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The influence of storage conditions on selected physical properties of freeze-dried carrot snacks covered with edible films based on pork gelatin.

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INTRODUCTION & AIM

Freeze-dried products are characterized by high hygroscopicity, and a delicate structure, so they need special packaging. The use of edible films for packaging freeze-dried bars can be an interesting alternative to plastic packaging. Edible, soluble films are made from natural raw materials, such as animal proteins, which is in line with the concept of sustainable food production.

The aim of this study was to investigate the changes in selected physical properties (microscopic analysis, porosity, mechanical properties, and water activity) of freeze-dried carrot snacks packed in edible films based on pork gelatin at concentrations of 8%, during storage at temperatures of 4°C and 20°C for 3 and 6 months.

METHOD

Preparation of freeze-dried carrot bars. Carrots were blanched in boiling water for 2 min, blended, and sodium alginate and calcium lactate were added. The gel cubes (1x1x1cm) were frozen at -40°C for 2 h, and then freeze-dried (24 h/63 Pa/30°C).

Edible films were prepared from porcine gelatin at concentrations of 8% and 12%. The gelatin was poured into beakers and topped up with water. The gelatin was heated to 60°C for 30 min. Glycerol was then added, equal to half the gelatin concentration, and the mixture was heated at 50°C for 30 min. The solutions were poured onto aluminum trays and dried at 30°C for 24 h.

Freeze-dried carrot cubes were wrapped in plastic wrap, the edges of which were sealed with a heat sealer. The prepared freeze-dried products were placed in an incubator (20°C) and at refrigerated temperature (4°C) for 3 and 6 months.

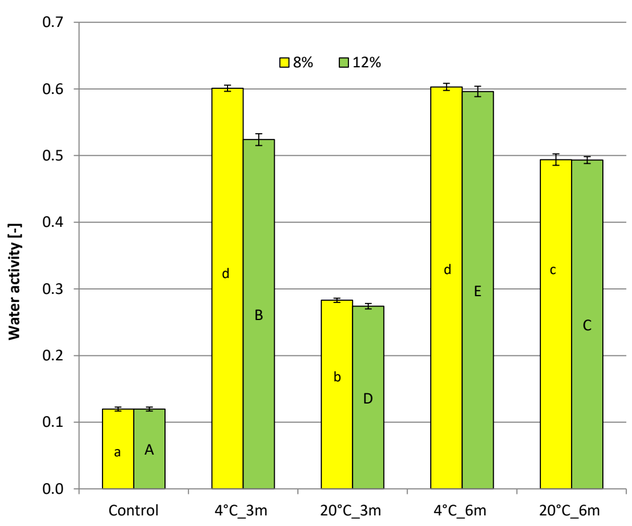
Water activity was measured using a HygroLab C1 Rotronic apparatus in accordance with the manufacturer's instructions, in 4 repetitions.

The mechanical properties were tested in 3 repetitions using a TA-XT2i STABLE MICRO SYSTEMS texturometer at a head speed of 1 mm/s to obtain a deformation of 50% of the sample height.

The internal structure of the freeze-dried cubes was examined using a TM 3000 scanning microscope (HITACHI, Japan) at 50× magnification.

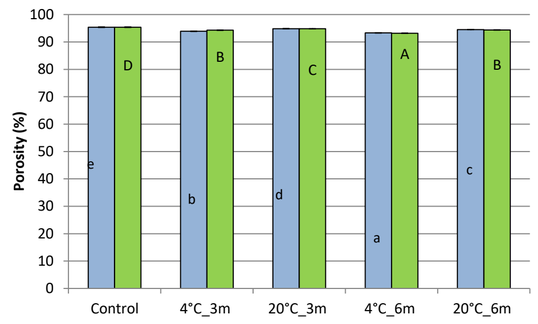
Porosity was determined using a helium pycnometer from Quantachrome Corporation (USA) according to the manufacturer's instructions. The results were entered into Pycnometer software version 2.

