Quality Deterioration during storage

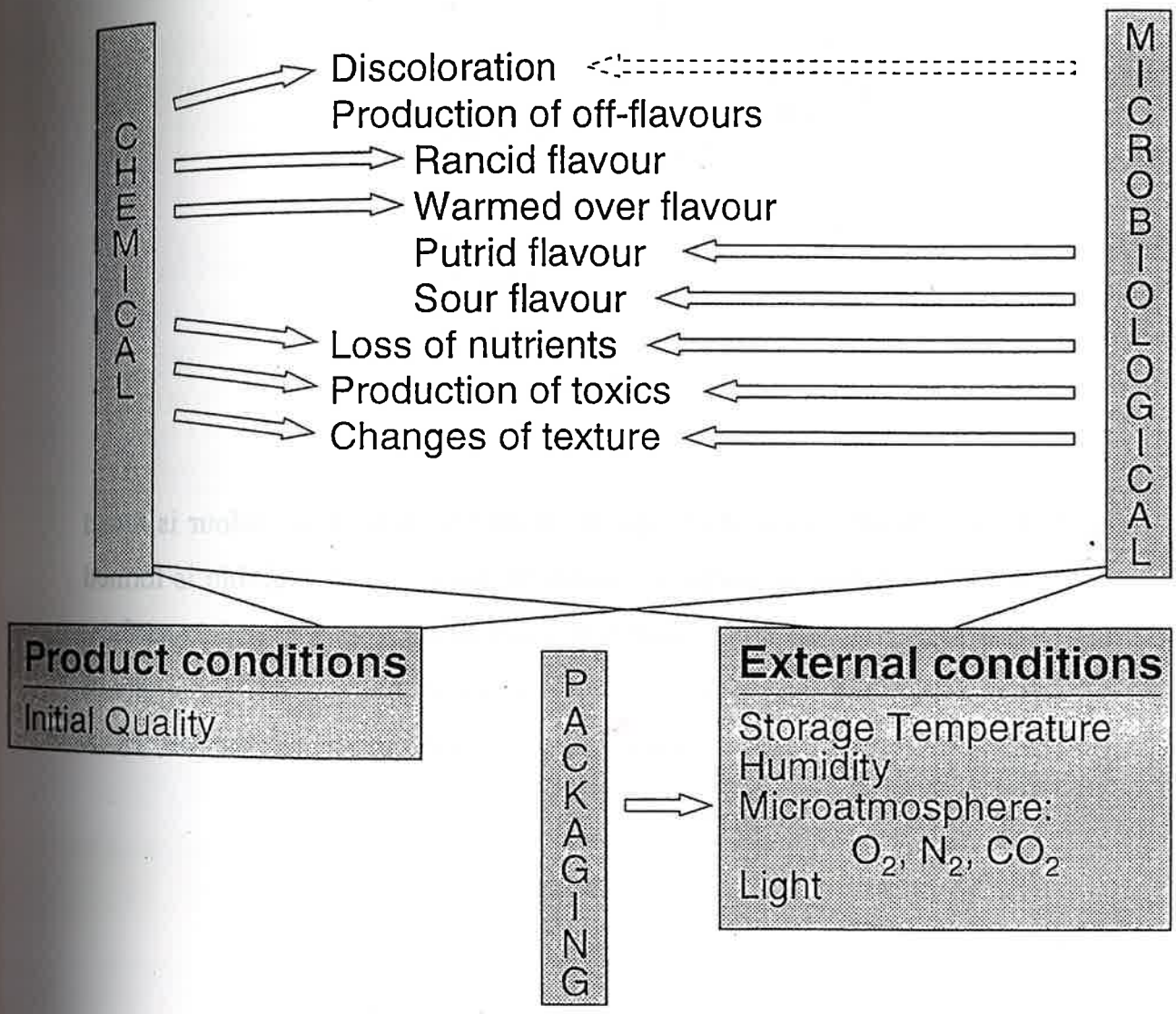


Fig. 1. Quality deterioration of foods during storage.

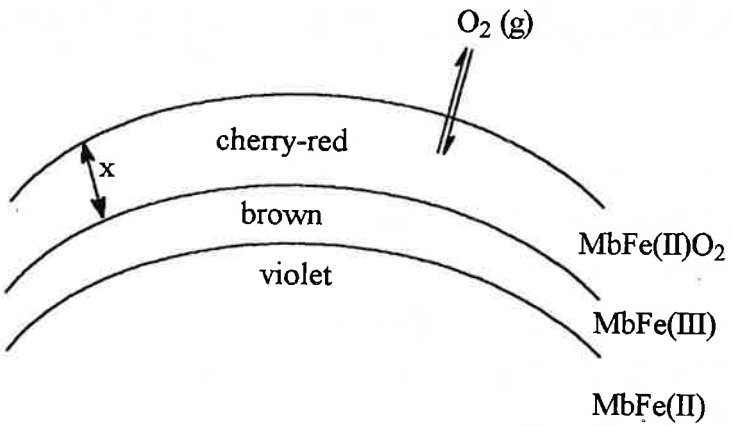


Fig. 2. The different forms of myoglobin of relevance for meat colour is found at different oxygen partial pressures in meat.[6,7] Metmyoglobin is formed at intermediate oxygen pressure at a distance x from the product surface, which depends on oxygen partial pressure at the surface, P_o, the rate of oxygen consumption by the tissue, A, and the diffusion constant, D: $x = \sqrt{(2p_o D/A)}$

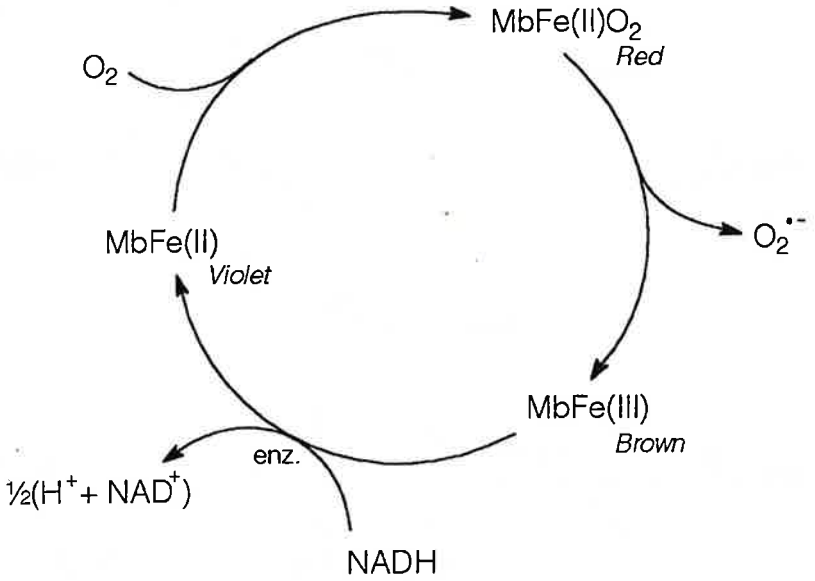


Fig. 3. Color cycle of raw meat.

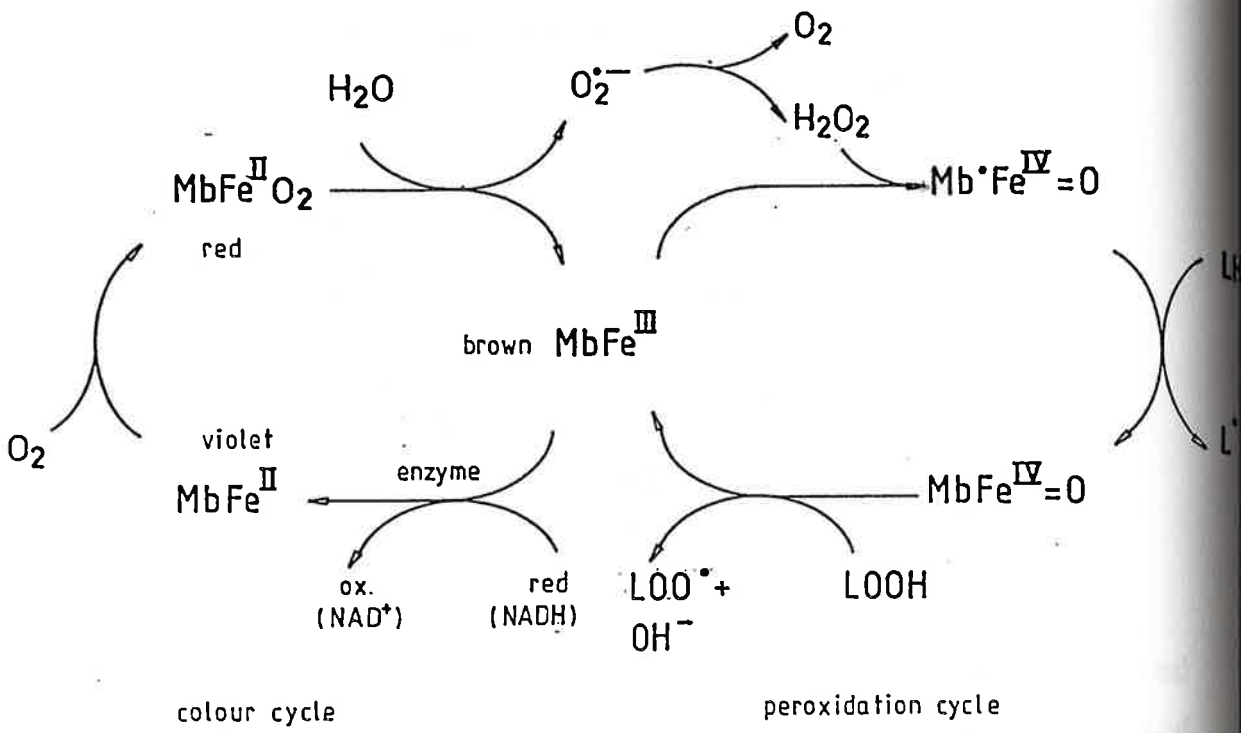


Fig. 4. Pseudo peroxidase cycle of myoglobins is linked to color cycle of meat. LH is a lipid and LOOH is a lipid peroxide.

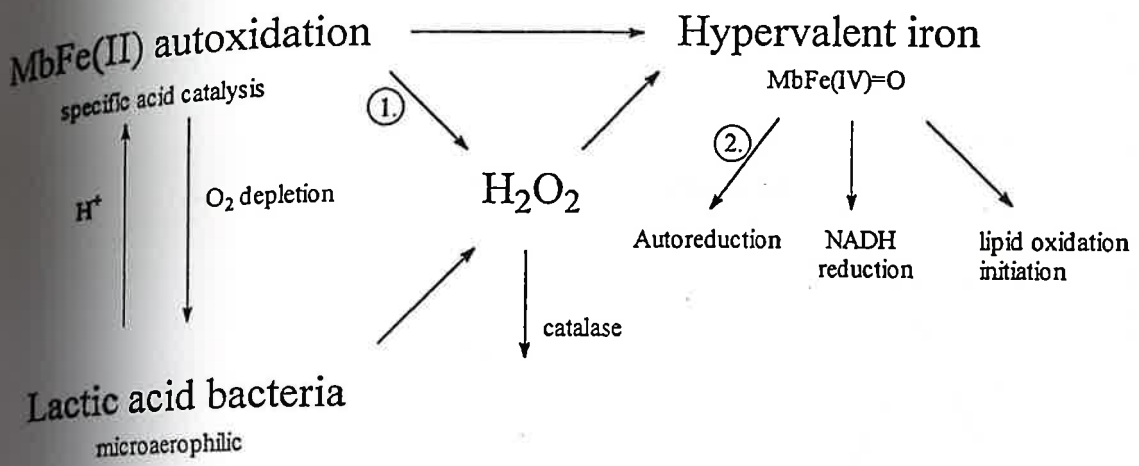


Fig. 5. Interaction between lactic acid bacteria growth and pigment catalyzed lipid oxidation in meat.

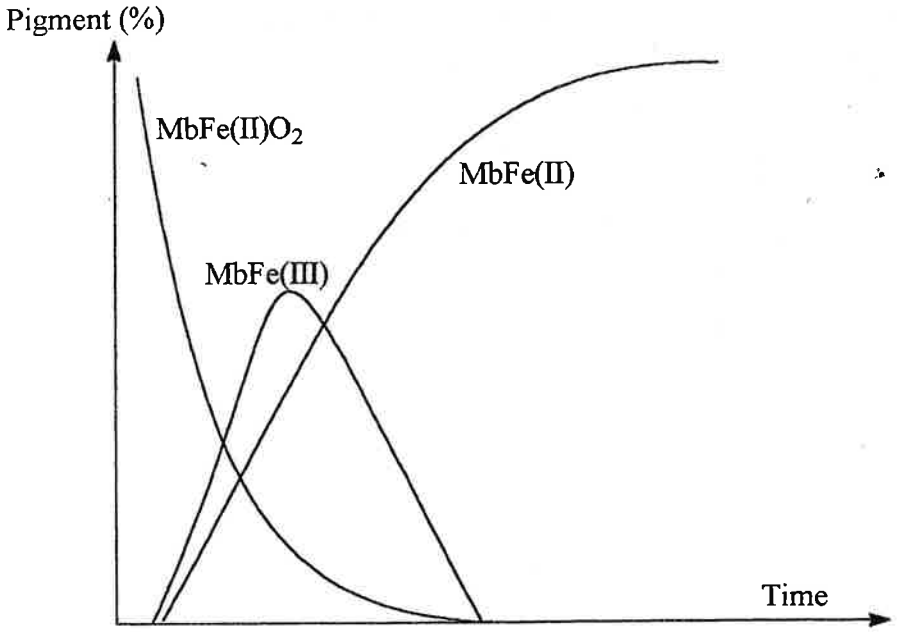


Fig. 6. The relative concentration of red oxymyoglobin, brown metmyo and purple myoglobin in vacuum-packed meat.

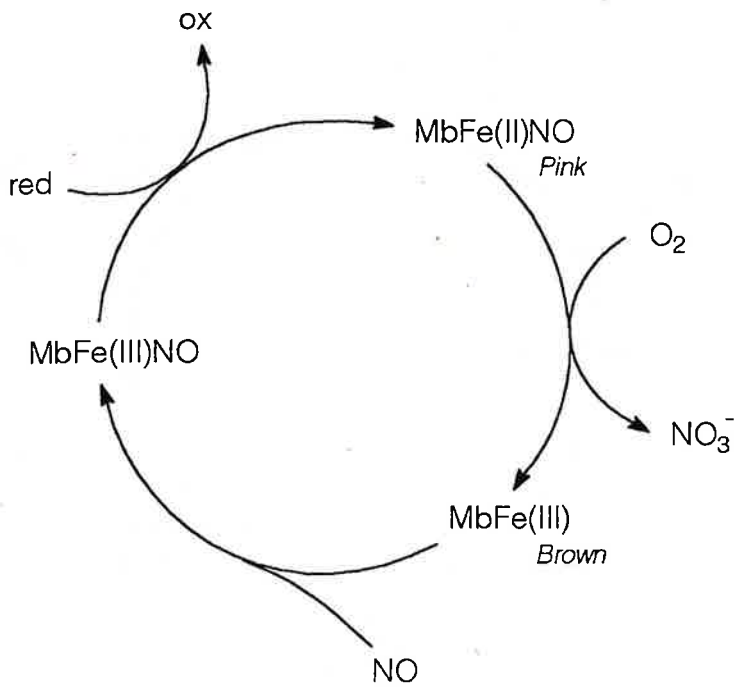


Fig. 7. The color cycle of cured meat may be observed when vacuum-packed ham is exposed to fluorescent light.

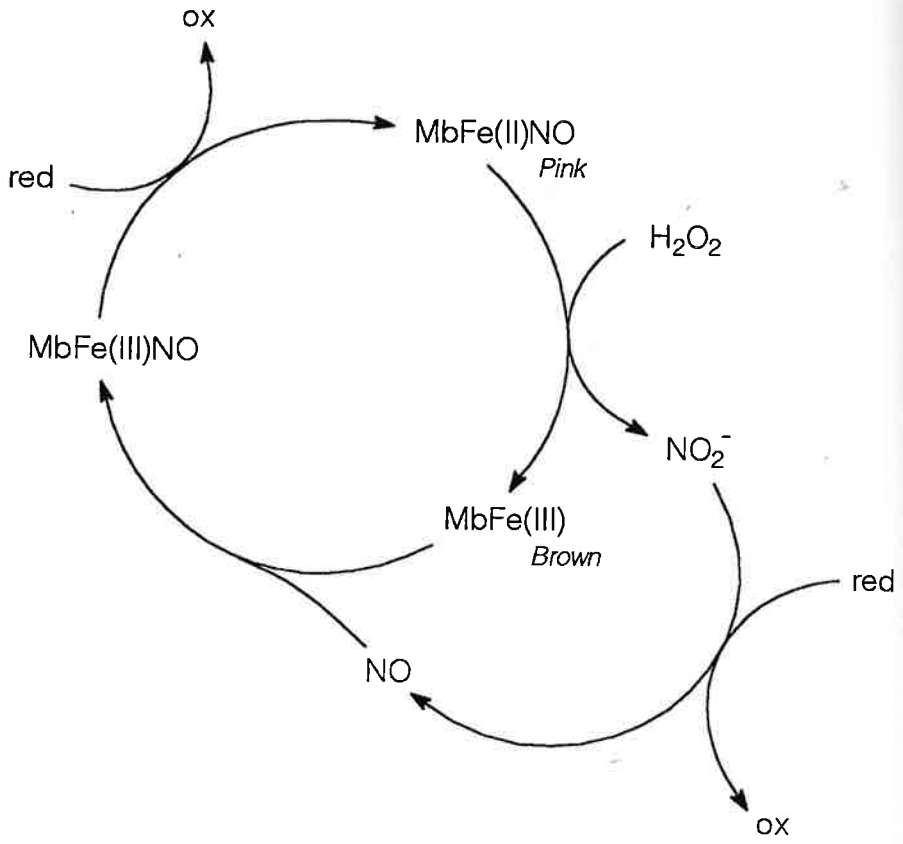
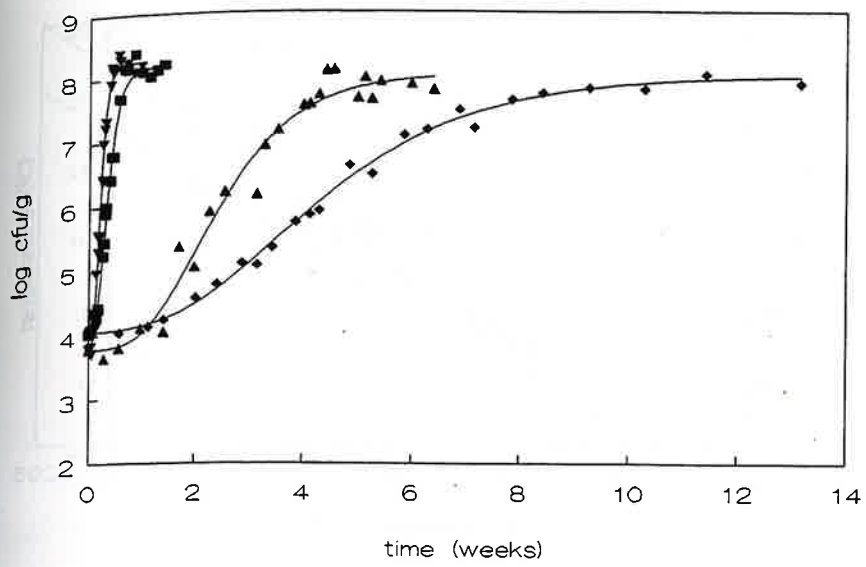
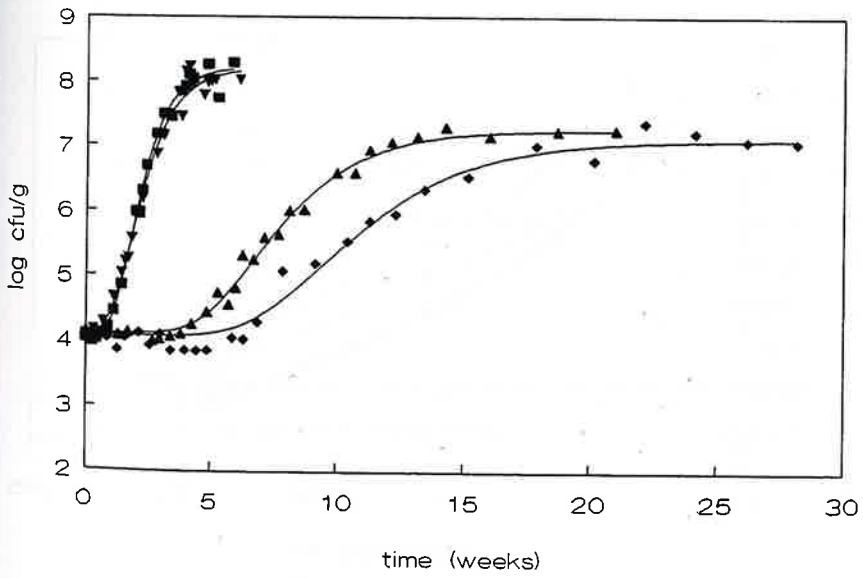


Fig. 8. The color cycle of cured meat is linked to the antioxidant activity of the nitric oxide free radical.



Effect of temperature and salt on growth of *L. curvatus* in vacuum-packaged Bologna-type sausage with no added lactate and 60 mg/kg nitrite: ▼, 15°C and 1% salt; ■, 15°C and 2% salt; ▲, 0°C and 1% salt; ◆, 0°C and 2% salt.



Effect of nitrite and lactate on growth of *L. curvatus* in vacuum-packaged Bologna-type sausage with 2% NaCl and a storage temperature of 3°C: ▼, 0% sodium lactate (NaL) and 30 mg/kg $NaNO_2$; ■, 0% NaL and 60 mg/kg $NaNO_2$; ▲, 3% NaL and 30 mg/kg $NaNO_2$; ◆, 3% NaL and 60 mg/kg $NaNO_2$.

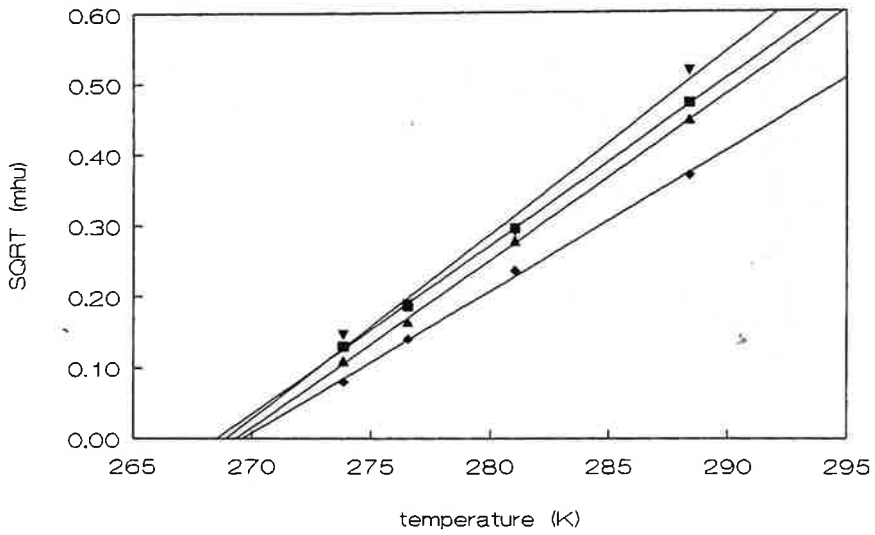


Figure 3 Relationship between the square root of the growth rate and the temperature for *L. curvatus* growing in vacuum-packaged Bologna-type sausage with 1% salt, 60 mg/kg nitrite and: ▼, 0% sodium lactate (NaL); ■, 1% NaL; ▲, 2% NaL; ♦, 3% NaL.

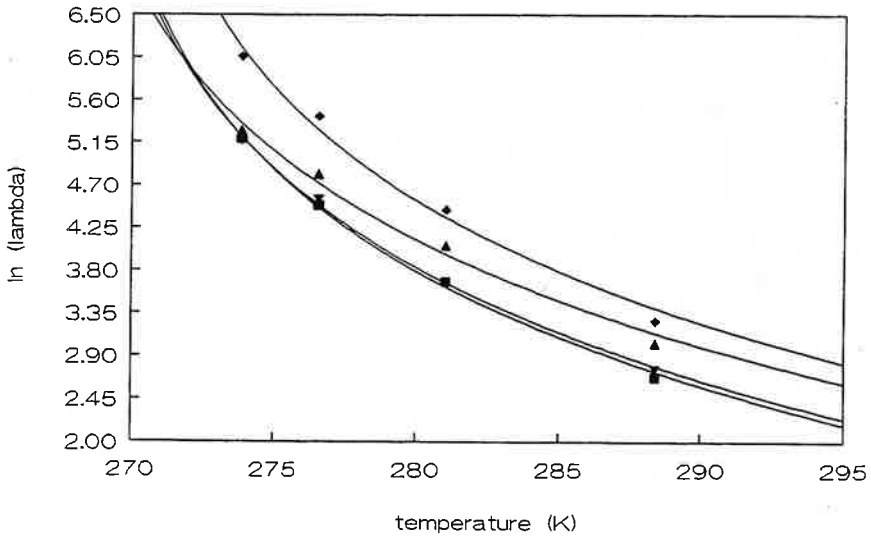


Figure 4 Relationship between the logarithm of the lag time and the temperature for *L. curvatus* growing in vacuum-packaged Bologna-type sausage with 1% salt, 60 ppm nitrite and: ▼, 0% sodium lactate (NaL); ■, 1% NaL; ▲, 2% NaL; ♦, 3% NaL.

