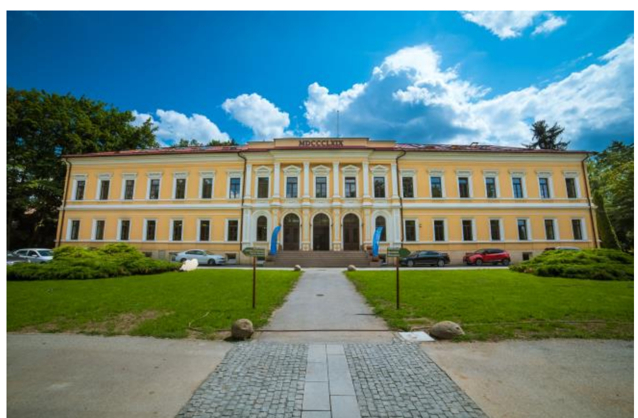
Department of Food Science,
Faculty of Food Science and Technology
University of Agricultural Sciences and Veterinary Medicine
Cluj-Napoca, Romania

Molecular Gastronomy: Food for Tomorrow

Prof. Dan C. Vodnar


Fermentative bioconversion

- obtaining added-value compounds from industrial by-products (e.g. bio-vanillin, omega-3; succinic acid; citric acid; lactic acid; polyols;
- optimization of fermentation processes for the cultivation of probiotic bacteria

Psyhobiotics - Microencapsulation

Specific probiotic bacteria

- selection, cultivation and production of probiotic bacteria in the form of food supplements
- application of microencapsulation technologies
- the specific use of probiotic bacteria in neurological diseases

Antimicrobial, antimutagenic activity of plant extracts

determination of the antimicrobial and antimutagenic activity of natural plant extracts and inorganic compounds

Molecular Gastronomy

Introduction in Molecular Gastronomy

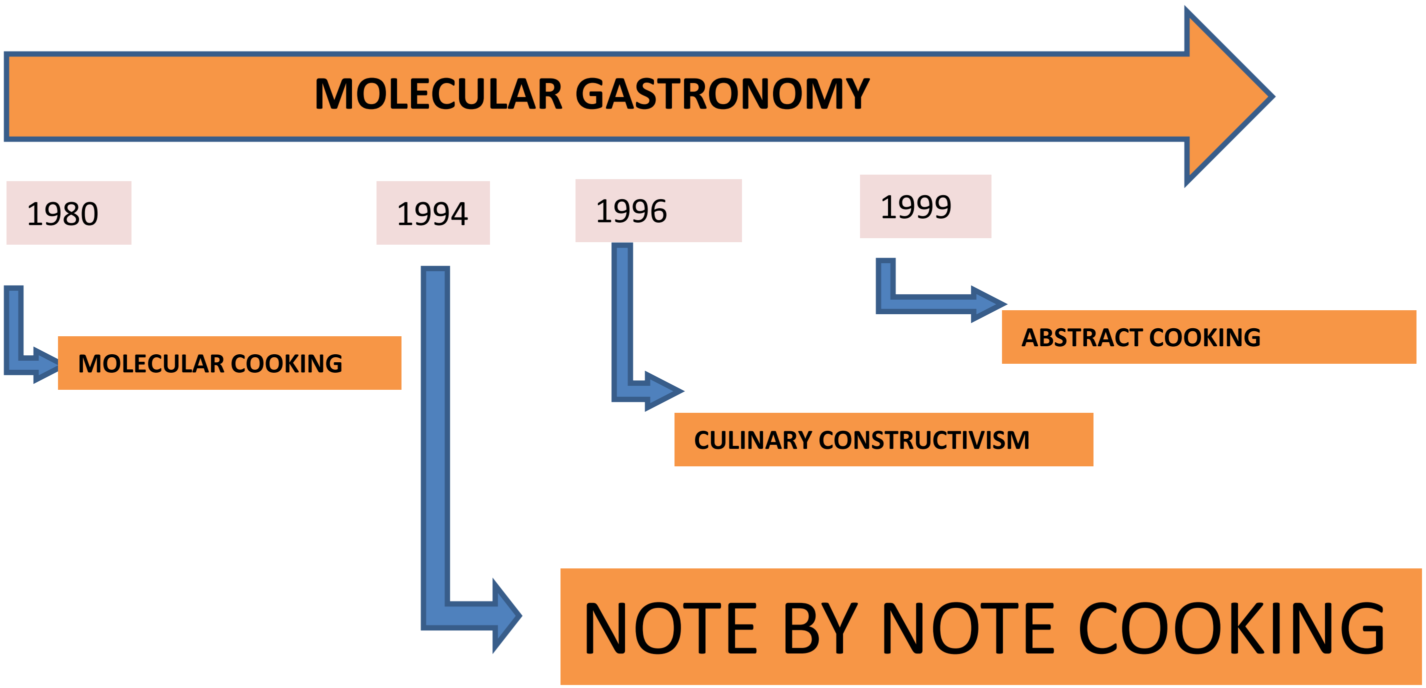
❖ Molecular Gastronomy

- Avant-garde approach
- Physics
- Chemistry
- Culinary Art
- Changing the structure and texture of the food
- Social and artistic impact

