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# **Opinion of the Scientific Committee on Veterinary Measures relating to Public Health**

## **The Cleaning and Disinfection of Knives in the Meat and Poultry Industry**

**(adopted on 20 – 21 June 2001)**

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## 1. TERMS OF REFERENCE

The Scientific Committee on Veterinary Measures relating to Public Health (SCVPH) is requested to address the question of cleaning and disinfection of knives in the meat and poultry industry and in particular the use of sanitising agents such as the addition of lactic acid combined with the use of water of less than 82°C.

## 2. BACKGROUND

Council Directive 64/433/EEC requires that meat-producing and -processing establishments must have facilities for disinfecting tools with hot water supplied at not less than 82°C. The Dutch authorities have claimed that, at this temperature, protein coagulates and that this coagulation may result in an inefficient disinfection of knives. They therefore propose an alternative method consisting of the use of water under pressure and at a lower temperature, e.g. 45°C, in combination with the addition of lactic acid.

## 3. INTRODUCTION

### 3.1. The use of knives and legislative requirements

Knives are used at various steps of the slaughtering process, the carcass preparation, and in the course of veterinary *post-mortem* inspection, where all the parts of slaughtered animals have to be presented, and during which some organs and lymph nodes are required to be incised. Risks arise in the course of this process and have to be specifically addressed.

There are specific rules regarding the use and the cleaning and disinfection of knives used for Specific Risk Material (SRM); they are not included in this "Opinion".

Under the terms of Council Directive 64/433/EEC on health problems affecting intra-Community trade in fresh meat (as amended and updated), Council Directive 92/116/EEC amending and updating Directive 71/118/EEC on health problems affecting trade in fresh poultry meat, and Council Directive 95/68/EC amending Directive 77/99/EEC on health problems affecting the production and marketing of meat products and certain other products of animal origin, it is a requirement that equipment and premises approved for slaughtering, carcass preparation and meat cutting are carefully cleaned and disinfected several times during, and at the end of, the working day, and before being re-used, so as to prevent contamination by some pathogenic micro-organisms or other micro-organisms associated with meat spoilage.

Finally, the EU meat hygiene Directives require that, during the production process, the temperature of water used to "decontaminate" hand-held tools (knives, hooks, saws) is maintained at 82°C or higher.

In the same way, the operations of cleaning and disinfection in food industries are realised in different ways according to sites: "opened" surfaces,

cleaning in place. This text concerns only operations on knives used in the plants of slaughter and transformation of animals.

### 3.2. Terminology

- Biofilm: cells immobilised on a *substratum* and often embedded in a matrix of microbially produced organic polymers (Carpentier and Cerf, 1993).
- Cleaning: removal of visible soil from surfaces by physical, chemical or mechanical means.
- D-value: decimal reduction time, or the time required to destroy 90 % of the organisms.
- Disinfection: the destruction of micro-organisms, but not usually bacterial spores. Not all micro-organisms will be killed, but their number will be reduced to a level that is not harmful, either to human health or to the quality of the food being produced.
- Good Hygienic Practice (GHP): a system to ensure that undesirable micro-organisms are minimised to the extent that they cannot cause harm to human health.<sup>1</sup> (Opinion of the Scientific Committee on Veterinary Measures related to Public Health on the evaluation of microbiological criteria for food products of animal origin for human consumption, 23 September 1999).
- On-line sanitisers: a facility for sanitising hand held utensils located at or near the point of operation.
- Sanitisation: a term used mainly in the food and catering industry. A process of both cleaning and disinfecting utensils, equipment and surfaces. It does not imply sterilisation.

### 3.3. Micro-organisms likely to contaminate knives

A number of bacterial pathogens able to cause food-borne diseases in humans can contaminate meat. Currently the most important bacterial pathogens associated with raw meat and poultry are *Campylobacter* spp., *Clostridium perfringens*, verotoxigenic *Escherichia coli* (VTEC), *Listeria monocytogenes*, *Salmonella* spp., *Staphylococcus aureus* and *Yersinia enterocolitica*. Table 1 summarises information on the growth and death of these bacteria.

