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Determination of the bacteriological quality of meat by impedance measurements.

DE ZUTTER, L. and J. VAN HOOF

Laboratory for Hygiene and Technology of Food from Animal Origin, Faculty of Veterinary medicine, State University of Ghent, Wolterslaan 16, B-9000 Ghent, Belgium.

Introduction

Production of foodstuffs of good microbiological quality has become an important subject in the meat processing industry. This requires microbiological checks not only of the raw materials and the end products but also an on-line critical point analysis.
Since traditional methods for the enumeration of bacteria by the pour plate or the surface plate technique are laborious to perform in high volume, mechanizing techniques such as the the Spiral Plate Maker (6) and the Droplette technique (7) have been introduced. The major disadvantage of the latter devices is still the long time to get results available. For this reason several approaches have been made to shorten the lenght of incubation (4). One of the alternative techniques is the so-called impedance method (3).
Microbial growth alters the chemical compostion of the growth medium. These chemical changes induce a change in the impedance of the medium. The time to measure detectable changes (Impedance Detection Time: IDT) is a measure for the initial bacterial concentration.
Impedance measurements have been successfully used for the rapid detection of microbial concentration in food, particularly in milk (1).
The purpose of this study was to evaluate the feasibility of the application of impedance measurements for the estimation of the numbers of bacteria belonging to some specific groups, present in raw meat and poultry meat.

Materials and Methods

a. Sampling

Various lots of cut pork meat were sampled in a meat factory. The lots enclosed salted (3% NaCl) as well as not salted meat, stored at 0°C for different periods of time (0-7 days).
A total number of 194 samples was collected.
Seventy six poultry carcasses stored for 1 day at +2°C, were obtained from 4 different slaughterhouses. At the laboratory one half of the carcasses was immediately examined, whereas the other half was stored during an other 4 days at 0-+2°C before examination.
For analysis homogenates (1/10) dilutions) of the samples were prepared in 0.1% peptone water.
From poultry carcasses neck skin samples were aseptically removed.

b. Impedance measurements

The impedance monitoring instrument used in this study was the Bactometer 32 (Bactometer Inc., Palo Alto, CA, USA). The instrument was operated according to the instructions provided by the manufacturer.
To the wells of the Bactometer modules 1ml of double-concentrated broth (Table 1) was pipetted. Next 1ml of 0.1% peptone water was added into the reference wells and 1ml of the homogenates or 10-fold dilutions of the homogenates was added into the module sample wells. Once the modules were inserted into the instrument, continuous automatic data collection was started. Impedances were monitored at 30°C, until all impedance detection times (IDT's) were obtained.

Table 1: Broths used with the Bactometer 32.

Broth	Sample	Impedimetric detection of
Brain Heart Infusion (BHI)	Pork and poultry	aerobic mesophiles
Enterobacteriaceae Enrichment Broth (EE)	Pork and poultry	enterobacteriaceae
MRS Broth	Pork	lactic acid bacteria
Kanamycin Aesculin Azide Broth (KAA)	Pork	fecal streptococci
GSP without agar	Poultry	pseudomonas spp.

c. Conventional microbiological prcedures

For the enumeration of the lactic acid bacteria, fecal streptococci and pseudomonas spp., the same media were used as for the impedance measurements. Howerever, to these broths the usual concentrations of agar were added to obtain solid agar media. Plate Count Agar (PCA) and Violet Red Bile Glucose Agar (VRBG) were used for the enumeration of aerobic mesophiles and enterobacteriaceae respectively. Plating of the homogenates was carried out by the Spiral Plate Maker. After inoculation an agar overlay was poured onto MRS agar and VRBG. KAA agar and VRBG were incubated at 37°C for 24 h, PCA agar and GSP agar at 30°C for 48 h and MRS agar at 28°C for 5 d.

