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E.H. Kampelmacher

From the National Institute of Public Health,
Sterrenbos 1, Utrecht, The Netherlands

## Problems in Modern Meat Hygiene.

The rapidly increasing world population and, therefore, need for protein foods, has prompted a considerable rise in the numbers of animals that are slaughtered. This has entailed that, especially in the U.S. and North Western Europe the processing of meat products has changed from house industry or slaughtering in small units to highly industrialized, large outfits. The numbers of animals slaughtered per unit of time, the complicated and highly mechanized way of post-slaughter processing and the subsequent distribution of each batch of products to large groups of the population have created new problems in safeguarding the health of the consumer. Whereas formerly meat inspection was the most important mode of prevention of foodborne illnesses, nowadays the improvement of hygienic conditions during slaughter and further processing must have the greatest attention, as may become clear from the following.

At the beginning of this century meat inspection was mainly based on macroscopic inspection by which it was possible to arrive at a reliable distinction between diseased and healthy animals. The eradication of diseases such as tuberculosis, trichinosis, echinoccosis and a few other

zoonoses is to a greater part due to meat inspection and subsequent condemnation of diseased animals. In most of the countries where a high percentage of meat is industrially processed a new problem has emerged after these diseases have been eradicated successfully. This has, without any doubt, been present earlier, but has not come clearly to the fore, because of the so much more serious situation of diseased animals. It rests basically in the fact that a relatively high percentage of slaughter animals is carrying micro-organisms pathogenic for man. These animals are clinically healthy so that meat inspection has no means, at the moment, to detect such animals immediately. Moreover, the high number of slaughter animals mentioned makes it impossible to examine each and every animal in order to detect pathogenic micro-organisms by the usual laboratory techniques. In a certain way this situation is even worse than that which existed at the beginning of this century. Due to the lack of detection methods, these pathogenic micro-organisms, unlike those predominating in the past, contaminate tools and materials in the course of inspection during slaughter and meat processing. They are able to multiply subsequently, if temperatures during processing or storage are suitable for further growth. This situation has created a food hygiene problem, especially in meat and meat products that must be called a serious one. It is clear that products which are consumed raw, or not sufficiently heated, are the most dangerous ones.

Salmonella infections play a major role in this respect. The cases of human Salmonellosis have increased considerably, especially in the western world, despite that sanitation has reached a high level there. Due to feeding mixed feeds made from ingredients imported from sub-tropical and tropical countries and to holding the animals in larger units the Salmonella problem has become a major topic in recent years. Large numbers of clinically healthy animals

are able to spread these bacteria during holding, slaughter and processing, especially through faecal contamination. To salmonellae meat and meat products are an excellent medium for growth, especially when temperatures above 10°C occur (Newell, 1967). Particularly in well-developed countries, where the consumer is convinced that the authorities are fully prepared to protect him from all potential hazards in food, water, air etc. no sufficient precautions are taken as far as cooling and heating of meat and meat products is concerned.

Staphylococcal food poisoning caused by strains producing one of the enterotoxins is also increasing in many countries. Here the pathogenic bacteria may, as in Salmonella infections stem from the slaughter animal. However, in the majority of cases animal products are secondarily contaminated by human carriers who harbour enterotoxinogenic strains on hands, and in nose and throat. The unpleasant complication with this micro-organism is that, once enterotoxin having been formed, this will not be inactivated by heating as used in food preparation, since the toxin is very heat-resistant (Casman, 1967).

Food poisoning caused by Clostridium perfringens also originates frequently from meat or meat products. Especially under mildly anaerobic conditions, which are often encountered in larger, previously heated, pieces of meat, growth of Cl. perfringens is possible and disease outbreaks have been described rather frequently (Hobbs, 1965; Hall & Lewis, 1967).

Leptospirosis, brucellosis, botulism, listeriosis and the parasitic diseases taeniasis, trichinosis, cysticercosis and toxoplasmosis are other examples of diseases which can effect man and where the micro-organisms are present in animals, which show only minor signs of disease or none whatsoever (Schwabe, 1964). As far as the former bacterial diseases are concerned, the same problems as with the above mentioned bacteria exist. However, in the case of parasitic

infections where proliferation after slaughter is precluded, the problem is totally limited to cases where meat inspection fails, because animals are only slightly infected and do not show any disease symptoms.

