BEEF SLAUGHTER HYGIENE MONITORED BY CARCASS BACTERIAL CONDITION

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Summary

Microbial carcass contamination is neither systematic nor repeated, therefore bacterial counts might have tremendous variation which, in turn might mask differences in abattoir visual hygiene conditions. Uneven distribution of bacteria on carcasses makes unsuitable the sampling on small carcass areas. The feasibility of using a microbiological sampling technique, which consider the whole carcass area overcomes the problem of uneven bacterial distribution and makes possible to characterize slaughterhouses based on hygiene level. The sponge technique is suitable not only for quantitative studies but also for monitoring the presence of pathogenic microorganisms of concern in the meat industry such as Listeria, Salmonella or Campylobacter on large surface areas.

Introduction

Microbial condition of meat and meat related surfaces is of prime interest to all the segments of the meat industry. Increasing awareness of food-borne diseases and the need of improving meat shelf-life have suggested monitoring microbial carcass condition. Microbiological testing is a tool relevant to the industry for commercial and management control and to the regulatory agencies as an adjunct to inspection, to check manufacturing practices or to comply with the correct microbial status of a product.

A key factor in evaluating microbiological surface contamination is the sampling procedure. Main factors influencing the use of a particular procedure are nature and type of surface, levels of contamination and type of microorganisms involved. Non-destructive techniques such as the swab method, agar contact method, adhesive tape method and the so-called sponge technique have been used (Kitchell et al 1973). Also rinsing procedures are non-destructive and suitable for qualitative studies. Currently, destructive procedures and particularly with the aid of stomaching are widely used. Excising methods have the advantages of providing most reliable enumeration and allow to count firmly attached bacteria. However, destructive techniques and non-destructive that consider small areas are unsuitable for sampling an entire carcass surface.

Sampling techniques for microbiological studies must be accurate and precise to make valid microbiological comparisons of either processes along the slaughterline within the abattoir or between slaughter plants. Systematic errors that result in lower level of accuracy should be only accepted if they do not substantially affect precision. Polyurethane sponges have been used to detect bacteria on food plant equipment surfaces, walls, work benches and on red meat carcasses. Some of the advantages of it use are ability to sample large areas, detection of low level of contaminants, no antibacterial activity, and no need of using glass containers. Furthermore, it makes sample collection easier and it has low cost of operation (Quevedo et al, 1977). The aims of this paper are to discuss the significance of microbial contamination at the abattoir and the application of microbial monitoring as a key factor in a preventive quality assurance program. This frame of discussion will be supported by data from more than 600 beef carcasses sampled at different abattoirs, during different years and considering small (less than 100 cm^2) sampling areas and the whole carcass area. Sampling on pork carcasses will be also discussed.

Microbial contamination in the abattoir

When cattle leave the ranch or farm for the slaughterhouses they will carry tremendous amounts of microorganisms in their intestinal tracts, on the hides and in the hooves. This microbial population will vary according to husbandry practices. Large herds confined in reduced areas (ie. feed lots) might become heavily contaminated with faces. Auctions or

other sites where cattle is transported to be sold, might constitute an important source of additional microorganism mainly due to animal concentration in small areas. That is why, most beef exporter slaughterhouses in Argentina buy directly at the ranch, further advantage of this practice is that by avoiding animal concentrations should be minimized the risk of getting contagious and infectious agents on healthy animals.

Two critical operation at the killing floor are the hide removal and the evisceration procedure. The hands, knives and steels of the slaughtermen that handle the carcass before the hide is removed are usually more contaminated than those from workers that handle the carcass after hide removal. In this step worker hand's might be more contaminated than those that carry the evisceration step. Care should be taken at this step to avoid carcass contamination with hide related materials, particularly important is to prevent contact between outside hide and exposed carcass surface since up to 10^8 CFU/cm² microorganisms were found on beef hides (Rodríguez and Rivelli, 1985). Furthermore, Lowry and Tiong (1988) reported that 17% of beef hides were contaminated with Listeria monocytogenes. Skinning knife might be also heavily contaminated and it is stressed that momentary knife immersion into 82°C might not destroy Salmonella. It has been suggested that knives should be immersed during 10sec to get rid of the bug. That is why, to avoid delaying at the slaughterline the use of two knives is recommended.

