PROTEIN AND BIOMOLECULES SOURCES FOR NUTRITIONAL SECURITY AND BIODIVERSITY OF BAKERY PRODUCTS IN A CIRCULAR FOOD SYSTEM

Evolution beyond Innovation in Circular Food Systems

Rome, 22.05.2023

Innovative biotechnologies as a tool for improving sustainability of the agrifood chains

Carlo Giuseppe Rizzello

Sapienza University of Rome, Italy

carlogiuseppe.rizzello@uniroma1.it

Department of Environmental Biology, Sapienza University of Rome, Italy

Origin and fate of the agri-food side-streams

Discarded during supply chain, at any stage:

- Production
- Processing
- Distribution
- Retail
- Consumption

By-products, surplus, defective/unsold/expired products…

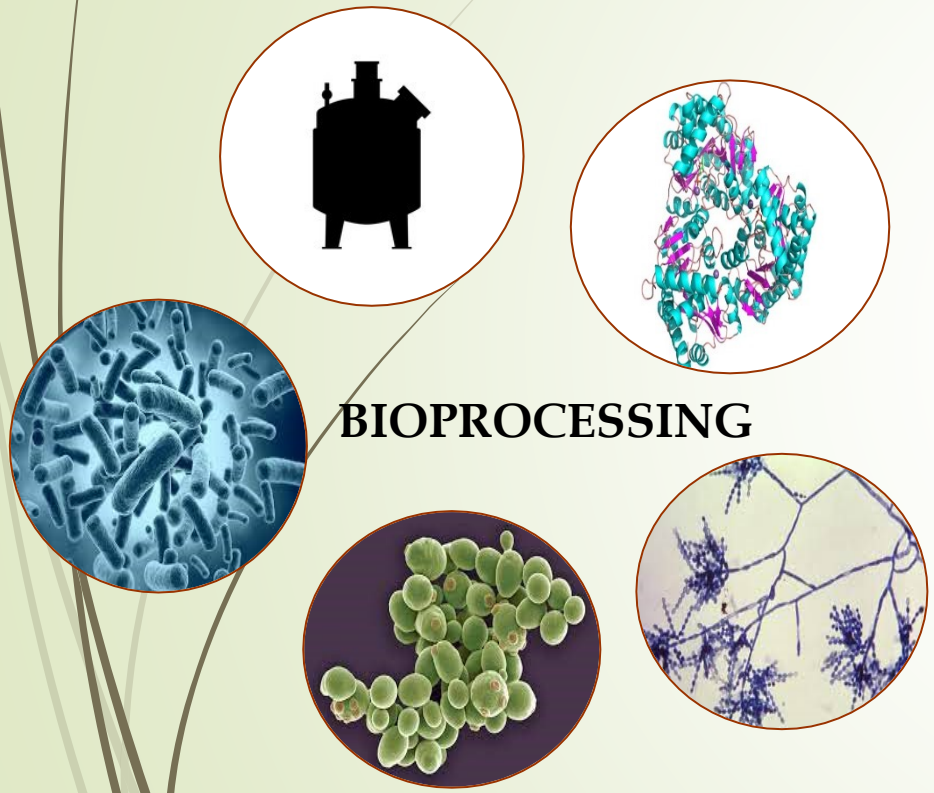
edible/not edible side-streams

compost – biogas/bioethanol - feed

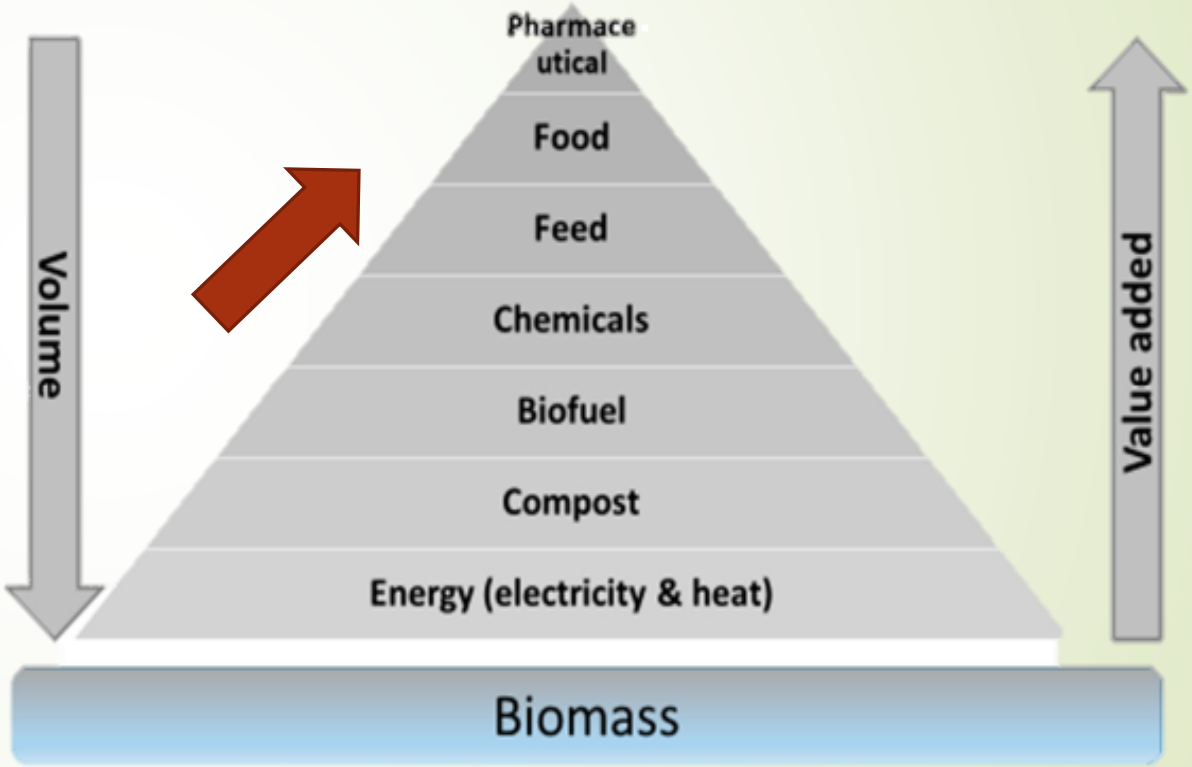
Agri-food side-streams UPCYCLING

very high organic load

economic loss



BIOPROCESSING



Department of Environmental Biology, Sapienza University of Rome, Italy

Recycling and valorisation through bioprocessing

a) use as substrate for microbial growth

microbial biomasses

- probiotics
- starters (fermented food)
- biocontrol/biopreservation

metabolites (biorefinery)

natural or recombinant microrganisms

- Bioplastics
- Biofungicides
- **Functional compounds**
  - **GABA**
  - **Bioactive peptides**
  - **Equol**
- Compounds for pharmaceutical and cosmetic uses

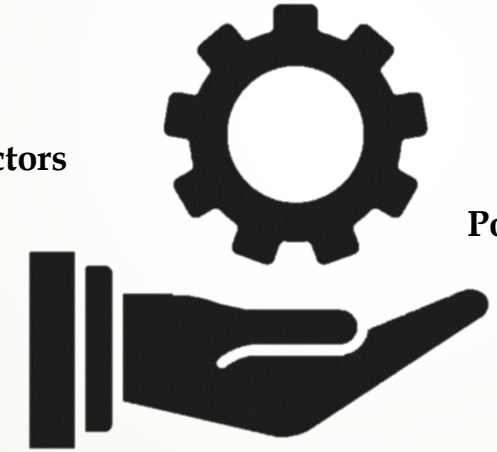
Recycling and valorisation through bioprocessing

b) food ingredients

Poor technological properties

Poor sensory properties

Antinutritional factors



Poor microbiological properties

Dietary fibers
Proteins
Phenolic and other functional compounds
Minerals

Upcycling side streams into food ingredients

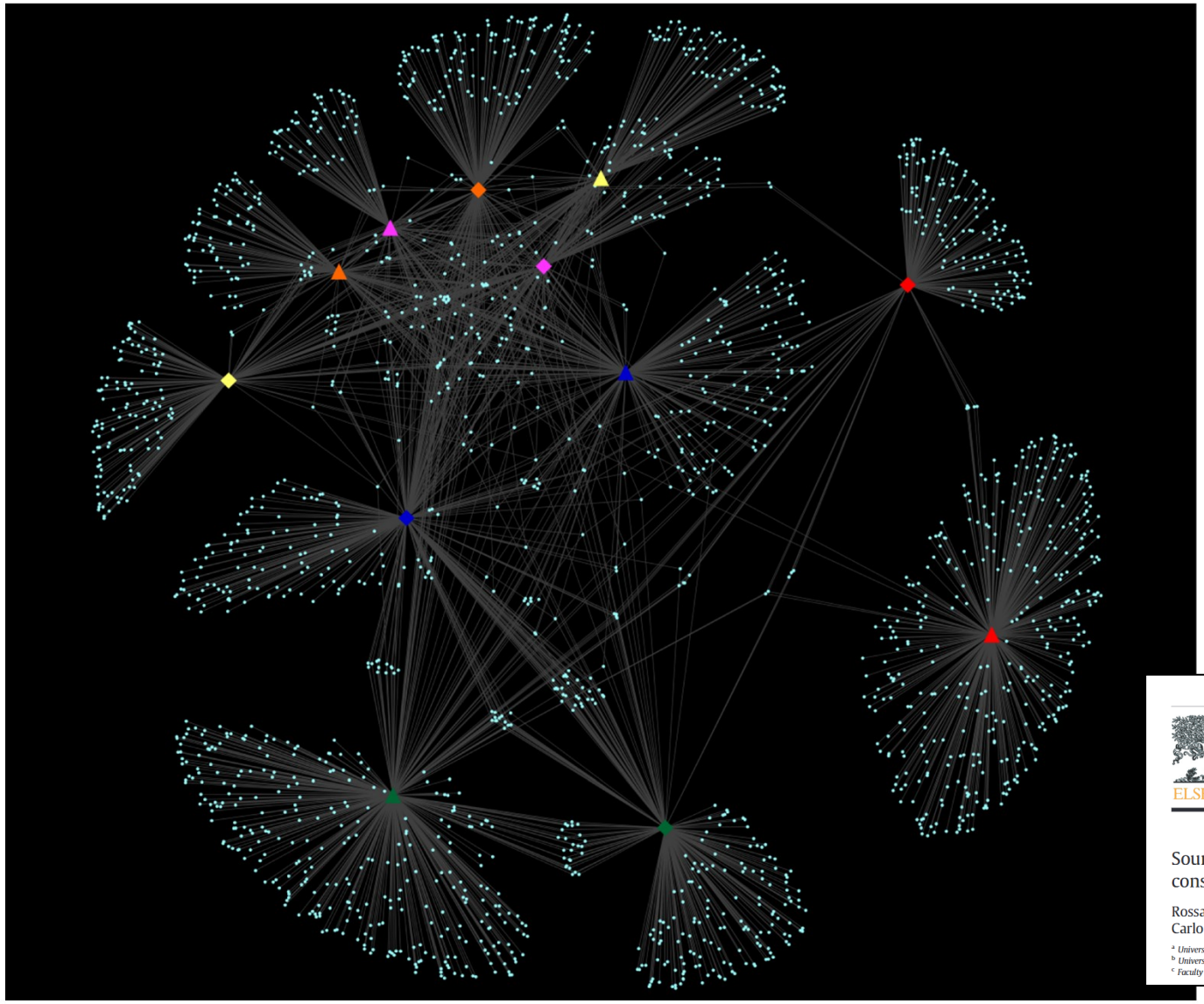
Development of the "strategy"

- *Control plan for the side-streams supply chain*
- *pre-process conditions (thermal treatments, wet milling)*
- **selection of starter microrganisms and enzymes**
- *set-up of the biotechnological protocol*
- *optimization of the process parameters*
- *stabilization conditions*

Agri-food side-streams

fruits and vegetables	*post-harvest losses, unsold, peels*
cereal industry	*surplus wasted bread* *milling by-products* *brewer's spent grain*
dairy sector	*whey* *ricotta cheese exhausted whey*
oenological sector	*grape pomace*

Simplified illustration of possible sourdough-microbe networks based on RNA data. Network diagrams are color- and symbol- coded by time of propagation and type of flour. Samples: Italian (square) and Finnish (triangle) faba bean doughs (prior to fermentation and before becoming sourdough) (Ita0 and Fi0, red colour); sourdoughs after 1 (Ita1 and Fi1, green colour), 2 (Ita2 and Fi2, blue colour), 5 (Ita5 and Fi5, pink colour), 7 (Ita7 and Fi7, orange colour) and 14 (Ita14 and Fi14, yellow colour) days of propagation.



