AIRBORNE CONTAMINATION OF CHILLING ROOMS IN POULTRY MEAT PROCESSING PLANTS

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SUMMARY

In a poultry processing plant hygienic relevant air conditions as temperature, rel. humidity and the dew point, were evaluated together with microbiological data from an air-chilling room and an spray-chilling room. The microbiological data were collected by means of an Anderson six-stage viable sampler using ISO-media to detect aerobic plate count (APC) and ISO-media which was overlayed with violet red bile glucose(VRBG)-media to detect the amount of enterobactericeae. The applied sampling method was effective under extremely high rel. humidity in the chilling room. In the air-chilling room the mean value of APCs was $1.9 10^3$ cfu/m^3 (with a maximum and minimum value of $4.5 10^3$ and $7 10^3$ cfu/m^3) and in the spray-chilling room $1.3 10^4$ cfu/m^3 (with a maximum and minimum value of $1.7 10^4$ and $8.2 10^3$ cfu/m^3). In contrast to these relatively high bacterial load only few Enterobacteriaceae could be detected in both types of air-chilling rooms. Contaminated air still remains an hygienic problem because of the spread of possible pathogen bacteria which were identified in the air of chilling rooms.

Introduction

Nowadays clean air is an indispensable commodity in the food industry. Exspecially during slaughtering, chilling and storage of meat, purity standards of air are becoming more stringent in line with requirements for better keeping qualities and storage stability of finshed products.

Bacterial contamination of products can occur in a great many procedures and in order to prevent this, equipment, handling and also ambient air must be clean. This is important not only for safety reasons. The shelf-life of perishable food like meat can be prolonged. Contamination with pathogene microorganisms can be avoid by maintaining clean conditions for the air.

For some years, different types of air-chilling systems have been replacing traditional "spin chillers" in most poultry meat producing plants. The main disadvantage of wet chilling using the "spin-chiller" was, that the process was not hygienic due to the likelihood of cross contamination ocurring between carcases in the same chilling water, as well the increasing bacterial load on individual carcases during their passage through the water bath (BROBST et al., 1958; BULLING and PIETSCH, 1966; LEISTNER, 1973; PIETSCH and LEVETZOW, 1974).

In contrast, in air-chilling systems the only possibilty of cross-contamination is through the air, which is maintained at low temperatures and has a velocity of maximum 12 m/sec. and a high rel. humidity. The aerobic plate count on the surface of chicken breasts ranged from $\log_{10}$ 3.4 cfu/cm^2 (BERNER et al., 1969) to $\log_{10}$ 4.1 cfu/cm^2 (PATTERSON and GIBBS, 1977). As mentioned above, air could be a contamination source for meat in chilling rooms. If contaminated and still warm carcases enter air-chilling rooms, pathogene microorganismes can be spread by air stream to other carcases and can continue to multiply. CASALE et al. (1965) detected a higher bacterial load of the carcases after air chilling than the had before they were chilled.

The aim of the study was to investigate the load of the air in a chilling room with microorganisms by total viable counts and Enterobacteriaceae as indicator for pathogens.

Materials and methods

The following locations in the slaughter hall of a poultry meat processing plant (line speed: 6-7000 animals/h) were investigated to find out climate conditions as air velocity, rel. humidity, temperature and the dew point: 1) Where defeathered poultry enter the slaughter hall, 2) at the evisceration machine, 3) where eviscerated and

final trimmed poultry leaves the slaughter hall and two locations in the air-chilling room, 4) at the beginning and 5) at the end of the cooling period for the carcases at the outlet of the chilling room.

After these preliminary evaluation, the bacterial load of the air was evaluated in an air-chilling room and also in an air-spray-chilling room (the same chilling effect but additional water is sprayed on the carcase surfaces in spray-chilling rooms).

The microbiological samples were collected by means of an six-stage viable particle sampler (Anderson air sampler) (**figure 1**) which was operated in the air-chilling room for a period of 5 min. (Aerobic plate Count = APC) and 8 min. (Enterobacteriaceae) with a constant draw of 28.3 liters/min. which is provided by a vacuum source. Before sampling, the Anderson air sampler was loaded with 6 petri dishes (diameter 8.9 cm). Each petri dish (collection plate) was filled with 27 ml of agar . One collection plate was inserted on each stage of the sampling instument. The air to be sampled entered the inlet cone and cascades through the succeeding orifice stages with succesively higher orifice velocities from stage 1 to stage 6. Sucessively smaller particles are inertially impacted onto the agar collection surface.

The mean number of viable counts per unit volume of air can be calculated if counts of all six petri dishes are counted.

To calculate the aerobic plate count, APC's were collected using ISO-media [according to ISO/TC 34/6N247] (REUTER, 1968; SINELL et al., 1965; Malik, 1988) and Enterobacteriaceae using the ISO-media for impaction of the organisms and a selective violet red bile glucose(VRBG)-media (ANON., 1983) where glucose was replaced by dextrose as an overlayer for the ISO-media. In the air-spray-chilling room, the sampling time was reduced to 5 min. for Enterobacteriaceae and 3 min. for APC.