RESULTS & DISCUSSION

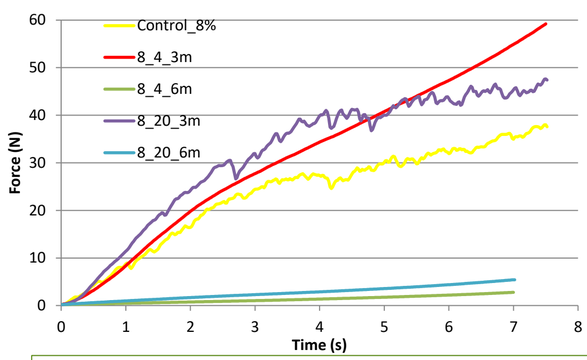


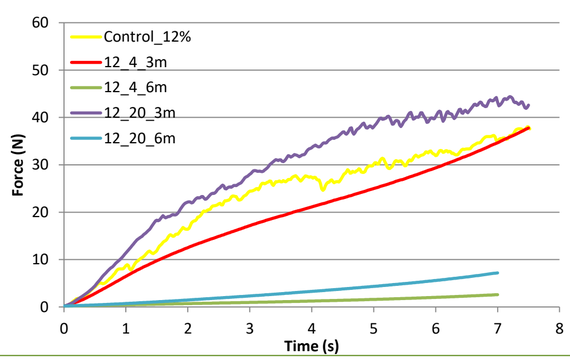
Storage of freeze-dried carrot cubes coated with edible film at gelatin concentrations of 8% and 12% resulted in a statistically significant increase in water activity compared to the control samples. A more favorable storage temperature was 20°C, at which the water activity of the samples was lower, but extending the storage time from 3 to 6 months resulted in a significant increase in this parameter.

RESULTS & DISCUSSION

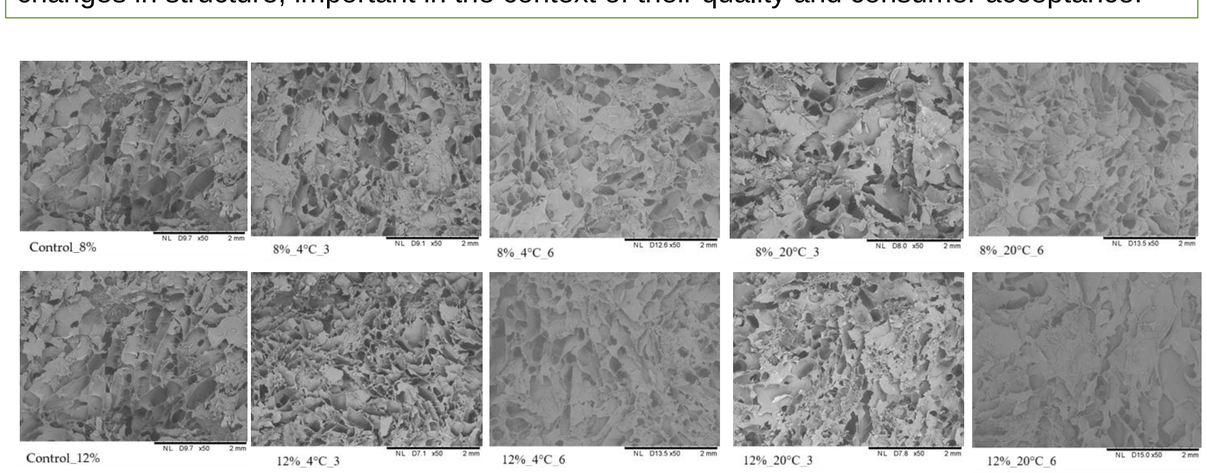


The porosity of the control samples was approximately 95%. Storage of the freeze-dried samples reduced this parameter, and extending the storage time from 3 to 6 months further reduced the porosity. Differences in porosity are visible depending on the storage temperature. Samples stored at 20°C retained higher porosity, regardless of the gelatin concentration.





Storage of freeze-dried carrot cubes wrapped in edible film with an 8% and 12% gelatin concentration at 20°C for 3 months resulted in a strengthening of the dried product structure compared to the control sample. Deformation by 50% required a compression force greater than the control sample. Storage of the freeze-dried cubes at 4°C for 3 months reduced the brittleness typical of freeze-dried cubes, and the compression curves were smooth. Extending the storage time to 6 months at both temperatures resulted in a significant weakening of the structure. Their deformation required almost 10 times less compression force. The compression curves correlate with the water activity results. Samples with higher water activity had a smooth course, which was associated with changes in structure, important in the context of their quality and consumer acceptance.



Samples coated with 8% and 12% gelatin content stored for 3 months retained high porosity, with internal structure similar to those of the control sample. Extending storage time from 3 to 6 months at 4°C and 20°C resulted in a significant structural collapse, and significant decrease of open pores. The observed structural changes confirm the porosity and mechanical properties.

CONCLUSION

- Storing freeze-dried carrot cubes in gelatin films at 8% and 12% concentrations increased the water activity of the samples. Changes occurred in the internal structure, which reduced mechanical strength and porosity.
- With extended storage time, unfavorable structural changes occur, resulting in deterioration of mechanical properties and a reduction in porosity, while water activity significantly increases.
- Increasing the storage temperature from 4 to 20℃ is more beneficial due to the physical properties of the freeze-dried products.

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