A Strategy for improvement of the bacteriological quality of frozen local bovine meat delivered to the GECAMINES (Shaba/Zaïre)

MATHIEU, A.-M., MBOYO, O. and VAN HOOF, J.*
Laboratoire d'Hygiène et de Technologie, Fac. Méd. Vét., UNILU, B.P. 3283 Lubumbashi, Zaïre
* Faculty of Veterinary Medicine, State University of Ghent, Belgium

Introduction:

From the very beginning the mining company GECAMINES in the south of Shaba (Zaïre) has paid much attention to the well-being of its workers and employees (36,000 in 1986): In return the company benifits from an improved motivation and efficiency from its personnel. So the company distributes frozen beef as well as other commodities such as fish, corn flower, milk poweder,...

During rainy season (December-June) the quantity of distributed beef amounts up to 250 tons, during the dry season stocks decrease by more than 50% and are compensated by the distribution of fish.

The variation in meat production between both seasons is due to the fact that cattle from the ranches arrive at Lubumbashi on foot ("trek") covering a distance of 500 to 700 km (25 km/day). Due to the lack of water and forage along the route these treks are nearly impossible during the dry season.

This meat consists in 220t deboned and frozen beef for workers-MW (2nd choice) and in 30t beef for employees-ME (top cuts).

Before 1984 the MW was frozen and delivered in plastic bags containing 40 kg meat each. As a consequence high economic losses due to putrefaction and drip losses occurred at the time of distribution. For that reason the GECAMINES called upon the services of the Laboratory of Hygiene and Technology of Food of animal Origin, University of Lubumbashi (UNILU) in order to improve the present situation.

This study points at some shortcomings which must be improved both at the abattoir and deboning plants. Therefore this study meets the aims of FAO and WHO in establishing guidelines and recommendations for control of foodstuffs in developing countries (5).

Material and Methods:

4 abattoirs (A, B, C, D) and 4 deboning plants (E, F, G, H) located in Lubumbashi have been checked for one year aiming at a decrease in losses related to faulty procedures.

At the beginning a new conditioning of MW was introduced in the deboning plants: the weight of plastic bags with MW cuts was reduced to 2, 2.5 and 3 kg respectively. Top cuts were already in portions weighing 2 to 4 kg.

The slaughter is carried out on an interrupted dressing line in the abattoirs A, B, C and in lying position, 2 places, in the abattoir D. Because of the lowness of the ceiling in the chillers carcass halves are devided in quarters directly after slaughter. The abattoirs A, C and D don't dispose of chillers and the refrigeration is realized in the deboning plant after transport by ordinary truck (5 km). Only abattoir B has one cold chain; its deboning plant is identified by the letter F.

The cooling and freezing capacities of the deboning plants are summarized in table 1.

The investigations are carried out as follows:

1. Bacteriological contamination of hot beef carcasses immediately after slaughter ($log_{10}N/cm^2$): counts for Enterobacteriaceae (VRBG-OXOID, 24 h at 37°C) and Total counts (PCA-OXOID, 48 h at 30°C) on 50 cm^2 of the neck, the back and the thigh.
2. Bacteriological contamination of beef carcasses after slow chilling at the abattoir B was carried out as described for hot carcasses.
3. Bacteriological contamination of hot carcasses after transport by ordinary truck from abattoir C to the deboning plant G (5 km) was carried out as described for hot carcasses.
4. Core temperature of fore- and hindquarters after 20 and 44 hours of chilling was measured in the deboning plant G with a thermocouple.
5. Bacteriological contamination of deboned meat after packing ($log_{10}N/g$): counts for Faecal coliforms (VRBG-OXOID, 24 h at 44°C) and Total counts (PCA-OXOID, 48 h at 30°C) on 10 grams of the surface of MW and ME.
6. Core temperature after 24 and 48 hours of freezing of the deboned meat was measured with a thermocouple.
7. Agar sausages containing VRBG-OXOID were used for evaluation of Enterobacteriaceae per cm^2 according to the OLGAARD Method (10, 11, 13) on the deboning surfaces (SUR), soil (SOI), walls (WAL), knives and hooks (KNI), clothings (CLO) and hands of the workers (HAN). After 10 checkings the deboning plants have been graded according to the number of Entero-bacteriaceae per cm^2.
8. The statistic evaluation of the results was made by use of the STUDENT t-test.

Results:

The results of the investigations are summarized in the tables 2, 3, 4, 5 and 6.

Discussion:

The term "Strategy for improvement" is used to indicate that the present work will be continued for a long period in order to ameliorate the local conditions of meat production and processing but also to change inadequate habits.

The results of the bacteriological contamination of hot beef carcasses (table 2) showed little variation between the 4 abattoirs applying similar slaughtering techniques: in most cases however, the bacterial load of neck was significantly different from other sites.

The high counts observed on the neck were mainly caused by repeated contact of the forequarter with the soil at the time of sectioning carcass halves into quarters (7). Our results showed that the initial contamination on most sites was slightly higher compared to the results observed by other authors (4, 8).

