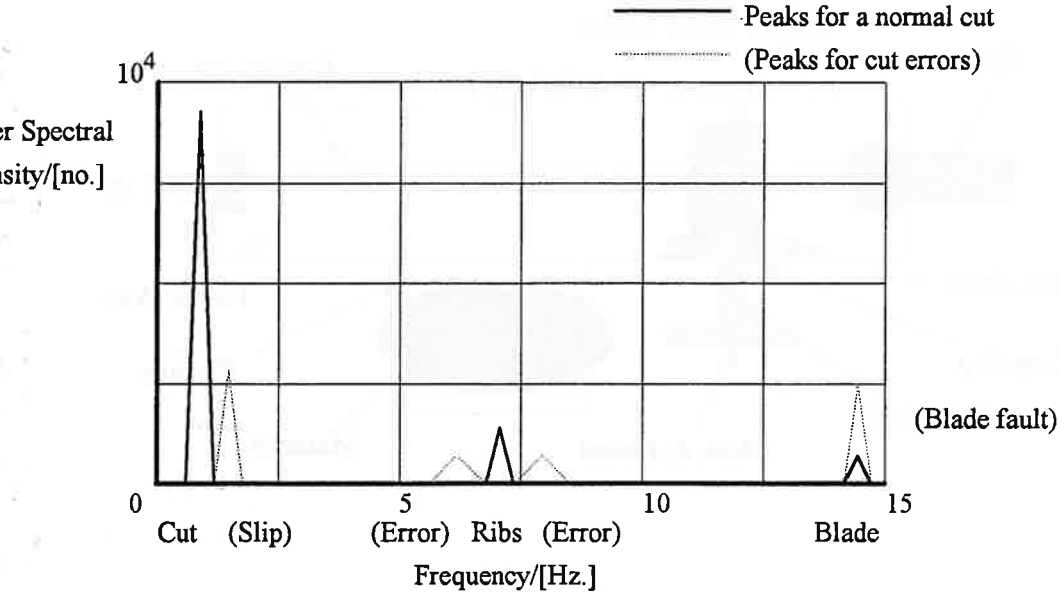


Figure 1; Schematic Configuration of an Automatic Separation System.

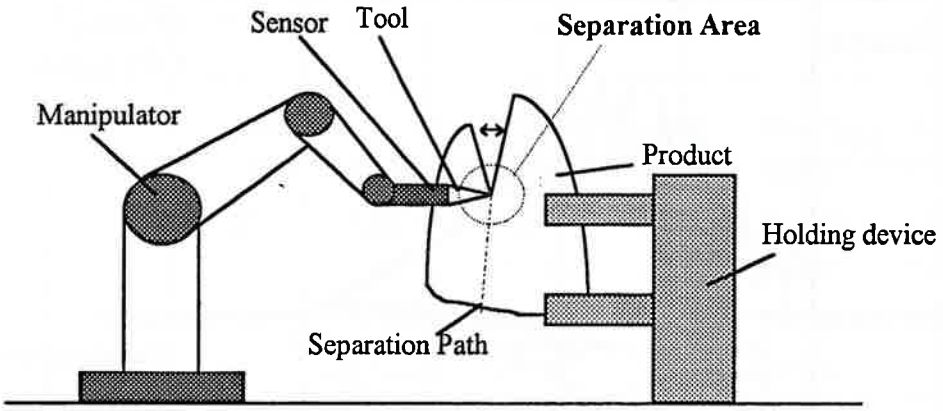


Figure 2; Cutting vs. Peeling Processes.

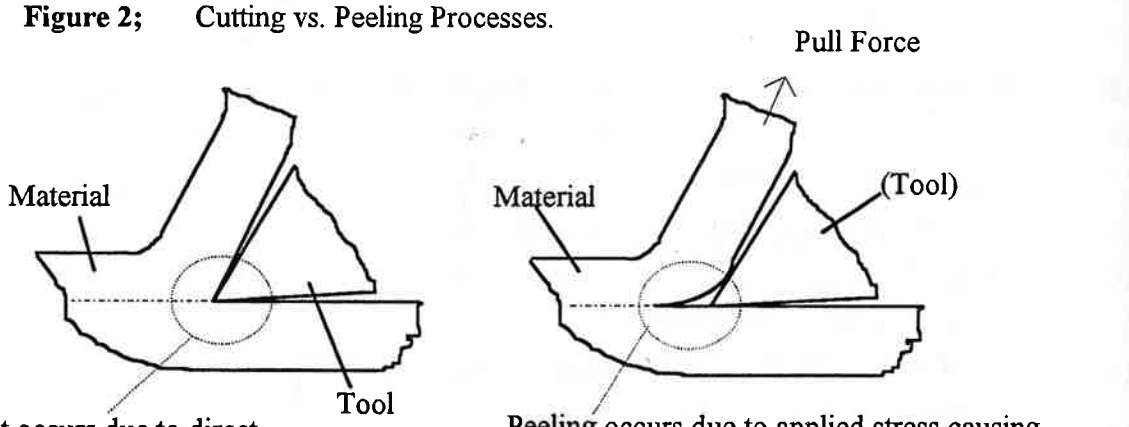


Figure 3; Sketch Plan of Test Rig.