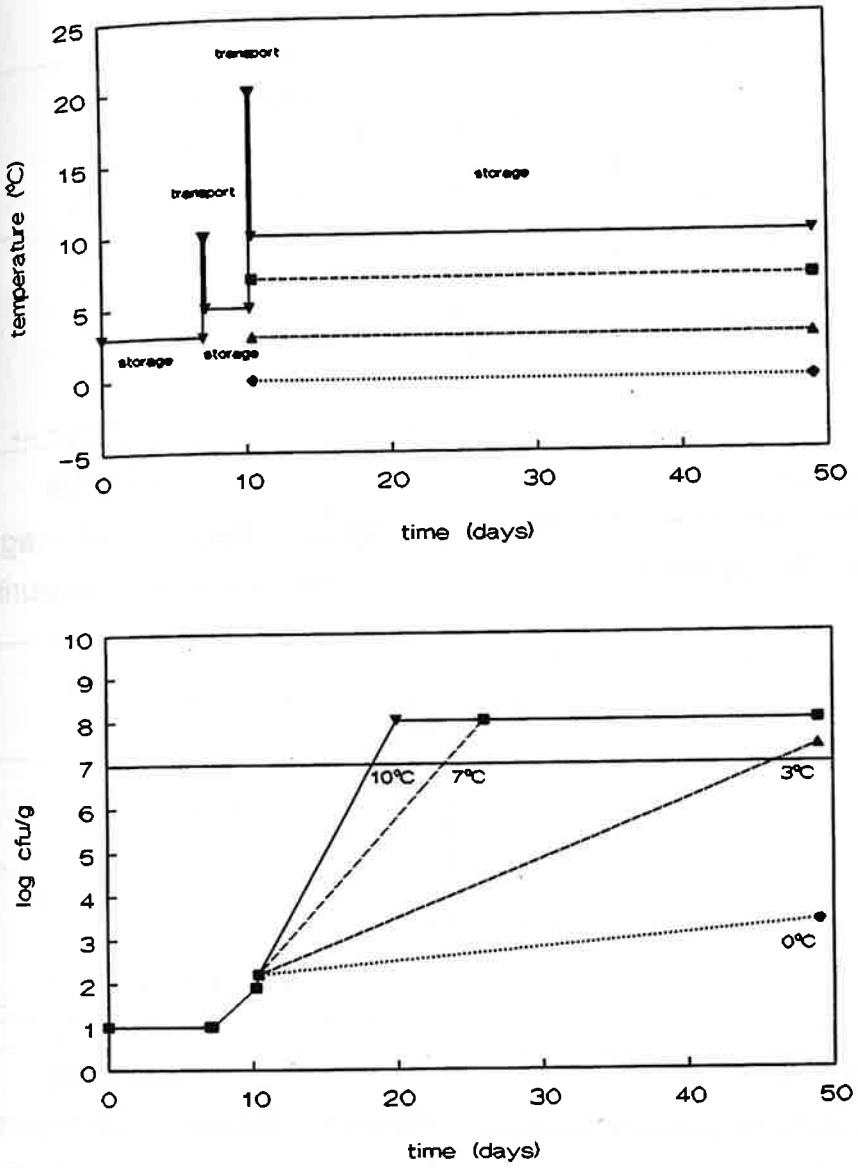


Figure 5

Predicted growth of *L. curvatus* in vacuum-packaged Bologna-type sausage as affected by different storage temperatures during an imaginary distribution process

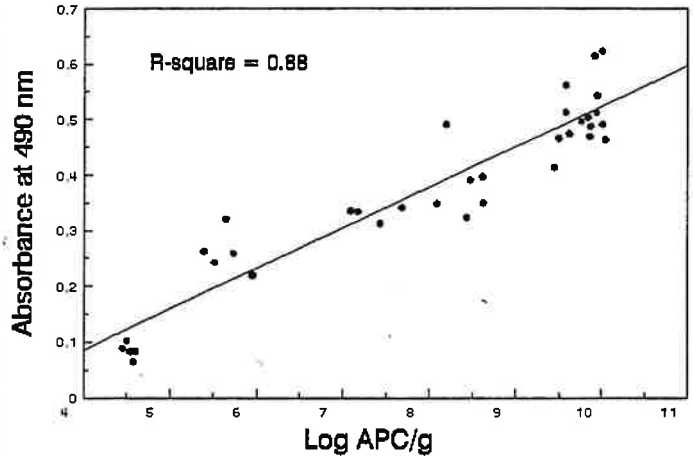


Figure 1 : First-order regression between bacterial count and FDA hydrolysis

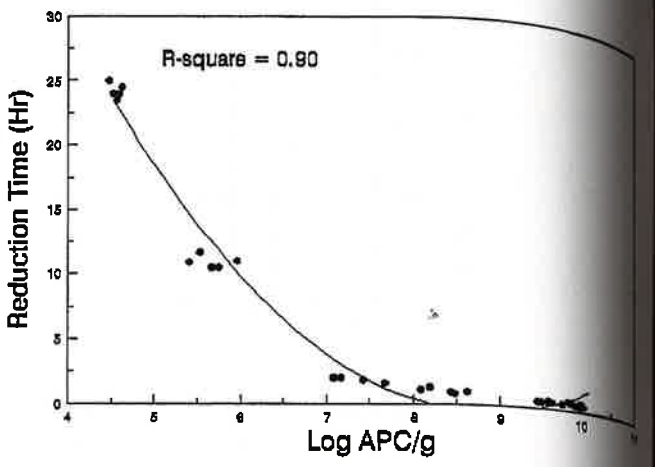


Figure 2 : Second-order regression between bacterial count and resazurin reduction

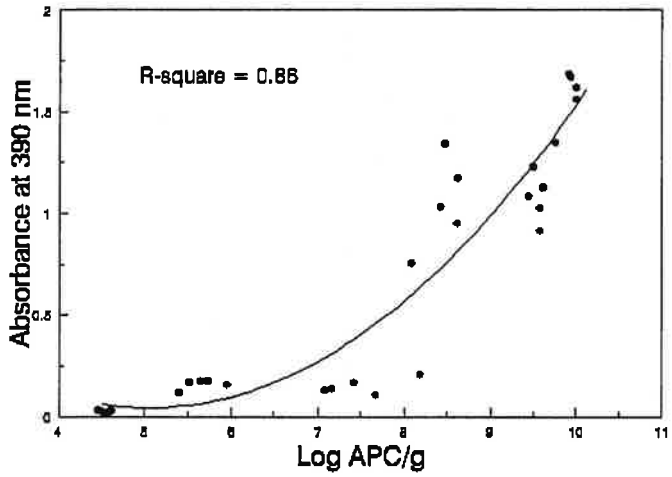


Figure 3 : Second-order regression between bacterial count and Aminopeptidase activity

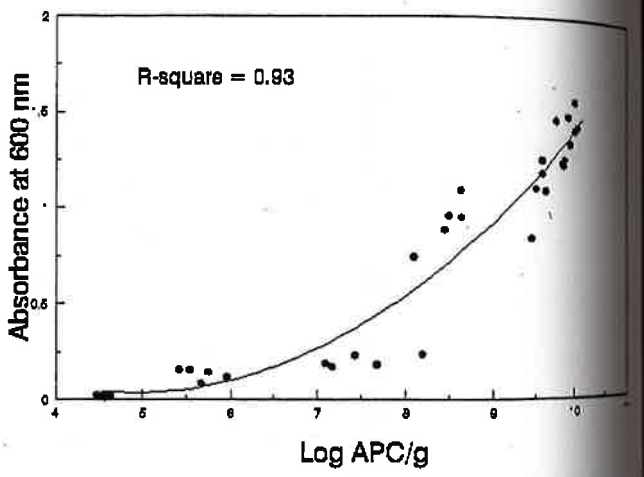


Figure 4 : Second-order regression between bacterial count and absorbance at 600 nm

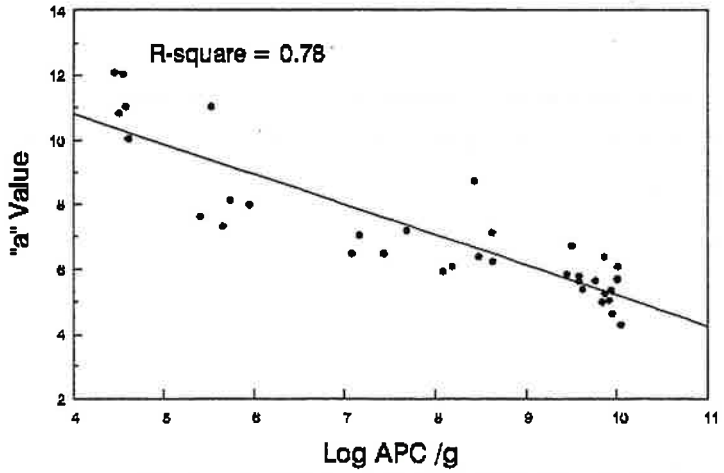


Figure 5 : First-order regression between bacterial count and "a" value

Figure 1 - Aerobic plate counts of PVC packaged steaks at 3 days of retail display after vacuum storage at either -1.1° or 2°C. (C = control, CA = sprayed with lactic acid post-storage, Aa and Aw = sprayed with lactic acid pre-storage, AW = sprayed with lactic acid pre-storage and water post-storage, AA = sprayed with lactic acid pre- and post-storage)

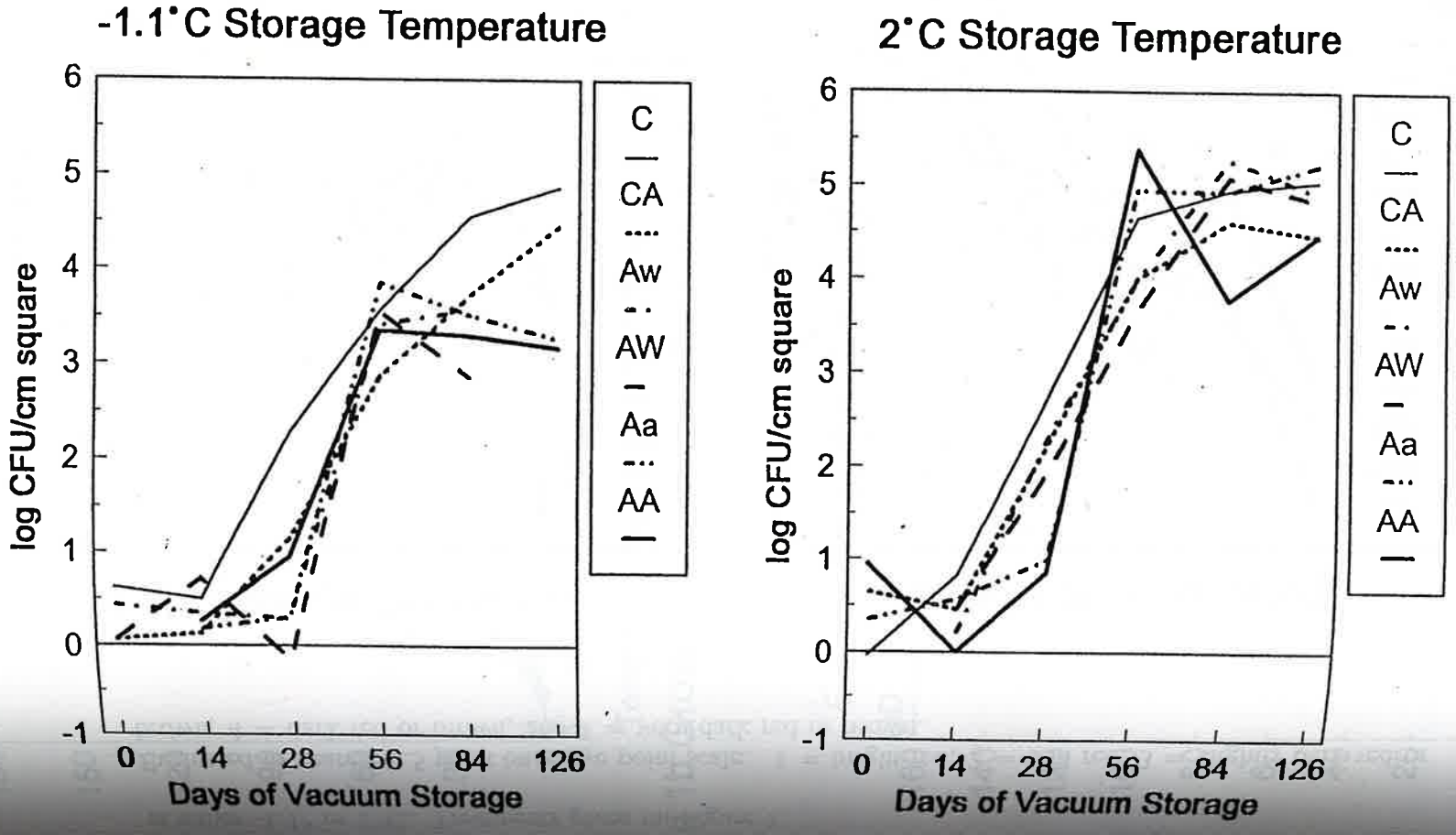
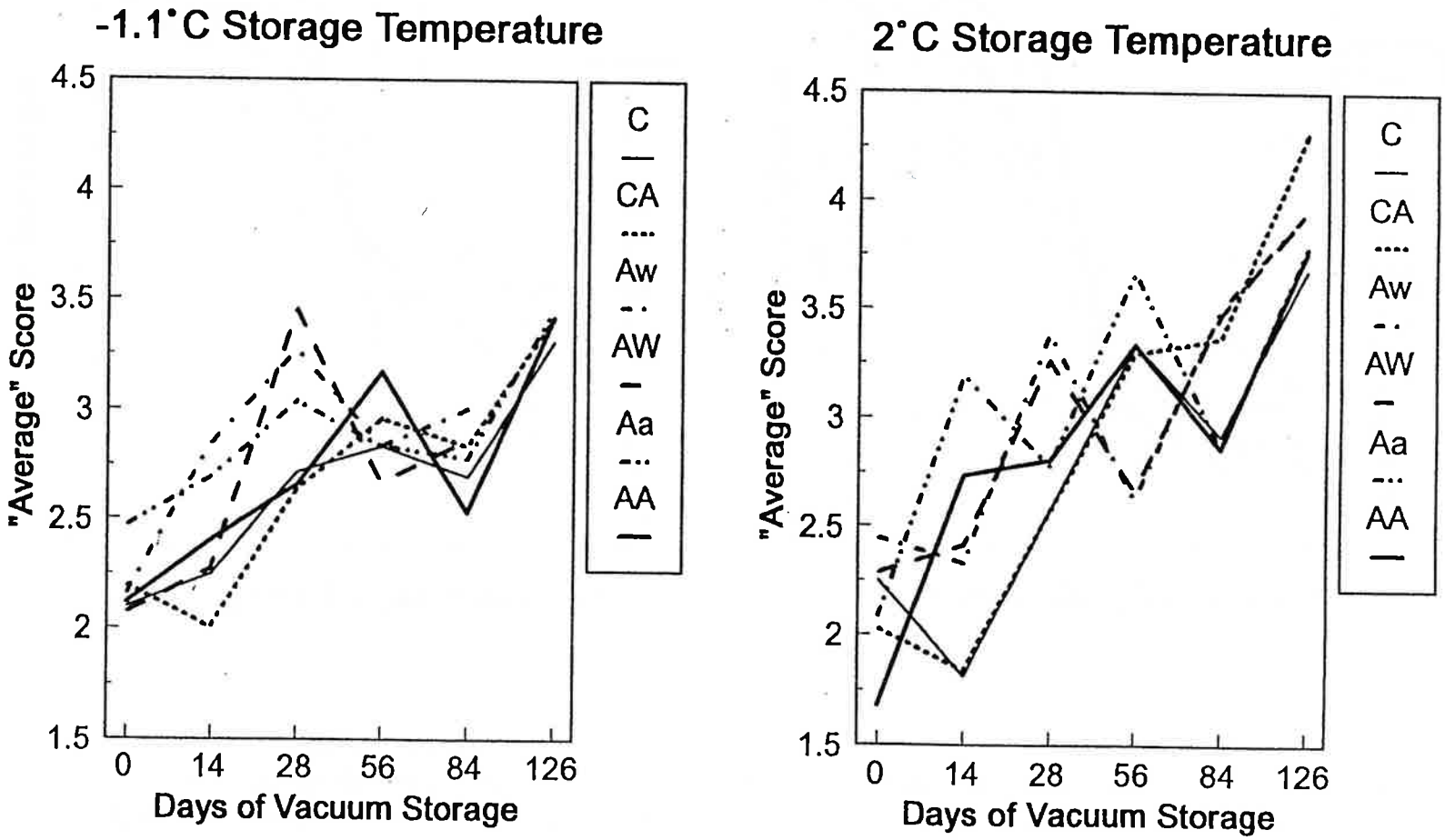


Figure 2 - Average visual color score[a] of PVC packaged steaks at 3 days of retail display after vacuum storage at either -1.1° or 2°C. Treatments given on Figure 1.

Evaluated to nearest 0.5 point on a five point scale: 1 = bright red, 2 = dull red, 3 = slightly dark red or brown, 4 = dark red or brown, and 5 = very dark red or brown.



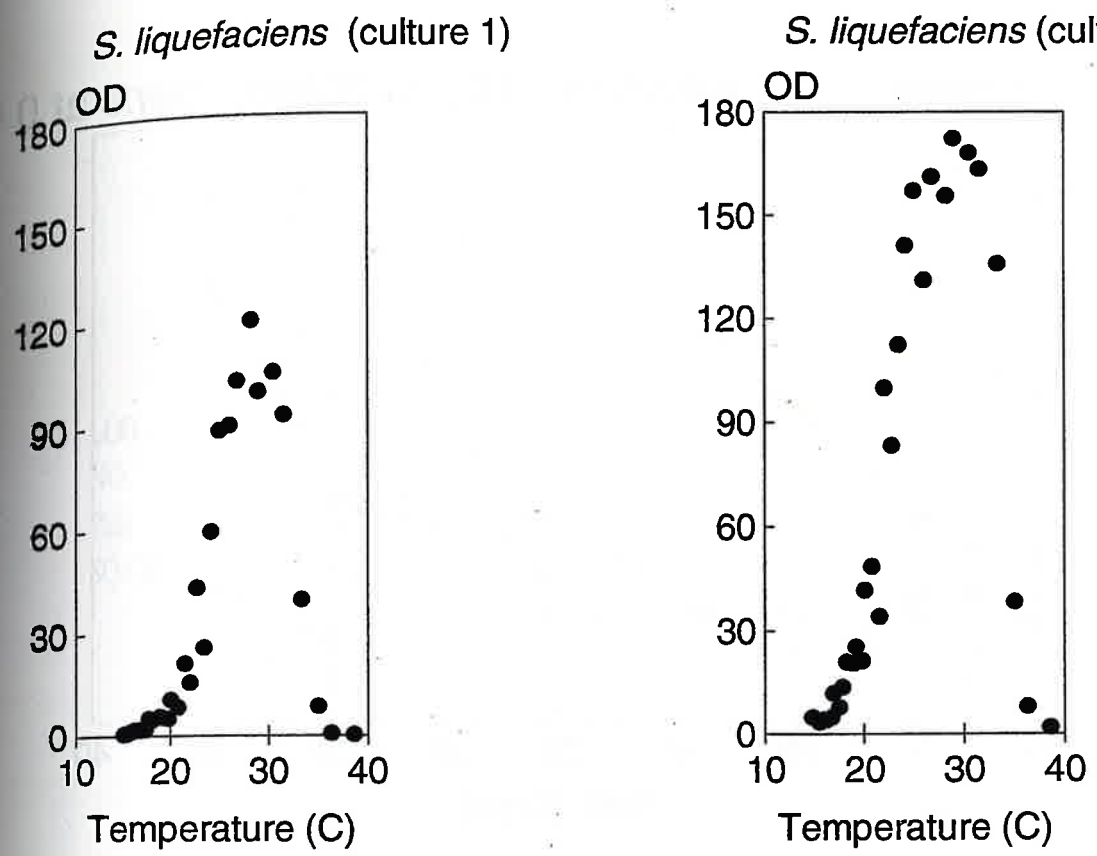


Fig 1b Growth of *Serratia liquefaciens* in BHIYE broth.

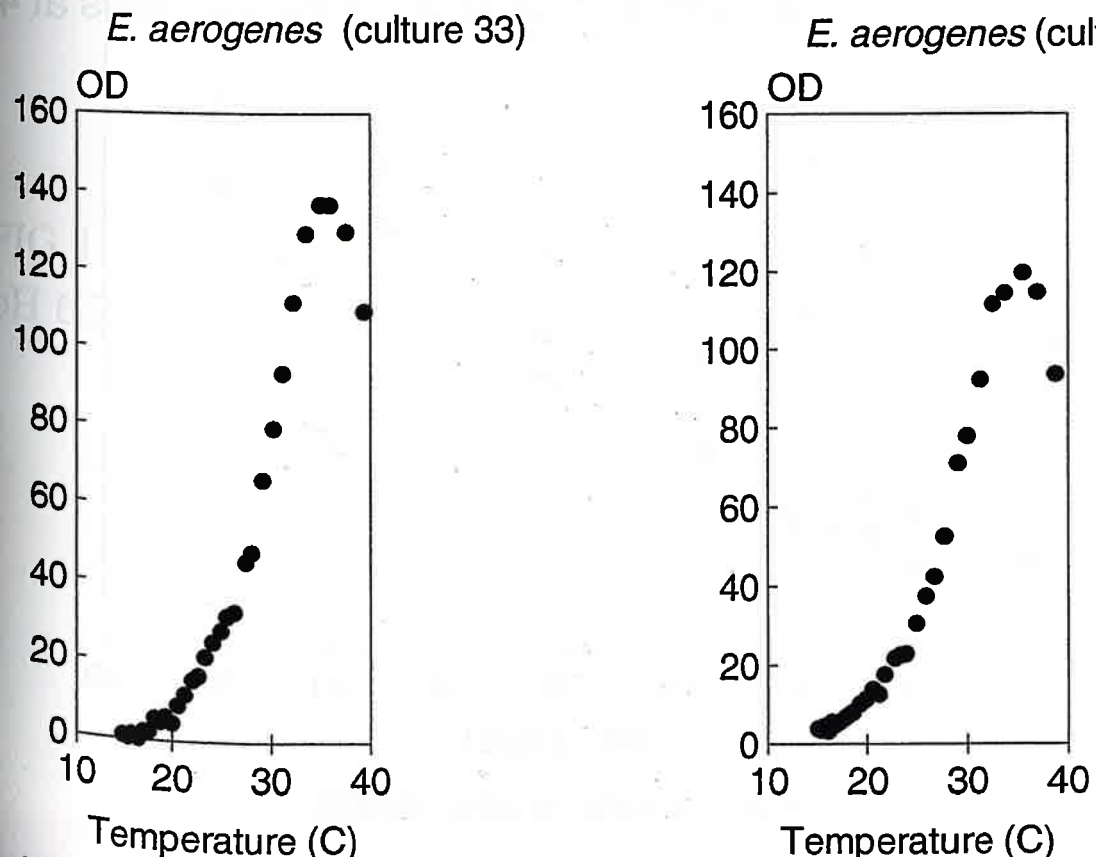
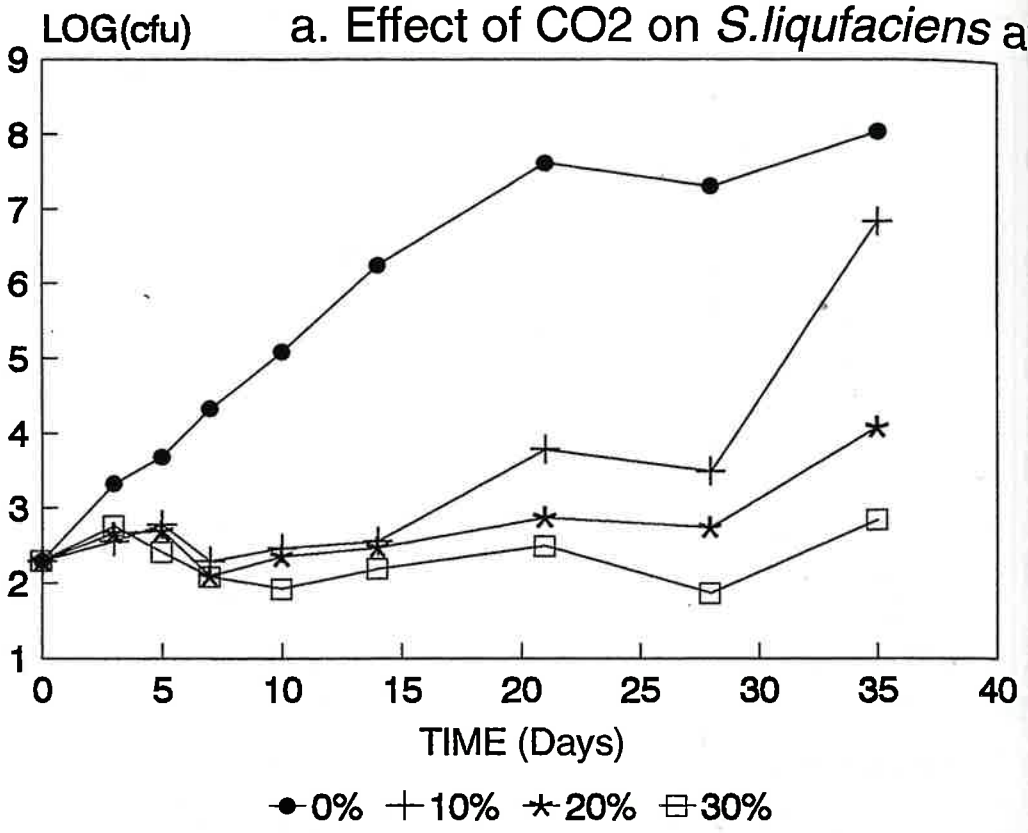


Fig 1a. Growth of *Enterobacter aerogenes* in BHIYE broth.



