



Chaya C., Novillo M.C., Rodríguez G. and Callejo M.J.

*13th ICC Cereal and Bread Congress  
Special session: revisiting top demanded cereal topics  
at Cerworld 21st*



## **HEALTHIER CEREAL PRODUCTS: BREADMAKING WITH BARLEY FLOUR**



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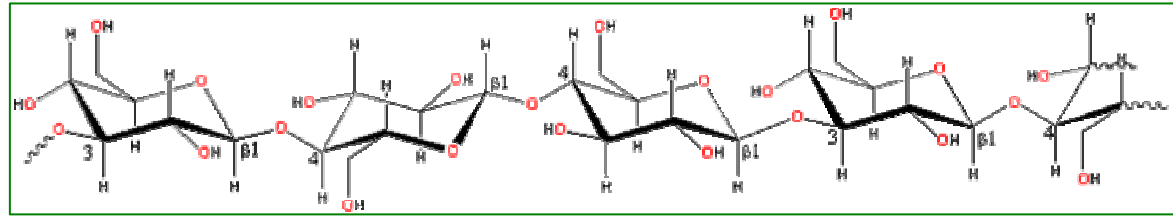
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***Promote consumption of barley breads, in order to improve intake of fibre and health-enhancing components***

- Instrumental evaluation of barley substituted wheat dough
- Bread-making performances of flours
- Instrumental evaluation of breads
- Sensory consumer evaluation of breads



# Health promotive compounds of barley



## Non-starch polysaccharides (NSP)

- (1→3,1→4)-β-D-glucan

4-10% [Holtekjølén et al \(2005\)](#)

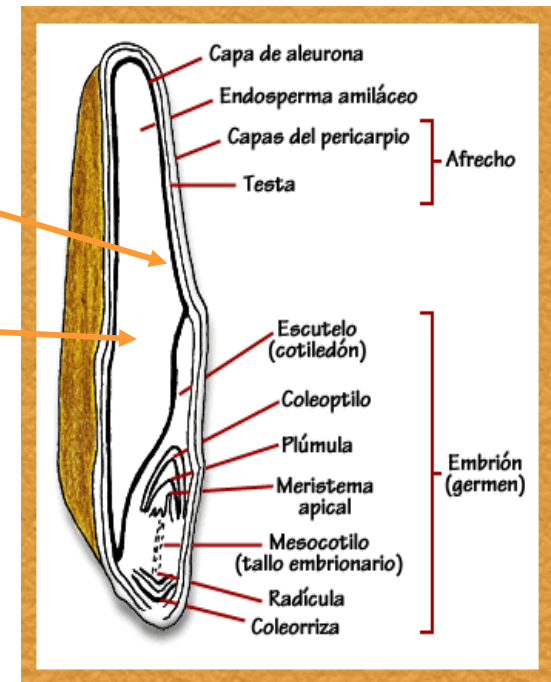
3-11% [Holtekjølén et al \(2006\)](#)

18% [Östman et al \(2006\)](#)

- arabinoxylans (AX):

7-16% ([Holtekjølén et al, 2006](#))

3–11% ([Han and Schwarz, 1996](#), [Jadhav et al., 1998](#) and [Lehtonen and Aikasalo, 1987b](#)). En [Holtekjølén et al \(2006\)](#)



## Proanthocyanidins

## Phenolic acids

## Minerals

## Antioxidants

[Holtekjølén et al \(2005\)](#), [Ragae S. et al \(2006\)](#)



## *High contents of $\beta$ -glucans barleys: suitable for functional food products*

- ④ Blood **glucose lowering** effect
- ④ Increase the viscosity of intestinal fluid and thereby **reduce** the rate of **sugar/starch absorption**
- ④ **Lower** blood **cholesterol** level and, therefore, reduce the risk of heart disease
- ④ Lower risk of different **cancers, coronary heart disease and diabetes**

*Keagy et al.(2001), Cavallero et al, 2002, Dhingra and Jood (2002), Gill et al. (2002), Vasanthan et al (2002), Dongowski et al (2006), Ragae and Abdel-Aal (2006)*



## ***Consequences of barley use: previous studies***

- ✦ **AX and (1→3,1→4)-β-D-glucan affect technological properties and **baking performance**** (*Trogha et al, 2004; Holtekjølen, 2005; Holtekjølen et al, 2006, Ragae and Abdel-Aal, 2006, Jacobs et al 2008*)
- ✦ **Organoleptic characteristics in bread** (*Shfali Dhingra and Jood, 2002*)
- ✦ **Physical properties and acceptability of pita bread, cakes or cookies** (*Ragae and Abdel-Aal, 2006*)
- ✦ **Nutricional properties** (*Trogha et al, 2004; Vasanthan et al, 2002; Gill et al, 2002; Ragae and Abdel-Aal, 2006*)



