Hazard analysis and critical control point programmes in relation to slaughter hygiene

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INTRODUCTION:

Much human enteric disease is associated with the consumption of food of animal origin from organisms present as part of the gut flora of healthy animals that are not detected by routine ante-mortem veterinary inspection. Organisms initially present at low numbers proliferate when food is incorrectly handled during processing, distribution or preparation. Prevention of foodborne illness therefore depends on control measures at all points in the food chain from live animal to consumption. This paper will deal mainly with the possibilities for control during the slaughter process but will also draw attention to the need to minimise opportunities for infection and cross-contamination in the live animal. We have drawn heavily on the publications of the ICMSF (1988) and WHO (1990) and SMULDERS (1987a).

SYSTEMS OF CONTROL:

Traditional control of food operations has relied on inspection to judge compliance with accepted good practices or food laws, and laboratory testing of the end product. This approach has several shortcomings: the relevant laws or codes are often unclear as to what the requirements are, or what constitutes compliance. Vague terms such as "adequate methods for cleaning", "appropriate measures", "as frequently as necessary" etc abound. Inspection is not continuous and, unless frequent, can be unrepresentative of normal practices. The requirements rarely distinguish between critical operations and those that have little effect on hygiene. The temptation is, therefore, to inspect operations or parts of the process where compliance can be evaluated easily, rather than those that are important.

Microbiological testing has been applied very successfully to drinking water but less successfully to end-product testing of perishable foods. The limitations of microbiology include; (1) the problem of sampling sufficient units to obtain meaningful information (KILSBY & PUGH, 1981); (2) the cost in time and effort; (3) the possible engendering of a false sense of security; (4) relatively slow and imprecise microbiological methods.

The hazard analysis critical control point (HACCP) system is, by contrast, a means of preventive control wherein the hazards are identified, the most important control points are specified, and the methods of control and the criteria for compliance are clearly defined.

THE HACCP SYSTEM:

The features of the HACCP system have been discussed in detail elsewhere (e.g. ICMSF 1988; WHO 1990) and only a brief summary is given here. The essential steps in setting up a HACCP system are:-

1. produce a detailed description of the process e.g. using a flow diagram
2. identify the hazards and assess their severity and the associated risks for each stage of the process
3. identify the critical control points (CCPs) at which hazards can be controlled and detail the method of control at each point
4. specify the criteria for control and the limits for compliance

5. establish methods for monitoring each CCP, using quick, cheap and easy methods, and institute methods of record keeping.
6. detail the corrective action necessary when monitoring indicates a loss of control at any CCP
7. verify that the HACCP system is working by use of additional information.

In 1980 the WHO concluded that HACCP is a desirable alternative to control systems based on inspection and testing. The application of HACCP to red meat slaughter has already been discussed (ICMSF, 1988; WHO, 1990) and much relevant information appears in the proceedings of an international symposium on prevention of contamination and decontamination in the meat industry (SMULDERS, 1987a).

THE MICROBIOLOGICAL PROBLEMS ASSOCIATED WITH MEAT:

Meat is acknowledged to be an important souce of *Salmonella* and *Clostridium perfringens*, both frequent causes of foodborne illness. *Yersinia enterocolitica, Campylobacter jejuni/coli* and *Listeria monocytogenes* also occur on carcasses but the importance of red meat in the epidemiology of human diseases caused by them has not been firmly established. Of recent serious concern is *Escherichia coli* 0157:H7 and other verotoxin-producing strains of *E.coli* that can cause a severe disease known as haemorrhagic colitis, which has been associated with consumption of undercooked burgers.

The frequency and extent of carcass contamination bacteria able to cause foodborne illness varies widely between countries, herds and species of animals. For example, salmonellae are relatively uncommon on sheep and adult cattle in the UK (MACKEY, 1989) and on lamb in New Zealand, but in parts of the USA and Australia very high rates of contamination have occasionally been reported (WEISSMAN & CARPENTER, 1969; SAMUEL et al. 1980).

Ante-mortem inspection cannot guarantee that animals presented for slaughter are pathogen-free. Hygienic slaughter practices that minimise cross-contamination and bacterial multiplication are therefore important. The effectiveness of slaughter hygiene can be judged by the total microbial load present on carcasses at the end of the slaughter line. Surveys over several years (INGRAM & ROBERTS, 1976; ROBERTS et al., 1980, 1984) revealed that counts of 10^3-10^4/cm^2 on the carcass surface are common, but that 10^2-10^3/cm^2 can be achieved with care. Careless slaughter, on the other hand can easily increase counts to 10^5-10^6/cm^2. The consensus of expert opinion is that the hygienic status of carcasses has improved little over the past twenty years despite costly modifications to the structure of abattoirs and to slaughterlines.

THE LIVE ANIMAL:

The principal source of microbial contamination of red meat carcasses are microbes in the intestines or on the skin/hide/fleece of the live animal. Given the complex epidemiology of carriage in the live animal and abundant sources of contamination during rearing, control in the live animal has proved difficult to achieve. Enteropathogens can be introduced with animals arriving from other sources and can be spread through contaminated feed or water and poor waste disposal practices. Control must depend in the first instance on good farming practice and effective veterinary surveillance, effective systems for identifying outbreaks of animal disease and mechanisms for certifying the health status of animals being desirable. Measures to eliminate salmonellae from components of animal feeds need to be improved and implemented.

Further opportunities for cross infection occur when animals from different origins are mixed at markets, during transportation and lairage. Transportation stress can also lead to the recrudescence of previously latent salmonellae infections in calves, and

animals may also become infected from contaminated vehicles or holding pens. Faecal contamination during transport can be reduced if food is withheld for 3-6 h before trucking. The design of vehicles to avoid contamination is important, especially in multi-level stock trucks where special attention must be given to avoiding faeces etc, falling from the upper decks to those below. Cleaning facilities are essential at slaughter plants to ensure that wagons are cleaned between loads.

