

# Biodegradable Packaging - Ecological Alternative or New Global Challenge

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**EU GREEN WEEK 2021 PARTNER EVENT**

**ZERO** #EUGreenWeek  
**POLLUTION**  
for healthier people and planet



# Plastic now pollutes every corner of Earth





# Historical excursion

## Historical steps

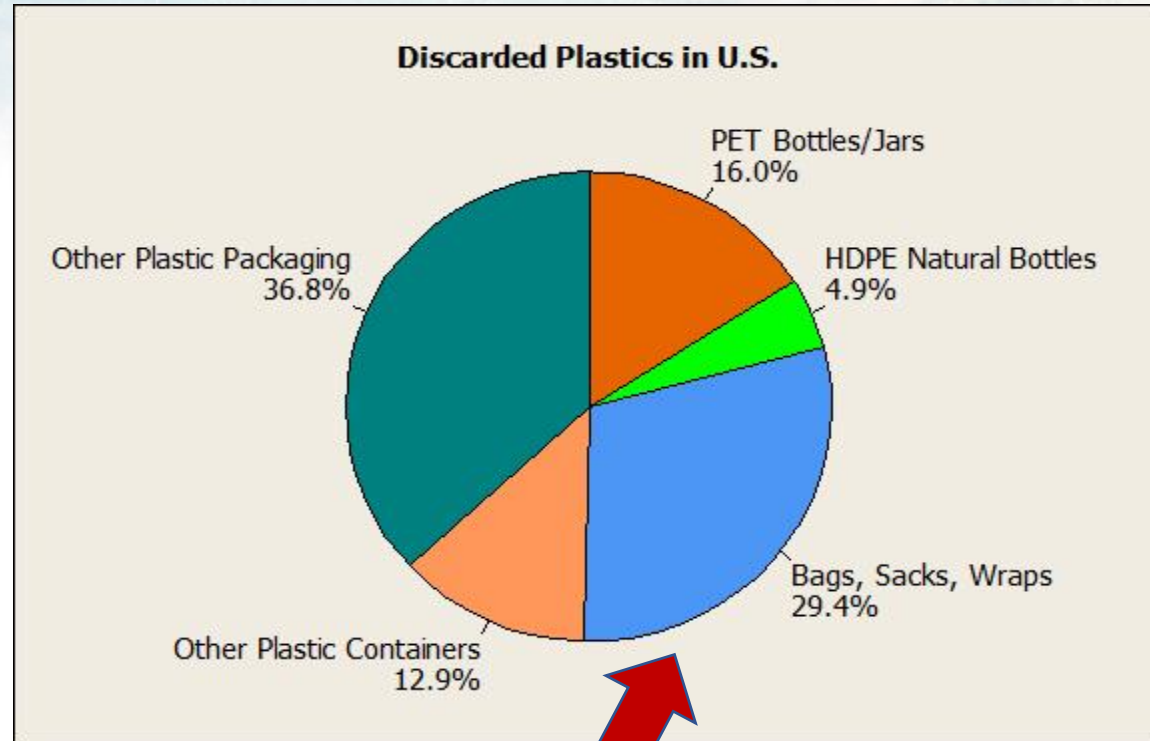
- The ***first plastic*** (celluloid) was invented more than 150 years ago.
- Since that there was a period of ***plastic's enthusiasm***.
- Plastic's reputation fell in the 1970s as anxiety about ***waste increased***.

## Proposed Solutions and Consequences

- Biodegradable composite plastic  ***Danger: microplastic!***
- ***Biodegradable synthetic plastics***  ***Biodegradable or biocompostable?***



# Structure of Plastic Waste



**29,4 % Bags, Sacks, Wraps**



# Biodegradable alternatives to conventional plastics: producing microplastic or currently non- sustainable

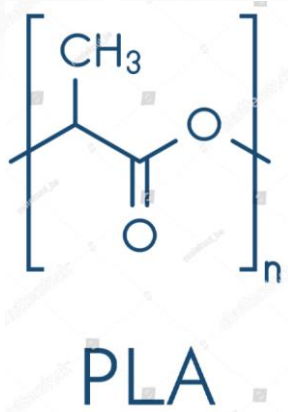
1. Composite Polyethylene-Starch: *non-biodegradable+biodegradable = biodegradable??*

2. Cellulose-paper industry pollutes the environment as well:  
*biodegradability is not the main thing!*





### 3. Biodegradable, PLA (or biocompostable?)



# Stay-of-the-art: there is no the only way out

- ✓ **DIRECTIVE (EU) 2015/720 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL**

The consumption: not exceed **40 lightweight plastic carrier bags** (with a wall thickness below 50 microns) per person by **31 December 2025**. **Very lightweight plastic carrier bags** (with a wall thickness below 14 microns) **may be excluded from** national consumption objectives;



**198 now!**



# Shrink, ban or without?

***Strict ban:*** Australia, Hong Kong, Kenya, some states of India, Singapore, Bangladesh, Zanzibar, Rwanda, Hawaii. In South Africa, for the sale of plastic bags facing imprisonment. Since 2019 - New Zealand.

***Reduce (due to fees, taxes or fines, life-bags):*** Italy, UK, France, Belgium, Germany, Denmark, Israel, Lithuania, Romania, Russia, Belarus, Azerbaijan, Kyrgyzstan, Georgia and etc.

***Without packaging (packaging ourselves)***





# Paper or long-life bags



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# Buyers pack food by themselves



## Zero Waste Bulk Store





# Stay-of-the-art: there is no the only way out

- ✓ **A European Strategy for Plastics in a Circular Economy sets a series of ambitious targets and initiatives up to 2030, within a spirit of commitment to future generations (Brussels, 16.1.2018 )**
- ✓ Re-use and recycling with the ambition to reach 60% for plastics packaging by 2030;
- ✓ 100% re-use, recycling and/or recovery of all plastics packaging in the EU-28,
- ✓ Norway and Switzerland by 2040.
- ✓ Preventing Plastics Leakage into the Environment
- ✓ Accelerating Resource Efficiency
- ✓ **Disposable items should have labels indicating how to dispose of them.**



# What about biodegradable in reality?

**Biodegradable** plastic is plastic that degrades due to the action of naturally occurring microorganisms such as bacteria, fungi and algae.

**Compostable plastic** is a plastic that breaks down through biological processes during composting, releasing carbon dioxide, water, inorganic compounds and forming biomass at a rate comparable to other known compostable materials, and does not leave visually distinguishable or toxic residues.

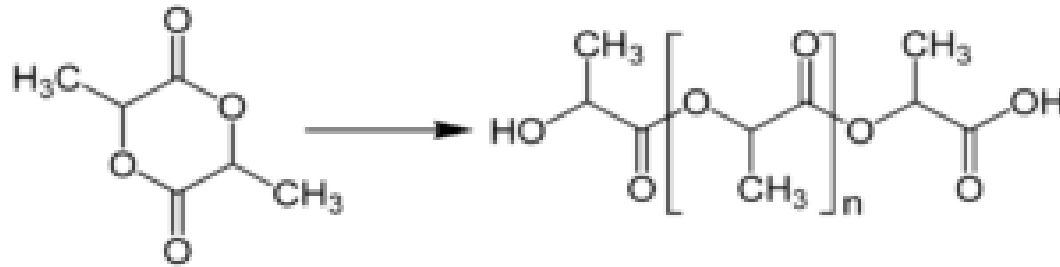
**Composting** is a natural process whereby organic material is degraded by microorganisms (mesophilic and thermophilic), including bacteria, fungi and actinomycetes. For its flow, the presence of carbon, nitrogen, water and oxygen is necessary. To speed up the process, a certain ratio C: N = 30: 1 is required.