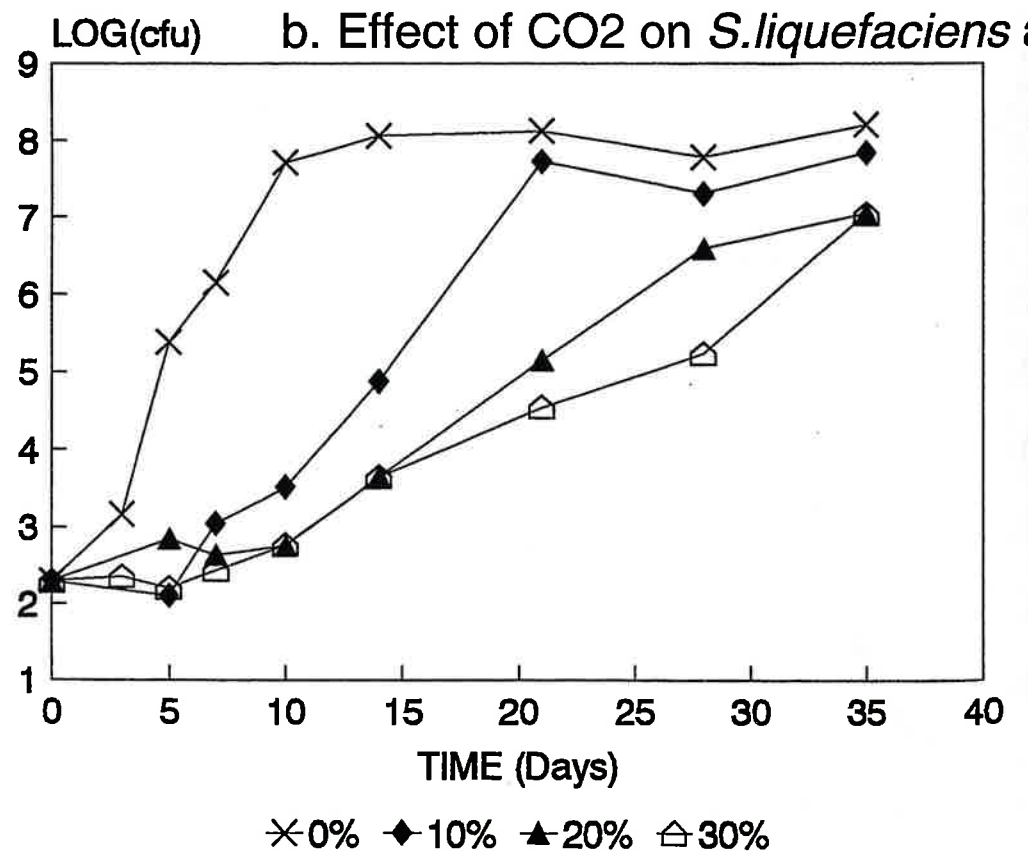


Fig 2. Growth of *Serratia* in VP with CO2

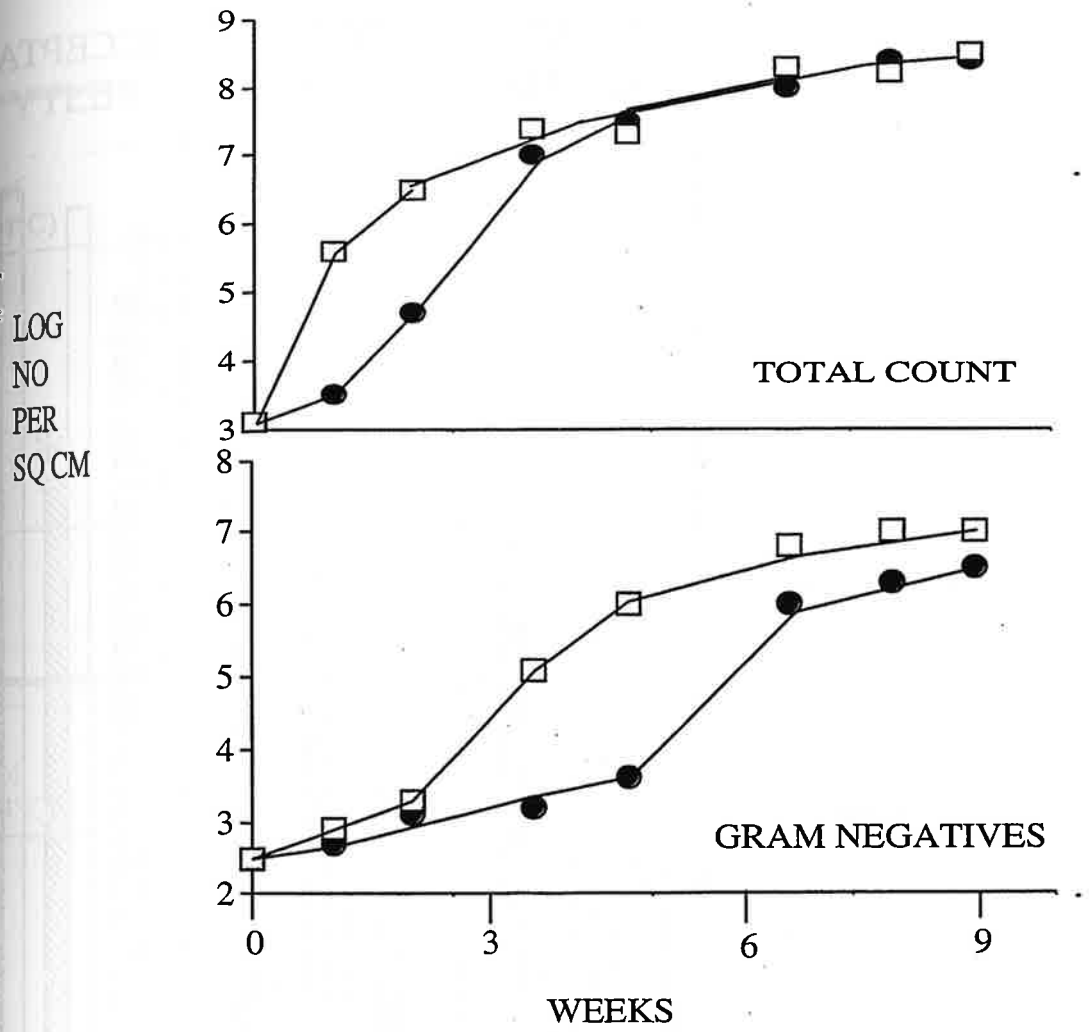


FIG 1. Growth of bacteria on vacuum-packaged pork of pH 6.2 to 6.6 stored at 0°C, □ and -1°C, ●.

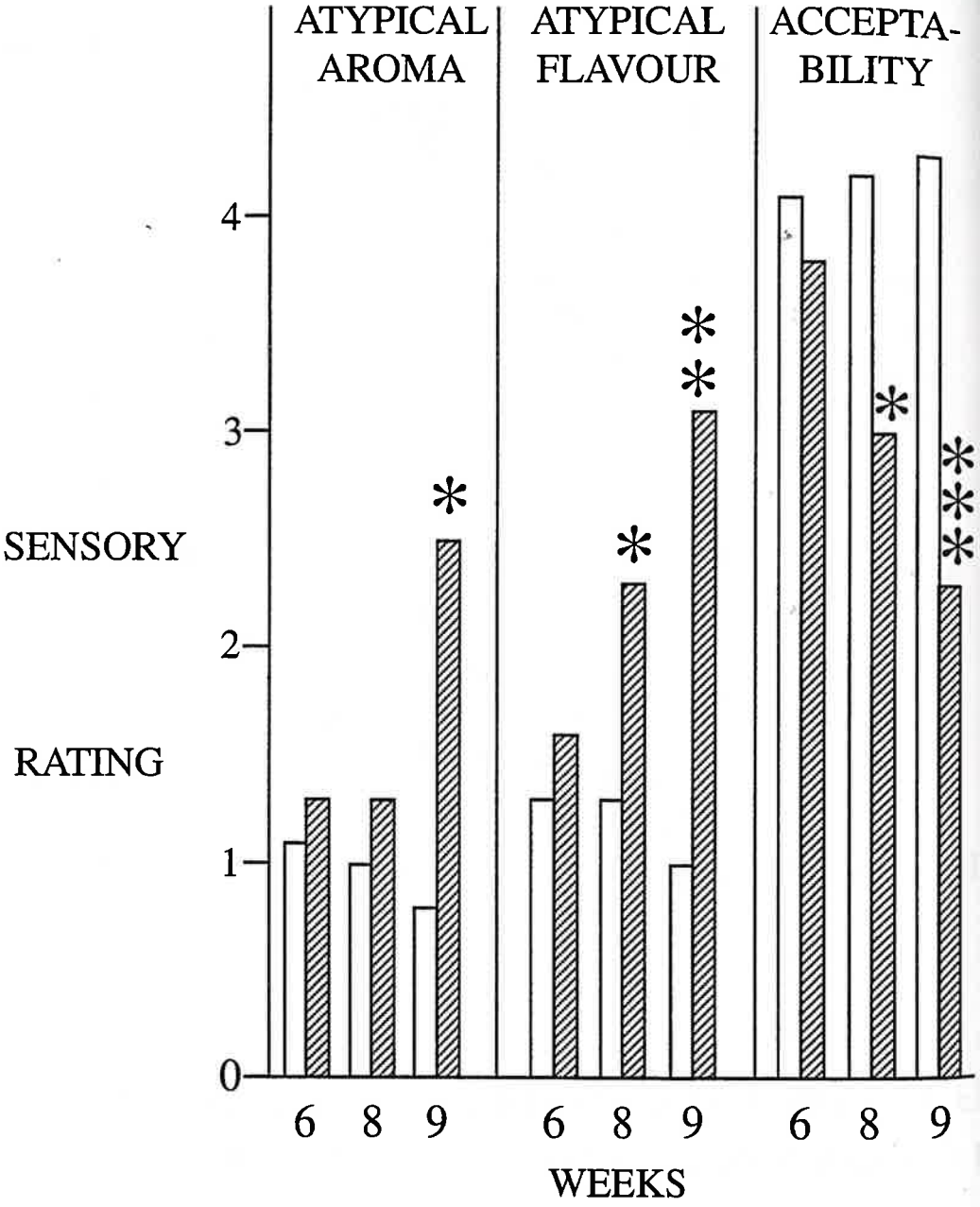


FIG 2. Taste panel assessment of pork stored at -20°C, □ and -1°C, ▨. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

Table 1

Days of storage (4°C)	*Listeria monocytogenes* Counts (log CFU/g)			
	Control	Sodium acetate	Sodium lactate	Potassium sorbate
0	3.46 ± 0.22	3.33 ± 0.08	3.35 ± 0.06	3.14 ± 0.18
7	5.75 ± 0.14	3.84 ± 0.08	5.32 ± 0.33	3.33 ± 0.03
14	8.29 ± 1.41	4.86 ± 0.36	7.07 ± 0.46	3.25 ± 0.07
21	7.29 ± 0.00	5.01 ± 0.34	8.14 ± 1.34	3.08 ± 0.13
28	7.58 ± 0.06	4.93 ± 0.46	5.80 ± 0.30	3.22 ± 0.05
42	7.25 ± 7.40	6.32 ± 0.04	8.56 ± 1.03	3.11 ± 0.14
56	8.28 ± 0.13	6.45 ± 0.04	5.07 ± 3.69	4.82 ± 3.10

Table 2

Days of storage (4°C)	*Listeria monocytogenes* Counts (log CFU/g)			
	Control	Sodium acetate	Sodium lactate	Potassium sorbate
0	2.93 ± 0.05	2.93 ± 0.08	2.81 ± 0.26	2.75 ± 0.24
7	5.58 ± 0.08	3.11 ± 0.20	5.27 ± 0.49	3.00 ± 0.10
14	7.42 ± 0.25	3.71 ± 0.16	6.92 ± 0.38	2.89 ± 0.11
21	6.83 ± 0.19	4.08 ± 0.45	6.05 ± 1.74	2.65 ± 0.07
28	7.17 ± 0.00	4.55 ± 0.11	6.89 ± 0.57	2.45 ± 0.39
42	7.91 ± 0.65	5.40 ± 1.12	8.26 ± 0.01	3.12 ± 0.04
56	8.10 ± 0.23	6.23 ± 1.64	8.01 ± 0.67	1.78 ± 0.43

Table 3

Days of storage (4°C)	Total Aerobic Mesophilic Plate Counts (log CFU/g)			
	Control	Sodium acetate	Sodium lactate	Potassium sorbate
0	4.51 ± 0.12	4.44 ± 0.37	4.30 ± 0.81	4.12 ± 0.15
7	7.29 ± 0.00	5.13 ± 0.41	6.71 ± 0.74	3.81 ± 0.08
14	8.67 ± 0.71	6.02 ± 0.07	8.10 ± 0.02	3.72 ± 0.01
21	9.29 ± 0.00	6.79 ± 1.05	8.99 ± 0.35	3.98 ± 0.16
28	9.29 ± 0.00	6.51 ± 0.99	8.61 ± 0.07	3.83 ± 0.20
42	9.27 ± 0.47	7.49 ± 0.11	8.94 ± 0.49	3.84 ± 0.35
56	9.19 ± 0.18	7.00 ± 0.20	6.09 ± 3.66	4.28 ± 1.43

Table 4

Days of storage (4°C)	Total Aerobic Mesophilic Plate Counts (log CFU/g)			
	Control	Sodium acetate	Sodium lactate	Potassium sorbate
0	3.42 ± 0.19	3.55 ± 0.17	4.58 ± 0.28	3.94 ± 0.00
7	6.64 ± 0.92	4.19 ± 0.70	5.63 ± 0.42	3.81 ± 0.02
14	8.53 ± 1.54	4.82 ± 1.02	8.10 ± 0.05	3.25 ± 0.18
21	9.29 ± 0.00	5.90 ± 0.20	8.28 ± 0.02	4.10 ± 0.09
28	7.19 ± 2.12	5.87 ± 0.27	8.60 ± 0.09	3.11 ± 0.17
42	9.66 ± 0.00	5.97 ± 0.12	8.59 ± 0.01	3.37 ± 0.13
56	8.87 ± 0.35	7.42 ± 0.44	8.86 ± 0.61	3.94 ± 1.91

Table 5

Days of storage (4°C)	Product pH			
	Control	Sodium acetate	Sodium lactate	Potassium sorbate
0	6.79 ± 0.01	6.76 ± 0.02	6.77 ± 0.00	6.82 ± 0.00
7	6.67 ± 0.01	6.73 ± 0.01	6.86 ± 0.10	6.75 ± 0.00
14	6.28 ± 0.01	6.43 ± 0.02	6.35 ± 0.00	6.48 ± 0.10
21	5.80 ± 0.02	6.38 ± 0.02	6.01 ± 0.10	6.48 ± 0.02
28	5.20 ± 0.03	6.49 ± 0.00	5.64 ± 0.01	6.52 ± 0.01
42	5.19 ± 0.10	6.47 ± 0.02	5.67 ± 0.01	6.50 ± 0.03
56	5.14 ± 0.04	6.58 ± 0.01	5.53 ± 0.15	6.60 ± 0.01

Table 6

Days of storage (4°C)	Product pH			
	Control	Sodium acetate	Sodium lactate	Potassium sorbate
0	6.83 ± 0.01	6.85 ± 0.00	6.83 ± 0.01	6.89 ± 0.01
7	6.68 ± 0.01	6.72 ± 0.01	6.68 ± 0.02	6.78 ± 0.01
14	6.32 ± 0.04	6.42 ± 0.03	6.37 ± 0.00	6.45 ± 0.02
21	5.71 ± 0.06	6.47 ± 0.01	6.33 ± 0.05	5.99 ± 0.70
28	5.25 ± 0.03	6.43 ± 0.04	5.62 ± 0.04	6.45 ± 0.00
42	5.31 ± 0.07	6.45 ± 0.02	5.67 ± 0.03	6.52 ± 0.00
56	5.07 ± 0.13	6.54 ± 0.01	5.54 ± 0.02	6.65 ± 0.01

Table 1. COLOR CHANGES DURING STORAGE

Days of Storage at 0°C.

Treatment	0	2	4	8	10	12
Control	Red	Brown	Reddish Brown	Brown	Light Brown	Brown
MA	Red	Bright Red	Red	Deep Red	Deep Red	Dull Red
MA+1.2% L.A	Red	Bright Red	Red	Deep Red	Brown	Red
M.A+3% L.A	Red	Red	Brown	Brown	Reddish Brown	Red

TABLE 2. NON-LINEAR REGRESSION RESULTS

	a	SST	SSE	A	B	C	D	E
CONTROL	10.49	187.50	14.58	234.04	24.14	-112.71775	-0.49465	-0.44
MA TREATMENT	18.54	73.34	49.42	121.70	167.17	0.00001	-0.00178	-0.33
MA +1.2% L.A.	17.58	205.69	70.65	1.73	-0.16	3.05746	-0.69898	0.38
MA +3.0% L.A.	14.88	413.61	265.11	2.10	42.79	0.00001	0.00028	0.25

a, AVERAGES OF OBSERVED VALUES
SSE, SUM OF SQUARES OF ERRORS
SST, SUM OF TOTALS, SQUARED
A,B,C,D AND E ARE ESTIMATED PARMETERS

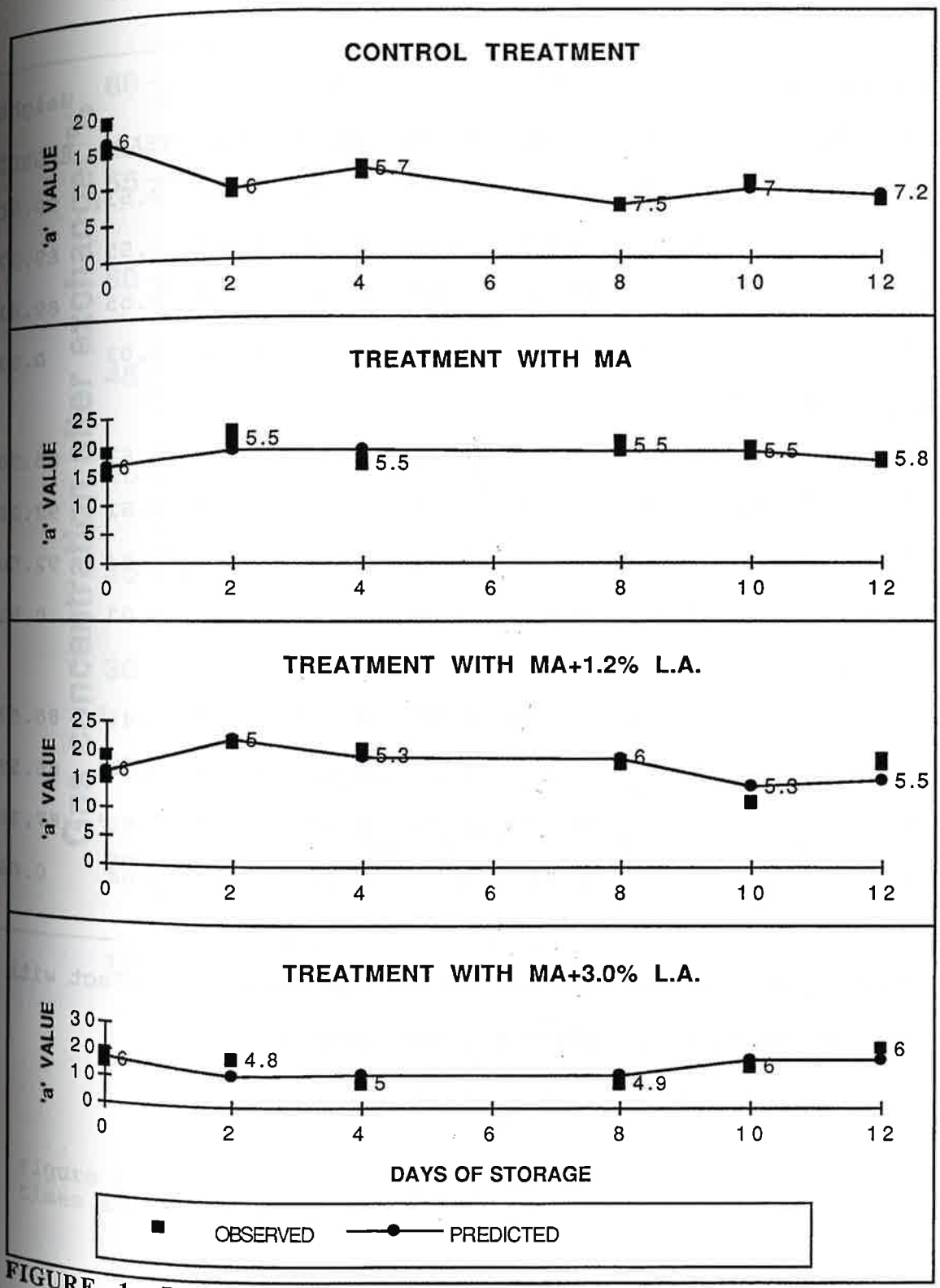


FIGURE 1. Preficted and Observed 'a' Values with Respect to Time. (Numbers next to observations are pH levels.)

Table 1. Properties of beef with postmortem fabrication time, packaging system, and display time.

Postmortem time, hr	pH	L value	a value	b value	PPC	TBARS	Weight Retention
½	5.69[a]	28.36[c]	13.88[a]	6.38[c]	3.75[c]	0.53	90.90[a]
48	5.54[b]	30.20[b]	14.03[a]	7.60[b]	4.06[b]	0.55	89.27[b]
96	5.51[b]	31.44[a]	12.27[b]	8.20[a]	4.76[a]	0.55	89.91[a]
s.e.m.	0.02	0.34	0.36	0.12	0.06	0.03	0.51
Package system							
VP-PVC	5.60	29.38[b]	14.12[a]	7.38	4.38[a]	0.57	85.30[b]
80% O_2:20% CO_2	5.58	30.68[a]	13.18[ab]	7.46	4.12[b]	0.51	92.28[a]
60% O_2:40% CO_2	5.57	29.94[ab]	12.88[b]	7.34	4.07[b]	0.54	92.50[a]
s.e.m.	0.02	0.34	0.36	0.12	0.06	0.03	0.51
Display, hr							
0	5.60	28.96[b]	10.07[b]	6.31[b]	4.90[b]	0.46[b]	86.67
12	5.54	31.15[a]	16.79[a]	9.04[a]	5.33[a]	0.74[a]	86.59
24	5.55	32.00[a]	16.14[a]	8.97[a]	5.26[a]	0.80[a]	87.38
s.e.m.	0.03	0.44	0.47	0.16	0.07	0.04	0.66

[abc]Least squares means in a column for the same main effect with the same superscripts are not different ($p<0.05$).

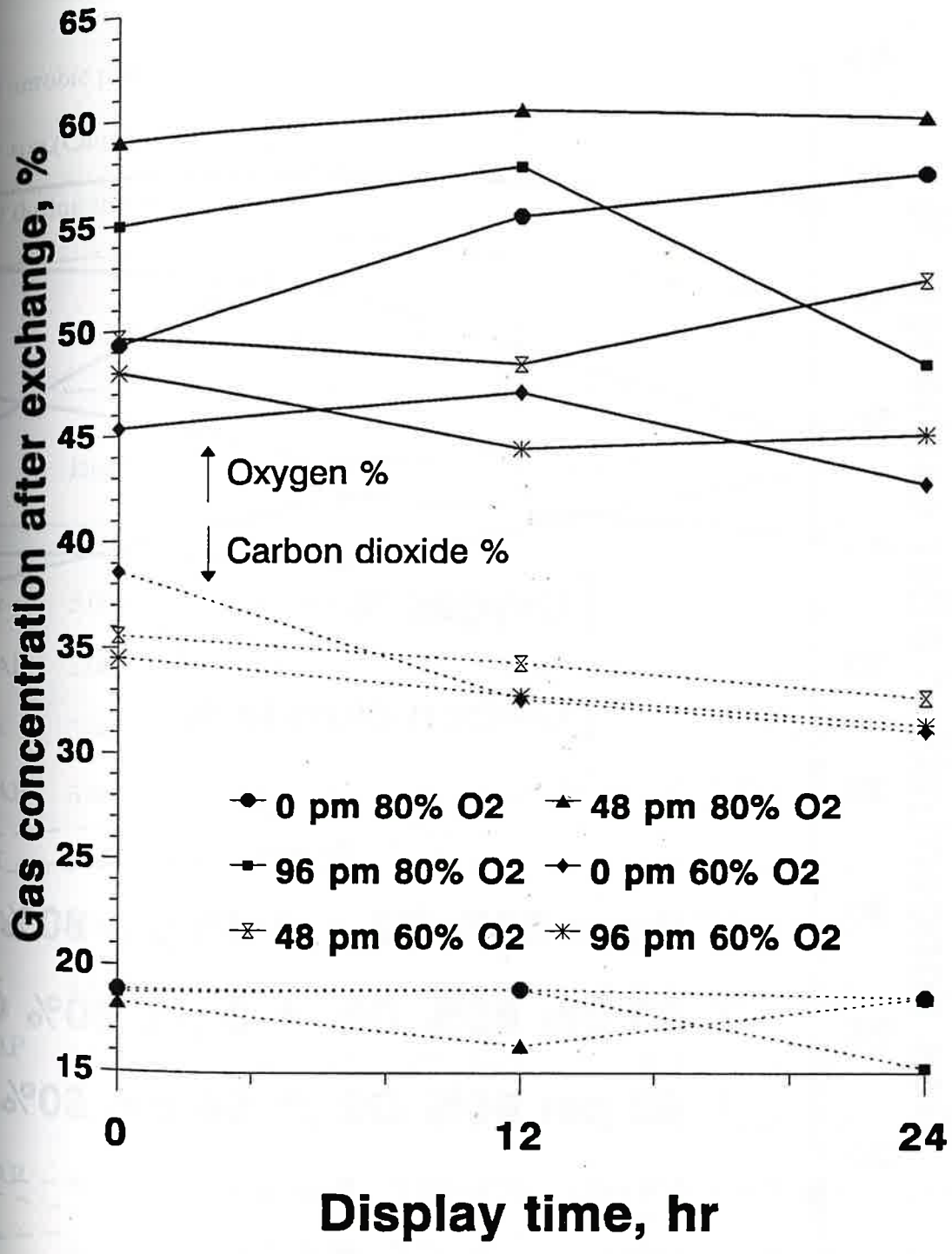
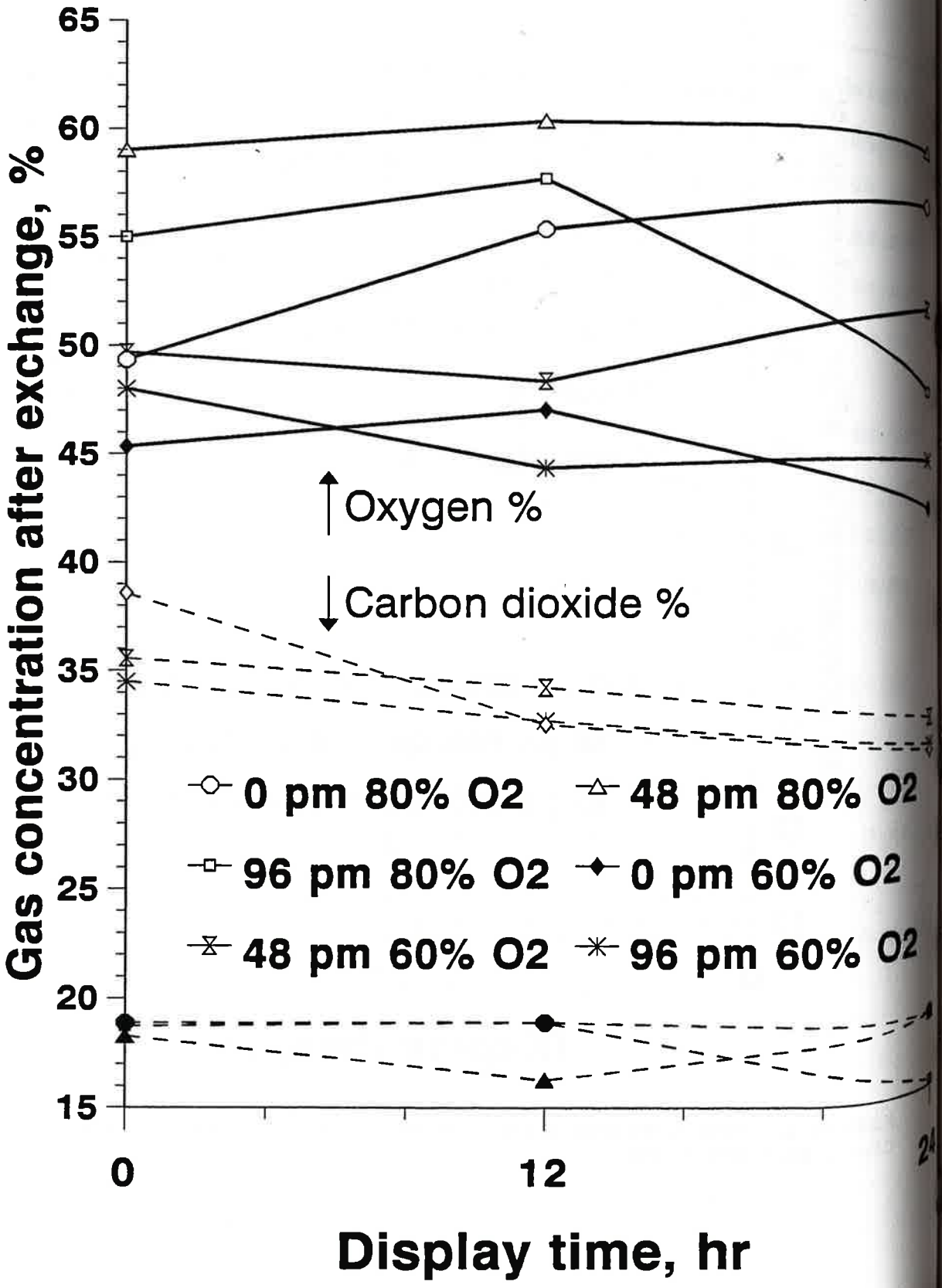


Figure 1. Gas concentration in MAP with different postmortem times and gas mixes.


