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BACTERIOLOGICAL QUALITY OF RAW MATERIALS USED IN FINNISH MINK FEED

By

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JUOKSLAHTI, T.: *Bacteriological quality of raw materials used in Finnish mink feed.* Acta vet. scand. 1979, *20*, 562—571. — Mink feed raw materials were analyzed for total bacterial count, the number of faecal streptococci, the coliform count, the number of haemolytic bacteria and the number of sulphite reducing bacteria. The investigation comprised samples from the following raw materials: four slaughter-house offal products, preserved and unpreserved slaughter blood, Baltic herring, cod filletting offal, fish silage, blood meal, fish meal, meat-bone meal, protein concentrate, brewer's yeast and cereal feed.

The slaughter-house offals and unpreserved slaughter blood had the poorest quality, in terms of all the bacterial types for which the samples were analyzed. There were statistically significant differences in bacterial contents between slaughter-house offals from different sources. The preserved slaughter blood had significantly lower bacterial contents as compared to the unpreserved slaughter blood. Single samples of the cod filletting offal, Baltic herring and the blood meal had relatively high total bacterial counts, but the specified mean bacterial counts were relatively low. The bacterial counts for the rest of the investigated raw materials were relatively low.

mink feed quality; bacteria in mink feed.

Many by-products of the food industry, varying considerably in origin and handling, are used as raw materials in mink feed (*Juokslahti* 1978 a). The bacteriological quality of the various kinds of raw materials used in mink feed also varies (*Chou & Marth* 1969, *Rutqvist* 1973, *Mejerland* 1975). In an earlier investigation (*Juokslahti* 1978 a), differences were found in the bacteriological quality of various ready-mixed mink feeds and during various production periods. The purpose of the present investigation was to evaluate the bacteriological status of raw materials of various origin and handling used in Finnish mink feeds.

MATERIALS AND METHODS

Raw material samples were taken during the period 1976—78 in connection with the regular feed quality control performed by the Feed Laboratory. They were taken as collective samples from the central kitchen stores, so that each sample was composed of three-five samples of 200—300 g each, taken from different parts of a batch. Deep-frozen raw materials were collected from the refrigerated store-rooms without previous thawing. Samples from unfrozen raw materials were taken so as to correspond to their state at the time of feed processing. Part of the samples of imported raw materials were taken by government officials in connection with importation control. The samples were forwarded to the laboratory and subjected to investigation as described in an earlier paper (*Juokslahti* 1978 a). The samples were analysed for their total bacterial count, and the counts of faecal streptococci, coliform bacteria, haemolytic bacteria and sulphite reducing bacteria.

Only such raw materials as were not suspected of involvement in clinical disease were included.

Raw materials

S l a u g h t e r - h o u s e o f f a l s. The slaughter-house offals used in mink feed are mainly materials derived from cattle and swine and classified as unsuitable for human consumption but suitable as animal feed ingredients. The offal includes lung, liver, spleen, kidney, stomach, tissue fat, genitals, soft bones and cartilage, intestine and part of or whole carcasses which have been condemned for organoleptic reasons (*Kangas & Juokslahti* 1976). The slaughter-house offals labelled A, C and D (Table 1) were derived from different special factories. The offals processed in these factories are collected from different slaughter-houses. There the various offals are ground and mixed to a mass, which is deep-frozen. This mass is then transported to the central kitchens, where it is used as a raw material in mink feed processing. The slaughter-house offal B included offal batches from different slaughter-houses but was not processed in the way mentioned above.

S l a u g h t e r b l o o d. The slaughter blood is derived from cattle and swine slaughter. In the slaughter-plants the blood is collected after sticking; the blood runs from the body into a col-

lecting-trough, from which it is led through a pipe-line to a store-tank. In some slaughter-houses the store-tanks are situated in could storages, in others the blood is chemically preserved by adding 2 % sodium bisulphite or 2 % concentrated formic acid.

Baltic herring. The Baltic herring (Clupea harengus) is caught in bow-nets during spawning time in the Gulf of Finland, the Gulf of Bothnia and the northern Baltic Sea. During the autumn and winter seasons the Baltic herring is trawled from the same waters. The trawled herring is mingled with sprat (Sprattus sprattus). The fish is kept in deep-freeze stores situated on the shore and later transported to the central kitchens. During the cold season the Baltic herring may be transported to the central kitchens without previous freezing.

Cod filletting offal. Cod filletting offal includes the head, skin and skeleton of filleted cod (Cadus morrhua), coalfish (Pollachius virens) and haddock (Gadus aeglefinus). This offal is frozen in the filletting plants and transported to the central kitchens. Most of the filletting offal used in Finland comes from northern Norway.