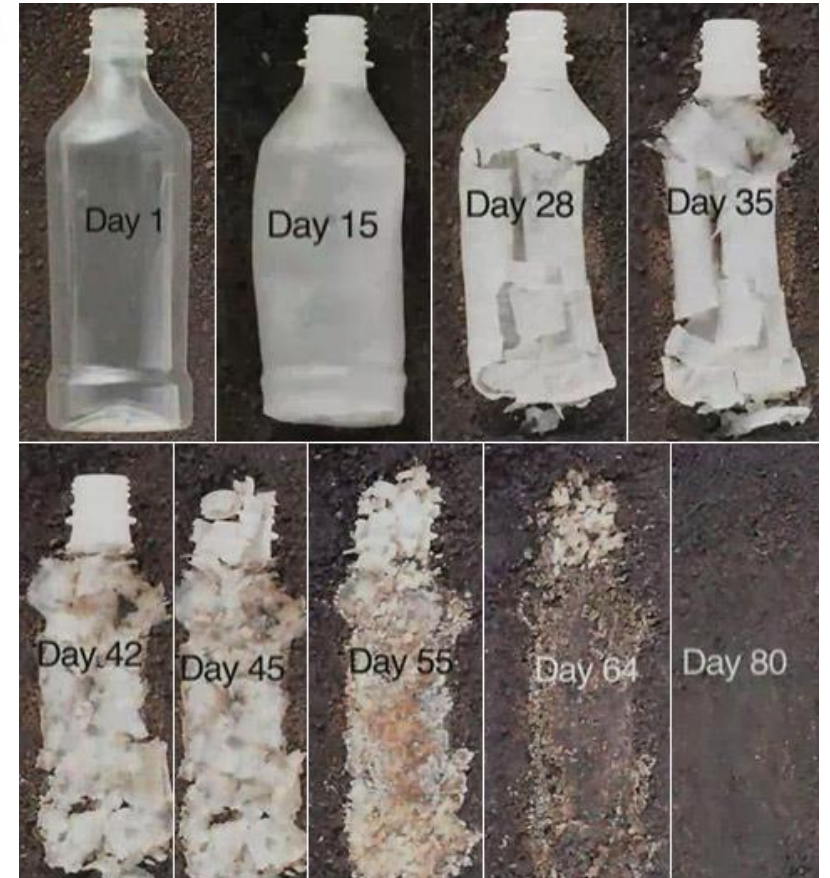
# Some words about so popular PLA



**Poly lactide [polydylactide, poly (3,6-dimethyl-1,4-di-oxane-2,5-dione)]**



**Belu Mineral Water, UK**

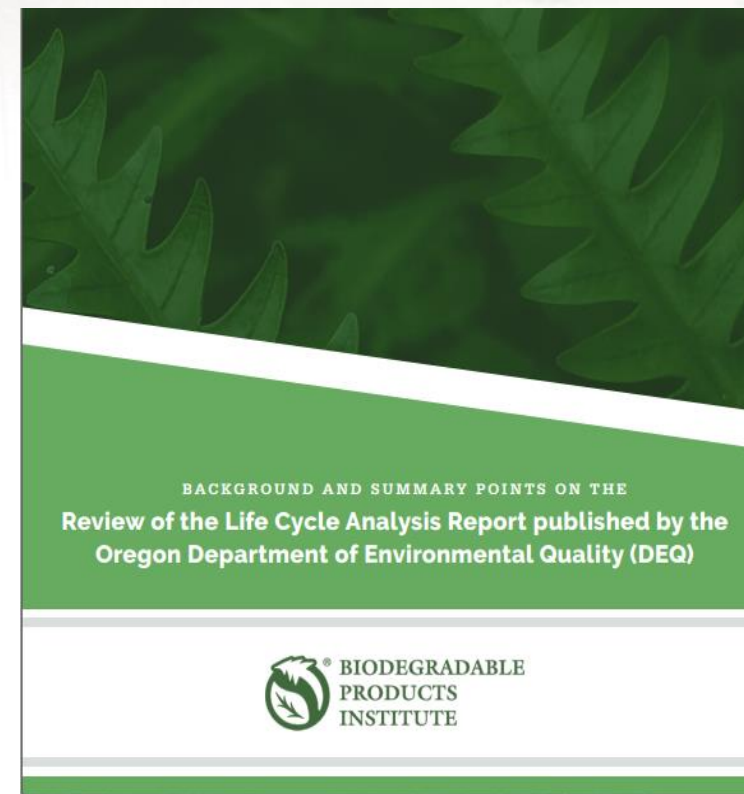


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# False Assumptions Utilized for Behavior of PLA in Landfills

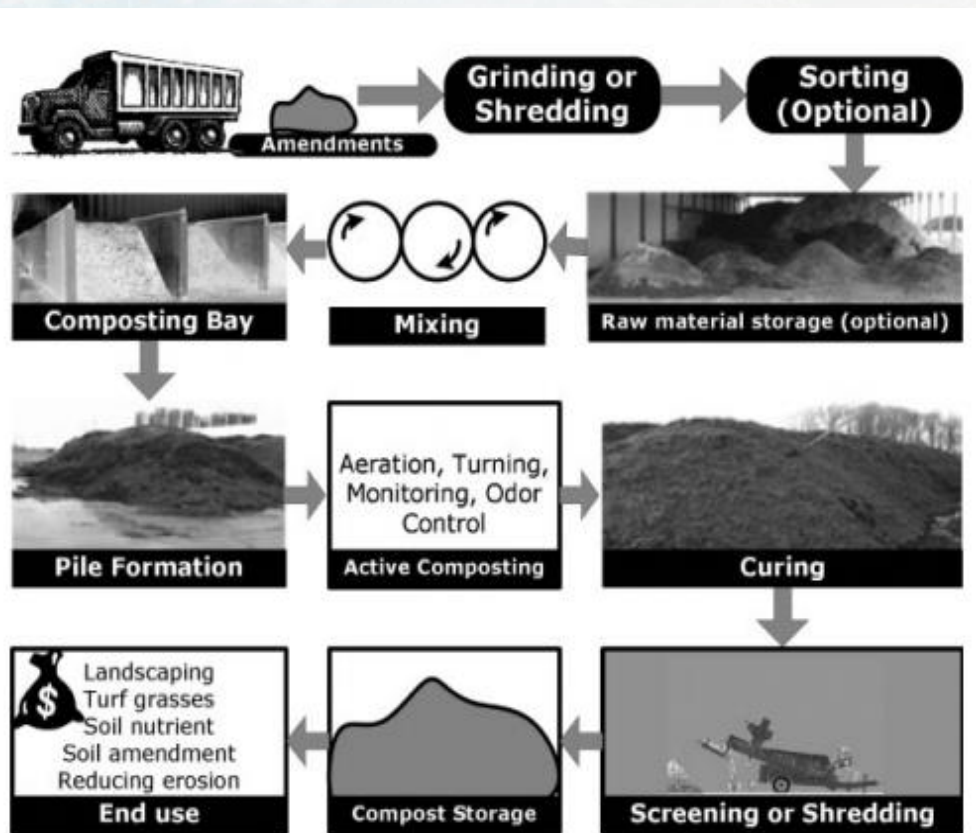
Many of the studies referenced are based on false assumptions and estimations of PLA and its behavior in landfills, which increased their estimated Global Warming Potential for compostable materials.

Published studies have shown that PLA is stable and does not significantly degrade in a landfill environment.

