Changes in Chemical Parameters During Breadmaking of *Broa* as Compared with Commercial Cereals and Breads

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INTRODUCTION

BROA **is a traditional type of bread, which is manufactured in Northern Portugal in the absence of a starter culture at the farm level, usually following ancient protocols. This food is obtained from maize and rye flours, which is inoculated with a given amount of previously fermented dough. Like doughs of similar breads in other countries, the dough for *BROA* contains a complex microflora which, owing to synergistic interactions, produces distinct acidic tastes and unique flavors; the low pH of which also contributes to extended shelf-lives.**

The consumption of this kind of sourdough bread has been increasing rapidly throughout the latest few years, especially in Central Europe Scandinavia; this trend anticipates a major opportunity for expansion of the international market of *BROA*.

In this work, several chemical parameters were studied in maize and rye flours, sourdough and final *BROA*, corresponding to a number of traditional producers, with the purpose of better understanding what happens during the fermentation and baking processes. In addition, our results were compared with those pertaining to other flours and breads from Finland, a country where a large number of sourdough breads originate.

The properties of *BROA* are indeed unique, and lie somewhere between commercial Wheat Bread and Rye Sourdough Breads. The fermentation time of *BROA* should in principle be extended so as to take full advantage of acidification, both towards desirable final taste and as a means to control undesirable microflora.

EXPERIMENTAL METHODS

Moisture content (moisture loss method), Ashes at 550ºC (incineration method), pH (potenciometric method), Total Titratable Acidity (titration method), Buffer Capacity (titration method), and Lactic and Acetic Acid (enzymatic method) were determined in samples of Maize flour (*m*), Rye flour (*r*) and *Broa* (*b*) provided by farmers in different geografical locations (*I, IV, V, XI* and *XIII*), and in samples of commercial Wheat flour (T), Rye Flour (C), White Bread (PT), Oat bran (A) and two Sourdough Rye Breads (PC1 and PC2).

RESULTS and DISCUSSION

Table I **- Mean values for the chemical parameters in maize and rye flours, sourdough and *Broa*, obtained from traditional producers**

	%Moisture	%Ashes	pH	Total Titratable Acidity ($ml_{NaOH\ 0.1N}/10_{gsample}$)	Buffer Capacity ($ml_{HCl\ 0.1N}/10_{gsample}$)	L-Lactic Acid	D-Lactic Acid	Acetic Acid	Fermentative Quocient ($mol_{Lactic\ Acid}/mol_{Acetic\ Acid}$)
Maize flour	14.3	1.3	6.4	5.5	1.0	-	-	-	-
Rye flour	13.4	1.6	6.5	5.8	1.3	-	-	-	-
Sourdough	52.3	1.4	4.1	12.9	-	0.5	0.4	0.08	5.0
Broa	44.7	1.2	5.2	6.0	-	0.09	0.08	0.05	2.1

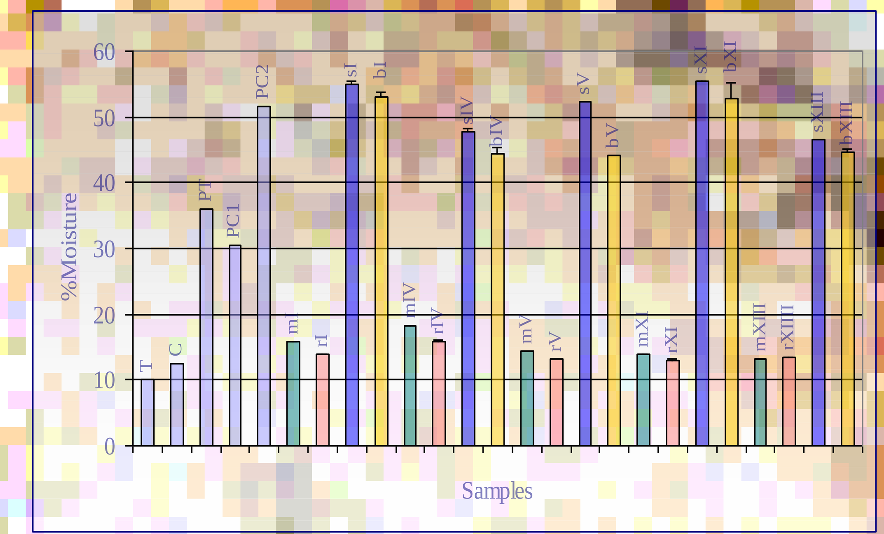

Figure 1 **- Percent Moisture in samples of Maize and Rye flours, Sourdough and *Broa*, obtained from traditional producers, as compared with commercial flours and breads.**

