RESEARCH STUDY CONCERNING THE FERMENTING POTENTIAL OF THE CULTIVATION MEDIUM COMPOSED OF A COMBINATION OF LADY CLAIRE VARIETY POTATO AND WHITE FLOUR 550 TYPE, CULTIVATED WITH *SACCHAROMYCES CEREVISIAE* YEAST, IN BATCH SYSTEM

— research paper —

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Abstract: The study was followed on different stages of dough preparation. A nutrient medium composed of: white wheat flour type 550, water and Lady Claire potato variety, was prepared. The consistency of the studied cultivation mediums was of 500 HE (Haubelt Einheit). *Saccharomyces cerevisiae* bakery yeast was used for the cultivation medium. The flour was replaced gradually with potato at a rate of 5%, 10%, 20%, 30%. The Lady Claire (L-CL) potato variety was of two types: hydrothermal treated and chopped when it was raw. The batch system was used as an operating system, at a temperature of 30°C. The study lasted for 5 hours. The amount of gas formed during the fermentation of the nutrient media was measured because it is a significant indicator of the fermentation in bread manufacture. When flour was mixed with hydrothermal processed potato pulp (PP), the water hydration decreased by 14.95% compared to the control sample. When flour was mixed with raw potato pulp (RP), then the moisturizing capacity decreased by 30.6% compared to the control sample. At a concentration of 30% the gas release reaches it maximum towards the second hour of fermentation and in the first hour the fermentation is inhibited. If raw potato pulp was used, the maximum release was of 900 cm^3, and it was recorded for the 30% working version. If raw potato pulp was used, the growth was of maximum 760 cm^3 for the 10% working version in the first hour. The total amount of carbon dioxide released into the air was very well correlated with the rate of flour replacement with PP. The correlation was not the same when replacing the flour with RP. At micro laboratory scale, this research has proven to be effective and economically attractive.

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INTRODUCTION

The methods dough preparations in bakery are the direct method and indirect method. Through the direct method a single phase is obtained-the dough. Through the indirect biphasic method, leaven phase is obtained, which is continued with the dough phase (Auerman, 1960).

The success of the technological process in bread making is conditioned by the formation of gas in the final hours of the technological process (Auerman, 1960). During this dough preparation phase, the solid substrate (SS) is transformed due to metabolic activity of yeasts. Solid-state fermentation (SSF) reproduces the natural microbiological processes (Couto, 2006). Early stages of biochemical and microbiological changes from the dough, in bakery, are characteristic to the "solid" environment in which microbial cells have reduced mobility (Iancu et. al., 2004).

SSF is defined as any fermentation process performed on a non soluble material that acts both as physical support and source of nutrients in absence of free flowing liquid (Pandey, 1992). In recent years, SSF has received more and more interest from researchers, science several studies for enzymes (Pandey et al., 1999), flavours (Ferron et al., 1996), colorants (Johns,et al.,1991) and other substances of interest to the food industry; for example, *Saccharomyces cerevisiae* is cultivated in SSF for ethanol production (Rimbault, 1998).

Saccharomyces cerevisiae strains have been selected for many years for their dough-leavening characteristics. Bakers yeast produces the CO_2 that results in dough leavening and contributed to the flavour and crumb structure of bread. The yeast gassing rate is critical in baking technology, and this depends on the dough formulation, on specific fermentation parameters and especially on intrinsic characteristics of bakers yeast (Randez-Gil et al., 1999).

The most important technological characteristic of bakery yeast is it fermentation capacity. *Saccharomyces cerevisiae* cultivating environment generally contains, among others, sources of potassium, magnesium and ammonium, which add in the form of chemical synthesis substances (Farmakis et al., 2007). Potato can provide some of these growing factors such as K, Mg, ascorbic acid, vitamin B1, B2, B6, PP, for microorganisms in a natural way, more than other nutritious media used in bakery.

Microorganisms cultivation systems in terms of nutrient substrate supply are: batch, fed batch and continuous, and in terms of the relationship with the external environment they are closed and open (Mironescu, 2005).
Through this study we aim to investigate the influence of adding of potato as nutritive substrate on *Saccharomyces cerevisiae* bakery yeast. The nutrient media that were differently prepared in the bioreactor by replacing the flour with potato at a rate of 5%, 10%, 20%, 30%. Work was done in non-sterile conditions, as in the baking bioprocesses. The idea was to develop a new strategy for allocating the components of a bread making recipe with potato in various stages of dough preparation.
A bioreactor build in our laboratory which is using microprobes was used (Iancu et al., 2010), and research in this way has proven to be efficient and attractive from an economic point of view, thus avoiding the loss of time and raw materials with industrial samples. By this study we aimed to create the possibility of directing and guiding the bioprocesses by applying procedures that maintain the values of several operational parameters constant (temperature and time) and to include various stimulators (as for example the potato pulp) in the nutrient medium.