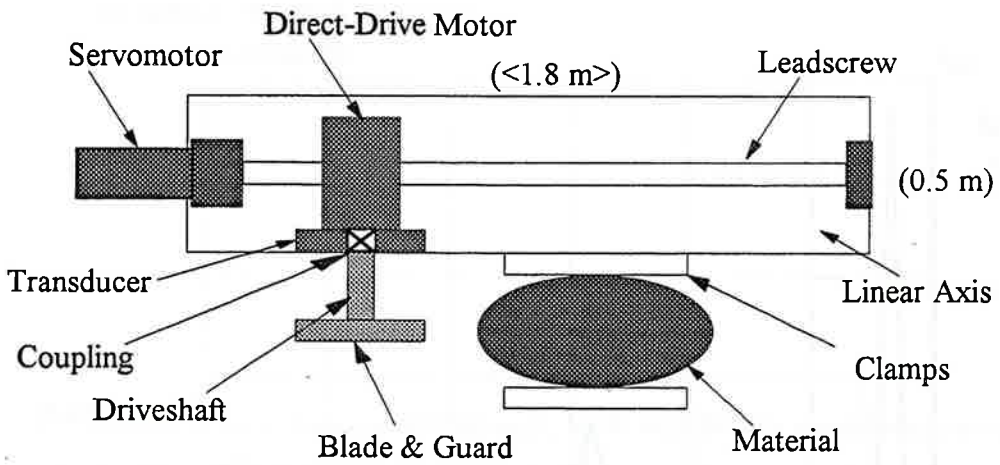


Exhibit 1; Macro-scheme of food preparation
Based on the value chain of Porter.

supporting activities		
internal transport organization		
laboratorium and research facilities		
medical care and advises concerning menus		
financial and organizational administration		
central kitchen	animal post	animals
meat department vegetable/fruit instant dry food fish and insects	portion preparation kitchens	distribution of suitable quantities

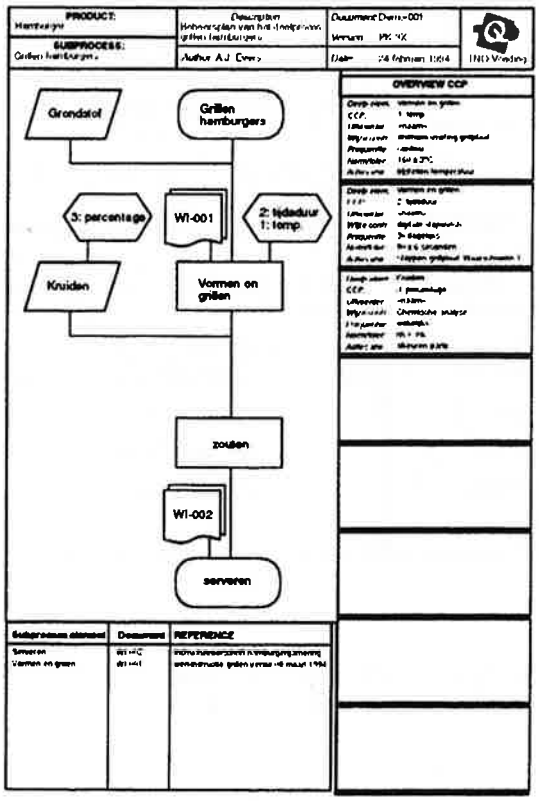


Figure 1. A process management plan based on PRO-Q FOOD.

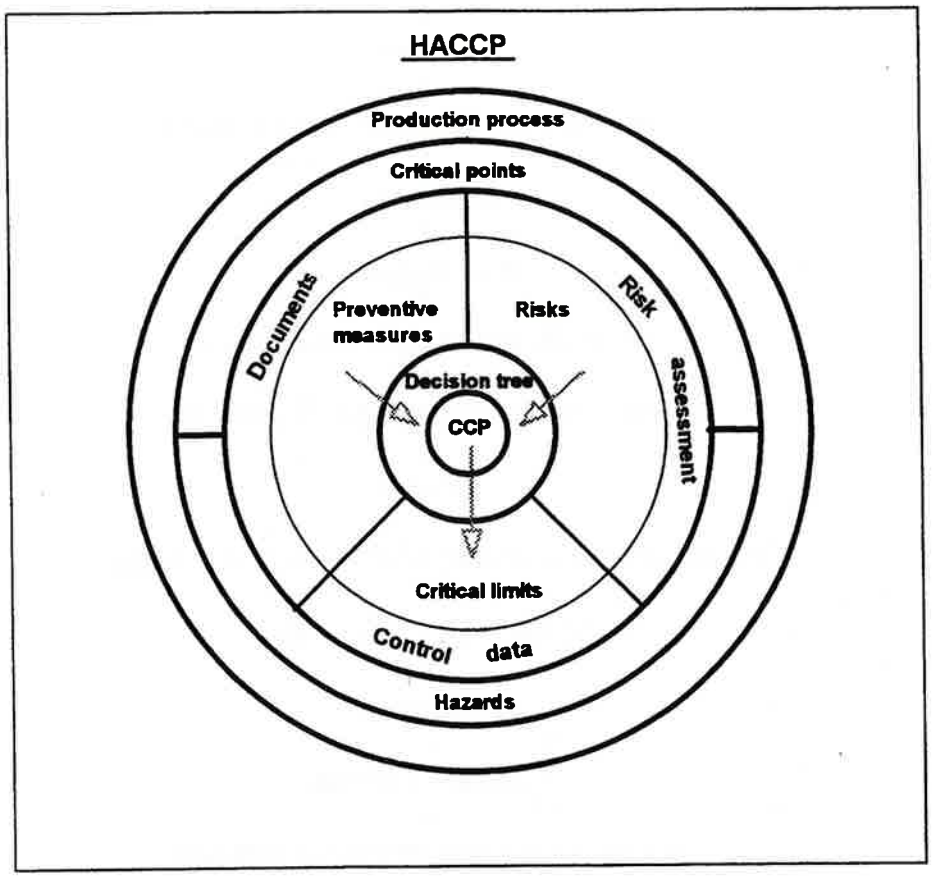


Figure 2. The essence of the HACCP method.