Fish silage. Fish silage is produced by mixing Baltic herring with 3 % conc. sulphuric acid and 1 % conc. formic acid. The acids cause hydrolysis of the the fish mass, giving it a fluid consistency. Fish silage has a pH of about 3.0. It is stored at the hydrolysing plants or central kitchens in silos until used in feed processing. Fish silage is used in feeds in late summer and autumn.

Blood meal. Blood meal is produced by spray-drying the cellular fraction of centrifugated blood.

Fish meal. The fish meal used in mink feed is mostly whole-fish meal of capelin (Mallotus villosus) and mackerel (Scomber scombrus), imported from Norway. The fish meal is fresh-produced, after which an antioxidant, etoxyquin, (*Enger* 1975) is added to the meal.

Meat-bone meal. Meat-bone meal is produced by the drying of slaughter-house by-products.

Protein concentrate. Protein concentrate is a mixture of protein feeds and cereals with added vitamins and minerals.

Brewer's yeast. Brewer's yeast is a dried by-product from the beer industry.

Cereal feed. Cereal feed consists mainly of gelatinized

and dehydrated wheat. Nowadays the central kitchens increasingly grind and boil unprepared cereals into a porridge-like mass before mixing into the feed.

RESULTS AND DISCUSSION

The results of the bacteriological analyses are given in Table 1. The mean total bacterial counts of the slaughter-house offals varied between logarithmic values (log) 6.58 and 7.85 per g. The lowest count was found in Product A. The difference between Product A and Product D was significant ($P = 0.01$). The mean values of the faecal streptococcal counts varied between log 3.69 and 5.69 per g. The lowest count was found in Product A, and the differences when compared with Products B, C and D were statistically significant ($P = 0.01$). The mean coliform count between different slaughter-house offals varied from log 3.18 to log 5.22 per g, the lowest count was in Product A, the differences to other products were significant ($P = 0.01$). The haemolytic bacterial counts varied between log 3.90 and 5.24 per g, the lowest count was in Product A, the differences as compared to Products C and D were statistically significant ($P = 0.01$).

The mean values of the sulphite-reducing bacterial counts varied between log 1.27 and 4.47 per g, the lowest count being again found in Product A. The differences when compared with the other products were statistically significant ($P = 0.01$). The results show that slaughter-house offals of different origin may differ considerably with regard to their bacterial counts. This is obviously a result of differences in the handling when the material is collected. When Product A was the only slaughter-house offal in ready-mixed mink feed, the health of the animals was noticed to be better than when the others were used (*Juokslahti* 1977). The feed producers were therefore advised to use this offal, especially during critical periods of breeding such as pregnancy, nursing and weaning (*Juokslahti* 1977). *Mejerland* (1975) reported the total bacterial count in Swedish slaughter-house offal to vary between log 10.30 and 5.60 bacteria per g, the coliform count was log 6.00—3.00 per g, the haemolytic bacterial count log 7.30—3.00 per g and the sulphite-reducing anaerobic bacterial count log 5.00—1.00 per g. In Denmark *Poulsen & Hansen* (1975) found a mean total bacterial count of slaughter-house offal of log 6.30 per g, with a faecal streptococci count of log 4.00 per g and a coliform count of log 4.00 per g.

Table 1. Bacteriological counts of mink feed raw materials (log per g).

Raw material		Total bacterial count	Faecal streptococcal count	Coliform bacterial count	Haemolytic bacterial count	Sulphite-reducing bacterial count
Slaughter-house offals, Product A	mean ± s	6.58 ± 1.22	3.69 ± 1.41	3.18 ± 1.48	3.90 ± 1.18	1.27 ± 1.56
	range	8.73...4.97	5.81...0	5.68...0	6.34...0	4.07...0
	n	47	47	47	47	46
Slaughter-house offals, Product B	mean ± s	7.05 ± 1.41	4.93 ± 1.37	4.69 ± 1.93	4.37 ± 1.62	3.88 ± 1.63
	range	9.90...4.04	6.72...2.30	7.81...2.00	6.88...0	5.95...0
	n	63	60	63	63	63
Slaughter-house offals, Product C	mean ± s	7.16 ± 2.06	4.77 ± 1.33	4.80 ± 1.53	4.92 ± 1.34	3.73 ± 1.65
	range	9.99...5.69	6.75...3.00	6.89...3.39	7.00...0	6.30...0
	n	97	97	97	97	96
Slaughter-house offals, Product D	mean ± s	7.85 ± 0.75	5.69 ± 0.50	5.22 ± 1.78	5.24 ± 1.27	4.47 ± 1.66
	range	10.11...6.00	6.72...4.55	7.84...4.00	7.00...3.77	6.00...0
	n	46	44	46	46	46
Slaughter blood, unpreserved	mean ± s	7.62 ± 0.80	4.91 ± 0.98	4.86 ± 0.94	5.84 ± 1.03	3.80 ± 1.86
	range	9.78...6.00	6.81...3.48	6.40...3.00	7.43...3.90	6.00...0
	n	26	26	26	29	26
Slaughter blood, preserved	mean ± s	5.97 ± 1.00	2.33 ± 1.80	2.91 ± 1.73	2.99 ± 2.32	2.25 ± 2.03
	range	7.80...4.00	4.81...0	6.04...0	6.72...0	5.30...0
	n	33	32	32	34	32
Baltic herring	mean ± s	5.60 ± 1.45	0.50 ± 1.22	1.23 ± 1.53	0	0
	range	8.72...4.00	3.47...0	4.63...0		
	n	13	13	13	13	13
Cod filletting offal	mean ± s	5.56 ± 1.10	0.17 ± 0.58	0.17 ± 0.58	0.17 ± 0.58	0
	range	7.36...4.00	2.00...0	2.00...0	2.00...0	
	n	17	12	12	12	12

