THE INFLUENCE OF GROWTH AGENTS ON THE QUALITY OF BAKERY PRODUCTS

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Abstract

Saccharomyces cerevisiae or bakery yeast is tha main leavening agent used in bakery products obtaining, being the responsible for the CO_2 generation thus ensuring the distinctive aerated structure of the dough. However, the role of yeast in dough is not limited to the gas production. Yeast cells are also partly responsible for the flavor of bread and can influence the rheological characteristics of the dough. The aim of this study is to evaluate the influence of fresh or dry yeast and of the different type of flour used (000/ 650/ 650+1350 variants). The same manufacturing recipe was used for all experimental variants. The bakery products investigated were coded according to the type of yeast used adding a numerical code specific to the type of flour used as follows: 000, 650 or 1350. The experimental variants were obtained with 100% superior flour (type 000), 100% white flour (650 type) or 50% white flour (650 type) + 50% wholemeal-flour (type 1350). The main objectives were the evaluation of the sensorial characteristics and the physical-chemical parameters of the bread samples obtained as well as the analysis of the quality of the yeast used. The results obtained showed that the experimental variant DYPk, even if it involved a longer fermentation period, gave the most appreciable quality results of the bakery products, namely: the shape of the products well contoured, not flattened and the appropriate volume. The pores were uniformly developed, the crumb was elastic, mellow, well bound to the shell. The experimental variant obtained with superior flour 000 for which the growth agent used was in dry form coded with DYPk showed the best quality characteristics with less changed even after 10 days of samples storage under refrigerated conditions.

Key words: yeast, baking products, quality parameters

Yeast is used worldwide as a raising agent in bakery products. Yeasts used in baking belong to the species *Saccharomyces cerevisiae* and are obtained from a strain of this species, selected for special qualities related to the needs of the baking industry (Leonte M., 2003).

The fermentative activity of baker's yeast is not only essential for the rising action of dough through the production of CO_2, but also in the production of a wide range of aroma compounds found in bread (Birch A. *et al*, 2013).

This yeast-mediated fermentation also produces secondary metabolites such as glycerol, organic acids, and flavor compounds. These fermentation metabolites play an important role in the dough properties and quality characteristics of the finished product. The yeast, through its activity in the dough mass, produces alcoholic fermentation, which results in CO_2, which causes the dough to become mellow (Moldoveanu G. *et al*, 1973). During alcoholic fermentation, yeast converts sugars to CO_2 and ethanol, with a preference for glucose consumption over fructose and maltose (Timmermans E., 2022).

A range of baker's yeasts are now produced and used to make bakery products: fresh and dried yeast, the intermediate between the two, being liquid or 'cream' yeast. Regarding, the optimal conditions for yeast storage is keeping in refrigerating conditions like major raw material; the main purpose being to assure a longer period of preservation (Sandu A. *et al*, 2020; Ghimpețeanu O.M. *et al*, 2016 - 2018).

Anatomically, the yeast cell consists of a thin outer shell (membrane), inside which the cell body is found (protoplasm). The optimal conditions for yeast growth are: temperature of 25-28°C, weakly acidic environment (about 2.5 degrees), watery, air free of carbon dioxide, an alcohol concentration of the environment of the maximum of 2%, and food (starch and sugar) (Akbar A., 2012; Moldoveanu G. *et al*, 1973).

Baker's yeast fermentation is strongly directed towards maximum biomass production,

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by-products such as ethanol are not beneficial (Akbar A., 2012).

The nutritional benefits of eating yeast bread obtained in food safety conditions, are countless (Goncearov M. *et al*, 2004, Petcu C.D. *et al*, 2007, Petcu C.D. *et al*, 2019).

In addition, the use of yeast helps to reduce the negative effects of phytic acid. Phytic acid prevents the absorption of certain important minerals from cereals, such as zinc and iron, and to a lesser extent calcium and magnesium.

Cereals contain a high amount of phytic acid. It is removed (to a small extent) by boiling, germination, or fermentation with commercial yeast (ca. 50%) or endogenous yeast (ca. 70%) (Margarit R., 2020). The influence of yeast on dough ripening includes lowering the pH, changing the interfacial tension in dough phases due to ethanol production, and physically weakening the dough as CO_2 expands.

Thus, the aim of the current research is to evaluate the influence of raising agents on the quality of bakery products using two types of yeast: fresh and dried. At the same time, the influence of different flour sorts (000, 650 and 1350) on the bakery quality products obtained was also investigated.

MATERIAL AND METHOD

The experimental products were made in the micro-production workshop, in the bakery section located in the Agricultural Products Processing Technology building. The growth agent used in the technology of obtaining bakery products was purchased from commercial network of Iasi, being represented by three different brands.