❖ Food for Tomorrow

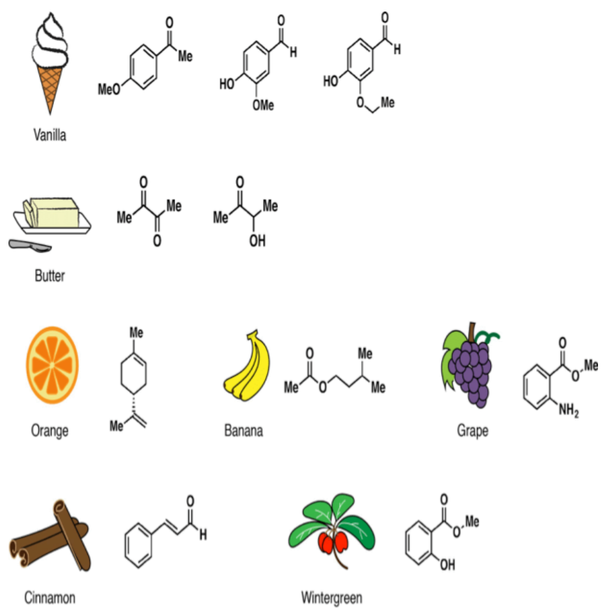
food for TOMORROW

Concept evolution



Note by Note cooking

Note by Note cooking-" a painter who uses primary colors or a musician who composes electro-acoustic music, sound with sound, using a computer"- Hervé This



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Cluj-Napoca, Romania

Production of Valuable Organic Chemicals

Dan C. Vodnar[1]
Joachim Venus[2]
Roland Schneider[2]
Carmen Socaciu[1]

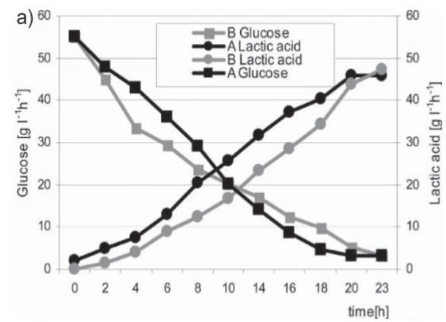
[1] Department of Biochemistry and Biotechnology, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Romania.

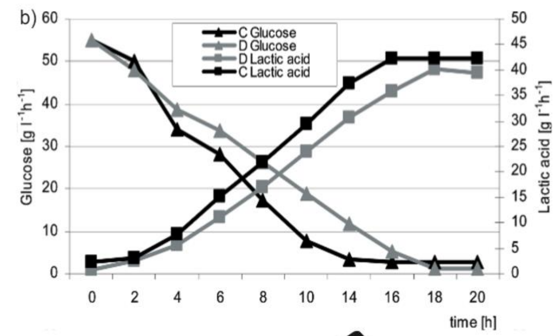
[2] Department of Bioengineering, Leibniz-Institute for Agricultural Engineering Potsdam-Bornim e. V.,

Research Article

Lactic Acid Production by *Lactobacillus paracasei* 168 in Discontinuous Fermentation Using Lucerne Green Juice as Nutrient Substitute

The aim of this study was the utilization of lucerne green juice (LGJ), obtained in 2005 and 2008, as nutrient substitute in lactic acid fermentation using *Lactobacillus paracasei* 168, in a discontinuous fermentation process with the addition of 55 g/L glucose and 15 g/L yeast extract. The LGJ after pressing fresh green mass





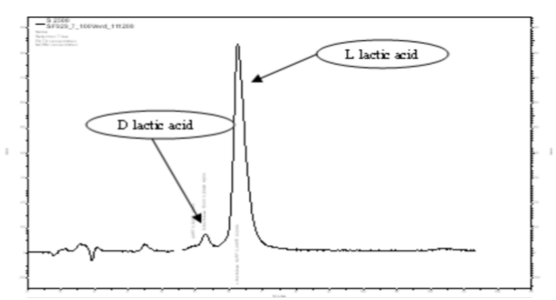


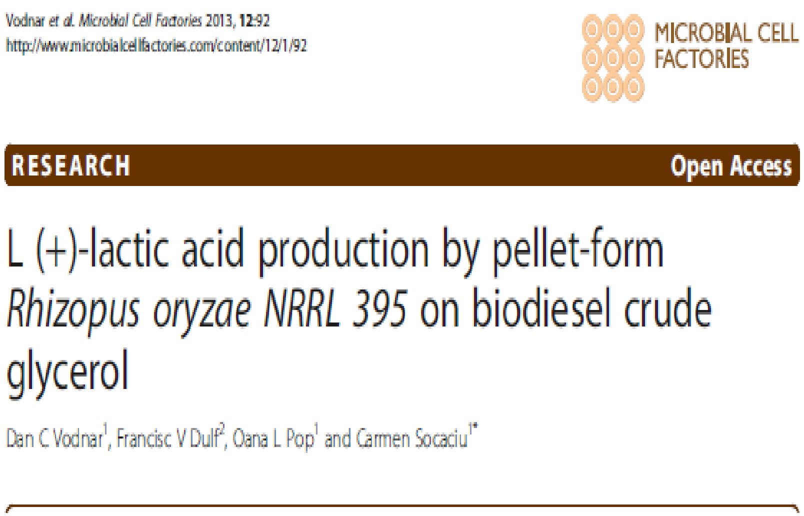
Figure 4. HPLC (Knauer) chromatogram to identify the optical isomers, *L*-(+) and *D*-(–), of lactic acid during the process. *L*-(+)-Lactic acid: t_R = 6.25 min; *D*-(–)-lactic acid: t_R = 5.3 min.

Table 4. Quantity of *L*-(+)- and *D*-(–)-lactic acid in all trials.