***Instrumental and sensory consumer evaluation of 3 different pan breads samples:***

- ***white pan bread (100% wheat flour) and two supplemented barley breads***



## *Flours composition*



- A strong commercial wheat flour (100 W) *Chopin blender*

And two flour blends consisting of :

- 85% wheat flour and 15% barley flour: (85W/15B)
- 70% wheat flour and 30% barley flour: (70W/30B)

Barley flour (11.87% protein (dm), 1.08% ash (dm))  
HARINAS ESTEBAN, S.A. , Valladolid, España



## Dough rheology

- ☞ Chopin Alveograph (ICC-No. 121: *Method for using the Chopin Alveograph*).
- ☞ Chopin Consistograph (ICC No. 171: *Determination of the water absorption capacity of wheat flours and of physical properties of wheat flour dough using the Consistograph*)
- ☞ Falling Number (ICC No. 107: *Determination of the "Falling Number" according to Hagberg-Perten as a Measure of the Degree of Alpha-Amylase Activity in Grain and Flour*)

*Falling Number*



*Chopin Alveoconsistograph*





## ***Baking performances***

using a fixed hearth bread baking process, in which

- ✓ 100 g (14% moisture basis) of wheat flour (control sample) or blended flour
- ✓ 1,1g active dry yeast (Saff Instant de Lesaffre)
- ✓ 1.8 g salt
- ✓ 59% water absorption
- ✓ Barley malt necessary for FN: 250 sec

- *mixing time until correct dough development*
- *Fermentation: 38 °C, 80%RH, time: 2 h*



# Instrumental evaluation of breads

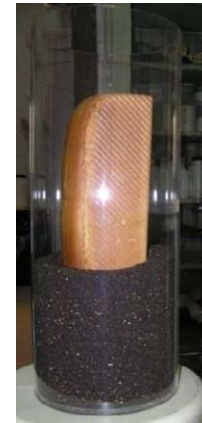


### TEST

- ✓ Single Cycle
- ✓ Compression of height: 8 mm
- ✓ Pre Test Speed: 1 mm/s
- ✓ Test Speed: 0,5 mm/s
- ✓ Post Test Speed: 10 mm/s
- ✓ Diameter of the Probe: 7 cm

Crumbs firmness on days 1, 4 and 7

### Volume



$$SV = \frac{\text{loaf volume (cm}^3\text{)}}{\text{loaf weight (g)}}$$

For each blend, 3 batches of dough were prepared  
 For each batch of dough 4 pan breads were baked

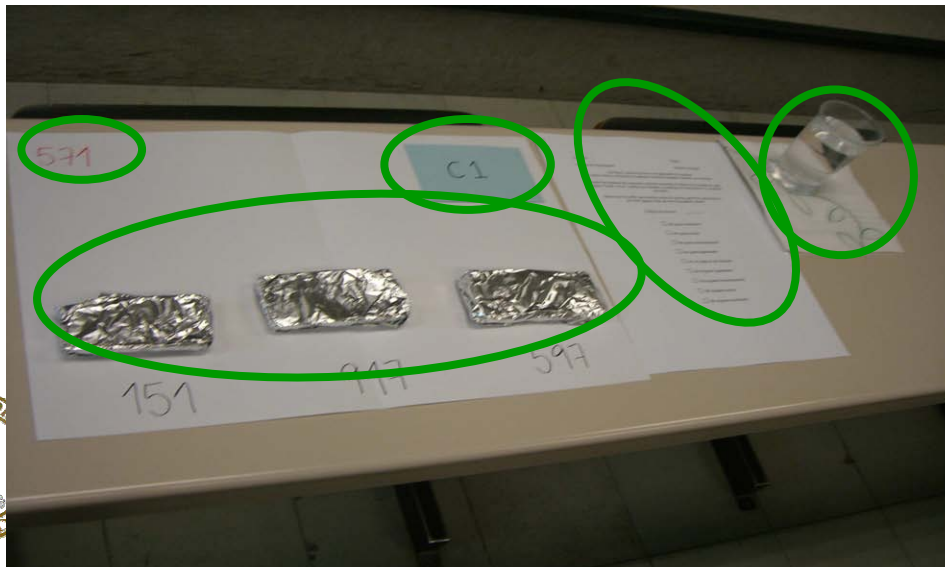


## Sensory consumer tests of breads

- 2 **pieces** of pan bread of different slices/sample.
- 84 **consumers** (36 men and 48 women) of different age and frequency of consumption
- Each consumer performed **2 sessions** of hedonic tests.
  - **First session:** blind hedonic tests.
  - **Second session:** barley breads labelled as “*containing functional ingredients*”.
  - The order of presentation of the samples was random and counterbalanced.