Holding for long periods in lairage can be stressful to the animal and presents opportunities for cross contamination. Some claim benefits from washing the live animal, but others have failed to detect any (ROBERTS, 1980). Exclusion of grossly contaminated animals from the slaughterhouse is desirable but difficult to rationalize and enforce.

SLAUGHTER OF CATTLE AND SHEEP:

The hide or fleece of the live animal is a potent source of contamination if skinning (flaying) is performed carelessly. Opportunities for transferring bacteria from hide to carcass surface occur when the knife cuts through the hide; when pieces of hide flap against the carcass surface; and when a slaughterman touches the hide and then the freshly exposed carcass surface with his hand. The hands, knives, steels and aprons of slaughtermen who handle the carcass before the hide is removed are more often highly contaminated than those who handle the carcass after the hide is removed (GRAU, 1987).

STOLLE (1981) examined the stages in cattle slaughter and found that highest incidences of salmonellae were associated with removal of horns and freeing the skin round the lower parts of the legs and from the sternum region. The next highest incidence was found at the stage when the abdominal cavity was opened but, because the intestinal carriage rates of salmonellae were low, GRAU (1987) argued that the abdominal tissue was probably contaminated during hide removal rather than during evisceration. Measures to reduce contamination from the hide include using automatic downward hide-pullers and decontamination of knives by immersion in water at 82°C. Although attempts are made to avoid contact between workers' hands and the carcass, even with automated systems there are ample opportunities for it to occur.

Contamination during evisceration can occur as a result of spillage from anus or oesophagus or when the gut is punctured by careless use of a knife. In Australian studies the highest contamination with salmonellae occurred during freeing of the rectum and anal sphincter during hide removal (GRAU, 1979). To prevent such contamination, the anal end of the intestine may be closed in a plastic bag. Clipping shut the oesophagus close to the rumen prevents the outflow of ruminal fluid during skinning and evisceration.

Contamination during cattle slaughter is summarized in Table 1.

Since most slaughter retains elements of manual operations, the skill and care of slaughtermen are critical in obtaining clean carcasses. Indeed, skilled slaughtermen can produce a microbiologically acceptable product even working under primitive conditions, provided they are skilled and have sufficient time remove the hide and eviscerate carefully. Table 2 shows that counts on beef carcasses processed on a commercial line operation were not significantly different from those on carcasses dressed out in the lying position in a wooden shed with an earth floor. Conversely, compliance with current EC regulations and the presence of a veterinary meat inspector do not guarantee microbiological cleanliness. Comparison of bacterial counts on the brisket region, which is consistently one of the dirtiest regions on beef carcasses, at small and medium sized abattoirs and at a large modern EC-approved export abattoir (in the UK) showed that the EC-approved abattoir consistently produced the dirtiest carcasses. The problem was traced to crowding of the carcasses on the line, rapid throughout and excessive use of water during the dressing operations.

SLAUGHTER OF PIGS:

The treatment of pigs differs from that of sheep and cattle in that the skin is not removed during slaughter; rather, hairs are removed by scalding and dehairing, sometimes followed by singeing. The scald tank water is usually intended to be at 60°C. This does not reduce microbial numbers significantly, given that dirt and faecal material is constantly being introduced into the system. Contaminated water can enter the stick wound and lungs, particularly if active movement continues after sticking. The temperature of the scald water should not fall below 60°C and flow rates should be sufficient to prevent excessive build-up of dirt in the water. Adjustment of the pH by adding lime reduces counts in the scald water but fails to reduce contamination on the skin. Closing the anus prior to scalding might reduce a cross contamination.

Automated singeing systems that singe most of carcass reduce microbial numbers on the skin, but recontamination occurs during subsequent scraping and polishing operations. Better design of machinery to allow effective decontamination is needed. The care of the slaughterman in cleaning knives and equipment and during evisceration is again critical for obtaining clean carcasses. Table 3 shows how extra care during slaughter reduced *Salmonella* counts on pig carcasses whilst Table 4 shows how careless slaughtering increased contamination with *Enterobacteriaceae*.

DECONTAMINATION:

Visible dirt is usually removed by some form of washing treatment varying from spraying carcasses with cold water from a hose-pipe to hot water delivered under controlled pressure from a spray-jet. Excessive use of water can spread contamination by splashing and causes the carcasses surface to dry slowly during chilling which has led to poor keeping quality in commercial operations.

Automated hot water washing systems show promise as effective methods of decontaminating carcasses. Better heat transfer and more economical running costs were achieved by the use of a 'waterfall' or 'weir' to deliver the hot water rather than spray nozzles (DAVEY & SMITH, 1989). Provided surface temperatures of 80°C were achieved for 10 seconds, counts of coliforms were reduced by around 100-fold with no permanent change in the appearance of the carcass. The advantage of hot water systems is that no residues are left on the meat.

Decontamination using organic acids especially lactic acid has also proved effective (reviewed by SMULDERS, 1987b). Organic acids have the advantage that some residual antimicrobial effect is often observed (Table 5) though there are practical problems associated with working with corrosive solutions and regulatory approval may be difficult to obtain.

CHILLING

Control of growth of microbes contaminating the carcasss is achieved by reducing the carcass temperature and by the drying of the carcass surface that occurs during chilling. Water evaporates from the carcass and condenses on the cooling coils of the refrigeration equipment, the rate of evaporation being determined by the temperature difference between carcass and surrounding air and the relative humidity and air speed close to the carcass surface. Often air flows are determined in empty chill rooms and consequently give misleading information about conditions achieved when the chillers are loaded with carcasses. Contact between carcasses reduces the cooling rate and allows areas of moist surface to remain, encouraging microbial growth. In commercial beef chillers vertical air flow gives more uniform distribution than either longitudinal or cross flow. An air flow of at least 0.25 m/s should be maintained over all parts of the carcass for effective heat transfer. Control of microbial growth on the surface is easier over the first

18-24h than later. Current regulations require the deep tissue to be cooled to 7°C. This cannot be achieved within 24h with large beef quarters without freezing the surface tissue. If chilling is continued for 48 rather than 24h to comply with the regulation, there is likely to be a greater growth of psychrotrophic spoilage bacteria with no increased security against *Salmonella* growth. Chilling the deep-butt to around 12-13°C in 24h is practically feasible and just as effective at controlling *Salmonella* provided that chilling is continued after 24h.