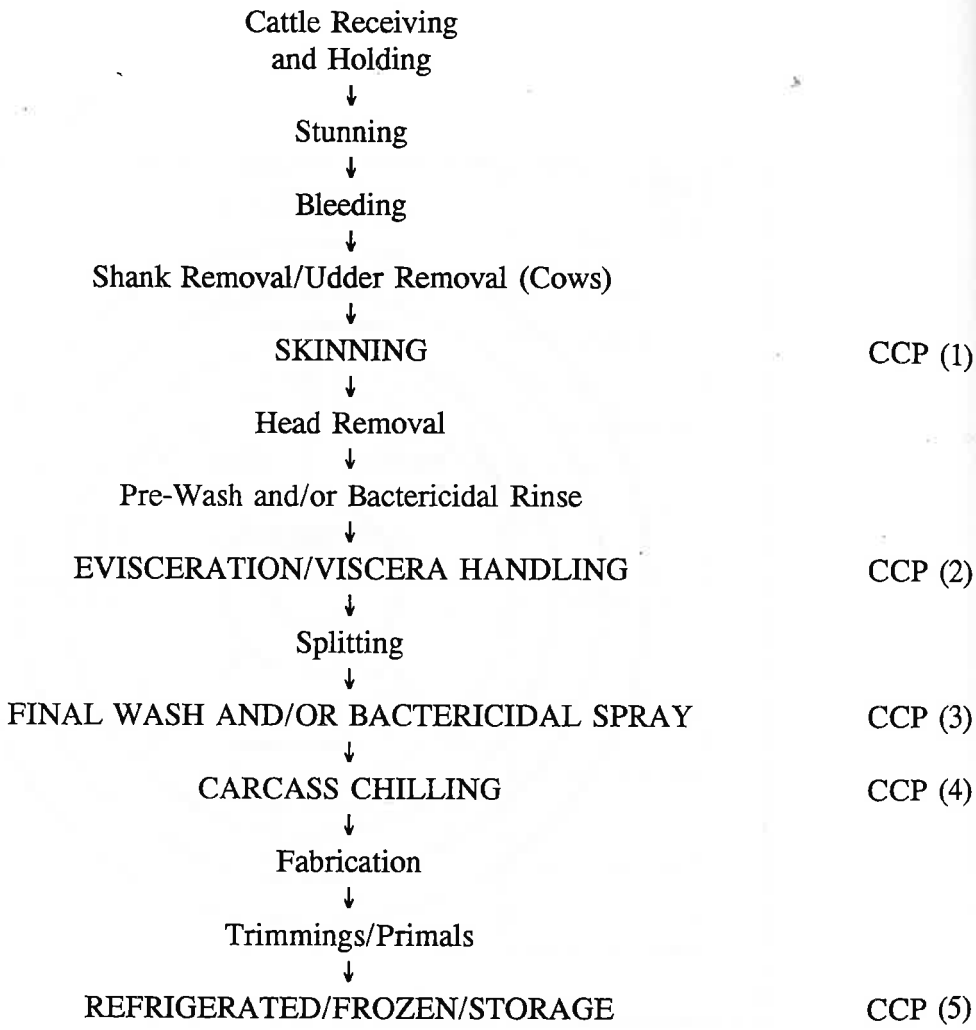


Figure 1. Beef slaughter and fabrication, example flow chart (CCP:critical control point).

Process/Step	CCP	CL	Monitoring Frequency	Records
SKINNING	1	0% dressing defects	Every hour	Random post-skinning carcass examination log-book
EVISCERA-TION	2	0% occurrence per single carcass of: fecal material, ingesta, urine or abscesses	Every hour	Random post-evisceration carcass examin-ation logbook
FINAL WASH	3	Organic acid rinse (a) Wash 32-38°C; 2,585-15,514 mmHg; 1 to 2% acid - or (b) 20-25 ppm chlorine; 517-2,069 mmHg	Every two hours	(a) Final spray wash and bac-tericidal spray logbook (b) Logbook of preventive main-tenance
CARCASS CHILLING	4	(a) Deep muscle (15 cm) to be <7°C	(a) Small plants, 1 of 10 carcasses; large plants, 1 per hour (b) Every hour	(a) Record deep-muscle tempera-ture of carcas-ses/cuts (7°C) prior to boning and keep temper-ature logbook (b) Carcass spacing: 3-5 cm apart; logbook
REFRIGER-ATED STORAGE	5	(a) All boneless meat/ trimmings temperatures shall be at ≤4°C at all stages of storage, transportation and distribution (b) Storage tempera-ture at 0°C	(a) Every four hours (b) Every four hours	(a) Maintain boneless meat/ trimmings temperature log-book (b) Keep cooler and trailer temperature log-book

Figure 2. HACCP model for beef slaughter and fabrication: process/step, critical control points (CCP), critical limits (CL), frequency of monitoring, and recording requirements.

TABLE N°1 CRITICAL CONTROL POINTS OF THE POULTRY SLAUGHTERHOUSE.

