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ORIGINAL RESEARCH PAPER

COMPARATIVE STUDY REGARDING THE EFFICIENCY OF SOME COMMERCIAL LACTIC STARTERS FROM THE ROMANIAN INGREDIENTS MARKET FOR BAKERY INDUSTRY

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Abstract: Sourdough influences in a good way all aspects of the bakery products quality. Sourdough fermentation has gained the worldwide attention due to its positive influence on sensorial, textural, nutritional and shelf life of baked goods. For this work, four commercial starter cultures were selected, in order to assess their influence on products quality. The major lactic bacteria in the starter cultures were: *Lactobacillus brevis*, *Lactobacillus sanfrancisco* and according the producer, specific facultative hetero-fermentative lactic strains. The obtained sourdoughs, fermented according to their supplier specifications, were added to wheat dough at 5 - 30 % amount level. The starters' performance was assessed in 2 stages protocol. Firstly, all starters were assessed by analysing the results of physico-chemical and sensorial properties. In the second stage, three starters were selected and the protocol was performed again. Physico-chemical analyses (porosity, elasticity, H/D, L/w, acidity) were performed according to SR 91/2007. Aroma profile and sensory analysis were assessed using a hedonic test. All starter cultures showed good performance on improving the bread quality in the conditions of this experiment, differences could be noticed in relation to textural and sensorial properties.

Keywords: *analysis, bread, sourdough starter*

INTRODUCTION

Bread is one of the most staple foods consumed by mankind, its appearance under different forms being given by cultural and nutritional particularities which differ from country to country [1] where, sourdough obtained by spontaneous fermentation was used as leavening agent to obtain more gaseous dough and, therefore, more aerated bread [2, 3].
The term of "sourdough" is defined as a type of dough from flour and water fermented by yeast and lactic acid bacteria present in flour or from a commercial starter culture, used as a leavening agent in bread making; its obtaining process is one of the oldest biotechnological processes in cereal-based food production [3 – 5]. The use of sourdough influences all aspects of bread quality [6]. As reported many authors [3, 7 – 10] the addition of sourdough helps to extend the shelf life of the end product, nutritional value of bread and improves its organoleptic properties [11]; it also been shown to be useful in the production of breads with slow starch digestibility and thus low glycaemic response [5]. Furthermore, its use enhances the bioavailability of functional compounds (e.g. minerals, soluble fibres, bioactive peptides, free phenolic acids) and facilitates the degradation of anti-nutritional compounds as phytic acid [12]. The use of sourdough as baking improver in combination with baker's yeast allows as well replacement of additives with "clean label" ingredients in industrial baking [13 – 16].
The purpose of this study was to assess the efficiency of four commercial lactic starters from Romanian ingredients market through monitoring the qualitative parameters of the obtained bakery products: pan bread and loaf bread.

MATERIALS AND METHODS

Four starter cultures were purchased from Romanian ingredients market for bakery industry (supplied by Lallemand, Canada; Millbo, Italy; Ernst Böcker GmbH & Co, Germany) and codified as follows: FLO- a mix starter of heterofermentative lactobacillus; AUR - a starter culture containing as specific microorganism *Lactobacillus brevis;* rye base starter (STS) with specific microorganism *Lactobacillus sanfrancisco* and wheat starter (STG) composed by a mixture of homofermentative *lactobacili* (both sourdough-type); also, the combination of STS + STG starters at the producer suggestion. Compressed yeast Fala (Bonopan), wheat flour (Boromir 650 type, moisture - 14.3 %, ash - 0.64 %, falling number - 349 seconds, WAC - 57 %) were acquired from the local market.

Sourdoughs fermentation

Sourdoughs were fermented according to their technical specifications (Table 1) using a Thermostat cabinet ST1 COMF (POL-EKO).

Table 1. *Technical parameters in sourdough obtaining*

Type of lactic culture	Starter dosage in sourdough* [%]	Water temperature [°C]	Fermentation time [h]
FLO	0,1	35	18-24
AUR	1	30	6-10
STS	20	28	16-18
STG	20	28	16-18
STS+STG	20	28	16-18

*dosage of lactic culture according to the flour quantity

Growth and acidification rate

The fermentation capacity of the strains was evaluated measuring microbial counts, *p*H and Total Titratable Acidity (TTA). Measurements for these determinations were taken during the fermentation process: at the beginning, at the middle and at the end of sourdough fermentation.