Results and Discussion

Results from impedance measurements were compared with those from the conventional microbiological procedures. Figure 1 shows a scattergram of IDT's plotted against the initial

aerobic mesophiles of cut pork meat and neck skin from poultry carcasses. Lineair regression analysis of these data gave the following regression line: y = 7.31 - 0.48x with a correlation coefficient of 0.95. Predicting the number of aerobic mesophiles on neck skin using this regression line should cause a systematic under-estimation of the real number of bacteria. Therefore lineair regression analysis was carried out for each group of samples. The analysis yielded the following results: for cut pork meat y = 6.82 - 0.43x, r = 0.96 and for neck skin from poultry carcasses y = 7.71 - 0.50x, r = 0.91. These equations indicated that in comparison with the pork meat samples, IDT's from neck skin samples decreased more for a similar increase in the number of aerobic mesophiles. The discrepancy between the IDT's from both groups of samples may be traced to differences in the composition of the microflora. IDT is not only a function of the initial microbial concentration, but also of the generation time of the organisms present and their lag phase in the particular growth medium ((2, 5).
The nature of the sample had no effect on IDT's (Figure 2) of enterobacteriaceae. Consequently the results of all samples belonged to the same regression line. Moreover a high correlation (r = 0.96) was calculated between the two methods.
For pseudomonas spp. from poultry carcasses impedance measurements appeared to possess an adequate relationship to the conventional method with a correlation coefficient of 0.92 (figure 3). Determination of the number of fecal streptococci and lactic acid bacteria from cut pork meat by impedance measurements was not successful (r = 0.51 and r = 0.31 respectively) (figures 4 and 5) These poor results are probably due to environmental conditions during impedance measurements. Following differences between impedance measurements and conventional microbiological methods can be mentioned: 1/ KAA broth is a selective medium for fecal streptococci, but allow also the growth of some other bacteria. On KAA agar specific colonies were taken into account, whereas impedance measurements made no difference between bacteria growing in the medium. 2/ Lactic acid bacteria were cultivated in small volumes of MRS broth. In such volumes oxygen can penetrate very well. Growth of several lactic acid bacteria is reduced at high concentrations of oxygen.

Conclusions

From this study it can be concluded that impedance measurements can be recommended as a rapid method for the estimation of aerobic mesophiles, enterobacteriaceae and pseudomonas spp. in the routine analysis of meat. However the results for aerobic mesophiles can be different according to the type of product examined.
Estimation of fecal streptococci and lacti acid bacteria under the conditions applied in this study was not successful. Changes in the incubation conditions and/or the use of high selective broths can probably render impedance measurements also useful for these group of bacteria.

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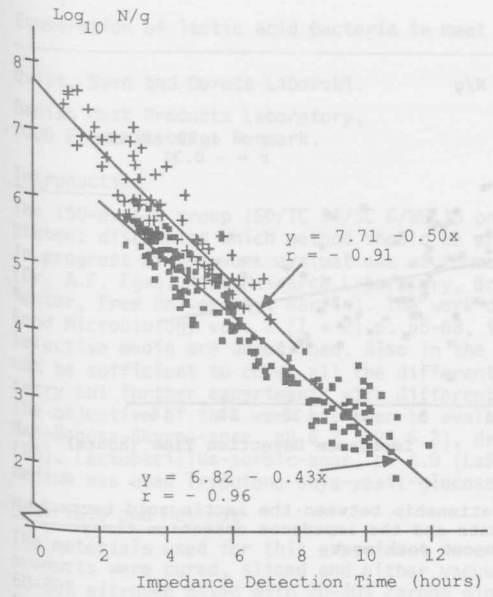

Figure 1 : Relationship between the aerobic mesophiles counts and the impedance detection times from cut pork meat (▪) and poultry neck skin (+).