Gas concentration after exchange, %
65
60
55
50
45
40
35
30
25
20
15
Oxygen %
Carbon dioxide %
0 pm 80% O2
48 pm 80% O2
96 pm 80% O2
0 pm 60% O2
48 pm 60% O2
96 pm 60% O2
0
12
Display time, hr

tal aerobic plate count(APC), total Enterobacteriaceae(Ent) and behaviour of
ter spp.(Camp), *L. monocytogenes*(List), *S. typhimurium*(Salm) and *Y. enterocolitica*(Yers)
=3) during storage in air or MAP at 3±1°C.

	No. of organisms in average $\log_{10}$ CFU or MPN/cm^2 ± s.e.					
	Day 0	Day 2	Day 4	Day 7	Day 9	Day 11
Air	5.00±0.10	4.96±0.03	5.41±0.30	7.99±0.15	8.92±0.22	8.61±0.74
MAP	5.00±0.10	4.86±0.02	4.81±0.05	4.82±0.15	5.04±0.15	4.77±0.10
Air	3.96±0.11	4.35±0.07	4.70±0.25	5.05±0.79	5.37±0.69	5.81±0.81
MAP	3.96±0.11	4.26±0.06	4.37±0.08	4.25±0.12	4.02±0.24	3.64±0.03
Air	6.36±0.14	5.56±0.32	4.65±0.41	3.71±0.81	3.34±0.74	2.22±1.00
MAP	6.36±0.14	4.91±0.30	2.26±0.74	1.94±0.87	0.86±0.26	0.78±0.19
Air	4.62±0.10	4.65±0.30	4.60±0.29	4.55±0.12	4.28±0.18	4.11±1.18
MAP	4.62±0.10	4.43±0.20	4.88±0.29	4.66±0.12	4.51±0.07	4.33±0.25
Air	4.43±0.00	4.29±0.33	4.76±0.19	4.33±0.29	4.08±0.00	4.17±0.33
MAP	4.43±0.00	4.44±0.33	4.89±0.10	4.68±0.32	4.43±0.20	4.45±0.22
Air	2.89±0.13	3.33±0.25	4.04±0.32	3.58±0.51	4.58±0.61	3.47±0.88
MAP	2.89±0.13	3.20±0.12	3.68±0.25	3.39±0.39	2.60±0.40	2.56±0.48

Table 1 : Mean counts at 28 days (log_{10}cfu/g) for Y.enterocolitica on lamb pieces packaged in different gas atmospheres and stored at 5 and 0°C.

Gas Atmosphere	Storage Temperature(°C)	
	5	0
80% O_2/20% CO_2	6.84	1.16
Vacuum Pack	8.11	5.88
50% CO_2/50% N_2	8.52	3.86
100% CO_2	5.56	1.56

Standard error of difference between means = 1.17
Degrees of freedom = 27

Table 2 : Mean counts at 28 days (log_{10}cfu/g) for Y.enterocolitica on minced lamb packaged in different gas atmospheres and stored at 5 and 0°C.

Gas Atmosphere	Storage Temperature(°C)	
	5	0
80% O_2/20% CO_2	2.40	0.78
Vacuum Pack	6.50	2.68
50% CO_2/50% N_2	5.25	1.29
100% CO_2	1.05	0.00

Standard error of difference between means = 1.17
Degrees of freedom = 27

Table 3 : Mean counts at 28 days (log_{10}cfu/g) for Y.enterocolitica on lamb pieces and mince packaged in different gas atmospheres and stored at 5°C.

Gas Atmosphere	Pieces	Mince
80% O_2/20% CO_2	6.84	2.40
Vacuum Pack	8.11	6.50
50% CO_2/50% N_2	8.52	5.25
100% CO_2	5.56	1.05

When comparing pieces versus mince for the same gas atmosphere, standard error of difference between means = 1.34.

When comparing gas atmospheres for pieces or mince, standard error of difference between means = 1.17

Degrees of freedom = 27

Table 4 : Mean counts at 28 days (log_{10}cfu/g) for Y.enterocolitica on lamb pieces and mince packaged in different gas atmospheres and stored at 0°C.

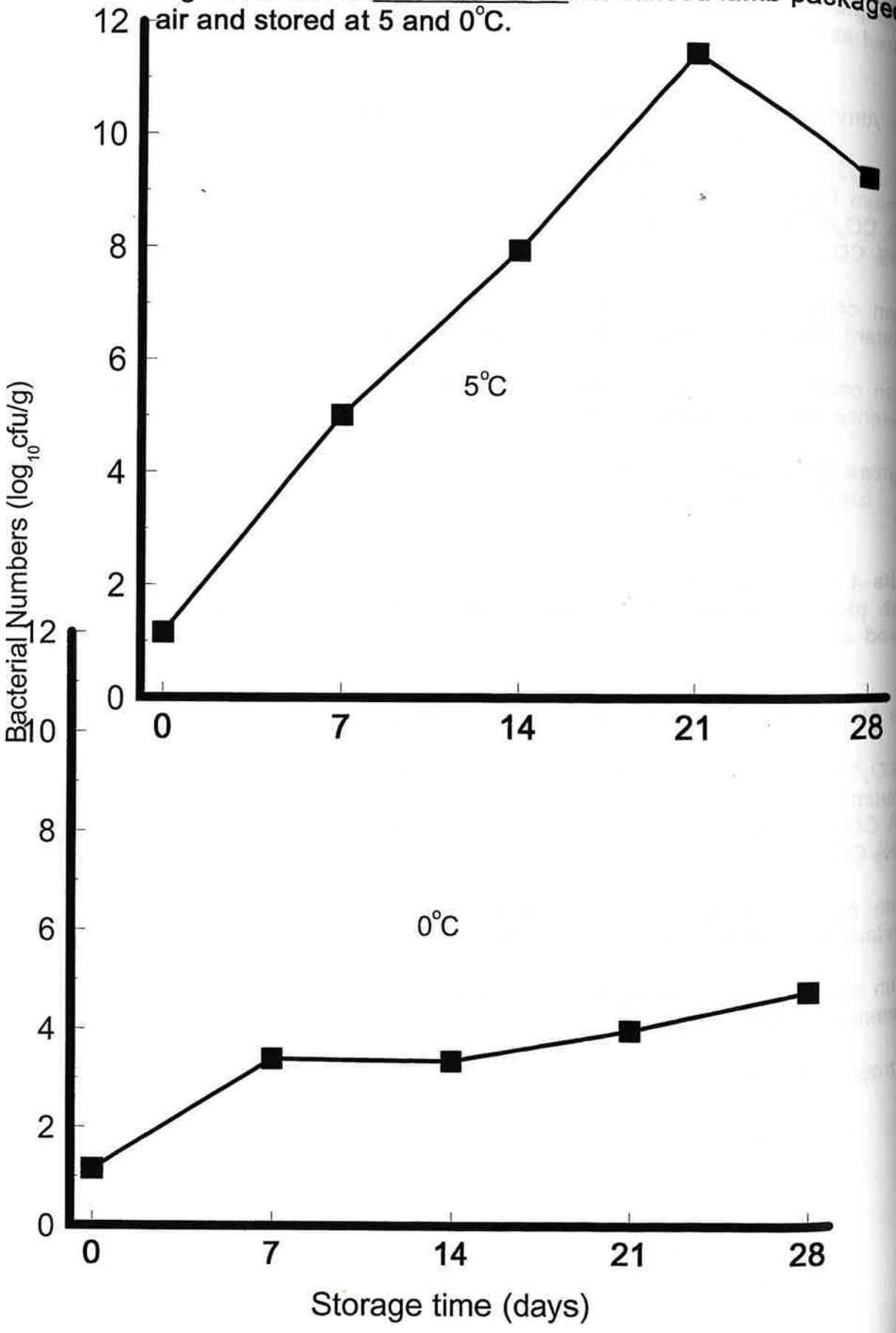
Gas Atmosphere	Pieces	Mince
80%O_2/20% CO_2	1.16	0.78
Vacuum Pack	5.88	2.68
50% CO_2/50% N_2	3.86	1.29
100% CO_2	1.56	0.00

When comparing pieces versus mince for the same gas atmosphere, standard error of difference between means = 1.34.

When comparing gas atmospheres for pieces or mince, standard error of difference between means = 1.17

Degrees of freedom = 27

Fig 1. Growth of Y.enterocolitica on minced lamb packaged in air and stored at 5 and 0°C.



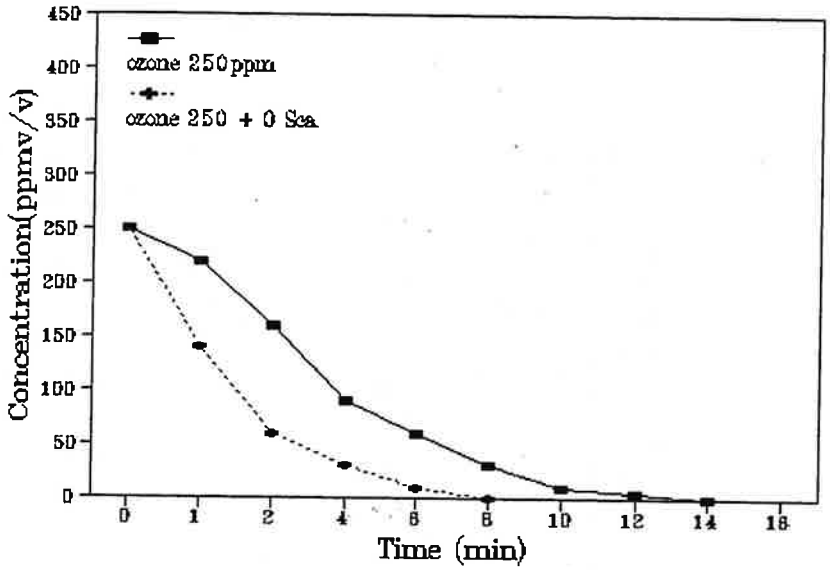


Fig. 1 Changes of Ozone Concentration in packaging at 5 C

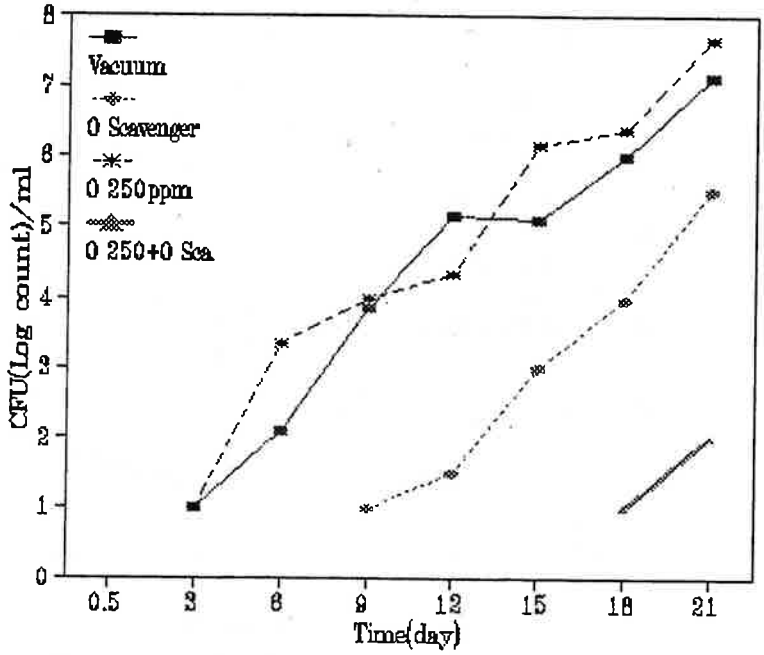


Fig 2. Growth of Total count bacteria in Vienna Sausage during storage at 5C

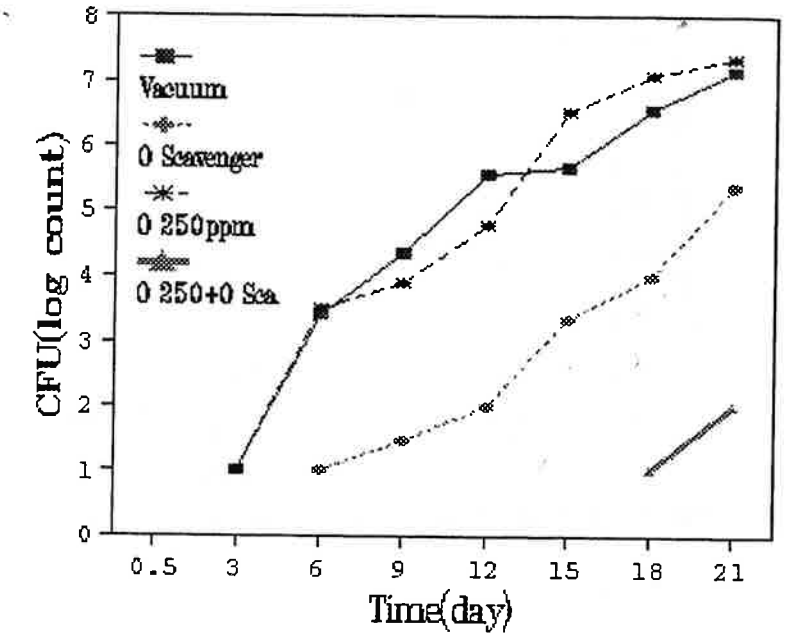


Fig 3. Growth of Psychrotropic bacteria in Vienna Sausage during storage at 5C

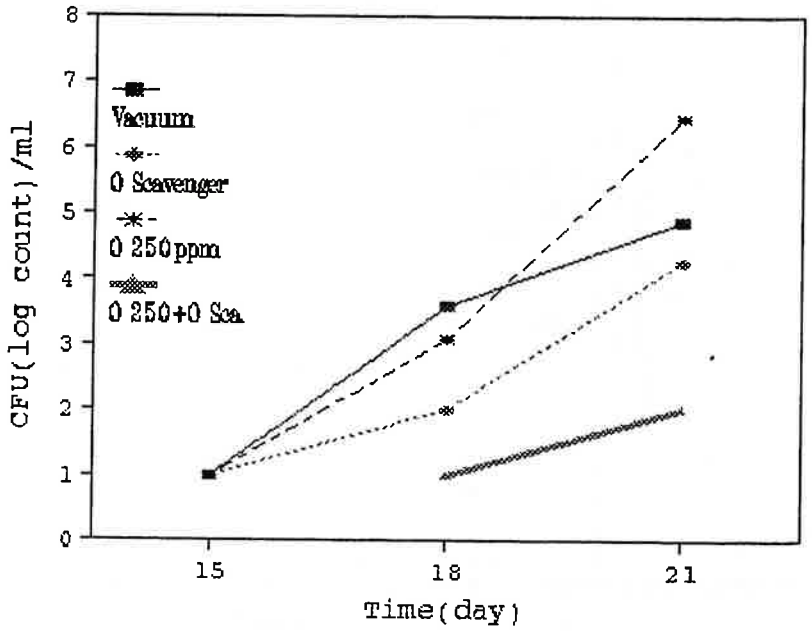


Fig 4. Growth of Lactic acid bacteria in Vienna Sausage during storage at 5C

Table 1. Changes of Nitroso-hematin value in Vienna Sausage during storage at 5℃ (n=3)

unit(%)

day Pac. method	0.5	6	12	21
Vacuum Packaging	62.9	55.4	84.3	71.7
O2 Scavenger Packaging	56.3	65.5	78.8	75.2
O3 Packaging	56.5	60.1	71.6	78.5
O2 Scavenger & O3 Packaging	62.1	62.4	68.4	66.2

Table 2. Changes of TBARS Value in Vienna Sausage during storage at 5℃ (n=3)

day Pac. method	0.5	6	12	21
Vacuum Packaging	0.030	0.020	0.025	0.033
O2 Scavenger Packaging	0.033	0.022	0.021	0.025
O3 Packaging	0.039	0.026	0.025	0.034
O2 Scavenger & O3 Packaging	0.031	0.027	0.018	0.021

Table 3. Changes of pH value in Vienna Sausage during storage at 5℃ (n=3)

day Pac. method	0.5	6	12	21
Vacuum Packaging	6.02	5.97	6.04	5.94
O2 Scavenger Packaging	6.02	5.98	6.08	6.07
O3 Packaging	5.98	6.03	6.10	6.03
O2 Scavenger & O3 Packaging	5.95	5.96	6.10	6.03

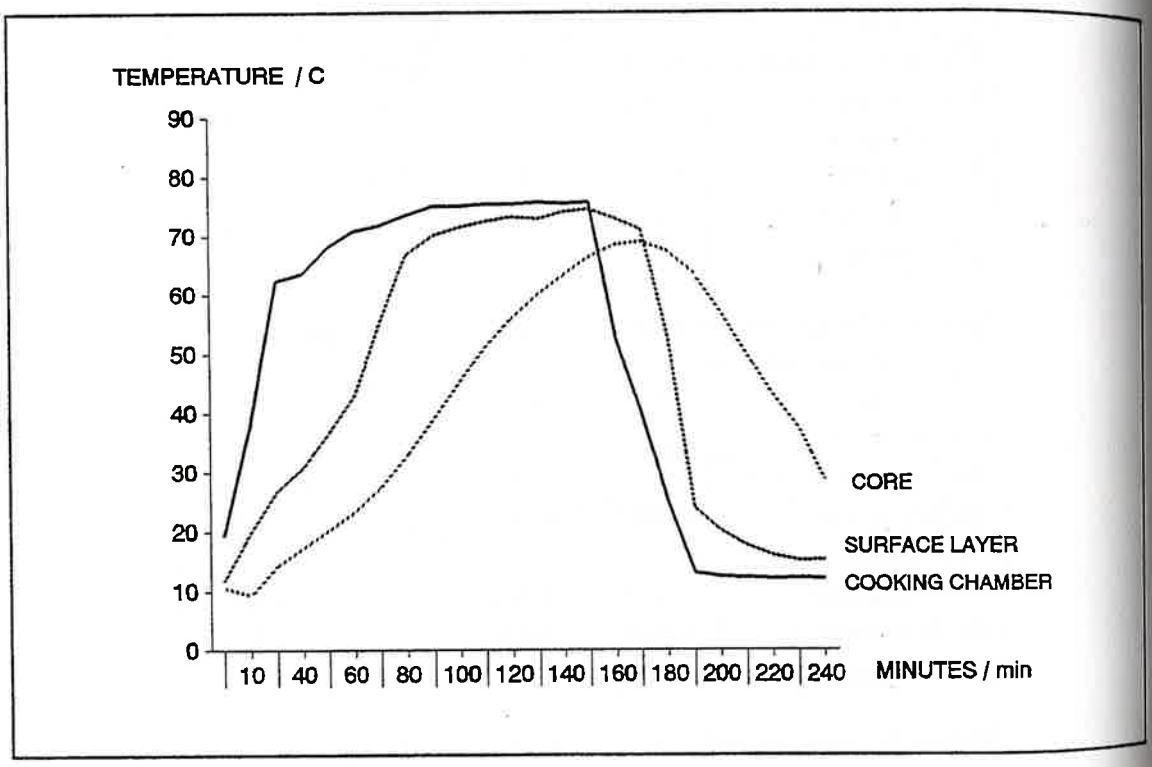


Figure 1. Temperature profile of cooking and chilling of experimental products.

Storing time, weeks		Surface layer pH-value <5.5	5.5-5.9	>6.0	Mixture	Core pH-value <5.5	5.5-5.9	>6.0	Mixture
		2)							
I	X	7.2^{a}	6.6^{a}	7.2^{a}	7.4^{a}	7.2^{a}	6.6^{a}	7.2^{a}	7.4^{a}
	s	0.5	0.6	0.6	0.6	0.5	0.6	0.6	0.6
0	X	2.0^{b}	3.0^{c}	2.2^{c}	1.3^{c}	2.1^{b}	2.4^{b}	1.9^{b}	2.7^{bc}
	s	1.0	1.2	0.5	0.6	0.9	0.5	0.5	0.4
2	X	3.3^{b}	3.6^{bc}	3.6^{bc}	2.5^{bc}	1.0^{b}A	2.4^{b}AB	3.3^{b}AB	3.9^{b}B
	s	1.9	0.6	0.5	1.6	0.0	1.2	1.6	1.4
4	X	5.7^{a}	4.6^{abc}	4.3^{b}	4.6^{ab}	3.4^{b}	4.2^{ab}	2.8^{b}	2.9^{bc}
	s	0.8	2.2	0.3	1.4	2.4	1.8	0.6	0.2
6	X	6.4^{a}A	6.1^{ab}AB	5.1^{b}AB	4.6^{b}B	3.4^{b}	3.5^{b}	3.4^{b}	1.5^{c}
	s	0.5	0.6	1.2	0.4	0.6	2.1	1.5	0.9

X = mean
s = standard deviation of mean
1) Means within the horizontal line not followed by the same capital letter are significantly different ($p<0.05$). If there are no letters after the means listed, there are no differences among them.
2) Means within the vertical line not followed by the same small letter are significantly different ($p=0.05$). If there are no letters after the means listed, there are no differences among them.

* The results of the surface layer and the centre of the products are calculated separately.

Table 1. Total count of aerobically growing bacteria (log colony forming units/g = cfu/g; plate count agar) in cooked meat products made from coarsely ground meat before and after cooking (0) and during storing for 6 weeks at 6°C.

Storage time, weeks		pH-value of meat raw-material <5.5 N=4	5.5-5.9 N=4	>6.0 N=4	<5.5+>6.0 1:1 N=3
2	P	0	0	0	0
2	S	0	0	0	0
4	P	1	1	1	1
4	S	0	0	0	0
5	P	3	3	3	3
5	S	1	2	2	1
6	P	4	4	4	3
6	S	3	3	4	2

Table 2. The appearance of bacterial growth (number of samples) in vacuum packages of whole products (P) and between slices packed in vacuum (S). The packages were stored at 6°C.

Experimental series	pH-value of meat raw-material <5.5	5-5.9	>6.0	<5.5+>6.0 1:1
I	5/9	8/9	8/9	7/9
II	3/10	10/10	9/10	-
III	1/7	7/7	6/7	5/7
IV	5/7	7/7	7/7	5/7
Total	14/33	*32/33	*30/33	*17/23

* significantly not-spoiled in paired test comparison ($p<0.05$)

Table 3. The number of "not-spoiled" evaluations on experimental products in different experimental series after storing for 6 weeks at 6°C ("not-spoiled evaluations/total number of evaluations).

Fig.1: Effect of 0% (A), 2.4% (B) and 4.8% of NaL in the heating broth (BHI) and 0% (circles), 2.4% (squares) and 4.8% (triangles) NaL in the recovery agar on the number of surviving *L.monocytogenes* cells heated at 60C for up to 30 min. Fig.1D: Refers to heating and recovery of the bacterium in the presence of the same level of NaL.

Fig.2 (A,B,C,D): Same conditions as in fig.1 but for *E.coli*.

Fig.3 (A,B,C,D): Same conditions as in fig.1 but for *Salmonella*.

FIGURE 1

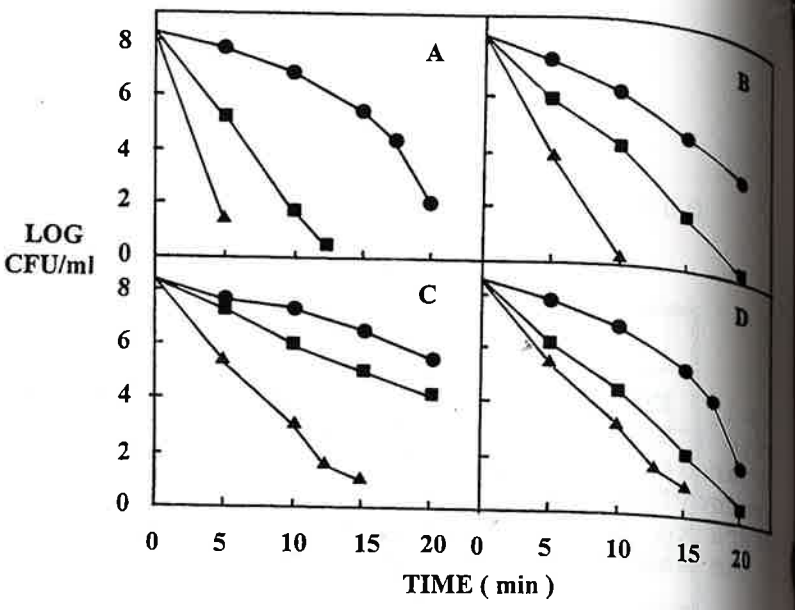


FIGURE 2

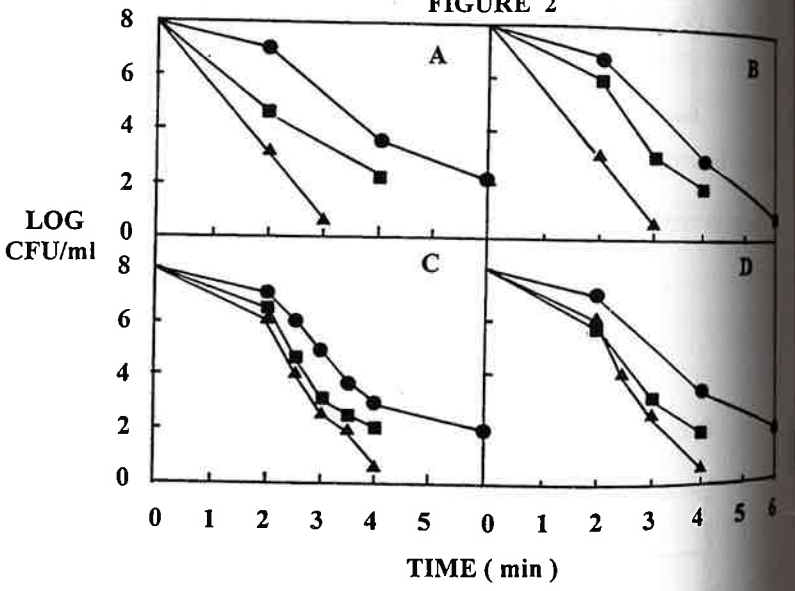


FIGURE 3

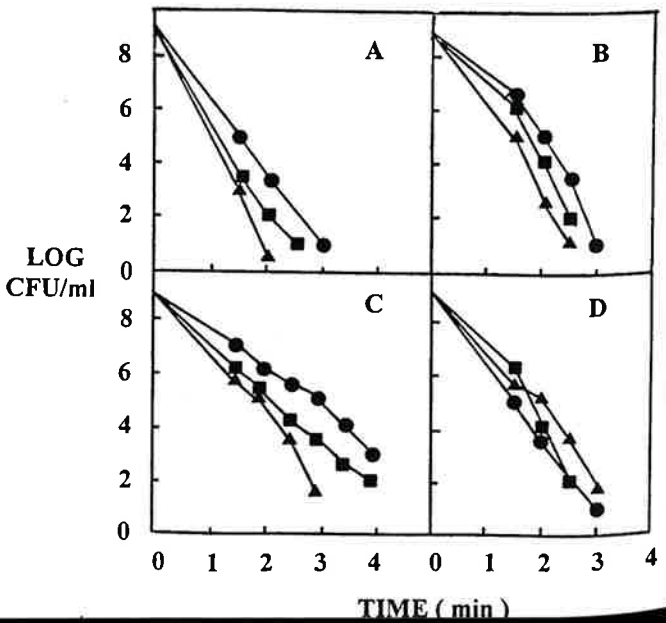


Table 1. Effect of Lactic Acid on the Growth of Spoilage Bacteria on Pork

		Log CFU/cm^2			
	Storage Time	Lean		Fat	
Bacteria	(days)	Water	Acid	Water	Acid
Pseudomonas fragi	0	5.11	3.85	4.92	1.39
	4	8.73	3.54	8.56	≤1.00
	15	9.72	4.70	9.03	≤1.00
Brochothrix thermosphacta	0	4.25	2.97	4.31	1.16
	4	6.00	1.92	6.59	≤1.00
	15	9.05	≤1.00	8.12	≤1.00

Meat discs were immersed in water or 3% lactic acid at 55^{0}C.