International Journal of Food Microbiology 248 (2017) 10–21

Contents lists available at ScienceDirect

International Journal of Food Microbiology

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

Sourdough-type propagation of faba bean flour: Dynamics of microbial consortia and biochemical implications

Rossana Coda [a], Maryam Kianjam [a], Erica Pontonio [b], Michela Verni [b], Raffaella Di Cagno [c], Kati Katina [a], Carlo Giuseppe Rizzello [b,*], Marco Gobbetti [c]

[a] University of Helsinki, Department of Food and Environmental Sciences, Agnes Sjöbergingkatu 2, Helsinki, Finland
[b] University of Bari "Aldo Moro", Department of Soil, Plant, and Food Science, Via Amendola 165/a, 70125 Bari, Italy
[c] Faculty of Food Science and Technology, University of Bozen, 39100 Bolzano, Italy

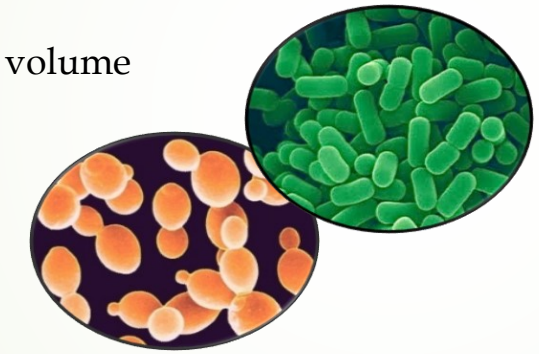
Lactic acid bacteria fermentation advantages

Nutritional

Decrease of the glycemic index, increase of the protein digestibility and mineral bioavailability

Technological

Improvement of the textural/structural features, volume and workability



Functional

Synthesis of bioactive compounds
Degradation of anti-nutritional compounds

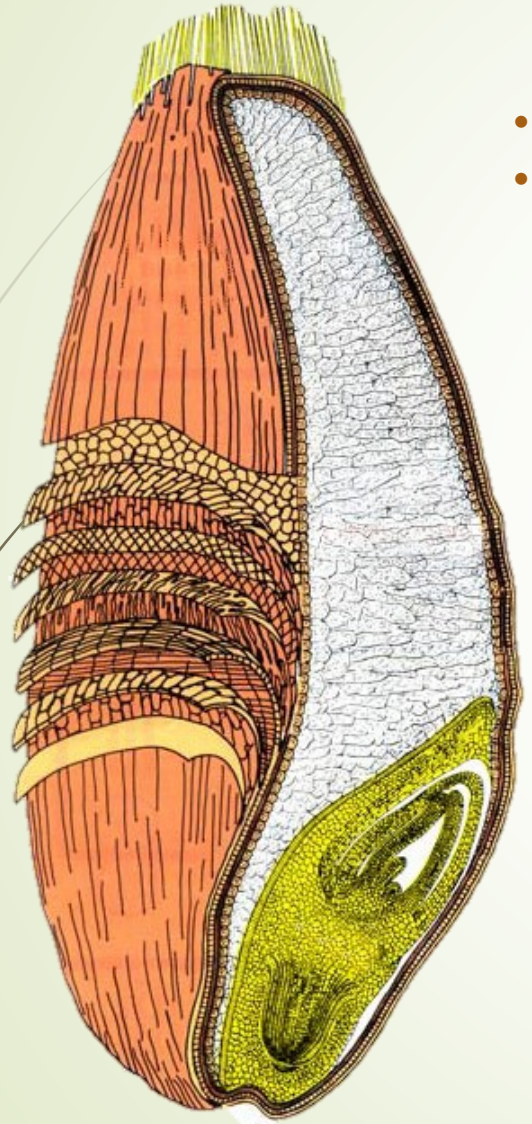
Sensory

Intensity and complexity of flavour and taste

Shelf-life

Inhibition of spore-forming bacteria and molds; decrease of the staling rate

Milling by-products - *Wheat bran-*



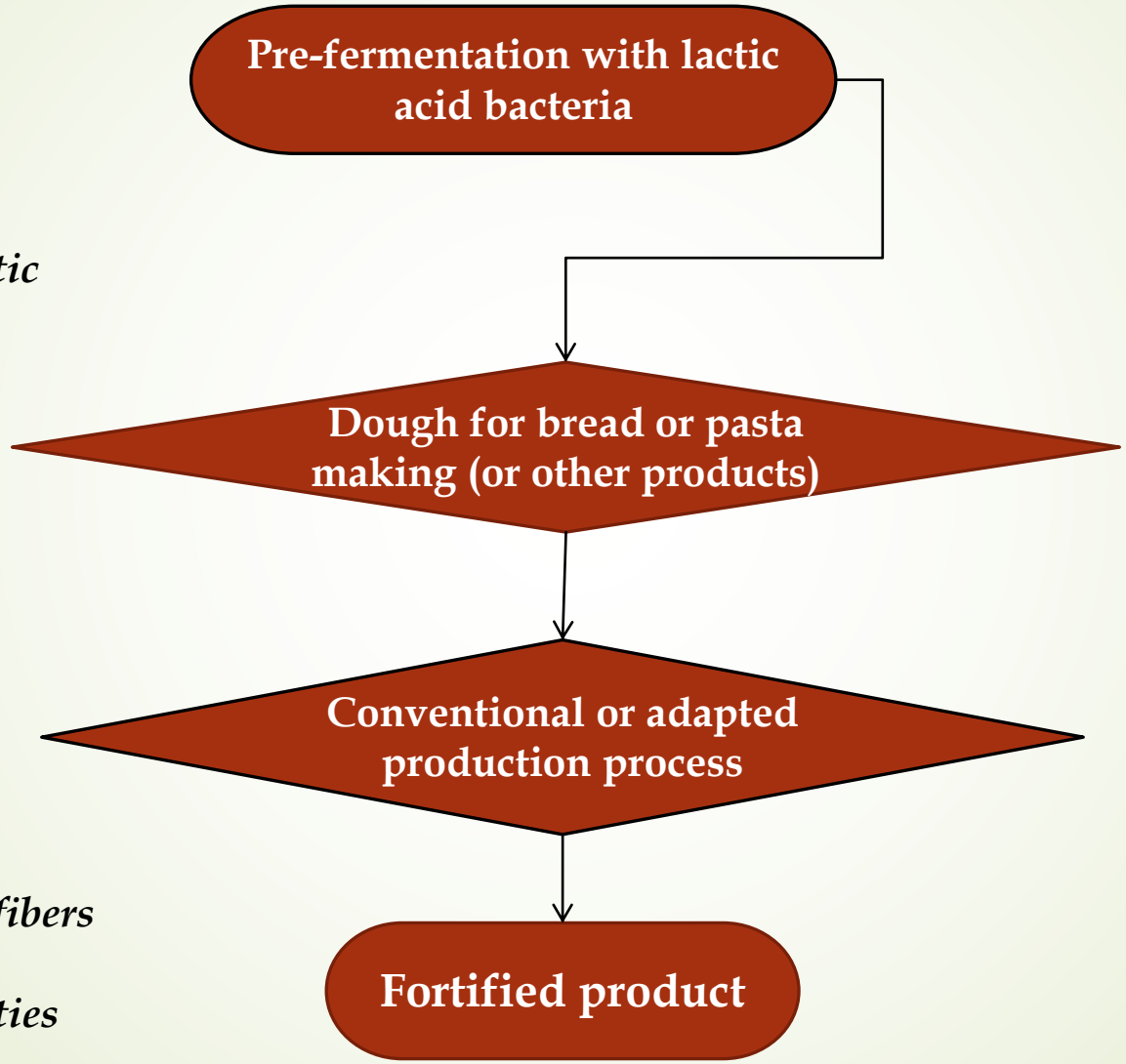
- **Technological issues**
- **Consumers' acceptability**

Source of:
- Fibers
- Minerals
- Proteins
- Phenols

Antinutritional factors
- Phytic acid

How to use «non-wheat» ingredients

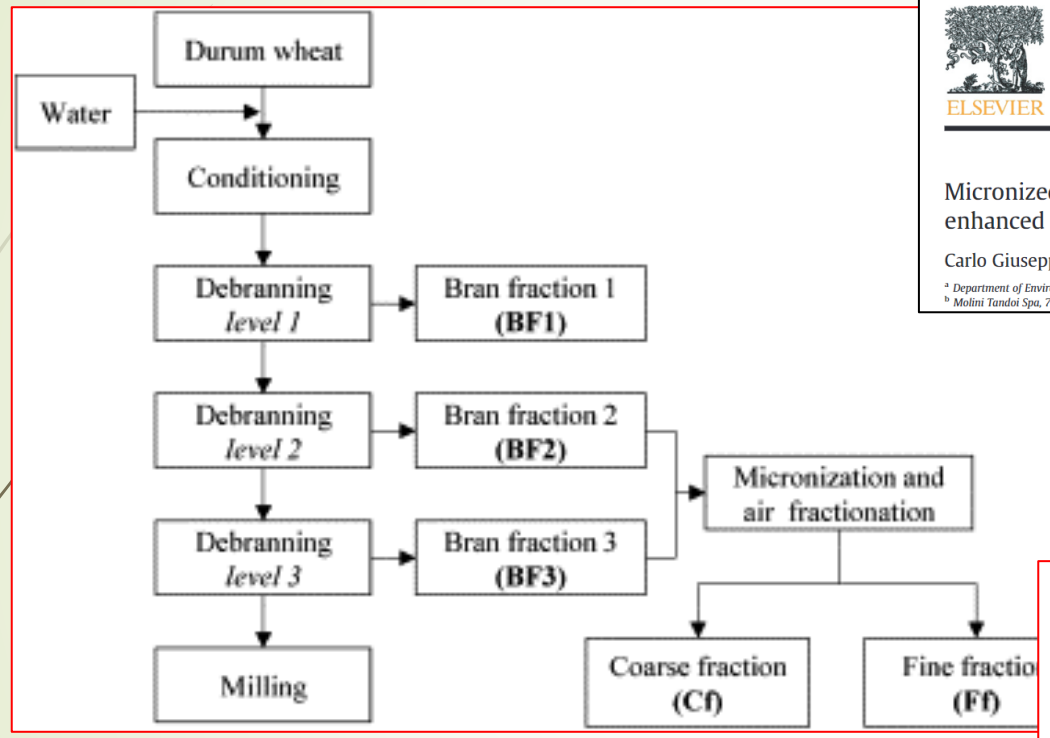
- *Promotion of the phytic acid degradation*