The study material consisted mainly in obtaining bakery products with the same recipe, with the specification that the experimental variants were based on different sorts of flour (000, 650, 1350). The bakery products taken in the study were coded according to the type of yeast used, as follows: FYGS, FYPk, DYPk, DYDQ; and also according to the type of flour used by adding a numerical code specific to the type of flour as follows: 000,650 and 1350. The products resulted are represented by 12 experimental variants as follows: FYGS 000; FYGS 650, 1350; FYGS 650; FYPK 000; FYPK 650, 1350; FYPK 650; DYPK 000; DYPK 650, 1350; DYPK 650; DYDQ 000; DYDQ 650, 1350 and DYDQ 650.

Three types of flour were used to make the dough: superior flour 000 type, white flour 650 type, and black flour 1350 type with four types of dry and fresh commercial yeast. The dough was prepared from 100% wheat flour, 50% water, 5% yeast, 2% oil, 2% sugar, and 1.5% salt.

A group of specialized tasters, professors from the "Ion Ionescu de la Brad University of Life Sciences" Iasi, was formed in order to re-evaluate the sensorial characteristics. In terms of sensory analysis, visual, taste, and structural parameters were followed.

The dough was obtained by the direct method characterized by mixing and kneading the raw and auxiliary materials in a single step. The kneading process of the dough was carried out with the aid of the mixer until all the components were homogenized. In the dough processing phase, the following steps were carried out: dividing, pre-shaping, pre-fermentation and shaping. Pre-fermentation was carried out in order to optimize the porosity of the dough. Both dividing and shaping were carried out manually. Pre-fermentation and final fermentation are indispensable because they result in a well-risen and mellow dough.

In order to achieve the qualitative parameters of the experimental variants obtained, the following physical-chemical analyses were determined: titratable acidity, pH, soluble dry matter, ash content, salt, porosity and color.

The acidity of the bread gives indications of the quality of the flour used, the technological process, the degree of freshness, and storage conditions. Thus, 25 g of bread crumbs were weighed from the sample to be analyzed, placed in a 500 cm^3 volumetric flask, and homogenized with 250 ml of distilled water. The resulting solution has been homogenized and allowed to stand for 5 minutes. From the decanted solution, 50 ml is taken into an Erlenmeyer glass. The aqueous extract of the test sample is titrated with 0,1 n sodium hydroxide solution, after the added 2-3 drops of phenolphthalein 1%, until a pale pink color appeared and persisted for 30 seconds.

The basic principle underlying the determination of the total dry matter is the loss in mass of the products under analysis by heating to 130°C±2°C. Thus, 12-15 g were cut from the center and from two places near the edge of the bread crust and homogenized. Approximately 5 g of the sample was introduced in a pre-weighed drying vial with a lid and then it were placed into the Biobase® oven previously heated to 140-145°C. The temperature was adjusted to 130±2°C and the heating process was made for 60 min. The vial is then removed from the oven, covered with the lid, and placed in a desiccator for cooling for 30-60 min and then weighted. Two determinations from the same sample are carried out in parallel for analysis. For the determination of minerals, the dry sample were grounded and calcined at 750±25ºC for 60 minutes.

Sodium chloride was determined by weighing 25 g of sample and grinding it with 100 cm^3 of distilled water. The mixture was placed in a 200 mL volumetric flask, it was homogenized for 1 minute, and allowed to stand for 1 hour, shaking every 10 minutes. The mixture in the flask was brought to the 200 cm^3 with distilled water, followed by homogenization and standing for a further 10 minutes. From the prepared solution, 50 mL is with drawn into an Erlenmeyer flask to which 0,5 mL K_2CrO_4 solution is added, and titrated with a solution of $AgNO_3$ until the orange-yellow color appears.

A quality bakery product must present uniform porosity, without large and irregular voids, and quality standards set the minimum porosity of the bread. The porosity structure is determined by looking at the size of the pores and the uniformity of their distribution over the cut surface. The porosity determination consisted in determining the total volume of air voids in a known volume of crumb, knowing its density and mass.

The Chroma Meters CR-410T® was used to measure the colour of the samples.

The L value represents the brightness component where the area value ranges from 0 to 100 while the a and b values are chromatic components ranging from red to green and blue to yellow. In this colour space, the L* value represents brightness (0 is black and 100 is white), the a* value represents red-green coordinates (a+ positive value indicates redness and a- negative value indicates greenness) and the b* value represents yellow-blue coordinates (positive b+ value indicates yellow and negative b- value indicates blue).