Trial	*L*-(+)-Lactic acid		*D*-(–)-Lactic acid	
	[g/L]	[%]	[g/L]	[%]
A	42.07	91.520	3.9	8.480
B	46.09	97.605	1.13	2.395
C	38.12	90.189	4.14	9.811
D	43.48	91.873	3.84	8.127
Control medium	41.56	98.987	0.42	1.013

Production of Valuable Organic Chemicals

L (+) lactic acid production on biodiesel crude glycerol



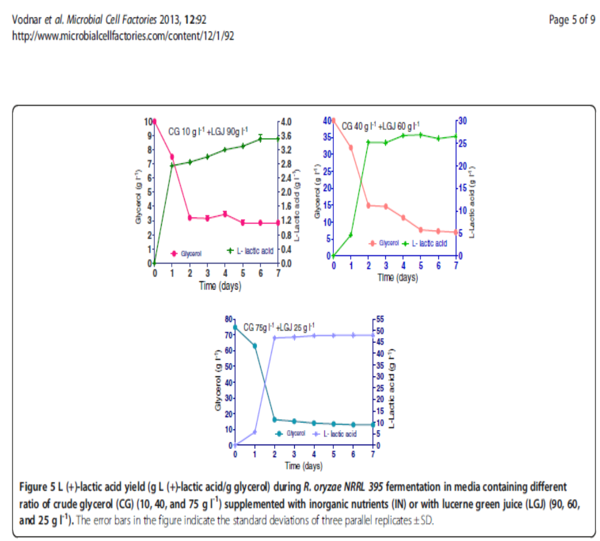
Vodnar et al. Microbial Cell Factories 2013, 12:92
http://www.microbialcellfactories.com/content/12/1/92

MICROBIAL CELL FACTORIES

RESEARCH Open Access

L (+)-lactic acid production by pellet-form *Rhizopus oryzae NRRL 395* on biodiesel crude glycerol

Dan C Vodnar[1], Francisc V Dulf[2], Oana L Pop[1] and Carmen Socaciu[1*]



Vodnar et al. Microbial Cell Factories 2013, 12:92
http://www.microbialcellfactories.com/content/12/1/92

Page 5 of 9

Figure 5 L (+)-lactic acid yield (g L (+)-lactic acid/g glycerol) during *R. oryzae NRRL 395* fermentation in media containing different ratio of crude glycerol (CG) (10, 40, and 75 g l^{-1}) supplemented with inorganic nutrients (IN) or with lucerne green juice (LGJ) (90, 60, and 25 g l^{-1}). The error bars in the figure indicate the standard deviations of three parallel replicates ± SD.

↑ C % Crude Glycerol

↓

↑ Lactic acid → Polylactic acid (PLA) → Antimicrobial Biofilm

Production of Valuable Organic Chemicals

2. Utilization of biodiesel derived-glycerol for 1,3 –Propandiol, Citric acid and Beta-carotene production

Mitrea et al. Microb Cell Fact (2017) 16:190
DOI 10.1186/s12934-017-0807-5

Microbial Cell Factories

REVIEW Open Access

Utilization of biodiesel derived-glycerol for 1,3-PD and citric acid production

Laura Mitrea[1], Monica Trif[1], Adriana-Florinela Cătoi[2] and Dan-Cristian Vodnar[1*]

REVIEW ARTICLES

Isolated Microorganisms for Bioconversion of Biodiesel-Derived Glycerol Into 1,3-Propanediol

Laura MITREA[1], Lavinia-Florina CĂLINOIU[1], Gabriela PRECUP[1], Maria BINDEA[1], Bogdan RUSU[1], Monica TRIF[1], Bianca-Eugenia ŞTEFĂNESCU[1,2], Ioana-Delia POP[1,3], Dan-Cristian VODNAR[1*]

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Bulletin UASVM Food Science and Technology 74(2)/2017
ISSN-L 2344-2344; Print ISSN 2344-2344; Electronic ISSN 2344-5300
DOI: 10.15835/buasvmcn-fst: 0014

Production of Valuable Organic Chemicals

Bindea *et al. Microb Cell Fact (2018) 17:97*
https://doi.org/10.1186/s12934-018-0945-4

Microbial Cell Factories

REVIEW — Open Access

Valorification of crude glycerol for pure fractions of docosahexaenoic acid and β-carotene production by using *Schizochytrium limacinum* and *Blakeslea trispora*

Maria Bindea[1], Bogdan Rusu[1], Alexandru Rusu[2], Monica Trif[1], Loredana Florina Leopold[1], Francisc Dulf[1*] and Dan Cristian Vodnar[1*]

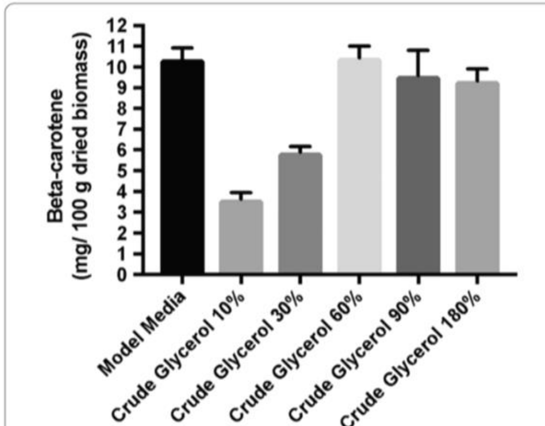

Fig. 7 β-Carotene production during fermentation processes on media containing crude glycerol

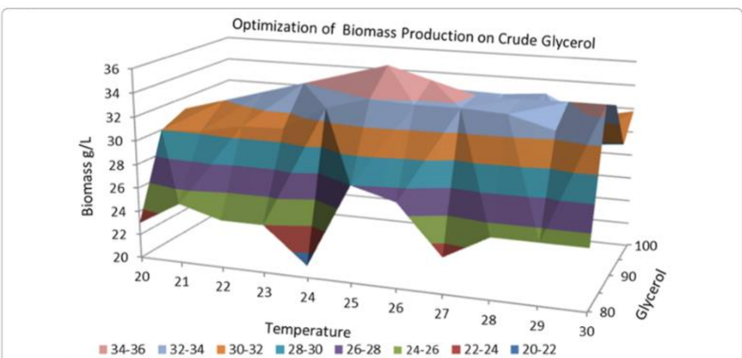

Fig. 10 Optimization of biomass production by *S. limacinum* on crude glycerol media