- As expected, the percent Moisture in Sourdough and *Broa* is much higher than in flours, due to the water added during preparation of dough

- The baking process does not lead to extensive water losses. However, the moisture value in White Bread (PT) is much lower than in *Broa*

- The Rye flours exhibit the highest ashes values, and *Broa* the lowest ones

- The percent Ashes in Sourdough Rye Breads (PC1 and PC2) make apparent the contribution of Rye flours for the final ashes content of breads

- The ashes increase the Acidity and the Volatile compound content in bread: studies have shown that high volatiles concentrations, produced by Lactic Acid Bacteria, are obained with high percent Ashes and Total Titratable Acidity, as well as highr amino acid content due large proteolytic activity

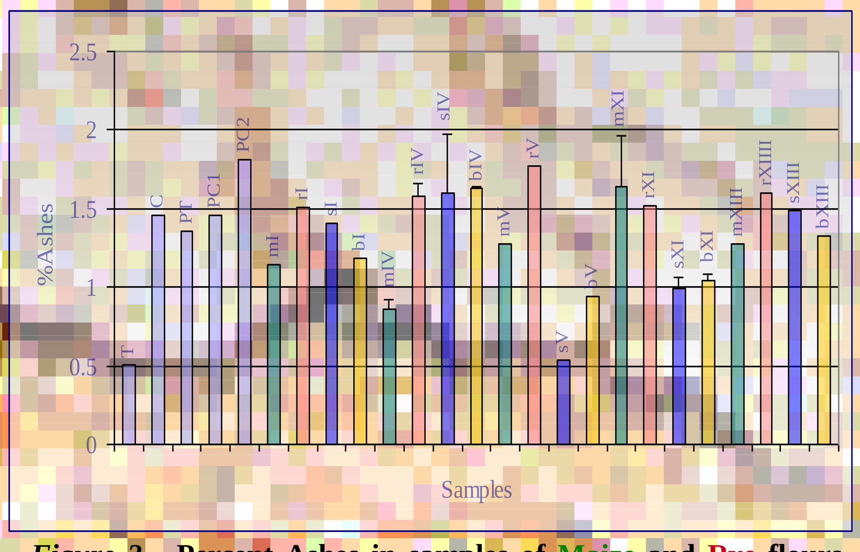

Figure 2 **- Percent Ashes in samples of Maize and Rye flours, Sourdough and *Broa*, obtained from traditional producers, as compared with commercial flours and breads.**

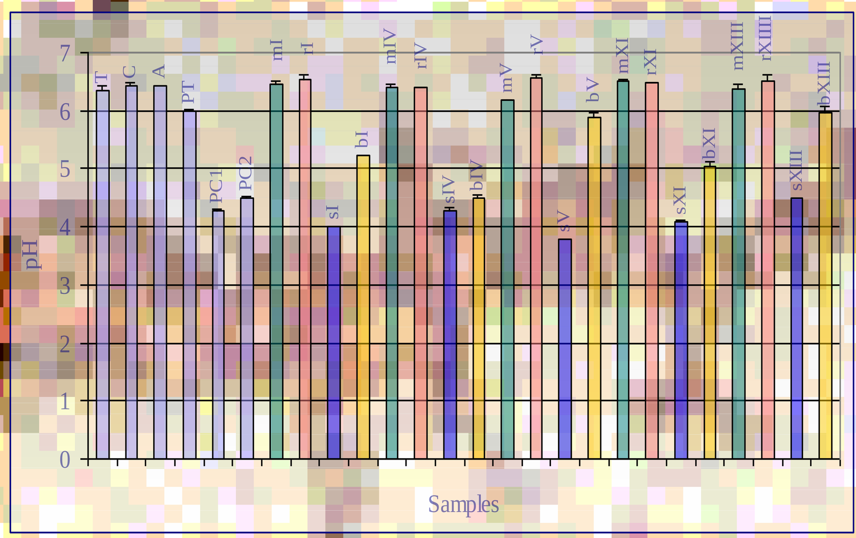

Figure 3 **- pH in samples of Maize and Rye flours, Sourdough and *Broa*, obtained from traditional producers, as compared with commercial flours and breads.**

- It is usual to rank Sourdoughs according to pH, TTA and FQ values

- It is expected that the Total titratable Acidity in Sourdoughs increases slightly during the initial stage of fermentation, due the low metabolic activity of Lactic Acid Bacteria and the high activity of yeasts

- Low pH values, as a result of fermentation by Lactic Acid Bacteria, promote increases in the loaf volume, whereas optimal baking conditions control the enzymatic activity and elasticity will improving the shelf-life

