USE OF HELIUM COLD PLASMA FOR MEAT SURFACE SANITIZATION

Natalia Ulbin – Figlewicz, Jagoda Ambrozik - Haba, Ewa Brychcy, Karolina Semeriak
The Faculty of Food Science
Department of Animal Products Technology and Quality Management

INTRODUCTION

The plasma is defined as a partially ionized gas containing neutral particles as well as an equivalent number of negative electrons and positive ions. Taking into consideration the energy of the particles constituting it, plasma is energetically the fourth state of the matter (Fig 1). One of the physical parameters defining plasma is its temperature (Grill 1994). Plasmas can be classified into two main groups: the high-temperature or fusion plasmas, and low-temperature plasmas or gas discharges (Bogaerts 2002). Cold plasma is obtained at lower pressures (< 0.1MPa) and use less power. Temperature of electrons (10^3–10^7 Ks) is much higher than heavy particles such as ions, atoms and molecules, therefore cold plasma is characterized by non-equilibrium (Moreau 2008). The plasma state exist in natural form (Fig 3): in the stars including our sun, in the tails of comets, and in flashes of lightning (Fig 2).

In recent years cold plasmas have been developed in view of their non-equilibrium properties and their capability to cause physical and chemical reactions with gas at relatively low temperatures.

The aim of this study was to determine antimicrobial efficiency of helium cold plasma treatment on surface microflora of meat.

MATERIALS AND METHODS

The microbiological analyses were done by applying the procedure describe in “Meat and meat products. Microbiological examination. Determination of total number of microorganisms” (PN-A-82055-6), “Meat and meat products. Microbiological examination. Determination of total number of yeast and mould” (PN-A-82055-16) and “Microbiology of food and feed. Horizontal method for the determination of the psychrotrophic microorganisms” (PN-ISO 17410). Samples were prepared according to PN-A-82055-3 (“Meat and meat products. Microbiological examination. Sample preparation and dilution”). The prototype generator of cold plasma (Etec Poland) works with helium at low pressure (0.3 mbar). Meat was exposed to helium plasma treatment for 0, 3, 6 minutes. Colour of fresh meat and after plasma treatment was measured using a colorimeter Minolta CR-400. Data were analyzed by one – way analysis of variance (Anova) using Statistic 9. Differences were defined at p<0.05 in Duncan’s test.

RESULTS

The total number of microorganisms on meat before plasma treatment was 5.6x10^5 CFU/g. The total number of microorganisms of treated meat with helium plasma decreased below 2.6x10^5 CFU/g after 6 min of exposure (Fig 4). Thus increasing time of exposure enhance the microbial reduction effect from 31 % to 53 %. However no significant differences were observed on total number of yeast and mould after 3 and 6 min of exposure (Fig 5). Inhibitory effect of helium plasma was noted on psychrotrophic microorganisms. Increasing a time of plasma treatment caused significant reduction of the number of mentioned above microorganism (Fig 6). Reduction 17 % and 30 % was observed after 3 and 6 min treatment. The color changes of fresh meat and meat treated by plasma were showed by variability of L*, a*, b* parameters in Table 1. No significant differences were found between color of the plasma treated samples and control sample.

CONCLUSIONS

1. The results of the present study have shown that helium cold plasma treatment has antimicrobial activity and can reduce total number of microorganism and psychrotrophic bacteria.
2. Cold plasma could be effective method for microbiological decontamination in food industry and also can have new interesting, innovative applications in pharmacy, pharmacology, or synthetic and analytic chemistry.

REFERENCES

1. A. Grill, Cold plasma in materials fabrication, IEEE, Nowy Jork 1994

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Fig. 1. The phase changes

Fig. 2. Diverse types of plasma, represented in terms of the parameters electron density and temperature

Fig. 3. Northern light

Fig. 4. Determination of total number of microorganism

Fig. 5. Determination of total number of yeast and mould

Fig. 6. Determination of the psychrotrophic microorganisms

Table 1. Color measurements of meat

<table>
<thead>
<tr>
<th>Sample</th>
<th>a*</th>
<th>b*</th>
<th>L*</th>
<th>Values with different superscript letters in each row are significantly different (P &lt; 0.05)</th>
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</thead>
<tbody>
<tr>
<td>Control</td>
<td>4.81*</td>
<td>6.57*</td>
<td>1.84*</td>
<td></td>
</tr>
<tr>
<td>H3</td>
<td>4.39*</td>
<td>5.67*</td>
<td>2.11*</td>
<td></td>
</tr>
<tr>
<td>H6</td>
<td>3.96*</td>
<td>6.31*</td>
<td>2.01*</td>
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