- *Increase of the dietary fibers*
- *Decrease of the GI*
- *Texture/sensory properties*

Technological options

1- Debranning,
2- micronization and air fractionation



Food Research International 46 (2012) 304–313

Contents lists available at SciVerse ScienceDirect

Food Research International

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

Micronized by-products from debranned durum wheat and sourdough fermentation enhanced the nutritional, textural and sensory features of bread

Carlo Giuseppe Rizzello [a], Rossana Coda [a,*], Francesco Mazzacane [a], Davide Minervini [b], Marco Gobbetti [a]

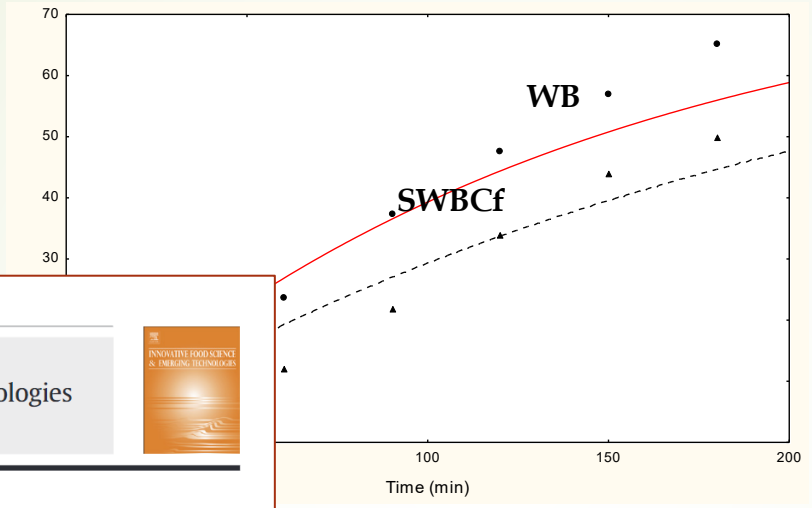
[a] Department of Environmental and Agro-Forestry Biology and Chemistry, University of Bari, 70125 Bari, Italy
[b] Molini Tandoi Spa, 70033 Corato, Bari, Italy

	Cf	Ff
Chemical and physical characteristics		
pH	$6.7 \pm 0.2^{n.s.}$	$6.7 \pm 0.1^{n.s.}$
TTA	13.7 ± 0.3^{b}	16.3 ± 0.1^{a}
Moisture (%)	$14.0 \pm 0.3^{n.s.}$	$14.0 \pm 0.1^{n.s.}$
Ash (% d.m.)	5.7 ± 0.2^{b}	7.1 ± 0.1^{a}
Total dietary fiber (% d.m.)	60.1 ± 0.8^{a}	38.2 ± 0.5^{b}
Starch (% d.m.)	5.1 ± 0.8^{b}	9.3 ± 0.8^{a}
Fat (% d.m.)	6.5 ± 0.2^{b}	9.0 ± 0.2^{a}
Protein (% d.m.)	8.0 ± 0.1^{b}	19.0 ± 0.3^{a}

Sourdough applications: pre-treatment of bran and micronized bran

5- Micronization and effect of the particle size

Rate of starch hydrolysis



Innovative Food Science and Emerging Technologies 25 (2014) 19–27

Contents lists available at ScienceDirect

Innovative Food Science and Emerging Technologies

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

Effect of bioprocessing and particle size on the nutritional properties of wheat bran fractions

Rossana Coda [a,*], Carlo Giuseppe Rizzello [b], José Antonio Curiel [b], Kaisa Poutanen [a,c], Kati Katina [a]

[a] VTT, Tietotie 2, 02044 VTT, Finland
[b] Department of Soil, Plant and Food Sciences, University of Bari, 70126 Bari, Italy
[c] Department of Clinical Nutrition, University of Eastern Finland, Kuopio Campus, P.O. Box 1627, FIN-70211 Kuopio, Finland

Food Research International 46 (2012) 304–313

Contents lists available at SciVerse ScienceDirect

Food Research International

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

Micronized by-products from debranned durum wheat and sourdough fermentation enhanced the nutritional, textural and sensory features of bread

Carlo Giuseppe Rizzello [a], Rossana Coda [a,*], Francesco Mazzacane [a], Davide Minervini [b], Marco Gobbetti [a]

[a] Department of Environmental and Agro-Forestry Biology and Chemistry, University of Bari, 70125 Bari, Italy
[b] Molini Tandoi Spa, 70033 Corato, Bari, Italy

Fermented bran as bread ingredient:

- -High concentration of functional compounds (phenols and dietary fibre),
- -Decrease of HI
- -Improving of the textural properties,
- Improving of sensory characteristics.
- Increased protein bioavailability (use of xylanases) and digestibility

Panel test

	WB	SWB	WBCf	SWBCf
Elasticity	7.5	7.8	6.3	7.8
Crumb color	3.8	4.5	7.3	7.6
Crust color	4.3	6.3	6.5	7.8
Acid flavor	1.8	4.8	3.0	5.0
Acid taste	1.5	5.3	2.8	5.8
Sweetness	4.7	4.7	5.7	5.0
Dryness	4.3	4.0	5.0	3.8
Taste	6.3	7.0	7.3	7.8
Salty	5.3	5.7	5.7	6.7

Technological options

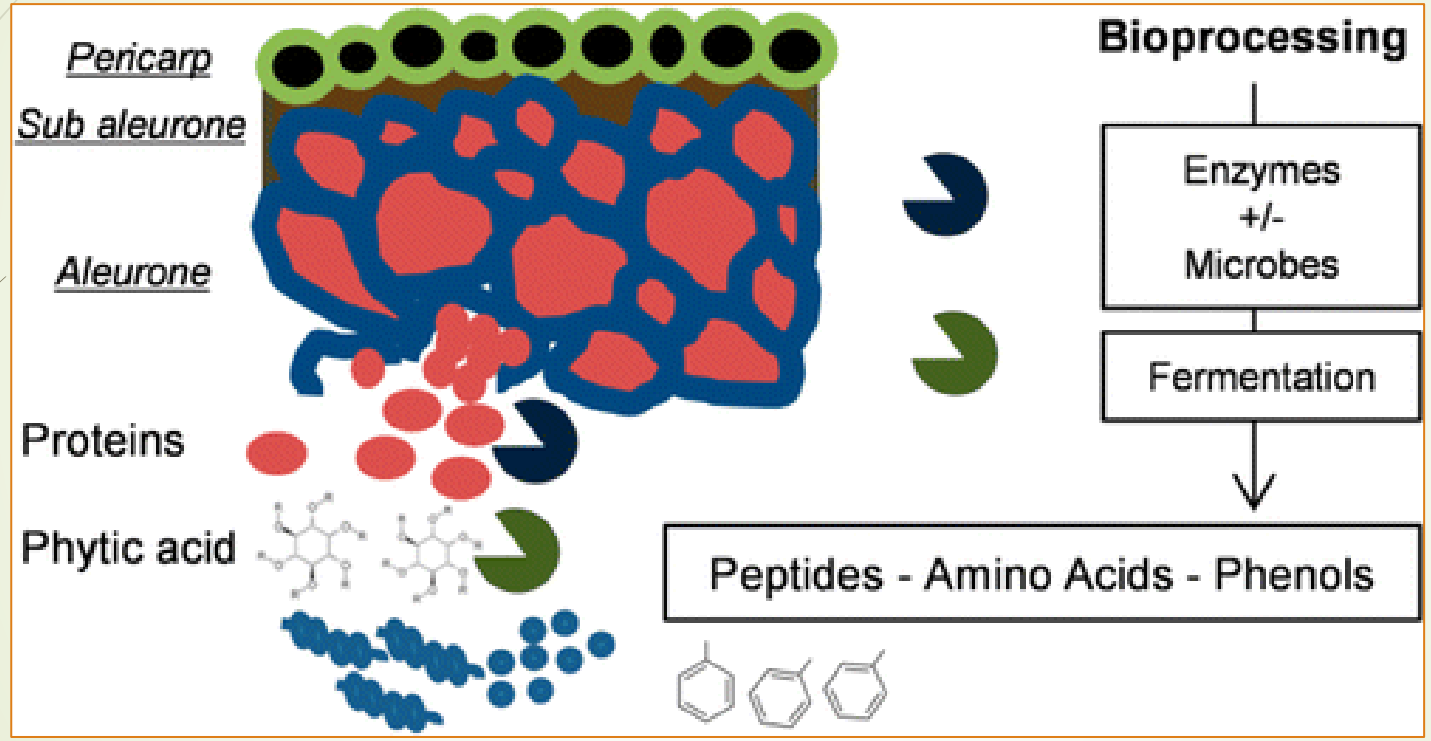
3- Enzymes

JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY
Article
pubs.acs.org/JAFC

Impact of Enzymatic and Microbial Bioprocessing on Protein Modification and Nutritional Properties of Wheat Bran

Elisa Arte,[†] Carlo G. Rizzello,[‡] Michela Verni,[‡] Emilia Nordlund,[§] Kati Katina,[†] and Rossana Coda*[,†]

[†]Department of Food and Environmental Sciences, University of Helsinki, P.O. Box 27, FI−00014 Helsinki, Finland
[‡]Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, University of Bari, Via G. Amendola 165/a, Bari 70126, Italy
[§]VTT Technical Research Centre of Finland, P.O. Box 1000, FI-02044 VTT Espoo, Finland



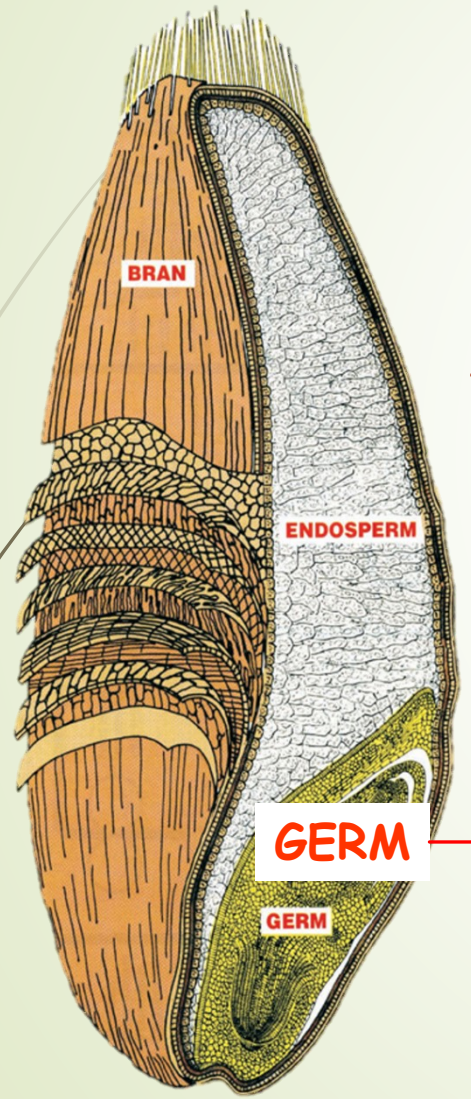
ELSEVIER
Available online at www.sciencedirect.com
ScienceDirect
Current Opinion in Food Science

Bran bioprocessing for enhanced functional properties

Rossana Coda[1], Kati Katina[1] and Carlo G Rizzello[2]