In order to analyze the microbial counts, 1ml of each sourdough was diluted in 9 mL of sterile 0.85 % NaCl. 0.1 mL of this mixture was spread on MRS agar (Merck, Darmstadt, Germany), in serial tenfold dilutions and incubated at 37 °C for 48 h. A colony counter (Colony Star 8500, Funke Gerber, Berlin, Germany) and an optical microscope (Zeiss 40X, Primo Star, Germany) were used in order to count and to analyze the specific microorganisms.

For the *p*H determination, a Hanna Instruments portable *p*H meter HI 98130 was used. For TTA, a sample (5 g) of sourdough was suspended in 50 mL of distilled water; the suspension was titrated with NaOH 0.1 n in the presence of phenolphthalein as indicator until it reached a pale pink color persisting 1 min; TTA was expressed as mL of NaOH 0.1 n needed to achieve the pale pink. All samples were analyzed in duplicate.

Breadmaking

Fermented sourdough was added to dough in different percentages at the manufacturer's suggestion, as is shown in Table 2. Bakery products were prepared using the formulation: flour- type 650 (100 %), sourdough, water (50 %), yeast (2 %), iodized salt (1.8 %), using the indirect (biphasic) method of production. Obtained doughs were divided and shaped as pan bread (1 kg baked product) and loaf bread (0.7 kg baked product), proofed at 28 °C, 60 min (final proofing) and baked at 220 °C for 45 min, in Zanolli electric oven (Italy).

Table 2. *Sourdough dosages*

Sourdough type	Used dosages [%]*		
FLO	10	20	30
AUR	10	20	24
STS	5	7	10
STG	10	15	20
STS + STG (5 % + 10 %)	5	10	15

*dosages related to the amount of flour according to manufacturer indication

Physico-chemical analysis

Physico-chemical analyses of the end-products: acidity, porosity and elasticity were performed according to Romanian regulation SR 91/2007.

Sensorial assay

The assessment of sensorial characteristics (appearance, crust, crumb, odor, taste, acceptability) was carried out by a sensory panel of twenty untrained person (19-23 years) by using a hedonic test in 9 point scale (where 1- unsatisfactory, 9-very pleasant). Secondary, for the aroma profile assessment a hedonic scale in 5 points was applied. The sensorial tests were carried out in the Sensory Analysis Laboratory of the Department of Food Engineering within University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca (Romania).

Statistical analysis

All data were statistically analyzed using Duncan multiple comparison test. All determinations were conducted for both- pan bread and loaf bread in triplicate.

RESULTS AND DISCUSSION

At the end of the fermentation, the microbial counts in the sourdoughs reached different growth values, thus in the FLO starter - $1.6 \cdot 10^9$ cfu per gram sourdough (cfu·g^{-1}), AUR - $6 \cdot 10^8$ cfu·g^{-1}, STG - $1.2 \cdot 10^9$ cfu·g^{-1}, STS - $2 \cdot 10^8$ cfu·g^{-1} and STS+STG - $1.2 \cdot 10^9$ cfu·g^{-1}. These data support de idea that in mature sourdoughs LAB range from $1 \cdot 10^8$ to $3 \cdot 10^9$ cfu·g^{-1} sourdough, as was reported previously [17]. For all the sourdough samples the *p*H reached a value between 3.7…3.9, while the TTA value was between 7.5...9.5°.
The assessment of products quality parameters was carried out in two stages. During the first stage, all samples (see Tab.2) were tested from the physico-chemical point of view (see Materials and methods section). By assessing the results obtained in the first stage, four samples: FLO 20 %, STS 5 %, STG 20 % and STS 5 % + STG 10 % were selected as the samples with the highest performances. Also, in the case of sample STS 5 % + STG 10 % a dosage adjustment was made, due to the observations (data not shown) regarding the final product quality. Therefore, the dosage STS 5 % + STG 20 % was further used. In the second stage, products (pan bread and loaf bread) obtained by using these four sourdough were subjected to physico-chemical and sensorial analyses.
During the sourdough fermentation, different organic acids are produced. These organic acids improve the flavor of bread, help the swelling of gluten, and increase gas retention, resulting in products with good texture and massive volume and also functioning as natural dough improvers [18]. According to the results obtained after the physico-chemical analysis, the starters STG 20 %, STS5 % and STS 5 % + STG 20 % led to the best values of quality parameters (for both assortments of baked goods (Figures 1 and 2).
According to internal normative, the H/D ratio taken as a reference was 0.4 - 0.5, while the reference value for L/w was 2.13. The H/D ratio had the highest value in case of