Table 2 Percental assessment of β-carotene and lutein purification by TLC and SPE

Carotenoids	Total β-carotene of TLC fraction (%)	*Cis* isomers % of TLC fraction (%)	Total lutein after SPE separation (%)	*Cis* isomers % of SPE fraction (%)
β-Carotene	99.9	38.83	99.9	31.53
Lutein	93.7	45.9	90	31

Production of Valuable Organic Chemicals

Bioreactor
fermentation of glycerol
by microorganisms
(Blakeslea trispora)

Sweet Burger

Production of Valuable Organic Chemicals

4. Identification of bioactive compounds from agro-industrial by-products

Food Chemistry 231 (2017) 131–140

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Identification of the bioactive compounds and antioxidant, antimutagenic and antimicrobial activities of thermally processed agro-industrial waste

Dan Cristian Vodnar[a,b,*], Lavinia Florina Călinoiu[a,b], Francisc Vasile Dulf[c,*], Bianca Eugenia Ştefănescu[b,d], Gianina Crişan[d], Carmen Socaciu[a,b]

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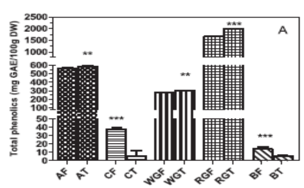
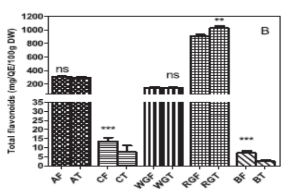
[b] Institute of Life Sciences, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Calea Mănăştur 3-5, 400372 Cluj-Napoca, Romania

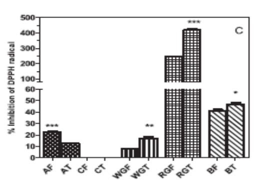
D.C. Vodnar et al. / Food Chemistry 231 (2017) 131–140



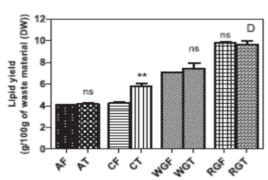
Total phenolic content of extracts via Folin–Ciocalteu method



Total flavonoids content of extracts



Antioxidant activity of the extracts



Total lipid content of the extracts

Table 1
Identification of the phenolic compounds (mg/100 g DW) in the extracts via HPLC-DAD-ESI-MS method.

Phenolic compounds	$[M+H]^+$ ion fragments	Samples (mg/%DW)									
		AF	AT	CF	CT	WGF	WGT	RGF	RGT	BF	BT
Anthocyanins	Petunidin 3-O-(6′-p-coumaroyl)-glucoside)	625, 317							2.454^a	2.356^b	
	Malvidin 3-O-(6′-p-coumaroyl)-glucoside	639, 331							7.358^b	8.365^a	
	Cyanidin 3-O-arabinoside	419, 287							7.745^b	7.625^a	
	Peonidin 3-O-glucoside	463, 301							2.984^a	1.892^b	
	Malvidin 3-O-glucoside	493, 331							13.015^b	13.958^a	
Cinnamic acid	Caffeic acid	181, 163					2.138^b	2.56^a			
	Caffeic acid-4-O-glucoside	343, 181,163	2.492^b	3.165^a							
	5-Caffeoylquinic acid	355, 181, 163			14.146^a	4.265^b					
	3-Caffeoylquinic acid	355, 181,163	1.27^b	2.65^a							
	3,4-Dicaffeoylquinic acid	515, 355			2.457^a	0.263^b					
Dihydrochalcones	Phloridzin (Phloretin 2′-O-glucoside)	437, 275	5.714^a	4.652^b							
	Phloretin 2′-O-xylosyl-glucoside	569, 437, 275	1.125^a	0.958^b							
Flavan-3-ols	Epicatechin	291					2.368^a	2.261^b			
	Catechin 3-O-glucose	453, 291					2.262^a	2.265^a			
Flavonol	Rutin (Quercetin 3-O-rutinoside)	611, 303	4.318^a	4.316^a							
	Quercitrin (Quercetin 3-O-rhamnoside)	449, 303	2.12^b	2.46^a							
	Quercetin 3,4′-O-diglucoside	627, 465,303	0.903^b	1.362^a							
Betacyanins											
Betanidin	Betanidin	389,345									
	Isobetanidin	389, 345									
	Betanidin-5-O-β-glucoside	551, 389									
	Isobetanidin-5-O-β-glucoside	551, 389									

Values (mean ± SD, n = 3) in the same row followed by different superscript letters (a, b) indicate signifi
samples of the same extract (Student's t-test – GraphPad Prism Version 5.0, Graph Pad Software Inc., Sa

Production of Valuable Organic Chemicals

4. Identification of bioactive compounds from agro-industrial by-products

Critical Reviews in Biotechnology ›
Volume 40, 2020 - Issue 5

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Review Articles

Recent advances in the biotechnological production of erythritol and mannitol

Gheorghe Adrian Martău, Vasile Coman & Dan Cristian Vodnar

Pages 608-622 | Received 10 May 2019, Accepted 27 Feb 2020, Published online: 16 Apr 2020

Download citation https://doi.org/10.1080/07388551.2020.1751057 Check for updates

ELSEVIER
Trends in Food Science & Technology
Volume 109, March 2021, Pages 579-592

Bio-vanillin: Towards a sustainable industrial production

Gheorghe Adrian Martău [a, 1], Lavinia-Florina Călinoiu [a, b, 1], Dan Cristian Vodnar [a, b]

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https://doi.org/10.1016/j.tifs.2021.01.059

Microencapsulation

5. Microencapsulated probiotic bacteria and their survival after exposure to gastric and intestinal juice

Dynamics of microcapsule density with probiotic bacteria under simulated gastric and intestinal juice