Fish silage	mean ± s	3.86 ± 0.14	0	0.32 ± 0.32	0.68 ± 0.44	0.25 ± 0.25
	range	4.00...3.00		2.60...0	2.47...0	2.00...0
	n	7	7	8	7	8
Blood meal	mean ± s	5.42 ± 2.27	0.86 ± 1.45	0	0.41 ± 1.10	0
	range	8.55...3.00	3.17...0		2.90...0	
	n	7	7	7	7	7
Fish meal	mean ± s	4.19 ± 0.19	0	0	1.05 ± 0.49	2.51 ± 0.69
	range	5.36...4.00			2.77...0	4.74...0
	n	7	7	7	7	7
Meat-bone meal	mean ± s	4.00 ± 0	0	0	0	0
	range	4.00...0				
	n	4	4	4	4	4
Protein	mean ± s	5.37 ± 0.56	0	0	2.13 ± 1.20	0.52 ± 1.16
	range	6.00...4.77			3.00...0	2.60...0
	n	6	5	5	5	5
Brewer's yeast	mean ± s	4.28 ± 0.88	0	0	0.54 ± 1.21	0
	range	5.57...3.00				
	n	6	5	5	5	5
Cereals	mean ± s	4.44 ± 0.21	0.46 ± 0.46	0	1.75 ± 0.60	0
	range	5.28...4.00	2.78...0		3.48...0	
	n	6	6	6	6	6

Test of significance for differences between raw materials:

Slaughter-house offals					
Product A — Product B		$P < 0.01$	$P < 0.01$		$P < 0.01$
Product A — Product C		$P < 0.01$	$P < 0.01$	$P < 0.01$	$P < 0.01$
Product A — Product D	$P < 0.01$	$P < 0.01$	$P < 0.01$	$P < 0.01$	$P < 0.01$
Product B — Product C				$P < 0.05$	
Product B — Product D	$P < 0.01$	$P < 0.01$		$P < 0.01$	
Product C — Product D	$P < 0.02$	$P < 0.01$			$P < 0.02$
Slaughter blood					
unpreserved — preserved	$P < 0.01$	$P < 0.01$	$P < 0.01$	$P < 0.01$	$P < 0.01$

The bacterial counts of unpreserved blood are eqvivalent to those of slaughter-house offals. The chemical preservation of slaughter blood significantly lowers the bacterial count ($P = 0.01$). Acid and sodium bisulphite preservation have been found to lower considerably the bacterial counts of contaminated blood (*Juokslahti* 1978 b). In *Mejerland*'s material, the total bacterial count of centrifuged blood mass varied between log 9.00 and 5.00 bacteria per g, the enterococci count (44°C) was log 5.77—0.00 per g, the coliform bacterial count log 6.77—3.00 per g, the haemolytic bacterial count log 7.84—3.00 per g, and the sulphite-reducing anaerobic count log 4.00—1.00 per g. In a Danish investigation (*Poulsen & Hansen*) the mean total bacterial count of bovine slaughter blood was log 5.69 per g, the faecal streptococci count log 3.39 per g and the coliform bacterial count log 3.00 per g. The mean total bacterial count of the Baltic herring was log 5.60 per g. The samples contained faecal streptococci and coliform bacteria; haemolytic bacteria and sulphite-reducing bacteria were not found. The Baltic herring used in feeds consists of the whole fish, including intestines and intestinal bacteria. In some samples high total bacterial counts were found (max. log 8.72 per g) as well as high counts for faecal streptococci and coliform bacteria. The mean values were still low, however, compared with those found in slaughter-house offal. *Poulsen & Hansen* reported the following mean values of bacterial counts of wholefish: total count log 5.69 per g, faecal streptococci log 3.39 per g and coliform bacteria log 3.00 per g.

