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Instituto de Agroquímica y Tecnología de Alimentos

CSIC
Consejo Superior de Investigaciones Científicas

MAKING HEALTHIER CEREAL FOODS BY APPLYING PHYSICAL TREATMENTS

Cristina M. Rosell

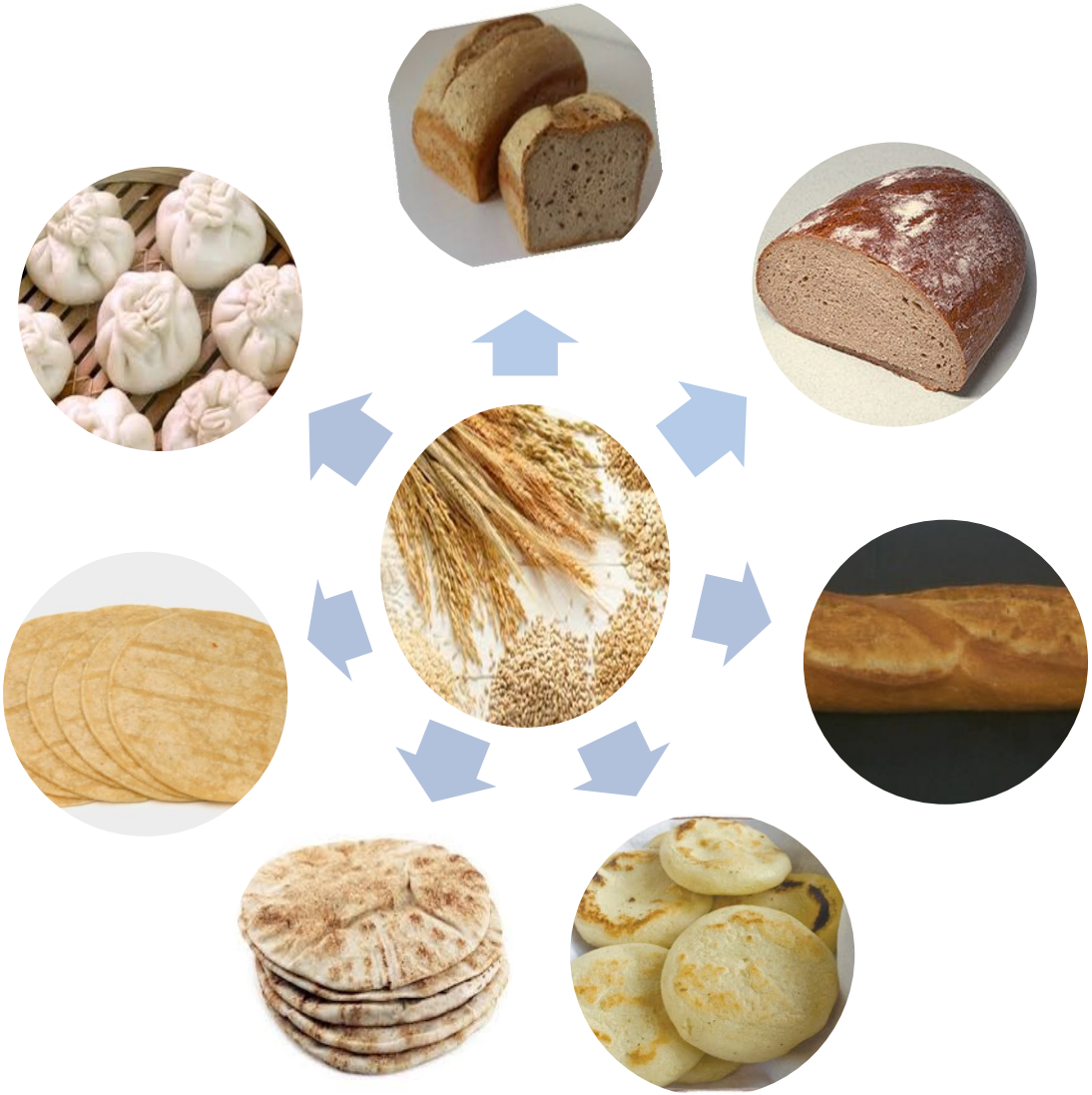
24/03/2018

LINCE
Leading Innovation in Cereals

From tradition to innovation in BREAD

- Volume
- Softness
- Taste
- ….

Worldwide concept of BREAD



Rosell & Garzon (2015). Chemical composition of Bakery Products. In Handbook of Food Chemistry.

NEWSLETTER MEDICALNEWSTODAY LOG IN

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Bread: Is it good or bad for you?

By Megan Ware RDN LD | Last updated Tue 30 May 2017

Reviewed by Natalie Butler, RD, LD

Carbohydrates in bread | Whole grains | When is bread not healthful? | Losing weight

Bread is a staple of the human diet. After thousands of years, it remains the most regularly consumed food in the world, due to its convenience, portability, nutrition, and taste.

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Health

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Is whole wheat bread healthier? It depends on the person, study suggests

ZEENEWS LIVE TV INDIA STATES WORLD BUSINESS SPORTS CRICKET ALL...

Tests show no harmful chemicals in bread: Bengal bakeries

The West Bengal Bakery Co-ordinators Committee and West Bengal Baker's Association said tests showed the absence of certain harmful chemicals which were reported in bread samples by a recent Centre For Science and Environment (CSE) study.

Jun 14, 2016, 16:27 PM IST

After cancer scare, bread makers not to use potassium bromate, iodate; CSE welcomes decision

Leading bread makers on Thursday said that they will give up the use of potassium bromate and potassium iodate in wake of a Centre for Science and Environment study flagging their harmful effects on health, including causing cancer. The CSE welcomed the decision.

May 26, 2016, 23:20 PM IST

WebMD SIGN IN

Diet & Weight Management > Feature Stories >

The Truth About Bread

Everything you need to know about the mother of all carbs.

By Elizabeth M. Ward, MS, RD

FROM THE WEBMD ARCHIVES

Do you have a love/hate relationship with bread? It's a staple of many people's diets, and also a top source of calories.

So which is it: Is bread OK to eat, or is the idea that bread is good for us half-baked? Here's what you should know.