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<sup>1</sup> GHP constitutes a pre-requisite for the successful implementation of Hazard Analysis and Critical Control Point (HACCP) Systems

**Table 1: Growth criteria for pathogenic and potentially pathogenic bacteria in meat and meat products\***

	°C			pH			A <sub>w</sub>	Heat resistance	
	min.	opt.	max.	min.	opt.	max.	min.	D value (min.)	Temperature (°C)
<i>Aeromonas</i> spp.	0-4	26-35	42-45	4,5	7,2		0,96	0,2	55
<i>Bacillus cereus</i>	4	28-40	50-55	4,9	6,0-7,0	9,3	0,95-0,91	8 220	100 (spores) 85 (spores)
<i>Campylobacter jejuni/coli</i>	30	43	45,5	4,9	7,0	8-9,5	0,99	0,2 1,0	60 55
<i>Clostridium botulinum</i> : A,B (proteolytic)	10	30-40	47-50	4,6	6,5-7,0	8,5	0,96-0,94	0,17 2,38	121 (spores) 110(spores)
C	>10	35	48	4,6	7,0	8,5-9,0	0,98-0,93	1,4 – 73,6	82,2(spores)
(non-proteolytic) E	3	28-30	45	5,0	6,5-7,2	8,0-9,0	0,97	0,78 72	80 (spores) 70(spores)
<i>Clostridium perfringens</i>	12	43-47	50	5,0	7,2	9,0	0,95-0,92	6 120	100 (spores) 80 (spores)
<i>Escherichia coli</i>	7-8	37	44-47	4,4	7,0	9,0	0,96-0,94	0,75	60
<i>Listeria monocytogenes</i>	0	30-37	45	4,6	7,1	9,6	0,93-0,90	0,1 – 0,27	70
<i>Salmonella</i> spp.	7,0	35-43	45-47	4,5	6,5-7,5	9,0	0,93	0,2 40 – 80	60 <sup>a</sup> 90 <sup>b</sup>
<i>Staphylococcus aureus</i>	6 -7	37	45	4,5	7,0	9,3	0,93	5 – 15	60
<i>Yersinia enterocolitica</i>	0	25-37	43	4,2	7,0	9,0	0,95	2 0,1 - 1	55 62,8

a : when heated in "wet" environments

b : when heated in "dry" environments such as chocolate.

\* compiled from Dooley and Roberts, 2000 and ICMSF, 1996 (for spores)

In the live animal many of these bacteria are confined to the alimentary tract, while intact tissues and meat derived from healthy animals are normally sterile (Concerted Action CT94-1456, 7). Occasionally, however, infected or clinically diseased animals may enter the abattoir, and these animals can carry pathogenic agents, including viruses and parasites as well as bacteria, in organs such as the liver, lungs, lymph nodes, and the bloodstream, and in abscesses. In such cases, incision of the organ or carcass may lead to contamination of the site with micro-organisms such as *C. perfringens* and *Salmonella* spp. which might then contaminate the incised muscle.

This microflora consists mainly of saprophytic species. During the rearing and production of animals a number of micro-organisms present in the environment, and for instance in the feed and water, colonise the integument (skin, feathers, etc...) and the alimentary tract of animals. These bacteria are then introduced into the abattoir and are a source of contamination of the meat during carcass preparation. The environment of the processing plant may also be an additional potential source of contamination (water, biofilm). Some of the bacteria from the processing environment can grow at low temperatures. Consequently, they can continue growing after chilling and adversely affect the shelf life of the product. These bacteria, which are very well equipped with lipolytic and proteolytic enzymes, and are adapted to growth at low temperatures, mainly comprise *Pseudomonas* spp. group, *Brochothrix thermosphacta*, psychrotrophic Enterobacteriaceae, *Shewanella putrefaciens*, lactic acid bacteria (including *Leuconostoc* spp., *Carnobacterium* spp., *Lactobacillus* spp., *Pediococcus* spp. and *Weissella* spp.) and *Clostridium* spp. However, some cold-tolerant bacterial pathogens, for example *Aeromonas* spp., *Listeria monocytogenes* and *Yersinia enterocolitica*, can grow on chill-stored meat, particularly meat with a high pH value.

### **3.4. Contamination of knives**

The extent of contamination distributed over the final product depends upon several factors that can be divided into five groups, i.e. the equipment, the animals, the personnel, the use of on-line sanitisers, and the efficiency of the sanitising method.

#### *3.4.1. Equipment*

The sterile muscle tissue has to be separated, using knives and other tools, from contaminated surfaces (such as hide, skin) and from contamination with gut-contents. Contamination of muscle tissue during the slaughter process may occur as a result of direct or indirect contact with e.g. faeces, skin, contaminated tools and equipment, personnel and clothing. Although this contamination may to a certain extent be difficult to avoid, its level can be substantially increased or decreased by poor or good slaughter procedures respectively (ICMSF, 1998, Chap. 1, Meat and Meat Products, pp.1-74).