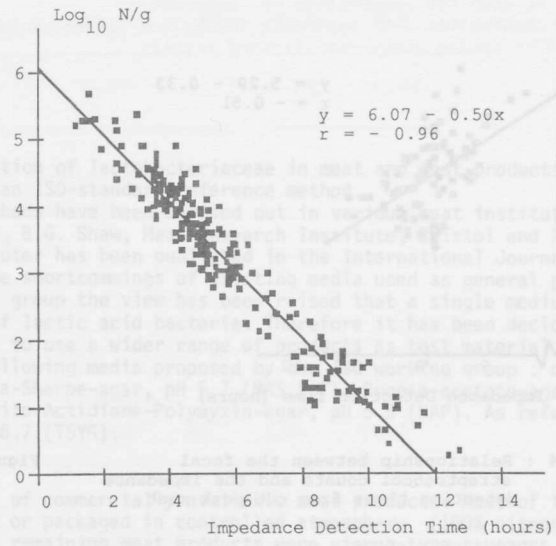

Figure 2 : Relationship between the enterobacteriaceae counts and the impedance detection times from cut pork meat and poultry neck skin.

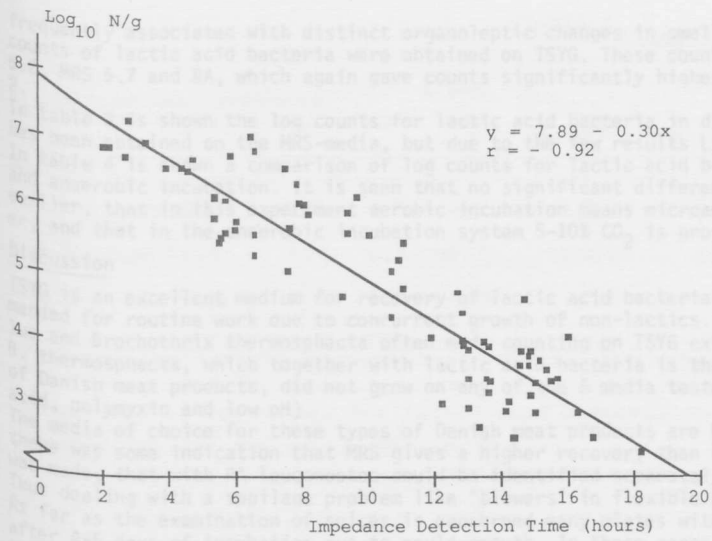

Figure 3 : Relationship between the pseudomonas spp. counts and the impedance detection times from poultry neck skin.

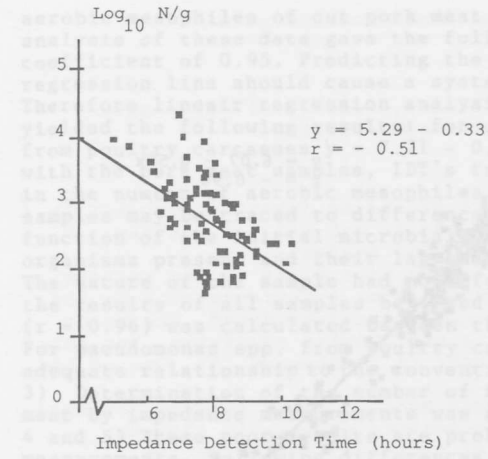

Figure 4 : Relationship between the fecal streptococci counts and the impedance detection times from cut pork meat.

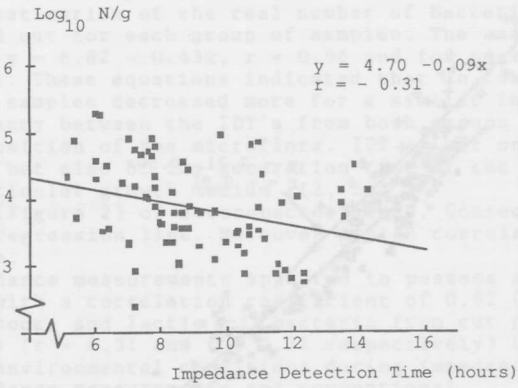

Figure 5 : Relationship between the lactic acid bacteria counts and the impedance detection times from cut pork meat.