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INFLUENCE OF AIR IONIZATION ON THE MICROBIAL CONTAMINATION OF CARCASSES DURING REFRIGERATION

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INTRODUCTION

Growth of microorganisms is the primary reason for quality deterioration and subsequent spoilage of fresh meat. Refrigeration at 0°C with a relative humidity rate of 80-90% extends the shelf life but causes important weight loss and delays the maturation of carcass meat. These disadvantages can be partially avoided by refrigerating at a higher temperature and an increased relative humidity, on the condition, however, that microbial growth is reduced in another way.
Air ionization has been proposed as an alternative method to limit the microbial proliferation.
The purpose of this study was to evaluate the effect of air ionization (Bentax) on the microbial contamination of carcasses stored in a cooling room used for commercial purposes.

MATERIAL AND METHODS

1. Material

After chilling of pork and beef carcasses, five pork hams and five beef hind quarters were selected for storage in a cooling room during 7 and 12 days respectively. From each meat portion, surface samples were taken three times to evaluate the microbial contamination. Besides, air samples were taken to follow the air contamination in the cooling room.
After this control examination, a similar study was performed in the presence of air ionizers. For that purpose the cooling room (130m^3) was fitted with 4 "Bentax" ionizers: i.e. 3 elements "40E2" and 1 element"4D1". The ionizers were switched on 8 days before starting the storage experiment and operated effectively 20 minutes/hour.
During the whole storage period, temperature and relative humidity were registered.
Afterwards the entire procedure was repeated.

2. Apparatus

The "Bentax" air ionizer is connected to the mains supply of 220 volt. It is composed of an internal and an external grid, between which an alternative current with a tension of 5000 volt is generated. This creates an "electron wind" in the environment, which is responsible for a negative charging of oxygen molecules, inducing oxygen-clusters. These accumulations of oxygen molecules(10-60) would have a high bactericidal effect as they damage cell membranes.

3. Sampling

From each pork ham samples of 17.5 cm^2 were taken aseptically with a cork borer at the meat- and rind side, after 1, 5 and 7 days of storage. From each beef hind quarter samples were collected at the medial- and lateral round with a template of 25 cm^2, after 1, 7 and 12 days of storage. To the samples of pork and beef, 17.5 ml and 25 ml of buffered pepton were added respectively, according to their surfaces. Consecutively, the samples were homogenised for 1 min with a Stomacher Colworth 400. Agar media were inoculated by use of a Spiral System device.

4. Bacteriological determinations

On all samples the following bacteriological determinations were performed:
- Total Plate Counts on PCA (Oxoid), 4d at 22°C
- Enterobacteriaceae on VRBG-Agar (Oxoid), 1d at 37°C
- Pseudomonas spp. on GSP-Agar (Oxoid), 4d at 22°C
- Yeasts and Moulds on OGY-Agar (Oxoid), 4d at 22°C

For air sampling, 4 petri dishes containing the previously mentioned media were inoculated with a Casella airsampler.

RESULTS AND DISCUSSION

1. Temperature and Relative Humidity

The cooling room temperature varied between 1°C and 5°C, whereas the relative humidity fluctuated around 80%. These variations must be attributed to the continuous commercial exploitation of the cooling room during the experiment.

2. Air sampling

Under air ionization, the increase of Total Plate Counts in the air occured to a lesser extend as compared with a control atmosphere. Air ionizers decreased the counts of Yeasts and Moulds in the air, whereas an increase was observed in ion-free conditions (fig). As Enterobacteriaceae and Pseudomonas spp. were not always demonstrable in the air, conclusions could not be drawn for these bacteria.

3. Carcass sampling

The microbial counts at the meat surface were converted into $\log_{10}N/cm^2$ and the mean was calculated for the several carcass portions. The development of the identified microorganisms in a control atmosphere and under ionization was compared for each group of meat portions.

The microbial counts increased to a lesser extend on beef than on pork carcasses. On beef Enterobacteriaceae and Pseudomonas spp. were frequently below the level of detection. On the other hand, Total Plate Counts, Yeasts and Moulds showed a distinct evolution.
Pork hams were more susceptible of microbial deterioration.
To evaluate the effect of air ionization on carcasses during refrigeration, the increase of $\log_{10}N/cm^2$ between the first and the last day of sampling was calculated for each group of values (Table 1 & 2). By comparing those results it can be observed that in 19 of 32 cases, the $\log_{10}N/cm^2$ increases to a lesser extend in presence of air ionization. In 8 cases the $\log_{10}N/cm^2$ increases more. Statistical calculation of those results with the nonparametric Sign Test yields a level of significance of 5% for a one-tailed evaluation.
In pork a slower development of microorganisms could be observed at the rind side in control circumstances. Under air ionization the microbial growth was obviously more delayed at that side.

