Development of Edible/Biodegradable Packaging Based on Plant Extracts and By Products

Razvoj jestive/biorazgradive ambalaže na bazi biljnih ekstrakata i nusproizvoda

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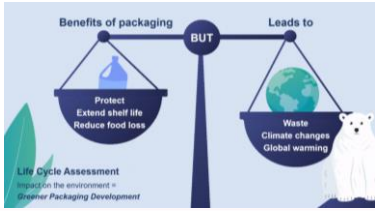
- Faculty of Veterinary Hygiene and Ecology

Department of Plant Origin Food Sciences

Current Packaging Problems

1. **Environmental Impact of Conventional Packaging**
   - Traditional plastic packaging is a major environmental pollutant.
   - Plastic waste contributes to landfills, ocean pollution, and adverse effects on wildlife.
   - Non-biodegradable nature of plastics means they persist for hundreds of years.
2. **Health Concerns**
   - Potential health risks from chemicals leaching out of plastic packaging into food products.
   - Micro and nano plastic is everywhere.



Introduction to Edible/Biodegradable Packaging

1. Definition and Concept

- Edible packaging: Materials that can be safely consumed along with the food product.
- Biodegradable packaging: Materials that can decompose naturally without harming the environment.

2. Advantages

- Reduction in plastic waste.
- Safe for consumption and environmentally friendly.
- Utilization of agricultural by-products, reducing food waste.
- Migration of bioactive compounds.

The use of waste, food by-products

The possibility for the fortification

Polymers for biodegradable packaging production

Furcellaran

anionic sulphated polysaccharide extracted from *Furcellaria lumbricalis* (red algae).

Carragenans

The source is red seaweeds *Rhodophyceae*

Chitosan

Linear polysaccharide composed of randomly distributed β--linked D-glucosamine and N-acetyl-D-glucosamine.

Forming solution pH around 3.2

Sources of Plant Extracts and By-Products

1. **Common Plant Sources**
    - Starches (corn, potato, tapioca)
    - Proteins (whey, soy, casein)
    - Polysaccharides (cellulose, pectin, alginate)
2. **By-Products from Agriculture and Food Industry**
    - Fruit and vegetable peels.
    - Cereal husks.
    - Oilseed cakes.
    - Popular food commodities
    - Spent coffee ground

polymers

MDPI

Article

Incorporation of Natural Blueberry, Red Grapes and Parsley Extract By-Products into the Production of Chitosan Edible Films

Simona Dordevic [1,*], Dani Dordevic [1], Petr Sedlacek [2], Michal Kalina [2], Karolina Tesikova [1], Bojan Antonic [1], Bohuslava Tremlova [1], Jakub Treml [3], Marcela Nejezchlebova [3], Lukas Vapenka [4], Ales Rajchl [4] and Monika Bulakova [3]

Table 1. Composition of prepared films.

Sample	Composition
CH_L	1.5 g chitosan + 1% lactic acid + glycerol
$5CH_{LBO}$	1.5 g chitosan + 1% lactic acid + 5% blueberry extract + glycerol
$10CH_{LBO}$	1.5 g chitosan + 1% lactic acid + 10% blueberry extract + glycerol
$20CH_{LBO}$	1.5 g chitosan + 1% lactic acid + 20% blueberry extract + glycerol
$5CH_{LPE}$	1.5 g chitosan + 1% lactic acid + 5% parsley extract + glycerol
$10CH_{LPE}$	1.5 g chitosan + 1% lactic acid + 10% parsley extract + glycerol
$20CH_{LPE}$	1.5 g chitosan + 1% lactic acid + 20% parsley extract + glycerol
$5CH_{LHR}$	1.5 g chitosan + 1% lactic acid + 5% red grapes extract + glycerol
$10CH_{LHR}$	1.5 g chitosan + 1% lactic acid + 10% red grapes extract + glycerol
$20CH_{LHR}$	1.5 g chitosan + 1% lactic acid + 20% red grapes extract + glycerol

The addition of extracts resulted the following:

- The reduction of the water content → the formation of hydrogen bonds – the reduced availability of hydroxyl groups and amino groups – the limited interaction between chitosan and water

- The solubility was not affected by the extracts

- The swelling degree was lower with the addition of extracts → Higher polyphenol content

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Furcellaran/gelatin hydrolysate/rosemary extract composite films as active and intelligent packaging materials