### ■ 9-points hedonic scale.

- |                          |                          |
|--------------------------|--------------------------|
| <input type="checkbox"/> | Like extremely           |
| <input type="checkbox"/> | Like very much           |
| <input type="checkbox"/> | Like moderately          |
| <input type="checkbox"/> | Like slightly            |
| <input type="checkbox"/> | Neither like nor dislike |
| <input type="checkbox"/> | Dislike slightly         |
| <input type="checkbox"/> | Dislike moderately       |
| <input type="checkbox"/> | Dislike very much        |
| <input type="checkbox"/> | Dislike extremely        |



## Statistical analyses

- ✦ **Balanced Analysis of Variance** ( $\alpha= 0,05$ )

**Instrumental evaluation**  
1 way fixed effect: **bread**s

**Sensory consumer evaluation**  
4 ways fixed effects

**Breads**  
**Information**  
**Sex**  
**Age**

- ✦ **Means comparison**

- ✓ Bonferroni
- ✓ LSD

- ✦ **Statistical software: *STATGRAPHICS*.**



## Dough rheology

### Chopin Alveograph

SAMPLE	P	L	P/L	W	Degradación	
					P' (%)	W' (%)
100 W	114	87	1.31	370	25.4	5
85W/15B	127	63	2.01	307	15	1
70W/30W	129	43	2.99	220	7.7	0.01

### Chopin Consistograph

SAMPLE	CH Consistogram		AH Consistogram			
	HYD 2200 (%)	Pr Max (mb)	Tol. (s)	D250 (mb)	D450 (mb)	TPr Max (s)
100 W	54.9	3,036	298	197	854	172
85W/15B	54.2	2,879	226	104	649	201
70W/30W	52.9	2,578	204	329	891	156

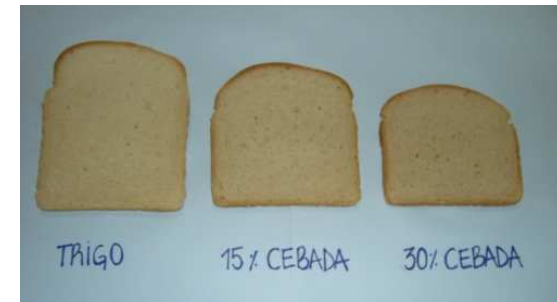
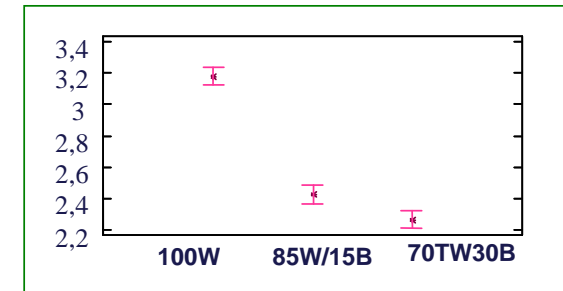
Knuckles *et al.*, 1997; Wang y Rosell, 2002; Callejo *et al.*, 2008; Sudha *et al.*, 2007



# Instrumental evaluation of breads

Specific Volume (cm<sup>3</sup>/g)

Day	SAMPLE			P-value
	100W	85W/15B	70W/30B	
	Estimated mean			
1	3.18	2.42	2.26	0.0000



Knuckles *et al.*, 1997; Gill *et al.*, 2002; Ragae y Abdel-Aal (2006)

# Instrumental evaluation of breads

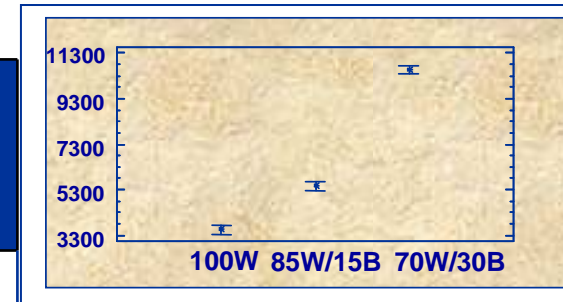
## Hardness (g) and Increases on Hardness (%)

Parameter	Day	SAMPLE			P-value
		100W	85W/15B	70W/30B	
Estimated mean					
Hardness (g)	1	3,547	5,454	10,574	0.0000
Increases on Hardness (%)	[1-4]	69	71	78	0.2276
Increases on Hardness (%)	[1-7]	106	107	112	0.2806

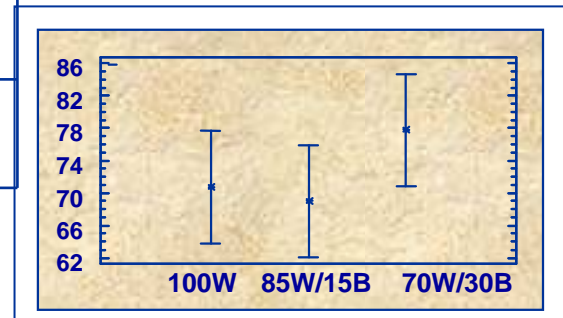
Increases on Hardness (%) [1-4] =  $[(H4-H1)/H1]*100$ .