After aerobic incubation for 72 h at 30°C APC were counted daily. For determination of Enterobacteriaceae ISO-VRBG-media were incubated 48 h at 30°C under aerobic conditions.

Results

Temperature, air velocity, rel. humidity and sampling time were measured by a TESTOTHERM test-kit and compiled in **table 1**. From the beginning to the end of the slaughter hall a temperature gradient from 19°C to ca. 16°C is detected. The rel. humidity rised slighly and was strongly dependend from the type of processing, that takes place in that area at the slaughter line where the data were collected. The dew point on all stages was only a little lower than detected temperatures. Temperatures from -3.5°C to 0°C were found in the air-chilling room. The rel. humidity ranges between 62.9% and 81.5%. Selected air parameters during air sampling with the Anderson-sampler in spray-chilling rooms and air-chilling rooms of poultry processing plants are shown in **table 2**. Temperatures in the center of breast and legs of random chosen poultry carcases entering the air-chilling room ranged between 40 to 42°C and decrease in legs to 1.8 - 2.0°C but in the center of breasts only to 8.4 - 8.9°C (**table 3**).

The collected microbiological data from 44 experiments are presented in **figure 2** and **3**, where mesotrophic aerobic plate counts and the amount of Enterobacteriaceae are displayed. In the air-chilling room the mean value of APCs was 1.910^3 cfu/m^3 (with a maximum and minimum value of 4.510^3 and 710^3 cfu/m^3) and in the spray-chilling room 1.310^4 cfu/m^3 (with a maximum and minimum value of 1.710^4 and 8.210^3 cfu/m^3). In contrast to these relatively high bacterial load only few Enterobacteriaceae could be detected in both types of air-chilling rooms. The differentiation of the APC's demonstrated the following microorganisms: *Micrococcaceae, Bacillaceae, Corynebacterium,* gram-negative rods, *Alcaligenes, Flavobacterium, Moraxella, Xantomonas* and yeasts.

Discussion

The separation of clean and less clean areas during poultry slaughtering process can destroyed by faults in conduction of air. This means air should be lead from clean to less cleaner areas. At the slaughter and chilling level, air is frequently cited as a contamination carrier because most of the bacteria, which contaminated meat are always transported by dust particles or aerosols which are spread out along the slaughter line (FOUNAUD and LAURET, 1985; TALON and MONTEL, 1986). Therefore the primary target was, to find out the significance of critical points for air during slaughter and chilling procedures of poultry. As presented by physical parameters, the air in the chilling room has the highest capacity to tranfer undesireble microorganisms by crosscontamination. The possible risk caused by contaminated air was illustrated by SIRAMI (1989), who found a direkt relationship between the bacterial load of the air and the contamination rate of carcase surface.

STEPHAN, F. and K. FEHLHABER (1993) reported lately, that despite of intensive rinsing carcases enter the cilling room with high bacterial load.

In air-chilling rooms carcases are refrigerated by high air velocities and a high humidity. Besides spoilage organisms Enterobacteriaceae could distributed in the air-chilling room from one carcase to each other.

Under the sampling conditions the air-chillig room and the spray-chilling room show relatively low contamination of the air with Enterobacteriaceae (**figure 2**). These data are in accordance with the results of HANNAN et al. (1993) and PATTERSON (1973). Both authors had found only few coliform counts in the air of chilling rooms. In contrast to the relatively low contamination with Enterobacteriaceae a hight amount of aerobic plate count was detected (**figure 3**): in the air-chilling room 1.910^3 cfu/m³ and in the spray-chilling room 1.310^4 cfu/m³. Similar data of aerobic plate count were reported by STEPHAN, F. and K. FEHLHABER (1993) for spray-chilling rooms.

The impact of microorganismes in the air on the shelf-life of meat ist still discussed. KRISPIEN (1976) and RÖDEL et al. (1984) pointed out, that the surface contamination/cm² is much higher than the bacterial load of the air/m³. Therefore these authors conclude, that even sterile air could not prolong the shelf-life of meat.

But following the classification of OREFICIO et al. (1985) and KRISPIEN (1976) the sampled air in both chilling rooms must be considered as "high contaminated". An air contamination in the surrounding of slaughter lines higher than 1.510 cfu/m³ should not be tolerated. Air contamination in chilling rooms should not exceed 510 cfu/m³.

Conclusion

It is concluded that environmental monitoring of poultry meat producing plants using air sampling procedures are useful to estimate the rate of airborne contamination of products by microorganisms. If higher leves than 510 cfu/m³ are detected, contamination levels/m³ should be reduced and efforts should be made in order to minimize the population of the pathogenic microorganisms found in this study.

The Anderson six-stage viable sampler is useful to detect microorganisms in chilling rooms with high air velocity and a high humidity.

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