- The experimental results reveal, as expected, a reverse relationship between pH and Total Titratable Acidity

- Mean Acidity values are much lower in flours when compared with those attained after the fermentation process (in dough and bread)

- The pH decreases during fermentation, and increases slightly during the baking process, due to Acid evaporation

- The pH values can be used to distinguish between White Bread (PT) (or Wheat Bread) and *Broa*: Wheat flour (T) has a pH value identical to Maize and Rye flours, but a lower Acidity. In spite of the similar pH values, White Bread (PT) has the highest pH and the lowest acidity and these values are very similar to those found in Wheat flour (T)

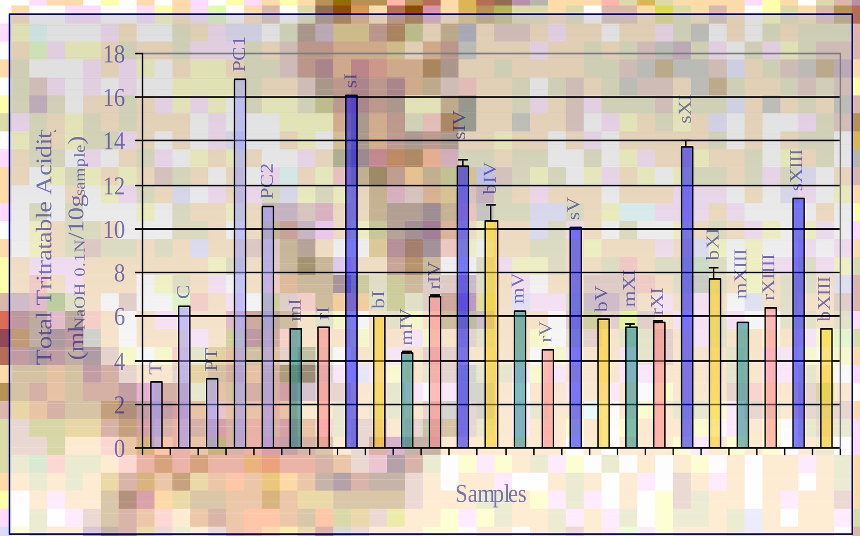

Figure 4 **- Total Tritratable Acidity in samples of Maize and Rye flours, Sourdough and *Broa*, obtained from traditional producers as compared with commercial flours and breads.**

- Wheat Bread fermentation is brought about only by yeasts, which are determinant for gas production and thus to the loaf volume, but lack the heterolactic fermentation, which is responsible for the acidic taste of *Broa*

- It can be concluded that *Broa* is intermediate between Wheat Bread and Rye Sourdough Breads in terms of acidity

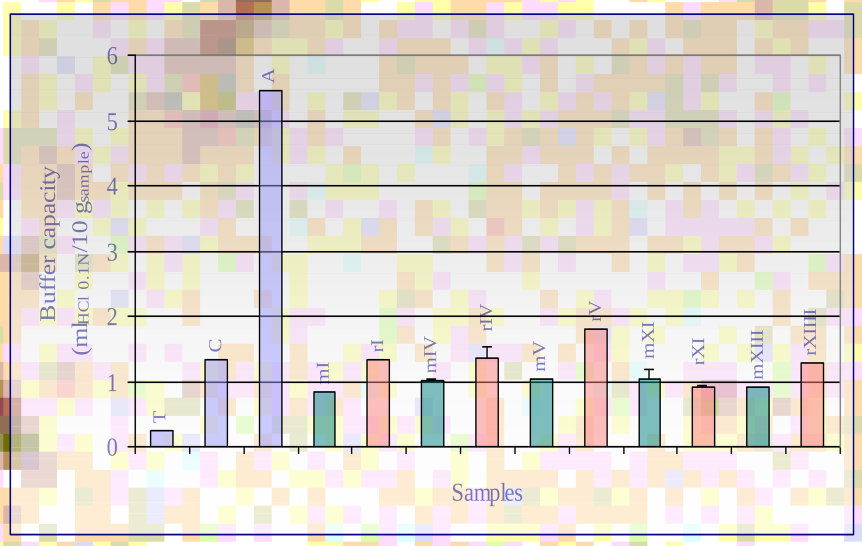

Figure 5 **- Buffer Capacity in samples of Maize and Rye flours, obtained from traditional producers as compared with commercial flours.**

- The Buffer Capacities in Maize and Rye flours are very similar

- Oat Bran (A) has a singular Buffer Capacity

- The lowest Buffer Capacity is accounted for by Wheat flour, hence indicating that the constant pH and ATT values obtained in Wheat Bread are due the type of prevailing fermentation

