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Effect of Pulsed Electrical Field on the Mechanical Properties of Raw, Blanched and Fried Potato Strips

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Abstract : French fry manufacturing involves a series of processes in which structural properties of potatoes are modified to produce crispy french fries which consumers enjoy. In addition to the traditional french fry manufacturing process, the industry is applying a relatively new process called pulsed electrical field (PEF) to the whole potatoes. There is a wealth of information on the technical treatment conditions of PEF, however, there is a lack of information about its effect on the structural properties that affect texture and its synergistic interactions with the other manufacturing steps of french fry production. The effect of PEF on starch gelatinisation properties of Russet Burbank potato was measured using a Differential Scanning Calorimeter. Cation content (K+, Ca2+ and Mg2+) was determined by inductively coupled plasma optical emission spectrophotometry. Firmness, and toughness of raw and blanched potatoes were determined in an uniaxial compression test. Moisture content was determined in a vacuum oven and oil content was measured using the soxhlet system with hexane. The final texture of the french fries – crispness - was determined using a three bend point test. Triangle tests were conducted to determine if consumers were able to perceive sensory differences between French fries that were PEF treated and those without treatment. The concentration of K+, Ca2+ and Mg2+ decreased significantly in the raw potatoes after the PEF treatment. The PEF treatment significantly increased modulus of elasticity, compression strain, compression force and toughness in the raw potato. The PEF-treated raw potato were firmer and stiffer, and its structure integrity held together longer, resisted higher force before fracture and stretched further than the untreated ones. The strain stress relationship exhibited by the PEF-treated raw potato could be due to an increase in the permeability of the plasmalema and tonoplasm allowing Ca2+ and Mg2+ cations to reach the cell wall and middle lamella, and be available for cross linking with the pectin molecule. The PEF-treated raw potato exhibited a slightly higher onset gelatinisation temperatures, similar peak temperatures and lower gelatinisation ranges than the untreated raw potatoes. The final moisture content of the french fries was not significantly affected by the PEF treatment. Oil content in the PEF- treated potatoes was lower than the untreated french fries, however, not statistically significant at 5 %. The PEF treatment did not have an overall significant effect on french fry crispness (modulus of elasticity), flexure stress or strain. The triangle tests show that most consumers could not detect a difference between French fries that received a PEF treatment from those that did not.

Keywords : french fries, mechanical properties, PEF, potatoes
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