Morphology, FTIR fingerprint and survivability of encapsulated lactic bacteria *D. C. Vodnar* et al. 2349

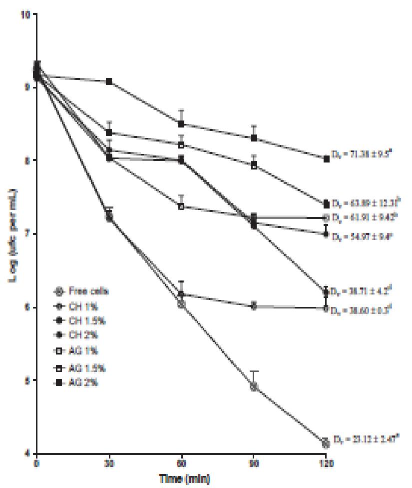


Figure 5 Dynamic of bacterial cell density (log cfu mL^{-1}) at different periods (after 30, 60, 90, 120 min) after incubation of beads containing bacteria cells (AG or CH at 2%, 1.5% or 1%) in simulated gastric juice (pH 1.5). Values are expressed as average ± standard error of triplicate ($n = 3$), comparatively with free cells. The decimal reduction time values (D_v – min) are represented for each variant. D_v values that are significantly different ($P < 0.05$) are marked by different letters.

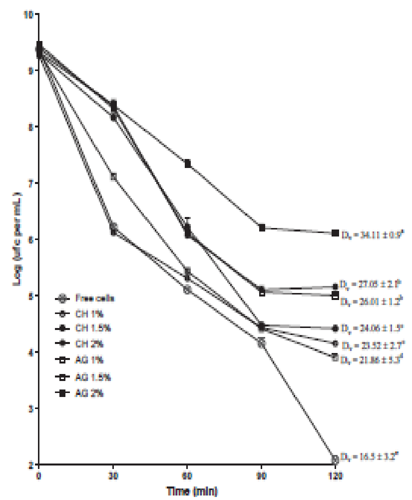


Figure 6 Dynamic of bacterial cell density (log cfu mL^{-1}) at different periods (30, 60, 90, 120 min) after successive incubation of beads containing bacteria cells (AG or CH at 2%, 1.5% or 1%) in simulated gastric juice (pH 1.5) for 60 min and in simulated intestinal juice at 37 °C, for 2 h. Values are expressed as average ± standard error of triplicate ($n = 3$), comparatively with free cells. The decimal reduction time values (D_v – min) are represented for each variant. D_v values that are significantly different ($P < 0.05$) are marked by different letters.

Microencapsulation

International Journal of Food Science & Technology

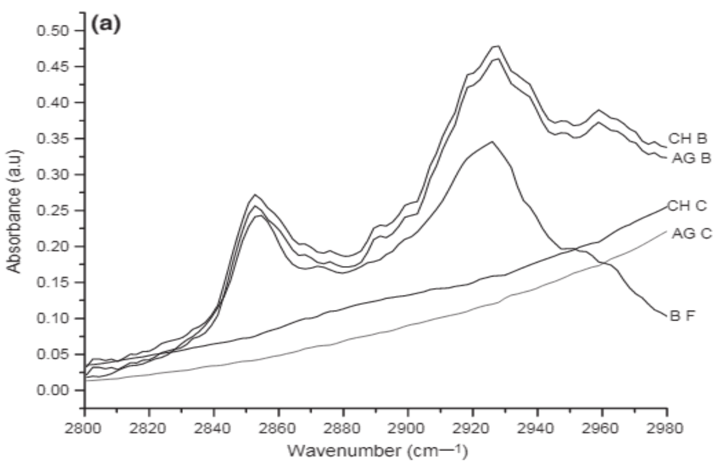
International Journal of Food Science and Technology 2010, **45**, 2345–2351

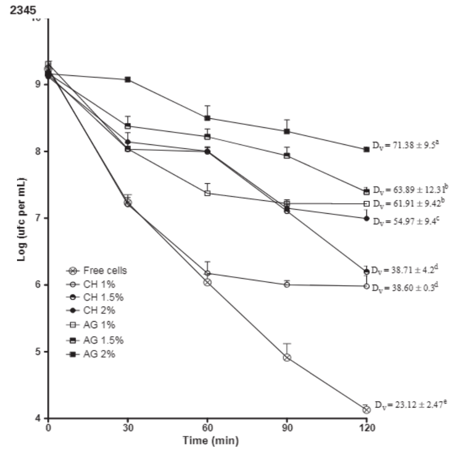
Original article

Morphology, FTIR fingerprint and survivability of encapsulated lactic bacteria (*Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*) in simulated gastric juice and intestinal juice

Dan C. Vodnar,[1,2]* Carmen Socaciu,[1] Ancuţa M. Rotar[2] & Andreea Stănilă[1]

1 Department of Chemistry and Biochemistry, University of Agricultural Sciences and Veterinary Medicine, Faculty of Agriculture, 3-5 Mănăştur str., 400372, Cluj-Napoca, România
2 Department of Food Microbiology, University of Agricultural Sciences and Veterinary Medicine, Faculty of Agriculture, 3-5 Mănăştur str., 400372, Cluj-Napoca, România





gure 5 Dynamic of bacterial cell density (log cfu mL^{-1}) at different riods (after 30, 60, 90, 120 min) after incubation of beads containing icteria cells (AG or CH at 2%, 1.5% or 1%) in simulated gastric juice H 1.5). Values are expressed as average ± standard error of iplicate (n = 3), comparatively with free cells. The decimal reduction ne values (D_v – min) are represented for each variant. D_v values that e significantly different (P < 0.05) are marked by different letters.