Slow refrigeration is used in all deboning plants; in contrast with other data (9, 12) the bacterial counts increased following a chilling period of 20 hours and was most obvious on the neck (table 3). The adverse effect of chilling can be explained by the high initial temperature at the start of cooling and by the considerable loading of the chiller (table 1).

At the time of deboning, generally less than 20 h after slaughter, core temperatures were in all cases superior to the maximum of +7°C stipulated by the Directive 83/90/EEC (2). This short period is due to the lack of available chilling rooms.

Transport of hot carcasses from abattoirs C to the deboning plant G (5 km) by ordinary truck resulted in a very significant increase of the microbiological contamination (table 4). Nevertheless counts on retail cuts after deboning differred not significantly from those where chilling was performed before transport.

Table 5 shows that the MW was more contaminated ($P \leqslant 0.01$) than the ME coming from the hindquarters; the values didn't meet the standards proposed by the ICMSF (6). For the ME results were more acceptable.

It has to be stressed however, that prolonged cooking applied by the local population for MW decreases the impact of the high microbiological contamination.

In order to obtain a core temperature below -6°C or -10°C as required for frozen meat (1, 3, 6) it is necessary to freeze for a minimum period of 48 h under good operating conditions (maximum 200 kg/m^3).

Counts of Enterobacteriaceae per cm^2 obtained with the agar sausage technique(10, 11, 13) given in table 6 revealed the non hygienic practices in the deboning plants. On the other hand these checks have a psychological effect on the workers but they also enable a classification among the deboning plants.

Conclusion:

The measures actually taken in order to improve the commercial techniques already result in the decrease of important economic losses but don't actually result in a significant improvement of the bacteriological status of the meat.

At the moment the GECAMINES urges the producers to adapt their deboning facilities and already some efforts are being made: new abattoir with cold chain under construction (plant E), air conditioning (plant F), new deboning plant and new chiller (306 m^3) in plant E.

However, one has still to face a number of restrictive factors such as the absence of strict and modern legislation, the insufficiency of the veterinary inspection, the reluctance to changing wrong habits, the local consumer with little or no exigence.

Table 1. Cooling and freezing capacities of the deboning plants

	Chilling room					Freezing room			
	E	F	G	H		E	F	G	H
1	160	149	49	55	1	194	207	120	114
2	378	379	115	153	2	529	584	328	273
3	500	530	160	200	7	95	105	59	49
4	0.32	0.28	0.31	0.28	8	ND	ND	-9.6±2.4	-11.0±5.9
5	0.76	0.72	0.72	0.77	9	ND	ND	+8.4±3.1	+ 6.8±5.9
6	12-14	ND	14-18	ND	10	ND	ND	-7.9±2.2	ND

1 Floor area (m^2), 2 Cubic capacity (m^3); 3 Maximum number of quarters stored usually in the chillers; 4 Area for one quarter (m^2); 5 Volume for one quarter (m^3); 6 Mean temperature of the air after loading (°C); 7 Maximum capacity of storage (T); 8 Minimum mean temperature measured in the chillers during one month (°C); 9 Maximum mean temperature measured in the chillers during one month (°C); 10 Monthly mean temperature at 7.30 a.m. (°C).

Table 2. Bacteriological contamination of hot carcasses immediately after slaughter($\log_{10}$ N/cm^2)

	Enterobacteriaceae			Total counts		
	Neck	Back	Thigh	Neck	Back	Thigh
A	2.35 ± 0.89 n=15	0.91 ± 0.44 n=5	1.05 ± 0.62 n=5	6.06 ± 0.75 n=15	4.36 ± 0.75 n=10	4.47 ± 0.81 n=10
B	2.44 ± 0.82 n=10	0.88 ± 0.84 n=10	1.18 ± 0.87 n=10	5.46 ± 0.48 n=10	4.39 ± 1.04 n=10	4.60 ± 0.67 n=10
C	2.62 ± 0.70 n=15	0.93 ± 0.94 n=15	1.44 ± 0.66 n=15	5.28 ± 0.52 n=15	4.26 ± 0.89 n=15	4.77 ± 0.81 n=15
D	2.70 ± 0.33 n=5	ND	ND	5.93 ± 0.74 n=5	ND	ND

Mean core temperatures (°C) measured after 20 h and 44 h respectively of chilling for the forequarters were 11.0 ± 0.5 and 3.0 ± 1.4, and for hindquarters 13.8 ± 0.8 and 3.4 ± 1.3. The values were approximately the same in the 4 deboning plants.