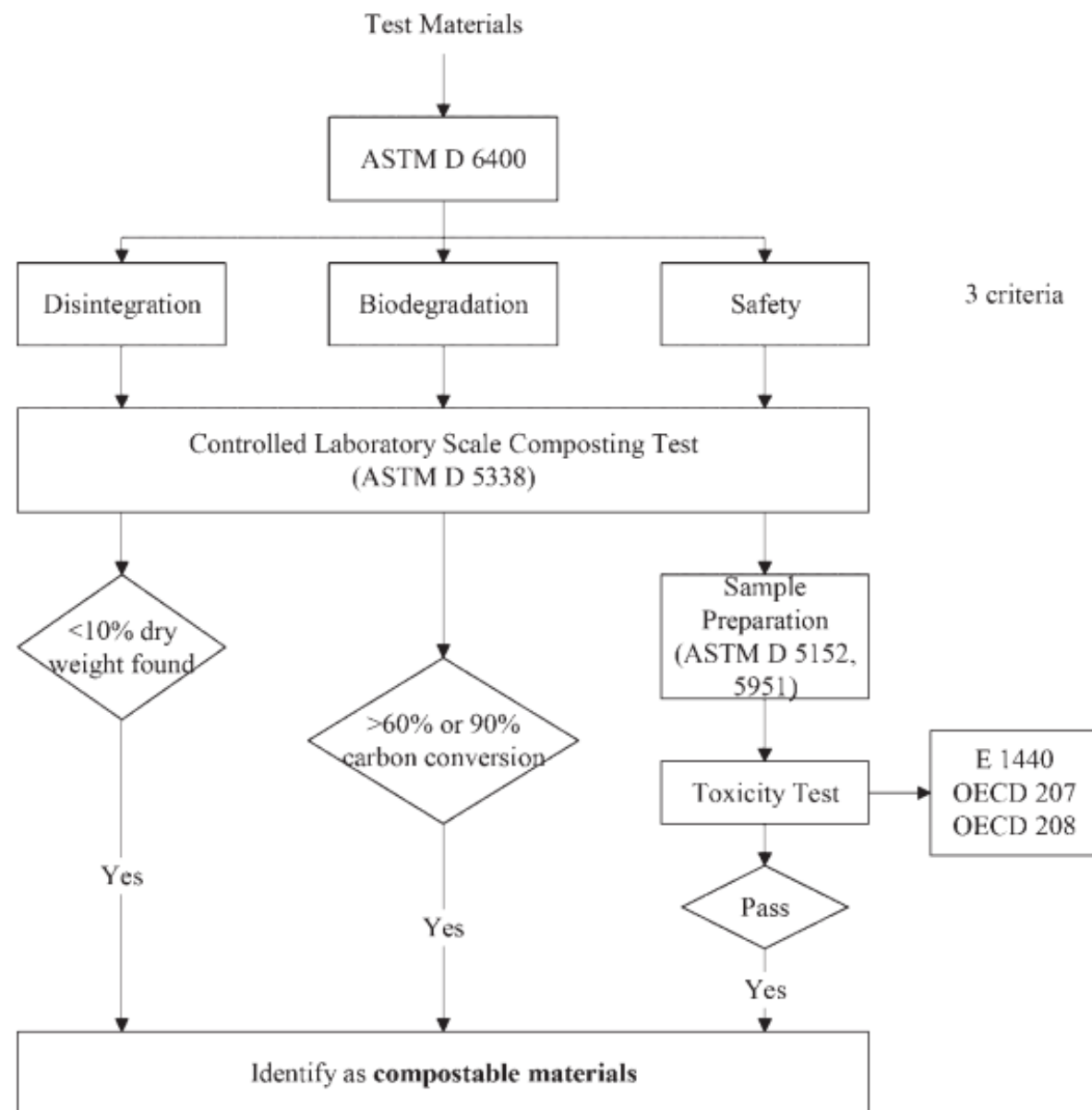




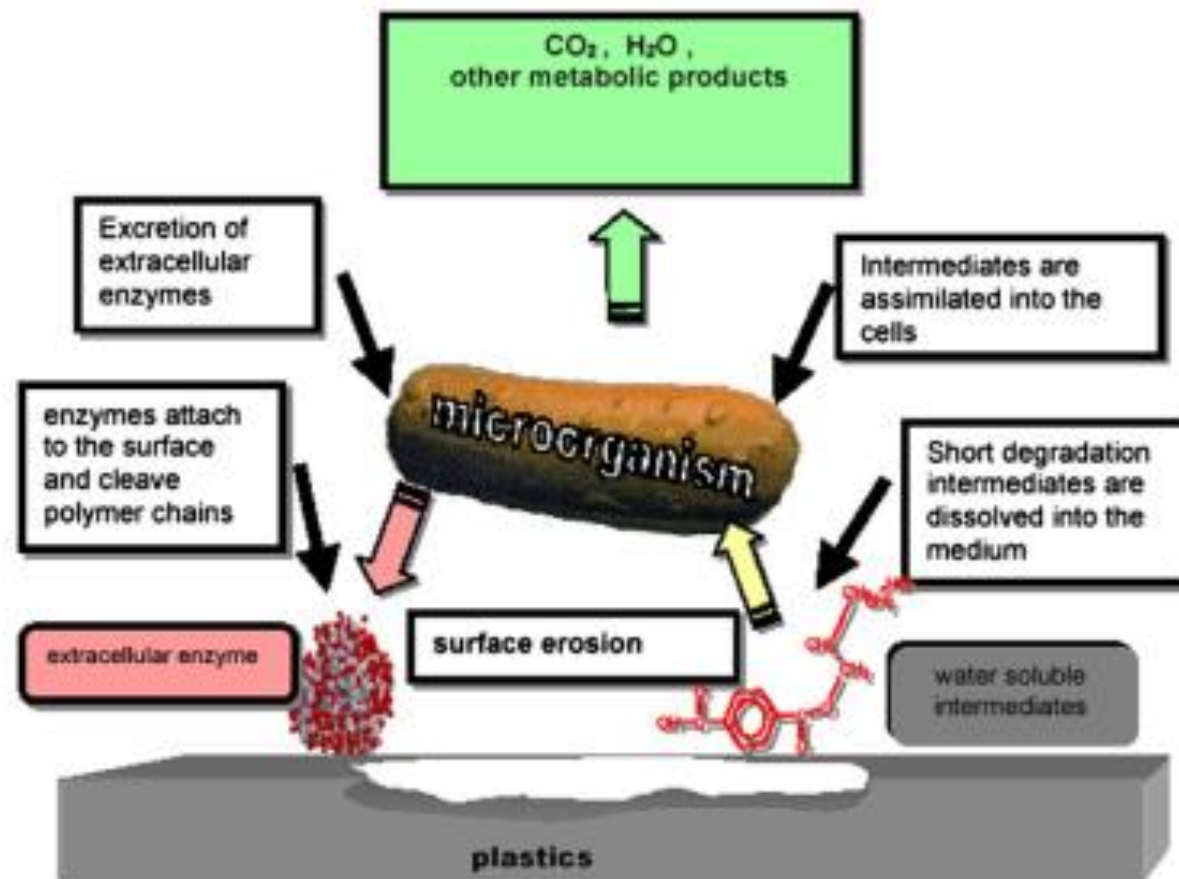
# ASTM International



[Kale, G. Compostability of Bioplastic Packaging Materials: an overview / G.Kale et al. // Macromolecular Bioscience. – 2008. – 7. – P. 255-277.



# The adventure of Plastic in compost



Shah, A.A. Biological degradation of plastics: a comprehensive review /A.Shah et al. // Biotechnology Advances. 2006. – Vol. 25. – P. 246-255.