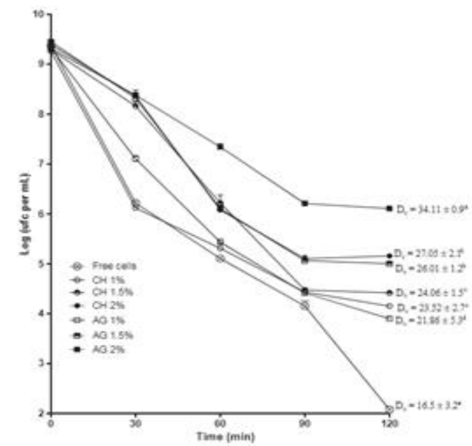


Figure 6 Dynamic of bacterial cell density (log cfu mL^{-1}) at different periods (30, 60, 90, 120 min) after successive incubation of beads containing bacteria cells (AG or CH at 2%, 1.5% or 1%) in simulated gastric juice (pH 1.5) for 60 min and in simulated intestinal juice at 37 °C, for 2 h. Values are expressed as average ± standard error of triplicate (n = 3), comparatively with free cells. The decimal reduction time values (D_v – min) are represented for each variant. D_v values that are significantly different (P < 0.05) are marked by different letters.

Microencapsulation

LWT - Food Science and Technology 57 (2014) 406–411

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LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Selenium enriched green tea increase stability of *Lactobacillus casei* and *Lactobacillus plantarum* in chitosan coated alginate microcapsules during exposure to simulated gastrointestinal and refrigerated conditions

CrossMark

Dan Cristian Vodnar*, Carmen Socaciu

Department of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine, Faculty of Food Science and Technology, 3-5 Mănăştur str., 400372 Cluj-Napoca, Romania

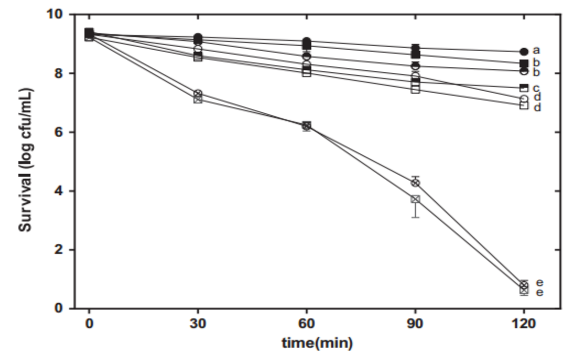

Fig. 2. Survival of free and encapsulated *L. plantarum* (P) and *L. casei* (C) with and without addition of selenium green tea during exposure to simulated gastric juice at 37 °C for 120min. The error bars indicate standard deviations from the mean values of three replicated experiments. Means ($n = 3$) ± SD. Means with different letter in a column are significantly different ($P < 0.05$). Symbols: Free *L. plantarum*, P, SGT1P, SGT2P, Free *L. casei*, C, SGT1C, SGT2C. For abbrevia-

RESEARCH ARTICLE | OPEN ACCESS

Green tea increases the survival yield of Bifidobacteria in simulated gastrointestinal environment and during refrigerated conditions

Dan C Vodnar and Carmen Socaciu

Chemistry Central Journal 2012 6:61 | DOI: 10.1186/1752-153X-6-61 | © Vodnar and Socaciu et al.; licensee BioMed Central Ltd. 2012

Received: 11 May 2012 | **Accepted:** 22 June 2012 | **Published:** 22 June 2012

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Chemistry Central Journal

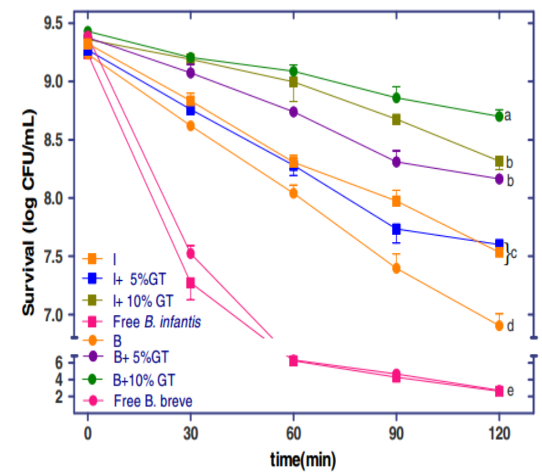
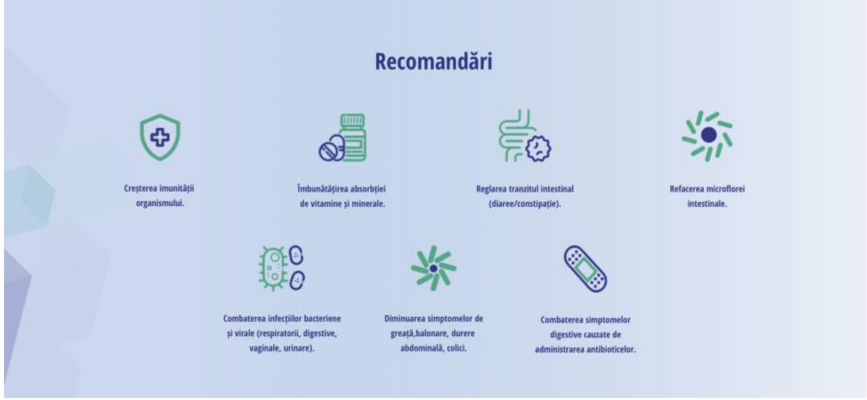


Figure 3 Survival of free and encapsulated *B. infantis* (I) and *B. breve* (B) with and without addition of 5% and 10% green tea (GT) during exposure to simulated gastric juice at 37°C for 120 min. The error bars indicate standard deviations from the mean values of three replicated experiments. Means with different letter in a column are significantly different (p < 0.05). For abbreviations see Table 4.