Table 3. Bacteriological contamination of beef carcasses after slow chilling at the deboning plant F ($log_{10}N/cm^2$); 200 quarters, 58 m^2, 133 m^3; n=10

	Enterobacteriaceae			Total counts		
	Neck	Back	Thigh	Neck	Back	Thigh
Before ref.	2.44 ± 0.82	0.88 ± 0.84	1.18 ± 0.87	5.46 ± 0.48	4.39 ± 1.04	4.60 ± 0.67
After ref.	3.61 ± 1.10*	1.41 ± 0.84°	1.79 ± 0.31°	6.72 ± 0.41**	5.00 ± 0.36°	5.66 ± 0.42**

* significantly different ($P \leqslant 0.05$)
** very significantly different ($P \leqslant 0.01$)
° not significantly different

Table 4. Bacteriological contamination of hot carcasses after transport from abattoir C to the deboning plant G ($log_{10}N/cm^2$); 5 km; n=15

	Enterobacteriaceae			Total counts		
	Neck	Back	Thigh	Neck	Back	Thigh
Before trans.	2.62 ± 0.70	0.93 ± 0.94	1.44 ± 0.66	5.28 ± 0.52	4.26 ± 0.89	4.77 ± 0.81
After trans.	4.48 ± 0.26**	3.08 ± 0.97**	3.58 ± 0.88**	6.58 ± 0.27**	5.38 ± 0.25**	5.57 ± 0.36**

** very significantly different ($P \leqslant 0.01$)

Table 4. Bacteriological contamination of deboned meat after packing ($log_{10}N/cm^2$)

	MW	ME
Faecal coliforms	4.89 ± 0.70 n=115	3.53 ± 1.10** n=60
Total counts	7.20 ± 0.48	6.51 ± 0.84**

** very significantly different ($P \leqslant 0.01$)

Core temperatures (°C) in deboning plant H after 24 h and 48 h respectively of freezing of the deboned meat were -4.7 and -9.9 under good operating conditions, i.e. MW in plastic bags of 2 kg and 100 kg/m^3.

Table 6. Evaluation of Enterobacteriaceae per cm^2 in the deboning plants at 6 sites of examination and classification of the deboning plants according to the number of Enterobacteriaceae per cm^2

	Enterobacteriaceae							classification						
	SUR	SOI	WAL	KNI	CLO	HAN		SUR	SOI	WAL	KNI	CLO	HAN	TOTAL
E	1112	111	10	19	120	48	E	4	2	3	2	2	2	15
F	31	137	9	68	15	31	F	1	3	2	3	1	1	11
G	470	376	7	10	222	188	G	3	4	1	1	3	3	15
H	111	38	10	120	376	342	H	2	1	3	4	4	4	18

References:

1. ANONYME (1974): Arrêté du 26 juin 1974 relatif à la Règlementation des conditions hygiéniques de congélation, de conservation et de décongélation des denrées animales et d'origine animale. J.O. du 31 juillet 1974, Paris.
2. C.E.E. (1983): Directive 83/90/CEE du Conseil du 7 février 1983 modifiant la Directive 64/433/CEE relative à des problèmes sanitaires en matière d'échanges intracommunautaires de viandes fraîches. J.O. CEE du 5 mars 1983.
3. DEBROT, S. et CONSTANTIN, A. (1968): Hygiène et Production de la viande. Ed. Maloine, Paris.
4. DE ZUTTER, L., DEBEVERE, J. and VAN HOOF, J. (1982): Bakteriologische contaminatie van vers geslachte runderkarkassen. Vlaams Diergeneesk. Tijdschr., 51, 201-212.
5. FAO/OMS (1976): Directives générales pour la mise au point d'un système national efficace de contrôle des aliments. Dérie FAO: Contrôle des Aliments N°1, Rome.
6. ICMSF (1978): Microorganisms in Foods. University of Toronto Press, Toronto.
7. MATHIEU, A.-M., ISIGIDI, B.K. et VAN HOOF, J. (1982): Dénombrement bactérien à la surface des carcasses de boeufs dans un abattoir privé de Lubumbashi. Proc. Productions animales tropicales au bénifice de l'homme, Institut de Médecine Tropicale Prince Léopold, Anvers, 529-534.
8. MULDER, S.J. and KROL, B. (1976): Een onderzoek naar de bacteriologische gesteldheid van vers vlees. I. De invloed van het slachten van runderen. Tijdschr. Diergeneesk., 101, 587-593.
9. NEWTON, K.G., HARRISON, J.C.L. and WAUTERS, A.M. (1978): Sources of Psychrotrophic Bacteria on Meat at the Abattoir. J. Appl. Bacteriol., 45, 75-82.
10. NORTJE, G.L. and NAUDE, R.T. (1981): Microbiology of Beef Carcass Surfaces. J. Food Prot., 44, 355-358.

11. NORTJE, G.L., VISSER, D., HOLZAPFEL, W.H. and NAUDE, R.T. (1979): The influence of the dressing on the mesophilic bacterial population of baconer carcass surfaces. S. Afr. J. Anim. Sci., 9, 53-57.
12. STRINGER, W.C., BILSKIE, M.E. and NAUMANN, H.D. (1969): Microbial Profiles of Fresh Beef. Food Technol., 23, January, 97-102.
13. TEN CATE, L. (1965): A note on a simple method of bacteriological sampling by means of agar sausages. J. Appl. Bacteriol., 28, 221-223.