CUTTING AND BONING:

Cutting and boning is carried out at 10°C to comply with EC regulations. At this temperature Salmonella requires at least 8 to 15h to double in number (MACKEY & KERRIDGE, 1988; SMITH, 1985) assuming there is no lag phase, and *Listeria monocytogenes* would double in 6 to 9h (KAYA & SCHMIDT, 1989). Boning operation are normally completed within about 2h so there is insufficient time for extension proliferation even of the more psychrotrophic *Listeria.* The main microbiological risk comes from possible growth on meat fragments or in liquid material remaining on cutting boards, equipment or floor. Ensuring that surfaces and equipment are sanitised and allowed to dry promptly is therefore an important control measure. Absorbent materials must be avoided. A monitoring system is needed to ensure that all cut and boned meat is returned promptly to the chill room or to the freezer. The ability of *L.monocytogenes* to multiply in cold moist environments in slaughterhouses and cutting rooms presents new problems in cleaning and sanitation.

MONITORING:

To develop an effective HACCP system for meat slaughtering requires that the hazards are identified and that appropriate control measures are specified. The most important sources of contamination have been broadly identified, but we are less able to detail effective control measures because many of the operations are manual and, by their very nature, not amenable to simple measures of performance. Some possible approaches are briefly mentioned:

1. Cleaning and decontamination operations are required for vehicles, slaughter instruments, machinery and working surfaces. Cleaning protocols should be specified as precisely as possible giving details of water temperatures, flow rates, concentration and type of sanitiser (if used), procedures and frequency. Monitoring could be by visual inspection at specified intervals perhaps supplemented by occasional more objective tests (microbiological, ATP) for demonstration and educative purposes.

2. Slaughter operations (eg. hide removal, evisceration) are difficult to specify and monitor. An initial approach might be to form a team (to include the slaughtermen and other relevant experts) to detail the exact procedures and specify requirements. Detailed monitoring is unlikely to be continuous, but regular checks are essential. Some operations could be monitored readily e.g. closure of anus and oesophagus, but avoidance of hand contact to carcass is more difficult. Inspection for visible dirt on carcasses does not ensure microbiological cleanliness, but identies grossly contaminated carcasses and is practically feasible.

3. Carcass cleaning methods can be specified precisely and are amenable to intermittent, if not continuous, monitoring. Where automated systems are in operation water temperatures, pressures and flow rates can be monitored.

4. Chilling can easily be monitored via continuous measurement of air tempeature. Air speed and RH should also be measured on a regular basis under operating conditions (i.e. not on empty rooms) and at several locations in a chiller. Visual checks to ensure that carcasses are not touching should be made when chill rooms are loaded - ideally the distance between the nearest parts of adjoining

carcasses should be at least 6cm. Given technological developments in temperature monitoring, it should be possible to monitor continuously the surface (e.g. 1mm deep) and deep (e.g. 15 cm deep at a specific anatomical location) of several carcasses to monitor effectively chiller performance.

5. Microbiological testing is, in general, slow and expensive, and because contamination is not uniform it is difficult to obtain representative samples (ROBERTS 1980). Testing at the end of slaughter can monitor hygienic performance, but should not be used for regulatory purposes, because it can lead to rejection of wholesome meat, may divert technical resources, may restrict development of new or improved processes, and may lead to a false sense of security (BAIRD-PARKER 1987).

Microbiological testing is of limited value for monitoring CCPs, because the time taken to obtain results does not permit action to be taken while slaughter is in process. However, limited microbiological testing is useful as a means of verifying by independent checks whether HACCP has been properly applied ie. the identified CCPs have been controlled. Such verification tests may also reveal unexpected hazards or CCPs that were overlooked in the hazard analysis.

When instituting a programme of microbiological testing it must be decided which microbes to seek. Some consider that the presence of *Salmonella* and *C.perfringens* on raw meat to be more a reflection of their presence in the live animal than breakdown of hygiene (FAO/WHO 1979). Given the extreme variabliity in the incidence of such pathogens there would seem little point in testing for their presence as a means of verifying hygienic practice. If meat is intended for consumption without cooking, then microbiological testing for pathogens is of more use. However this is a separate matter and should not be used as an argument for the general testing for pathogens.

In many instances the "total viable count" (= aerobic plate count, standard plate count) is the simplest and most suitable method of monitoring hygiene. The media required are cheap and the procedures simple, enabling more testing to be done for the same outlay in time and expense.

Sampling at the end of chilling monitors the "end product" of the slaughter operations and hence can verify the effectiveness of the whole procedure. High microbial counts could be the result of a breakdown at any stage in the slaughter process or by inadequate chilling. Further tests would be needed to identify the cause of the breakdown.

SUGGESTED MONITORING SCHEME:

The scheme must take account of abattoir to abattoir, carcass to carcass, day to day, and site to site variation. At the same time the amount of work involved must not be unreasonable in terms of effort and cost.

1. In a "batch" or "lot", at least 10 carcasses should be sampled at 3 or 4 sites (those shown to be "most frequently contaminated")
2. In our experience non-destructive sampling is adequate but we recognize that some prefer destructive sampling. The surface sample should be by swabbing 50 or 100 cm^2.
3. apply "total viable count" ("aerobic plate count", "standard plate count", "total mesophilic count"), incubating at 30-32°C. Give choice of "standard" media.
4. Decide whether samples are to be taken at the end of the slaughter line (to monitor the hygiene of slaughter) or after chilling (to reflect also the efficacy of the chilling regime)

5. The method of counting is not, in our view, critical. We routinely spread a standard volume (0.02ml) from decimal dilutions on quarters of pre-dried agar plates. The decimal dilutions can be made with pipettes, disposable plastic pipettes or calibrated wire loops with equivalent precision
6. The method of calculating viable numbers should be specified and standardized
7. The interpretation of the numerical data must be laid down. For example, there are likely to be differences between abattoirs, and between visits to the same abattoir.