Bread and the Battle of the Bulge

Full Plate LIVING

How to Eat Bread and Still Lose Weight

By Diana Fleming

Diana Fleming, PhD, LDN, is a co-

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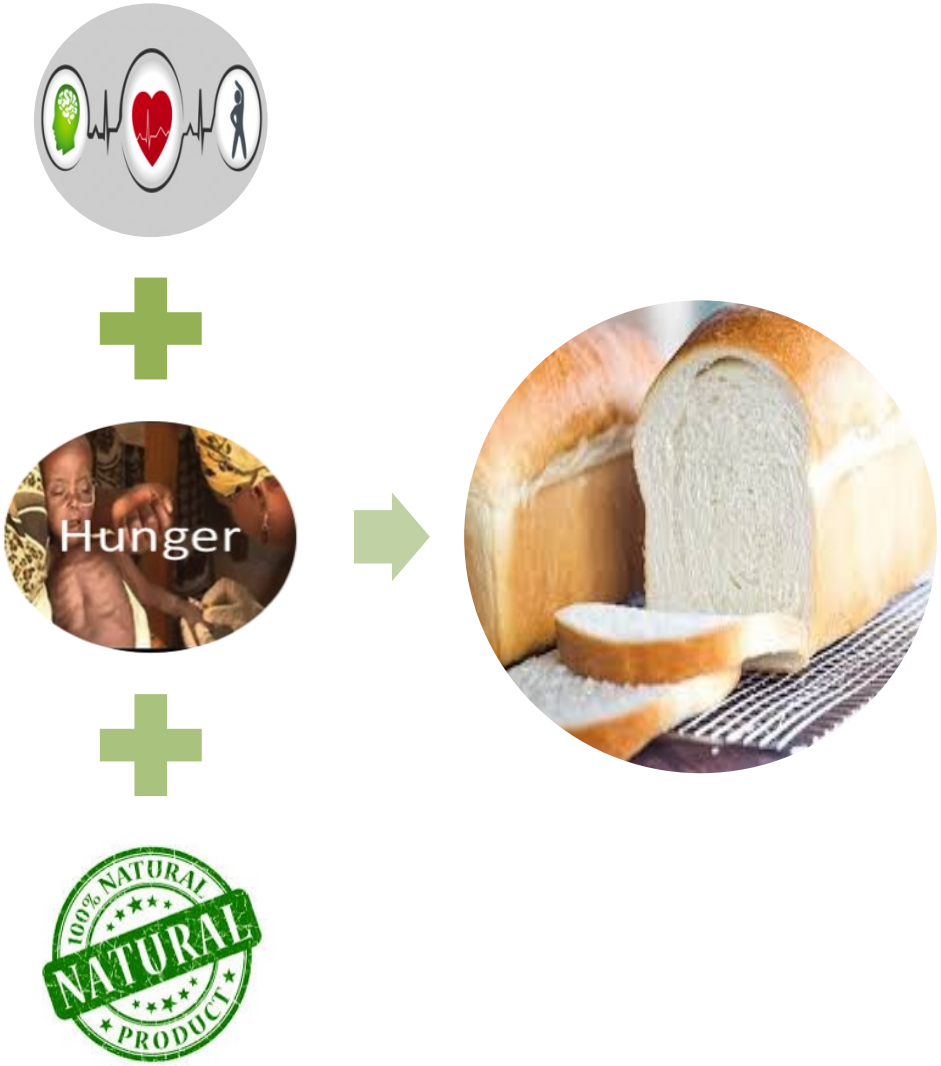
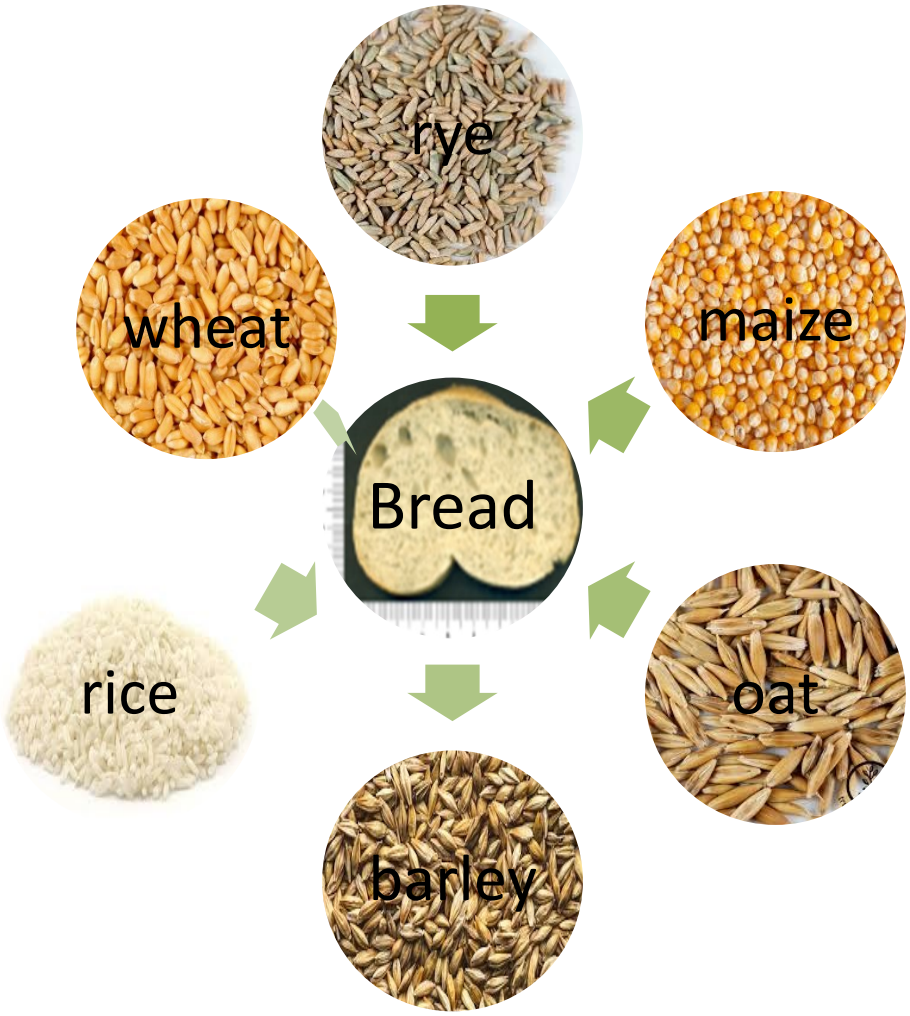
Current trends and consumer demands….



Traditional raw materials….



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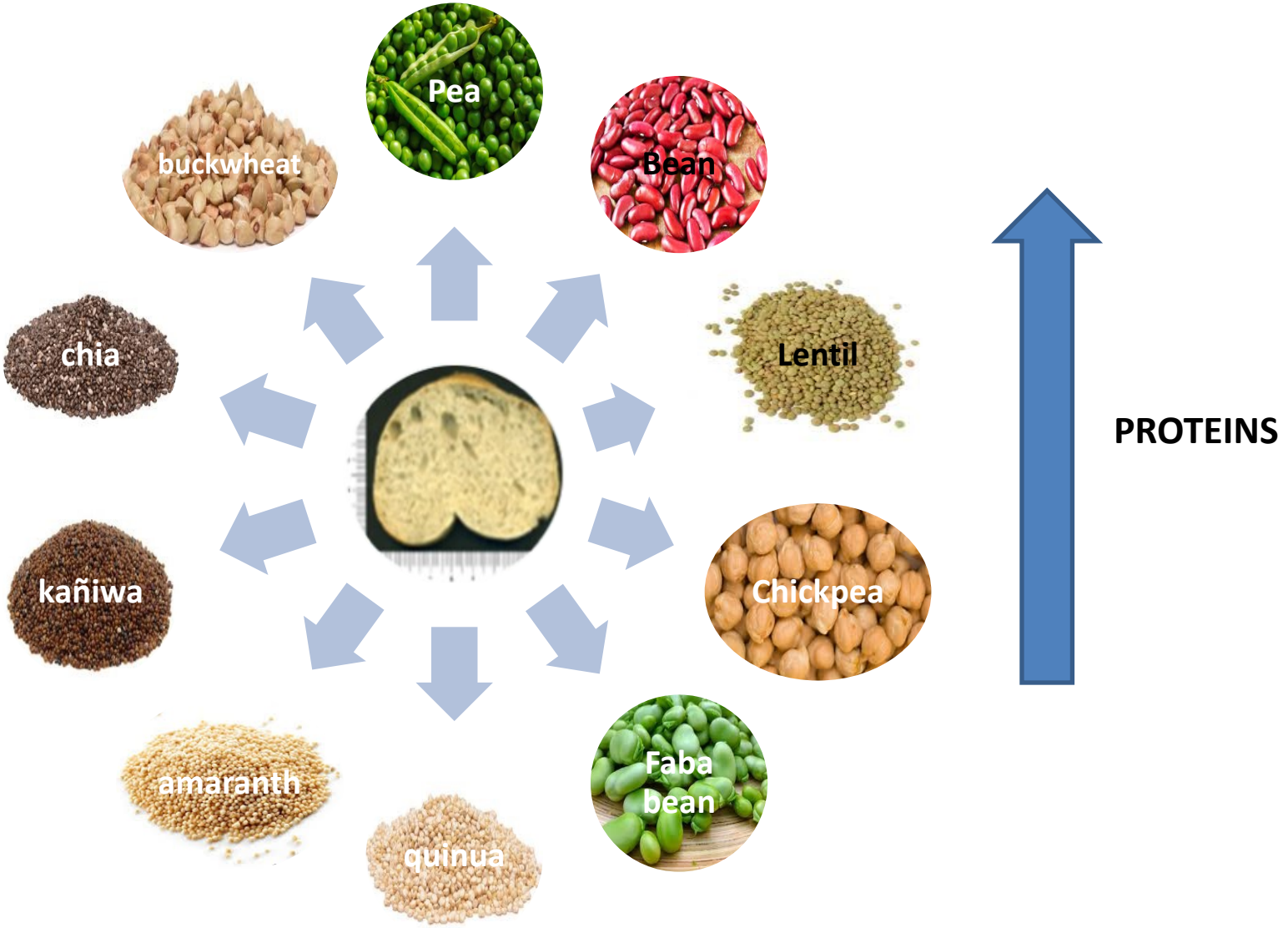
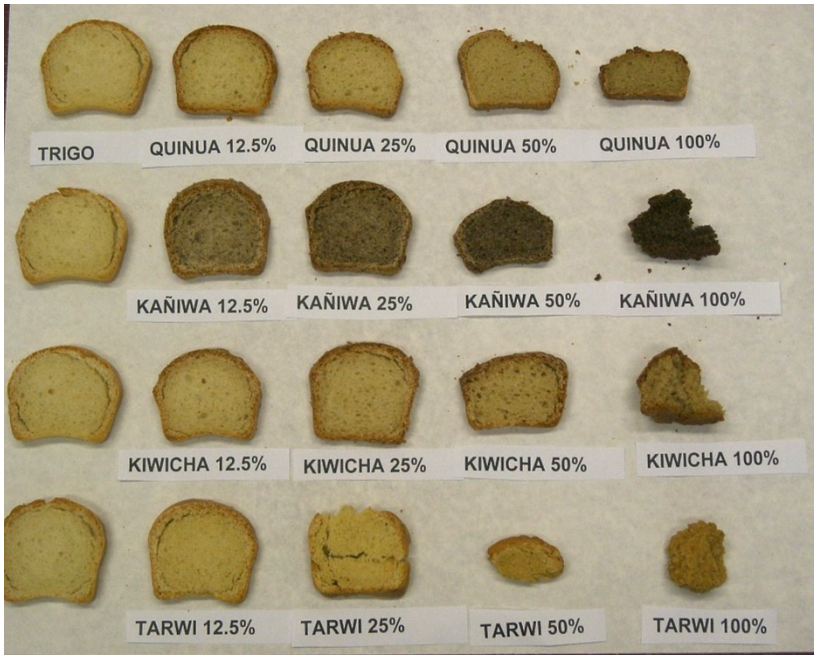
Alternatively….