# Problems with compostable polymers

- **Compost contamination with non-biodegradable polymers**
- **Contamination of recycled polymers with compostable polymers**

Plastic	Density, kg/m <sup>3</sup>	T m °C
Polyethylene therephtalate (PET)	1350–1390	255
Low pressure polyethylene (LPP)	930–970	125
Polyvinyl chloride (PVC)	1100–1450	210
Polylactid (PLA)	1200–1450	155–165
Poly-3-hydroxyl butyrate (PHB)	1300	180
Polyethylene furanoate (PEF)	1400–1550	225

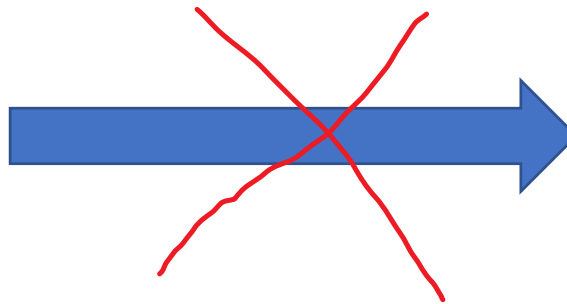
**The appearance on the market of products made of PLA, PHA, and PEF**

**can be more accurately positioned**

**not as the emergence of new materials,**

**but as the creation of a new type of waste.**

# What about non-reusable, non-recyclable bags ?





# Our Proposal and Project (Belarus-Slovakia)

**“The formulation of novel compositions and properties study of the polysaccharide based edible films and coatings with antimicrobial and antioxidant plant additives”**

**Project of the Belarusian Republican Foundation of Fundamental Research - BRFFR № X20CЛKГ-003 от 17.02.2020**

**Belarusian side: Research Institute for Physical and Chemical Problems of the Belarusian State University.**

**Belarus, Minsk, Principle Investigator:** Head of the Laboratory, professor Dzmitry Hrynshpan

**The executive of the project:** Professor T.Savitskaya, the author of the first monography in Belarus on edible films and coatings (Savitskaya T. Biodegradable composites based on natural polysaccharides, 2018, Minsk, BSU. – 207 p.)

**Slovak side: Slovak University of Agriculture in Nitra. Faculty of Biotechnology and Food Sciences. Slovak**

**Republic Principle Investigator:** Professor MiroslavaKačániová, Department of microbiology

Objective: Developing of new films' composition with starch as film-forming material and antimicrobial, antioxidant plant additives and evaluation of their properties.

# Definitions

**Edible films and coatings** are biodegradable polymeric materials that demonstrate the mechanism of biodegradation under the action of intracellular and non-cellular enzymes (endo- and exoenzymes) contained in the stomach and intestines of humans and animals, which is alternative to the microbial mechanism (environmental degradation by bacteria or fungi), consisting in the oxidation and hydrolysis reactions.

This is the **primary** packaging for edible ingredients, which in most cases requires external, secondary packaging!

**Edible films are not meant to, or could they ever, replace non-edible outer packaging**





# Edible films developed at BSU



**More than 80% of starch**





# **Starch films production in China has been implemented by skillful women's hands**



**By the chemical nature starch is not a good polymer for films making.**

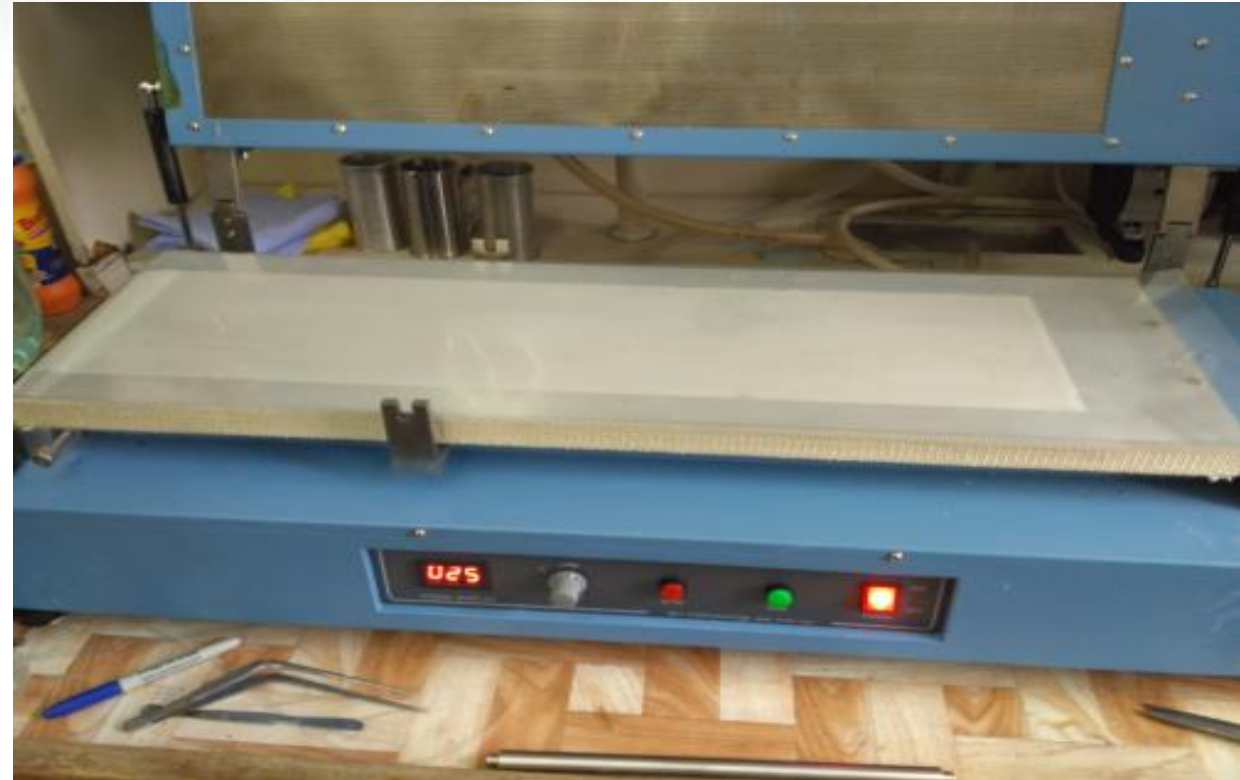




**Candies in edible primary packaging. Starch films are not strong and elastic according to the chemical nature of starch.**