CONCLUSION

Application of air ionization in cooling rooms significantly reduced the development of microorganisms on pork hams and beef hind quarters during refrigerated storage. This effect was more obvious at the rind side of the hams.
The air contamination in the cool rooms was also confined.
These results give evidence that the application of air ionization in cooling rooms may extend the shelf life of fresh meat.

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Talble 1: Initial meat contamination ($\log_{10}N/cm^2$)

	Tot.Plat.Co.		Enterobac.		Pseudomon.		Yeast/Mould.	
	Cont.	Ioniz.	Cont.	Ioniz.	Cont.	Ioniz.	Cont.	Ioniz.
EXPERIMENT 1								
Medial Round	3.5	3.5	-	-	0.9	1.0	2.3	1.0
Lateral Round	2.8	3.8	-	-	1.0	1.4	1.9	1.8
Pork Meat	3.5	5.9	1.2	4.3	3.1	4.7	2.2	3.8
Pork Rind	4.4	5.3	1.5	2.0	2.5	3.8	3.0	3.2
EXPERIMENT 2								
Medial Round	2.7	3.4	-	-	1.0	1.0	1.0	2.0
Lateral Round	2.6	3.7	-	-	1.0	1.1	1.1	2.1
Pork Meat	4.0	5.0	1.8	2.4	2.0	3.6	2.9	3.6
Pork Rind	3.4	4.7	2.6	1.8	2.7	3.4	2.6	3.2

Table 2: Increase of $\log_{10}N/cm^2$

	Tot.Plat.Co.		Enterobac.		Pseudomon.		Yeast/Mould.	
	Cont.	Ioniz.	Cont.	Ioniz.	Cont.	Ioniz.	Cont.	Ioniz
EXPERIMENT 1								
Medial Round	0.7	0.7	-	-	0.6	1.7	-1.0	1.3
Lateral Round	1.8	0	-	-	0.3	-0.2	1.0	0.4
Pork Meat	3.6	2.0	1.6	2.1	3.8	3.9	2.4	2.0
Pork Rind	1.2	-0.1	0.8	-0.3	2.1	-1.1	0.5	-0.3
EXPERIMENT 2								
Medial Round	1.9	0.8	-	-	1.9	0.9	2.5	0.2
Lateral Round	0.9	2.2	-	-	1.4	1.3	1.7	2.7
Pork Meat	3.2	2.6	3.2	3.5	4.9	3.5	2.8	2.2
Pork Rind	2.3	0.9	0.4	0.5	2.4	0.2	1.2	0.7

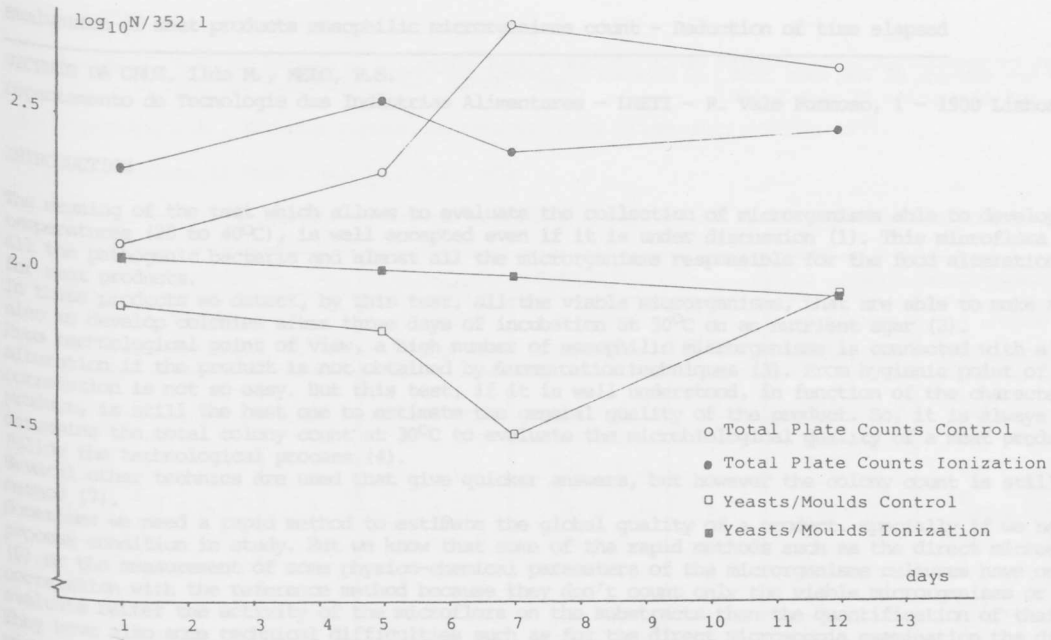

Figure: evolution of the air contamination during refrigeration of carcasses