Alternative ingredients

Sample	Blend [a] %	Hardness g force	Overall Acceptance 1-10
Quinoa	0	508 a	7.3 b
	12.5	461 a	8.0 b
	25	1013 b	7.5 b
	50	2815 c	5.5 a
	100	4249 d	4.5 a
Kañiwa	0	508 a	7.3 c
	12.5	497 a	7.5 c
	25	645 a	7.0 c
	50	3886 b	3.8 b
	100	nd	0.7 a
Kiwicha	0	508 a	7.3 c
	12.5	455 a	8.3 d
	25	454 a	7.3 c
	50	1520 b	5.8 b
	100	2599 c	2.0 a
Tarwi	0	508 a	7.3 d
	12.5	1014 b	6.3 c
	25	2427 c	3.3 b
	50	6105 d	1.0 a
	100	nd	0.3 a



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Rosell, Cortez, Repo-Carrasco (2009)

Alternative ingredients

African Journal of Food Science Vol. 5(8), pp. 466 - 472, August 2011
Available online http://www.academicjournals.org/ajfs
ISSN 1996-0794 ©2011 Academic Journals

Full Length Research Paper

Evaluation of the nutritional and sensory quality of functional breads produced from whole wheat and soya bean flour blends

Joel Ndife*, L. O. Abdulraheem and U. M. Zakari

International Food Research Journal 19(2): 521-525 (2012)

Impact of adding chickpea (*Cicer arietinum* L.) flour to wheat flour on the rheological properties of toast bread

[1]Hefnawy, T. M. H., [2]El-Shourbagy, G. A. and [1*]Ramadan, M. F.

Journal of the Science of Food and Agriculture

J Sci Food Agric **85**:1889–1896 (2005)
DOI: 10.1002/jsfa.2191

Effect of soybean addition on the rheological properties and breadmaking quality of wheat flour

Pablo D Ribotta,[1,2] Sebastián A Arnulphi,[2] Alberto E León[2]*
and María C Añón[3]

Industrial Crops and Products 36 (2012) 196–202

Contents lists available at SciVerse ScienceDirect

Industrial Crops and Products

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

Journal of Microbiology, Biotechnology and Food Sciences

Bojňanská et al. 2012 : 1 (February Special issue) 876-886

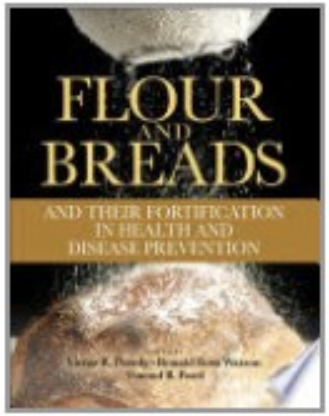
Dough rheology and bread quality of wheat–chickpea flour blends

Idriss Mohammed[a,b], Abdelrahman R. Ahmed[a,c,*], B. Senge[a]

REGULAR ARTICLE

LEGUMES – THE ALTERNATIVE RAW MATERIALS FOR BREAD PRODUCTION

Tatiana Bojňanská, Helena Frančáková, Miriam Líšková, Marian Tokár*



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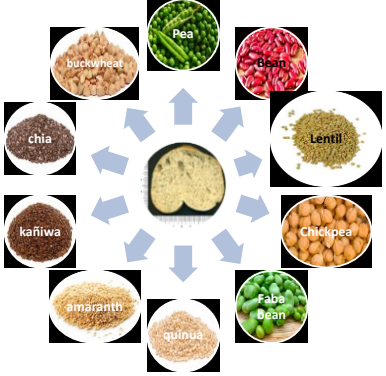
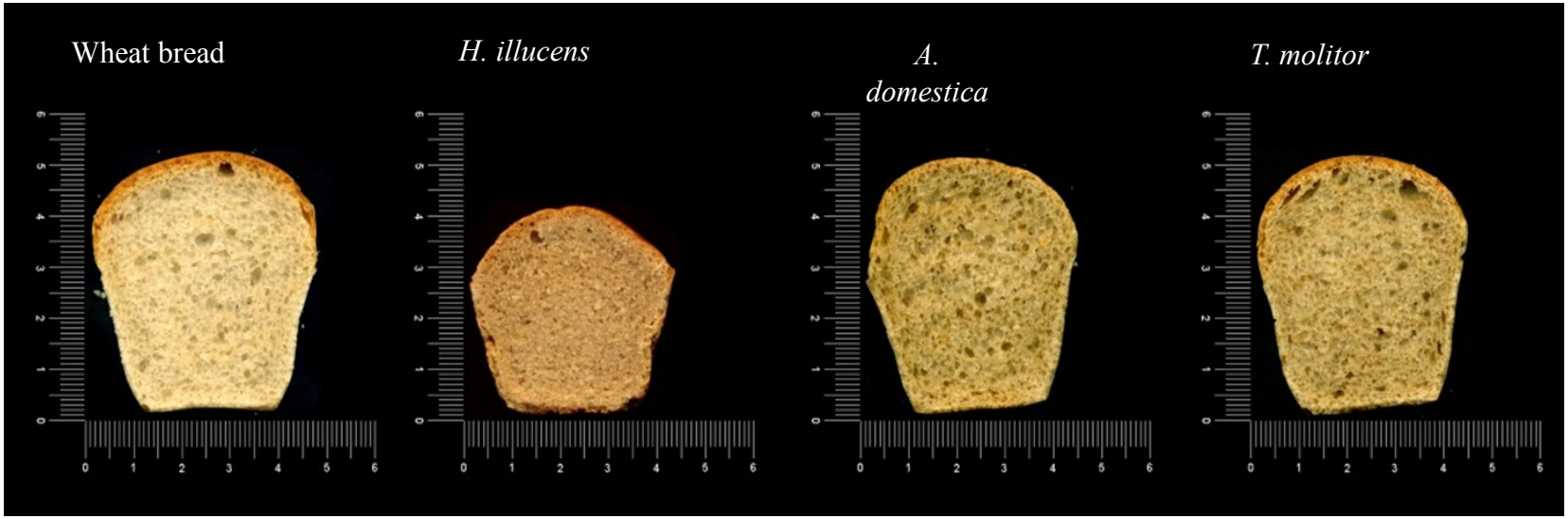
Rosell, Cortez, Repo-Carrasco (2009)

Alternative ingredients



	Wheat Flour			*H. Illucens*			*A. domestica*			*T. molitor*		
Proteins	12.69	±	0.60[a]	45.09	±	0.82[b]	56.58	±	0.86[d]	48.82	±	0.76[c]
NPN	-	±	-	0.52	±	0.02[a]	0.66	±	0.00[b]	0.85	±	0.07[c]
Fat	1.19	±	0.02[a]	35.82	±	0.66[d]	27.08	±	0.72[b]	30.69	±	0.80[c]
Ash	0.64	±	0.01[a]	4.25	±	0.00[c]	4.02	±	0.01[b]	4.25	±	0.01[c]
C.H	70.83	±	0.00[d]	10.41	±	0.00[c]	2.15	±	0.00[a]	9.59	±	0.00[b]



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Gonzalez CM, Garzon R, Rosell CM, (2018.) Submitted