Tools such as knives, as well as hands and clothing, are primarily contaminated through contact with surfaces that are rich in bacteria, such as the skin of slaughtered animals, intestinal contents, abscesses and the incised surfaces of lymph nodes. Regarding the sharpening of knives on the line, the steel used for this purpose must also be sanitised at regular and frequent intervals, and knives must be re-sanitised after sharpening. During some meat and poultry deboning operations, knives may be cleaned and disinfected only once or twice a day, e.g. during breaks and at night. In such circumstances, more than one knife should be used by each worker. For the veterinary inspection, the knife must be disinfected after each incision; making it necessary to use 2 or more knives, and to have the facility to disinfect knives as soon as possible after use, and consequently to use a water bath at more than 82°C.

#### 3.4.2. *Animals*

It is a normal occurrence that healthy, but nevertheless highly contaminated, animals occasionally enter the slaughter line, and have a significant impact on the final level of carcass contamination. The faeces are particularly important in relation to this hazard. For instance, within groups of slaughtered pigs there is a strong correlation between the proportion of animals with *Salmonella* spp. in their faeces and the proportion of contaminated carcasses identified at the end of the line (Berends *et al.*, 1997; Berends *et al.*, 1998).

#### 3.4.3. *Personnel*

Failure of workers on the slaughter line and their supervisors to apply their knowledge of operational hygiene, and to formally established procedures for reducing contamination on tools and equipment, can in itself constitute a risk. Personnel need to be motivated to act in accordance with Good Hygienic Practice (GHP). Supervision and consistent compliance with agreed working practices within a working group are the most important factors. For instance, if the leader of a group fails to set a good example in the matter of hygienic behaviour, other individuals in the group cannot be expected to act in accordance with GHP. In effect, shortcomings in management clearly impact negatively on hygienic working behaviour (Gerats, 1990).

#### 3.4.4. *On-line sanitisers*

EU legislation regarding fresh meat, including poultry meat, prescribes that the temperature of water used for disinfection of tools has to be at least 82°C. In practice, that requirement exposes the personnel involved to unfavourable working conditions due to release of steam and heat at the site of operation. In addition, ergonomic problems arise as a result of the requirement to use water at such a high temperature. Poor access to sanitisers may prevent their frequent use. For instance, sanitisers not located at each workstation can lead to time-consuming movement of workers away from their point of operation for the sole purpose of sanitising knives and other tools. This discourages the use of these facilities.



### 3.4.5. *Efficiency of the sanitisers*

For proper sanitisation of knives, it is first necessary to remove organic material from the knife's surface. Modern slaughter lines operate at such a fast rate that frequent disinfection of knives is difficult to achieve. Immersion of heavily contaminated knives in hot water results in coagulation of protein on knife surfaces, making those surfaces inaccessible to heat or chemical decontamination.

Furthermore, repeated immersion of used knives in the same container of warm water can lead to the accumulation of fat and other organic material on the water surface. As a result, the "disinfected" edges may be re-contaminated with the microflora floating on the surface as the knife is removed from the water.

## **3.5. Scope of the report**

As mentioned above, the mode of contamination of knife surfaces involves primarily direct or indirect contact either with the hide of the animal, the content of the alimentary tract, inflammatory lesions and infected lymph nodes. Consequently, knives in contact with those surfaces play an important role in the transfer of microbial contaminants to meat, and these tools are required to be sanitised frequently in the course of slaughter and carcasses preparation.

The Committee has focused its attention on the method used for sanitising knives and the extent to which this procedure may represent a risk factor as requested in the terms of reference. It should be emphasised, however, that the other three factors, namely, animals, personnel, and the availability of ready access to on-line sanitisers are also important.

## **4. RED MEAT PRODUCTION**

### **4.1. Slaughter plant**

#### *4.1.1. Slaughter*

The instruments used at the point of slaughter are the subject of particular attention. Since the knives (including so-called hollow knives) used for the bleeding of slaughter animals may come into contact with the animal's integument, and are handled by operatives who are dealing with live animals in a confined space, the potential for direct contamination is considerable. Such contamination entering the blood stream of the animal in its agonal stages can have consequences that are both quality- and health-related.

Using separate knives for incising the skin and opening the major vessels provides a means of reducing this risk. Transfer of such contamination, *via* the knives, between different animals at slaughter represents a further hazard.