Two critical steps prior to evisceration are done before hide removal. First the esophagus clipping shut near the rumen. This prevent ruminal flow on neck related areas. Rumen, depending on pre-slaughter treatment, might contain Salmonella and C. jejuni. In addition, when freeing the anal sphincter and rectum, care also should be taken in tightly close this area. It is pointed out that up to 10^{10} CFU/g might be found on intestinal content. Salmonella, C. perfringens and L. monocytogenes are usually isolated from this content. Important in the dissemination of certain pathogenic microorganisms are the mesenteric lymph nodes.

Microbial monitoring in preventive quality assurance (A)

Quality assurance might be defined as those activities and functions concerned with the attainment and maintenance of quality. Therefore, with respect of meat microbial control involves the control of microbiological hazards and risks associated with animal husbandry, slaughtering procedures, deboning, processing and merchandising of a particular meat item (Baird-Parker, 1987). We will focus our attention, however, in the slaughtering procedures. In terms of a better understanding of the QA concept is necessary to define other relevant parts of this system. A microbial hazard analysis of a meat operation involves basically the knowledge of pathogenic and spoilage organisms that potentially would deteriorate or become the product harmful. In a second step, it is determined how these hazards might arise and a a probability of occurrence is set up at each operation site. A critical control point can be defined as a location, processing step or procedure where control have to and can be carried out in order to prevent one or more hazard. Finally, monitoring is the checking that a particular processing at a particular critical point is properly carried out and is under control (Baird-Parker, 1987).

Microbial carcass condition is important in terms of establishing a QA system. Therefore, proper sampling procedures are the key to successfully accomplish the goals of this system. We will discuss first sampling on small carcass areas and later on sampling with sponges on whole beef carcasses. Finally we will discuss the use of sponge in monitoring pork carcass condition. Slaughterhouses to be sampled were chosen base on an evaluation procedure developed by the Argentine Federal Meat Inspection Service, which takes into account slaughtering practices and facility characteristics. This protocol assigns an index to the abattoir infrastructure and to each one of the operations carried out at the slaughterline, which will characterize in turn the plant hygiene condition. Abattoirs were evaluated prior to sampling. In all cases carcasses were sampled at the end of the slaughterline.

For small sampling areas two abattoirs were considered, one classified as "fair" and

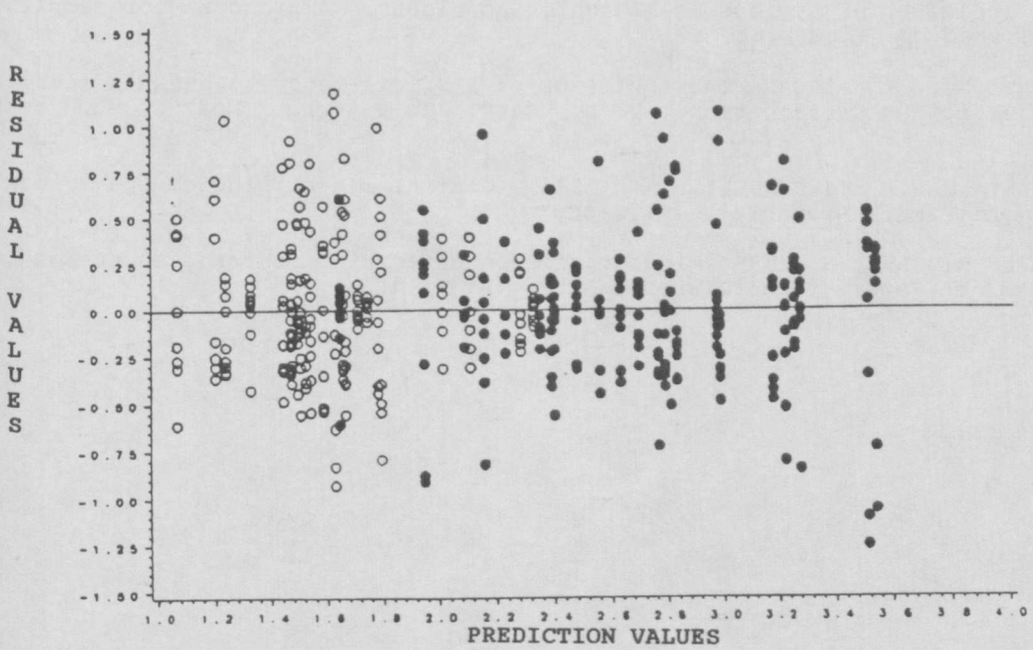
the other as "good". Sampling areas of 10 cm^2 and 100 cm^2 from the outer brisket part and the internal side round were considered. Each plant was visited five times and nine carcasses were sampled per visit (45 carcasses per plant). Counts from abattoir "good" were always lower than counts from "fair" plant. Nevertheless, significant differences were found only in counts from 100 cm^2 round. It is worthy of being mentioned that as the sample area increases the variability seemed to decrease (Lasta and Fonrouge, 1988). This reinforced the idea of sampling a larger area to set differences, between counts, from carcasses coming from different abattoirs.