Insects are richer

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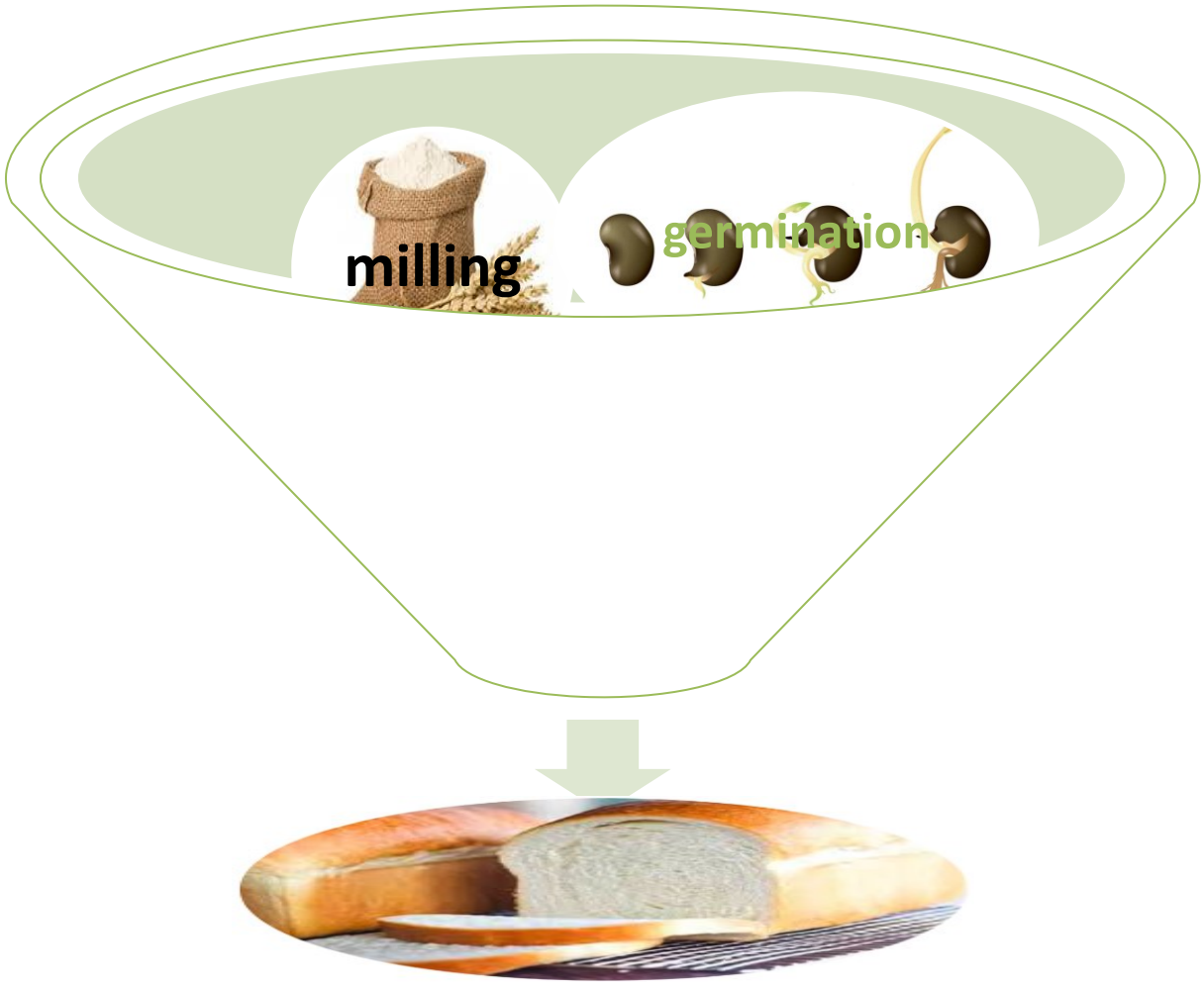
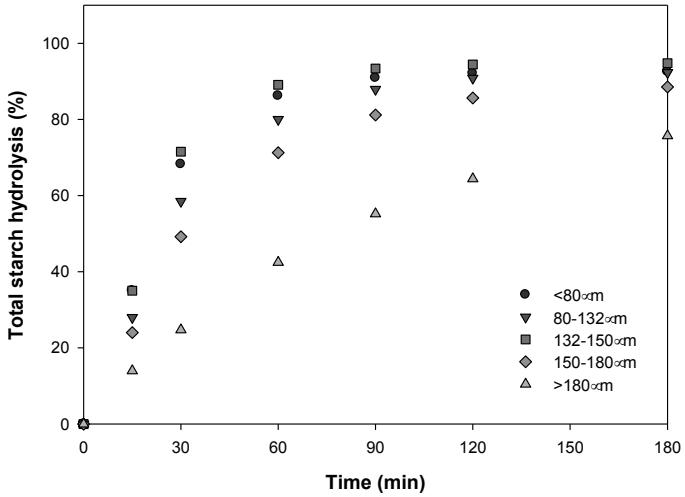
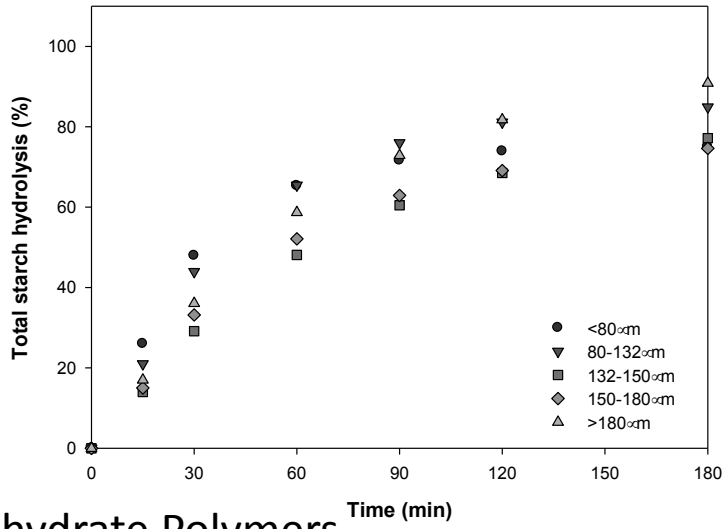
Physical processing….



Fractionation

		Resistant starch (%)
Short grain	<80	2.30
	80-132	3.80
	132-150	2.25
	150-180	3.68
	>180	2.42
Long grain	<80	2.15
	80-132	2.30
	132-150	2.50
	150-180	2.33
	>180	3.80





de la Hera, Gómez, Rosell (2013), Carbohydrate Polymers

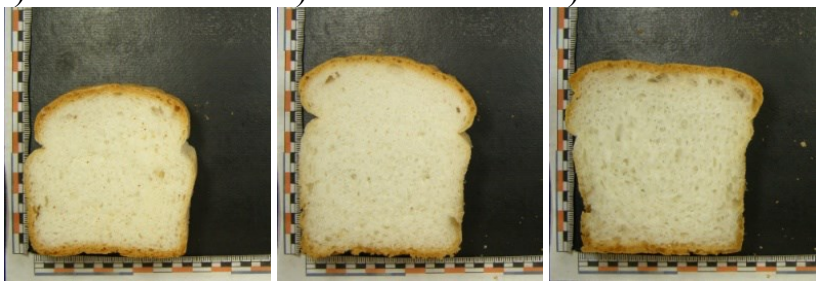
Fractionation

A)

Fine

B)

Coarse



		C_∞ (g/100g)	k (min^{-1})	AUC	H90	HI	eGI
	Overall Mean	96.55	0.108	48.82	95	96	91
Particle Size	Fine	97.4 a	0.131 b	48.61 a	95 a	95 a	90 a
	Coarse	95.7 a	0.086 a	49.01 a	96 a	96 a	91 a
Water Content (%)	70	96.5 a	0.085 a	46.99 a	93 a	92 a	87 a
	90	96.4 a	0.120 b	49.41 b	96 b	97 b	92 b
	110	96.7 a	0.120 b	50.05 b	97 b	98 b	93 b

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de la Hera, Rosell, Gómez (2014), Food Chem

Intensive milling & Fractionation

Table 1 Sample codes describing the jet mill settings for the samples treatment

Flour code	Air pressure (bar)	Feed Rate (kg/h)	Vibration Rate of Feeder (%)	Feedback	Particle size d50 (μm)
Control	–	–	–	–	127.45
F1	4	2.71	100	No	62.30
F2	8	4.08	100	No	22.94
F3	8	1.93	100	Yes	11.44

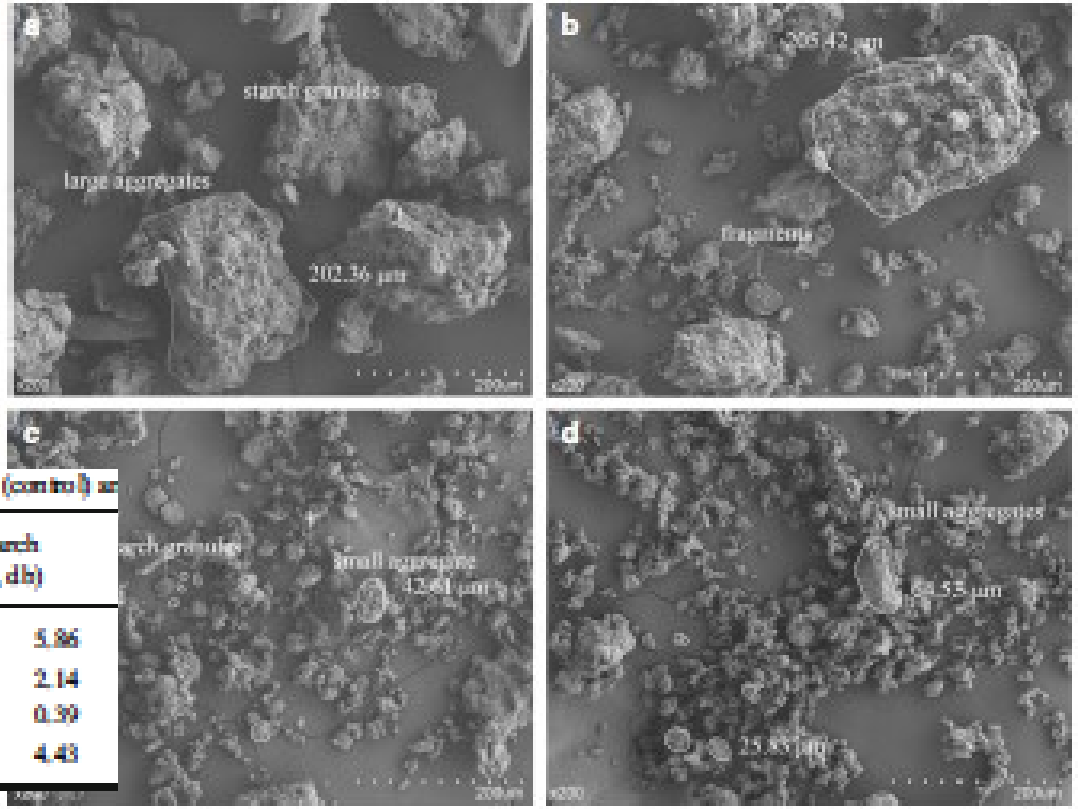

Table 5 Kinetic parameters of the starch hydrolysis of wheat flour samples (control) a