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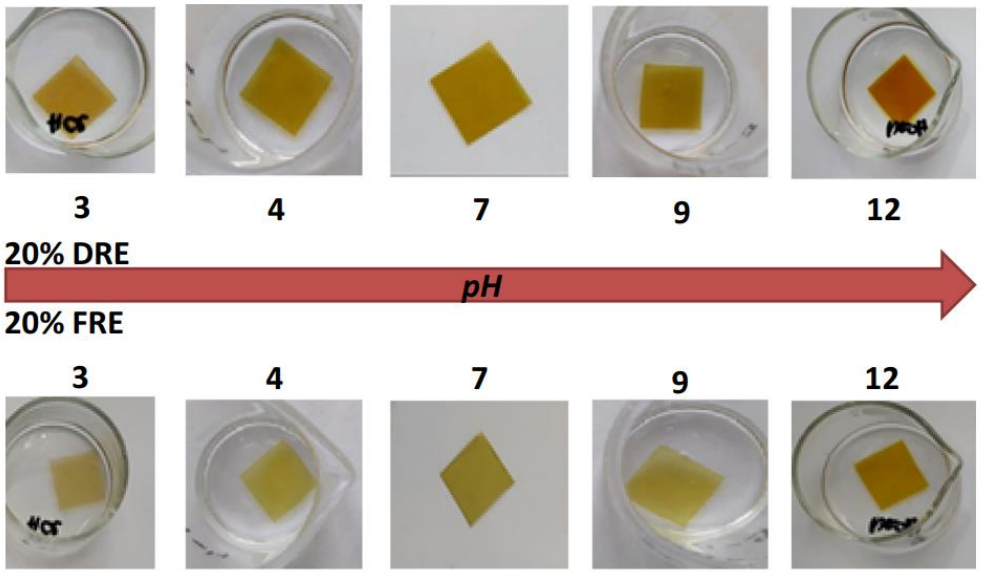

Fig. 4. Photographs of the intelligent films 20% DRE and 20% FRE after subjecting to solutions with different pH.

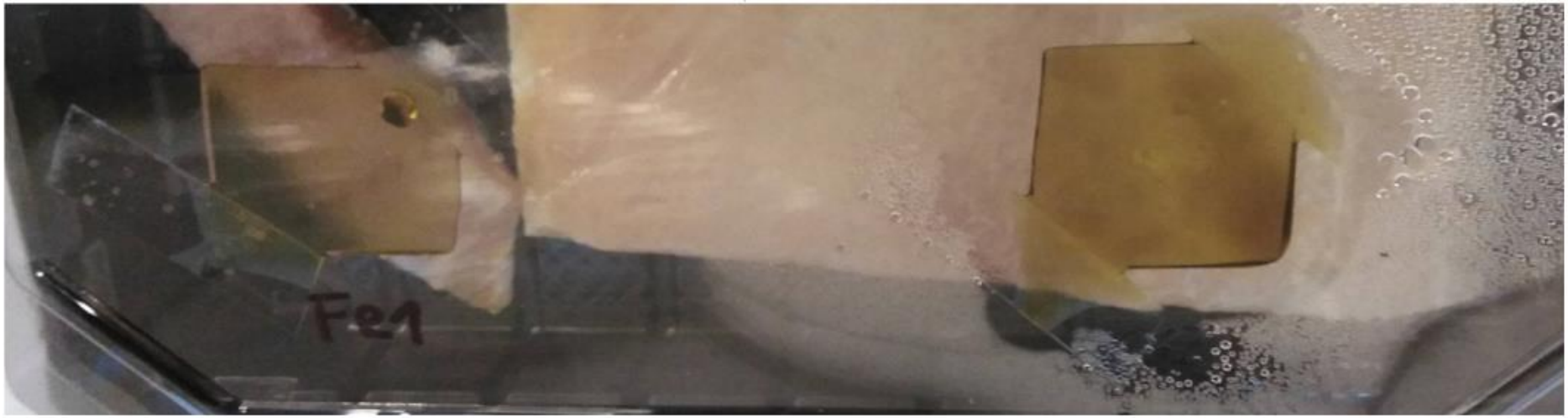

Figure 2. Color changes of FUR/GELH with 20 % DRE and 20 % FRE films in the fish spoilage test

- chitosan/corn starch films with red cabbage extract, the films exhibited much more pronounced effect after 7 days of refrigerated storage.
- multicolor sensor for monitoring fish spoilage based on hypoxanthine formation

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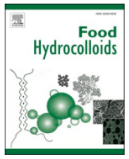

Development of active pH-sensitive biodegradable films based on chitosan and κ -carrageenan biopolymers enriched in beluga black lentil additives