Prototypes


COLD PRESSED + NO WASTE + 1.000.000 PROBIOTIC BACTERIA
3 ÎN 1
302 ml e
BY-PRO GUT
MERE ȘI MORCOVI
BY-PRO GUT
STRUGURI NEGRI ȘI SFECLĂ

Prototypes


Recomandări
Creșterea imunității organismului.
Îmbunătățirea absorbției de vitamine și minerale.
Reglarea tranzitul intestinal (diaree/constipație).
Refacerea microflorei intestinale.
Combaterea infecțiilor bacteriene și virale (respiratorii, digestive, vaginale, urinare).
Diminuarea simptomelor de greață,balonare, durere abdominală, colici.
Combaterea simptomelor digestive cauzate de administrarea antibioticelor.


Suplimentul alimentar ECHIBIOTIC conține un complex activ format din șase tipuri de tulpini de probiotice special selecționate pentru refacerea microflorei intestinale. Pentru a intensifica efectul probioticelor la nivel intestinal ECHIBIOTIC - COMPLEX SIMBIOTIC este suplimentat cu fibre solubile din surse naturale (inulină). Inulina face parte din clasa fibrelor alimentare și are un rol funcțional în organism deoarece facilitează dezvoltarea bacteriilor probiotice la nivel intestinal.
ECHIBIOTIC
Complex simbiotic
Supliment alimentar
7 plicuri
Produs de Agronomia Agro Food Innovation SRL
Dezvoltat de USAMV Cluj-Napoca sub coordonarea Prof. dr. Dan C. Vodnar

Prototypes

Antimicrobial biofilm

Sweet Burger

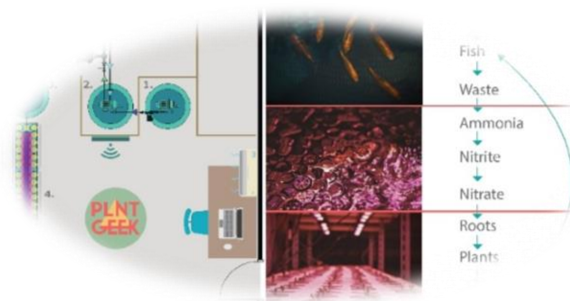
Caprese Salad

Aplications of Molecular Gastronomy made at USAMV CN

3D Printed food

Molecular Cocktaill

Edible Molecular Lipstick



PlantGeek

Department of Food Science,
Faculty of Food Science and Technology
University of Agricultural Sciences and Veterinary Medicine
Cluj-Napoca, Romania

Antimicrobial Biofilm

GOLD Medal at International Exhibition of Inventions GENEVA 2017

Patent No: 3/270/30.12.2016 . ANTIMICROBIAL BIOFILM, FORMULATION PROCEDURE AND UTILISATION. Authors: . **Vodnar Dan Cristian,** Carmen Socaciu

Project PN-II-IN-CI-2012-1-0372, **175 CI/2012**, Food safety and security management system applied in the development of bioactive packaging with antimicrobial effect, type biofilm. Funding: UEFISCDI

MINISTRY OF RESEARCHAND INNOVATION

BIOFILM WITH ANTIMICROBIAL ACTIVITY, FORMULATION PROCEDURE AND UTILISATION

Dan-Cristian VODNAR, Carmen SOCACIU
Patent No. 3/270 from 30.12.2016

Faculty of Food Science and Technology, University of Agricultural Sciences and Veterinary Medicine, Mănăștur 3-5 400372 Cluj-Napoca, Romania
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INTRODUCTION

The main objective of the invention relates to a bioactive form of packaging film, designed to reduce the microbial concentration from the "ready to eat" meat products, to a process of obtaining it, and its utilization during the refrigeration. The bioactive packaging film takes the form of a plastic pellicle that when it is applied to the surface of meat products does not change any of the sensory properties (taste, smell, color, consistency). It contains as a main ingredient 2% chitosan combined with aqueous extracts of green tea and basil.
The presented biofilm is based exclusively on nontoxic, biodegradable and biocompatible compounds, using aqueous extracts of the plants with antimicrobial activity.

RESULTS

Fig.1.Inhibitory effect of biofilms on the growth of *L.monocytogenes* during refrigeration

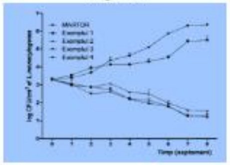

Fig.2.FTIR fingerprint of the biofilm formulation

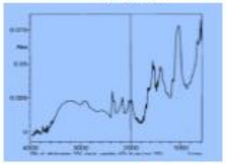

Fig.1 Edible Antimicrobial Biofilm Filled with Dehydrated and Candied Fruits

Fig.3.Chromatographic fingerprint specific for the green tea extract (4%) and basil (2%) used in biofilm formulation

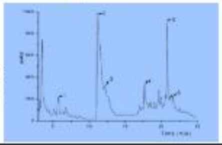

Fig.4.Biofilm on Ready-to-eat meat product

Fig.3.Molecular lipstick

APPLICABILITY

The antimicrobial biofilm is:
- used at the surface of "ready to eat" meat products for its antimicrobial characteristic. (Fig.4).
- used as an edible food packaging filled with different matrices. (Fig.1)
- applied at the surface of food products, for example " molecular lipstick" for antimicrobial action (Fig.2)
- biodegradable packaging;
- avoiding the use of chemically synthesized substances as antimicrobial additives.