Likewise, using multiple sets of knives of appropriate design for the slaughter of each animal in sequence is a necessary precaution at all stages of

carcass dressing. This approach can be effective, provided there are suitable means available for sanitising knives between animals. This requires using a suitably designed knife-sanitising unit to deal with multiple sets of knives. Such units should be strategically located within easy reach of the operative in a suitably illuminated location. Hand- and arm-washing and sanitising facilities are normally available at this site, as the process of slaughtering inevitably brings the hand and arm into direct contact with the exposed *fascia* and major vessels. Proper instruction and supervision of operatives are essential.

The dressing of the head requires special mention because this part of the carcass is hot-deboned in some premises, and the significance of any lapse in operational hygiene is all the greater. Consequently, effective sanitisation of the knife and other instruments, such as hand hooks used in the process, at regular and frequent intervals, is essential.

#### *4.1.2. Veterinary inspection of carcasses and offals*

The current EU Directives require the incision of specific organs and tissues such as the masseter muscles, tongue, diaphragm, liver, lung and designated lymph nodes, in addition to visual observation and palpation, in routine *post mortem* meat inspection.

The Opinion of the Scientific Committee on Veterinary Measures related to Public Health on revision on meat inspection procedures of 24 February 2000 recommended that there should be no unnecessary use of knives in the course of veterinary inspection.

Knives are required to be sanitised immediately following exploratory incision of pathological lesions, and at regular and frequent intervals throughout the period of inspection. Of particular concern is the use of knives in the investigation of tuberculosis-like lesions in cattle.

However, in all cases rigorous sanitisation of the knife and other equipment used is required.

Special care is also required when examining carcasses detained for further inspection and examination and when dealing with casualty and emergency slaughter cases.

## **4.2. Cutting plant**

### *4.2.1. Procedures in the cutting plant*

In principle, meat entering the cutting plant has already been certified as fit for human consumption, has attained a relatively low pH, and has been held at a temperature of 7°C or lower under approved hygienic conditions of storage. The cutting plant facilities are located remote from other areas of the slaughter plant or may be completely separated from such potential sources of contamination. The staff of the cutting plant is engaged exclusively in this activity and are required to be suitably attired and provided with appropriate equipment including knives of the proper design and material. Lastly, the

environment of the cutting plant is required to be suitably lit, properly ventilated and controlled to ensure that the environmental temperature of the cutting up facility does not exceed 12°C.

In these circumstances, the judicious placement of sanitising units within easy reach of the cutting line is necessary so as to deal with situations in which pathological lesions within the carcass are incised in the course of cutting up. Otherwise, it is a standard practice for all knives to be sanitised at all breaks, using these units, and for all hand held utensils to be sanitised in batch sanitising units, with or without the use of ultra-violet irradiation, both overnight and at week-ends.

#### 4.2.2. *Veterinary inspection*

Veterinary inspection in the cutting plant is concerned *inter alia* with supervision of the implementation of the practices mentioned at 4.2.1 above.

## 5. **POULTRY MEAT PRODUCTION**

Slaughtering and processing of poultry starts with a live animal that carries large numbers of different micro-organisms on the skin, on the feathers and in the alimentary tract (Mead, 1989). During the first stages of slaughtering, a high proportion of these organisms are removed. Nevertheless, significant numbers remain on the carcass and at any stage further contamination can occur (Salvat *et al.*, 1993). Significant changes in the composition and numbers of contaminating micro-organisms on the surface of the carcass result from scalding, plucking, evisceration, washing, chilling and freezing. During those processing steps, further contamination may arise from e.g. sprays and aerosols, process-water, ice, equipment and the hands of workers. Rapid processing speeds reaching or even exceeding 10,000 birds/h on some lines, favour the spread of micro-organisms (ICMSF, 1998, Chap. 2 Poultry and Poultry Products, pp. 75-129).

According to the specific requirements laid down by the poultry meat Council Directive 71/118/EEC, an establishment must have, *inter alia*, separate rooms for (1) *ante-mortem* inspection before slaughtering, (2) for slaughtering, with separate areas for stunning, bleeding, scalding and plucking as well as for (3) evisceration and further processing. Those three rooms, in addition to the different areas within each room, operate under different levels of operational hygiene and must therefore be properly separated.

All manipulations of living birds or carcasses have to be considered in the context of the overall hygiene regime in each of the three rooms respectively.

### 5.1. **Slaughter plant**

#### 5.1.1. *Slaughter*

##### 5.1.1.1. Bleeding

The bleeding procedure, whether automated or manual, is generally unhygienic, as the blade of the knife cuts through feathers and dirty skin and into the muscles and vessels of the bird's neck. Even with automated devices,

a back-up operator has to be present to ensure that all birds are properly bled. Sometimes, in the bleeding area, the same knives are used for bleeding all the slaughtered birds (e.g. guinea-fowls), especially in small factories or for religious practices.