PROCESS STEP	CCP HAZARD NUMBER	CCP DESCRIPTION	CRITICAL LIMITS	MONITORING	CORRECTIVE ACTION	HACCP RECORDS	HACCP VERIFICATION
CLEANING AND DESINFECTION (SANITATION)	-CCP.N°1 MICROBIOLOGICAL	-PRE-OPERATIVE SANITATION (VISUAL)	-VISUAL CONTROL.	-PRE-OPERATIVE VISUAL INSPECTION OF EQUIPMENT AND ENVIRONMENT.	-REWASH, SANITIZE, REINSPECT, PRIOR TO THE OPERATION. -REVIEW THE SANITATION PLANT. -INSTALLATION AND MACHINERY DESIGN.	-RECORD ALL RESULTS AND CORRECTIVE ACTIONS. -CHECK LIST	-AUDIT TO VERIFY THE SANITATION. -MICROBIOLOGICAL SURFACE ANALYSIS (RODAC PLATE) (TARGET VALUE OF 10^2 IN TOTALS.) -AUDIT HOW THE RECORDINGS ARE TAKEN AND HOW THE GOOD MANUFACTURING PRACTICES ARE CARRIED OUT.
SLAUGHTER MACHINE	-CCP.N°2 MICROBIOLOGICAL	-BLADE REGULATION.	-SLAUGHTER MACHINE REGULATION.	-EQUIPMENT INSPECTION BEFORE EACH LOT. -DAILY BLADE CHANGE.	-EQUIPMENT REGULATION. (DEPENDING ON THE NUMBER OF LOTS TO WORK)	-RECORD ALL DATA DEPENDING ON THE SIZE AND TYPE OF THE CHICKEN.	-SLAUGHTER OPERATION INSPECTION, DEPENDING ON THE QUALITY OF CONTROL IN DIFFERENT LOTS.
SCALDING	-CCP.N°3 MICROBIOLOGICAL	-FRESH WATER INPUT	-0,8 LTS.WATER INPUT PER BIRD (CHICKEN) WHICH GOES THROUGH THE SCALDING MACHINE.	-MONITOR FLOW TO MAINTAIN AN INPUT OF 0,8 LTS.OF FRESH WATER PER BIRD.	-ADJUST FRESH WATER FLOW, RECHECK EVERY 15 MINUTES DURING ONE HOUR, THEN ONCE EACH HOUR.	-RECORD ALL THE RESULTS AND CORRECTIVE ACTIONS IN A CHECK LIST.	-VERIFY CALIBRATION OF METERING METHOD OF WATER SUPPLY.
PLUCKING MACHINE	-CCP.N°4 MICROBIOLOGICAL	-PLUCKING MACHINE REGULATION.	-R.P.M. REGULATION (600 R.P.M.) -ROLLER OPENING CONTROL DEPENDING ON THE CHICKEN SIZE.	-EQUIPMENT INSPECTION BEFORE EACH LOT.	-EQUIPMENT REGULATION DEPENDING ON THE LOT. (SIZE AND PHYSICAL SITUATION) -CHANGE THE RUBBER FINGERS IN BAD CONDITION.	-RECORD DATA FROM R.P.M. AND ROLLER OPENING, ACCORDING TO THE TYPE OF CHICKEN.	-PRE-OPERATIVE INSPECTION OF PLUCKING MACHINE. -SECTION EMPLOYEE CAN CARRY OUT THE INSPECTION.

TABLE N°2 CRITICAL CONTROL POINTS OF THE POULTRY SLAUGHTERHOUSE.

PROCESS STEP	CCP HAZARD NUMBER	CCP DESCRIPTION	CRITICAL LIMITS	MONITORING	CORRECTIVE ACTION	HACCP RECORDS	HACCP VERIFICATION
CLEAN PICK WASHER AND FINISHER	-CCP.N°5 MICROBIOLOGICAL	-WATER CHLORINATION. -WATER QUANTITY. (1,5 LTS.PER BIRD) -WATER TEMPERATURE (15°C)	-≥3PPM -VOLUME,PRESURE AND SUITABLE WATER DIRECTION.	-CARCASSES´ VISUAL CONTROL,TO DETERMINE IF THERE IS CONTAMINATION.	-INFORM MAINTENANCE GROUP. -ADJUST CHLORINATION AND OBSERVE IT DURING 15 MIN. -ADJUST THE CAUDAL, PRESSURE AND WATER DIRECTION. -CONTROL THE TEMPERATURE.	-RECORD THE CHLORINATION LEVEL AND CORRECTIVE ACTIONS. -RECORD DATA PRESSURE AND VOLUME.	-CHLORINATION "KIT" CONTROL. (VOLUMETRY WITH Na TIOSULFATE) -MONTHLY MICROBIOLOGICAL ANALYSIS. -ANNUAL PHYSICAL-CHEMICAL ANALYSIS. -CONTROL WATER PRESSURE AND VOLUME.
CROPPING	-CCP.N°6 MICROBIOLOGICAL	-EMPLOYERS´ SANITARY EDUCATION. -KNIFE STERILIZER TEMPERATURE.	-MEAT MANIPULATOR LICENCE. -GOOD MANUFACTURING PRACTICES (G.M.P.) -T°≥82°C	-SANITARY DIRECTIONS. -CHECK LIST. -RECORD THE T° OF THE KNIFE STERILIZER. -OBSRVE IF THE EMPLOYEE USES IT.	-INFORM THE EMPLOYEE -INFORM THE SECTION EMPLOYER IN CHARGE. -INFORM THE MAINTENANCE GROUP. -KNIFE STERILLIZER SANITATION.	-CHECK LIST. -CHECK LIST.	-VISUAL INSPECTION BY QUALITY CONTROL -MICROBIOLOGICAL ANALYSIS OF HANDS, GLOVES,ETC. -CALIBRATER THERMOMETER. -MICROBIOLOGICAL ANALYSIS OF KNIVES AND WATER. -PERIODIC STERILIZER CHECKING.
MANUAL TRANSFER	-CCP.N°7 MICROBIOLOGICAL	-EMPLOYERS´ SANITARY EDUCATION.	-MEAT MANIPULATOR LICENCE. -GOOD MANUFACTURING PRACTICES. (G.M.P.)	-CHECK LIST. -GOOD MANUFACTURING PRACTICES.(G.M.P.)	-INFORM EMPLOYEE. -INFORM THE SECTION EMPLOYEE IN CHARGE.	-CHECK LIS	-OPERATION INSPECTION BY QUALITY CONTROL. -MICROBIOLOGICAL ANALYSIS OF HANDS,GLOVES,ECT.
MANUAL EVISCERATION	-CCP.N°8 MICROBIOLOGICAL	-EMPLOYERS´ SANITARY EDUCATION. -WATER CHLORINATION. -KNIFE STERILIZER TEMPERATURE.	-MEAT MANIPULATOR LICENCE. -GOOD MANUFACTURING PRACTICES. (G.M.P.) -CHLORINE≥3PPM. -KNIFE STERILIZATOR T°≥82°C.	-CHECK LIST -SANITARY DIRECTIONS. -CHICKEN VISUALLY CONTROL. -CHLORINATION ANALYSIS. -REGISTER THE KNIFE STERILIZER TEMPERATURE. -CHECK LIST.	-INFORM EMPLOYEE -INFORM THE SECTION EMPLOYEE IN CHARGE. -INFORM MAINTENANCE GROUP.(IF A PROBLEM APPEARS IN THE CHLORINATION AND STERILIZATOR SYSTEM)	-CHECK LIST. -RECORD CHLORINATION REGISTER. -CHECK LIST.	-VISUAL INSPECTION BY QUALITY CONTROL -CHLORINATION "KIT" CONTROL. -WATER AND KNIVES MICROBIOLOGICAL ANALYSIS. -PERIODIC STERILIZER CHECKING. -CALIBRATE THERMOMETER.