Sample	Free sugars (mg/100 mg, db)				Resistant Starch (mg/100 mg, db)			Digestible starch (mg/100 mg, db)		
Control	0.54	±	0.01	a	6.85	±	3.42	58.94	±	5.86
F1	0.82	±	0.00	b	9.58	±	2.88	58.78	±	2.14
F2	0.94	±	0.00	b	9.75	±	2.88	57.85	±	0.39
F3	1.25	±	0.01	c	11.64	±	0.79	57.84	±	4.43

Angelidis, Protonotariou S., I. Mandala, C. M. Rosell (2016)

Intensive milling & Fractionation

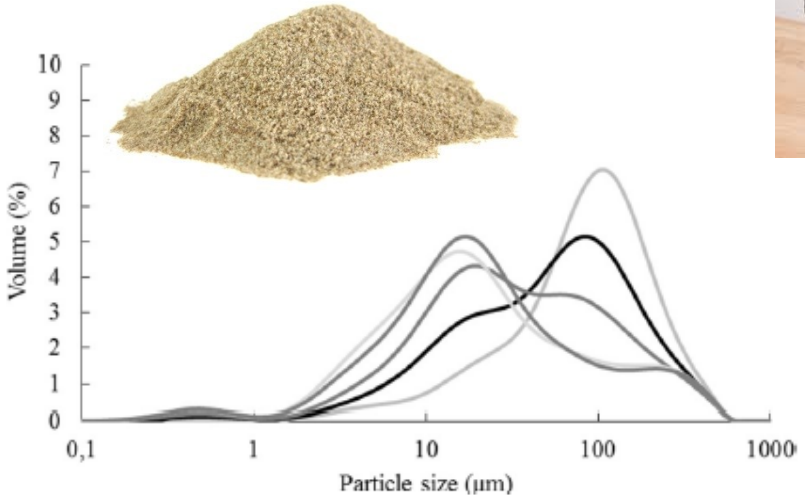

Fig. 1 Particle size distribution by volume of whole wheat flour of whole wheat flour WWF and jet milled whole wheat flours at different milling conditions: WWF (—), WF1 (—), WF2 (—), WF3 (—), and WF4 (—)

Table 1 Settings used for jet milling of whole wheat flour

Flour abbreviation	Air pressure (bar)	Feed rate (kg/h)	Vibration rate of feeder (%)	Feedback	d_{50} (µm)	d_{32} (µm)	d_{43} (µm)
WWF	–	–	–	–	84.15 ± 2.45 a	49.23 ± 6.43 a	120.25 ± 2.52 a
WF1	4	4.51	100	No	53.49 ± 3.38 b	18.37 ± 0.17 b	90.62 ± 2.38 b
WF2	8	0.67	70	No	18.11 ± 1.73 c	7.23 ± 2.72 c	57.18 ± 1.11 c
WF3	8	5.18	100	No	29.10 ± 3.09 d	10.57 ± 0.77 d	70.04 ± 1.47 d
WF4	8	2.54	100	Yes	17.02 ± 1.38 c	6.94 ± 1.27 c	57.79 ± 0.53 c

Included are particle sizes (µm) of control (WWF) and jet milled flours (WF1, WF2, WF3, WF4)

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Protonotariou S., I. Mandala, C. M. Rosell (2015)

Intensive milling & Fractionation

Flour Sample	Moisture (%)				Protein (%, db)				Ash (%,db)			Insoluble Fiber (%, db)				Total Fiber (%, db)			
WWF	11.95	±	0.00	d	15.00	±	0.18	a	1.31	±	0.00	a	9.23	±	0.11	b	13.01	±	0.53	a
WF1	8.57	±	0.01	c	15.08	±	0.32	ab	1.31	±	0.01	a	8.39	±	0.34	ab	14.25	±	0.66	b
WF2	6.64	±	0.08	a	15.51	±	0.01	b	1.42	±	0.00	b	8.89	±	0.72	ab	14.72	±	0.16	b
WF3	7.84	±	0.05	b	15.22	±	0.09	ab	1.33	±	0.02	a	8.39	±	0.06	ab	14.24	±	0.04	b
WF4	6.61	±	0.01	a	15.30	±	0.02	ab	1.33	±	0.00	a	7.82	±	0.79	a	14.30	±	0.10	b

Protonotariou S., I. Mandala, C. M. Rosell (2015)

Intensive milling & Fractionation

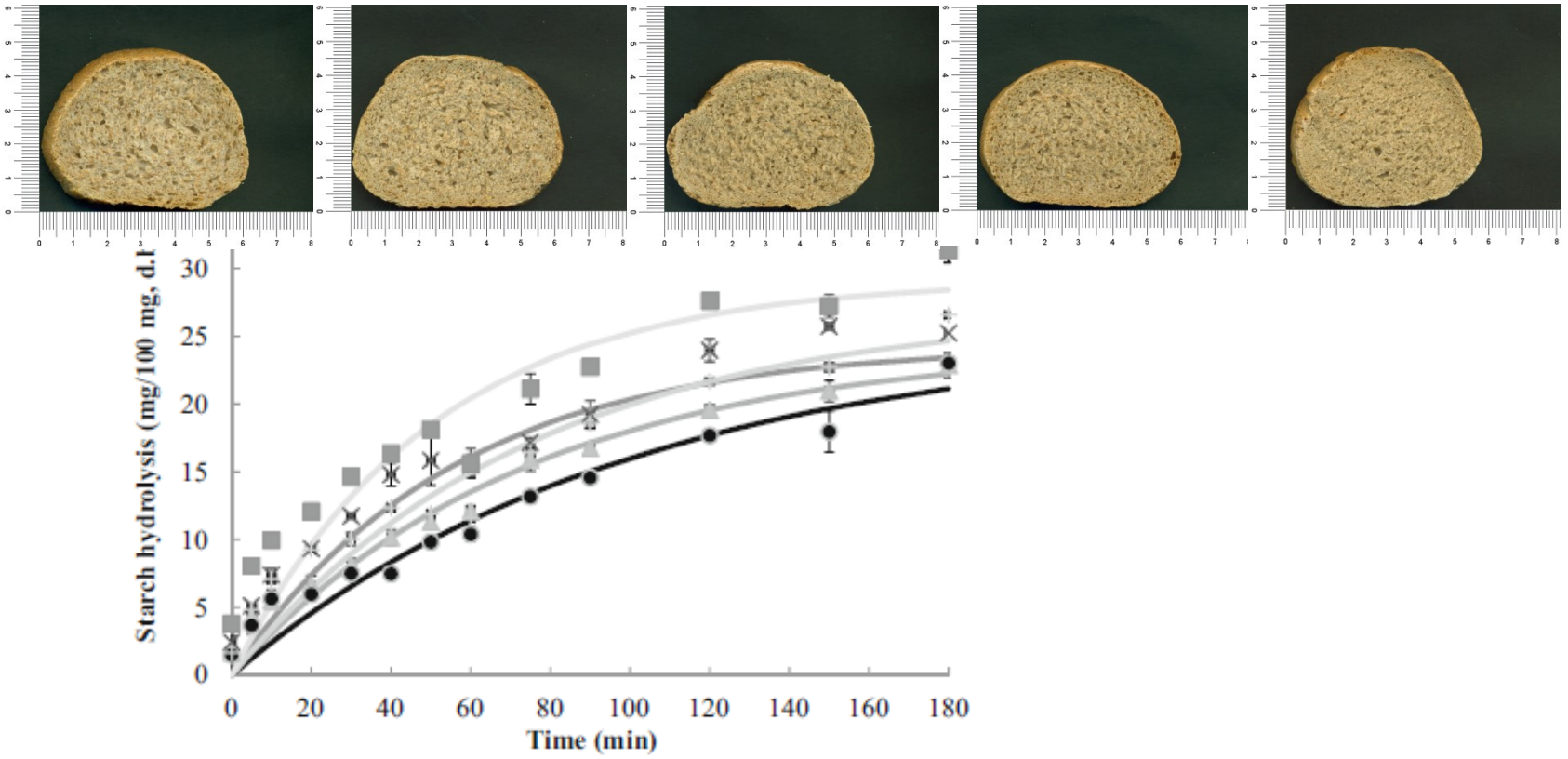


Fig. 3 Effect of different jet milling conditions in the enzymatic starch hydrolysis kinetics of whole wheat flour WWF (*triangle*), WF1 (*circle*), WF2 (*multiplication sign*), WF3 (*plus sign*), and WF4 (*square*). Particle size order is WWF>WF1>WF3>WF2≥WF4

Protonotariou S., I. Mandala, C. M. Rosell (2015)