As also recommended for other locations, at this point on the line a set of knives should be provided together with sanitising facilities.

#### 5.1.1.2. Evisceration

In large establishments the evisceration of chickens, turkeys and ducks is usually carried out by means of fully automated equipment with only limited use of knives.

The effectiveness of cleaning and disinfection of automated evisceration equipment and ancillary equipment is questionable, as the rate of operation of the poultry processing line in the larger plants is such as to render sanitisation of such equipment difficult to achieve consistently. Regular and routine sanitisation of such equipment in practice is considered to be uncommon and, therefore, concern is expressed at the continued use of unhygienic equipment in the larger poultry meat plants (Colin, 1985). It is beyond the scope of this report to address this particular issue in more detail. However, this is a matter of some concern, and current practices are in need of revision because the potential for carcasses contamination from this source is considered to be significant.

In smaller establishments, more traditional evisceration procedures are used. In such premises, cleaning and disinfection of knives between every carcass is not readily achieved on a consistent basis. Again, high line speeds, together with poor design, availability, and accessibility of on-line sanitisers, may limit the extent to which knives can be routinely sanitised on-line in these premises. The potential risk of cross-contamination of carcasses from unsanitised knives is therefore considerable.

#### 5.1.2. *Veterinary inspection*

During veterinary inspection on the slaughter line, the extent of the risk of contamination of knives depends on the health status of the flock and of the individual bird being slaughtered. As knives are frequently used at inspection points, frequent cleaning and disinfection are essential. Facilities for cleaning and disinfection of knives and other tools used at these points are required to be available convenient to the inspection points.

#### 5.1.3. *Further handling*

After inspection, all carcasses fit for human consumption are transferred to chilling rooms and, after weighting and grading, are packed or sent for portioning.

## 5.2. Cutting plant

In many plants, cutting is done mechanically, especially for chickens. In the case of turkeys and ducks, de-boning and cutting are done by hand, using knives and other tools.

As mentioned in paragraph 5.1.3, poultry meat certified as having passed a veterinary inspection is considered to be fit for human consumption. At all subsequent processing steps in the cutting plant knives are used for cutting carcasses by hand.

In the cutting rooms, employees are required to have free access to washing and disinfecting facilities. Where fixed facilities are provided, these are required to be located within easy access of each workstation. In order to prevent the release of steam from sanitisers containing water at 82°C or higher in cutting rooms, batch sanitisation of a set of knives for each worker could be considered as an alternative. The use of a batch sanitiser located in a room adjacent to the cutting room would remove the need to provide multiple sanitisers with water at 82°C or higher in an area, the ambient temperature of which is required to be at a temperature of 12°C or lower during operation. Regular use of such a facility during breaks, or when otherwise required, could be included in the routine hygiene programme operated by the plant.

## 6. CHARACTERISTICS OF METHODS OF SANITISATION

### 6.1. Pre-requisites : currently authorised method (water at 82°C or higher)

At present the only prescribed procedure for sanitisation is the immersion of the knife in flowing water at  $\geq 82^\circ\text{C}$  for an undefined period. Such water must be of potable quality. The method used for heating this water may be local or remote, using steam or direct heat. This latter procedure has the disadvantage that the heat treatment causes coagulation of fat and proteins on the blade, which reduces the bactericidal effect. Consequently, prior removal by physical means, or otherwise, of all organic material is a pre-requisite if the procedure is to be effective.

The design of the knives used at each phase of carcass dressing and evisceration is required to be such as to facilitate good hygienic practice. Otherwise, accumulation of organic material at the interface between the blade and the handle of the knives and/or the development of a biofilm during use may result.

The use of porous materials in the knife handle is not allowed under EU law, as such materials are not readily sanitised.

As already mentioned, the physical effect of exposure of tissues such as fat and proteins to such a high temperature is counter-productive to the required bactericidal action and is therefore a limiting factor.

Investigation by Snijders *et al.* (1985) indicated that when fats or proteins are absent, even a high bacterial contamination on the blades of the knives is

eliminated by immersion in water at  $\geq 82^{\circ}\text{C}$  for 1 second. On the other hand, if a high amount of fat and protein contamination is present, even a 10 seconds immersion in water at this temperature does not give satisfactory results. In fact, optimal disinfection of contaminated knives is extremely difficult to achieve without the use of mechanical means such as a high-pressure water-jet to remove the organic material.