Our knowledge about the significance of viruses spread by clinically healthy animals is limited at the moment. However, there is a strong feeling that foods may play a certain role in these human viroses (Cliver, 1967). Meat and meat products may in this respect not only act as vectors but may also be primarily infected.

Due to the fact that these clinically healthy animals carrying pathogenic micro-organisms are not recognized by meat-inspection, it is clear that the possibility of contamination of the meat processing line with pathogenic micro-organisms is continuously present. Based on this knowledge a great amount of research work has been done in recent years in order to evaluate and if possible, to control this situation. It is clear that the production of animals free of pathogenic micro-organisms would virtually entirely solve the problem and work is going on in this direction. Clearly, this is not an easily achieved goal. Such pathogen-free animals, and meat and meat products derived from them, could be produced on a small scale for some particularly sensitive groups of consumers, such as diseased persons, small children and aged persons. But it can-not be expected that this can be done on such a scale that it will solve the entire problem in the coming decades. Therefore, all measures should be taken to prevent spreading of contamination and outgrowth of bacteria. The best way to achieve this goal is a considerable improvement in hygiene during slaughter, processing and distribution. Also, and perhaps explicitly, the hygiene of the kitchen of the consumer should be included in this program.

Fortunately, the adequacy of hygienic measures in food producing factories in general can be assessed easily at present by fast but reliable methods which have been developed in recent years and have shown to be of great practical

value, if applied wisely and continuously. Techniques such as those making use of agar "sausages", adhesive tape and swabs are extremely easy tools in checking for general hygiene even in the hands of those who are no professional bacteriologists (Mossel et al., 1966). We have introduced the so-called hygienogram which gives a good visual picture of the sanitary condition of the whole line at a certain moment. By repeating such investigations from time to time and at moments not known before to the workers an excellent impression of the hygienic condition can be achieved (Van Schothorst et al., 1966).

Moreover, and this is especially true for agar "sausages" and tapes, it has been possible to exert a psychological effect on the workers, who are indeed in the front line as far as the maintenance of hygiene measures is concerned. By the demonstration of bacterial growth on agar "sausage" slices within 18-24 hours even a lay man can be totally convinced of the unsanitary condition of his hands, cloths or tools. It has been clearly demonstrated during surveillance exercised in a great number of Dutch meat inspection services that this aspect is of great importance. Continuously checking of the slaughter and meat processing lines by the tools just mentioned will keep the general bacteriological flora on a low level - which is one of the main factors in the prevention of health hazards. As long as pathogenic micro-organisms will only be present in low numbers no infections will occur. The efficacy of control measures such as disinfection, cleaning, washing etc. can also be checked successfully with the above mentioned tools.

However, the consumer might nullify this prevention, if food is not treated hygienically in the kitchen. Informing the consumer by showing exactly the dangers present and how to avoid these can be very helpful. Relative-ly easy preventative measures such as adequate cooling and heating of food, should be emphasized by all publicity media available, such as newspapers, broadcasting and television.

In reviewing problems in modern meat hygiene, one must finally not overlook another group of problems which is approaching the meat hygienist very fast, namely the problem of residues in meats of all kinds of biologically active substances, such as antibiotics, pesticides, insecticides, hormones etc. These substances have been applied frequently and will be applied on an increasing scale in the health protection of animals and in agriculture and animal production techniques. To cope with these problems, first of all the development of reliable methods of detection of such residues is of utmost importance (Zweig, 1963 1967). Moreover, a closer co-operation between the practising veterinarian, the farmer and the slaughter house authorities, including the meat inspection service, will be required in future. It is not impossible that very soon meat inspection will be based more on data concerning all kinds of treatments and additions to feed substances used on the farm during the life of the animal, than on the macroscopic inspection of the animals offered for slaughter as done hitherto.

It is clear that all these problems require intensive research but also an adapted education of the new generation of veterinary scientists. Moreover a multidisciplinar approach, in which meat-technologists, hygienists, epidemiologists, chemists and others cooperate, is required to avoid the public health dangers described above. It is therefore of utmost importance that the profession dealing with meat-inspection is adequately informed about all problem of meat processing, production techniques, packing, transport, retailing, etc. On the other hand it may be very useful for all those, working in the field of meat production and therefore meat hygiene to be informed about the problems in the slaughterhouse and even on the farms. If all circles concerned realize in time the occurring changes in the field of meat hygiene and are prepared for new responsibilities, there is good hope that a multi-

disciplinar approach will be able to fulfil with success this task of production of safe meats and meat products.

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