RESULTS AND DISCUSSIONS

The results obtained reveal the importance of the use of the growth agent and the degree of extraction of the flour. As an overview, the results of the sensory evaluation (*figure 1*) from the perspective of visual indicators show that all samples obtained from superior 000 flour, regardless of the type of raising agent used, were rated with the highest mean values, with one exception represented by sample FYPK000 for the shape and shell integrity parameters. On the opposite side, intermediate bread made with 650 and 1350 flour was rated with the lowest mean values for all parameters.

Figure 2 shows that all the experimental samples exhibited a specific taste, with sweetness predominating in sample DYPK 000.

Fresh PK yeast influenced the experimental variants to be brittle compared to the other samples. At the same time, it is shown that the type of flour influences this parameter, the samples obtained with 1350, 650 flour sorts presents a higher level of crumbling respectively (*figure 3*).

The fresh yeast coded "GS" leads the elasticity of the bread, which is noted in the experimental products based on flour 000 and 650. At the same time, the intermediate bread obtained from flour 650 and 1350 resulted in a bread with a high degree of hardness (*figure 3*).

According to the results obtained (*table 1*), it can be seen that for the experimental samples made from 000 flour, the acidity did not exceed the threshold of 1.6, regardless of the type of growth agent used. Fresh yeast causes an increase in acidity highlighted in flour 650 for both 'GS' and 'PK' coded yeast, in contrast to the samples using dry yeast (*table 1*). As regards pH, the research reveals a range of values between 5.3 for the DYDQ 650 sample and 6.54 for the DYPK 000 experimental sample.

Each of the process variables used in this study, represented by fermentation temperature, type of flour, and origin of the raising agent, had a significant effect on the figures describing the acidity of the bread. The type of flour (white and black wheat flour) had a significant effect on theacidity. One explanation for the higher acid content of white and black bread is the degree of extraction of the flour; compounds such as phytate, present in dark flour, allow lactic fermentation without suppression caused by low pH (Murariu O.C. *et al*, 2016; 2019; Petcu C. *et al*, 2019).

The origin of the raising agent had low effect on the pH or titratable acidity value (*table 1*). However, fresh yeast coded "GS" produced higher concentrations of lactic acid and acetic acid for the bread made with 650 flour sort than did the other experimental yeasts under similar conditions.

Regarding the sodium chloride content, the results obtained fall within the lower range of 0.2 delimited by FYGS 650, 1350, and the upper range of 0,9 represented by FYGS 650. Sodium chloride in bread has multiple functions such as improving taste, stabilizing yeast fermentation, strengthening gluten, and causing a delay in proteolytic activity. At the same time, in high quantities and introduced into the technological process at the wrong time, salt inhibits yeast activity and dough expansion inhibits gluten hydration and causes the dough network to harden. It is recommended to add sodium chloride at the end of the kneading stage or add fat-coated salt; its action becomes available only in the last stages of dough preparation or in the first stages of baking (Mondal A. *et al*, 2008; Reißner, A. 2019).

The results obtained for the ash content shows the highest value for samples obtained with 1350,650 sorts flour for all the experimental variants (*table 1*). The lowest values were recorded for the samples obtained from white flour (000) delimited by DYDQ and FYGS. The mineral content of flours depends on many factors such as: the wheat variety, grain size, quality of wheat, and degree of extraction. At the same time, minerals are unevenly distributed in the different anatomical parts of the wheat. Thus, flour with a higher degree of extraction will have a higher content, due to the high content of substances in the pericarp. The results of the total dry matter show that it varies between 54% and 68%.