## 6.2. Alternative methods

To address the difficulty associated with using the authorised method in processing plants, as describe above, some experiments using alternative methods have been performed. Chemicals were added to hot water, in which case a rinsing time should be introduced if the chemicals used are not recognised as safe for consumers. The use of diluted organic acid solutions at temperatures lower than  $82^{\circ}\text{C}$  is also effective, provided all organic material has been previously removed. Effective use of other chemicals is also dependent upon prior removal of organic material from the knife.

### 6.2.1. *Water at lower temperatures*

A water temperature of less than  $82^{\circ}\text{C}$  will kill most non-spore forming pathogenic and spoilage bacteria (see Table 1), but, in practice, bacteria are protected by organic material and the disinfection effect is significantly diminished. To avoid this “protection” effect of organic matter, cleaning before disinfection with water at approximately  $60^{\circ}\text{C}$  is necessary (Weise and Levetzow, 1976; Schütt *et al.*, 1992).

### 6.2.2. *Water between $60^{\circ}\text{C}$ and $82^{\circ}\text{C}$ and organic acid*

The bacteriostatic / bactericidal efficacy of dilute organic acids at temperatures between  $60^{\circ}\text{C}$  and  $82^{\circ}\text{C}$  has been described by Snijders *et al.* (1985). The undesirable effects of exposure to the higher temperature do not apply at the lower temperatures in this range.

The addition of the acid to the water at the required concentration can be achieved with suitable equipment.

### 6.2.3. *Water lower than $60^{\circ}\text{C}$ and organic acid*

Snijders *et al.* (1985) showed that immersion in a 5% lactic acid solution at  $20^{\circ}\text{C}$ , or in a 2% lactic acid solution at  $45^{\circ}\text{C}$ , were as effective as immersion in water at  $82^{\circ}\text{C}$ . However, microbial inactivation could be improved considerably by using the same lactic acid solutions at a water pressure of 15 atm. in a disinfection unit.

### 6.2.4. *Chemical sanitisation with water and chemicals (authorised as disinfectants/sanitising agents) and rinse*

A possible alternative to the currently authorised procedure could be the use of chemical disinfectants that may avoid the problems identified above.

Using chemicals at appropriate concentrations and temperatures that have a sanitising effect, and which are not harmful to human health and do not give

rise to taint, requires further consideration. Those chemicals include tri-sodium-phosphate, polyphosphates, hydrogen peroxide and isopropyl alcohol.

No information is available regarding the efficacy of polyphosphates and tri-sodium-phosphate for the disinfection of knives. However, these products are considered completely safe, and are used as food additives.

There is a potential benefit to be gained from the use, under suitably controlled conditions, of certain chemicals already approved in human medicine for the sanitisation of surgical and dental equipment and prosthetics (Cottone and Molinari, 1991). Rinsing of knives in running potable water following such treatments is essential.

Regarding the disinfection of medical and surgical devices, Mandell *et al.* (1995) defined three different categories of disinfectants:

- (a) high-level disinfectants that are effective against viable endospores if the exposure is long enough;
- (b) intermediate-level disinfectants that are tuberculocidal but not sporicidal;
- (c) low-level disinfectants that do not reliably destroy bacterial endospores, tuberculous bacilli, or small, non lipid RNA viruses (e.g. enterovirus).

Considering the possible risk of contamination of knives used during the slaughter process, probably one intermediate-level disinfectant is sufficient to assure an adequate result, but different parameters must be evaluated before an opinion can be expressed.

For this reason the characteristics of the following chemical disinfectants are considered.

#### 6.2.4.1. Alcohol

Ethyl alcohol and isopropyl alcohol are rapidly bactericidal rather than bacteriostatic against vegetative forms of bacteria. They are also tuberculocidal, fungicidal, as well as virucidal, but they do not destroy bacterial spores.

Alcohols are not recommended for sterilising medical and surgical material, principally because of their lack of sporicidal action and their inability to penetrate protein-rich material.

For the same reasons their use for disinfection of knives may be problematic for use in meat plants.

Isopropyl alcohol is an eye and skin irritant, is corrosive and is not completely safe with respect to possible residues in meat.

#### 6.2.4.2. Chlorine and chlorine compounds

Hypochlorites are the most widely used of the chlorine disinfectants and are available in different forms. They have a broad spectrum of antimicrobial activity (i.e., bactericidal, fungicidal, tuberculocidal, sporicidal and virucidal) and are inexpensive and fast acting.

The principal limitations are their corrosiveness, inactivation by organic matter, and relative instability.