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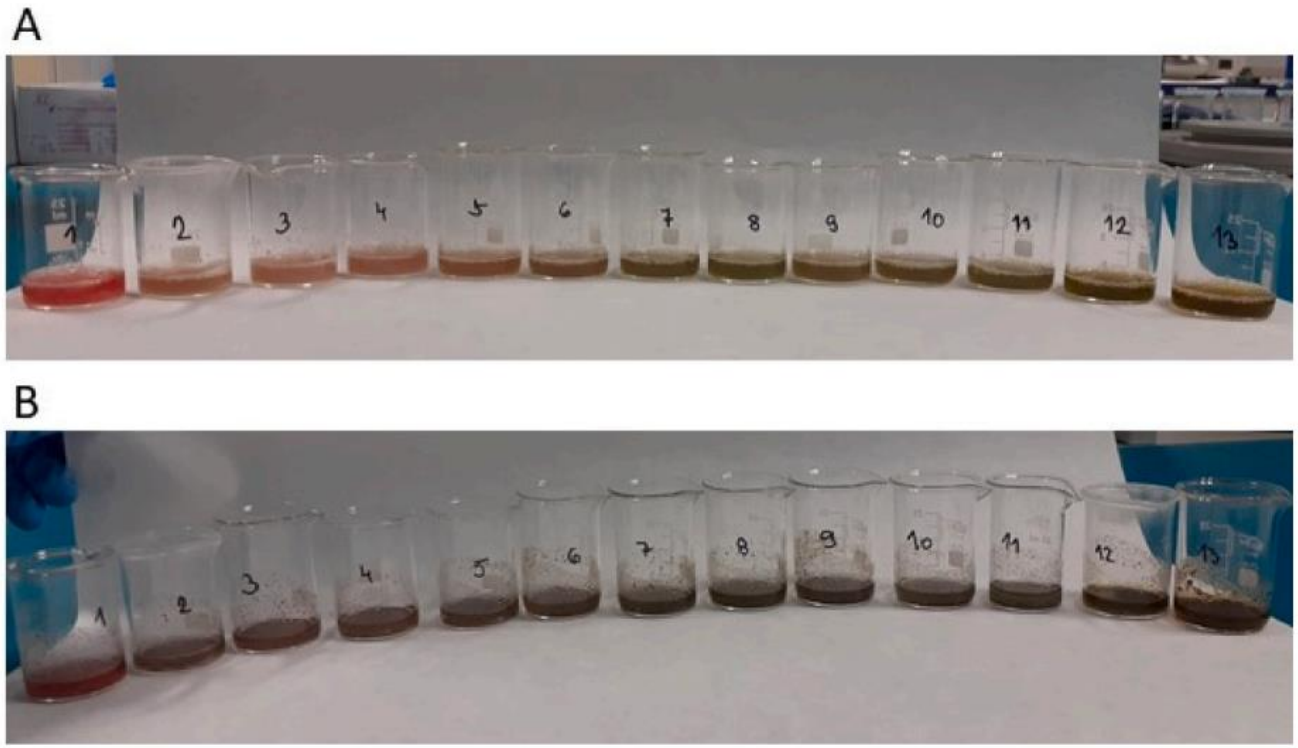

Fig. 1. Applications of anthocyanin-rich beluga lentils in the preparation of pH-sensitive smart packaging films and visual monitoring of the freshness of food products. Color-change of (A) Beluga lentil leachate anthocyanin and (B) Beluga lentil powder anthocyanin in pH range 1–13.

foods

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Article

Edible/Biodegradable Packaging with the Addition of Spent Coffee Grounds Oil

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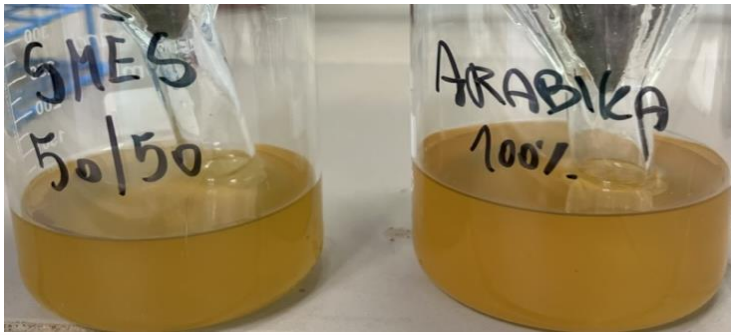
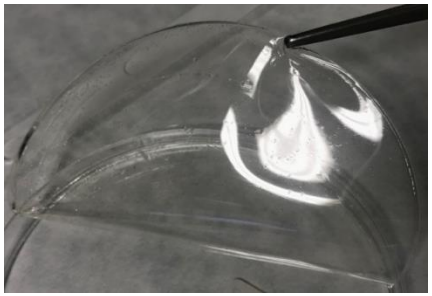
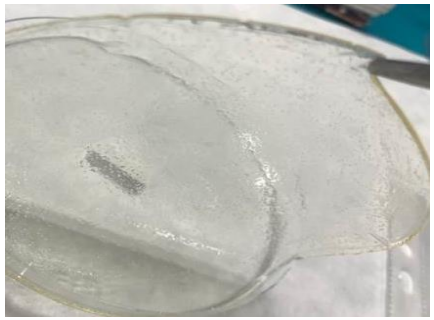


Table 1. The sample labeling and used ingredients.