TABLE N°3 CRITICAL CONTROL POINTS OF THE POULTRY SLAUGHTERHOUSE.

PROCESS STEP	CCP HAZARD NUMBER	CCP DESCRIPTION	CRITICAL LIMITS	MONITORING	CORRECTIVE ACTION	HACCP RECORDS	HACCP VERIFICATION
INSIDE AND OUTSIDE BIRD WASHER.	-CCP.N°9 MICROBIOLOGICAL	-WATER CHLORINATION. -VOLUME, PRESSURE AND DIRECTION OF THE SHOWER.	-CHLORINE ≥3PPM. -VOLUME, PRESSURE AND DIRECTION SUITABLE.	-CHICKEN VISUAL CONTROL TO DETERMINATE THE SANITATION LEVEL.	-INFORM MAINTENANCE GROUP. -ADJUST CHLORINATION. -ADJUST THE PRESSURE, VOLUME AND WATER DIRECTION.	-RECORD CHLORINATION DATA. -RECORD DATA: PRESSURE, DIRECTION AND VOLUME OF WATER AND SPRINKLERS.	-CHLORINATION "KIT" CONTROL. -MONTHLY MICROBIOLOGICAL ANALYSIS AND ANNUAL PHYSICAL-CHEMICAL ANALYSIS. -CONTROL AND CALIBRATE THE VOLUME AND PRESSURE CONTROLLER. -CONTROL AND CALIBRATE THE SPRINKLERS DIRECTION.
CARCASS CHILLING.	-CCP.N°10 MICROBIOLOGICAL	-TEMPERATURE -COLD WATER CAUDAL. -WATER CHLORINATION.	-T°BETWEEN 1° AND 2°C. -1,5 LTS.OF WATER PER CHIKEN.	-INSPECT THAT TEMPERATURE MANTAINS THE TOLERANCES. -CHECK LIST. -CHLORINE ANALYSIS. -DETERMINATE WATER CAUDAL.	-ADJUST TEMPERATURE AND CONTROL IT EVERY 30 MIN. -INFORM MAINTENANCE GROUP. -RECORD CHLORINE VALUES. -ADJUST CAUDAL.	-RECORD ALL RESULTS AND CORRECTIVE ACTIONS. -CHECK LIST.	-CALIBRATE THE THERMOMETERS AND DRILLS. -CHLORINATION "KIT" CONTROL. -MONTHLY MICROBIOLOGICAL ANALYSIS AND ANNUAL PHISICAL-CHEMICAL ANALYSIS. -VERIFY CALIBRATION OF CAUDAL METERING METHOD.
COLD AIR TUNNEL.	-CCP.N°11 MICROBIOLOGICAL	-TEMPERATURE -AIR RENOVATIONS SPEED.	-T° BETWEEN 2° AND 3°C. -AIR SPEED. (7 MTS/SG)	-CHECK LIST. -MANTAIN THE TOLERANCES TEMPERATURES.	-INFORM MAINTENANCE GROUP. -TEMPERATURE REGULATION. -ADJUST AIR CAUDAL.	-RECORD THE TEMPERATURE AND AIR CAUDAL VARIATIONS.	-CALIBRATE THE DRILLS. -ADJUST THE AIR DIRECTION. -CONTROL THE CHICKEN TEMPERATURE LEAVES THE TUNNEL. (3°C IN SKIN) (17°C IN BREAST)
SECOND CATEGORY CHICKEN SEPARATION	-CCP.N°12 MICROBIOLOGICAL	-SANITARY EDUCATION.	-MEAT MANIPULATOR LICENCE. -GOOD MANUFACTURING PRACTICES. (G.M.P.)	-SANITARY DIRECTIONS -CHECK LIST.	-INFORM EMPLOYEE -INFORM SECTION EMPLOYEE IN CHARGE.	-CHECK LIST.	-INSPECTION BY QUALITY CONTROL. -MICROBIOLOGICAL ANALYSIS OF HANDS AND GLOVES.

TABLE N°4 CRITICAL CONTROL POINTS OF THE POULTRY SLAUGHTERHOUSE.