# Films composition and technology production was tested by different scale equipment: Lab at BSU, Belarus





# Small pilot-scale equipment in USA





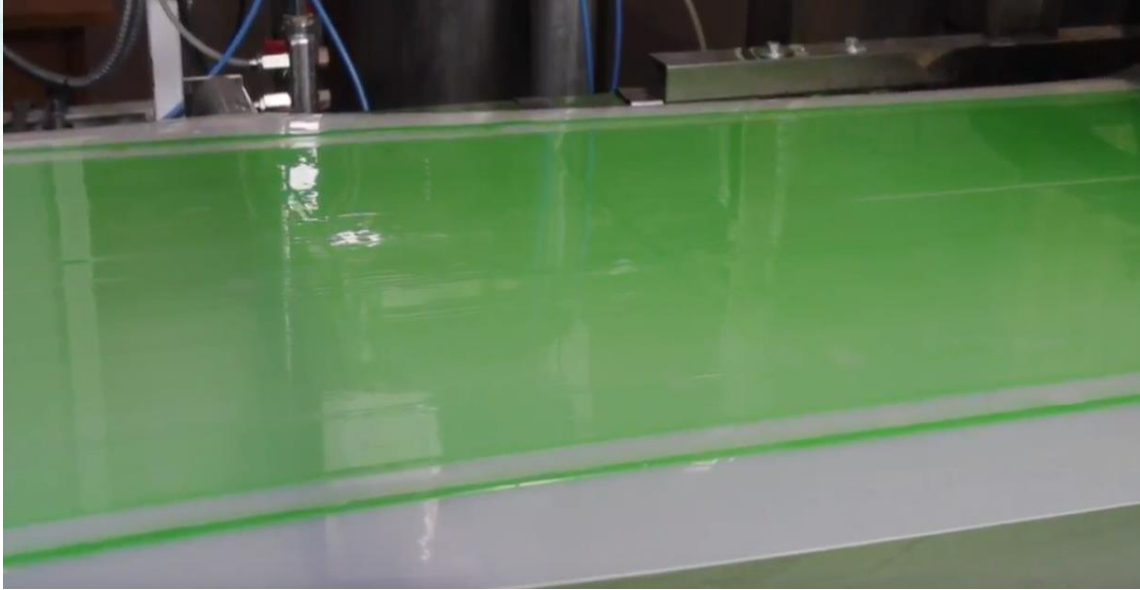
# Pilot-scale Equipment



**Pilot-scale machine developed by LLC “Borisov’s plant of plastic packaging “Polimiz” in Belarus**



# Film casting



# Edible films colored by food dyes





# Examples of possible application



**Tensile strength  
is the main BSU  
films' advantage**

# Wrappers for candy with natural anti-carries additives





Disc	Extract								
		<i>STREPTOCOCCUS PNEUMONIAE*</i>				<i>HAEMOPHILUS INFLUENZAE</i>			
		Microbial growth around the disc (+)		Lack (-) / suppression (±) of growth under the disc		Microbial growth around the disc (+)		Lack (-) / suppression (±) of growth under the disc	
		24 час.	48 час.	24 час.	48 час.	24 час.	48 час.	24 час.	48 час.
I	without	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)
II	<i>Curcuma longa</i> 30 %	(+)	(+)	(±)	(±)	(+)	(+)	(±)	(±)
III	<i>Cinnamomum inem</i> 10 %	(+)	(+)	(±)	(±)	(+)	(+)	(±)	(±)
IV	<i>Cinnamomum inem</i> 30%	(+)	(+)	(±)	(±)	(+)	(+)	(-)	(-)
V	<i>Myristica fragrans</i> 10 %	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)
VI	<i>Myristica fragrans</i> 20 %	(+)	(+)	(±)	(±)	(+)	(+)	(±)	(±)
VII	<i>Myristica fragrans</i> 30 %	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)
VIII	<i>Caryophilly aromatici</i> 30 %	(+)	(+)	(±)	(±)	(-) d=2 mm	(-) d=2 mm	(-)	(-)
IX	<i>Caryophilly aromatici</i> 10 %	(+)	(+)	(±)	(±)	(+)	(+)	(±)	(±)
X	<i>Zingiber officinale</i> 3,8	(+)	(+)	(±)	(±)	(+)	(+)	(+)	(+)
XI	<i>Camellia sinensis</i> 7,7 %	(+)	(+)	(±)	(±)	(+)	(+)	(±)	(±)
XII	<i>Aspalathus linearis</i>	(+)	(+)	(+)	(+)	(+)	(+)	(+)	(+)

## DISCO-DIFFUSION METHOD FOR STUDYING GROWTH SUPPRESSION *STREPTOCOCCUS PNEUMONIAE* AND *HAEMOPHILUS INFLUENZAE* (DISC CONTAINING VEGETABLE EXTRACTS)

It is tasty!



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# Portion packaging



# For honey packaging







**American astronaut Anna Lee Fisher  
at BSU in 2018:**

"Honey in edible packaging is what we lacked  
in space "



