Low temperature atmospheric pressure plasma treatment for medicine, agriculture and food industry

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Low temperature plasma technology is widely investigated for processing of biological and abiotic non-heat resistant materials such as seeds, juices and medical implants. In this work impact of plasma treatment on chitosan/ β -1,3-glucan/HA biomaterial is reported. Moreover, results of onion seeds and fresh tomato juice plasma treatment and its influence on seed germination and on selected juice properties are summarized.

1. Introduction

Non-thermal plasma methods are powerful surface treatment tools, successfully combining the effects of high electric fields, VUV/UV radiation and active chemical compounds [1]. Plasma jets and glide arc reactors are considered versatile and easy to control, thus, they are predestined for high efficiency surface modification, especially for non-heat resistant materials, so common in medical, agricultural and food technology fields.

One of extensively investigated biomaterials is chitosan/ β -1,3-glucan/HA. It increases bone alkaline phosphatase level thereby enhancing cell differentiation and it is promoting osteoblasts' growth and proliferation. Thus, it is considered as implantable, non-toxic material - important for regenerative medicine [2].

Short-time plasma treatment, except biological and chemical decontamination, may further enhance formation of desirable surface properties of chitosan/ β -1,3-glucan/HA.

Decontaminative and simulative properties of non thermal plasma gain great importance for processing of not chemically preserved food, plants and seeds [3,4]. Plasma impact on selected properties of fresh tomato juice was investigated. Moreover, simulative effect of plasma treatment on onion seeds' germination was tested.

2. Experimental set-up

In the presented experiments, two types of plasma reactors were used: glidearc and RF plasma jet.

Two electrode AC glidearc reactor (GAD) [5], operating with nitrogen substrate gas was utilized for short (16s) treatment of chitosan/ β -1,3-glucan/HA [2] and then wettability and chemical composition of material were tested using Kruss DSA25E goniometer and ATR-FTIR, respectively.

The same reactor was used for 30, 60, 120, and 300s processing of 5 ml tomato (*Solanum lycopersicum* L.) juice in air. Tomato juice properties such as pH, total carotenoid and lycopene content (spectrophotometric method) and content of vitamin C (Tillmans dye method) were tested. Plasma influence on background microflora, including the total aerobic mesophilic viable count and the total yeast and mold count was investigated.

The RF plasma jet [6] operating with helium/nitrogen mixture was applied for onion seeds (*Allium cepa* L.) treatment. Nozzle was placed 5 cm from the seeds, the treatment time was 60, 120, 240 and 480 seconds. The germination energy and germination capacity were determined.

2. Results and discussion

16 s of GAD treatment in nitrogen gas did not changed chemical structure of chitosan/ β -1,3-glucan/HA porous material. Slight change in the behaviour of polar groups affecting wettability was observed during the measurement of advancing water contact angle. Before liquid penetration to the pores, CA rapidly decreased from 100^o to 40^o and from 120^o to 20^o for control and plasma treated sample, respectively.

In the case of fresh tomato juice, more than 3 log reduction of the number of microorganisms was reached after 5 min. of plasma treatment.

3.32-log CFU/ml reduction of molds (Fig.1), 3.55-log CFU/ml reduction for yeast and 3.45-log CFU/ml reduction for the total aerobic mesophilic bacteria colonies were attained.

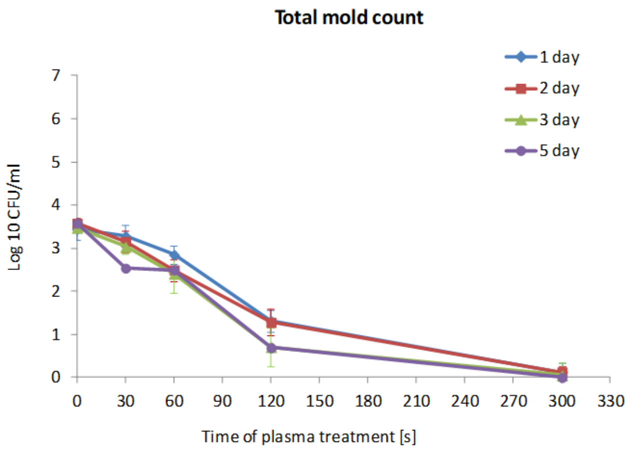

Fig. 1. Total mold count of un-pasteurized tomato juice treated with non-thermal atmospheric pressure plasma for 0, 30, 60, 120, and 300 s and stored at +4°C for 1-5 days.

13% increase in the total carotenoid and 11% increase in lycopene content were observed. pH was not changed. Maximum 5% loss of vitamin C after 5 minutes of plasma treatment was measured.

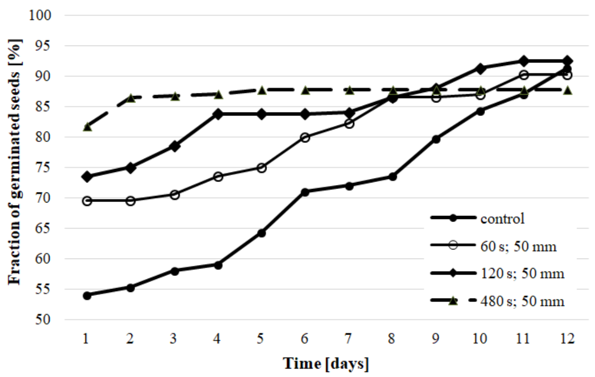

Fig. 2. Germination of onion seeds treated with plasma generated in RF reactor (He+N_2)

Fig. 2. presents the dynamics of the process of germination of onion seeds treated with plasma generated in RF reactor (He+N_2). Germination energy and germination capacity for the control sample ranged 71.0%±0.82 and 91.25%±0.96, respectively. For 240s of RF plasma treatment germination energy ranged 93.25%±1.79 while germination capacity was 99.25%±0.83. Pre-sowing plasma stimulation of seeds improved the germination parameters such as: germination capacity and germination energy comparing to the control.

3. Acknowledgement

This work was supported by NCN M-Era-net PNANO4BONE project no. 2016/22/Z/ST8/00694, Polish-Slovak Bilateral Cooperation Programme (PlasmaBioAgro) PPN/BIL/2018/1/00065 and SK-PL-18-0090. We would like to thank CEEPUS CIII-AT-0063 members for fruitful discussions.

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