PROCESS STEP	CCP HAZARD NUMBER	CCP DESCRIPTION	CRITICAL LIMITS	MONITORING	CORRECTIVE ACTION	HACCP RECORDS	HACCP VERIFICATION
PACKAGING (BOXES)	-CCP.N°13 MICROBIOLOGICAL CHEMICAL.	-EMPLOYEE SANITARY EDUCATION. -WHOLENESS AND SANITATION OF BOXES.	-MEAT MANIPULATOR LICENCE. -GOOD MANUFACTURING PRACTICES. (G.M.P.) -VISUAL CONTROL OF BOXES.	-SANITARY DIRECTIONS -CHECK LIST. -VISUAL INSPECTION OF BOXES.	-INFORM THE EMPLOYEE. -INFORM THE SECTION EMPLOYEE IN CHARGE. -INFORM MAINTENANCE TO REGULATE BOX WASHER.	-CHECK LIST.	-INSPECTION OF THE OPERATION BY QUALITY CONTROL STAFF. -CONTROL PRESSURE AND TEMPERATURE IN THE BOX WASHER. -CONTROL IN THE PUMP THAT ABSORBS DETERGENT FROM THE BOX WASHER. -SURFACE MICROBIOLOGICAL CONTROL. (RODAC PLATE) -AUDIT THE QUANTITY OF DETERGENT DILUTE. ERROR: -OVER EXCEEDED: CHEMICAL HAZARD -UNDER EXCEEDED: MICROBIOLOGICAL HAZARD.
COLD-STORAGE	-CCP.N°14 MICROBIOLOGICAL	-COLD-STORAGE ROOM TEMPERATURE. -WHOLENESS AND SANITATION OF BOXES AND PACKING.	-COLD-STORAGE ROOM TEMPERATURE. (T° ± 3°C). -VISUAL CONTROL.	-CHECK THAT THE TEMPERATURE IS WITHIN THE TOLERANCES. -CHECK LIST.	-INFORM MAINTENANCE TEAM. -TO CORRECT NECESSARY TEMPERATURES. -INFORM STORAGE EMPLOYEE IN CHARGE.	-TEMPERATURE RECORDING EVERY 20 MIN. (AUTOMATIC DRILLS CONNECTED TO A COMPUTER AND TO A PRINTER). -CHECK LIST.	-VERIFY THE AUTOMATIC DRILLS. -STORE INSPECTION BY QUALITY CONTROL STAFF.

FIGURE N°1
POULTRY SLAUGHTERHOUSE
FLOW CHART

richinosis in Wild Meat

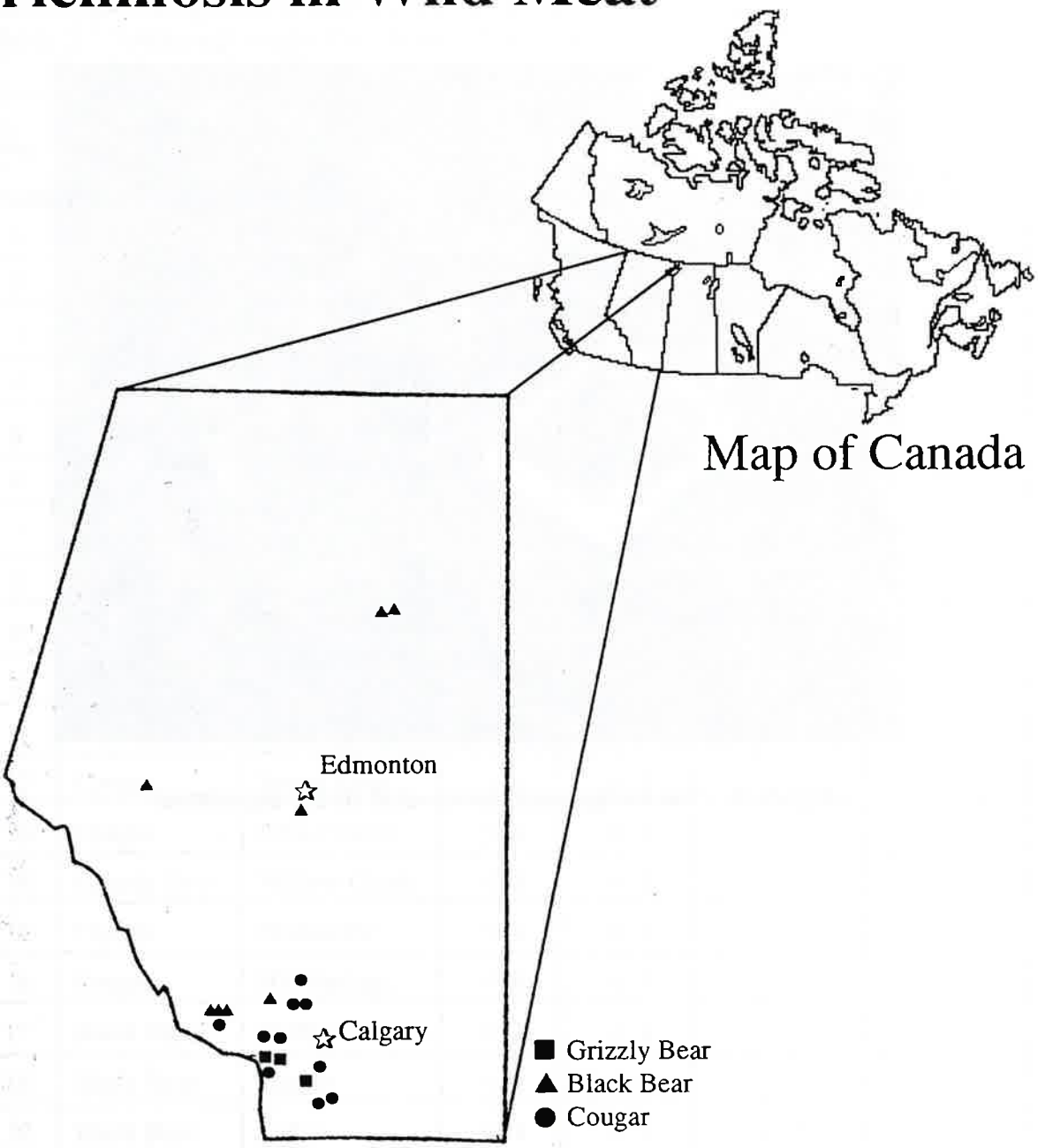


Figure 1: Geographical locations of the specimens (1992-93)

