INTRODUCTION

Low-temperature plasma, also known as cold plasma is a form of matter resembling partially ionized gas, which contains electrons, positive and negative ions, radicals, atoms or photons (Fig. 1).

Plasmas can be classified as low or high pressure. Low-pressure plasma is formed at or below atmospheric pressure [1]. Plasma is used for decontamination of product surfaces. Application of this method is effective in the case of thermolabile substances and may be an alternative to conventional sterilization methods which require high temperature or chemical substances [5]. Plasma technologies are used in many fields such as metallurgy and materials science, medicine, and ecotechnology. Inactivation of gram-negative and gram-positive bacteria, yeast, fungi, biofilm formers, and endosporers was proved by Moreau [2]. Recently, the possibility of using plasma has been investigated for inactivation of contaminated food products such as almonds [6], pericarps of mangos, melons [7] and surfaces of fresh cut fruit [8]. The possibilities for use of this technique have not been fully understood, and further study is required.

The objective was to check the possibility of meat surface decontamination by plasma of argon gas.

MATERIALS & METHODS

The longissimus dorsi muscle (musculus longissimus thoracis) was collected from Meat Industry „Dworeczy” (Golejewo, Poland) plant. The study was conducted with samples not exposed to the cold plasma and samples treated with cold plasma using a laboratory pulsed plasma reactor (Ertex, Wroclaw, Poland), where the plasma state is maintained by high-energy pulses of electric fields in a glass cupula with a capacity of 30 cm³ with the vacuum ≤ 1 mbar. Plasma is generated in the space between the electrodes of the discharge condenser located on a high voltage table, where the meat sample is placed. Electrical impulses were generated using a pulse generator operating at frequencies around 70 kHz and 1.2 kVA power, adjustable in the range 0.5 to 20 kV AC, with a minimum pulse repetition time of 0.5 s. Samples of meat were exposed to argon plasma treatment for 3 or 6 minutes at the final vacuum 0.9 MPa and gas pressure 0.6 MPa.

The microbial conditions of fresh meat and meat treated with cold plasma were determined. Psychrotrophs were counted after 10 days of incubation at 6 °C (ISO 17410:2001). Meat was minced and homogenized in sterile bags using a Stomacher. Samples were serially diluted and plated on agar with hydrolyzed casein, yeast extract and glucose. Total number of bacteria was determined by plate count at 30 °C (PN-A-82055-6). Series of dilutions were prepared and inoculated using a pour technique to a medium containing: tryptone, yeast extract, glucose and agar. After 72 h of incubation, bacterial colonies were counted. Sample preparation to determine number of yeast and mould was the same like for total number of bacteria. Test conditions were 25 °C of temperature for 72, 96 and 120 hours (PN-A-82055-6). Four technique was used for inoculation in selective medium with yeast extract, α-D-glucose, agar, oxetatecycline and gentamic. The results are presented as log cfug.

Instrumental evaluation of color parameters L*, a*, b* was performed by colorimeter MINOLTA CR-400. Parameters of color L*, a*, b* were measured, where L* indicates lightness, a* and b* are the chromaticity coordinates. The a* and b* indicate color directions: +a* is the red direction, -a* is the green direction, +b* is the yellow direction, and -b* is the blue direction. Colorimeter was calibrated to white master (Y = 93.8, x = 0.3158, y = 0.3323), before every measurement.

pH values were determined using pH-meter.

Statistical analysis of results was performed using STATISTICA 9. Multifactorial analysis of variance (ANOVA) was used to test significant differences defined at p<0.05 in Duncan’s test.

RESULTS/ DISCUSSION

Survival curve of psychrophotrophs, total number of bacteria and yeast and mould as a function of time of plasma treatment are illustrated in Fig. 2.

Figure 2. Reduction of psychrophotrophs (P), total number of bacteria (TNB) and yeast and mould (Y&M)

All plasma treatments result in significant reduction of psychrophotrophs, total bacteria, and yeast and mould. Psychrophotrophs were little affected by active plasma after 3 minutes. After 6 minutes of plasma action the numbers of psychrophotrophs hard decreased almost by 1 log cfug (Fig. 3). Total numbers of bacteria were reduced about 1 log cfu. A longer time of exposure caused greater inactivation of microbes on meat surfaces. Kim found that increasing power and longer time of plasma treatment can reduce pathogens on beef surfaces [9]. Reductions of Listeria were also obtained by increasing these two conditions of plasma treatment in sliced cheese and ham [10]. The significant effect of cold plasma on yeasts and moulds in meat was noted, but the reduction was not as great as reductions of bacteria. It should be possible to obtain better reductions with longer time of exposure or with other gases.

CONCLUSIONS

It is possible to use argon as a gas in cold plasma generation, for effective reduction of surface contaminants of meat, without any changes in color parameters of product.

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REFERENCES