STS5 % + STG 20 %, the others having similar values. L/w ratio had best results on samples FLOa 20 %, STSa 5 % and STSa 5 % + STGa 20 %. A possible explanation for these results would be that these three starters led to a better fermentation with an enhanced gases production and retention in the gluten matrix. So, the final products show highest values for porosity and elasticity. Also, it could be seen (Figure 1) that samples FLO 20 % and STS 5 % + STG 20 % recorded the highest acidity values; acidity also contributed to the enhancement of gluten rheological characteristics by strengthening the gluten matrix and the gases retention capacity. Finally, the products obtained with these starters reached an increment of volume, elasticity and porosity.

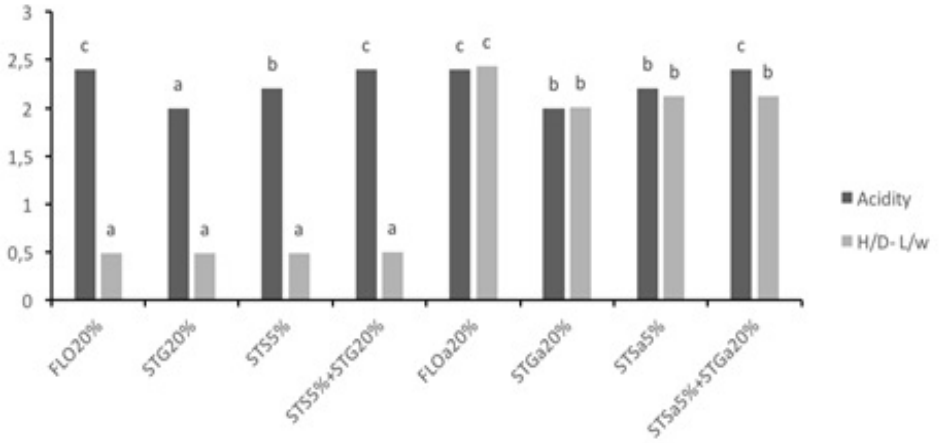

Figure 1. *Results after optimization for determination of acidity, H/D (for pan bread) and L/w (for loaf bread). FLO 20 %, STS 5 %, STG 20 %, STS 5 % + STG 20 %- sourdoughs concentration for pan bread; FLOa 20%, STSa 5%, STGa 20 %, STSa 5 %+ STGa 20 %- sourdoughs concentration for loaf bread*

*small different letters indicate the statistically significant difference ($p < 0.05$), between samples

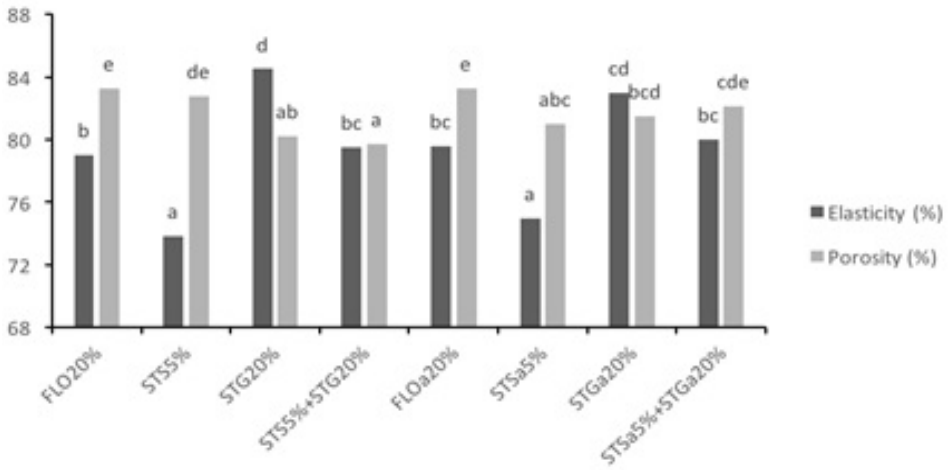

Figure 2. *Results after optimization of elasticity and porosity. FLO 20 %, STS 5 %, STG 20 %, STS 5 % + STG 20 % - sourdoughs concentration for pan bread; FLOa 20 %, STSa 5 %, STGa 20 %, STSa 5 % + STGa 20 %- sourdoughs concentration for loaf bread*