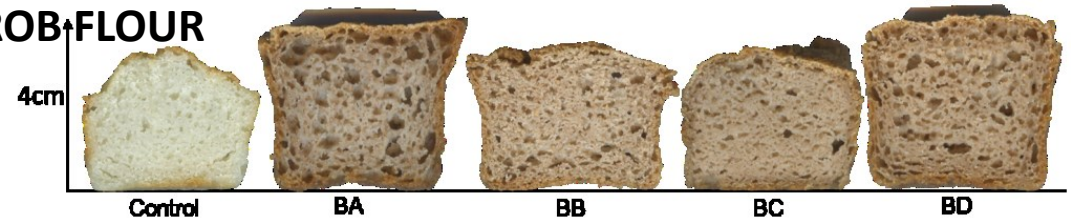
Intensive milling & Fractionation

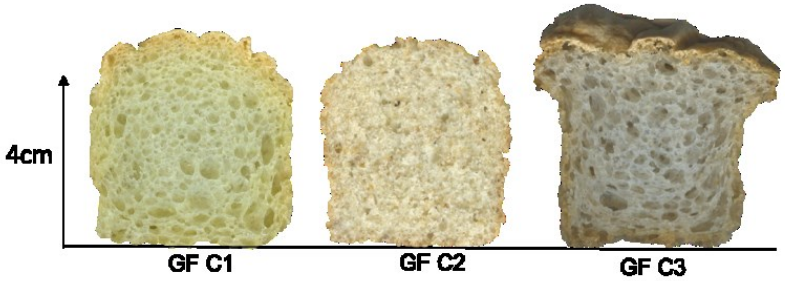
CAROB FLOUR

Samples	D_{50} (µm)	Moisture (%)	Protein (% w.b.)	Dietary Fibre (% w.b.)
Carob flour fractions				
FA	258.55 (0.68)[a]	9.39 (0.01)[a]	14.93 (0.24)[a]	65.61 (2.34)[c]
FB	174.73 (0.45)[b]	8.75 (0.05)[a]	22.96 (0.74)[c]	51.80 (2.67)[b]
FC	126.37 (2.10)[c]	9.28 (0.07)[a]	25.70 (0.03)[d]	43.46 (1.45)[a]
FD	80.36 (6.38)[d]	9.82 (0.06)[b]	18.86 (0.09)[b]	53.25 (1.64)[b]
Rice /Carob flour blend (85/15)		Water added for breadmaking (% flour basis)		
MA		150	8.5	10.2
MB		140	9.7	8.1
MC		120	10.1	6.9
MD		130	9.1	8.4
Commercial GF blends				
C1		80*	2.3	-
C2		80*	5.5	6.3
C3		86*	3.5	4.7

Intensive milling & Fractionation

CAROB FLOUR





Sample code	Moisture content	Protein	Insoluble Dietary Fibre	Total Dietary Fibre	Ash	eGI
Control	58.27 (1.13)^{b}	9.06 (0.05)^{e}	3.28 (0.14)^{bc}	3.79 (0.00)^{abc}	0.54 (0.02)^{b}	119.03 (3.25)^{e}
BA	65.36 (2.63)^{de}	7.80 (0.00)^{d}	4.58 (1.43)^{c}	6.26 (0.91)^{c}	0.56 (0.03)^{b}	92.34 (1.97)^{cd}
BB	65.89 (0.27)^{e}	9.79(0.02)^{f}	4.21 (2.02)^{c}	5.79 (0.49)^{bc}	0.71 (0.03)^{c}	104.19 (15.08)^{d}
BC	61.69 (1.02)^{c}	9.99(0.05)^{f}	2.84 (0.04)^{bc}	4.69 (2.56)^{abc}	0.76 (0.00)^{c}	62.86 (1.87)^{b}
BD	63.11 (1.13)^{cd}	9.06(0.04)^{e}	3.52 (0.00)^{bc}	3.53 (0.00)^{abc}	0.74 (0.05)^{c}	47.33 (0.10)^{a}
GF C1	53.30 (1.22)^{a}	2.42(0.13)^{a}	1.66 (0.72)^{ab}	2.02 (2.11)^{a}	0.44 (0.03)^{a}	82.76 (2.64)^{c}
GF C2	53.77 (0.76)^{a}	4.74(0.03)^{c}	0.36 (0.10)^{a}	5.14 (0.69)^{bc}	1.34 (0.03)^{d}	55.90 (1.13)^{ab}
GF C3	54.13 (1.98)^{a}	3.07(0.23)^{b}	3.06 (0.01)^{bc}	3.21 (0.80)^{ab}	0.73 (0.04)^{c}	60.85 (4.38)^{b}

iata Tsatsaragkou K, Kara T, Ritzoulis C, Mandala I, Rosell CM (2017)

Extrusion

Flour Code	Barrel Temperature (ºC)	Feed Rate (Kg/h)	Feed Moisture Content (%)
0	-	-	-
1	80	275	3.6
2	120	900	4.4
3	120	400	15
4	120	275	21.8
5	160	500	10

	k (min^{-1}) by first order eq.	k (min^{-1}) by LOS	C_∞ (%)	C_∞ (%) by LOS	Resistant starch (%)
0	0.048	0.046	125.00	130.32	6.11
1	0.103	0.094	292.46	306.15	8.96
2	0.034	0.034	137.82	142.06	4.50
3	0.055	0.053	147.10	156.94	5.80
4	0.049	0.047	147.90	155.73	3.69
5	0.093	0.088	223.81	255.40	2.29

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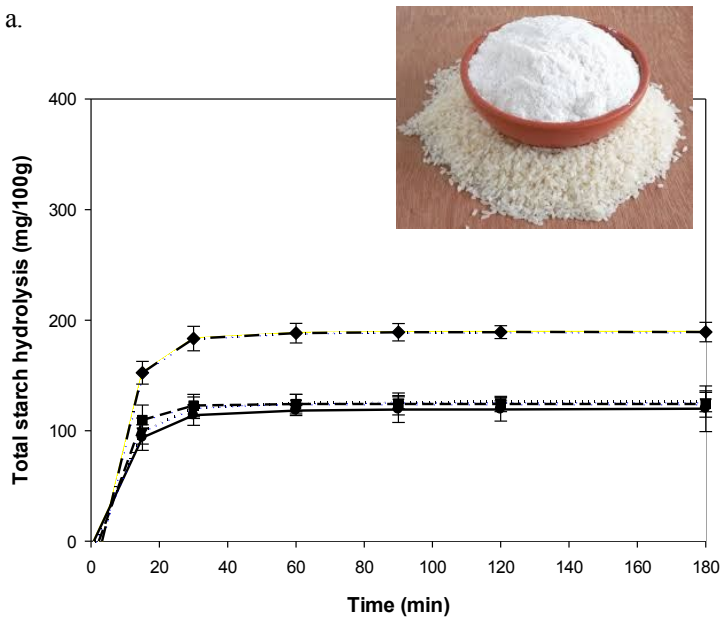
Martínez, Rosell, Gómez. (2014) Journal of Food Engineering

Extrusion

	Resistant starch (%)
0f	5.52(0.50)
0c	5.91(0.86)
1f	3.29(0.38)
2f	4.01(0.74)
3f	2.23(0.36)
1c	6.10(1.32)
2c	5.75(0.98)
3c	2.11(0.51)



Coarse

Fig 2 Effect of extrusion treatment on the enzymatic hydrolysis of rice flours with different particle size. Flour 0 (●,black line), flour 1 (▼, clear grey line), flour 2 (■, intermediate tone grey line), flour 3 (♦, dark grey line). Coarse flours (a), fine flours (b)

Fine

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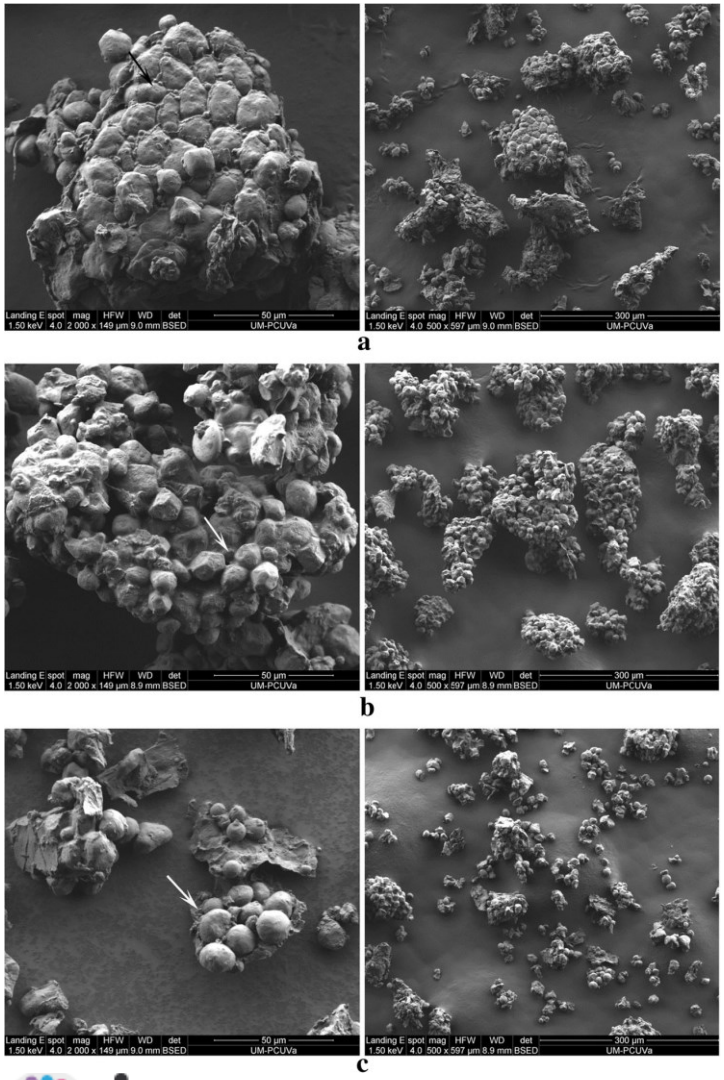
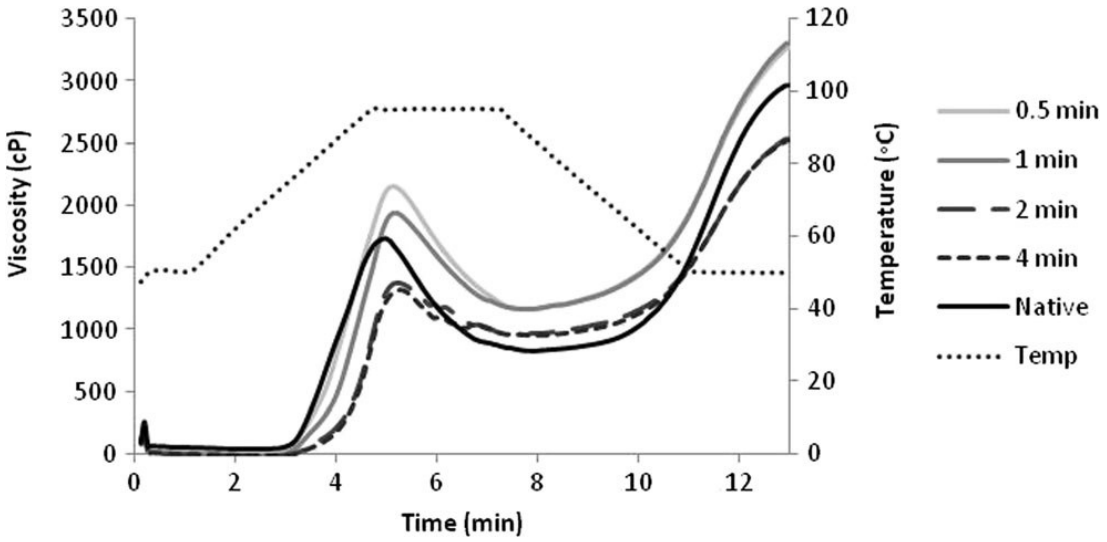
Martínez, Calviño, Rosell, Gómez (2014) Food Bioprocess Technol.