# Edible Tartlets





# Edible packaging for baking cupcakes



# Edible coating instead of sugar and wax



Conventional coatings



Edible coating





# Edible packaging for spices



# Edible packaging for instant noodles spices



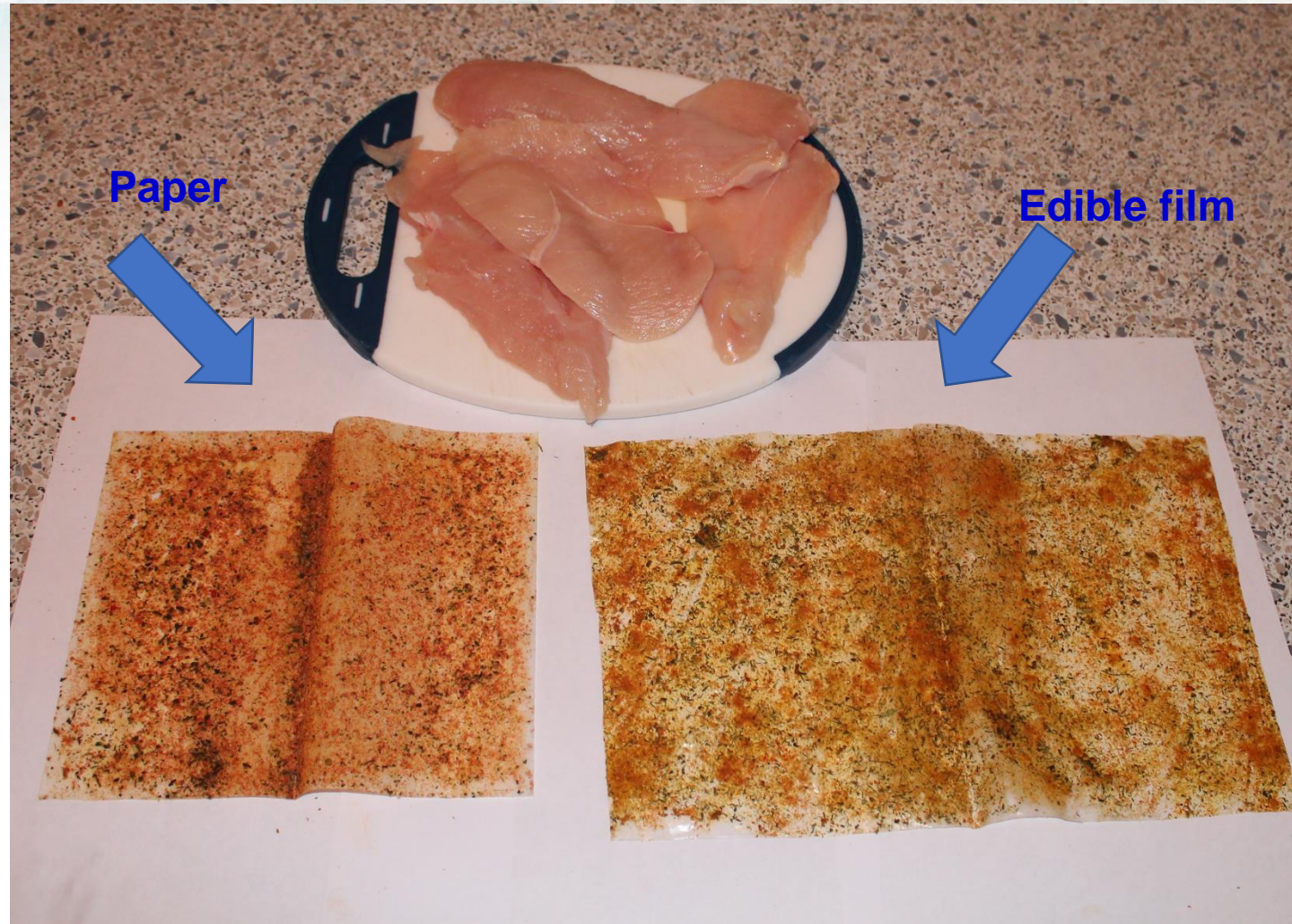


# They dissolve without changing noodle taste





# Edible film as an alternative to paper for frying





# Edible films for frying fish, poultry



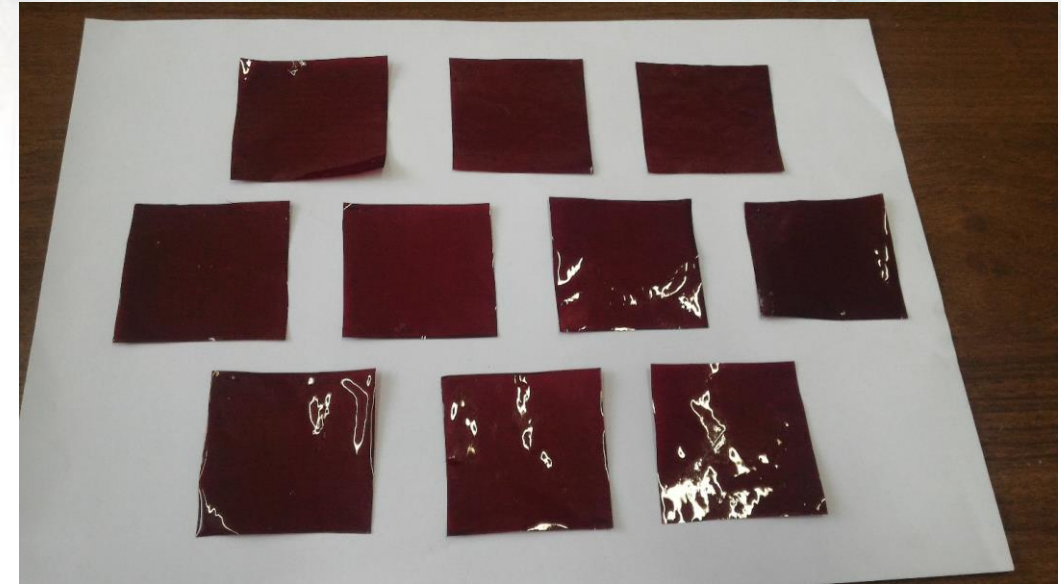
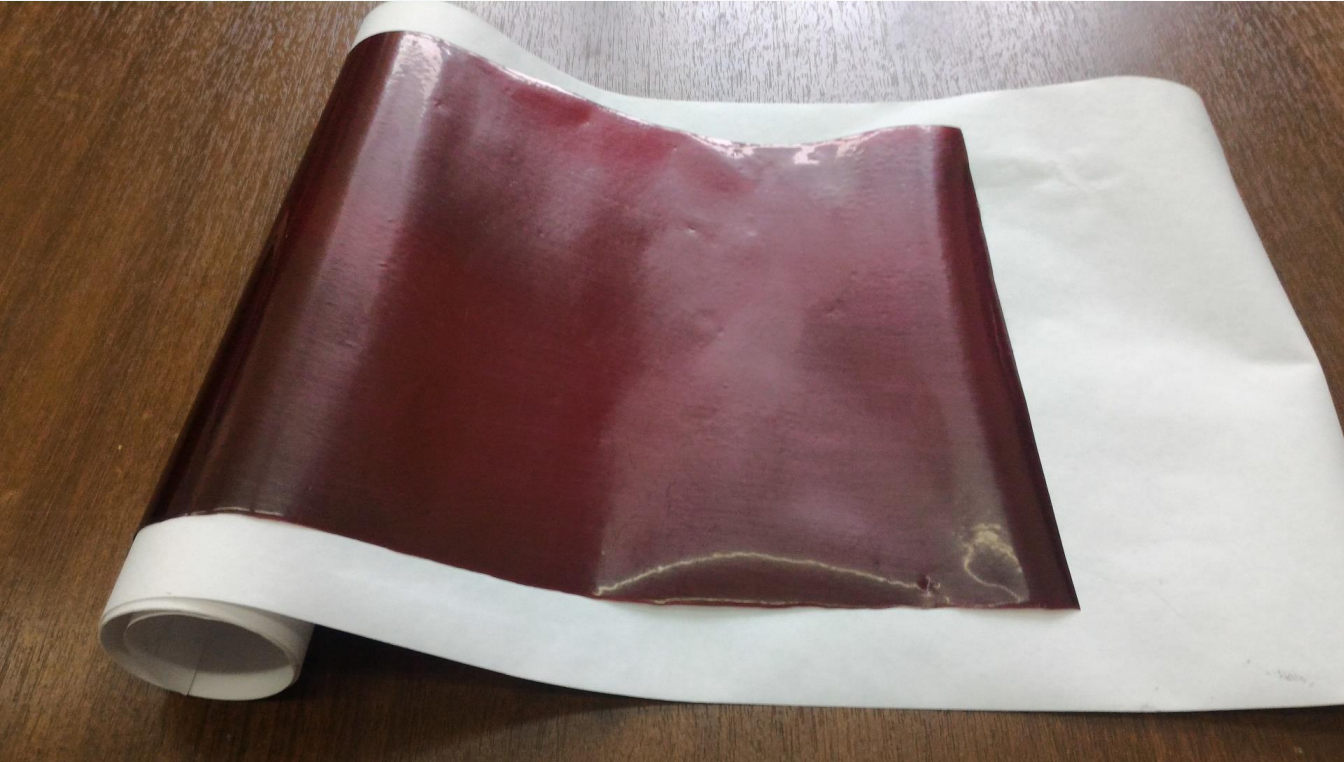


# Edible films for frying poultry





# Easter eggs coloring film



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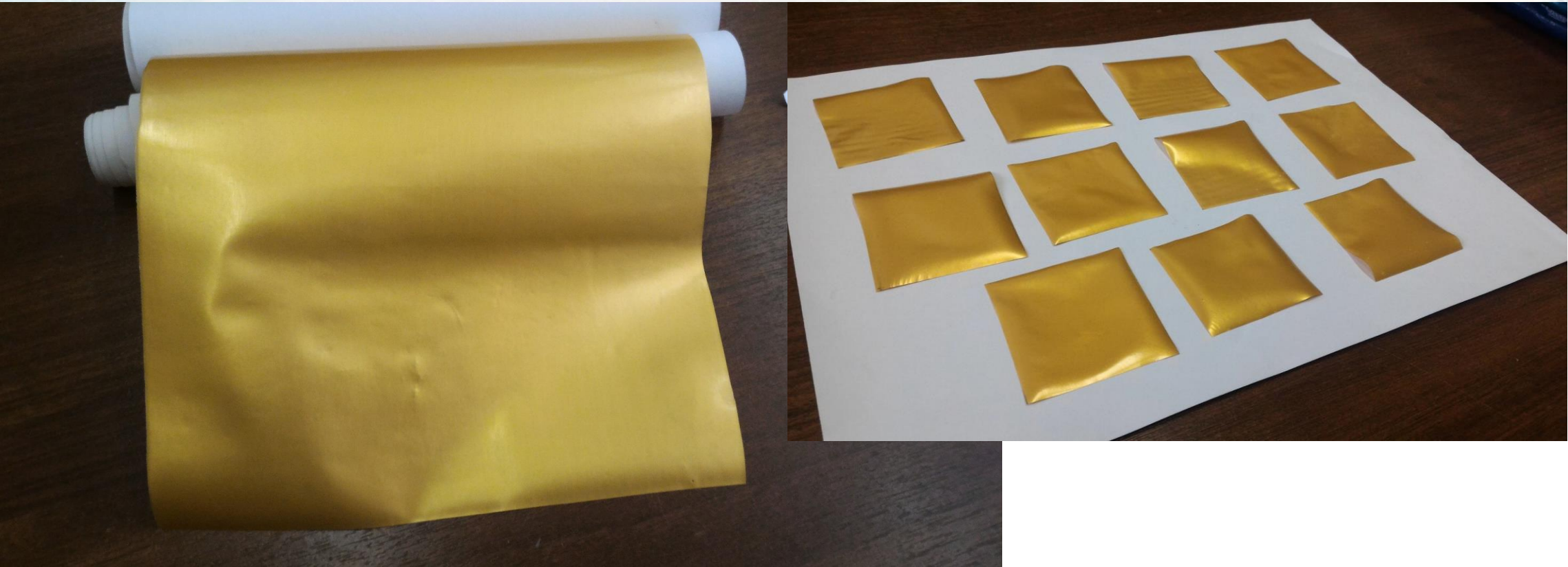