CrossMark

Sourdough applications: pre-treatment of wheat germ



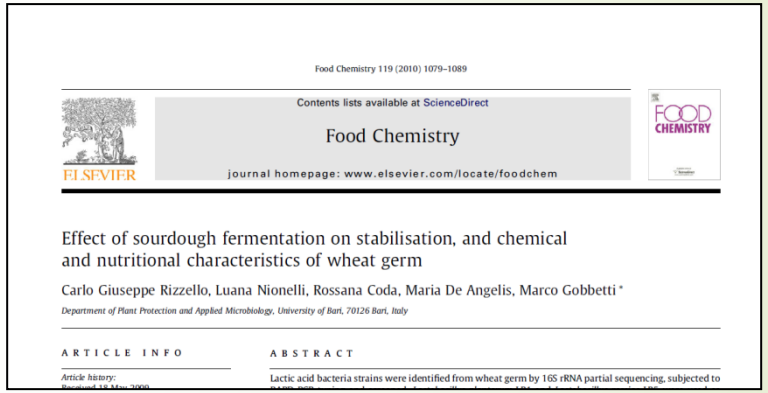
- ✓ α-Tocopherol
- ✓ Vitamins B
- ✓ Dietary fibre
- ✓ Minerals
- ✓ Proteins
- ✓ Phytochemicals (flavonoids, sterols,…)
- ✓ Unsatured fatty acids

Antinutritional factors

- ✓ Raffinose
- ✓ Phytic acid
- ✓ Wheat germ agglutinin

- Wheat germ-

- **Technological issues**
- **Storage issues**
- **Consumers' acceptability**



Food Chemistry 119 (2010) 1079–1089

Contents lists available at ScienceDirect

Food Chemistry

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

Effect of sourdough fermentation on stabilisation, and chemical and nutritional characteristics of wheat germ

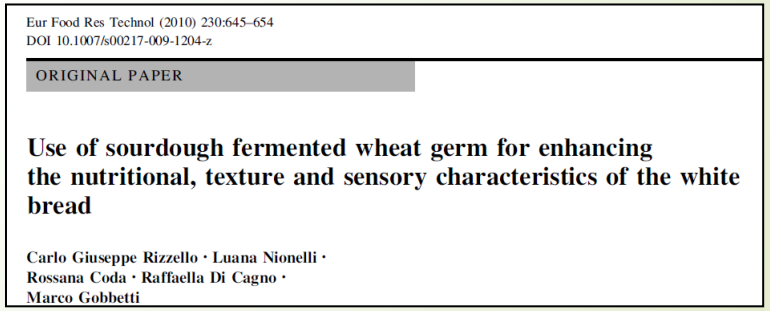
Carlo Giuseppe Rizzello, Luana Nionelli, Rossana Coda, Maria De Angelis, Marco Gobbetti *

Department of Plant Protection and Applied Microbiology, University of Bari, 70126 Bari, Italy

ARTICLE INFO

ABSTRACT

Lactic acid bacteria strains were identified from wheat germ by 16S rRNA partial sequencing, subjected to



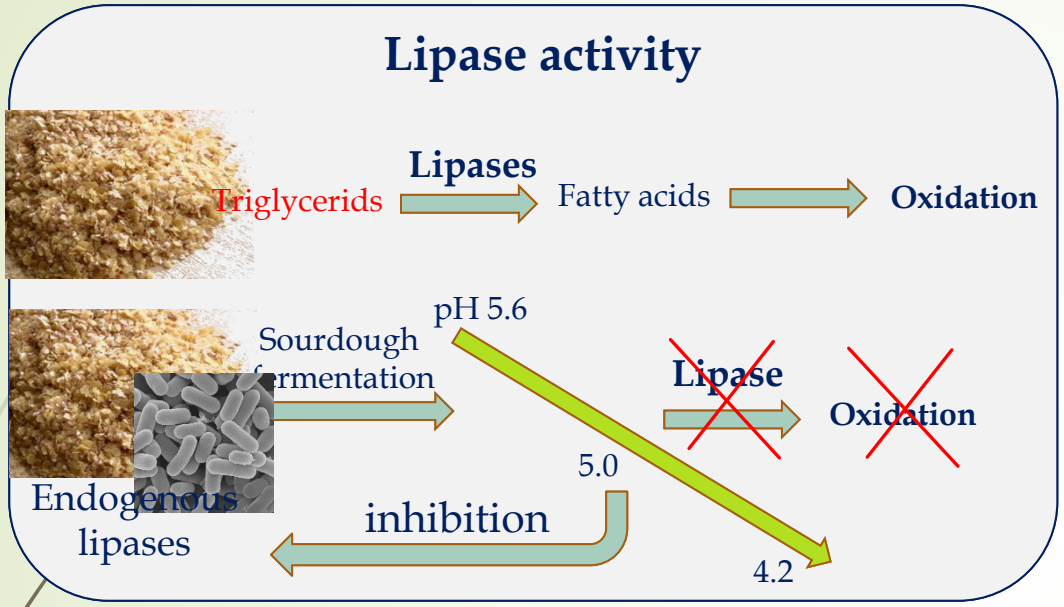
Eur Food Res Technol (2010) 230:645–654
DOI 10.1007/s00217-009-1204-z

ORIGINAL PAPER

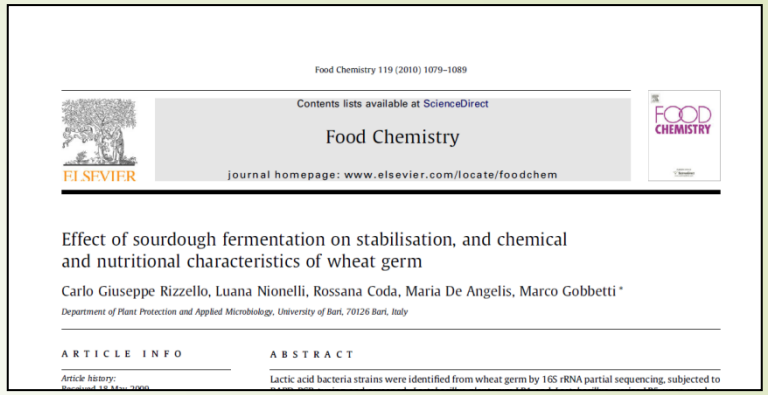
Use of sourdough fermented wheat germ for enhancing the nutritional, texture and sensory characteristics of the white bread

Carlo Giuseppe Rizzello · Luana Nionelli · Rossana Coda · Raffaella Di Cagno · Marco Gobbetti

Pre-fermentation of wheat germ with selected lactic acid bacteria



- ✓ Decrease of the lipase activity (2.6 times lower than control)
- ✓ 40 days monitoring of hexanal and volatile markers of lipidic oxidation


Food Chemistry 119 (2010) 1079–1089
Contents lists available at ScienceDirect
Food Chemistry
journal homepage: www.elsevier.com/locate/foodchem

Effect of sourdough fermentation on stabilisation, and chemical and nutritional characteristics of wheat germ

Carlo Giuseppe Rizzello, Luana Nionelli, Rossana Coda, Maria De Angelis, Marco Gobbetti *
Department of Plant Protection and Applied Microbiology, University of Bari, 70126 Bari, Italy

ARTICLE INFO

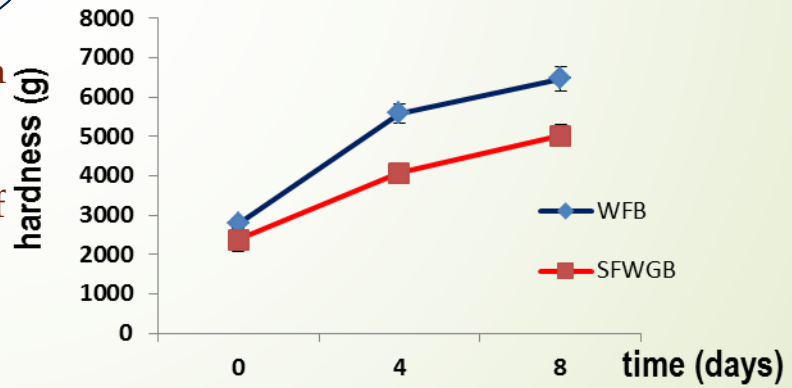
ABSTRACT

Lactic acid bacteria strains were identified from wheat germ by 16S rRNA partial sequencing, subjected to

SFWG as bread ingredient

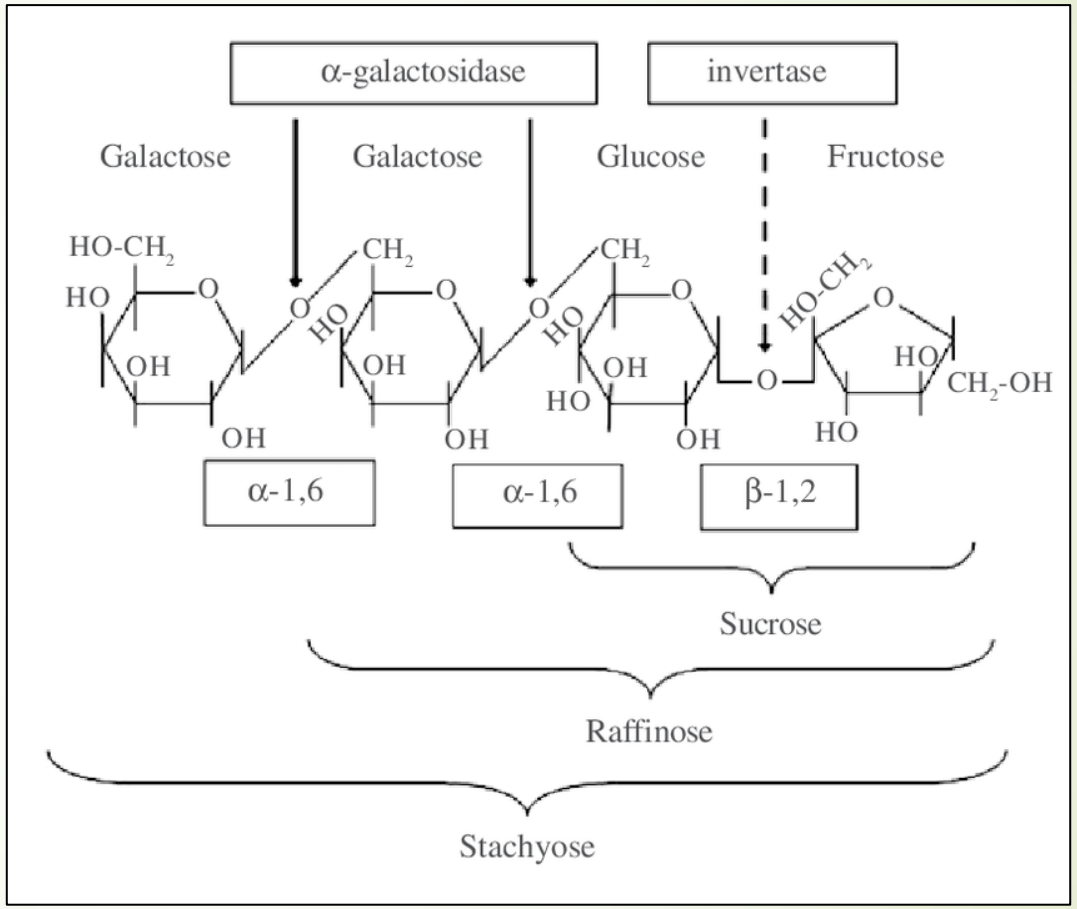
(4% on flour weight)