   It would be unreasonable to expect all abattoirs to deliver carcasses carrying the same numbers of bacteria.

   The data should initially be used WITHIN an abattoir to monitor its day to day (month to month) performance e.g. by producing control charts.

   It is highly desirable that the data from all participating abattoirs be stored centrally, so that sensible decisions can be taken after the data have been reviewed and analysed.
8. An attempt should be made to identify "target" contamination levels compatible with good hygienic practices. These are likely to differ for beef, lambs/sheep and pigs (hogs). These values should be reviewed after, say, 6 or 12 months of data collection, and modified if necessary.
9. In our opinion, no attempt should be made to define absolute categories of "acceptable" or "not acceptable".

   A graded ADVISORY scale of performance could be developed

   e.g. Excellent = mean of the logarithm of counts not above $10^3/cm^2$

   "Good" = mean of the logarithm of counts not above $10^4/cm^2$

   "Must try harder to be hygienic!" = mean of the logarithm of counts $10^5/cm^2$ or greater

   N.B. In addition, as data are accumulated, attention should be paid to the distribution of log counts as well as the mean values. In our experience the log counts are usually normally distributed, so attributes or variables plans would apply.

FUTURE:

There is a need for rapid on-line tests, so that as contamination goes above the specified limits corrective action can be taken immediately rather than retrospectively.

Omitting those techniques obviously NOT appropriate to the abattoir environment, such as radiometry, such tests could be -

- chemical (e.g. ATP, another measure of biomass/activity - dye reduction)
- microscopic (e.g. DEFT)
- physical (flow cytometer, photometric systems, impedance/conductance)
- electrical counting and sizing (Coulter counter)
- electrochemical "probes"

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Table 1: Salmonella contamination during cattle slaughter

Processing[a] stage	% samples positive for *Salmonella*		
	Berlin[b]		Australia[c]
	equipment	carcass	carcass
Hind leg	20.7	17.2	4
fore-leg/sternum	13.8	13.8	-
sternum	-	-	3
anal sphincter	-	-	26
abdominal opening	5.2	5.2	-

[a] when hide removed, except for abdomen

[b] 2/267 faecal samples positive (STOLLE, 1981)

[c] from GRAU (1979)

Table 2: Bacterial counts on carasses slaughtered in the hanging (H) or lying (L) position

	just after slaughter		24h after slaughter, chilled	
	L	H	L	H
number of carcasses	6	36	9	11
neck	3.9*	3.6	4.5	3.8
mid-back	2.9	3.6	3.8	3.4
hind-quarter	3.9	3.9	4.1	4.1
pleura	3.4	2.8	3.5	3.0
mean	3.5	3.5	4.0	3.6

(* log10/cm^2)

Table 3: Effect of care during evisceration on contamination of pig carcasses with *Enterobacteriaceae*

	% carcasses carrying $>20/cm^2$	mean number/cm^2
Normal	40	60
Knives & hands not washed	84	100
Injury to intestines	100	1250

(From GERATS et al., 1981)

Table 4: Effect of slaughter procedures on incidence of salmonellas on pig carcasses

	number of carcasses	number positive for *Salmonella*
Normal slaughter	35	16 (46%)
Extra care during singeing, evisceration	30	2 (7%)

(From OOSTEROM & NOTERMANS, 1983)

Table 5: Decontamination of cattle carcasses using lactic acid (1% lactic acid spray applied 45 min p.m.)

	aerobic plate count		*Enterobacteriaceae* count	
days	0	3	0	3
breast				
untreated	4.7*	5.3	2.0	2.1
treated	2.9	2.9	<1.3	<1.3

(* log10/cm^2)

from SNIJDERS et al. EMMRW 1984 paper 5.10

INVITATION

We invite all members and friends of the international meat science community to attend the 37th International Congress of Meat Science and Technology. This Congress will be held in the city of Kulmbach, Germany, from September 1 - 6, 1991.

The Federal Centre for Meat Research at Kulmbach has the privilege to host this Congress for the third time. After 1956 and 1978, it will be held in 1991 in an united Germany.

The city of Kulmbach is rather small but attractive, and there is a castle with a history of more than 950 years. The Congress will take place in a new convention hall located in the centre of the city.

The organizers strive for a high scientific standard of the 37th ICoMST, and they are grateful that distinguished scientists of meat science have agreed to contribute to the success of this Congress as invited speakers or chairmen.

Furthermore, we would like to make a special effort for memorable social events. Evening arrangements at the castle, an ancient opera house as well as at our institute are planned. For non-delegates several sightseeing and cultural tours in the lovely surroundings of Kulmbach will be arranged.

We hope to welcome you all in September 1991 in a peaceful world.