Increases on Hardness (%) [1-7]  $[(H7-H1)/H1]*100$ .

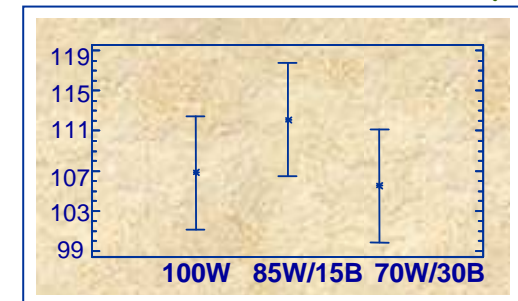
Hardness (g)



Increases on Hardness (%) days 1-4



Increases on Hardness (%) days 1-7

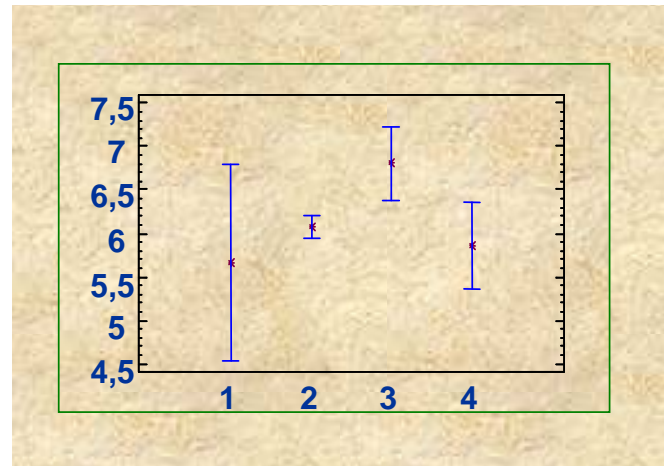


Knuckles *et al.* (1997), Gill *et al.* (2002), Sudha *et al.* (2007)

## Sensory consumer tests

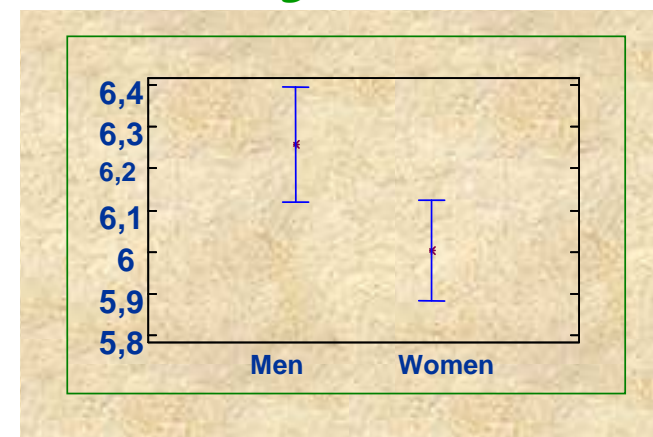
Analysis of Variance for hedo - Type III Sums of Squares					
Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
-----					
MAIN EFFECTS					
A:pan	6,68254	2	3,34127	1,49	0,2254
B:info	2,57143	1	2,57143	1,15	0,2841
C:edad	26,8157	3	8,93858	4,00	0,0079
D:sexo	12,549	1	12,549	5,61	0,0182
RESIDUAL	1109,14	496	2,23616		
-----					
TOTAL (CORRECTED)	1161,61	503			

*According to age:*



1: < 20 years old  
 2: 20-35 years old  
 3: 36-50 years old  
 4: 51-65 years old

*According to sex:*





### ***Instrumental evaluation***

1. ***Significant differences*** among the three breads (control pan wheat bread and the two barley flour supplemented breads) in ***specific volume*** and ***crumb firmness*** evaluated ***24 hours*** after baking were found.
2. From the ***staling*** point of view, evaluated on the basis of the evolution of the increase on firmness over 7 days, ***no statistically significant differences*** were found among the three breads neither between days 1 and 4, neither between days 4 and 7.

### ***Sensory consumer evaluation***

3. ***No significant differences*** were found on the ***hedonic ratings*** of the three breads.
4. ***Information*** about the positive functional properties of barley breads had ***no significant effect*** on the hedonic evaluation by consumers.
5. ***Significant differences*** by ***sex*** and ***age*** of consumers on the hedonic evaluation of breads were found





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