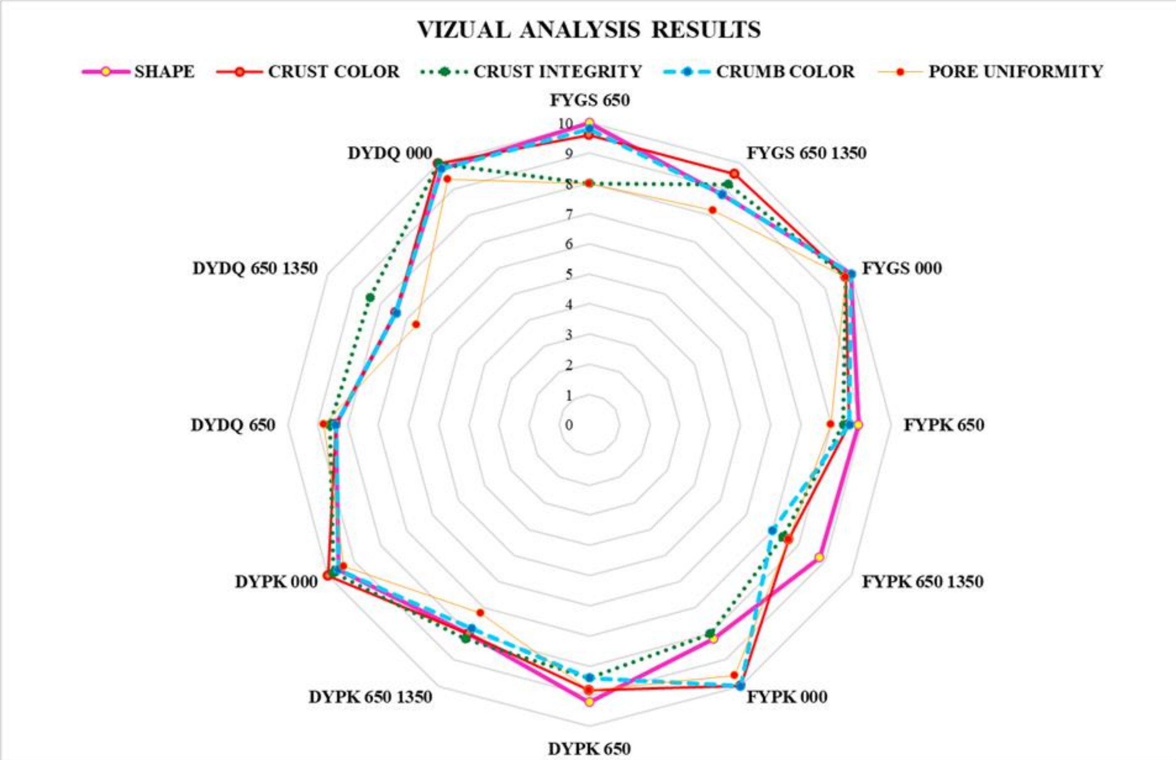

Figure 1 **Visual analysis results**

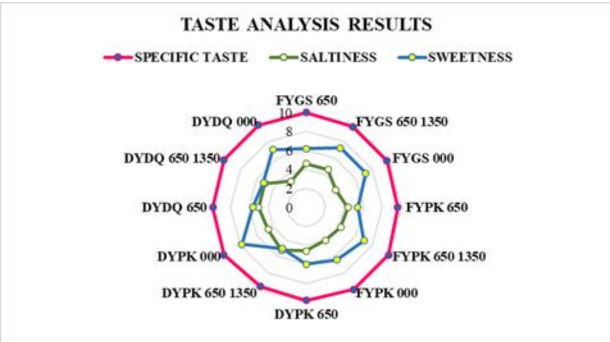

Figure 2. **Taste analysis results**

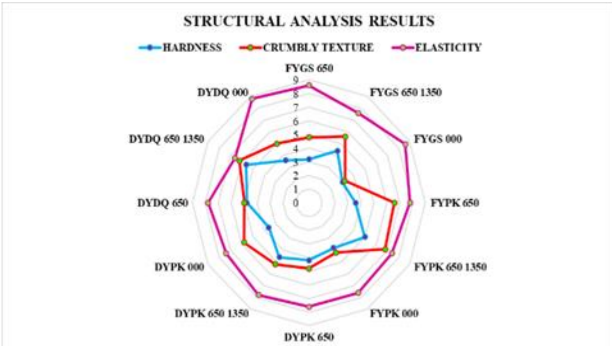

Figure 3. **Structural analysis results**

According to the results obtained (*table 1*), it can be seen that for the experimental samples obtained with 000 flour, the acidity did not exceed the value of 1.6, regardless of the type of growth agent used.

Fresh yeast causes an increase in acidity highlighted in flour 650 for both 'GS' and 'PK' coded yeast, in contrast to the samples using dry yeast (*table 1*). As regards pH, the research reveals a range of values between 5.3 for the DYDQ 650 sample and 6.54 for the DYPK 000 experimental sample. Each of the process variables used in this study, represented by fermentation temperature, type of flour and origin of the raising agent, had a significant effect on the figures describing the acidity of the bread.

The flour sorts had a significant effect on the parameters analyzed. One explanation for the higher acid content of intermediate bread is the degree of extraction of the flour; compounds such as phytate, present in dark flour, that allow lactic fermentation without suppression caused by low pH.