MATERIALS AND METHODS

Materials

For this research we prepared the nutrient media composed of white flour type 550, water, hydrothermal treated potato (PP) and potato pulp sliced while being raw (RP). To this mixture we added *Saccharomyces cerevisiae* bakery yeast. Their provenience and their main characteristics are given in Table 1.

Table 1 Physical and chemical characteristics of the raw material and analysis methods

Raw material	Characteristic of raw material	Producer	Method of analysis
White flour Type 550	u=14,5%;Gl_u=29%; ID = 5,5 mm;I_{GL}=49; FN =330 s; TTA =2,3 degree, ash 0,549 %,HD=55,6 %	Mill Cibin Sibiu, Romania	Gl wet, AACC METHOD 38-10 Hand Wasing Method; ID-STAS 89-90- STAS 6283; Ash ICC STANDARD 105/2; Acidity STAS 90-88; „Falling Number"ISO 3093-97, ICC STANDARD No.107/1-1995; Hydration degree ISO 5530/1/1999 ICC No115/1- Haubelt 2006, Umidity –termoanalyzer
Potato	13 % content of	Potato	The acidity of the paste potato was

Laura variety	starch u = 73,5 %,	Research and Development Station Târgu Secuiesc	determinated with STAS 90-88 and moisture with method gravimetric with thermobalance.
Yeast bakery	Power of growth=10 minute; u=68,9%, with STAS senzoriale characteristics	Pakmaya-SC Rompak S.R.L-Paşcani, Romania	The organoleptic characteristics(STAS 985-79), umidity (%)(STAS 985-79), Power of growth, the rapid method.

White flour type 550 with 14.5% moisture was used. Drinking tap water was used to prepare the nutrient media. The potato paste (PP) was obtained by hydro thermally processing of the unpeeled raw potato for 30 minutes at water boiling temperature, then cooling it, peeling, and mashing it by passing it through the 2 mm mesh sieve. The raw potato (RP) was washed, peeled, finely minced and passed through a 2 mm mesh sieve.
The flour was gradually replaced by potato at a rate of 5%, 10%, 20%, 30%.

Methods

The mash preparation recipe and the chosen operational parameters are a hybrid version of the existing recipes at macro process level. Were battered the mash simulating the mechanical action during dough processing in the industrial technological processes at a laboratory level.
The amount of water that is added at the preparation of fermented mash in the bioreactor was calculated using the Haubelt Flourgraph E6 according to the hydration capacity of the flour and PP or RP. Mixture consistency was of 500 HE (Haubelt Einheit). A mixer HV4 with sieve ϕ2 mm was used for mixing the samples and analytical balance type WPS 210/C/1 Partner was used for weighting.
Work was not done in sterile conditions in a bioreactor built in the lab. We used the batch system as an operating system.
Moisture content was determined with a Moisture Analyser AND ML-50, based on the principle of thermo gravimetric analysis.
The device used for CO_2 measuring in this study measures the amount of gases released from the fermenting dough at t= 30^oC, from 5 hour, expressed as volume of NaCl solution. The volume of NaCl solution gathered outside the

fermentation vessel is the released volume in ml of CO_2. It was measured using a measuring graded cylinder. To measure the fermentation intensity (from 1 to 1 hour) we used a cylinder, 0,1ml.
We opted for a volumetric method (Auerman, 1960), in order to determine the ability of potato-flour mixture to form gas. We first calculated the amount of mixture that is subjected to fermentation. The mixture was prepared similarly with that subjected to the rheological analysis.

RESULTS AND DISCUSSIONS

The existing method for studying the fermentative potential of the culture medium, used in bread manufacture (Auerman, 1960) examines a culture medium with an adding of water of 60 ml/100 g flour with 14% humidity. The processing method for the culture medium presented in this research was modified. The amount of water to be added to the mixture of flour and potato, with 10% bakery yeast was calculated in accordance with the potato mixture hydrating capacity. The hydrating capacity was calculated with the Haubelt E6 Flourgraph. In order to calculate the needed amount of flour and potato pulp we used material balance equations (Iancu, Haubelt et al., 2010). Such calculations are necessary because the mixture humidity is significantly higher than 14%. From the results (Figure 1) we can observe that the hydrating capacity is decreasing once we increased the replacement rate of flour with potato pulp, compared to the control sample.