The mean total bacterial count of the cod filletting offal was log 5.56 per g; in this material faecal streptococci, coliform and haemolytic bacteria were discovered, but no sulphite-reducing bacteria. As far as bacteriological quality is concerned cod filletting offal is a good raw material for mink feed. The bacterial count is low since the intestines are excluded. According to *Mejerland* the bacterial count of filletting offal varies between log 5.30 and 2.00 per g and the sulphite-reducing anaerobe count between log 2.00 and 0.00. He found no haemolytic bacteria, faecal enterococci or coliform bacteria in his material. *Poulsen & Hansen* reported bacterial counts of fish offal to be about log 6.00 per g, faecal streptococci log 2.69 and coliform bacteria log 2.69 per g.

The mean total bacterial count of acid-preserved Baltic herring was log 3.86 per g. Coliform, haemolytic and sulphite-reducing bacteria were encountered but no faecal streptococci. The

total bacterial count of the acid-preserved Baltic herring was the lowest found in our raw materials. The low pH obviously has an inhibitory effect on bacterial growth. The haemolytic and sulphite-reducing bacteria content found in the acid-preserved Baltic herring was probably due to contamination of the raw material or the samples, as these bacteria were not found in fresh fish. During acid-preservation, spore-producing bacteria may survive in spore form and germinate when the samples are analysed. This is at least known to be the case with Clostridium botulinum type E, which has often been demonstrated in fish (*Wirahadikusumah* 1968). *Poulsen & Hansen* found a mean bacterial count in acid-preserved fish of log 4.69 per g. In their material neither faecal streptococci nor coliform bacteria were encountered. The mean total bacterial count of the blood meal was log 5.42 per g. Faecal streptococci and haemolytic bacteria were found, but no coliform or sulphite-reducing bacteria.

The fish meal had a mean total bacterial count of log 4.19 per g; in this case haemolytic and sulphite-reducing bacteria were found but no faecal streptococci or coliform bacteria. The total bacterial count of the fish meal most commonly used in Finland is, according to the producer, log 5.00 per g (*Arefjord* 1975). This corresponds to the results achieved in this investigation. A relatively high count of sulphite-reducing bacteria was found. In an earlier investigation (*Stenberg & Estola* 1963), a material of 60 samples included three cases containing sulphite-reducing bacteria, diagnosed as Cl. perfringens. In the material of *Poulsen & Hansen* the mean total bacterial count in fish meal was log 5.00 bacteria per g. They found log 3.00 per g coliform bacteria but no faecal streptococci.

The mean total bacterial count of meat-bone meal was log 4.00 per g. In this raw material no faecal streptococci, coliform, haemolytic or sulphite-reducing bacteria were found.

The mean total bacterial count in the protein concentrates was log 5.37 per g. Haemolytic and sulphite-reducing bacteria were demonstrated, but no faecal streptococci or coliform bacteria.

The mean total bacterial count in the brewer's yeast was log 4.28 per g. Haemolytic bacteria were encountered but no faecal streptococci, coliform or sulphite-reducing bacteria.

The mean total bacterial count of the cereals was log 4.44 per g. Faecal streptococci and haemolytic bacteria were found but no coliform or sulphite-reducing bacteria.

Comparing the bacterial counts found in this investigation with the results of an earlier work concerning ready-mixed mink feed (*Juokslahti* 1978a), it can be concluded that slaughter-house offal and unpreserved slaughter blood show the poorest quality, in terms of all the bacterial types for which the samples were analysed. The total bacterial count of the filletting offal of the cod and the Baltic herring may sometimes be higher than that of the ready-mixed feed, but the specified mean bacterial counts are lower than in ready-mixed feed. The bacterial counts for the rest of the investigated raw materials were lower than the mean values for the ready-mixed feed.

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SAMMANFATTNING

Råvarornas bakteriologiska kvalitet i finskt minkfoder.

Minkfoderråvaror analyserades för totalantalet bakterier, antalet faekala streptokocker, antalet koliforma bakterier, antalet hemolyserande bakterier och antalet sulfitreducerande bakterier. Undersökningen omfattade prov från följande råvaror: fyra olika slaktavfallsprodukter, konserverat och okonserverat slaktblod, strömming, torskfileteringsavfall, fiskensilage, blodmjöl, fiskmjöl, köttbenmjöl, proteinkoncentrat, bryggerijäst och spannmålsfoder.

Slaktavfallsprodukterna och okonserverat slaktblod hade den svagaste kvaliteten i fråga om alla undersökta bakterietyper. Det förelåg statistiskt signifikanta differenser i bakteriehalter mellan slaktavfallsprodukter från olika källor. Konserverat slaktblod hade signifikant lägre bakteriehalt jämfört med okonserverat slaktblod. Enstaka prov av torskfileavfall, strömming och blodmjöl hade höga halter av totalantalet bakterier, men medelhalterna av specifika bakterietyper var relativt låga. Andra råvarors bakteriehalter var relativt låga.

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