The origin of the raising agent had little effect on the pH or titratable acidity value (*table 1*). However, fresh yeast coded ”GS” produced higher concentrations of acids for the bread made with 650 flour sort than did the other experimental yeasts under similar conditions. As for the sodium chloride content, the results obtained fall within the lower range of 0.2 delimited by FYGS 650, 1350, and the upper range of 0.9 represented by FYGS 650. Sodium chloride in bread has multiple functions such as improving taste, stabilizing yeast fermentation, strengthening gluten, and causing a delay in proteolytic activity. At the same time, in high quantities and introduced into the technological process at the wrong time, salt inhibits yeast activity and dough expansion inhibits gluten hydration and causes the dough network to harden. It is recommended to add sodium chloride at the end of the kneading stage or add fat-coated salt; its action becomes available only in the last stages of dough preparation or in the first stages of baking (Mondal A. *et al*, 2008; Reißner, A. 2019).

The results obtained for the ash content shows the highest value for bread obtained with flour sorts 650, 1350 for all the experimental variants (table 1). The lowest values were recorded for the samples obtained from white flour (000) delimited by DYDQ and FYGS.

The mineral content of flour depends on many factors such as the wheat variety, grain size, quality of wheat, and degree of extraction. At the same time, minerals are unevenly distributed in the different anatomical parts of the wheat. Thus, flour with a higher degree of extraction will have a higher content, due to the high content of mineral substances in the pericarp.

The results of the total water content show that it varies between 54 to 68%.

Table 1

Physico-chemical parameters of bread

	pH	T.A.	T.D.M,%	ASH,%	NaCl, %
FYGS 650	5.9	2.45	56	0.07	0.9
FYGS 650 1350	5.95	2.05	62	0.13	0.2
FYGS 000	5.97	1.64	66	0.04	0.7
FYGS 650	5.95	2.05	54	0.06	0.4
FYP$_K$ 650 1350	6.08	2.46	58	0.13	0.8
FYP$_K$ 000	6.08	1.23	68	0.08	0.3
DYP$_K$ 650	6.04	2.25	60	0.04	0.6
DYP$_K$ 650 1350	5.92	2.36	58	0.15	0.5
DYP$_K$ 000	6.54	1.02	66	0.07	0.6
DYDQ 650	5.3	1.84	60	0.04	0.4
DYDQ 650 1350	5.93	2.05	64	0.11	0.4
DYDQ 000	6.02	1.43	56	0.04	0.4

The results obtained from the colour determination (*table 2*) show varied values characteristic of the type of flour used. Thus, the brightness indicator shows maximum values represented by the DYPK 000 sample, with a value of 78,38. The lowest values are found for samples FYPk 650, 1350, with a value of 65,60. According to the literature phenolic substances contained in bran are responsible for the darker color of the bread. At the same time, it is specified that the core shade can be influenced by the baking process, as a result of caramelization of reducing sugars leading to the appearance of dark brown color (Van Hung P. *et al*, 2007).

Table 2

Porosity and colour determination

	Porosity,%	Colour		
		L*©	**a*©**	**b*©**
FYGS 650	69	72,41	-3,06	23,12
FYGS 650 1350	75	66,33	-0,58	21,65
FYGS 000	75	75,22	-4,45	23,54
FYGS 650	66	70,89	-2,63	23,71
FYP$_K$ 650 1350	66	65,60	-0,39	21,19
FYP$_K$ 000	76	78,14	-4,10	22,30
DYP$_K$ 650	63	75,93	-3,31	21,98
DYP$_K$ 650 1350	64	69,99	-0,75	20,56
DYP$_K$ 000	72	78,83	-4,83	23,51
DYDQ 650	75	73,99	-2,93	22,76
DYDQ 650 1350	63	68,28	-1,28	22,34
DYDQ 000	79	78,56	-5,13	24,17

The results of porosity determination indicate numerical superiority for the experimental sample DYDQ (superior wheat flour) recording a value of 79%.

The high percentage result is due to the growth agent used characterized by fresh yeast "GS". The experimental variants DYPK and DYDQ (white wheat flour 650, black wheat flour 1350) are numerically inferior (63%).

The differences noted in the samples analyzed are due to the type of flour used (000, 650, 1350) (Murariu O., 2021). An insignificant difference is noted in the use of dry yeast from the two traders. Similar data were also obtained by *Munteanu G*. (2019) who conducted a study on the dynamics of the bread fermentation process using different types of yeast.

CONCLUSIONS

The results obtained showed that the experimental variant DYPk000 obtained the best quality results of the bakery products, namely: well-contoured, non-flattened product shape and adequate volume. The pores were uniformly developed, and the core was elastic, soft and well-bonded to the crust.

The experimental variant obtained with the superior 000 flour for which the growth agent used was in dry form coded with DYPk showed the best quality characteristics, with fewer changes even after 10 days of keeping the sample under refrigerated conditions.

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