- ✓ Specific volume **+ 16-18%**
- ✓ Increase of the structural features; firmness delay



Raffinose (and RFO) degradation

- Most mammals, including man, lack pancreatic alpha-galactosidase (alpha-Gal), which is necessary for the hydrolysis of these sugars.
- RFO can be fermented by gas-producing microorganisms present in the cecum and large intestine, which in turn can induce flatulence and other gastrointestinal disorders in sensitive individuals
- the use of microorganisms expressing alpha-Gal is a promising solution to the elimination of NDO before they reach the large intestine



Leblanc et al., 2004

Pre-fermentation of milling by-products: applications

Journal of Cereal Science 77 (2017) 235–242

Contents lists available at ScienceDirect

Journal of Cereal Science

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

Use of fermented milling by-products as functional ingredient to develop a low-glycaemic index bread

Erica Pontonio [a], Anna Lorusso [a], Marco Gobbetti [b], Carlo Giuseppe Rizzello [a,*]

vallefiorita®

patent n. 102016000015871
16.2.2016

- Low glycemic index bread
  (**GI *in vivo* 36.9%**)
- **"source of fibers"**
  (6%, w/w)

ORIGINAL RESEARCH ARTICLE
Front. Microbiol., 19 March 2019 | https://doi.org/10.3389/fmicb.2019.00561

Maize Milling By-Products: From Food Wastes to Functional Ingredients Through Lactic Acid Bacteria Fermentation

Erica Pontonio[1]*, Cinzia Dingeo[1], Marco Gobbetti[2] and Carlo Giuseppe Rizzello[1]

[1]Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Bari, Italy
[2]Faculty of Science and Technology, Free University of Bozen-Bolzano, Bolzano, Italy

patent n. WO 2021/260543

International Journal of Food Microbiology 313 (2020) 108384

Contents lists available at ScienceDirect

International Journal of Food Microbiology

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

Brans from hull-less barley, emmer and pigmented wheat varieties: From by-products to bread nutritional improvers using selected lactic acid bacteria and xylanase

Erica Pontonio[a], Cinzia Dingeo[a], Raffaella Di Cagno[b,*], Massimo Blandino[c], Marco Gobbetti[b], Carlo Giuseppe Rizzello[a]

[a] Department of Soil, Plant and Food Science, University of Bari Aldo Moro, 70126 Bari, Italy
[b] Faculty of Science and Technology, Free University of Bozen-Bolzano, 39100 Bolzano, Italy
[c] Department of Agricultural, Forest and Food Sciences, University of Turin, 10095 Grugliasco, Italy

Emmer – barley – pigmented wheat

Use of defatted wheat germ

Table 1
Proximate composition of the defatted wheat germ (DWG).

Chemical composition (g/100 g)	DWG
Moisture	7.00 ± 0.28
Protein (d.m.)[a]	25.20 ± 0.77
Fat (d.m.)	0.51 ± 0.20
Carbohydrates (d.m.)	28.19 ± 1.30
Total dietary fibers (d.m.)	35.44 ± 3.13
Salt (d.m.)	0.02 ± 0.00
Ash (d.m.)	5.05 ± 0.55

LWT - Food Science and Technology 163 (2022) 113566

Contents lists available at ScienceDirect

LWT

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

Defatted durum wheat germ to produce type-II and III sourdoughs: Characterization and use as bread ingredient

Giuseppe Perri [a], Marcello Greco Miani [b], Gianfranco Amendolagine [b], Erica Pontonio [a], Carlo Giuseppe Rizzello [c,*]

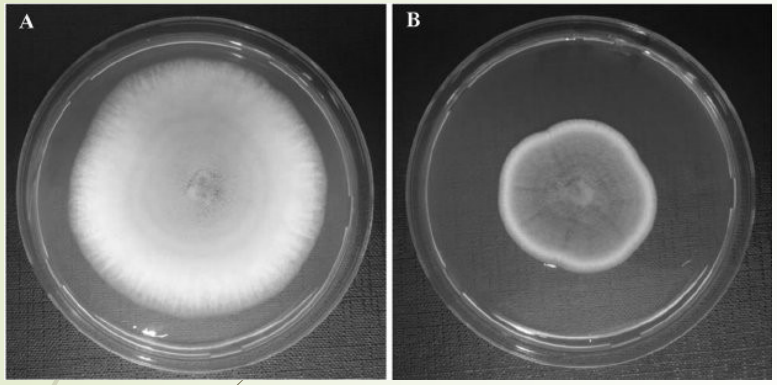
Cell density of lactic acid bacteria (log10 cfu/g), pH, concentration of lactic and acetic acids, fermentation quotient (FQ), total titratable acidity (TTA), phytic acid, raffinose and total free amino acids (TFAA) content, of the fermented defatted wheat germ (fDWG) before (0 h) and after (24 h) fermentation at 30 °C with *L. plantarum* T6B10 and *F. sanfranciscensis* A2S5. Data refer to wet samples (DY 200).

	fDWG	
	0 h	24 h
Lactic acid bacteria (log10 cfu/g)	7.43 ± 0.48[b]	9.76 ± 0.20[a]
pH	6.22 ± 0.15[a]	3.74 ± 0.31[b]
TTA (ml NaOH)	2.70 ± 0.11[b]	44.14 ± 2.25[a]
Lactic acid (mmol/kg)	0.27 ± 0.02[b]	167.7 ± 9.57[a]
Acetic acid (mmol/kg)	1.04 ± 0.09[b]	15.01 ± 1.15[a]
FQ	0.25 ± 0.02[b]	11.17 ± 2.50[a]
TFAA (mg/kg)	1307.61 ± 118[b]	4268.5 ± 301[a]
Phytic acid (g/100g)	1.43 ± 0.24[a]	0.77 ± 0.15[b]
Raffinose (g/100g)	0.66 ± 0.18[a]	0.06 ± 0.02[b]

Casillo GROUP

Department of Environmental Biology, Sapienza University of Rome, Italy

Antifungal organic acids and peptides purified from sourdough fermented wheat germ



Organic acids	Activity
Organic acid mixture[b]	+ + +
Oxalic acid (1.57 mM)	-
Lactic acid (24.3 mM)	±
Formic acid (24.7 mM)	++
Acetic acid (10.8 mM)	±
Citric acid (3.2 mM)	-
Citric acid (18.2 mM)	-
Phenyl lactic acid (0.4 mM)	+
Valeric acid (0.98 mM)	±

Food Chemistry 127 (2011) 952–959

Contents lists available at ScienceDirect

Food Chemistry

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

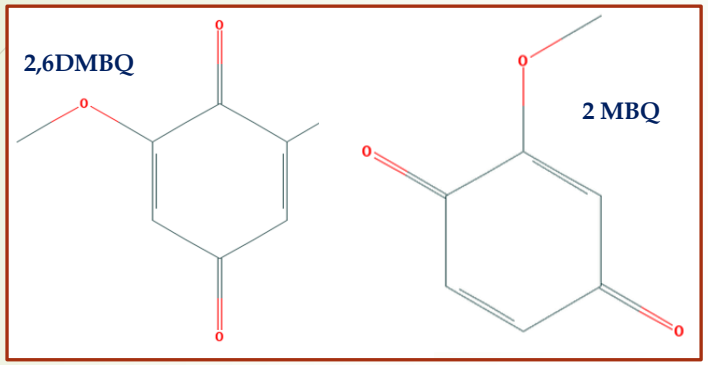
Antifungal activity of sourdough fermented wheat germ used as an ingredient for bread making

Carlo Giuseppe Rizzello, Angela Cassone, Rossana Coda, Marco Gobbetti *

Dipartimento di Biologia e Chimica Agro-Forestale ed Ambientale, University of Bari, 70126 Bari, Italy

Sequence	Source Protein NCBI accession
VLHEPLF	FH4_ORYSJ, Q8H8K7
YNNPIIYVTENGIAEGNN	BGL29_ORYSJ,;
KSLPITEAL	A3C053
ALKAAPSPA	HOX2_ORYSI, Q84U86
AILIIVMLFGR	HKT6_ORYSJ, Q6H501
AAAAVFLSLLAVGHCAAA	EXPB4_ORYSJ,;
DFNATDADADFAGNGVD	Q94LR4
FNSSDAAVYWGPWTKAR	

Synthesis of functional compounds during sourdough fermentation of wheat germ



Rizzello et al. Microbial Cell Factories 2013, 12:105
http://www.microbialcellfactories.com/content/12/1/105

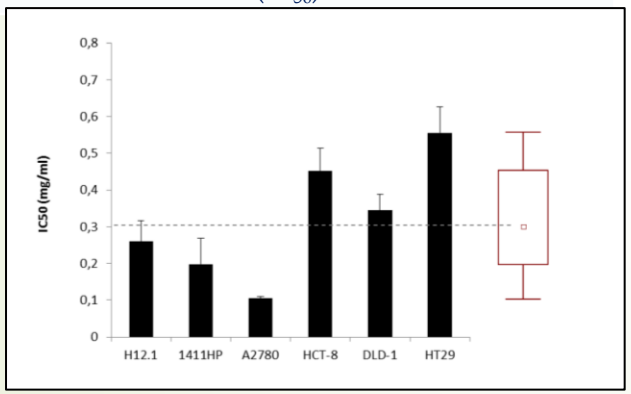
MICROBIAL CELL FACTORIES

RESEARCH Open Access

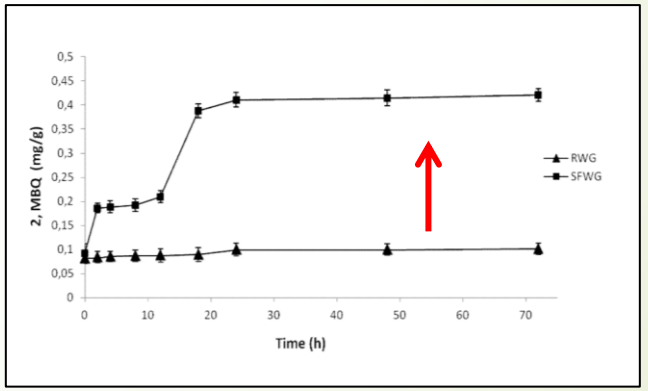
Synthesis of 2-methoxy benzoquinone and 2,6-dimethoxybenzoquinone by selected lactic acid bacteria during sourdough fermentation of wheat germ

Carlo Giuseppe Rizzello[1*], Thomas Mueller[2], Rossana Coda[1], Franziska Reipsch[2], Luana Nionelli[1], José Antonio Curiel[1] and Marco Gobbetti[1]

Antiproliferative activity on tumoral human cells (IC_{50})



Kinetics of synthesis



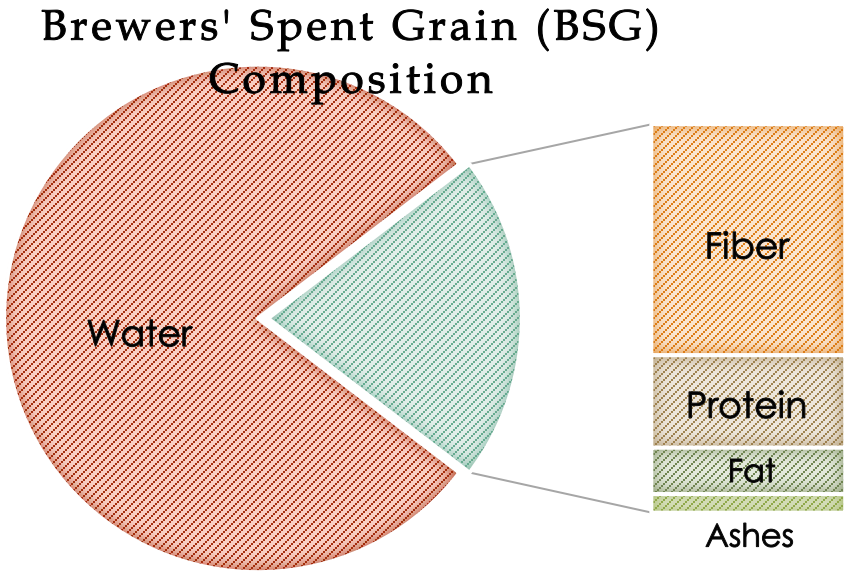
Biotransformation of brewer´s spent grain: increased functionality for novel food applications

70% low-value animal feed (~€35/ton)

10% biogas

20% landfill

Bianco et al., 2020. *Appl. Microbiol. Biotechnol.* 1-18.