Microwave



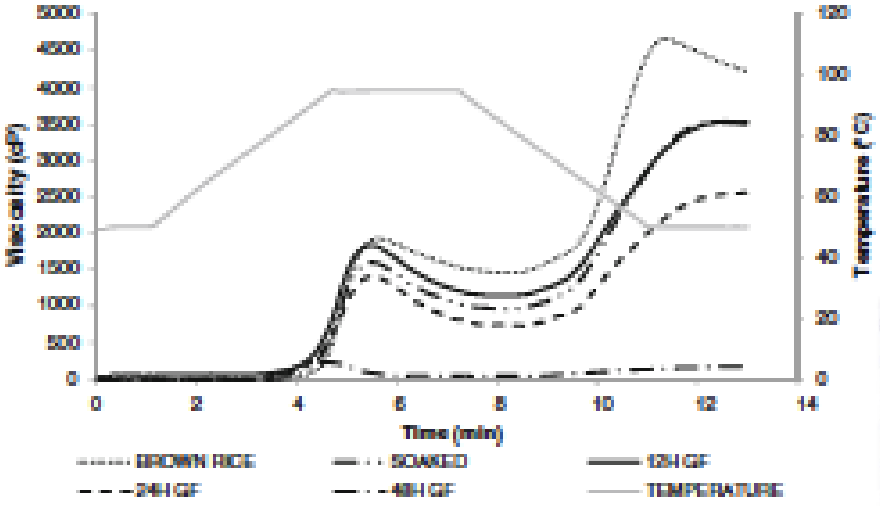
Corn flour



Martínez, Calviño, Rosell, Gómez (2014) Food Bioprocess Technol.

Germination

Treatment	WBC (g/g)	WHC (g/g)	SV (ml/g)	WAI (g/g)	WSI (g/100g)	SP (g/g)	OAC (g/g)
Brown Rice	1.52±0.03^{a}	1.68±0.14^{a}	3.10±0.00^{a}	11.64±0.21^{a}	0.03±0.00^{c}	12.02±0.23^{a}	1.59±0.01^{b}
Soaked	1.39±0.04^{b}	1.23±0.05^{c}	3.03±0.06^{a}	9.72±0.31^{b}	0.05±0.01^{b}	10.27±0.35^{b}	1.63±0.02^{b}
12H GF	1.35±0.02^{b}	1.43±0.07^{b}	3.00±0.00^{a}	9.87±0.22^{b}	0.06±0.01^{b}	10.63±0.52^{b}	1.63±0.07^{b}
24H GF	1.26±0.04^{c}	1.55±0.18^{ab}	2.43±0.12^{b}	9.95±0.25^{b}	0.05±0.01^{bc}	10.46±0.28^{b}	1.60±0.01^{b}
48H GF	1.02±0.04^{d}	0.89±0.01^{d}	2.49±0.00^{b}	5.65±0.31^{c}	0.15±0.03^{a}	6.46±0.55^{c}	1.71±0.02^{a}



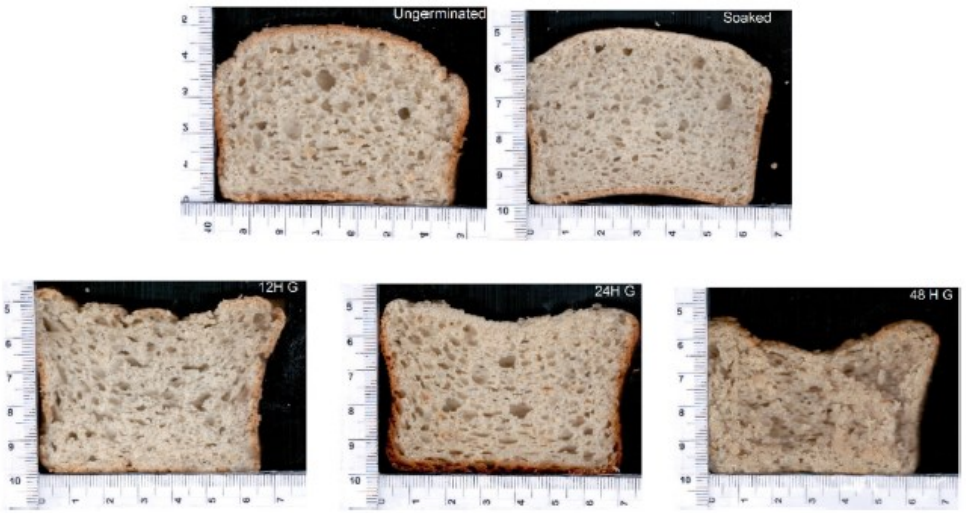


Fig. 2 Gluten free bread slices from brown, soaked and germinated brown rice flour

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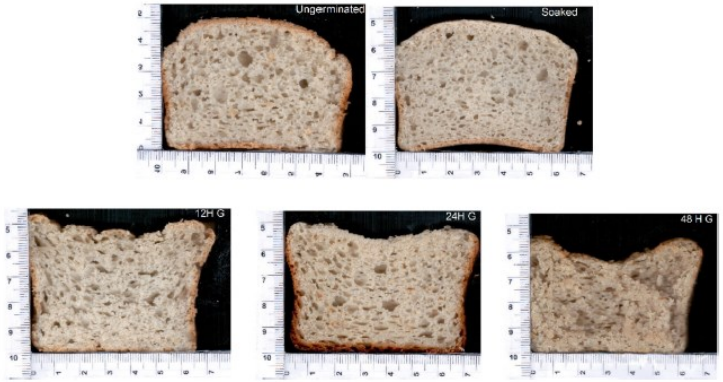

Fig. 2 Gluten free bread slices from brown, soaked and germinated brown rice flour

Treatment	Moisture (g/100g)	Total Protein (g/100g)	Fat (g/100g)	Carbohydrates (g/100g)	Ash (g/100g)	Energy (Kcal)	Free Glucose (g/100g)	Phytic acid (g/100g)
BR	49.77±2.15a	6.03±0.05c	6.96±0.05b	74.19±0.91a	2.85±0.01a	214±9b	0.29±0.02d	1.09±0.05c
Pre-GBR	50.08±1.40a	6.12±0.04c	6.74±0.04c	74.20±1.01a	2.42±0.03d	213±6b	0.31±0.02d	0.82±0.06a
12h GBR	50.46±1.72a	8.14±0.21a	6.50±0.06d	72.45±1.18b	2.65±0.04b	210±7b	0.39±0.03c	0.82±0.08a
24h GBR	49.98±0.75a	8.01±0.08ab	5.58±0.03e	73.74±0.55ab	2.52±0.03c	209±3b	0.52±0.04b	0.95±0.02b
48h GBR	44.45±1.49b	7.81±0.12b	7.72±0.04a	72.49±0.51b	2.35±0.05e	230±1a	0.97±0.02a	0.81±0.02a