In a larger study six abattoirs were sampled, three were regarded as having "very good" hygiene condition and the other three as having "good" conditions of hygiene. Visits for sampling were done twice a week (10 carcasses visit/plant), during a 4 week-run corresponding to a typical month of summer, winter and fall. In total there were sampled more than 500 carcasses within the six abattoirs over four different years . Abattoirs scored as "very good" were differentiated from the "good" ones by the psychrotroph count, while mesophile was not consistent to that purpose. On the other hand, counts of Enterobacteria, total and fecal coliforms and S. aureus did not set apart differences between groups of abattoirs. This findings are important in term of a characterization of the beef carcass microflora. It is also an important fact in order to establish a correct hazard analysis since provide information about spoilage and potential harmful bacteria at the slaughterline. Data are particularly interesting also, since comes from a large sampling study in a major beef producer and exporter market.

Discrimination of abattoirs close-related in GMP's might be important in terms of meat inspection and meat trade. This differentiation can be showed on Fig. 1 where residual plots from psychrotroph counts are presented. It is possible to visualize three different fields on it, two end fields with exclusively either low ("very good") or high ("good") prediction values and a middle field where observations are mixed. The presence of residuals from abat-

FIGURE 1.

Residual Plot from Psychrotroph Counts (log CFU/cm^2) on Beef Carcasses
° Abattoirs "Very Good"; • Abattoirs "Good". N=445 (126 observations are hidden)



toirs "good" in the zone of low counts would suggest that these abattoirs follow GMP's. Moreover, differences between abattoirs were slight. It might also prove that the sponge technique allow us to recognize small difference in counts (Lasta et al, 1992).

Sampling on pork slaughter operations using the sponge technique should be important to set differences in close-related GMP's abattoirs. However, pork operations have certain facility conditions and processing steps (ie. scalding tank, dehairing machine and surface flaming) which might have an effect in evenly distributing or in disseminating the bacterial microflora, as has been reported (Dockerty, et al 1970). These might be important also in terms of the QA program since provides data for a better understanding of the microbial behavior at pork operations plants.

Based on the results obtained with the sponge technique at beef plants it would be possible to establish microbiological guidelines to characterize either carcass or plant hygiene condition. This procedure might allow meat trader also to compare abattoirs which might be important in terms of domestic or international trade. The sponge technique, in addition, might provide a tool for ecological studies during carcass chilling and carcass fabrication.

Conclusions

The feasibility of using a precise, rapid, safe, and inexpensive sampling technique that considers the whole carcass area was discussed. The sponge technique provides microbiological bases to discriminate close-related GMP's abattoirs and should allow carcass monitoring under a QA system.

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