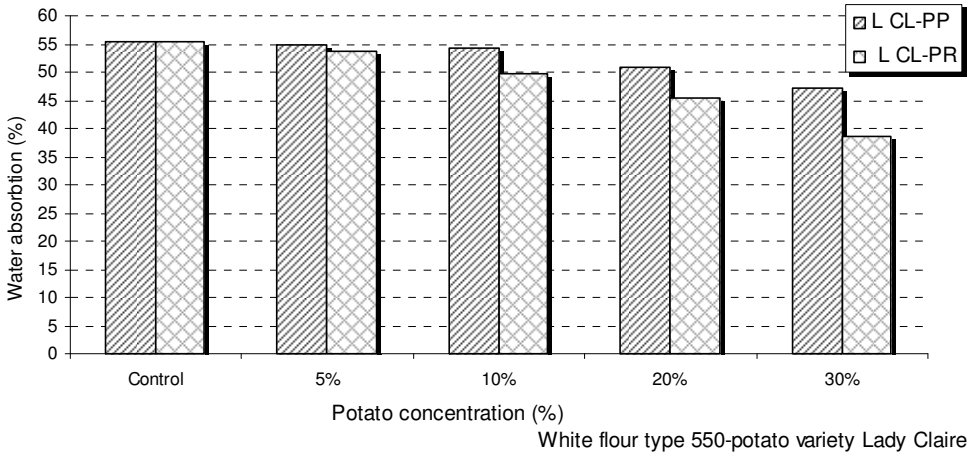

Figure 1. The variation of the hydrating capacity of mixtures created from white flour type 550 and hydrothermally processed Lady Claire variety potato pulp and raw potato pulp (L CL-RP), determined with the Haubelt E6 Flourgraph.

If we mixed flour with PP, the hydrating capacity decreased by 14.95% compared to the control sample. If we mixed flour with RP, the hydrating capacity decreased by 30.6% compared with the control sample.
From the second graph (Figure 2) we can observe that for the control sample, the gas release occurs in the first hour of fermentation. If we added the hydrothermally processed Lady Claire variety potato pulp, the result was an accumulation of CO_2, measured in milliliters, in different amounts depending on the replacement rate of flour with potato.

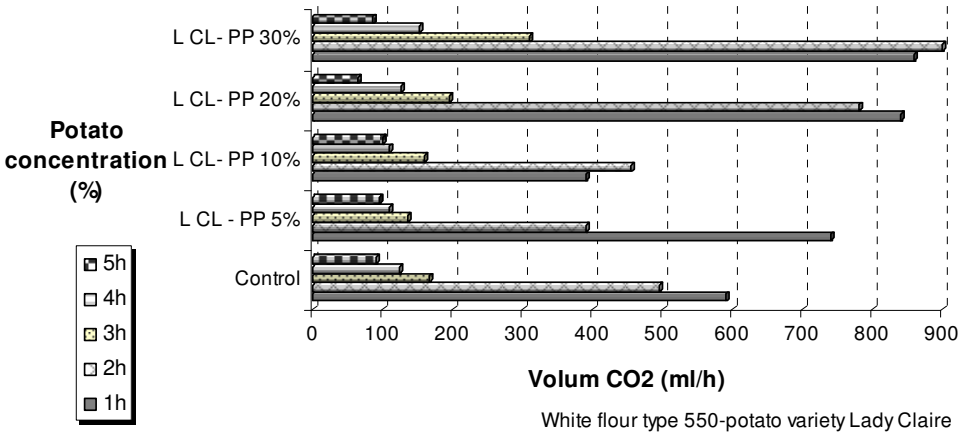

Figure 2. The evolution of the total released quantity of carbon dioxide, per hour, for the fermentation of the mixture of hydrothermally processed Lady Claire variety potato pulp and white flour type 550 to which *Saccharomyces cerevisiae* bakery yeast was added, cultivated in batch system.

At a concentration of 5%, 20% for the Lady Claire potato variety mixture the highest CO_2 release was registered in the first hour and at a concentration of 10%, 30% the maximum CO_2 concentration passes to the second hour of fermentation and the first hour is inhibited.

At the use of raw potato pulp (Figure 3), the CO_2 volume increased only in the first hour of fermentation for all work versions compared with the control sample. The maximum CO_2 release was of 760 cm^3 and it was recorded for the working version of 10%.
The total quantity of gases released during the process of fermentation (Figure 4) increased by 57.4% compared to the control sample if we replace flour with hydrothermally processed potato pulp. If RP is used, the growth is maximum 1320 cm^3 for the working version of 30%.