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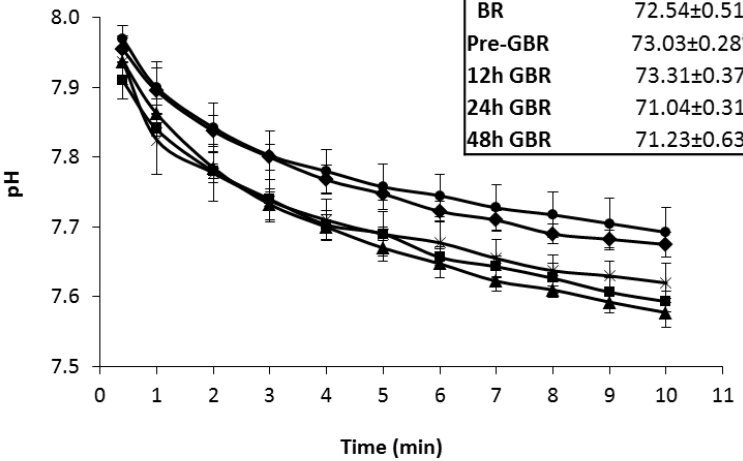
Breads	Protein digestibility (%)
BR	72.54±0.51[b]
Pre-GBR	73.03±0.28[ab]
12h GBR	73.31±0.37[a]
24h GBR	71.04±0.31[c]
48h GBR	71.23±0.63[c]



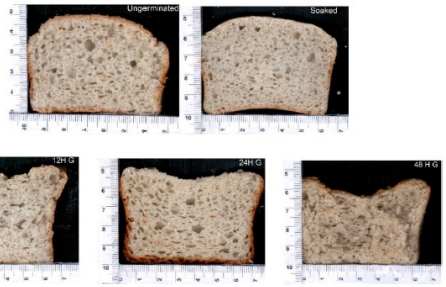
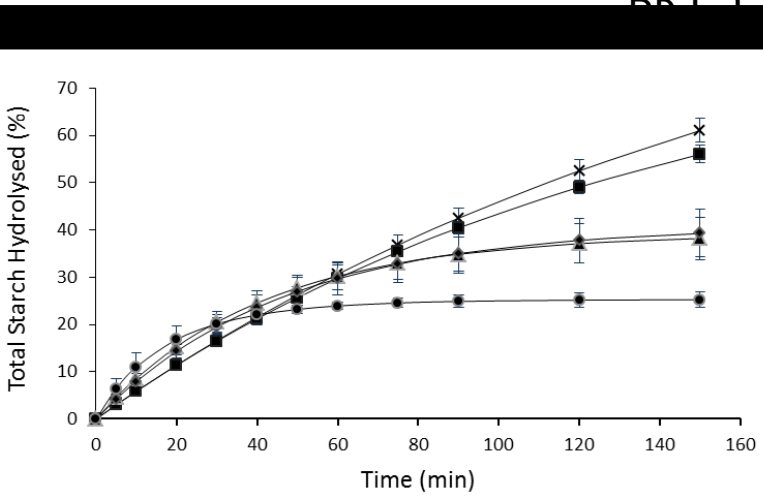


Fig. 2 Gluten free bread slices from brown, soaked and germinated brown rice flour

BR (*), Pre-GBR (■),12h GBR (▲), 24h GBR (◆),48h GBR (●).



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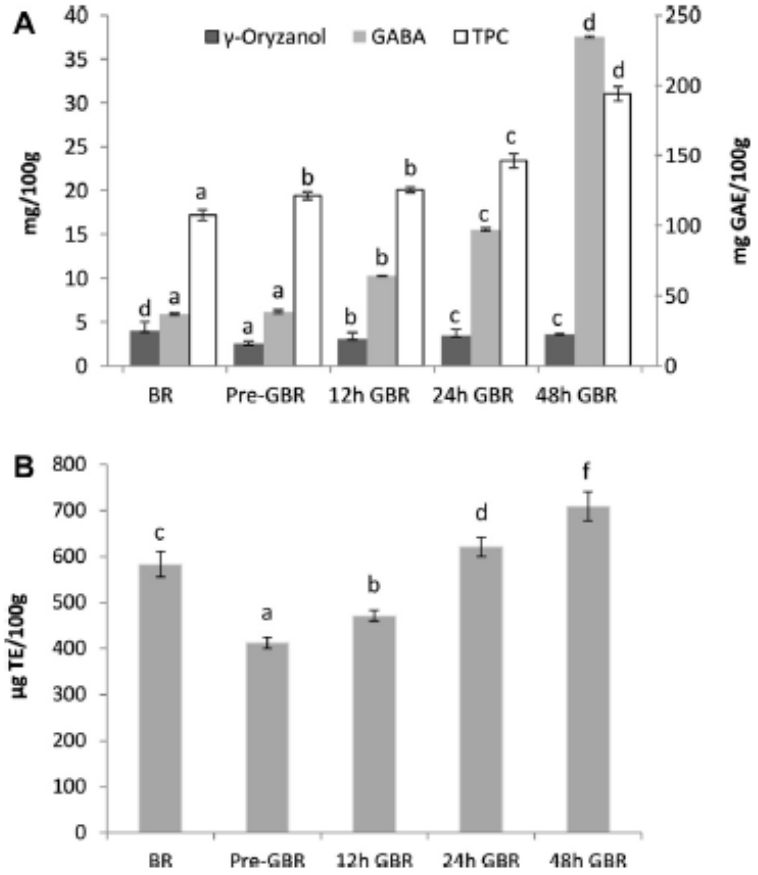

Fig. 2. GABA, γ-oryzanol and total polyphenol contents (TPC) (A); and antioxidant activity (B) of gluten free breads from brown rice (BR), pre-germinated brown rice (Pre-GBR) and germinated brown rice for 12 (12 h GBR), 24 (24 h GBR) and 48 h (48 h GBR). Error bars indicate standard deviation. Different letters indicate significant differences ($P \leq 0.05$, LSD test).

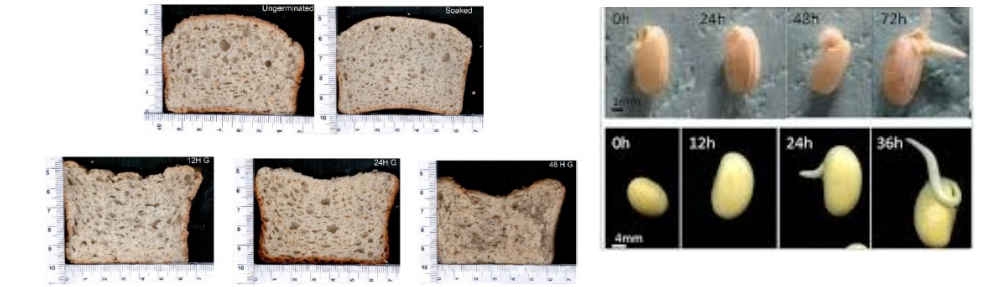

Fig. 2 Gluten free bread slices from brown, soaked and germinated brown rice flour

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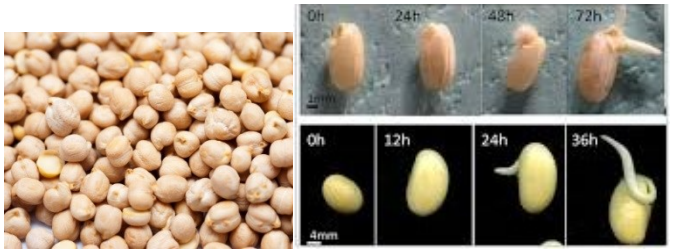

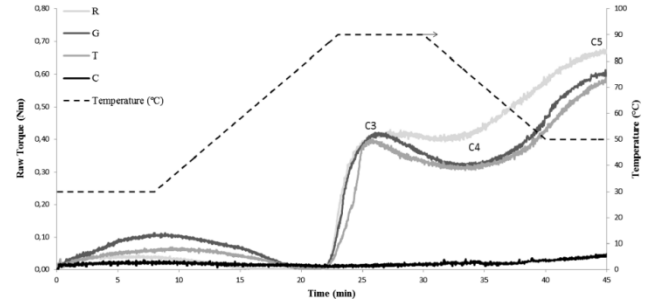

Mixolab® curves of raw (R), germinated (G), toasted (T) and cooked (C) chickpea flours

Raw Germinated Toasted Cooked

Table 4 Chemical composition of chickpea based breads

Chickpea processing	Ash content (% as is)	Fat content (% as is)	Protein content (% as is)	Carbohydrate * content (% as is)
Raw	2.17 ± 0.00d	3.73 ± 0.00b	11.16 ± 0.18c	33.70 ± 0.18d
Germinated	2.11 ± 0.01c	3.37 ± 0.06a	11.22 ± 0.07c	31.96 ± 0.12c
Toasted	1.89 ± 0.01b	4.33 ± 0.06c	10.14 ± 0.02b	31.23 ± 0.07b
Cooked	1.35 ± 0.00a	4.41 ± 0.01c	8.66 ± 0.05a	25.00 ± 0.06a
P-value	0.0000	0.0000	0.0000	0.0000

Means in a column with different letters are significantly different ($P < 0.05$)

* Carbohydrate content was calculated by difference

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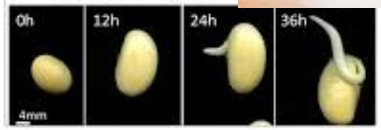
Making innovation from a traditional food

- Volume
- Softness
- Taste
- ….



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