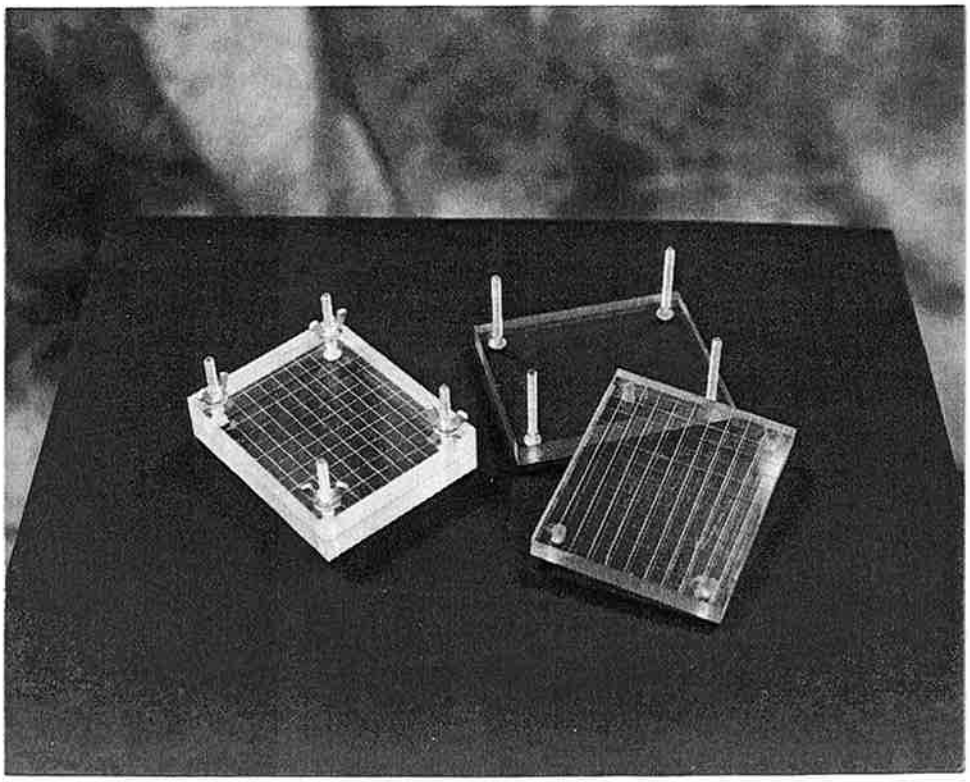


Figure 2: The compressor device used in the experiment

Table 1. Trichnosis results for 21 animals were obtained from different geographical locations in Alberta

No.	Animal Species	Geographical Location	Larvae per gram from			
			Tongue	Masseter	Diaphragm	Intercostal
1	Cougar	Cochrane	3	3	4	< 1
2	Cougar	Olds	< 1	< 1	--	--
3	Grizzly Bear	Kananaskis	4	4	--	--
4	Cougar	Cochrane	< 1	< 1	--	--
5	Cougar	Kananaskis	< 1	< 1	--	--
6	Black Bear	Fort McMurry	< 1	< 1	6	<1
7	Black Bear	Canmore	< 1	< 1	--	--
8	Black Bear	Canmore	< 1	< 1	--	--
9	Black Bear	Canmore	< 1	< 1	--	--
10	Black Bear	Fort McMurry	< 1	< 1	< 1	< 1
11	Grizzly Bear	Nordegg	< 1	< 1	--	--
12	Cougar	James River	< 1	< 1	--	--
13	Cougar	Elbow River	< 1	< 1	--	--
14	Grizzly Bear	Willow Creek	< 1	< 1	< 1	< 1
15	Cougar	Millarville	< 1	< 1	--	--
16	Cougar	Hill Springs	< 1	< 1	--	--
17	Black Bear	Exshaw	< 1	< 1	--	--
18	Black Bear	Hinton	< 1	< 1	--	--
19	Black Bear	Leduc	< 1	< 1	< 1	--
20	Cougar	Nanton	< 1	< 1	< 1	--
21	Cougar	Canmore	< 1	< 1	< 1	< 1

TABLE 1

Groups of professions	1990		1991	
	students	%	students	%
TOTAL	583 889	100	565 928	100
including:				
natural sciences	51 742	8,9	5i 582	9,1
humanitarian sciences	63 934	11,0	67 472	11,9
culture and art	14 825	2,5	14 389	2,5
food production technology	9 133	1,5	7 876	1,4
agriculture and forestry	42 466	7,2	41 608	7,4

The structure of the IX semester

TABLE 2

No	Compulsory subjects	No	Electives
1	General technology of meat production industry	1	Applied biotechnology
2	Principles of animal breeding	2	Principles of refrigerating storage and processing
3	Meat industry equipment	3	Principles of no-waste technologies and ecologically pure products
4	Automation of food industry equipment and processes	4	Packaging
5	Small business conducting	5	Food chemistry and principles of rational nutrition
6	Meat biochemistry	6	Meat and meat product rheology
7	Meat microbiology	7	Principles of production intensification