*small different letters indicate the statistically significant difference ($p < 0.05$) between samples

The taste and the flavor are undoubtedly the most important characteristics determining the quality of bread [3, 19]. The aroma of sourdoughs' bread is given by volatile compound generated in the proteolysis of gluten, during processing and baking. The sourdough fermentation is fundamental to achieve an acceptable flavor [20] and the sourdough bread volatile and aromatic profile is more complex with LAB fermentation than with yeast [21, 22]. In this work, sensory and aroma profile assessments showed that the most appreciated was sample of STS 5 % + STG 20 % (pan bread and loaf bread), starters STG 20 % and STS 5 % gained the similar scores, while sample FLO 20 % obtained the lowest results, which is shown in Figure 3 and 4. The products (pan bread and loaf bread) obtained by adding rye-based starters (STS 5 % + STG 20 %, STS 5 %) had the best score, supporting that the homofermentative lactobacilli used on rye and wheat flours lead to product with good volume and porosity but also with enhanced aroma and taste. The fact that rye sourdough has a complex aroma profile is reported also by [23]. Sourdough applications in bread production are steadily increasing since the last decade due to the consumers demand for traditional and natural products containing less chemical additives. It is well known that sourdough obtaining is a time-consuming process and a very sensitive method, which depends on various parameters that must be well monitored [16, 22], but the resulting baked goods are exceptional in terms of quality.

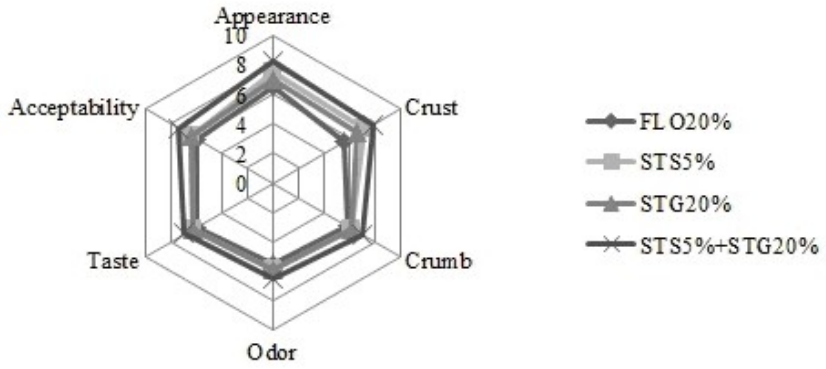

Figure 3. *Results of sensory evaluation*
*Because of identic results for samples of bread and loaf, they were not displayed separate

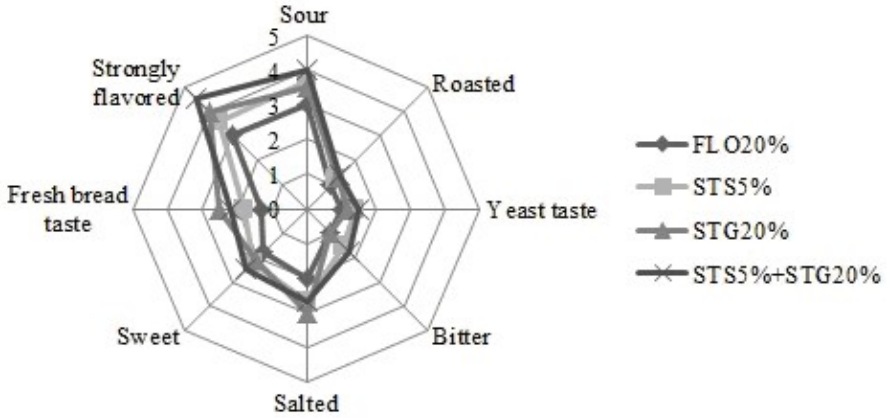

Figure 4. *Results of aroma profile test*
*Because of identic results for samples of bread and loaf, they were not displayed separate

CONCLUSIONS

Four lactic starter were compared in order to assess their efficiency in breadmaking. The results obtained from the physico-chemical and sensorial analyses carried out on pan bread and loaf bread, highlighted that starter STS 5 % + STG 20 % led to the products with more rich aroma and highest sensorial appreciation, as well better H/D ratio for pan bread in comparison with other starters used in the current study; while FLO 20 % and STS 5 % showed better results on L/w ratio ratio for loaf bread in comparison with STG 20 % and STS 5 % + STG 20 %.

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