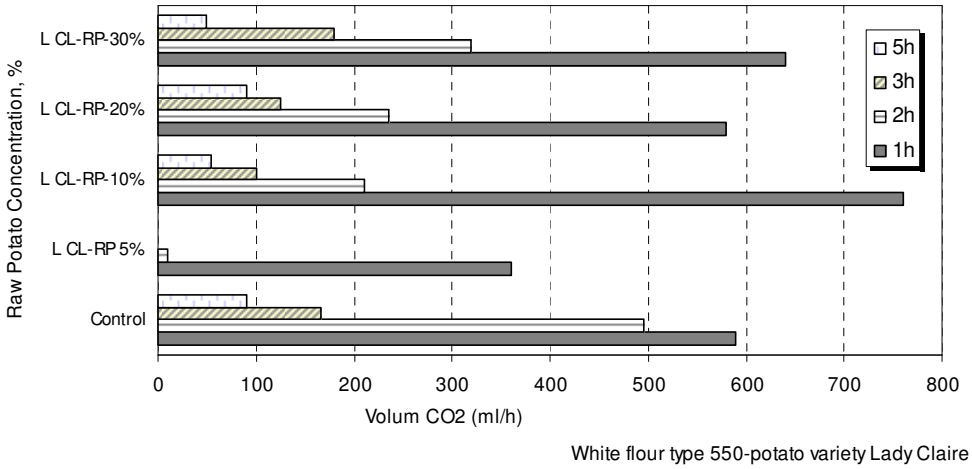

Figure 3 The evolution of the total released quantity of carbon dioxide, per hour, for the fermentation of the mixture of hydrothermally processed Lady Claire variety potato pulp and white flour type 550 to which I added Saccharomyces cerevisiae bakery yeast, cultivated in batch system.

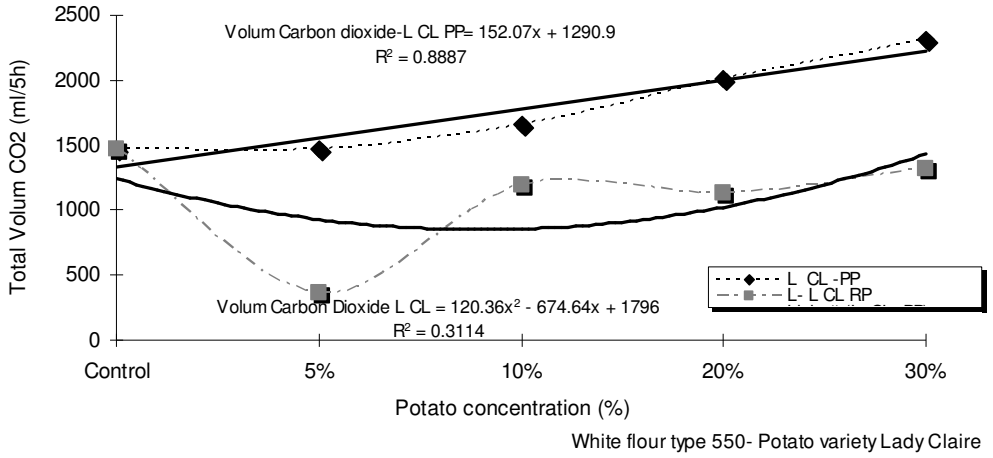

Figure 4 The evolution of the total released quantity of carbon dioxide, per 5 hour, for the fermentation of the mixture of hydrothermally processed Lady Claire variety potato pulp and raw potato and white flour type 550 to which *Saccharomyces cerevisiae* bakery yeast was added, cultivated in batch system.

The calculus of CO_2 dependence to the rate volume of replacing flour with potato pulp is by a linear equation. The correlation index is very good R^2 = 0.8887, so the replacement rate of flour with potato pulp is an important influencing factor. The calculus of CO_2 dependence to the rate volume of replacing flour with raw potato pulp is by a linear equation. The correlation index is not very good R^2 = 0.3114 so the replacement rate of flour with potato pulp is not an important influencing factor. The sign of the first equation term is negative, which shows that the trend of CO_2 volume is to decrease with the increase of the replacement rate of flour with potato pulp.

CONCLUSIONS

Laboratory microprobes were used for the bioreactor and research in this way has proven to be efficient and attractive from an economic point of view, thus avoiding loss of time and raw materials with industrial samples. By this study we demonstrated that biopreparates fermented in the bioreactor have the capacity of increasing the fermentative potential of the used mixture flour and potato. The consistency of these biopreparates was of 500 HE (Haubelt Eiheit). In accordance with the proposed objective, to develop a strategy for allocating the components of potato bread dough recipe preparation, I conclude the following. Due to the hydrothermal processing of the potato pulp, the accessibility of yeast to the macromolecular component as main carbon dioxide generator increased. Food sources have been improved and the mixture capacity to form gas has improved. In the long-term, raw potato pulp does not improve the medium fermentation capacity; in the short term, for the first hour of fermentation the fermentation is enhanced. I obtained a maximum value for the working version with 30% adding. The starch that was not hydrothermal processed is difficult to access. The sugars are consumed in the metabolic processes and the vitamins and minerals stimulate yeast activity. In the case of hydrothermal processed raw potato pulp these are partially destroyed. The total amount of gas released during a period of 5 hours increased with the rising of the replacement rate of flour with potato and reached a maximum for the version of 30% adding.

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