Log colony forming units/cm^2 (CFU/cm^2) were determined after each interval of aerobic storage at 4^{0}C.

Data are means of 5 replicates.

Table 2. Effect of Lactic Acid on the Growth of Cold Tolerant Pathogens on Pork

		Log CFU/cm^2			
	Storage Time	Lean		Fat	
Bacteria	(days)	Water	Acid	Water	Acid
Listeria monocytogenes	0	5.32	4.22	5.25	2.31
	4	5.41	3.81	6.40	≤1.00
	15	5.24	3.63	8.05	≤1.00
Yersinia enterocolitica	0	4.94	4.21	4.81	2.93
	4	4.63	3.37	6.48	1.06
	15	6.26	1.38	7.99	≤1.00
Aeromonas hydrophila	0	4.65	≤1.00	5.00	≤1.00
	4	2.00	≤1.00	5.38	≤1.00
	15	1.06	≤1.00	4.43	≤1.00

Meat discs were immersed in water or 3% lactic acid at 55^{0}C.

Log colony forming units/cm^2 (CFU/cm^2) were determined after each interval of aerobic storage at 4^{0}C.

Data are means of 5 replicates.

Table 3. Effect of Lactic Acid on Pork pH

Storage Time (days)	pH			
	Lean		Fat	
	Water	Acid	Water	Acid
0	5.64	4.72	6.58	3.57
4	5.65	5.34	6.63	4.06
15	5.70	5.24	6.56	3.49

Meat discs were immersed in water or 3% lactic acid at 55^0C.

Surface pH was measured after each interval of aerobic storage at 4^0C.

Data are means of 5 replicates.

Table 4. Effect of Lactic Acid on Pork Lean Colour Reflectance

Storage Time (days)	Reflectance Value L* Water	L* Acid	a* Water	a* Acid	b* Water	b* Acid
0	55.02	56.80	6.68	7.60	5.50	5.76
4	53.38	58.70	5.44	5.30	6.58	7.78
15	46.42	54.00	4.36	3.18	7.16	8.68

Meat discs were immersed in water or 3% lactic acid at 55^0C.

CIE L* (dark to light) a* (green-red) b* (blue-yellow) surface reflectance values were measured after each interval of aerobic storage at 4^0C.

Data are means of 5 replicates.

Captions for Tables

Table 1. Effect of lactic acid on the growth of spoilage bacteria on pork.

Table 2. Effect of lactic acid on the growth of cold tolerant pathogens on pork.

Table 3. Effect of lactic acid on pork pH.

Table 4. Effect of lactic acid on pork lean colour reflectance.

Table (1) Effect of benzoic acid on fungi assaciated with beef carcasses*

Fungi	C	NT %C	NT %F	T C	T %C	T %F	T %DC
Acremonium strictum W. Gams	16	1.4	17.5	9	1	8.8	0.8
Alternaria	12	1.0	7.5	3	0.3	2.5	0.3
A. Alternata (Fr.) keissler	11	0.9	7.5	3	0.3	2.5	0.6
A. tenuissima (Kunze ex Press). Wiltshire	1	0.1	1.3	-	-	-	-
Aspergillus	1054	89.9	56.3	803	85.5	56.3	68.5
A. alutaceus Berk. & curt.	1	0.1	1.3	3	0.3	1.3	0.3
A. egyptiacus Moubasher & Moustafa	1	0.1	1.3	2	0.2	2.5	0.2
A. flavus Link	642	54.7	27.5	515	54.9	21.3	43.9
A. flavus var. columnaris Raper & Fennell	12	1.0	2.5	-	-	-	-
A. melleus Yukawa	1	0.1	1.3	-	-	-	-
A. niger van Tieghem	384	32.7	46.3	263	28.0	50	22.4
A. oryzae (Ahlburg) Cohn	1	0.1	1.3	-	-	-	-
A. sydowii (Bainier & Sartory) Thom & Church	3	0.3	1.3	7	0.8	7.5	0.6
Cladosporium	30	2.6	22.5	39	4.2	27.5	3.3
C. cladosporioides (Fres.) de Vries	11	0.9	8.8	15	1.6	12.5	1.3
C. sphaerospermum Penzig	19	1.3	15	24	2.6	16.3	2.1
Emericella nidulans (Eidam) Vuillemin	3	0.3	3.8	6	0.6	5	0.5
Epicoccum nigrum Link	2	0.2	2.5	3	0.3	1.3	0.3
Eurotium niveoglaucum (Thom & Raper) Malloch & Cain	1	0.1	1.3	-	-	-	-
Fennellia flavipes Wiley & Simmons	1	0.1	1.3	-	-	-	-
Fusarium oxysporum Schlecht.	3	0.3	3.8	5	0.5	3.8	0.4
Gibberella	3	0.3	3.8	1	0.1	1.3	0.1
G. Fujikuroi (Sawada) Ito	2	0.2	2.5	1	0.1	1.3	0.1
G. intricans Wollenweber	1	0.1	1.3	-	-	-	-
Isaria sp.	1	0.1	1.3	-	-	-	-
Malbranchea sp.	2	0.2	2.5	-	-	-	-
Microascus cinereus (Emile - Weil & Gaudin) Curzi	1	0.1	1.3	-	-	-	-
Nectria Haematocacca Berk. & Broome	17	1.5	11.3	14	1.5	8.8	1.2
Nigrospora sacchari (Speg.) Mason	1	0.1	1.3	-	-	-	-

Table 1:Cont.

Fungi	NT			T			
	C	%C	%F	C	%C	%F	%DC
Paecilomyces variotii Bainier	1	0.1	1.3	2	0.2	1.3	0.2
Penicillium	22	1.9	18.8	45	4.8	13.8	3.8
P. aurantiogriseum Dierckx	7	0.6	7.5	11	1.2	6.3	0.9
P. chrysogenum Thom	4	0.3	5	10	1.1	3.8	0.9
P. duclauxii Delacr.	1	0.1	1.3	2	0.2	2.5	0.2
P. islandicum Sopp	1	0.1	1.3	14	1.5	1.3	1.2
P. oxalicum Currie & Thom	1	0.1	1.3	1	0.1	1.3	0.1
P. pinophilum Hedgecock	2	0.2	2.5	-	-	-	-
P. purpurogenum Stoll	6	0.5	1.3	7	0.8	2.5	0.6
Pleospora herbarum Rabenh. ex Ces. & de Not.	1	0.1	1.3	-	-	-	-
Rhizopus stolonifer (Ehrenb.) Link	1	0.1	1.3	-	-	-	-
Torula herbarum (Pers.) Link	1	0.1	1.3	-	-	-	-
Total fungi	1173		90	939		85	80.1
Total number of genera	20			11			
Total number of species.	36+1 variety			22			

*NT:non treated, T:treated with 0.7% benzoic acid, C:count per 80 samples, %F: percentage frequency calculated per 80 samples, %DC: percentage decrease in count related to the non treated one.

Table 2: Effect of benzoic acid on yeast associated with beef carcasses.*

	NT			T			
Yeast	C	%C	%F	C	%C	%F	%DC
Candida albicans	53	20.2	27.5	43	17.6	16.3	16.3
Geotrichum candidum Link	1	0.4	1.3	1	0.4	1.3	0.4
Trichosporon cuteanum (de Beurm., Goug. & Vauch.) Ota	2	0.8	2.5	14	5.7	7.5	1.2
Unidentified yeasts	207	78.7	8.8	187	76.3	8.8	71.1
Total yeasts	263	100	37.5	245	100	30	93.2
Total bacteria	593		67.5	516		67.5	103.7

*Legend as in table (1).

Figure 1
Increase in resistance of bacteria to disinfectant II
A - "use concentration" according to modified AOAC test

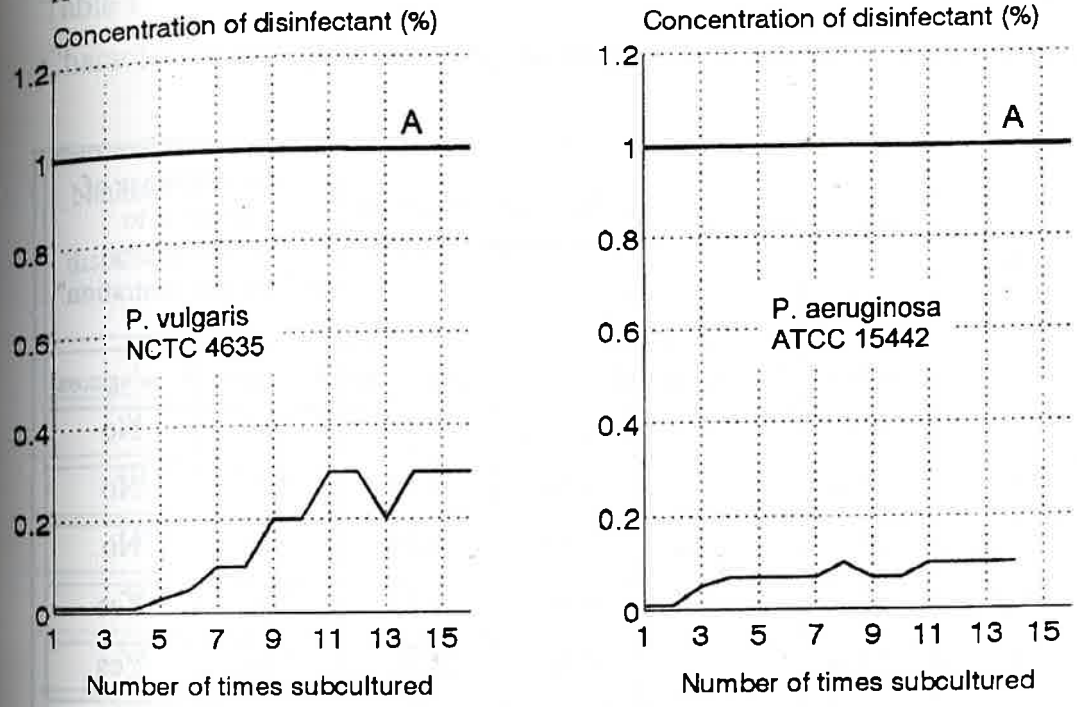


Table 2

Resistance development of bacteria to QAC disinfectants

Number of disinfectant	Increase in resistance		The highest tolerated concentration of QAC		The resistance of bacteria to disinfectants in "use concentration"	
	P. vulgaris	P. aeruginosa	P. vulgaris	P. aeruginosa	P. vulgaris	P. aeruginosa
I	100 x	10 x	0,09	0,09	No	No
II	30 x	10 x	0,03	0,13	No	No
III	100 x	4 x	0,13	0,04	Yes	No
IV	60 x	17 x	0,04	0,11	No	Yes
V	20 x	22 x	0,02	0,18	No	Yes
VI	360 x	31 x	0,60	0,10	Yes	No
VII	375 x	17 x	0,72	0,62	Yes	Yes

Table 1
Characteristics of disinfectants

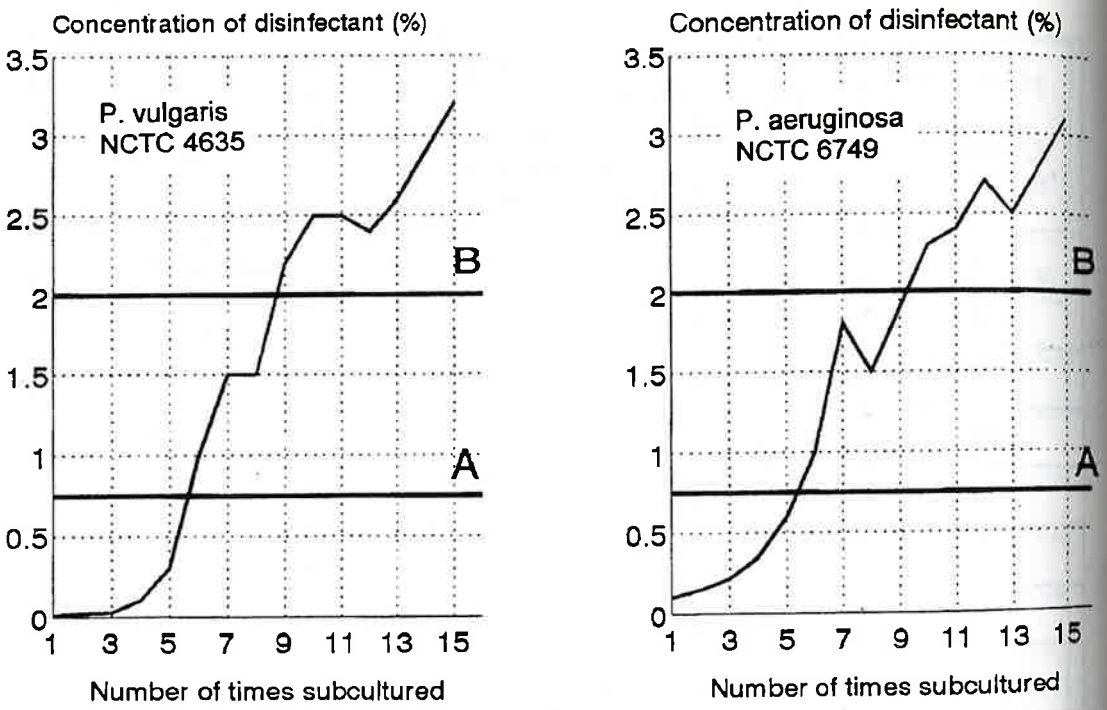
Number of disinfectant	Composition			
	QAC	Aldehyde		Sequestrant
		Glutaraldehyde	Glyoxal	
I	A	-	-	Sequion 40 Na 32
II	B	-	-	EDTA
III	C	-	-	-
IV	A	+	+	Phosphates
V	A	+	-	-
VI	A	-	-	Sequion 40 Na 32
VII	A	-	-	-

A - didecyl dimethyl ammonium chloride

B - dodecyl dihydroxyethyl benzyl ammonium chloride

C - octyl dimethyl benzyl ammonium chloride,
diisobutyl phenoxyethoxy ethyl dimethyl benzyl ammonium chloride,
diisobutyl cresoxyethoxyethyl dimethyl benzyl ammonium chloride

Figure 3
Increase in resistance of bacteria to disinfectant VII
A - "use concentration" according to DGHM
B - "use concentration" according to modified AOAC test



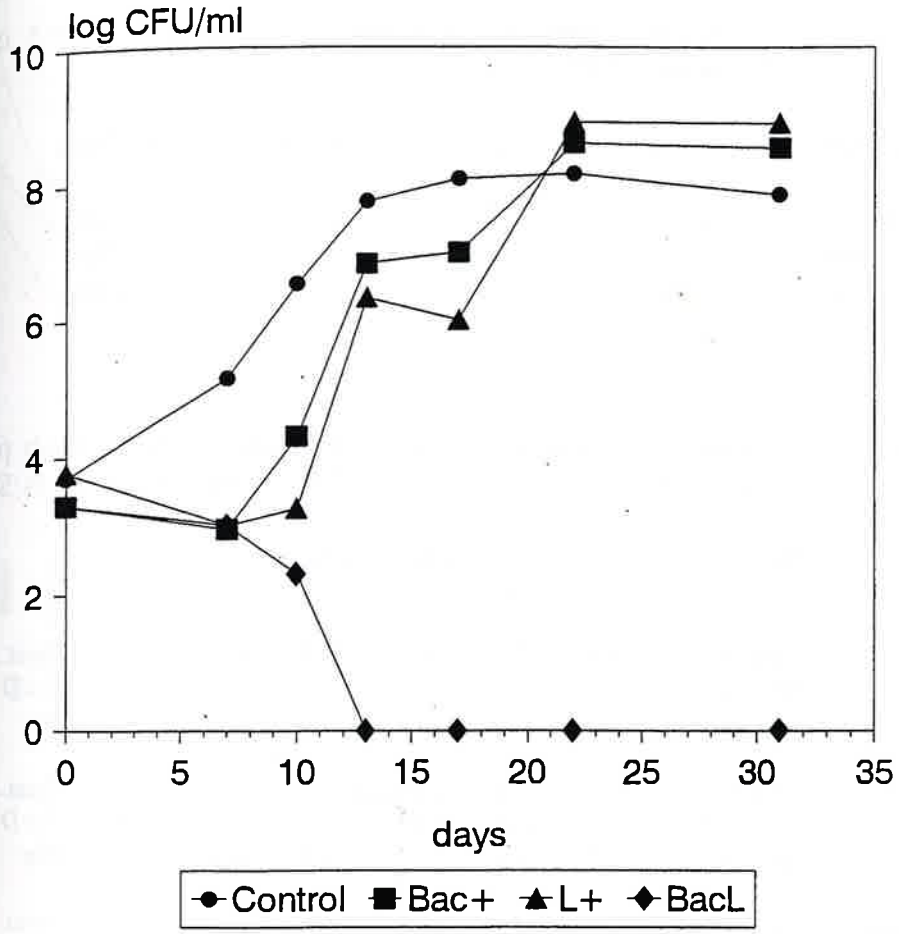


Figure 1. Evolution of different preservatives treatments in pepper sauces. **Control:** sauce + E. faecalis, **Bac+:** sauce + E. faecalis + BCE, **L+:** sauce + E. faecalis + 1% sodium lactate, **BacL:** sauce + E. faecalis + BCE + 1% sodium lactate.

Table 1 Mean TBA values for lamb products during storage (N=3, overall standard deviation = 0.08).

Treatment	0 Days	15 Days	30 Days	45 Days	65 Days
2°C VP	1.95	1.89	2.19	2.20	3.58
30°C VP	1.95	1.82	1.90	1.31	1.08
30°C Air	1.95	4.10	4.15	4.59	4.04

Table 2 Analysis of variance of sensory evaluation data for lamb products during storage (N =10; *** P < 0.001; ** P < 0.01; * P < 0.05; N/S P > 0.05).

Variable	Treatment	Days of Storage 0	14	28	42	56	70	Interactions		
Darkness	2°C VP	35.4	51.8	51.4	53.7	51.4	53.1	Treat	0.95	***
	30°C VP	34.3	31.4	28.7	35.9	32.5	35.8	T x D	2.34	***
	30°C Air	34.8	29.8	19.3	25.3	14.4	16.7	Day	1.35	*
Redness	2°C VP	18.2	21.9	21.1	21.4	20.1	25.5	Treat	0.65	***
	30°C VP	18.1	14.5	14.7	17.0	17.0	16.0	T x D	1.59	*
	30°C Air	17.7	14.9	13.0	14.0	10.1	13.5	Day	0.92	NS
Brownness	2°C VP	34.1	44.1	45.6	47.6	40.5	44.8	Treat	0.97	***
	30°C VP	33.6	28.7	29.7	31.4	32.5	33.6	T x D	2.38	***
	30°C Air	34.0	28.0	18.8	23.3	16.7	21.6	Day	1.37	NS
Glossiness	2°C VP	31.5	35.5	32.1	20.1	36.0	36.4	Treat	1.05	***
	30°C VP	34.5	23.5	29.1	25.0	26.6	33.5	T x D	2.56	*
	30°C Air	29.5	23.0	24.0	24.2	16.3	25.8	Day	1.48	**
Graininess	2°C VP	34.7	26.9	25.8	17.1	17.6	23.5	Treat	1.09	***
	30°C VP	36.0	28.4	27.6	17.8	16.0	16.1	T x D	2.67	***
	30°C Air	31.8	56.6	70.8	74.7	69.3	72.8	Day	1.54	*
Fatty Odour	2°C VP	41.0	36.4	37.5	36.5	36.0	42.7	Treat	1.25	***
	30°C VP	43.8	55.3	44.1	36.6	44.3	44.1	T x D	3.05	***
	30°C Air	35.9	48.2	39.5	52.0	40.8	46.7	Day	1.76	*
Rancid Odour	2°C VP	29.4	34.1	29.2	28.4	28.9	34.1	Treat	1.13	**
	30°C VP	31.7	37.5	32.0	30.3	34.1	38.5	T x D	2.76	***
	30°C Air	27.5	38.2	32.5	37.8	33.2	46.8	Day	1.6	***
Raw Lamb Odour	2°C VP	32.7	28.8	32.4	30.6	31.6	37.8	Treat	1.07	NS
	30°C VP	29.7	35.0	33.6	34.5	38.7	36.3	T x D	2.63	NS
	30°C Air	32.1	35.0	28.9	41.9	34.5	40.2	Day	1.52	*
Spoilt Meat Odour	2°C VP	28.5	28.0	26.5	28.9	26.3	32.1	Treat	1.06	***
	30°C VP	27.5	34.5	30.1	30.3	31.1	36.0	T x D	2.60	NS
	30°C Air	32.1	38.1	29.9	32.2	30.8	46.7	Day	1.50	***

Figure 1 The spectra of minced lamb after initial processing

Figure 2 The spectra of overwrapped lamb products stored at 30°C

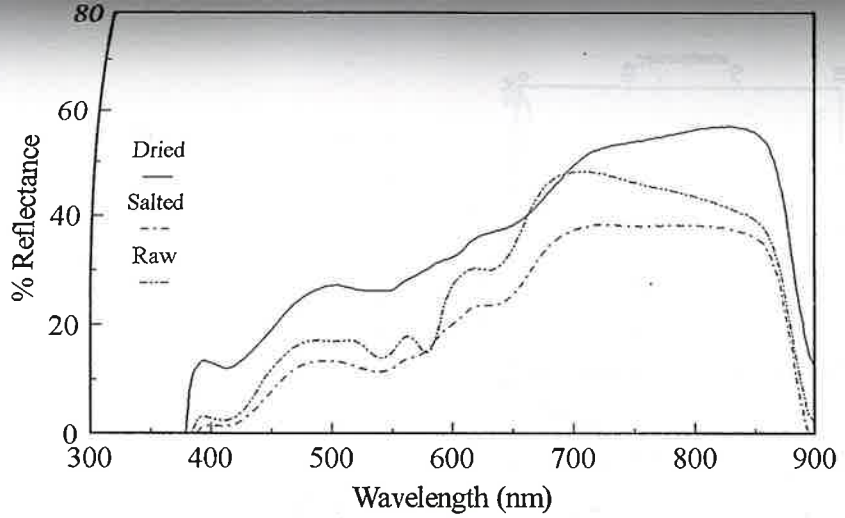


Figure 3 The spectra of vacuum packed lamb products stored at 30°C

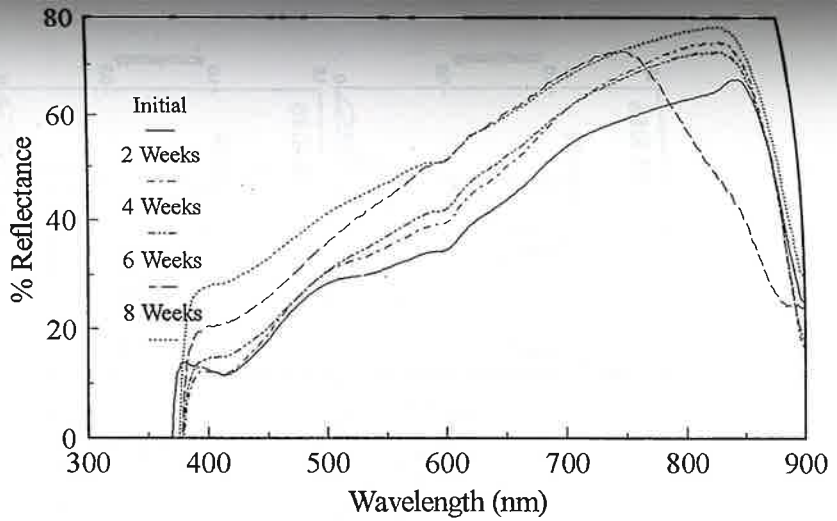
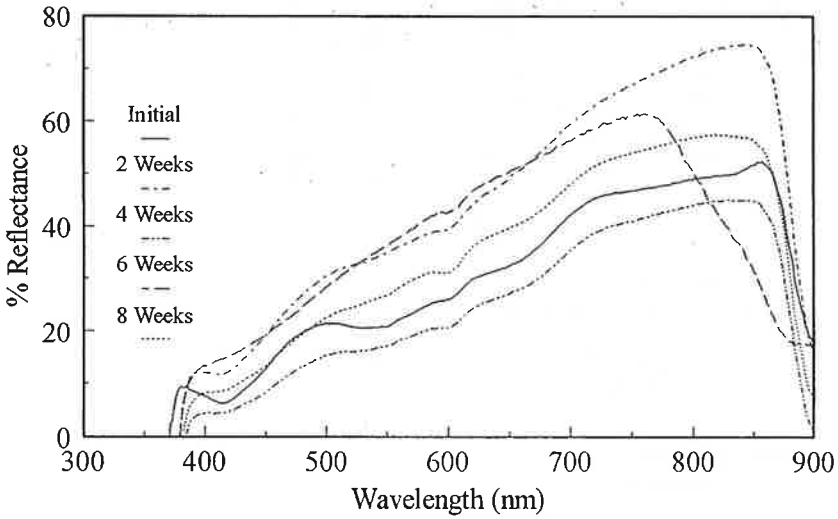
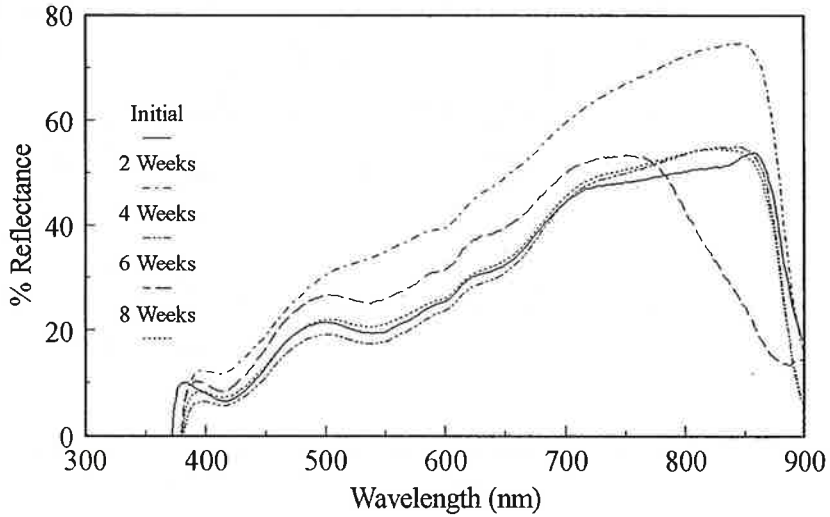