- A high Buffer Capacity in flours correlates well with a high Acid concentration in the Bread

- A decrease in Lactic and Acetic Acid contents is apparent during the baking process, which is in agreement with results for Total Titratable Acidity

- The L-Lactic Acid concentration is slighly higher than that of D-Lactic Acid

- The Acetic Acid is present in lower concentrations

- The Acetic Acid is very important to protect bread against microbial contaminations. Homofermentative Lactic Acid Bacteria have a higher inhibitory effect than heterofermentative, against coliforms

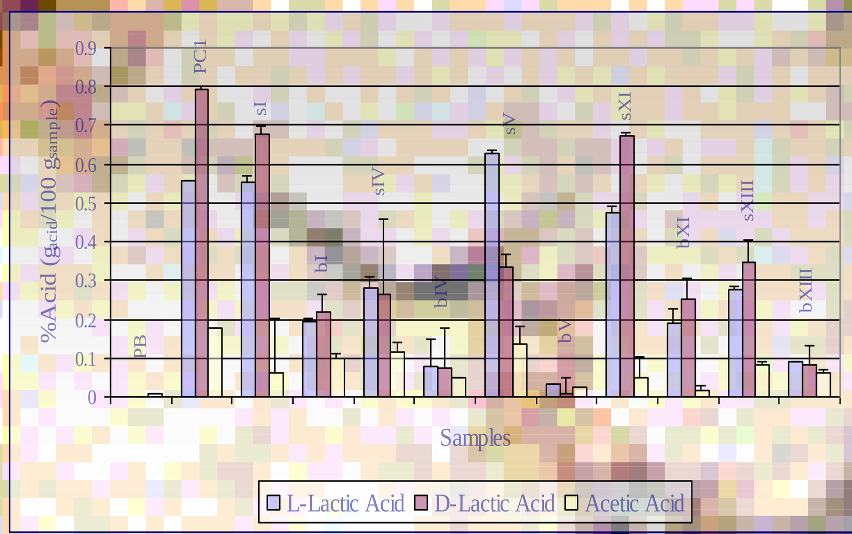

Figure 6 **- L-Lactic, D-Lactic and Acetic Acid contents in samples of Sourdough and *Broa*, obtained from traditional producers as compared with commercial breads.**

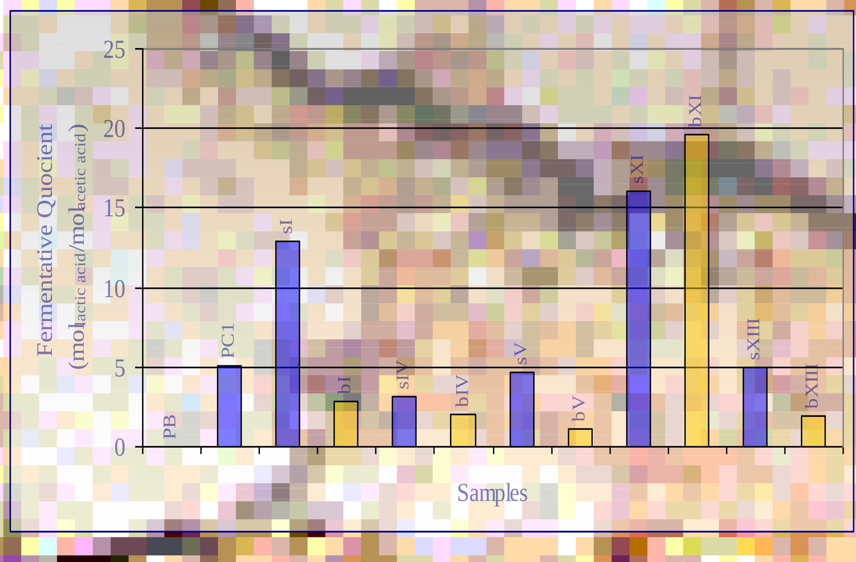

Figure 7 **- Fermentative Quocient (FQ) in samples of Sourdough and *Broa*, obtained from traditional producers as compared with commercial breads.**

- The Sourdough capacity as preservative against microbial spoilage depends upon the amounts of the Lactic and mainly Acetic Acid produced by Lactic Acid Bacteria, as well as the strains present and the contents of Fermentable Substrates, Initial pH and Buffer Capacity

- Usually, homofermentative strains promote higher FQ than heterofermentative strains of Lactic Acid Bacteria

- When compared with Acetic Acid, the Lactic Acid, the major product of the heterolactic fermentation, possesses a slight taste

- Only "sIV" possesses a FQ value within the optimal range [1.5: 4.0]; "sV" and "sXII" have FQ values near the optimal

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