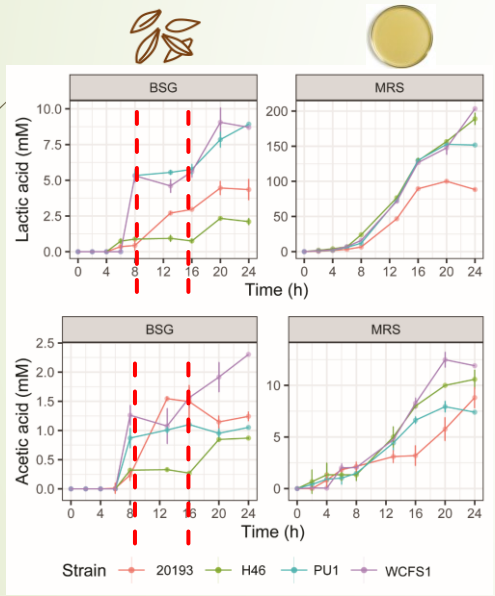


BSG: a by-product with hidden potential, after all…

Department of Environmental Biology, Sapienza University of Rome, Italy

Phenotype switching and gene expression

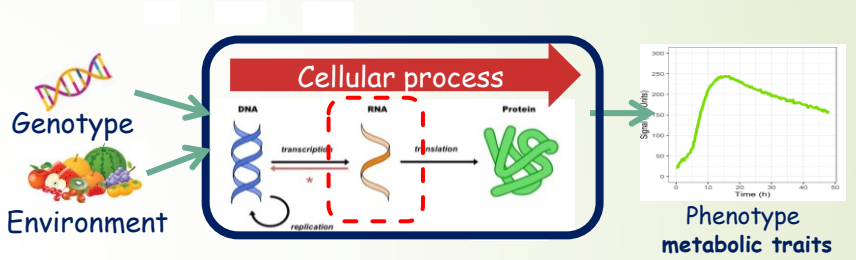
- All strains showed **organic acid** production divided into **two phases** in BSG **(diauxic growth)**.
- **Expression of genes** related to selected substrates that strains consumed more intensely under BSG conditions during the two phases

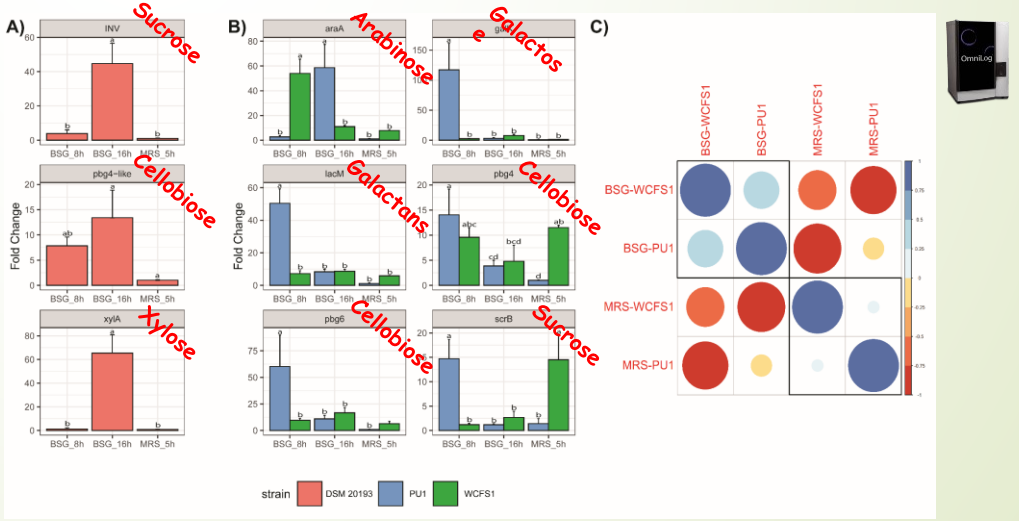


microbial biotechnology
sfam
Open Access
Research Article | Open Access

How water-soluble saccharides drive the metabolism of lactic acid bacteria during fermentation of brewers' spent grain

Marta Acin-Albiac, Pasquale Filannino, Rossana Coda, Carlo Giuseppe Rizzello, Marco Gobbetti, Raffaella Di Cagno



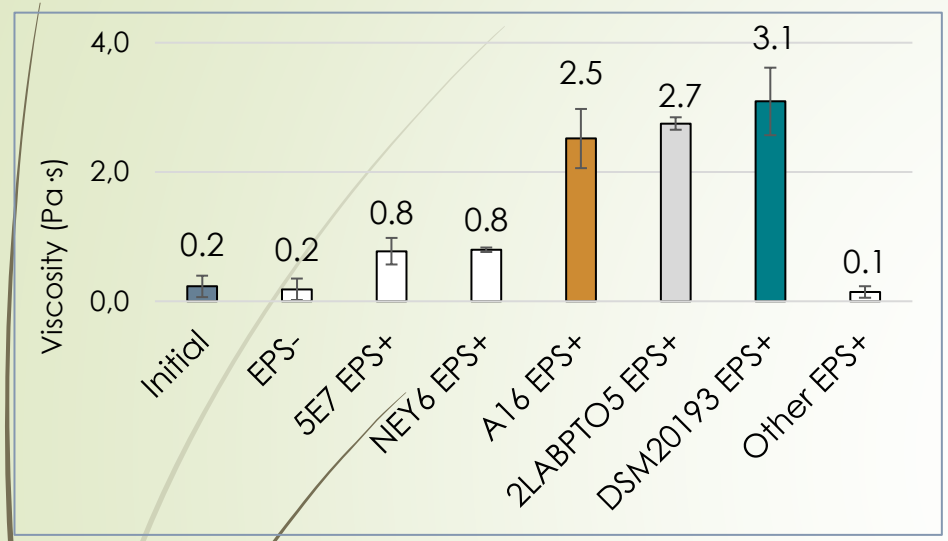


Department of Environmental Biology, Sapienza University of Rome, Italy

BSG bioprocessing: dextran synthesis by Lactic Acid Bacteria

UNIVERSITY OF HELSINKI

Viscosity increase



Untreated spent

Fermented spent

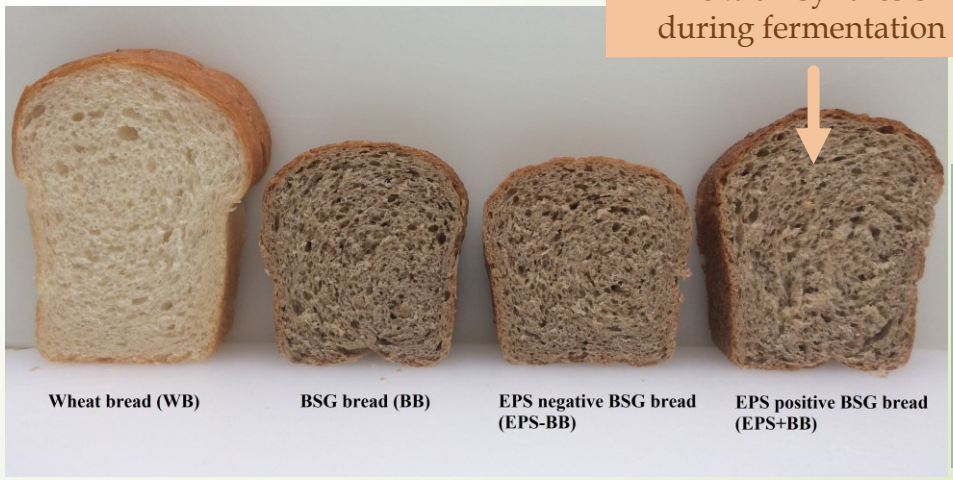
- BSG amount: ca. 33-37% of dough weigh
- Dextran content ca. 1.6% w/w→ 0.59% of dextran in bread (effective as hydrocolloid)

RESEARCH Open Access

Brewers' spent grain as substrate for dextran biosynthesis by *Leuconostoc pseudomesenteroides* DSM20193 and *Weissella confusa* A16

Prabin Koirala[1], Ndegwa Henry Maina[1], Hanna Nihtilä[1], Kati Katina[1] and Rossana Coda[1,2*]

Dextran synthesis during fermentation



BSG bread containing dextran vs native BSG

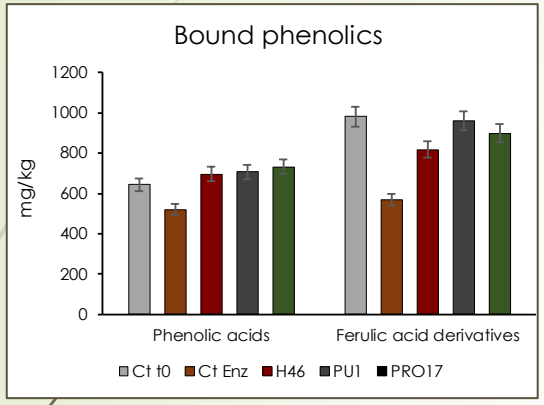
- Volume + 13%
- Hardness – 40%
- Staling rate – 33%
- taste/mouthfeel perception

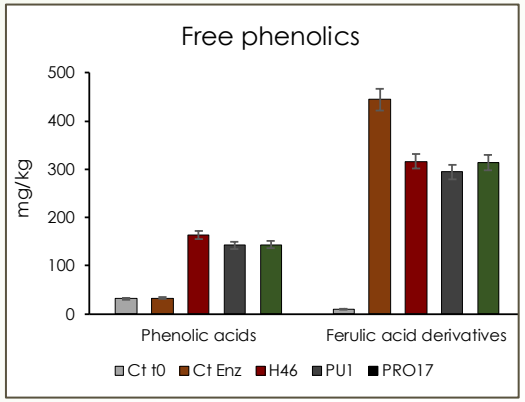
Department of Environmental Biology, Sapienza University of Rome, Italy

BSG bioprocessing: increase of the antioxidant activity

use of xylanase + lactic acid bacteria fermentation

Phenolic compounds

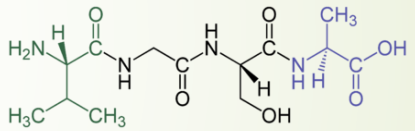


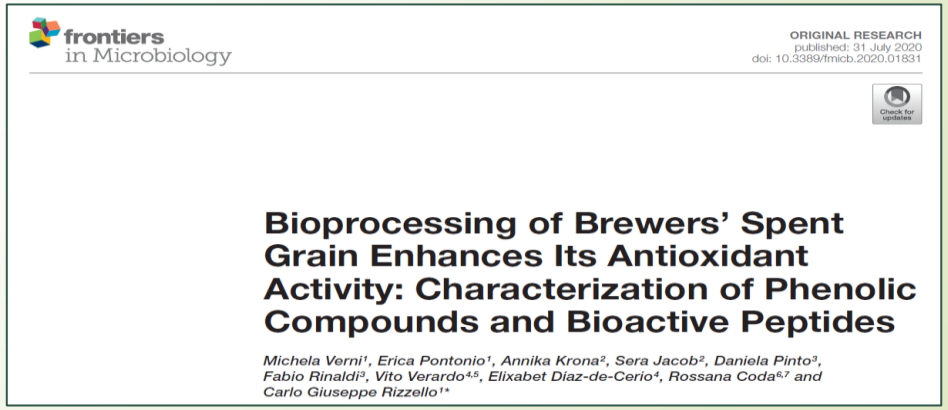


Xylanase liberated 25% of the **phenolic compounds bound to lignocellulosic** material and, therefore, not available to exert their function. Whereas **LAB metabolized phenolic acids** and polymeric forms of **proanthocyanidins** into more active forms.