Figure 4 The spectra of vacuum packed lamb products stored at 2°C





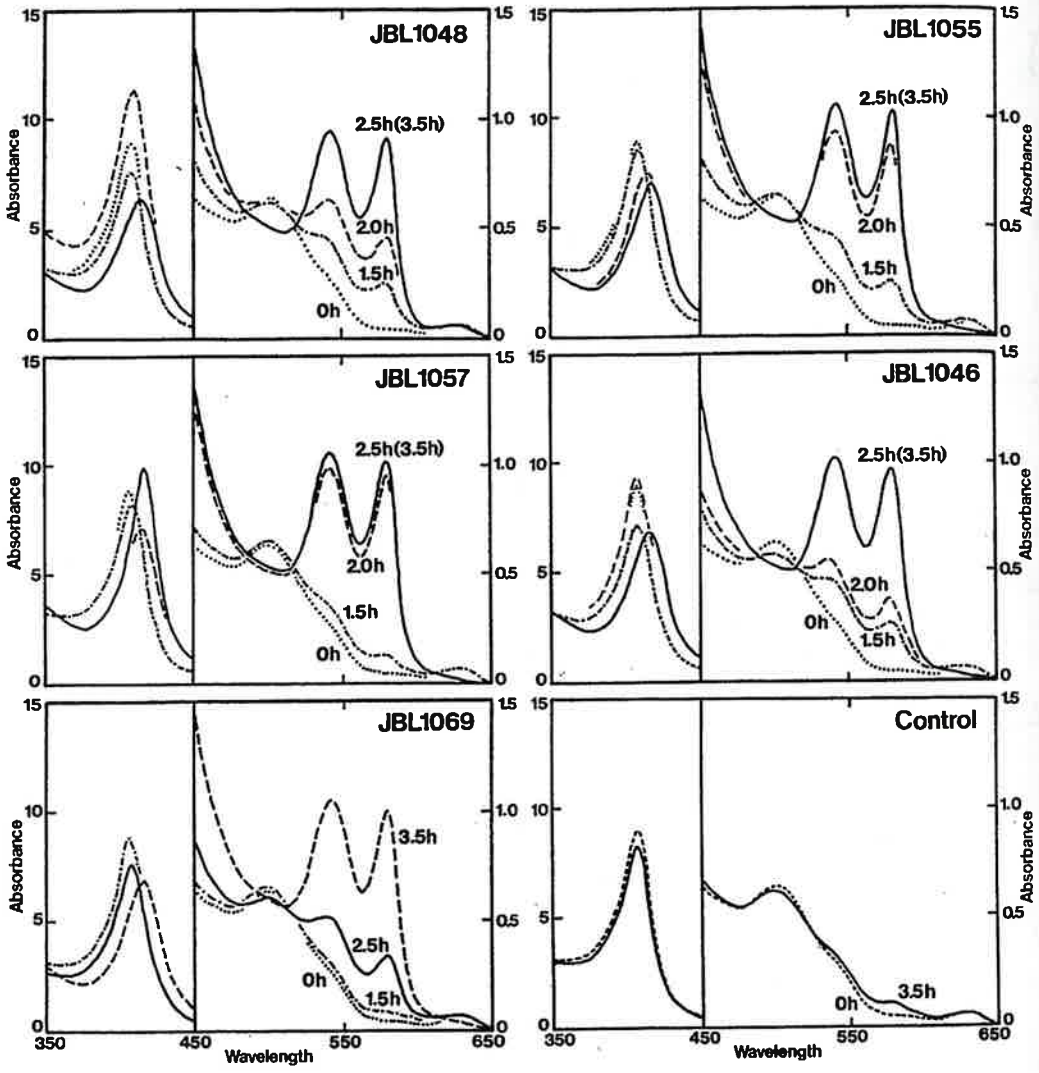


Figure 5. Absorption spectra of metmyoglobin-containing BHI broth inoculated with enterococci. Control contained sterile BHI broth in place of cultures. (from Arihara et al., 1994a)

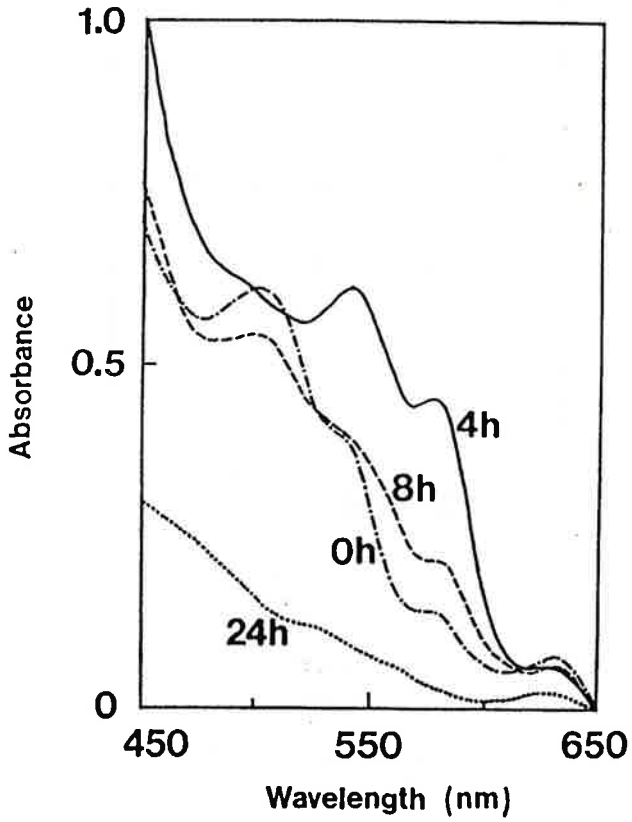


Figure 4. Absorption spectra of metmyoglobin-containing MRS broth inoculated with *L. fermentum* JCM1173. Control contained MRS broth in place of culture. (from Arihara et al., 1993a)

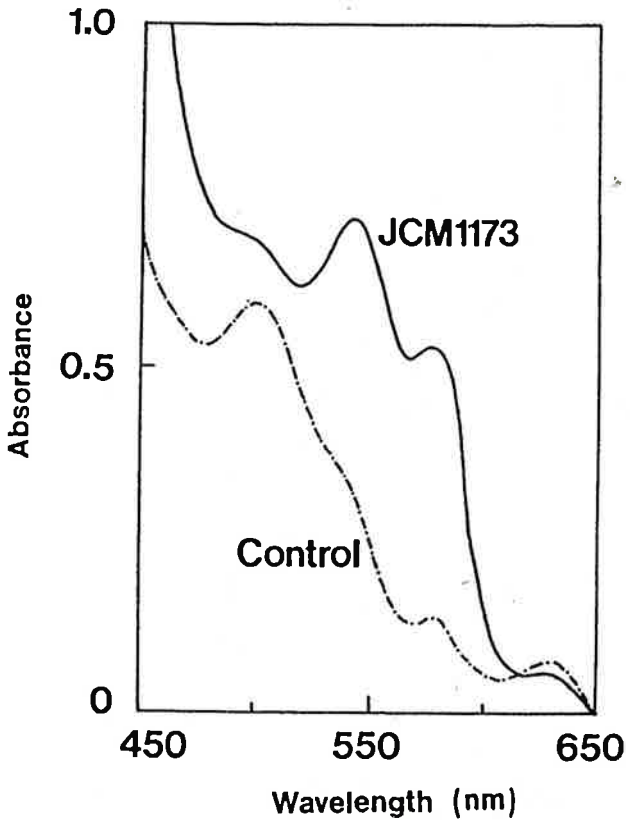


Figure 3. Absorption spectra of metmyoglobin solution in dialysis tubing in 0.2% glucose-containing MRS broth inoculated with *L. fermentum* JCM1173. Control was incubated without the addition of *L. fermentum*. (from Arihara et al., 1993a)

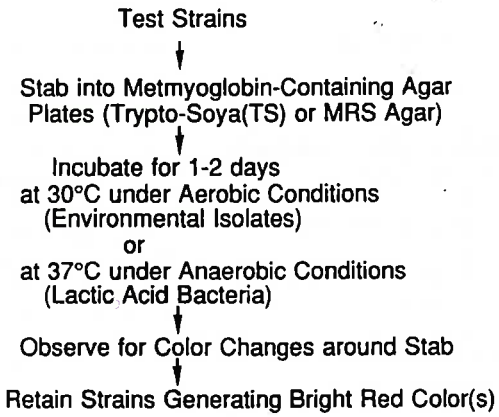


Figure 2. Characterization of myoglobin derivatives.

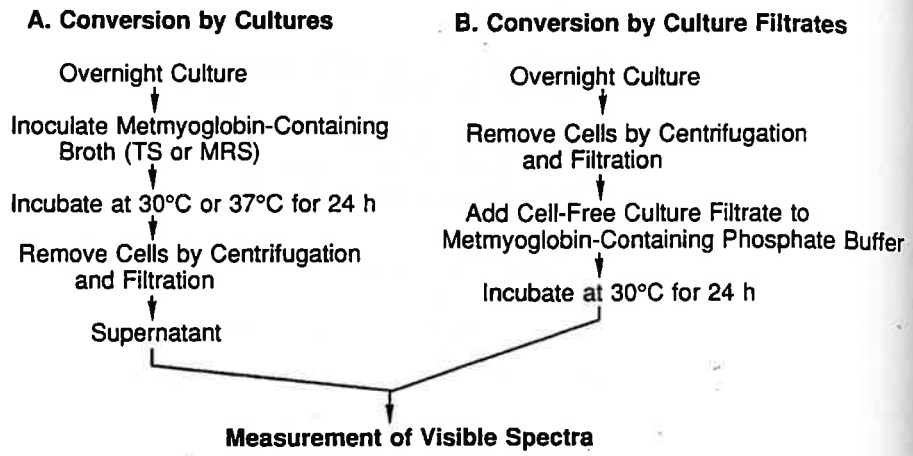


Figure 1. Screening bacteria for metmyoglobin conversion activity.

Table 1. Growth of enterococci with metmyoglobin reduction activity in metmyoglobin-containing BHI broth during incubation. (from Arihara et al., 1994b)

Enterococcus strains		Optical density at 650 nm							
		0[a]	0.5	1.0	1.5	2.0	2.5	3.0	12.0
E. faecalis	JBL1048	0	0.01	0.03	0.03	0.04	0.07	0.14	1.61
	JBL1055	0	0.03	0.05	0.05	0.05	0.06	0.13	1.54
	JBL1057	0	0.01	0.01	0.02	0.02	0.02	0.05	1.38
E. gallinarum	JBL1046	0	0.00	0.02	0.02	0.03	0.04	0.09	0.95
E. mundtii	JBL1069	0	0.02	0.03	0.04	0.08	0.19	0.38	1.38

[a] Time (in hours) after addition of enterococci to metmyoglobin-containing BHI broth. With the exception of JBL1069, metmyoglobin reduction was accomplished within 2.5 h (Figure 5).

Table 1

Number of micro-organisms per gram in meat and meat products (surface plating, 3 day incubation at 25°C)

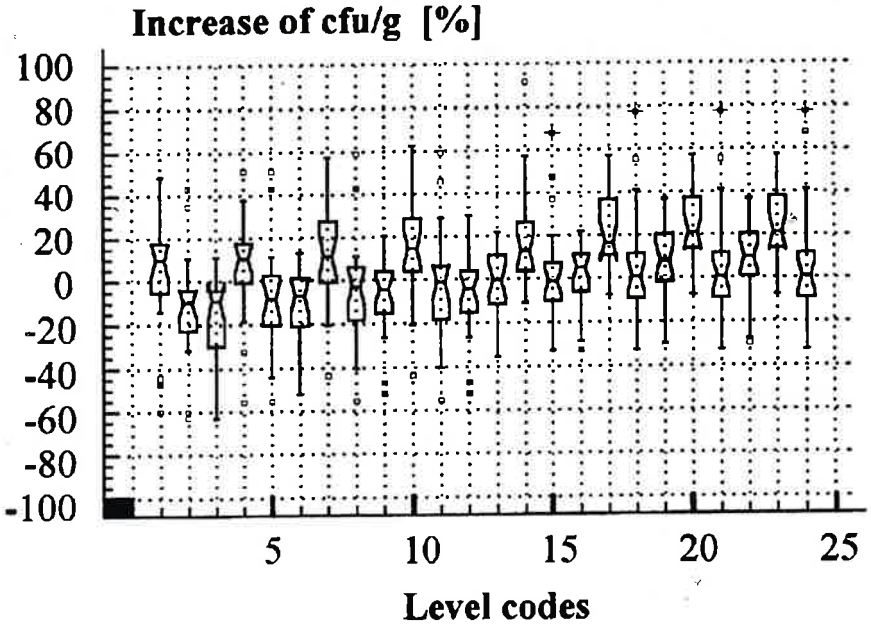
Sample number	Meat and meat products	Number of micro-organisms per gram		
		Medium		
		PCA	TGE-agar	APT-agar
1	Beef meat	$2,0 \times 10^3$	$2,6 \times 10^3$	$2,0 \times 10^3$
2	Pork meat	$1,6 \times 10^3$	$1,5 \times 10^3$	$1,7 \times 10^3$
3	Pork-loin	$2,3 \times 10^5$	$3,2 \times 10^5$	$2,4 \times 10^5$
4	Pork meat	$1,4 \times 10^4$	$1,5 \times 10^4$	$1,1 \times 10^4$
5	Back fat	$2,5 \times 10^7$	$2,4 \times 10^7$	$2,3 \times 10^7$
6	Back fat	$2,4 \times 10^7$	$2,2 \times 10^7$	$1,8 \times 10^7$
7	Back fat	$2,4 \times 10^7$	$2,4 \times 10^7$	$1,9 \times 10^7$
8	Back fat	$2,6 \times 10^7$	$2,4 \times 10^7$	$2,3 \times 10^7$
9	Back fat	$2,3 \times 10^7$	$2,7 \times 10^7$	$2,2 \times 10^7$
10	Minced meat	$1,2 \times 10^7$	$1,8 \times 10^7$	$1,8 \times 10^7$
11	Hamburger meat	$2,6 \times 10^5$	$2,8 \times 10^5$	$2,3 \times 10^5$
12	Canned ham	$1,1 \times 10^4$	$1,1 \times 10^4$	$8,5 \times 10^3$
13	Canned ham	$1,1 \times 10^4$	$1,1 \times 10^4$	$9,5 \times 10^3$
14	Canned ham	$1,0 \times 10^4$	$1,1 \times 10^4$	$9,6 \times 10^3$
15	Canned ham	$8,6 \times 10^3$	$1,1 \times 10^4$	$9,7 \times 10^3$
16	Canned ham	$1,2 \times 10^4$	$1,1 \times 10^4$	$9,4 \times 10^3$
17	Minced ham	$8,5 \times 10^3$	$1,4 \times 10^4$	$7,7 \times 10^3$
18	Chicken sausage	$9,5 \times 10^3$	$1,4 \times 10^4$	$1,3 \times 10^4$
19	Cooked sausage	$2,1 \times 10^3$	$4,0 \times 10^3$	$3,5 \times 10^3$
20	Mortadel	$1,9 \times 10^3$	$5,2 \times 10^3$	$3,7 \times 10^3$
21	Salami	$2,2 \times 10^8$	$3,9 \times 10^8$	$3,4 \times 10^8$
22	Salami	$2,4 \times 10^8$	$2,5 \times 10^8$	$2,7 \times 10^8$

Table 2

Explanation to codes' numbers to figure 1

Technique of plating	Time of incubation (days)	Medium		
		PCA	TGE-agar	APT-agar
Pour	3	1	2	3
	5	4	5	6
	7	7	8	9
	10	10	11	12
Surface	3	13	14	15
	5	16	17	18
	7	19	20	21
	10	22	23	24

Figure 1
Percentage increase of cfu/g in relation to 3 days of incubation



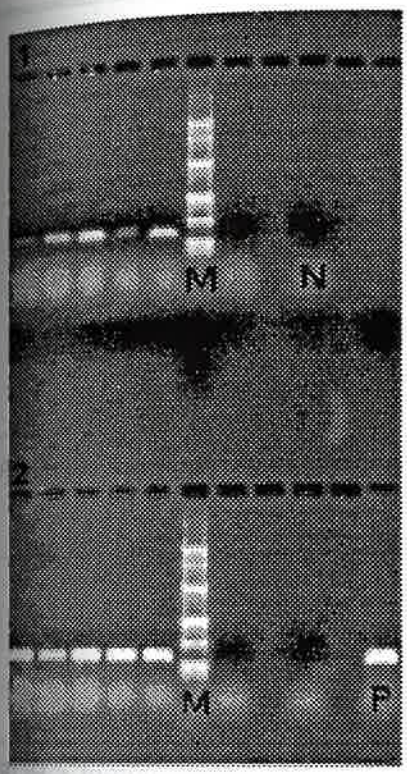


Figure 4: Improvement of the PCR signals with IMS after 20-hours enrichment of artificially contaminated meat samples. The internal control in this experiment was omitted. Row 1: PCR results without IMS. Row 2: PCR results after IMS. N = negative control, P = positive control, M = molecular weight marker.

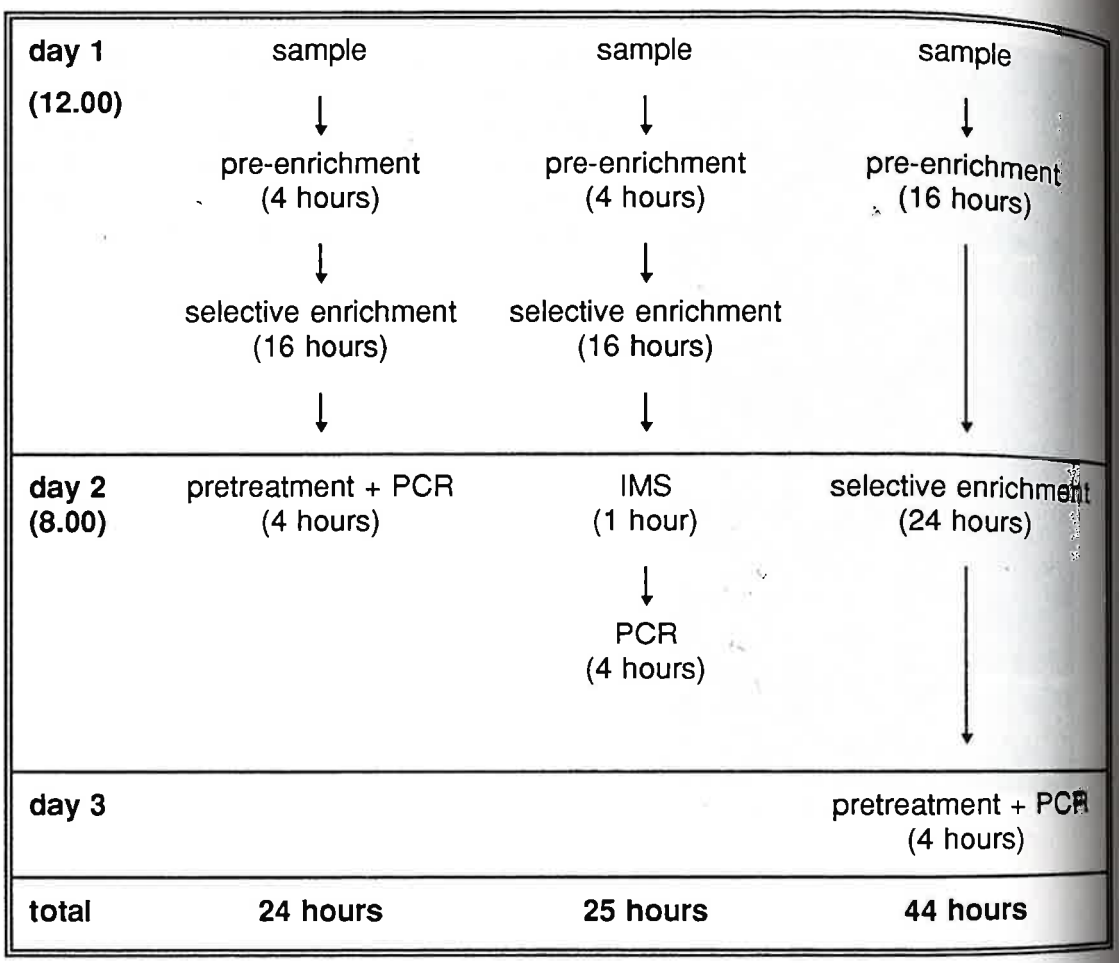


Figure 3: Time-schedule for the developed (IMS-)PCR methods.

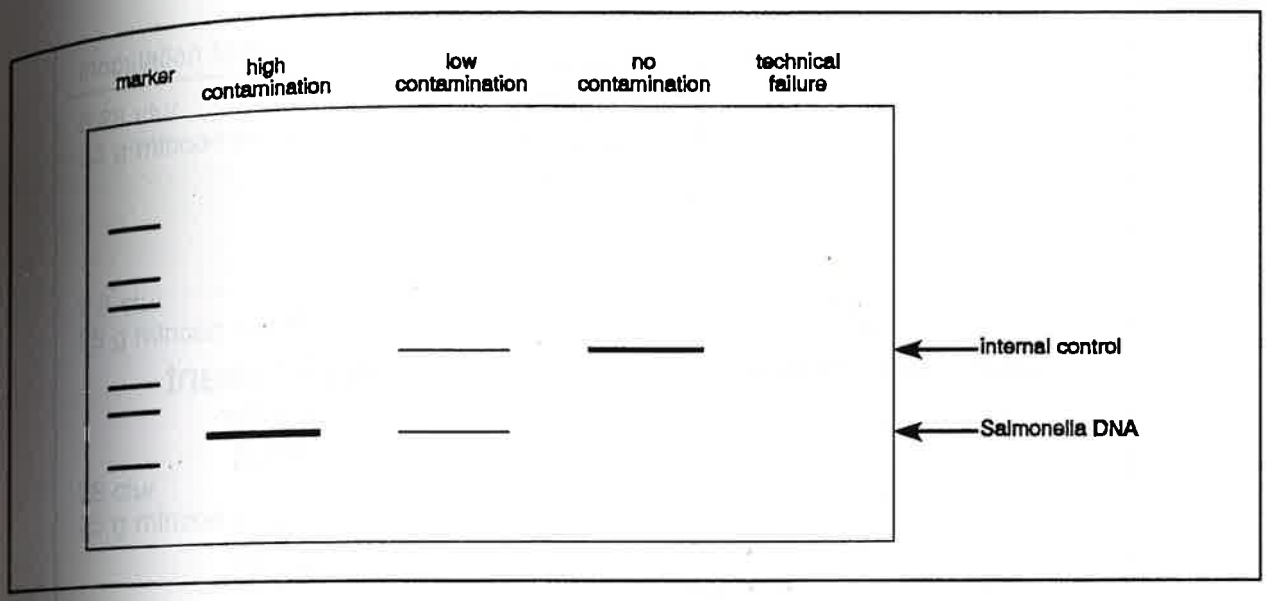


Figure 2: Interpretation of the PCR results.

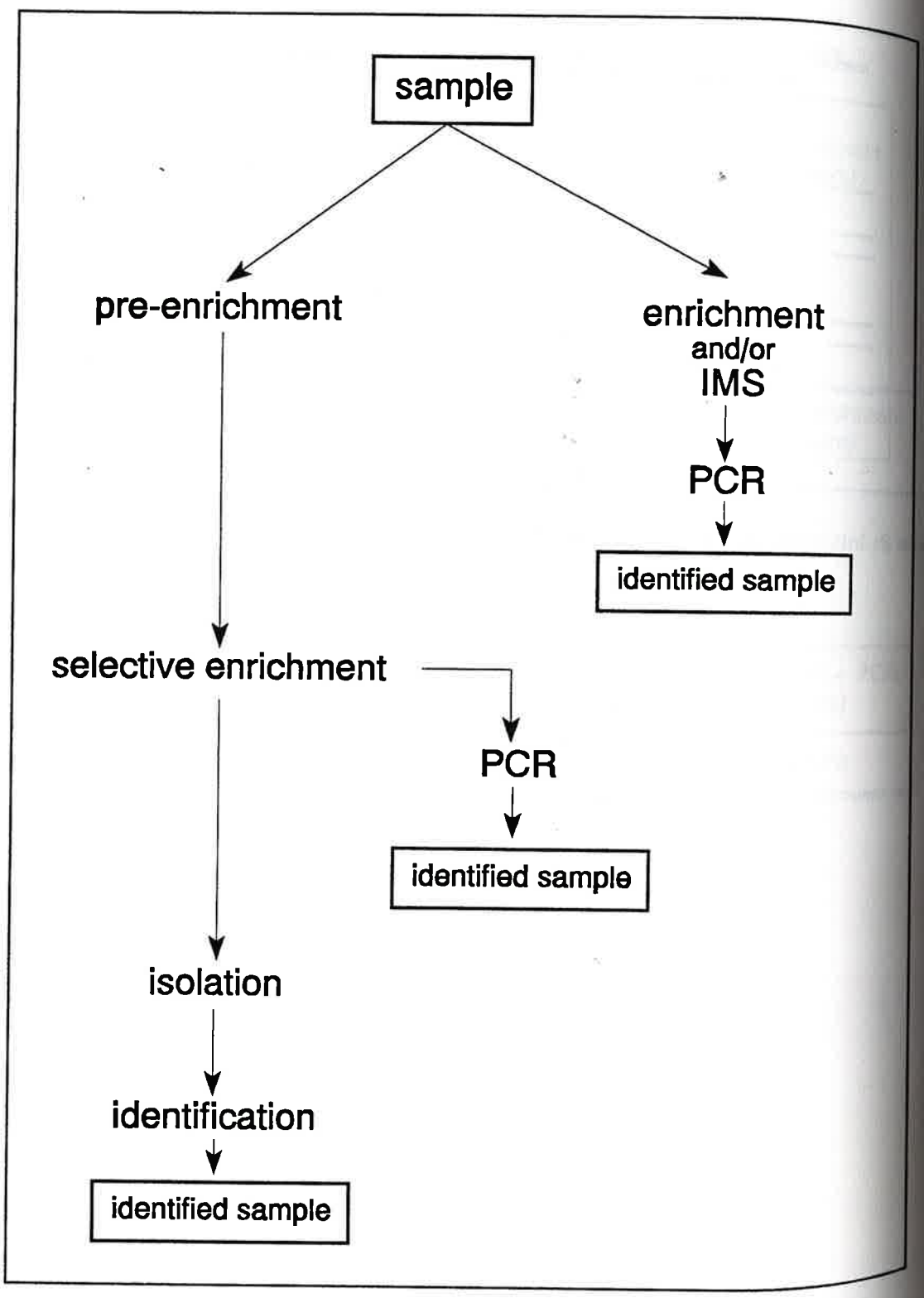


Figure 1: Implementation of PCR techniques for routine detection of *Salmonella* in food samples.

inoculation level	24-hours PCR	IMS-PCR
0,28 cfu/ 25 g minced bovine meat	+	++++
	-	-
	-	-
	(1/3)	**(1/3)**
2,8 cfu/ 25 g minced bovine meat	-	++++
	+	++++
	++	+++
	(2/3)	**(3/3)**
28 cfu/ 25 g minced bovine meat	++	++++
	-	++++
	++	++++
	(2/3)	**(3/3)**

Table 1: Detection levels for the 24-hours PCR method and the IMS-PCR method. Three samples were investigated per inoculation level (Most Probable Number technique).

Table 1: PCR results of human fecal E. coli isolates and isolates from raw meats, both belonging to serotype O157. Represented is the number of positive strains for SLT I, SLT II and eae gene sequences.

Source	n[a]	SLT I	SLT II	SLT I & SLT II	*eae*
human	53	0	48	5	53
meat	6	0	0	0	0

[a]: number of strains tested

Table 2: Isolation of SLTEC from raw beef products using selective enrichment in mTSB+A (20-24 h,37°c, 100 rpm) followed by PCR.