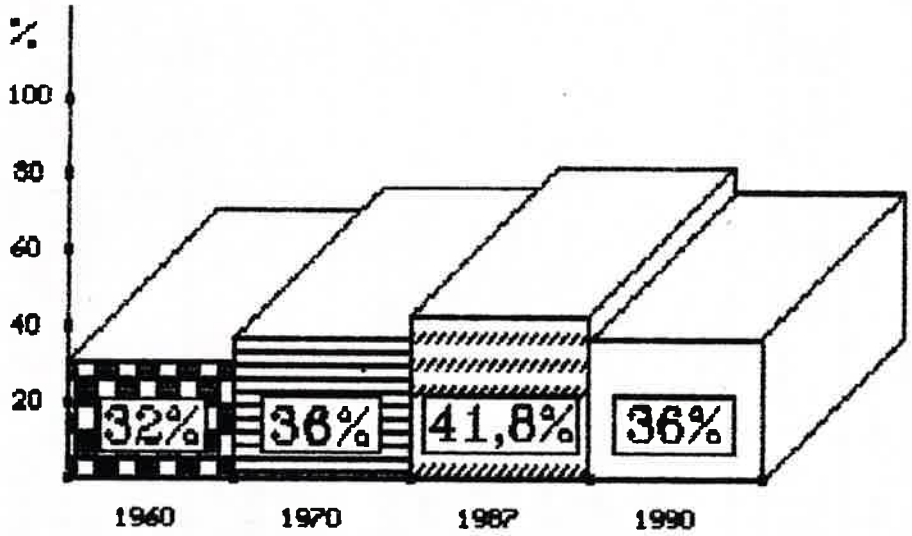


Figure 1

Diagram of the number of higher school graduates with engineering specialization.

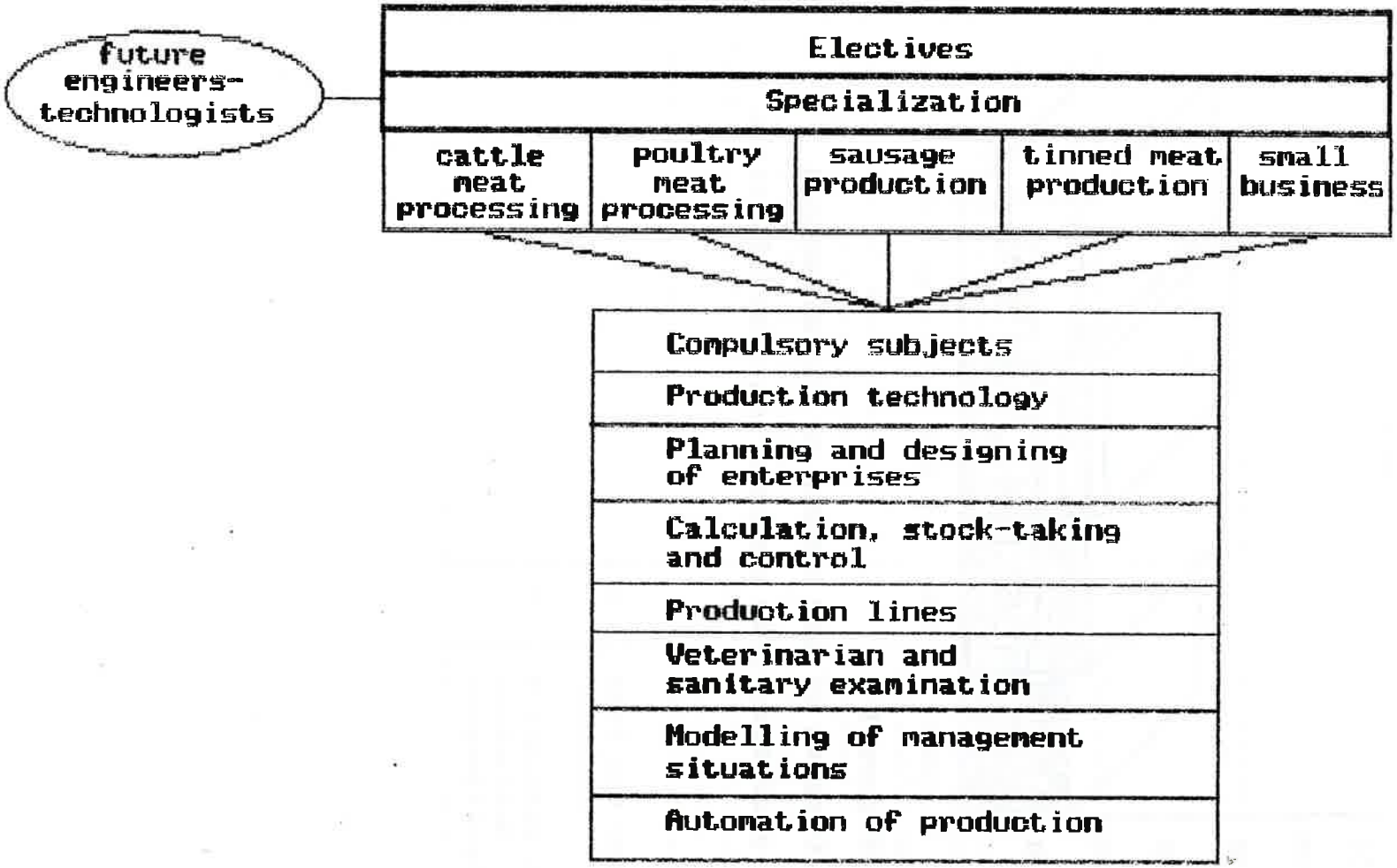


Figure 2

Struoture of deep professional training and eduoation.