# Easter eggs coloring films

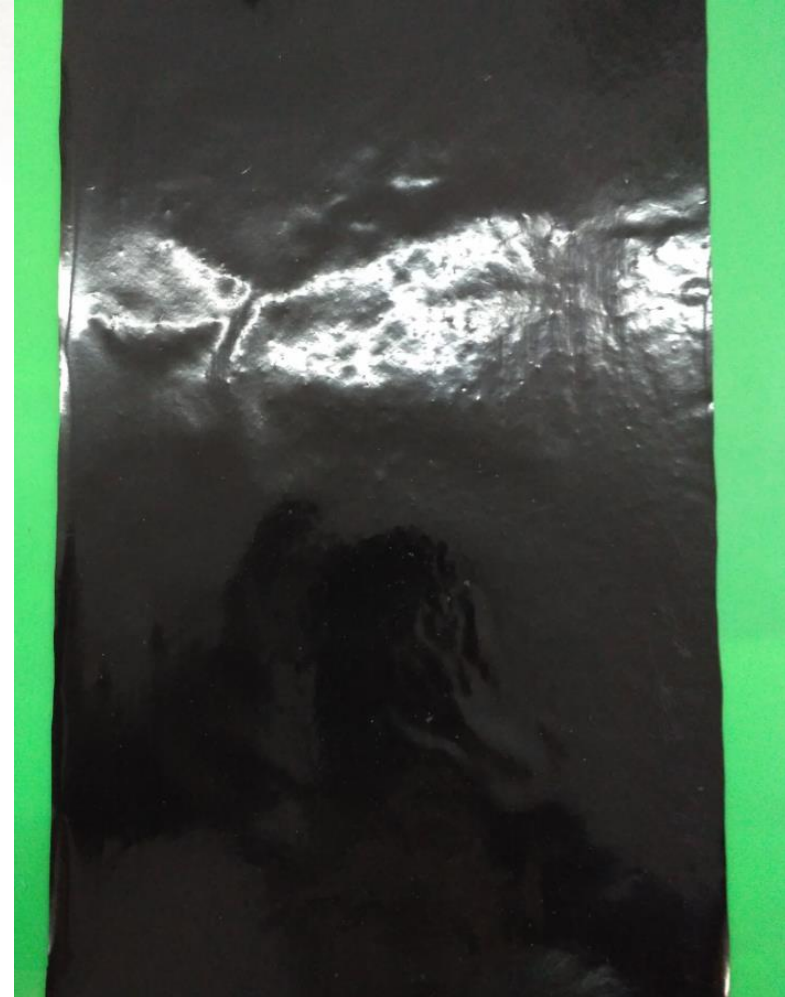




# Edible decoration films



# Unexpected additives





# Edible coating for inner packaging of butter



# Ideal pair

It is important to correctly combine products, these are alpha and omega of proper nutrition

Active ingredient in turmeric(curcumin) in the form of a spice has low bioavailability and is absorbed only by 5-10%



Chemical substance piperine -main active ingredient, contained in black pepper and enhancing the action of curcumin.



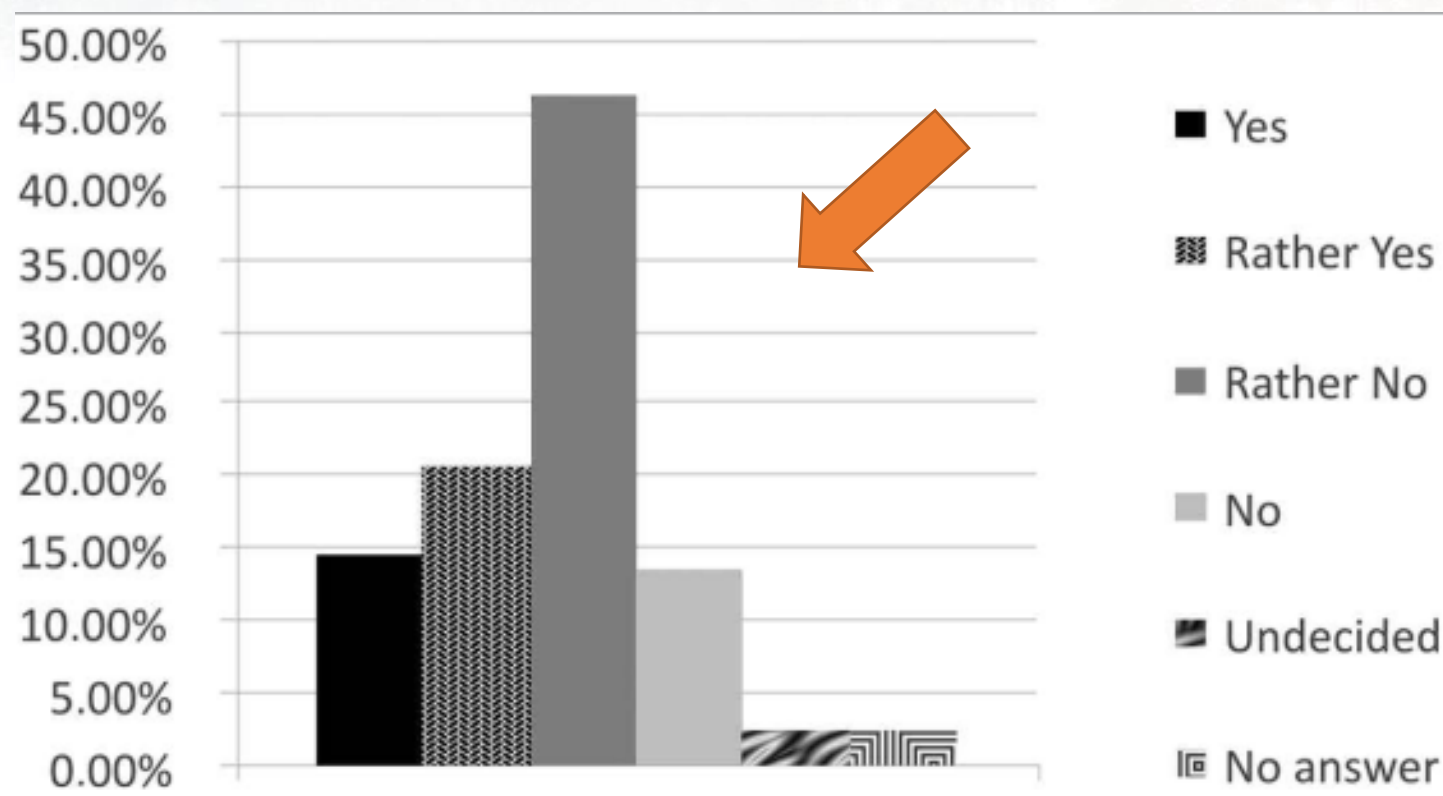
**There is turmeric introduced into the film and packing pepper =**