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Vodnar Chemistry Central Journal 2012, 6:74
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RESEARCH ARTICLE

Chemistry Central Journal

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Inhibition of *Listeria monocytogenes* ATCC 19115 on ham steak by tea bioactive compounds incorporated into chitosan-coated plastic films

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Antimicrobial Efficiency of Edible Films in Food Industry

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Edible Biofilm

Vodnar *Chemistry Central Journal* 2012, **6**:74
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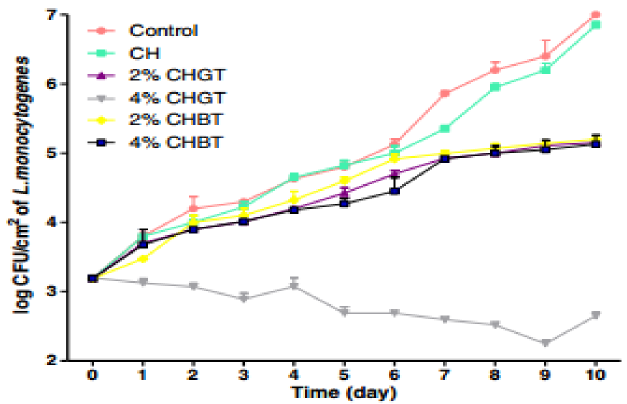

Figure 3 Effect of chitosan-coated plastic films (CH) incorporating 2%, 4% Green tea (CHGT) and 2%, 4% Black tea (CHBT) extracts on the growth of *L. monocytogenes* on ham steak at room temperature storage.

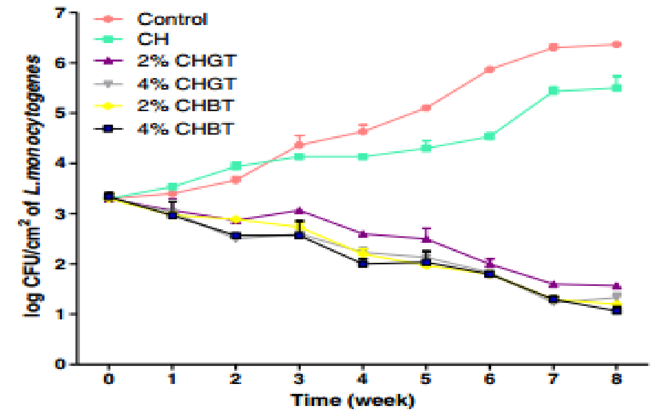

Figure 4 Effect of chitosan-coated plastic films (CH) incorporating 2%, 4% Green tea (CHGT) and 2%, 4% Black tea (CHBT) extracts on the growth of *L. monocytogenes* on ham steak stored at 4°C.

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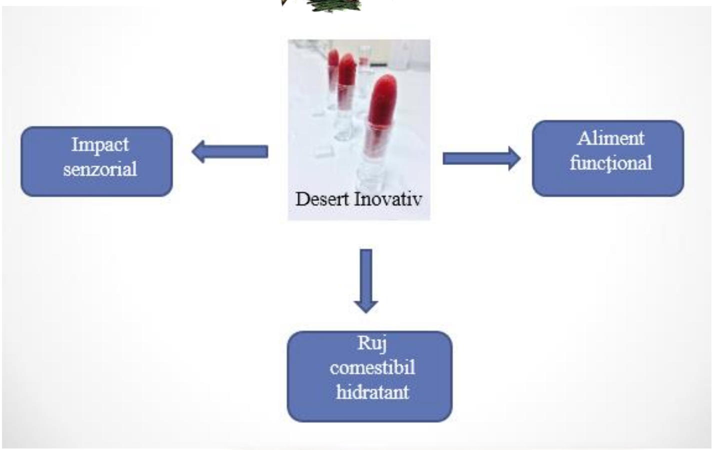
Aplications of Molecular Gastronomy

3D Printed Food – Bocusini Printer

Aplications

Edible Molecular Lipstick



MASSIVE SOCIAL IMPACT

Molecular Restructuring of CAPRESE Salad

Polydextrose → concentration 50 g / 100 ml
Egg white → microstructures → stable foam
→ oven 100 ° C / 2 h


Iota Carrageenan 0.5% concentration → hot dissolution → air incorporation → gel-foam structure


Siphon tube (N2O loading pressure) → Foam stabilization → **Microwave** 45 sec / 800W



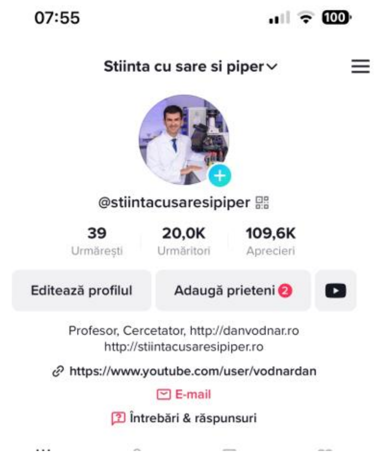
Calcium> 3% in **Alginate bath 0.5% for 3½ minutes** → **microspheres - capsules**
Methods of injection: in the alginate bath and above the alginate bath

Molecular Gastronomy –Education at USAMV

Prototypes

Molecular Gastronomy –Education

- **Science communication**
- **Educating the population**



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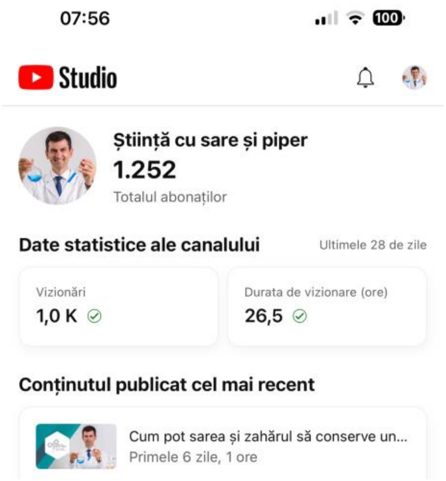

Instead of conclusions...
Thank you!