Congress Committee of the 37th ICoMST

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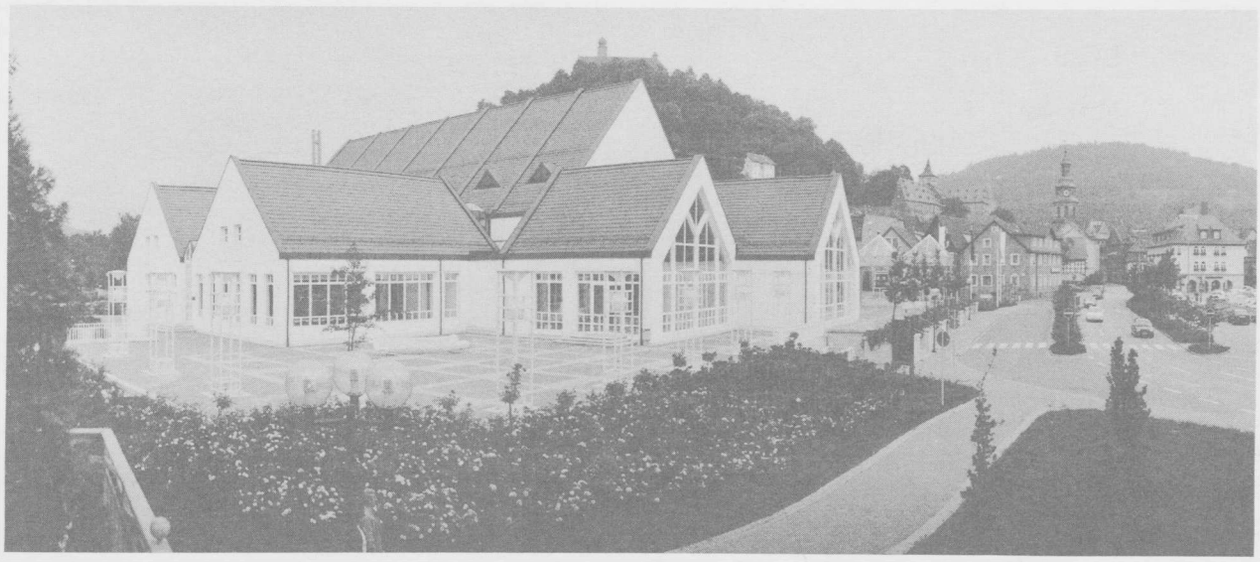
GENERAL INFORMATION

CONGRESS SITE

The Congress will be held at the STADTHALLE of Kulmbach (picture), located in the centre of the city. Transport will be provided between several hotels and the Congress site. Parking facilities are available underneath the STADTHALLE.
Luncheons for the delegates as well as some evening events will take place at the Federal Centre for Meat Research (BUNDESANSTALT).



REGISTRATION AND INFORMATION DESK

The desk will be located at the STADTHALLE, and will be open from September 1 through 6:

Sunday, 13:00 - 20:00
Monday through Thursday, 8:00 - 18:00
Friday, 8:00 - 14:00

CONGRESS LANGUAGE

The official language of the Congress is English. Abstracts and full papers will be accepted in English only.

TRAVEL

Kulmbach is connected with the German network of **motorways** (Autobahn). By **train** Kulmbach can be approached from Frankfurt/Main via Würzburg - Bamberg, or from München via Nürnberg - Bamberg, or from Berlin via Probstzella - Lichtenfels or Berlin via Hof/Saale. **Airports** which are recommended are located in Nürnberg and Frankfurt/Main (see map on the last page of this Information Circular). On Monday through Saturday there are scheduled flights (carrier: NFD) from Frankfurt/Main to Bayreuth (only 20 km from Kulmbach). On Sunday, September 1, and Friday, September 6, we will provide a **bus shuttle** from and to Nürnberg airport in the afternoon.

REGISTRATION FEES

(Please use the registration form supplied in this booklet)

	Before June 1, 1991	After June 1, 1991
Delegates	DM 750,-	DM 800,-
Non-delegates	DM 300,-	DM 350,-

All payments for the meeting must be made in DM (Deutsche Mark) and they may remitted to: Bundeskasse bei der Oberfinanzdirektion Nürnberg, **Landeszentralbank Nürnberg**, Account-No. 76 001 005, Bank Code 760 000 00, Keyword: BAFF/ICOMST and name of the participant.

Registration fee includes:	**Delegates**	**Non-delegates**
Welcoming party	x	x
Admission to opening ceremony	x	x
Admission to scientific sessions	x	--
Non-delegates' program	--	x
Luncheons from Monday to Friday	x	x
Coffee and refreshments at breaks	x	--
Evening at the Opera House	x	x
Evening at the Castle	x	x
Congress Dinner	x	x
Technical and scenic tours	x	x
Admission to closing session	x	x
One copy of Congress programm	x	x
One copy of published abstracts	x	--
One copy of published proceedings	x	--

Registration fees do not include:

Bus shuttle from and to Nürnberg airport (DM 15,-/person/one way)

Extra copies of the Congress abstracts and proceedings will be available for purchase at DM 25,- and DM 100,-, respectively.

SOCIAL ACTIVITIES

Sunday - Welcoming Party with beer and sausage at the Federal Centre for Meat Research (BUNDESANSTALT, Kulmbach) - sponsored by the City of Kulmbach - included in the Congress fee.

Monday - Evening at the Opera House (MARKGRÄFLICHES OPERNHAUS, Bayreuth) - followed by snacks and wine - sponsored by the Association of Friends of the Federal Centre for Meat Research (FÖRDERERGESELLSCHAFT) - included in the Congress fee.

Tuesday - Evening at the Castle (PLASSENBURG on KULMBACH) - sponsored by the German Butcher Association - entertainment sponsored by RAPS & Co. - dinner, beer and soft drinks included in the Congress fee, wine and other drinks extra.

Wednesday - Technical and scenic tours - included in the Congress fee - evening at free disposal.

Thursday - Congress Dinner, Federal Centre for Meat Research (BUNDESANSTALT, Kulmbach) - sponsored by the German Meat Industry Association - entertainment sponsored by RAPS & Co. - dinner, beer and soft drinks included in the Congress fee, wine and other drinks extra.

Friday - Farewell Luncheon, Federal Centre for Meat Research (BUNDESANSTALT, Kulmbach) - included in the Congress fee.

Castle of Kulmbach (Plassenburg) where the evening function on Tuesday will take place

TECHNICAL TOUR

On Wednesday tour of the German Meat Centre at Kulmbach (meat research institute, school for meat technologists, slaughter-house, processing plant, spice mill) and some local butchers. This tour is included in Congress fee.

SCENIC TOUR

On Wednesday alternatively tour to interesting sights and cities in the vicinity of Kulmbach (see page 13). This tour is included in the Congress fee.

ACCOMMODATION

Accommodations will be arranged by the Congress Secretary. Four types of Accommodation have been reserved for the participants. The **price per night** quoted below includes breakfast, service and tax. Please indicate on the registration form your choices in numerical order, and we will do our very best to fulfill your wishes. Early registration should ensure you receive your first choice. Hotel reservations will be made in Kulmbach and surrounding cities. Therefore, please indicate if you arrive by car. For those participants coming by train or plane, we will provide a bus service to hotels outside Kulmbach. Delegates are requiried to pay accommodation expenses directly to the hotels at the time of check out. The room reservations for participants will be confirmed.