Meat product	n[a]	m[b]	Number of SLTEC-positive samples SLT I	SLT II	SLT I & SLT II
ground meat from beef(50%)/pork(50%)	88	16	1	10	5
ground meat from beef(100%)	48	8		4	4
chopped raw beef	17	1		1	
raw beef products, other than ground meat	27	4		2	2
	180	29	1	17	11

[a]: number of samples tested; [b]: number of samples positive for SLTEC

Table 1: ELISA of 335 pooled samples of chicken sera with various antigens

	LPS[@] O:1,9,12	LPS[#] O:1,4,[5],9,12	Flagella[$] H:g,m:-	Flagella[+] H:i:e,n,z_{15}
Positive	97 (29%)*	103 (36%)	165 (49%)	137 (41%)
Negative	238 (71%)*	184 (64%)	170 (51%)	198 (59%)

* only 287 of the 335 samples tested, [@] lipopolysaccharide isolated from *S. enteritidis* was used as an antigen, [#] a mixture of lipopolysaccharide from *S. typhimurium* and *S. panama*, [$] flagellar antigen isolated from *S. godesberg*, and [+] flagellar antigen isolated from *S. bergen*.

Table 2: H-antigen specificity[#] of the anti-flagellar Monoclonal antibodies

Strain	H-serotype*	Mab2	Mab3	Mab5	Mab8	Mab10	Mab16	Mab18
S. agona	f,g,s:[1,2]	-	-	-	-	-	+	+
S. derby	f,g:[1,2]	-	-	+	+	+	+	+
S. dublin	f,g:-	-	-	-	+	+	+	+
S. enteritidis	[f],g,m,[p]:[1,7]	+	+	+	+	+	+	+
S. gallinarum	-,-	-	-	-	-	-	-	-
S. godesberg	g,m:-	+	+	+	+	+	+	+
S. monshaui	m,t:-	-	-	-	-	-	+	+
S. typhimurium	i:1,2	-	-	-	-	-	-	+

[#] Mab recognition of the listed strains was assayed on Western-blots that contained total bacterial protein. +: flagellar protein is recognized by the Mab, -: no recognition.
* H-serotype according to Kauffman-White.

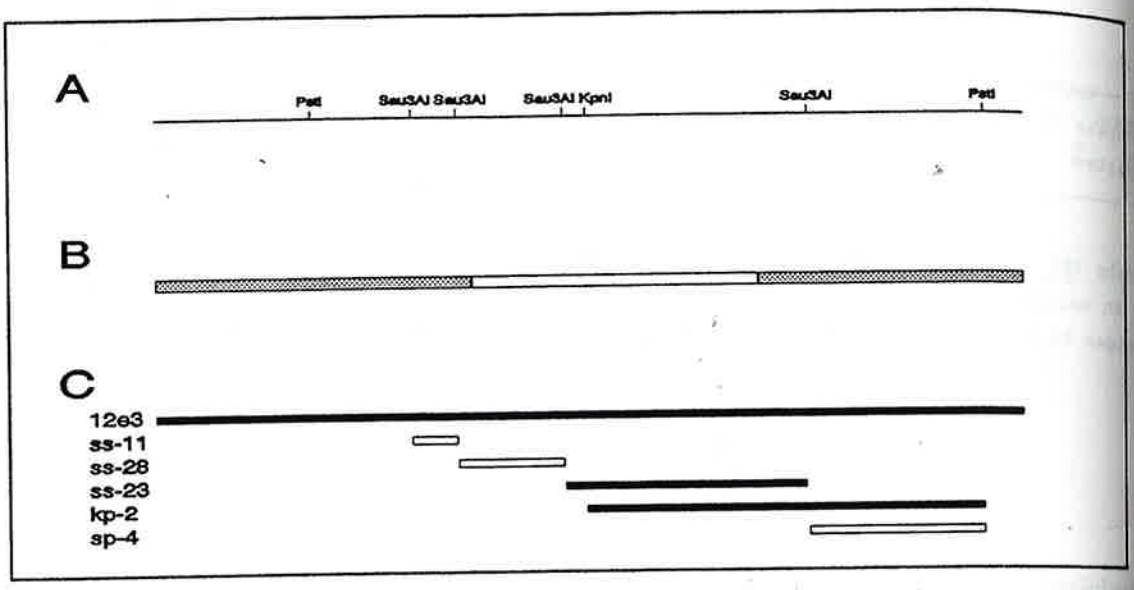


Figure 1. Location of recombinant-flagellin expression proteins. A: schematic representation of the 1479 bp flagelin encoding PCR product. The location of the restriction endonuclease sites used in the construction of the recombinant-flagellin expression clones is indicated. B: The location of the encoded flagellin. The conserved (gray) and the variable area (white) as based on amino acid alignments are indicated. C: Relative location of the expression products encoded by the recombinant-DNA clones. The reaction of these expression products with the H-type g,m specific antibodies is indicated: white = negative, black = positive.

Table 3: Antibody recognition of recombinant-flagellin proteins

Anti-serum*	Recombinant clone					
	12E3	SS-11	SS-28	SS-23	KP-2	SP-4
Mab 2	+	-	-	+	+	-
Mab 3	+	-	-	+	+	-
Mab 5	+	-	-	+	+	-
Mab 8	+	-	-	+	+	-
Mab 10	+	-	-	-	-	-
Mab 16	+	+	-	-	-	-
Mab 18	+	-	-	-	-	-
α-g,m	+	-	-	+	+	-
α-g,m,s	+	-	-	+	+	-
α-m,t	+	-	-	+	+	-

* Mab: monoclonal antibody; α-g,m, α-g,m,s, and α-m,t: H-type g,m, g,m,s and m,t specific polyclonal antibodies, respectively.

Table 4: Reactivity of SS-23 protein with H-type specific polyclonal antibodies

Antiserum	Reactivity*	Antiserum	Reactivity*
anti-i	-	anti-m	-
anti-e-complex	-	anti-m,t	+
anti-f	-	anti-p	=
anti-f,g	+	anti-r	-
anti-g	+	anti-s	-
anti-g,m	+	anti-t	-
anti-g,m,s	+	anti-q	-
anti-g,m,q	+	anti-u	-
anti-g,p	+	anti-v	-
anti-g,p,u	+	anti-x,z16	-
anti-g,q	+	anti-z	=
anti-g,s,t	+	anti-1-complex	-
anti-g,z51	+	anti-2	-
anti-g,z62	+	anti-5	-
anti-h	-	anti-6	-
anti-l-complex	-	anti-7	-

* +: positive; =: very weak positive; and -: negative in ELISA. The weak positive reaction (=) is probably not due to true recognition of the antigen by the antiserum, but more likely a result of an incomplete absorbtion of the anti-g antibodies that were present in the unabsorbed sera that were used to produce these H-type specific antisera.

Table 5: SS-23 flagella-ELISA# of sera and eggs

Strain used for infection	Serum Week 2	Egg yolk Week 1	Egg yolk Week 2
S. enteritidis	+*	+	+
S. panama	-	-	-
S. typhimurium	-	-	-
non infected control	-	-	-

#: The flagellar fragment expressed by clone SS-23 was used as antigen, sera and eggs were from orraly infected chickens. Serum was collected two weeks post infection, eggs at one and two weeks post infection.
*: + positive, and - negative antibody titre.

Table 1. Results of Immunomagnetic Separation[1] for *Y. enterocolitica* in minced meat.

Buffer[2]	Minced meat homogenate	Microflora[3] (cfu/ml)	*Y. entero-colitica*[4] (cfu/ml)	Recovery on Nutriënt Agar[5] (%)	
				Y. enterocolitica	competitive flora
1 ml	-	-	1.1×10^5	99.1±6.7	-
-	1 ml A[6]	6.0×10^4	-	-	0.3±0.1
-	1 ml A[6]	6.0×10^4	1.1×10^5	44.3±3.8	0.6±0.1
-	1 ml B[6]	5.2×10^4	-	-	0.3±0.01
-	1 ml B[6]	5.2×10^4	1.1×10^5	50.0±2.3	0.3±0.4

[1]: 10^7 IMP were incubated for 20 min at room temperature with 1 ml buffer or minced meat homogenate

[2]: PBS-0.1% caseïn

[3]: Microflora present in the minced meat

[4]: *Y. enterocolitica* is added

[5]: results from duplicate samples

[6]: 10 g of the 2 samples A and B is homogenized in 90 ml of peptone-saline solution

Preparation	IMS		IMS
	↓		↓
Detection	Conductance assay	Conductance assay	PCR-assay
	↓	↓	↓
Confirmation/ Identification	PCR, IF	PCR, IF	DNA-hybri-dization

Figure 2. Development of a new detection method for *Y. enterocolitica*

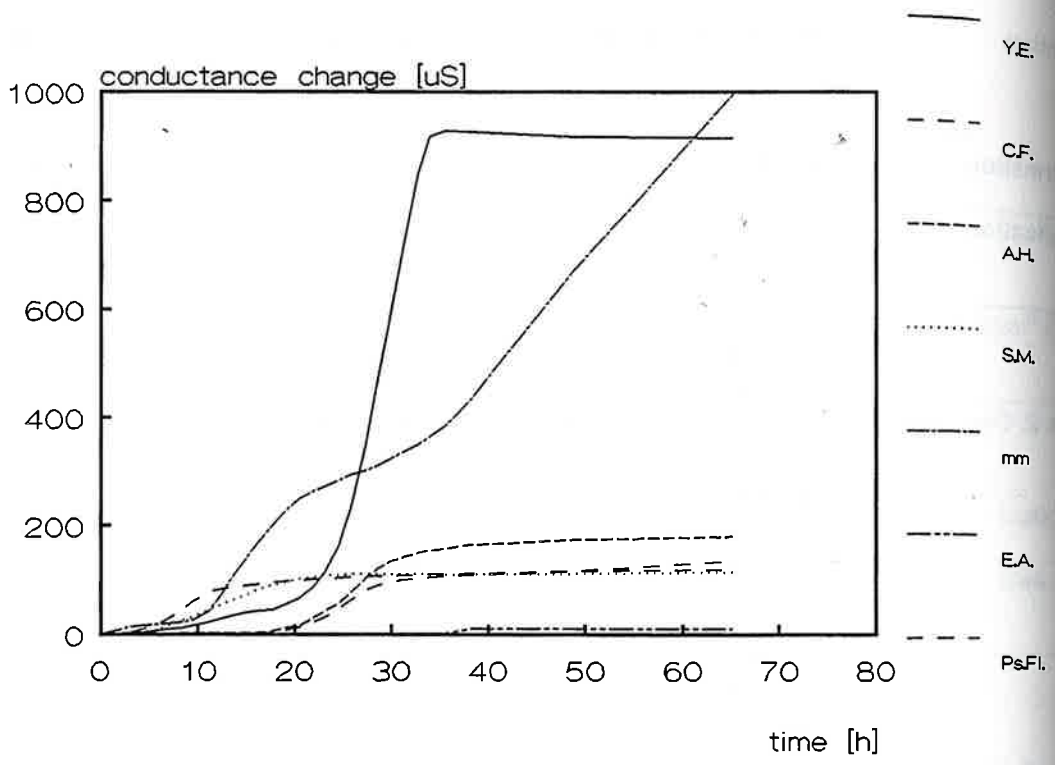


Figure 1. Conductance curve of pure cultures of *Y. enterocolitica, Citrobacter freundii, Aeromonas hydrophila, Serratia marcescens, Enterobacter agglomerans* and *Pseudomonas fluorescens* and of naturally contaminated minced meat (mm).

Table 1. Contamination levels (log colony forming units) of five types of bacteria on pork loins at four sampling sites[1] during fabrication of pork carcasses.

Sampling Site	Psychrotrophs	Coliforms	Aerobic Mesophiles
1	2.55[b]	1.12[c]	2.94[b,c]
2	2.48[b]	1.53[a,b]	2.79[c]
3	3.06[a]	1.88[a]	3.39[a]
4	2.87[a]	1.27[b,c]	3.15[a,b]

[1]Sampling sites: 1 - chilled carcasses, immediately prior to cutting; 2 - pork loins after being pulled from carcasses; 3 - pork loins immediately prior to trimming and deboning; and 4 - boneless loins at the point of vacuum packaging.

[a,b,c]Means with the same superscript in the same column are not significantly different (P>0.05).

Table 2. Contamination levels (log colony forming units) of five types of bacteria on pork loins, pH values, and levels of purge after 4 weeks of vacuum-packaged storage.

Psychrotrophs	Coliforms	Aerobic Mesophiles	Anaerobes	Lactics	pH	purge (ml)
6.59	3.43	6.59	6.44	4.42	5.61	2.84

Table 3. Contamination levels (log colony forming units/cm^2) of three types of bacteria on contact surfaces, on the cutting line, of three midwestern pork packing plants.

Contact Surfaces	Psychrotrophs	Coliforms	Mesophilic Aerobes
Loin saddles	1.81[a]	1.40[a]	2.45[a]
Rubber gloves	1.73[a]	1.16[a]	2.67[a]
Main metal conveyor	1.70[a]	1.21[a]	2.12[a]
PVC conveyor	1.63[a]	1.16[a]	2.49[a]
Mesh gloves	1.60[a]	1.03[a]	2.84[a]
Chute between floors	1.55*	1.13*	1.96*
Wizard knives	1.41[a]	0.77[a,b]	2.45[a]
Straight boning knives	0.90*	0.54*	1.72*
Draw knives	0.40[b]	0.20[b]	1.05[b]

[a,b] Means in a column with different letters are significantly (P>0.05) different.
* Data from only one of the three plants, therefore not included in statistical analysis.

Table 4. Contamination levels (log colony forming units/cm^2) of three types bacteria on contact surfaces, on the fabrication or boning line, of three midwestern pork packing plants.

Contact Surfaces	Psychrotrophs	Coliforms	Mesophilic Aerobes
Straight boning knives	2.87^{a}	1.75^{a}	3.29^{a}
Main metal conveyor	2.82^{a,b}	1.36^{a,b}	2.62^{a}
Cotton gloves	2.64*	1,37*	3.05*
Cutting boards	2.62*	0.49*	2.87*
Mesh gloves	2.57^{a,b}	1.46^{a,b}	3.02^{a}
Rubber gloves	2.23^{b}	1.14^{b,d}	2.87^{a}
Loin saddles	2.20*	1.36*	2.55*
Wizard knives	1.5^{c}	0.65^{c,d}	2.17^{b}
Stainless steel tanks	1.07*	0.73*	1.60*

^{a,b,c,d}Means in a column with different letters are significantly (P>0.05) different.
* Data from only one of the three plants, therefore not included in statistical analysis.

Table 5. Contamination levels (log colony forming units/cm^2) of three types bacteria on pork loins, in three midwestern pork packing plants.

Meat Surfaces	Psychrotrophs	Coliforms	Mesophilic Aerobes
Loins, before boning	1.52^{a}	0.52^{a}	1.71^{a}
Loins, after boning	1.53^{a}	0.57^{a}	1.83^{a}
Loins, after trimming, before packaging	1.13^{b}	0.29^{a}	1.35^{a}

^{a,b} Means in a column with different letters are significantly (P>0.05) different.
* Data from only one of the three plants, therefore not included in statistical analysis.

Table 1 Slaughtering and Dressing methods of slaughterhouses in Japan

Slaughtering and Dressing			Source of slaughterhouse	The number of slaughtered per day
Skinning	Evisceration	Slaughter operation		
Skin removal by machine	Before skin removal	USDA-registered	G	150
			MY	60
			K	100
		Conventional	H	100
			I	100
			SA	250
			N	25
			KA	70
	After skin removal	Conventional	M	90
Skin removal by hand	Before skin removal	Conventional	SG	30
			A	50
	After skin removal	Conventional	SS	50
			NR	50
			Y	60

Table 2 Aerobic bacteria contamination(winter and summer season) on carcasses at final processing step in the slaughterhouse

Slaughterhouse	Number of Samples	Part of carcasses						Thoractic cavitiy		Average		Total av evaluati points[1]
		Flank		Brisket		Neck						
		Win.	Sum.	Win.	Sum.	Win.	Sum.	Win.	Sum.	Win.	Sum.	
1. G	60	0.5[2]	0.8	0.6	1.0	0.7	1.3	0.2	0.1	0.5	0.8	0.7
2. MY	30	2.2	NT[3]	2.3	NT	1.7	NT	1.5	NT	1.9	NT	1.9
3. K	55	2.3	2.3	2.1	2.1	1.9	1.6	0.4	0.6	1.7	1.7	1.7
Average		1.6	1.6	1.7	1.6	1.4	1.5	0.7	0.4	1.4	1.3	1.4
4. H	60	4.0	3.4	3.8	3.4	3.0	3.3	3.4	2.3	3.5	3.1	3.3
5. I	60	4.2	3.5	3.6	3.6	3.3	3.3	2.2	2.2	3.3	3.1	3.2
6. S	60	3.1	2.9	3.2	2.8	3.4	3.5	2.5	2.6	3.1	3.0	3.0
7. N	60	2.1	2.2	2.4	2.4	1.9	2.1	0.7	1.7	1.8	2.1	1.9
8. KA	50	2.9	3.1	2.9	3.5	2.5	3.1	1.6	2.4	2.5	3.0	2.7
9. M	50	2.1	2.2	2.5	2.8	2.4	2.6	1.5	1.4	2.1	2.2	2.2
10. Y	45	3.1	3.9	3.2	4.2	2.9	3.9	3.5	4.3	3.2	4.1	3.6
11. SG	40	2.9	4.0	3.0	3.9	3.6	4.1	2.1	2.7	2.9	3.7	3.3
12. A	25	3.0	3.4	1.9	3.0	2.3	2.8	1.6	1.8	2.2	2.7	2.5
13. SS	45	3.6	3.2	3.2	3.1	3.1	3.4	1.8	5.5	2.9	3.8	3.4
14. NR	60	3.6	4.4	3.6	4.7	3.1	4.0	2.8	3.2	3.3	4.1	3.7
Average		3.2	3.3	3.0	3.4	2.9	3.3	2.2	2.7	2.8	3.2	3.0

Slaughterhouse No. 1～3: USDA-registered slaughterhouse

1) Evaluation points: Average of data in winter and summer season.

2) Average of total aerobic bacteria counts(log_{10}/cm^2

3) NT: Not tested

Table 3 Coliform bacteria contamination(winter and summer season) on carcasses at final processing step in the slaughterhouse

Slaughterhouse	Number of Samples	Part of carcasses: Flank Win.	Flank Sum.	Brisket Win.	Brisket Sum.	Neck Win.	Neck Sum.	Thoractic cavitiy Win.	Thoractic cavitiy Sum.	Average Win.	Average Sum.	Total average evaluation points[1)]
1. G	60	0.0[2)]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. MY	30	0.3	NT[3)]	0.2	NT	0.2	NT	0.2	NT	0.2	NT	0.2
3. K	55	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average		0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1
4. H	60	0.8	0.6	0.7	0.6	0.3	0.4	0.3	0.0	0.5	0.4	0.5
5. I	60	0.4	0.4	0.3	0.1	0.1	0.3	0.0	0.1	0.2	0.2	0.2
6. S	60	0.0	0.2	0.0	0.3	0.0	0.6	0.0	0.3	0.0	0.4	0.2
7. N	60	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0
8. KA	50	0.3	0.6	0.2	0.6	0.2	0.6	0.0	0.1	0.2	0.5	0.3
9. M	50	0.0	0.1	0.1	0.0	0.0	0.2	0.1	0.1	0.1	0.1	0.1
10. Y	45	0.1	1.2	0.2	1.2	0.1	1.3	0.1	1.1	0.1	1.2	0.7
11. SG	40	0.0	0.0	0.0	0.1	0.1	0.3	0.0	0.0	0.0	0.1	0.1
12. A	25	0.0	0.1	0.0	0.1	0.2	0.1	0.0	0.0	0.1	0.1	0.1
13. SS	45	0.3	0.4	0.1	0.3	0.1	0.5	0.0	0.1	0.1	0.3	0.2
14. NR	60	1.5	2.2	1.4	1.9	0.8	1.6	0.5	1.0	1.1	1.7	1.4
Average		0.3	0.5	0.3	0.5	0.2	0.5	0.1	0.3	0.2	0.5	0.3

Slaughterhouse No. 1～3: USDA-registered slaughterhouses
1) Evaluation points: Average of data in winter and summer season
2) Average of Coliform counts(log_{10}/cm^2)
3) NT: Not tested

Table 4 Sanitary evaluation in slaughterhouse based on Total Aerobic Bacteria Counts of beef carcasses

Slaughterhouse / Evaluation Point	G 0.7	MY 1.9	K 1.7	H 3.3	I 3.2	S 3.0	N 1.9	KA 2.7	M 2.2	Y 3.6	SG 3.3	A 2.5	SS 3.4	NR 3.7	Ave.
1. Effective livestock washing															
Yes	0.7	1.9	1.7							3.6					2.0
No				3.3	3.2	3.0	1.9	2.7	2.2		3.3	2.5	3.4	3.7	2.9
2. Dreesing order															
1) Bleeding after Hanging	0.7	1.9	1.7				1.9								1.6
2) Bleeding before Hanging					3.2			2.7	2.2	3.6	3.3	2.5		3.7	3.0
3) Bleeding during Hanging				3.3		3.0							3.4		3.2
3. Rodding & Anus tying															
YES	0.7	1.9	1.7												1.4
NO				3.3	3.2	3.0	1.9	2.7	2.2	3.6	3.3	2.5	3.4	3.7	3.0
4. Contamination with hide & skin															
YES		1.9		3.3		3.0		2.7	2.2	3.6	3.3			3.7	3.0
NO	0.7		1.7		3.2		1.9					2.5	3.4		2.2
5. Inadequate water washing of carcass															
YES	0.7	1.9	1.7					2.7	2.2						1.8
NO				3.3	3.2	3.0	1.9			3.6	3.3	2.5	3.4	3.7	3.1
6. Hi-pressured water pistol															
YES	0.7	1.9	1.7	3.3		3.0	1.9		2.2	3.6	3.3	2.5			2.4
NO					3.2			2.7					3.4	3.7	3.3
7. Cleaning & sterilization of utensils during operation															
Yes	0.7	1.9	1.7												1.4
No				3.3	3.2	3.0	1.9	2.7	2.2	3.6	3.3	2.5	3.4	3.7	3.0
8. Cotton gloves															
Yes	0.7	1.9	1.7				1.9								1.5
No				3.3	3.2	3.0		2.7	2.2	3.6	3.3	2.5	3.4	3.7	3.1
9. Carcasses contact with floor & walls															
Yes	0.7	1.9	1.7					2.7							1.5
No				3.3	3.2	3.0	1.9		2.2	3.6	3.3	2.5	3.4	3.7	3.0
10. Cleaning & sterilization of utensils after operation															
Yes	0.7	1.9	1.7		3.2		1.9			3.6		2.5			2.5
No				3.3		3.0		2.7	2.2		3.3		3.4	3.7	3.1

Table 1. Mean value and s.d. of the colony counts of Enterobacteriaceae and campylobacter in the faeces of the pigs (in log c.f.u./g). The numbers of positive samples for campylobacter in 1 g are also mentioned per sampling day and farm.

Farm	Sampling day	Enterobacter. mean	s.d.	n	Campylobacter mean	s.d.	n	pos.1g
SPF	1	8.6	0.3	20	<1.8		20	0
	2	8.8	0.3	20	<1.8		20	0
1	1	7.2	0.4	5	<1.8		20	0
2	1	7.4	0.5	20	<1.8		20	1
	2	7.4	0.6	20	<1.8		20	0
	3	7.3	0.5	20	3.4		2	3
3	1	6.9	0.7	20	4.8	1.5	20	20
4	1	7.5	0.5	20	3.1	1.0	20	20
5	1	6.7	0.7	5	3.9	0.8	5	5

Farms:

SPF-farm: the SPF-farm of the Central Veterinary Institute at Lelystad (NL)

Farm 1: a small (non-SPF) testing farm with 5 porkers born under SPF-conditions

Farm 2: a conventional (non-SPF) piggery repopulated 2.5 years ago with SPF-sows

Farms 3, 4 and 5: top-breeding farms without connections with SPF-breeding

Table 1:
Air conditions (temperature and rel. humidity) in a poultry slaughter room and air-chilling room at different locations (n = 20)

Location	Temperature (°C)	Rel. Humidity(%)
entry of the slaughter line	18.4 - 19.0	97.0 - 99.1
evisceration	18.2 - 18.8	93.6 - 96.0
exit of the slaughter line	15.7 - 17.7	99.9
chilling room: carcase enter chilling room	-3.5 - -0.2	62.9 - 78.9
chilling room: carcase leave chilling room	-1.9 - 0.0	75.0. - 81.5

Table 2:
Selected air parameters during air sampling with the ANDERSEN-sampler in spray-chilling rooms and air-chilling rooms of poultry processing plants

	spray chilling	air-chilling
air velocity (m/s)	0.9 - 12	0.9 - 12
rel. humidity (%)	93 - 96	98
sampling time(min.)		
enterobacteriaceae	8	8
aerobic plate count	5	3

Table 3:
Temperatures in breasts and legs of randomly chosen poultry carcases entering and leaving the air-chilling room (n = 50)

	Temperature °C	
	entering the chilling room	leaving the chilling room
Sampling site: breast	40 - 42	8.4 - 8.9
leg	39 - 42	1.8 - 2.0

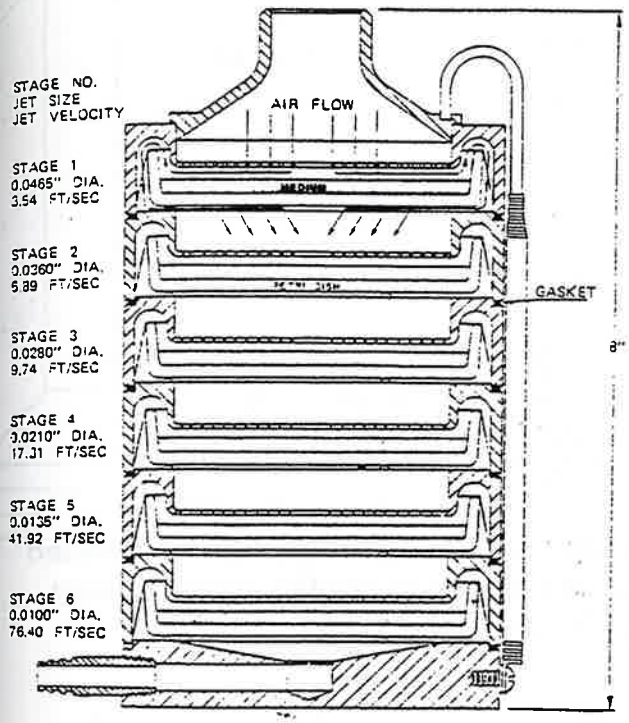


Figure 1:
Schematic diagram of the ANDERSEN six-stage viable sampler

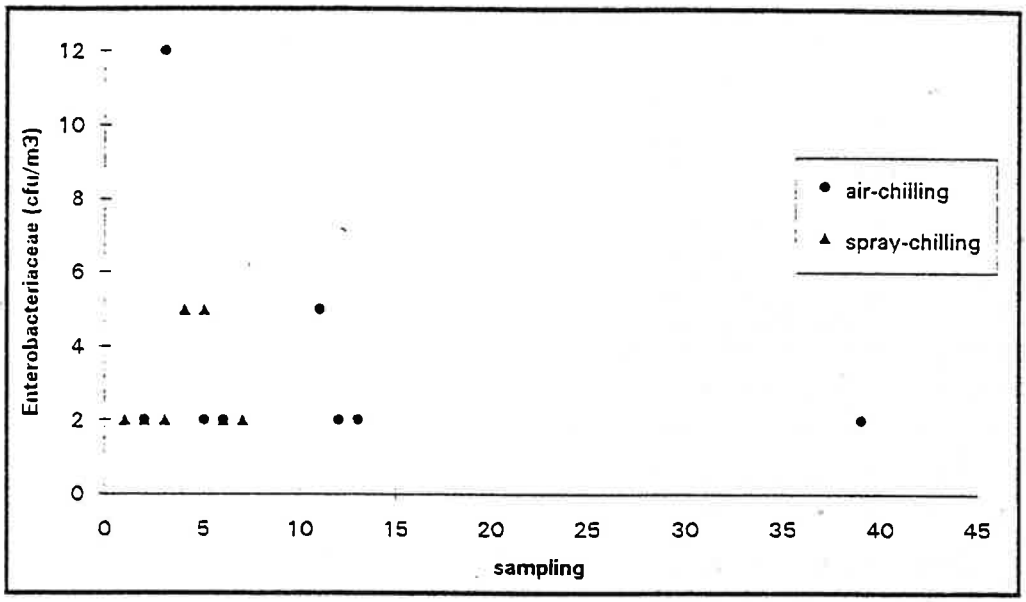


Figure 2:
enterobacteriaceae displayed as colony forming units(cfu)/m^3 detected with the ANDERSEN six-stage viable sampler in poultry spray-chilling rooms (n = 10) and air-chilling rooms (n = 44).