Sample Labeling	Ingredients
CACO	Control
CA0.1TW20	Carrageenan + 0.1 mL of oil from spent coffee ground + tween 20
CA0.45TW20	Carrageenan + 0.45 mL of oil from spent coffee ground + tween 20
CA0.8TW20	Carrageenan + 0.8 mL of oil from spent coffee ground + tween 20
CA1TW20	Carrageenan + 1 mL of oil from spent coffee ground + tween 20
CA0.1TW80	Carrageenan + 0.1 mL of oil from spent coffee ground + tween 80
CA0.45TW80	Carrageenan + 0.45 mL of oil from spent coffee ground + tween 80
CA0.8TW80	Carrageenan + 0.8 mL of oil from spent coffee ground + tween 80
CA1TW80	Carrageenan + 1 mL of oil from spent coffee ground + tween 80
CA0.1	Carrageenan + 0.1 mL of oil from spent coffee ground





Plant extracts are added to edible packaging for several beneficial reasons:

1. Enhanced Functional Properties
- Antimicrobial Activity
- Antioxidant Properties

2. Improved Mechanical and Barrier Properties
- Strength and Flexibility
- Moisture and Gas Barrier

→ **Hydrophobic Components**

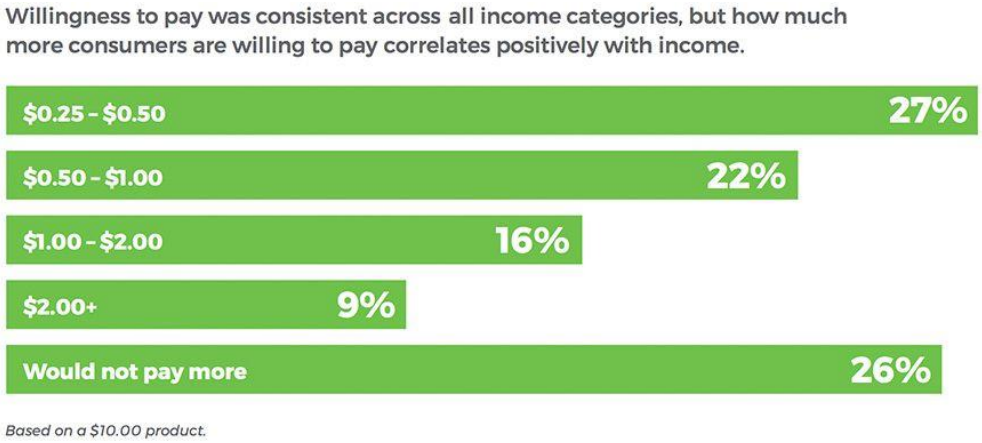
→ **Increase Structural Integrity**

→ **Increase Film Formation**

3. Nutritional and Health Benefits
- Nutrient Enrichment
- Health-Promoting Compounds

4. Natural and Safe Additives
- Consumer Acceptance

5. Sustainability and Waste Reduction
- Utilization of By-Products
- Biodegradability



The future perspective

- The experimental step

Experimentally can be monitored produced material more in detail

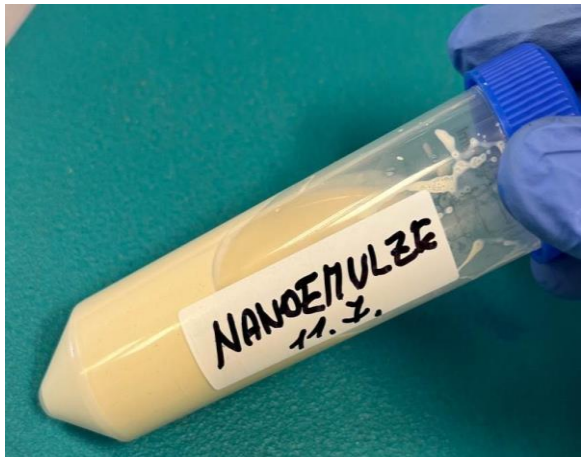
Far away from the industrial production

Industry is often faster than experimental work

How to use produced films/ ideas for thinking

- Secondary packaging for certain commodities:

How to use produced films/ ideas for thinking



THANK YOU FOR THE ATTENTION!

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