Category	Single room	Double room
1. Hotels with bath/WC or shower/WC	DM 90 - 120	DM 118 - 160
2. Hotels garni with shower	DM 50 - 80	DM 78 - 120
3. Hotels garni	DM 30 - 45	DM 38 - 78
4. Youth Hostel incl. breakfast	6 beds per room for DM 19,- per night/person	

CURRENCY AND PAYMENT

Hotels will accept Traveller Cheques. Banks in Kulmbach only accept Euro- and Master Cards.

VISA

For information please inquire at the Embassy of Germany or her representation in your country. Please take notice that pre and post Congress tours include Prag/Czechoslovakia, Paris/France, Rome/Italy, Athens/Greece, and Salzburg/Austria.

LIABILITY AND INSURANCE

Participants are encouraged to take insurance against medical expenses, accidents and loss of personal belongings. The organizers can in no way be held responsible.

WEATHER AND DRESS

The average temperature in Germany at the beginning of September is about 20°C during the day with cool nights. During the last few years weather in September has been rather summer-like with temperatures around 25°C. However, a rain coat and sweater are recommended. For excursions and tours appropriate shoes are advisable. Official Congress events do not require formal dress.

CANCELLATION

A confirmed Congress registration can only be cancelled until three weeks before the Congress. An 80% refund of the Congress fee will be made.

After the hotel reservations have been confirmed by the organizers, the responsibility rests with the occupants.

PRE AND POST CONGRESS TOURS

The travel agency of Kulmbach has planned four special touristic tours (A to D) for participants of the 37th ICoMST which will be carried out if a minimum of 25 persons will participate. The prizes (total amounts per person) quoted include accomodations, transportation, meals and sightseeing tickets.

If you wish to take part in pre or post Congress tours, please complete the form included with this circular and mail it directly to the travel agency. In addition, indicate your choice as information for the Congress Secretary in the attached Registration Form.

Tour A (pre Congress tour by bus, 6 days): August 27 - September 1, 1991

Erfurt - Leipzig - Dresden - Prag

Aug. 27: Frankfurt/Main - overnight stay at "Novotel" near airport
Aug. 28: Erfurt with cathedral and Krämerbridge
Aug. 29: Leipzig - sightseeing tour with Thomas-Church (Johann Sebastian Bach), Völkerschlachtdenkmal (Monument of the Battle of Leipzig, 1813)
Aug. 30: Dresden - known as "Elbflorenz" with "Zwinger" and "Green Vault"
Aug. 31: Prag - known as "Golden Town" - sightseeing tour, typical evening in a beer-house "U-Fleku"
Sept. 1: Journey to Kulmbach

Total amount per person: DM 1.160,- double room
DM 1.490,- single room

Tour B (pre Congress tour by bus and ship, 5 days): August 28 - September 1, 1991

Rhein - Mosel, Rüdesheim (journey by ship on the Rhine - Loreley), Koblenz, Bernkastel-Kues (Mosel) - Idar-Oberstein - Heidelberg

Aug. 28: Frankfurt/Main - overnight stay at "Novotel" near the airport
Aug. 29: Rüdesheim (Rhine) - journey by ship (Loreley) to Koblenz - journey by bus to Bernkastel-Kues along the river Mosel
Aug. 30: Bernkastel-Kues - visit of a vineyard with winetasting
Aug. 31: Idar-Oberstein - attendance at a church built in a rock-cave - visit of a gem (precious stone) museum - journey to Heidelberg - sightseeing tour including the castle
Sept. 1: Journey to Kulmbach

Total amount per person: DM 810,- double room
DM 990,- single room

Tour C (post Congress tour by bus, 7 days): September 6 - 12, 1991

Nürnberg - München - Garmisch-Partenkirchen - Salzburg/Austria - Lindau (Bodensee) - Titisee (Schwarzwald)

Sept. 6: Nürnberg - sightseeing tour including castle, old town, typical Franconian evening meal
Sept. 7: München - stop at the Olympiapark - Garmisch-Partenkirchen - Bavarian evening including Bavarian "Schuhplattler" (clog dance)
Sept. 8: Garmisch-Partenkirchen - walking tour through the "Partnachklamm" - visit of the castle Neuschwanstein
Sept. 9: Driving up the Zugspitze (Germany's highest mountain) - Salzburg/Austria (Wolfgang Amadeus Mozart) - comfortable evening including Zither-music
Sept. 10: Salzburg - sightseeing tour - visiting Mozart's birthplace - Getreidegasse - Lindau/Bodensee (Lake of Constance)
Sept. 11: Journey by ship to the "Flower Island" Mainau and visit of the Rhine-Falls - journey to the Schwarzwald (Black Forest) - Titisee
Sept. 12: Visit of a cockoo-clock workshop - journey to Frankfurt/Main (end of the program about 15:00 - 16:00 h at Frankfurt/Main). Possibility of booking an overnight stay at Frankfurt/Main.

Total amount per person: DM 1.380,- double room
DM 1.490,- single room

Tour D (post Congress flight tour, 8 days): September 6 - 13, 1991

Paris - Rome - Athens

Sept. 6: Flight Frankfurt/Main - Paris in the evening
Sept. 7: Paris - sightseeing tour half a day - visit of Louvre in the afternoon
Sept. 8: Paris - visit of the catacombs - flight Paris - Rome in the evening
Sept. 9: Rome - sightseeing tour for the whole day "Antique Rome"
Sept. 10: Rome - sighseeing-tour for half a day "Christian Rome"
Sept. 11: Flight Rome - Athens in the morning - Athens sightseeing tour
Sept. 12: Athens - trip to the isle "Ägina"
Sept. 13: Flight Athens - Frankfurt/Main in the morning

Total amount per person: DM 2.990,- double room
DM 3.410,- single room

Further information concerning travel arrangements may be obtained from the travel agency under following address:

Reisebüro Schaffranek
Attn.: Mr. Uwe Ruckdäschel
Webergasse 8
D-8650 Kulmbach, Germany
Telephone: + 92 21/20 31
Facsimile: + 92 21/8 42 31

CONGRESS PROGRAMM

SCIENTIFIC THEMES

The scientific program includes nine topics which will be introduced and addressed by invited speakers. These themes and keynote speakers are:

1. **Growth, Carcass Characteristics and Meat Quality**
   Dr. Michael E. Dikeman - USA

2. **Preslaughter Handling and Slaughter Technology**
   Dr. Frans J. M. Smulders - Netherlands

3. **Muscle Biology and Biochemistry**
   Dr. Christian Valin - France

4. **Microbiology and Hygiene**
   Dr. Terry A. Roberts - U. K.