UNIQUE PRODUCT with ANTI-CANCER EFFECT



# Before thanking you for your attention

## Are consumers ready?

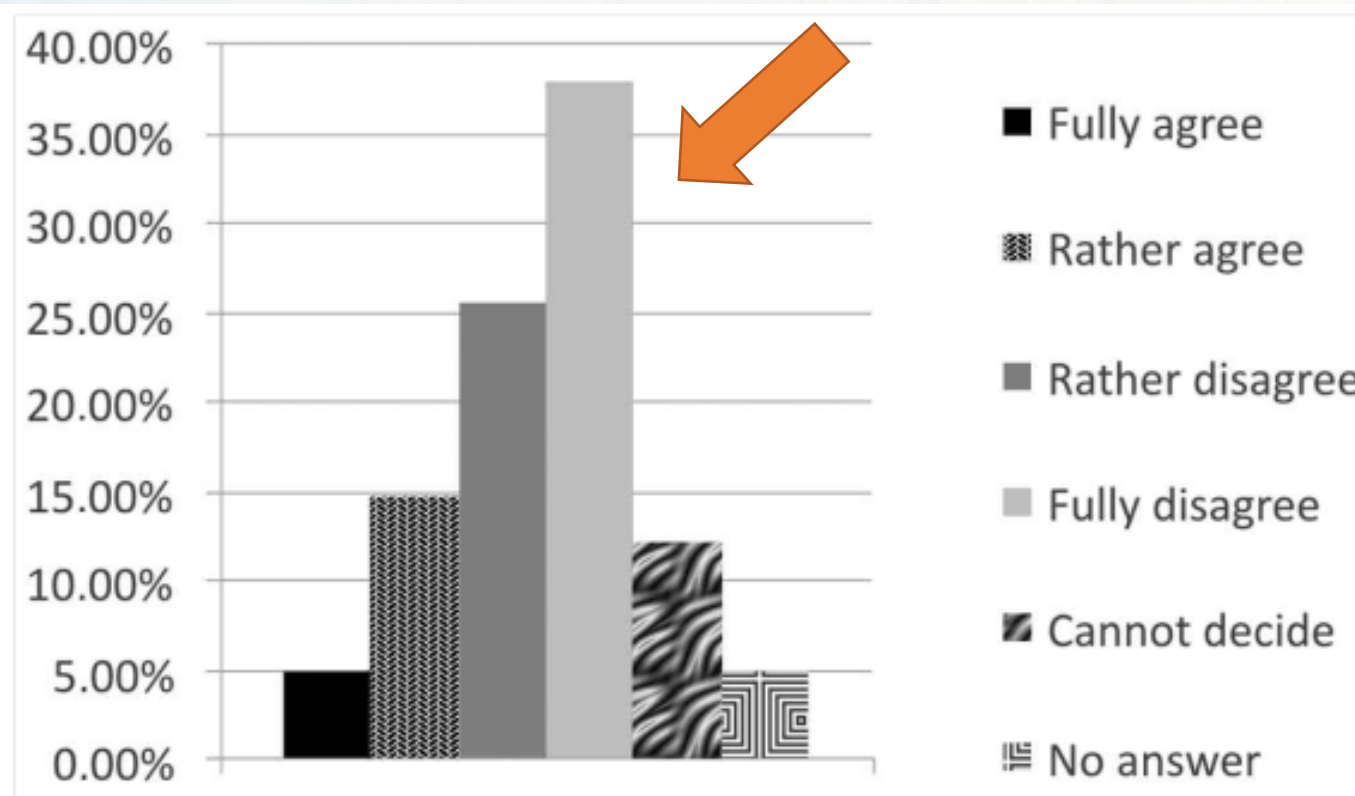


Are you familiar with the nature of edible coatings?

S.Pashova et al. Edible coating in Food Industry Related to Circular Economy/ Quality: Access to success, vol.19, number 166/October 2018.

*University of Economics – Varna, Bulgaria*

# Are consumers ready?



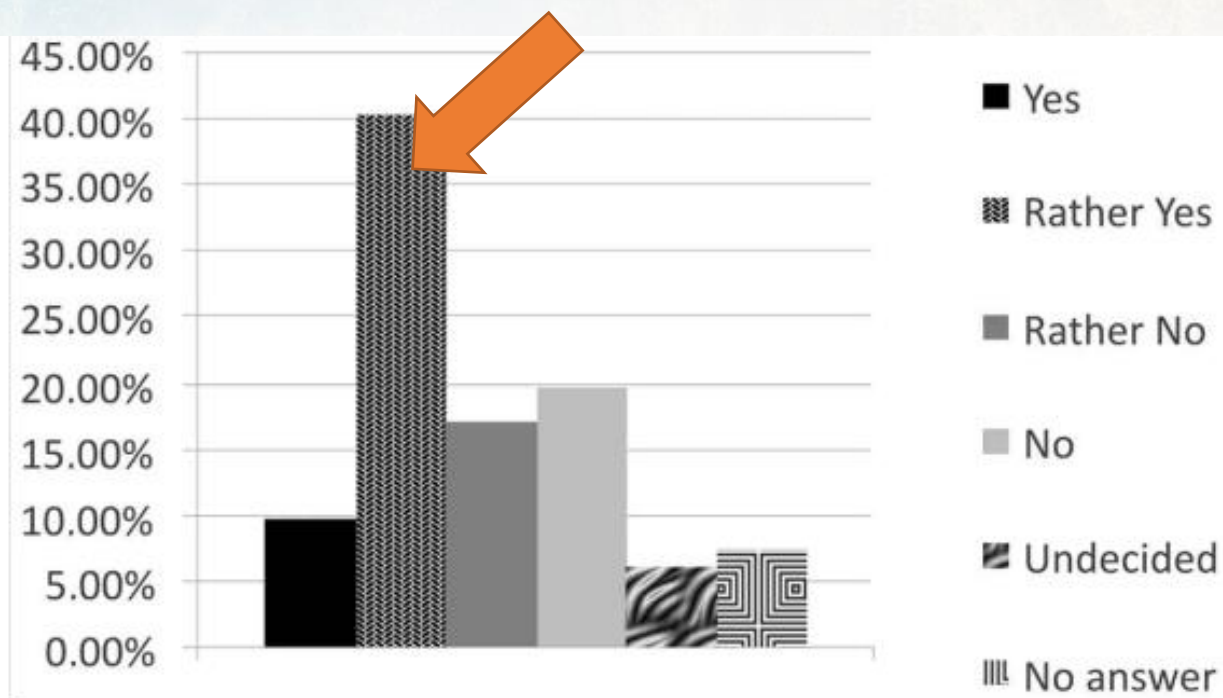
Agreement with the statement  
"I would rather consume foods with edible coatings"

S.Pashova et al. Edible coating in Food Industry Related to Circular Economy/ Quality: Access to success, vol.19, number 166/October 2018.

*University of Economics – Varna, Bulgaria*



# How to attract consumers?



Influence of the fact "the producer of foodstuffs with edible coatings generates a negligible amount of waste or collects its industrial waste separately" on consumer choice



**Thank you for your attention!**



**The Green Chemistry message is simple:  
Seek prevention, not cure!**