An alternative compound that releases chlorine is chloramine-T that exerts a more prolonged bactericidal effect.

Chlorine and chlorine compounds are used in some countries as disinfectant for poultry carcasses and meat. This is not permitted in E.U.

#### 6.2.4.3. Hydrogen peroxide

Commercially available 3% hydrogen peroxide is stable and is an effective disinfectant against bacteria, virus, spores and fungi. This product is a skin and eye irritant but it is free of risks of residues in meat.

#### 6.2.4.4. Quaternary ammonium compounds (QAC)

Chemically, the quaternaries are organically substituted ammonium compounds in which the nitrogen atom has a valency of 5, four of the substituent radicals are heterocyclic radicals of a given size or chain length, and the fifth is a halide, sulphate or similar radical.

The quaternaries are good cleaning agents but, as with several other disinfectants, some Gram-negative bacteria have been found to survive, or even grow, in them. In addition the published literature indicates that the quaternaries are generally fungicidal, bactericidal, and virucidal against lipophilic viruses. They are not sporicidal and generally are not tuberculocidal or virucidal against hydrophilic viruses.

Quaternary ammonium compounds are skin and eye irritants and therefore precautions are necessary when used by workers.

Another aspect is the possible presence of quaternary compounds or residue thereof on the surface of knives and the consequent possible contamination of meat.

Frank and Chmielewski (1997) studied the effectiveness of sanitisation with two different disinfectants against *Staphylococcus aureus* on different experimentally contaminated kitchenware. Their results showed that sanitisation with quaternary ammonium compounds or chlorine reduced the *S. aureus* population.

#### 6.2.5. Ultrasonic techniques

This technique facilitates removal of dirt from surfaces of materials placed in hot water (approx. 60°C) by imploding microscopic bubbles produced by the



sound waves (Concerted Action CT94-1456- 5 - Cleaning and disinfection of equipment and premises). Its use in certain cases to clean materials provided evidence of a bactericidal effect of the acoustic phenomenon accompanying the effect of elimination of the organic particles (O' Leary *et al.*, 1997). This technology could be used for the cleaning of knives during working breaks, but the bactericidal effect requires to be further investigated.

### **6.3. Batch sanitisation**

A thermo-disinfector (modified dishwasher) is regarded as an acceptable alternative for knives and tools disinfection in cutting rooms. Such a facility would avoid every worker requiring a disinfection facility within his immediate reach. However, a major disadvantage is that the total time needed for filling, cleaning and emptying the washer is ca 15 minutes. Consequently, the knives can only be sanitised by these means during breaks in production.

In cases where a batch sanitisation (i.e. systematic use of separate washing and sterilisation facilities which may be located in a separate area or in a separate room) is applied for cleaning and disinfection of tools during breaks, a washing machine can ensure adequate cleaning and disinfection of tools like knives. While cleaning is a very important prerequisite to ensure efficient disinfection of knives, the disinfection temperature provided by the washing machine during the disinfection procedure is at least as effective against heat-sensitive micro-organisms.

Batch sanitisation includes a washing mode with approx. 40°C warm water to provide clean surfaces and to prevent coagulation of proteins on surfaces. If the cleaning step uses detergents to enhance removal of dirt and bacterial load, this primary cleaning step is followed by disinfection with hot water. The disinfection and final rinsing step, using potable water at 60°C prevent any residues of chemical substances on the cleaned surfaces coming into contact with meat (DIN, 1996).

Where there is a final rinsing step using potable water, the earlier disinfection step may include the use of a chemical disinfectant or diluted organic acids.

Relevant parameters (e.g. time/temperature settings, amount of detergent used) must be clearly indicated on the machine, and preferably be fixed to facilitate routine use in the meat plant.

### **6.4. Other procedures**

The use of ultra violet irradiation has an application for overnight treatment of previously sanitised knives. Other physical procedures, such as high pressure and oscillating magnetic field pulses, were not considered at this stage.

## 7. EXAMPLE OF GHP AND QUALITY ASSURANCE

The location of the sanitisers should, in each case, be properly illuminated, so as to allow thorough examination of the knife after each treatment.

The effectiveness of the cleaning and disinfection procedures for each type of installation used in meat plants can be determined, and the relevant specified parameters (e.g. time, temperature, chemical agent, washing procedure) can be further confirmed by means of specific bio-indicators (Reuter, 1989) such as *Staphylococcus aureus* ATCC 6538, *Streptococcus faecalis* ATCC 6057, *Escherichia coli* ATCC 11229, *Proteus mirabilis* ATCC 14153 and *Pseudomonas aeruginosa* ATCC 15442. Such information should be provided by the manufacturer of the unit, and be the subject of independent certification as a condition of sale.