5. **Meat Processing: Cooked Products**
   Dr. Günther Hammer - Germany

6. **Meat Processing: Raw and Fermented Products**
   Dr. Kalman Incze - Hungary

7. **Product Management and Process Control**
   Mr. K. B. Madsen - Denmark

8. **Analytical Methods**
   Dr. Werner Pfannhauser - Austria

9. **Nutrition, Residues and Health**
   Dr. Johanna Fink-Gremmels, Germany

In each of these nine sessions the review presented by the invited speaker will be followed by a poster session and a plenary discussion. **All accepted papers shall be presented as posters (see page 16) in the corresponding poster session**. Discussions will be led by invited chairmen.

WORKSHOP

A workshop with the theme: **Meats in Developing Countries** is planned with the participation of eminent scientists representing different parts of the world. These colleagues will bring into focus the problems and developments with meat and meat products of their region. An invited chairman will lead the discussion.

PROVISIONAL PROGRAM FOR DELEGATES

Sunday, September 1

13:00 - 20:00	Registration at the desk of the Conference Center (STADTHALLE), Kulmbach
19:00 - 21:00	Welcoming Party at the Federal Centre for Meat Research (BUNDESANSTALT), Kulmbach

Monday, September 2

9:00 - 10:00	Congress Opening Ceremony
10:00 - 10:30	Break
10:30 - 11:15	Session 1: Carcass characteristics - Review
11:15 - 12:00	Session 1: Posters
12:00 - 13:30	Lunch
13.30 - 14:15	Session 1: Discussion
14:15 - 15:00	Session 2: Slaughter technology - Review
15:00 - 16:00	Session 2: Posters
16:00 - 16:45	Session 2: Discussion
19:30	Evening at the Opera House, Bayreuth (no formal dress required)

Tuesday, September 3

9:00 - 9:45	Session 3: Biochemistry - Review
9:45 - 10:30	Session 3: Posters
10:30 - 11:15	Session 3: Discussion
11:15 - 12:00	Session 4: Microbiology - Review
12:00 - 13:30	Lunch
13:30 - 14:30	Session 4: Posters
14:30 - 15:15	Session 4: Discussion
15:15 - 16:45	Video Shows on Science & Technology Topics
19.30	Evening at the Castle, Kulmbach (no formal dress required)

Wednesday, September 4

9:00 - 12:00	**Technical Tour** through the Meat Centre of Kulmbach (Federal Centre for Meat Research, school of meat technologists, slaughter-house, meat processing plant, spice mill)
12:00 - 13:30	Lunch
13:30 - 15:00	Visits to local butchers
15:00 - 17:00	Workshop: Meats in Developing Countries

Scenic Tour for Delegates and Non-Delegates on Wednesday will be offered alternatively, including visits to interesting sights and cities in the surroundings of Kulmbach.

Free Evening

Thursday, September 5

9:00 - 9:45	Session 5: Cooked products - Review
9:45 - 10:30	Session 5: Posters
10:30 - 11:15	Session 5: Discussion
11:15 - 12:00	Session 6: Fermented products - Review
12:00 - 13:30	Lunch
13:30 - 14:30	Session 6: Posters
14:30 - 15:15	Session 6: Discussion
15:15 - 16:00	Session 7: Production management
16:00 - 16:30	Session 7: Posters
16:30 - 17:10	Session 7: Discussion
19:30	Congress Dinner at the BUNDESANSTALT, Kulmbach (no formal dress required)

Friday, September 6

9:00 - 9:45	Session 8: Analytical methods - Review
9:45 - 10:45	Session 8: Posters
10:45 - 11:30	Session 8: Discussion
11:30 - 12:15	Session 9: Nutrition and health - Review
12:15 - 12:45	Session 9: Posters
12:45 - 13:15	Session 9: Discussion
13:15 - 13:45	Closing Session
14:00	Farewell Luncheon at the BUNDESANSTALT, Kulmbach

PROVISIONAL PROGRAM FOR NON-DELEGATES

Sunday, September 1

19:00 - 21:00 Welcoming Party at the Federal Centre for Meat Research (BUNDESANSTALT), Kulmbach

Kulmbach is located at one of Europe's heartlands, with pleasant scenic surroundings and a rich history. This allows the organizers to arrange several attractive excursions to cities and sights of general interest. However, the tours outlined below will be open to change, depending primarely on the number of registered Non-Delegates.