Bioactive peptides

LAB proteolytic system enabled the **release of small bioactive peptides** sequences encrypted in barley and maize native proteins, showing common features of antioxidant peptides.




frontiers in Microbiology

ORIGINAL RESEARCH
published: 31 July 2020
doi: 10.3389/fmicb.2020.01831

Bioprocessing of Brewers' Spent Grain Enhances Its Antioxidant Activity: Characterization of Phenolic Compounds and Bioactive Peptides

Michela Verni[1], Erica Pontonio[1], Annika Krona[2], Sera Jacob[2], Daniela Pinto[3], Fabio Rinaldi[3], Vito Verardo[4,5], Elixabet Díaz-de-Cerio[4], Rossana Coda[6,7] and Carlo Giuseppe Rizzello[1]

Department of Environmental Biology, Sapienza University of Rome, Italy

Bioprocessed BSG for functional pasta and extruded snacks

''High fiber'' content (~8%)
''Source of protein''
according to EU regulation 1924/2006

Improved **Protein Digestibility** and quality indices

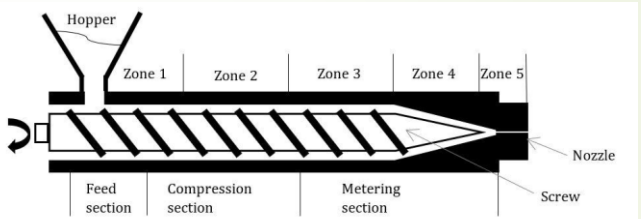
Low glycaemic index
compared to semolina pasta

antioxidants MDPI

Article

Bioprocessed Brewers' Spent Grain Improves Nutritional and Antioxidant Properties of Pasta

Rosa Schettino [1], Michela Verni [1], Marta Acin-Albiac [2], Olimpia Vincentini [3], Annika Krona [4], Antti Knaapila [5], Raffaella Di Cagno [2], Marco Gobbetti [2], Carlo Giuseppe Rizzello [6,*] and Rossana Coda [5,7]



expansion

- Blend ingredients; total water 26%
- Extrusion at 30/80/90/110/95 °C, 50 rpm
- Microwave 12 g at 750 W for 45 s to expand

Technological properties

- ✓ D**egraded arabinoxylan structure**
- ✓ More homogeneous **protein network**

Functional properties

- ✓ Rich in **phenolic compounds** and **bioactive peptides**
- ✓ Protective effects of **digested pasta** towards induced **oxidative stress** in Caco-2 cells cultures

RI. SE

Department of Environmental Biology, Sapienza University of Rome, Italy

Wasted Bread

- **European project WASTEBAKE**
- Biotechnological functionalization of bakery waste - *(Call: EUROTRANSBIO)*

- Valle Fiorita Catering Srl (Italy) - Koivulan Leipomo Oy (Finland) - Senson (Finland) - Iceberg LLC (Russia) – University of Bari (Italy) - University of Helsinki (Finland) - ITMO University (Russia)

Wasted Bread

Enrichment in EPS

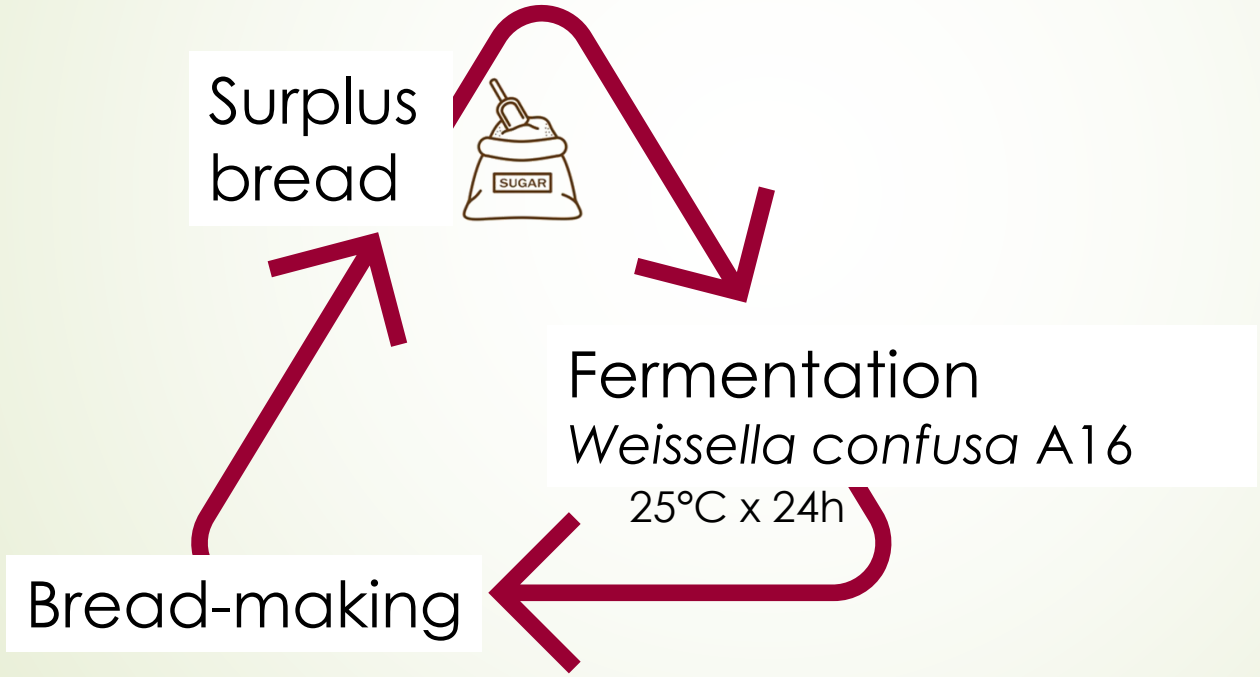
Contents lists available at ScienceDirect

International Journal of Food Microbiology

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

Waste bread recycling as a baking ingredient by tailored lactic acid fermentation

Mikko Immonen[a,*], Ndegwa H. Maina[a], Yaqin Wang[a], Rossana Coda[a,b], Kati Katina[a]



Wasted Bread

GABA enrichment

- **GABA content 136 mg/kg**
- **Higher Free Amino Acids**
- **Higher *In vitro* Protein Digetibility**
- **Lower predicted Glycaemic Index**
- **Good technological properties**

Journal of Applied Microbiology

ORIGINAL ARTICLE | Open Access

Biosynthesis of γ-aminobutyric acid by lactic acid bacteria in surplus bread and its use in bread-making

Michela Verni, Anna Vekka, Mikko Immonen, Kati Katina, Carlo Giuseppe Rizzello, Rossana Coda,

First published: 23 October 2021 | https://doi.org/10.1111/jam.15332

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as doi:10.1111/jam.15332

Accepted Articles

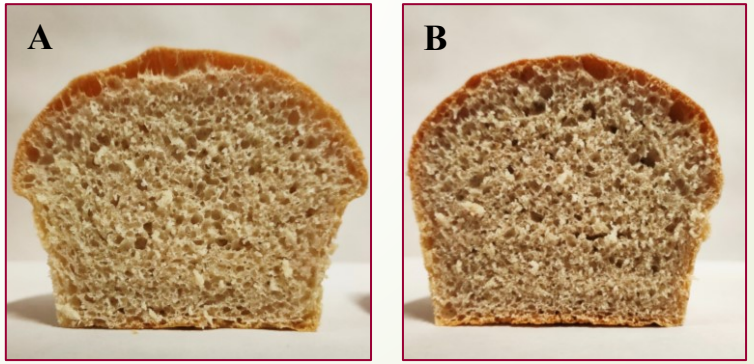
Accepted, unedited articles published online and citable. The final edited and typeset version of record will appear in the future.

Related | Information

Recommended

Lactic acid bacteria and yeasts associated with *gowé* production from sorghum in Bénin

Image and cross section of common wheat flour bread (A) and **bread produced with surplus bread slurry containing 30% of wheat bran and fermented with *L. plantarum* H64** (B)



Wasted Bread

Antifungal ingredient

Contents lists available at ScienceDirect

Food Control

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

Antifungal effect of bioprocessed surplus bread as ingredient for bread-making: Identification of active compounds and impact on shelf-life

L. Nionelli [a,1], Y. Wang [a], E. Pontonio [b], M. Immonen [a], C.G. Rizzello [b], H.N. Maina [a], K. Katina [a], R. Coda [a,c,*]

Sequence	Mass (Da)	Length	Net charge	Hydrophobic ratio (%)	NCBI Accession number (Protein)
NIQVDPSGQVQ	1183,5833	11	-1	27	P08453.1 (γ-gliadin)
EGEGVIVLLR	1083,6282	10	-1	50	B8AL97.1 (Globulin-like)
LTAASITAVCR	1161,6175	11	1	63	P01085.1 (a-amylase inhibitor)
DCCQQLADINNEWCR	1980,7927	15	-2	46	ABF93411.1 (a-amylase inhibitor)
DVAGGGGAQQCPVETK	1572,7193	16	-1	31	P33432.2 (Puroindoline-A)
DYVLQQTCGTFTPGSK	1800,8404	16	0	25	AQT26482.1 (a-amylase/ trypsin inhibitor)
SGNVGESGLIDLPGCPR	1726,8316	17	-1	29	
QQCCGELANIPQQCR	1860,8077	15	0	40	
QQCCQPLAQISEQAR	1815,8396	15	0	40	P0CZ09.1 (Avenin-like)

Yogurt-like (plant-based) beverages

patent n. 102020000001231, 22.01.2020

CELERY

International Journal of Food Microbiology 185 (2014) 17–26

Contents lists available at ScienceDirect

International Journal of Food Microbiology

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

Manufacture and characterization of a yogurt-like beverage made with oat flakes fermented by selected lactic acid bacteria

Nionelli Luana [a], Coda Rossana [b], José Antonio Curiel [a], Poutanen Kaisa [b,c], Gobbetti Marco [a], Carlo Giuseppe Rizzello [a,*]

foods

MDPI

Article

Use of Selected Lactic Acid Bacteria and Quinoa Flour for Manufacturing Novel Yogurt-Like Beverages

Anna Lorusso [1], Rossana Coda [2], Marco Montemurro [1] and Carlo Giuseppe Rizzello [1,*]

Food Microbiology 28 (2011) 526–536

Contents lists available at ScienceDirect

Food Microbiology

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

Manufacture and characterization of functional emmer beverages fermented by selected lactic acid bacteria