For checks on the efficacy of the cleaning and disinfection procedure recommended for knives, sampling for total viable counts on the blades after cleaning and disinfection may be used. Other aspects of the performance of the machine could also be assessed by other microbiological means.

On a daily basis, routine control of the sanitisation equipment includes recording the working temperature at the beginning and during working, of the visual cleanliness of the knives and the surrounding area where the knives are kept, and of the amount of detergents and sanitisers used. Those data should be recorded on a regular basis and be available for inspection.

## 8. CONCLUSIONS

- (1) Knives are used at various steps of the slaughtering process and carcass preparation. They are also used by the control authorities in the course of veterinary *post-mortem* inspection, where all the parts of slaughtered animals have to be presented, and during which some organs and lymph nodes may require to be incised.
- (2) Contamination of knives with pathogenic organisms, as well as with organisms associated with spoilage, can occur during slaughtering, carcass preparation and veterinary inspection procedures, and to a lesser extent in cutting plants. The extent of contamination of knives is affected by factors relating to animals, personnel, and on-line sanitisers and their mode and frequency of use.
- (3) In some processing plants, the probability of microbial contamination associated with the continuous use of contaminated mechanical equipment for bleeding, evisceration and portioning are considerably higher than from contaminated knives.
- (4) Whatever disinfection protocols are selected, pre-cleaning and cleaning operations are essential, as the removal of soils and biofilms, using mechanical actions such as pressure or detergents, improves the efficacy of the subsequent disinfection procedures.
- (5) The currently approved procedure of sanitisation using running water at a temperature of 82°C or higher is considered not to be fully effective in the absence of cleaning. This procedure may be not appropriate in every location

within the meat plant due to the disadvantages of generating steam in an environment where the ambient temperature should not exceed 12°C, such as in cutting plants.

- (6) The use of water at lower temperatures with the addition of solution of lactic acid at 2 or 5 % is as effective as the use of water at 82°C or higher. Other chemicals that have disinfectant properties can also be considered. However, their use may require rinsing the treated knives with potable water before the knives are re-used. The use of these alternatives would be subject to compliance with quality assurance conditions and may be limited by the difficulty of monitoring and maintaining the concentration of sanitising agents. The importance of adequate training of personnel in relation to the application of GHP on a regular and frequent basis is emphasised.
- (7) During breaks in production, knives can be cleaned and disinfected in a thermo-disinfector. This batch sanitisation is an acceptable alternative, but probably takes longer than others procedures.

## **9. RECOMMENDATIONS**

- (1) Sanitisation of knives must be considered a component of the overall hygienic control.
- (2) If sanitisation using water at a temperature of 82°C or higher is used, organic material should be first removed from knives.
- (3) Combination of water at temperatures lower than 82°C with chemical disinfectants such as lactic acid or other agents considered not to be harmful to workers' and consumers' health, can be used as a satisfactory alternative to the currently approved procedure.
- (4) The use of any of the alternative methods proposed should be in accordance with GHP, including comparison and testing the antimicrobial efficacy of the method.
- (5) Batch sanitisation of all knives during breaks and overnight should be adopted as a standard operational practice.
- (6) Disinfection and hygienic control of mechanical equipment, especially that used in poultry meat processing, should be subject to further study.

## 10. ANNEX

**Characteristics of 3 mains groups of disinfectants (adapted from Concerted Action CT94-1456 - Microbial control in the meat industry - 5 Cleaning and disinfection, and Holah, 1995) and other procedures.**

<b>Microbial control and Property</b>	<b>Chlorine</b>	<b>Hydrogen peroxide</b>	<b>QAC*</b>	<b>Hot water (&gt; 82°C)</b>	<b>Water + lactic acid</b>
Gram positive bacteria	++	++	++	++	++
Gram negative bacteria	++	++	+	++	++
Spores	+	++	-	-	?
Fungi	++	++	++	+	+
Inactivation by organic matter	++	+	+	+	+
Inactivation by water hardness	-	-	+	-	+
Detergency	-	-	++	+	+
Foaming potential	-	-	++	-	-
Rinsability	++	++	-	++	++
Workers safety	+	++	-	++	++
Cost	-	+	++	-	-

\* QAC : quaternary ammonium compounds

++ = large effect      + = effect      - = no effect      ? = no scientific evidence

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## 12. ACKNOWLEDGEMENTS

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