Monday, September 2

9:00 - 10:00 Congress Opening Ceremony

10:30 - 16:30 In the morning excursion to "Fränkische Schweiz" (attractive franconian hilly region), visit to an ancient village (Thurnau) with a museum for ceramic art as well as potter's workshops in the afternoon

19:30 Evening at the Opera House, Bayreuth
(no formal dress required)

Tuesday, September 3

9:00 - 15:00 a) Excursion to Kronach which is a city with a long tradition and the birth place of the famous painter Lucas Cranach; visits to the Rosenthal Company (china ware designer manufacturer) and the Veste Rosenberg (Castle of Kronach).
Alternatively:
b) Excursion to the "Teufelshöhle" (stalactive cave) and a visit to the Basilica of Gößweinstein

19:30 Evening at the Castle, Kulmbach
(no formal dress required)

Wednesday, September 4

9:00 - 12:00	**Technical Tour** through the Meat Centre of Kulmbach (Federal Centre for Meat Research, school of meat technologists, slaughter-house, meat processing plant, spice mill)
12:00 - 13:30	Lunch
13.30 - 15.00	Visits to local butchers
Free Evening	
9:00 - 17:00	Alternatively **Scenic Tours** for Non-Delegates and Delegates will be offered: a) Excursion to the town of Warmensteinach (Franconian Forest) and visits of a glass-blower's workshop as well as the Monastery Abbey of Waldsassen: famous wood-carved library and relicts of Zisterzienser Order, or b) Wasserschloß Mitwitz (chateau built into water), visit of a figurine manufacturer (Goebel Company, well known by its "Hummel"-Figures) and Veste Coburg (castle of Coburg), which was a hiding-place for Martin Luther during the Reformation. Coburg is also the birth place of Prince Albert who became the husband of Queen Victoria.
Free Evening	

Thursday, September 5

9:00 - 16:00	Visit of the famous Rokoko-Basilica "Vierzehnheiligen" (Fourteen Saints), excursion to the bishops residence city of Bamberg with a gothic Cathedral and other memorably sights
19:30	Congress Dinner at the Bundesanstalt, Kulmbach (no formal dress required)

Friday, September 6

Morning	At free disposal
13:15 - 13:45	Closing Session
14:00	Farewell Luncheon at the BUNDESANSTALT, Kulmbach

REQUIREMENTS FOR SCIENTIFIC CONTRIBUTIONS

GENERAL

Participants are invited to submit scientific contributions on any aspect of meat science and technology and to indicate which session (see pages 9 - 11) they consider most appropriate for their paper. The organizers reserve the right to allocate contributions to other sessions if they consider it necessary. At least one of the authors must be a delegate of the Congress. **Registration of that author must be completed by June 1, 1991.**

All contributions must be presented in English only. The scientific content and editorial aspects of contributions are solely the responsibility of the authors. The manuscript will be reproduced as received. However, submitted papers are refereed before approval, and only contributions of international standard will be included into the proceedings. Strict observance of the style guides given here will reduce the effort required from authors and organizers alike to produce high quality Congress proceedings.

All contributions must be written on the enclosed sheets with the blue lines. It is necessary to type broadside and double-spacing by following the format and instructions given in the "examples" for abstracts and full papers. Abstracts and full papers will be photographed and will appear in the published documents reduced to half of their original size. Please type only on one side of the sheets provided.

Abstracts and Full Papers should be sent to:

37th International Congress of
Meat Science and Technology
c/o Prof. Dr. L. Leistner
Bundesanstalt für Fleischforschung
E.-C.-Baumann-Str. 20
D-8650 Kulmbach, Germany

ABSTRACTS

Abstracts (maximum one of the sheets provided, minimum 250 words) should state concisely the scope of work and give the practical findings. The use of abbreviations and references should be avoided. Please refer to the enclosed example. **Abstracts must be received not later than March 15, 1991.**

FULL PAPERS

Each paper should not exceed eight (8) pages of the sheets provided, including all text, tables, illustrations, diagrams and references. Invited speakers may use more space for their review articles (maximum 30 pages of the sheets provided). Tables, illustrations and diagrams must be inbedded in the submitted text. Please refer to the enclosed example. Pages should be mailed flat. **Papers must be received not later than May 1, 1991.**

Abstracts and papers which do not follow the requested format or in the opinion of the organizers lack sufficient detail will not be included in the Congress proceedings.

TABLES & FIGURES

Graphical presentation should be used where practical. All tables and figures must be furnished with a legend (simple spacing) and are to be numbered in separate sequences using arabic numerals. They must be mentioned in the text. Letters and symbols must at least be the size of typescript and readable when reduced to half of their size. Tabular and graphical presentation of the same data should be avoided.

PHOTOGRAPHS

Only black and white photographs can be reproduced. The photographs supplied should be printed on glossy paper and should show a full range of tones and good contrasts. A high quality original (not exceeding 240 x 169 mm, i.e. the blue lines of the provided sheets) of each illustration or photograph should be supplied. These originals will be returned only if requested. A scale bar should be inserted on all photomicrographs.

VISUAL AIDS

Especially for the invited speakers giving review papers projectors for normal 5 x 5 cm slides as well as overhead transparencies will be available. These facilities may also be used during the discussion periods by other participants, after agreement with the respective Session Chairman. Letters and figures in the slides or transparencies must be **sufficiently large for clear projection**. Slides should be submitted to the organizers well in time before the appropriate session.

On Tuesday afternoon from 15:15 to 16:15 time has been allocated for video presentations. The use of video cassettes of the following video systems can be arranged: VHS Pal 50/60 Hz, Super VHS, SECAM, NTSC, and 8 mm video. The presentation of non-commercial videos on interesting themes of meat science and technology is encouraged. Please contact the organizers for appropriate arrangements well before the Congress.

POSTER PRESENTATIONS

All contributions to the Congess except the review papers, must be presented as posters. Efforts will be made by organizers to ensure an appropriate poster presentation. The authors should bring their posters in person to the Congress. Do not mail your poster.

The poster boards provided will allow poster dimensions of 1.20 m wide and 1.00 m high. Posters should be readable from a distance of 2 m. Therefore, the title of your poster (the same as that of the abstract) should use letters 2 - 3 cm high. The names of the authors, institution, city and country should be indicated by letters 1.5 - 2 cm high. It is advisable to organize your poster in sections: Introduction, Aim, Conclusions, Methods and Results (see example below). The use of colours is recommended.

Materials (adhesive tapes) for assembling posters will be provided by the organizers. During the poster sessions, authors must be present to discuss their work. Poster authors will be asked to mount their material before the appropriate session (i.e. in the morning before the meeting starts, during the lunch period, during the previous discussion time, repectively) and remove it after the session is closed. Poster authors might bring along one or two slides or overhead sheets to show the most relevant and characteristic data during the discussion period of their session.