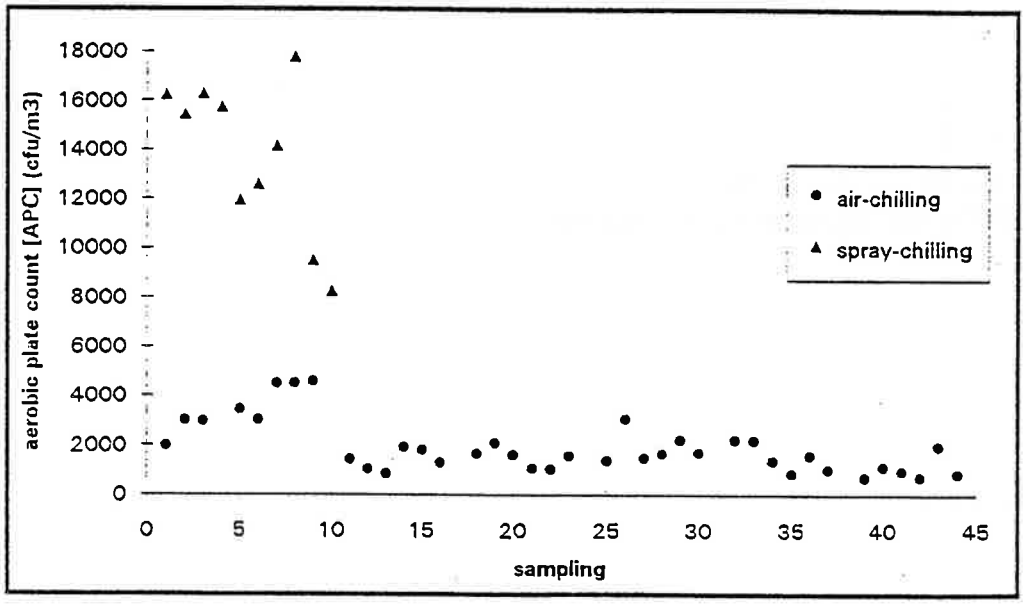


Figure 3:
Aerobic plate count (APC) displayed as colony forming units(cfu)/m^3 detected with the ANDERSEN six-stage viable sampler in poultry spray-chilling rooms (n = 10) and air-chilling rooms (n = 44).

ig 1. Distribution of total viable counts in raw pork.

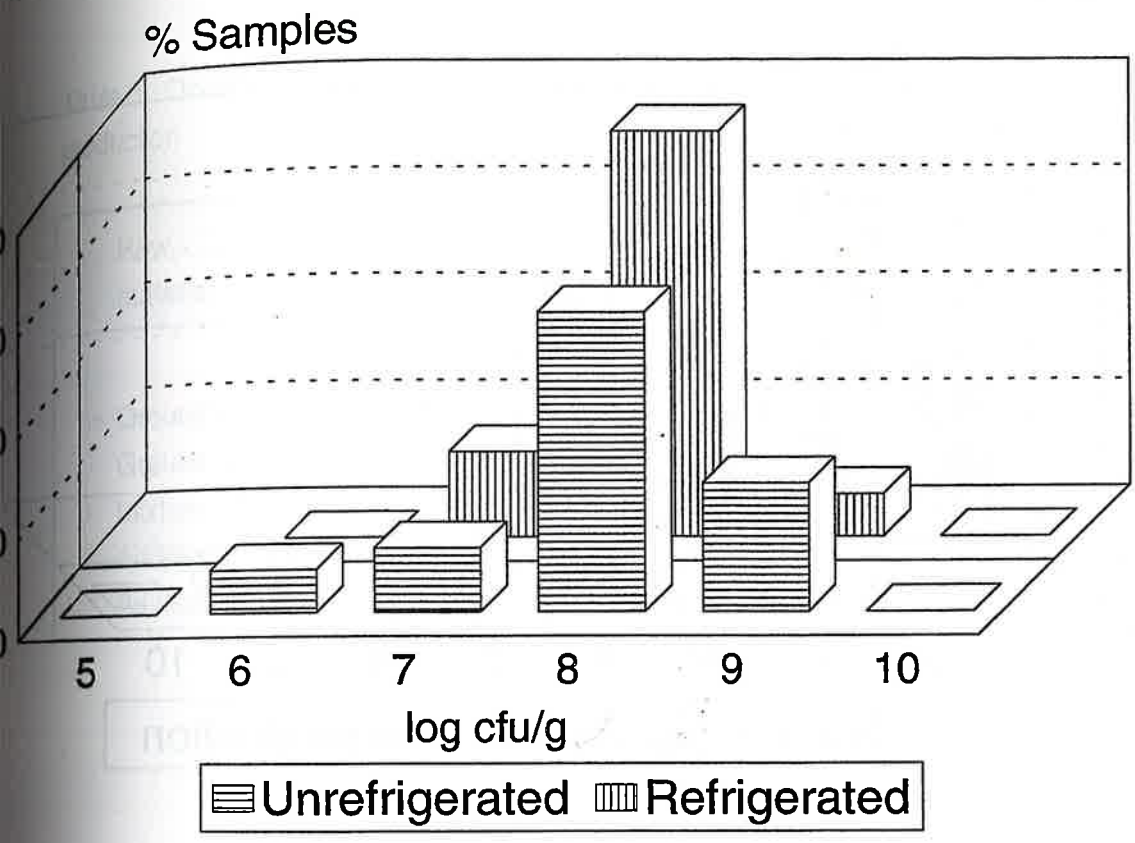


Fig 2. Distribution of Enterobacteriaceae counts in raw pork.

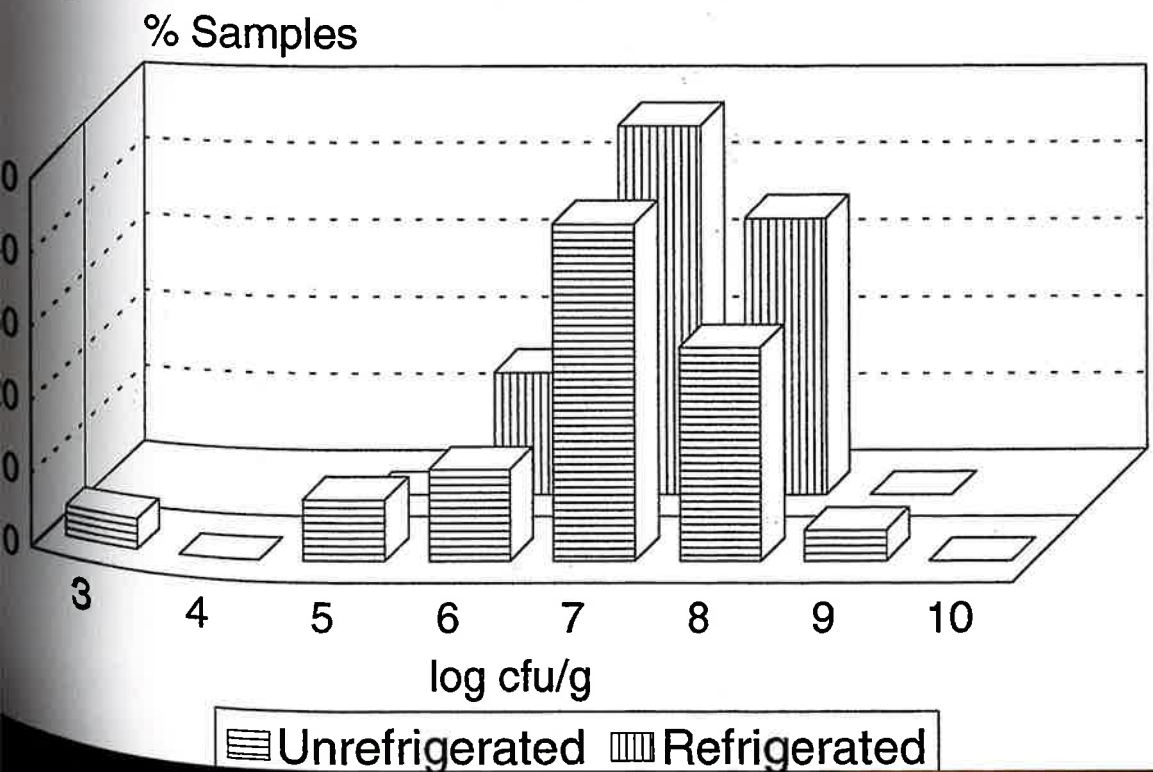


Fig 3. Distribution of Enterobacteriaceae counts in chorizo.

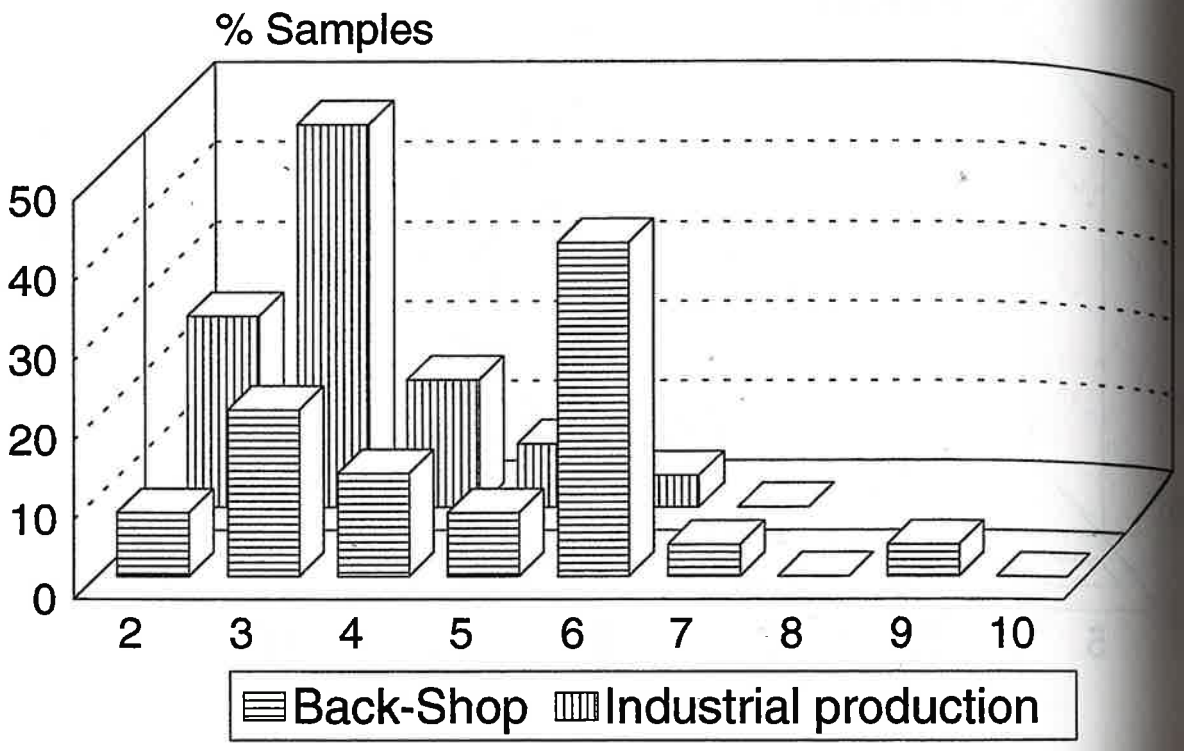


Table 1. Occurence of ochratoxin A-producing moulds in raw materials for dry sausage production

Raw material	Mould species	
	P. aurantiogriseum	P. chrysogenum
Ground pork		+
Ground beef		
Mixture of spices		
Additive 1	+	
Additive 2	+	+

Table 2. Occurence of ochratoxin A-producing moulds on sausage surface during the processing and storage

Sausages	Mould species			
	A. ochraceus	P. aurantio-griseum	P. chryso-genum	P. commune
After filling		+		+
After smoking		+		
10th day of ripening	+			
20th day of ripening				
5th day of storage		+	+	
10th day of storage		+	+	
15th day of storage		+		

Table 3. Occurence of ochratoxin A-producing moulds in air in meat processing plant

Sausage	Mould species		
	P. aurantiogriseum	P. chrysogenum	P. commune
Filling-house	+		
Smoke-house	+	+	
Ripening-house	+		
10th day of ripening	+	+	
20th day of ripening	+	+	
Store-house			
5th day of storage	+		
10th day of storage	+	+	
20h day of storage	+	+	+

Fig. 1

Effect of CTAB on growth of *S. carlsbergensis* in the absence of HT-2 toxin (♦) and in the presence of 10 µg of HT-2 toxin per ml (●)

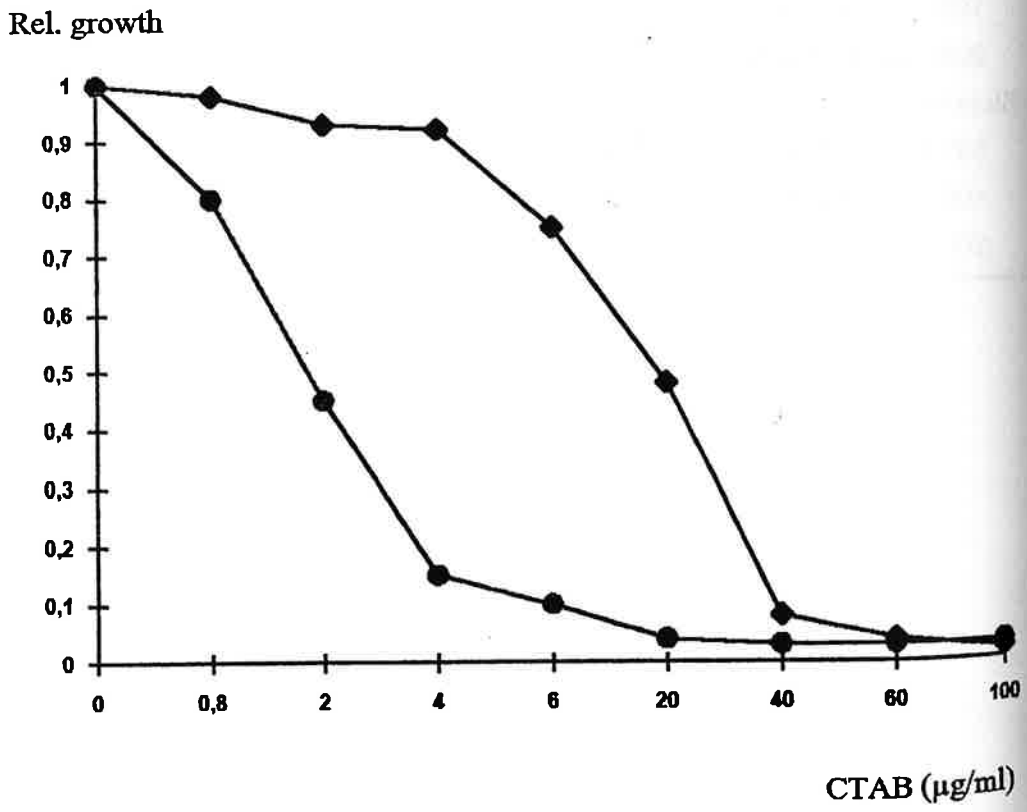


Fig. 2

Effect of CTAB and ethanol on growth reduction caused by HT-2 toxin

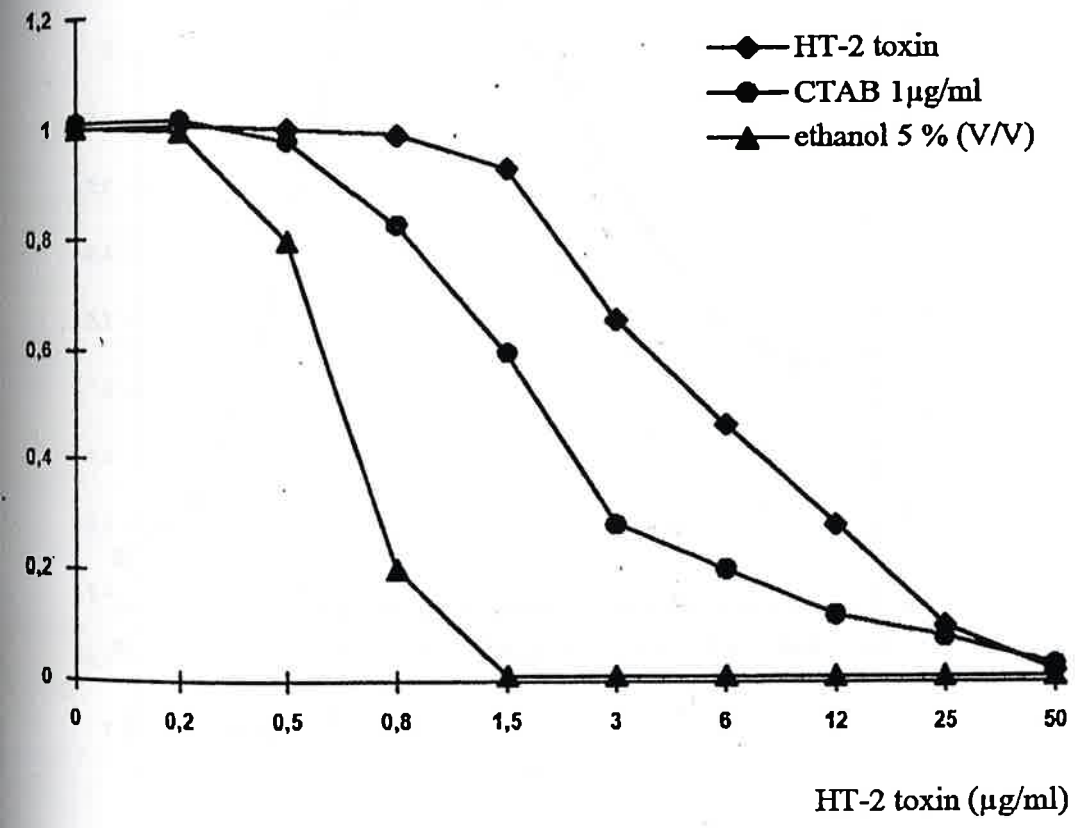


Fig. 3

Influence of Triton on growth reduction caused by 10 µg of HT-2 toxin per ml

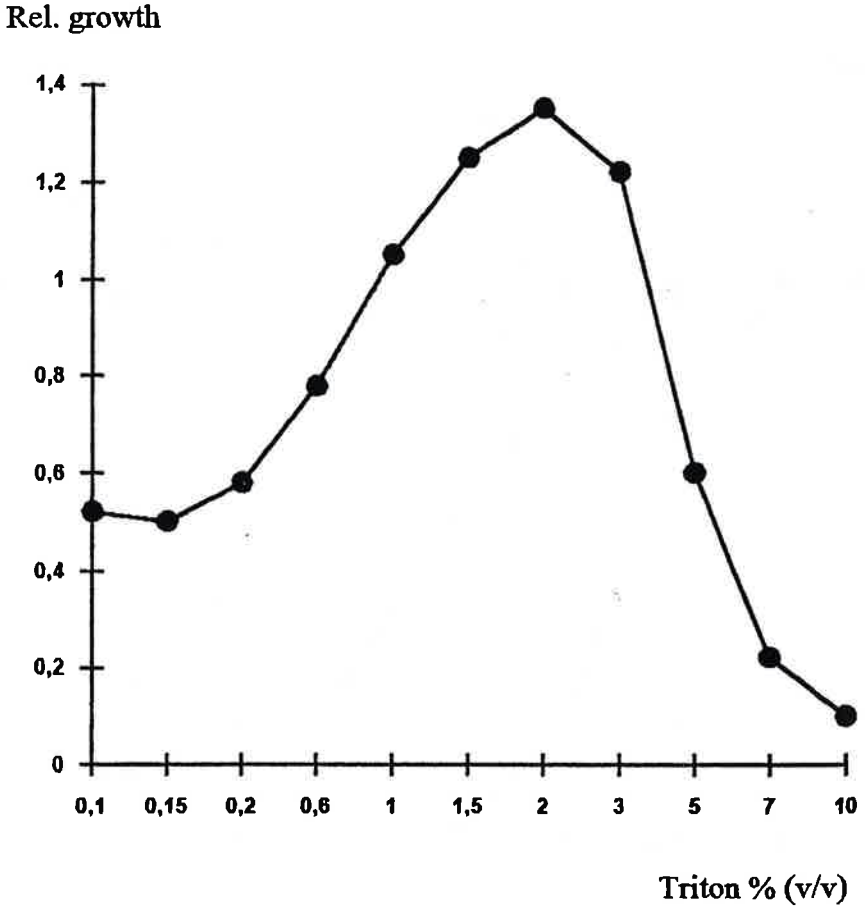


Fig. 4

Influence of incubation temperature on growth rate reduction caused by HT-2 toxin at 10 µg/ml

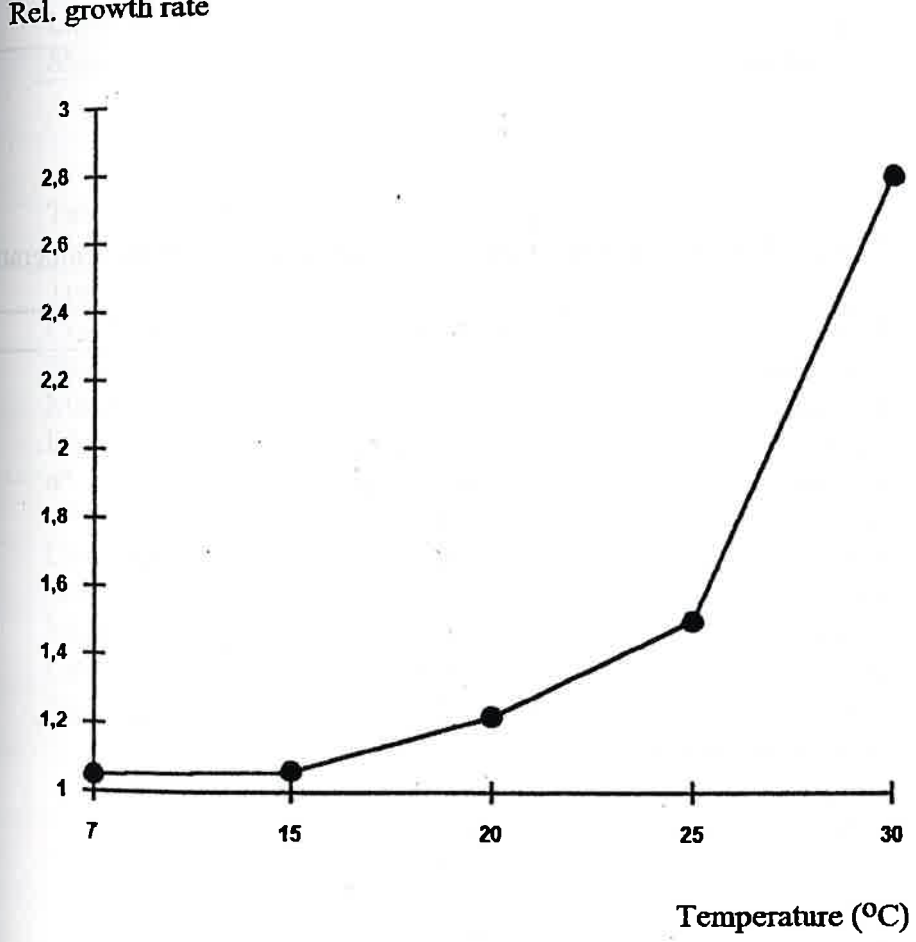


Table 1. Effect of vascular infusion of cold water on carcass and offal yields

Trait	Control	Infused	Probability
Live weight, kg	97.7	94.2	0.557
Warm carcass weight, g kg^{-1}	824	863	0.004
Chiller shrinkage, g kg^{-1}	30.6	28.9	0.203
Liver, g kg^{-1}	16.5	24.7	0.001
Heart, g kg^{-1}	3.5	4.9	0.001
Spleen, g kg^{-1}	1.7	2.7	0.251
Lungs, trachea, tongue g kg^{-1}	19.6	24.5	0.021

g kg^{-1} of live weight

Table 2. Effect of vascular infusion of cold water on muscle temperature and pH

Trait	Control	Infused	Probability
Longissimus thoracis			
Temp, ^{0}C:			
45 min	39.6	37.8	0.012
3h	18.9	18.4	0.780
24h	1.8	1.8	0.954
pH			
45 min	5.55	5.56	0.756
3h	5.54	5.57	0.336
24h	5.52	5.55	0.314
Semimembranosus			
Temp, ^{0}C:			
45 min	41.9	40.0	0.002
3h	27.6	26.6	0.423
24h	2.5	2.3	0.757
pH			
45 min	5.69	5.70	0.862
3h	5.62	5.65	0.553
24h	5.62	5.65	0.394

Table 3. Effect of vascular infusion of cold water on longissimus thoracis muscle quality

Trait	Control	Infused	Probability
Colour score	1.33	1.50	0.586
Structure score	1.17	1.71	0.023
Minolta Meter:			
L*	64.6	63.1	0.144
a*	10.9	11.1	0.783
b*	7.1	6.4	0.207
Drip loss, mg g^{-1}	51.8	58.8	0.256
Soluble protein, mg g^{-1}	103.3	119.6	0.001
Moisture, mg g^{-1}	754	763	0.045
Lipid, mg g^{-1}	22.5	19.2	0.285
Shear, kg	7.76	7.62	0.823

Table 4. Effect of vascular infusion of cold water on semimembranosus muscle quality

Trait	Control	Infused	Probability
Colour score	2.17	2.07	0.794
Structure score	2.00	2.07	0.527
Minolta Meter:			
L*	54.0	55.6	0.426
a*	14.0	13.9	0.929
b*	6.9	7.6	0.376
Drip loss, mg g^{-1}	54.6	58.0	0.530
Soluble protein, mg g^{-1}	144.5	143.6	0.921
Moisture, mg g^{-1}	765	767	0.606
Lipid, mg g^{-1}	12.8	12.2	0.774
Shear, kg	10.1	9.6	0.605