Rossana Coda, Carlo Giuseppe Rizzello*, Antonio Trani, Marco Gobbetti

frontiers in Microbiology

ORIGINAL RESEARCH

Nutritional, Functional, and Technological Characterization of a Novel Gluten- and Lactose-Free Yogurt-Style Snack Produced With Selected Lactic Acid Bacteria and Leguminosae Flours

OPEN ACCESS

Erica Pontonio[1], Susanna Raho[1], Cinzia Dingeo[1], Domenico Centrone[2], Vito Emanuele Carofiglio[2] and Carlo Giuseppe Rizzello[1]*

foods

MDPI

Article

Design and Characterization of a Novel Fermented Beverage from Lentil Grains

Michela Verni [1], Chiara Demarinis [2], Carlo Giuseppe Rizzello [1] and Federico Baruzzi [2,*]

Plant-based ice-cream

Gluten-, soy-, milk- and lactose- free,

IUPPI PERTUTTI

LWT - Food Science and Technology 161 (2022) 113327

Contents lists available at ScienceDirect

LWT

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

Design and characterization of a plant-based ice cream obtained from a cereal/legume yogurt-like

Erica Pontonio [a], Marco Montemurro [a], Cinzia Dingeo [a,b], Michele Rotolo [c], Domenico Centrone [b], Vito Emanuele Carofiglio [b], Carlo Giuseppe Rizzello [d,*]

Department of Environmental Biology, Sapienza University of Rome, Italy

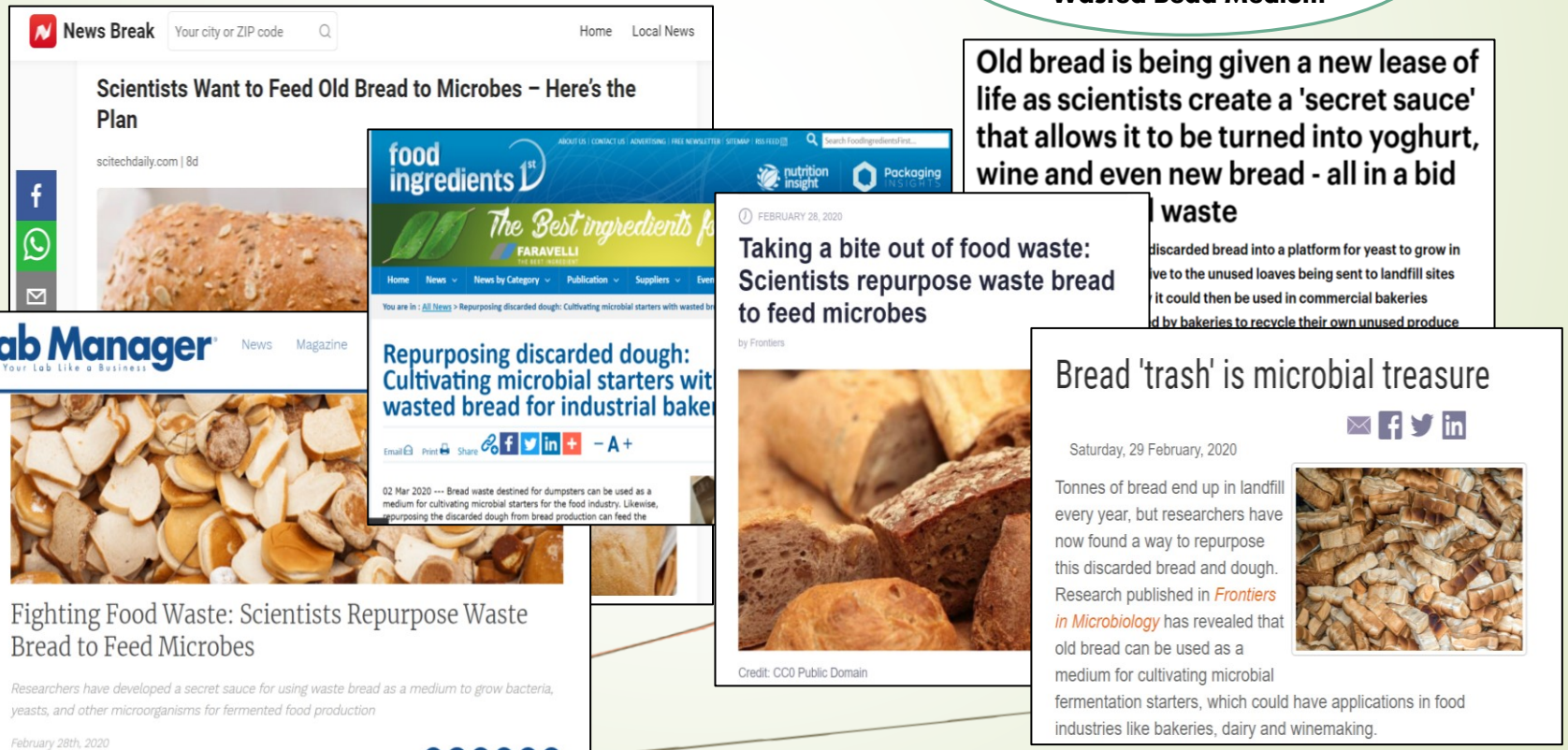
Alternative options for cereal by-products valorisation:

Substrate for the cultivation of starters

vallefiorita®

Patent n. 102019000017408, 27.09.2019.

WBM
Wasted Bead Medium



Next-generation soil-improvers

a FORK TO FARM approach?

- *Supplement for OC and TN*
- *LAB as PGPM*
- *Acidification effect*
- *Antimicrobial activity*

Chemical and physicochemical properties of CTR, WBA and FWBA soils

Samples	pH_{H2O}	pH_{KCl}	EC $\mu S\ m^{-1}$	O.C. %	TN %	P_{ava} $mg\ kg^{-1}$
T0	8.2 a	7.2	200 b	16.0 b	1.6 bc	45.5 ab
CTR	8.2 a	7.3	319 b	15.2 b	1.5 c	46.9 a
WBA	7.7 b	7.3	805 a	20.3 a	2.1 a	37.3 bc
bWBA	7.7 b	7.2	764 a	20.8 a	1.9 ab	36.1 c
HSD.test	***	ns	***	***	**	**

Mean biometric features of plants at the end of the trial

Samples	Average n. of leaves/plant	Treated/CTP leaves ratio	Average head escarole fresh weight (g)	Treated/CTP yield ratio
CTP	13 b	-	18.2 b	-
WBP	22 a	1.7	64.5 a	1.97
bWBP	19 ab	1.4	55.9 a	1.70
HSD.test	*	ns	***	ns

foods

MDPI

Article

Reuse of Wasted Bread as Soil Amendment: Bioprocessing, Effects on Alkaline Soil and Escarole (*Cichorium endivia*) Production

Claudio Cacace [1], Carlo Giuseppe Rizzello [2], Gennaro Brunetti [1], Michela Verni [1,*] and Claudio Cocozza [1]

8 weeks

frontiers | Frontiers in Sustainable Food Systems

TYPE Original Research
PUBLISHED 24 November 2022
DOI 10.3389/fsufs.2022.1010890

Check for updates

OPEN ACCESS

EDITED BY
Claudio Bellia,
University of Catania, Italy

REVIEWED BY
Zina Flagella,
Università degli Studi di Foggia, Italy
Miloš Radosavljević,
University of Novi Sad, Serbia

*CORRESPONDENCE
Michela Verni
michela.verni@uniba.it

Potential of native and bioprocessed brewers' spent grains as organic soil amendments

Claudio Cacace[1†], Claudio Cocozza[1†], Andreina Traversa[1], Rossana Coda[2,3], Carlo Giuseppe Rizzello[4], Erica Pontonio[1], Francesco De Mastro[1], Gennaro Brunetti[1] and Michela Verni[1*]

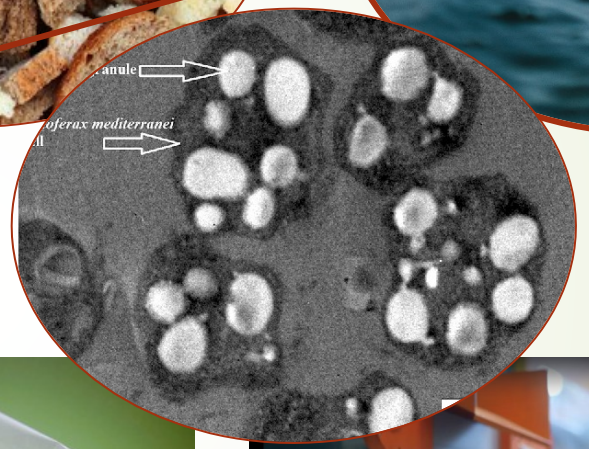
Department of Environmental Biology, Sapienza University of Rome, Italy

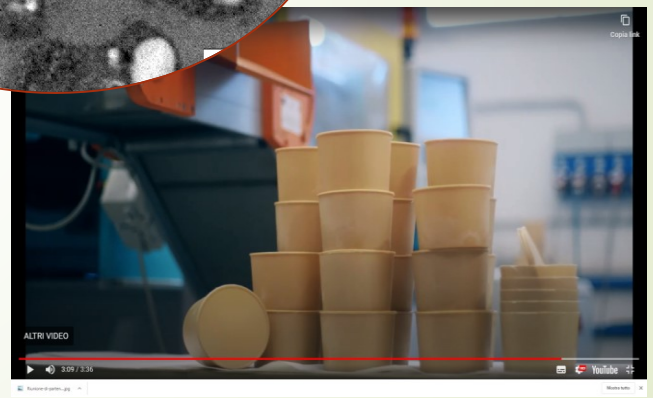
Bioplastic production (microbial synthesys of PHBV)

- *Why Hfx mediterranei?*
  - *PHA-producer*
  - *Halophilic*
    - *No sterilization*
    - *Green Extraction*
  - *Starch metabolism*

- ***Salts supplementation***

- ***Purity***
- ***Composition***
- ***Technological properties***





frontiers | Frontiers in Microbiology

TYPE Original Research
PUBLISHED 21 September 2022
DOI 10.3389/fmicb.2022.1000962

Check for updates

OPEN ACCESS

EDITED BY
Yinglong Su,
East China Normal University, China

REVIEWED BY
Steven Pratt,
The University of Queensland, Australia
Manish Kumar,
National Environmental Engineering Research Institute (CSIR), India
Sanjay Kumar Singh Patel,
Konkuk University, South Korea

*CORRESPONDENCE
Carlo Giuseppe Rizzello
carlogiuseppe.rizzello@uniroma1.it

SPECIALTY SECTION
This article was submitted to

Exploitation of wasted bread as substrate for polyhydroxyalkanoates production through the use of *Haloferax mediterranei* and seawater

Marco Montemurro[1], Gaia Salvatori[2], Sara Alfano[2], Andrea Martinelli[2], Michela Verni[1], Erica Pontonio[1], Marianna Villano[2,3] and Carlo Giuseppe Rizzello[4]*

Department of Environmental Biology, Sapienza University of Rome, Italy

Sapienza University of Rome, Italy
carlogiuseppe.rizzello@uniroma1.it

University of Bari Aldo Moro

Erica Pontonio
Michela Verni
Marco Montemurro
Giuseppe Perri
Chiara De Marinis
Andrea Torreggiani
Angela Longo

University of Helsinki
Rossana Coda
Kati Katina

Free University of Bozen
Marco Gobbetti
Raffaella di Cagno