TOYOTARITY

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Production/Service Processes Improvement

Chapter 9

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ATTEMPT TO USE DRY BIOPAN-S SOURDOUGH TO MODIFY THE TECHNOLOGICAL PROCESS OF WHOLE-GRAIN, RYE BREAD PRODUCTION

Abstract: Rivalry in every branch of industry requires constant upgrades of produce and services that fulfil the present and even future requirements of customers. This phenomenon is mirrored by the Ist TQM rule. Bakers too are under this pressure if they want to keep a steady level of sales. They have to modify their technological processes to make sure that they follow current nutritional trends. Taking the above into consideration it can be found of interest to acknowledge the research dealing with modifying of the technological production of whole-grain rye bread (of 0,750g volume) using dry Biopan-S sourdough. During the course of the research there were multiple attempts of baking bread in universal baking equipment and following those attempts with organoleptic tests as well as tests qualifying its' physical and chemical features. On the basis of the amount of points the bread received from organoleptic evaluation it was classified into specific level of bread quality according to the PN-A-74108:11996 norm.

Key words: improvement of baked goods, bread, organoleptic evaluation.

9.1. Theoretical foundations

Whole-grain rye bread is produced using whole-grain rye flour that is made through single grinding of the grains. It is made using acid which is produced through the multi-phased fermentation process. Contents of flour in the acid should take up 50 % of the acid's amount. Flour's temperature should be ranging from 28 to 30 degrees Celsius and its' productivity should be about 200. Fermentation lasts 3 hours. Temperature should be between 30 and 32 degrees Celsius. Bread is produced in loafs of various shapes that

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undergo fermentation on the boards or in baking forms (GŁADYSIAK, GŁOWACKI 1976). It is possible to replace the multi-phased fermentation process with using dry sourdough instead. Whole-grain rye bread is rich in mineral nutrients and vitamins. In this kind of bread's contents we can find all of the necessary nutrients responsible for energy, building and regulation of the human body. Nutritious value of whole-grain rye bread is defined by the following ingredients: Water, Protein, Fat, Carbohydrates, Mineral nutrients and Vitamins.

Water content in the 100g of bread comes to 41, 1%. A content of protein comes to 5g, of fat 2g and of carbohydrates altogether to 49g in which fibre comes to 1g. Among the mineral nutrients we can distinguish calcium amounting to 26mg, phosphorus- 200mg, iron 02,5mg and magnesium- 61mg. Bread of this weight is also capable of delivering: 0,16mg of B_1 vitamin, 0,12mg of B_2 vitamin and 0,7mg of PP (AMBROZIAK 1998, KUNACHOWICZ 2005).

Physical and chemical requirements for whole-grain rye bread according to the PN-92-A-74101 are illustrated in table number 9.1.

Table 9.1. Physical and chemical requirements for whole-grain rye bread. According to the PN-92-A-74101

No.	Quality	Requirements	
1	Acidity, [°], not higher than	11	
2	Moisture content after 8 hours from being baked [%], not higher than	50	
3	Volume of the 100g of bread, [cm^3], not smaller than	140	
4	Heavy metal contents, [mg/kg], not higher than	arsenic	0,2
		lead	0,4
		copper	5
		zinc	40
		cadmium	0,1

Source: (PN-92 A-74101)

During the whole technological process of whole-grain rye bread production, certain requirements included in the PN-92-A-74101 norm, have to

be fulfilled. It was decided that the most important organoleptic characteristics of the whole-grain rye bread are the following:

- the shape of the bread should be elongated
- the surface of the crust according to the norm has to be coarse, of brown to dark brown colouring, the upper crust's thickness cannot be less then 3mm.
- bread crumb complies with the norm when it is evenly coloured, dry to touch and its' porosity is even and when lightly pressed it comes back to its' original shape (elasticity)
- smell and taste is characteristic for his type of bread

9.2. Description and outline of the technological process of whole-grain rye bread production

On the industrial scale the technological process of whole-grain rye bread production is multistage. However in the laboratory conditions using universal bread baking equipment and using dry Biopan-S sourdough this process became shortened and modified. Its' main stages are:

➢ Preparation of basic resources such as:

- Flour -should have a constant and even quality. It has to be mentioned that the flour that has been sifted during the process of dough production has better ability of water absorption which is not insignificant in the economical aspect of bread production (FALCZYK i in. 2006).
- Water -is warmed up or mixed with a warm dose. It takes place at the feeders and lasts until the desired temperature is achieved (FALCZYK i in. 2006).
- Yeast -are used to create dough or leaven, it happens after they are crumbled and mixed with water to create aqueous suspension (FALCZYK i in. 2006).
- Salt is dissolved in water and after a suitable amount of time it is filtered and in this state added to the dough (FALCZYK i in. 2006).

➢ Dough production:

Dough production is based on kneading the resources given in the formula. Use of the standard baking equipment and application of the dry

Biopan-S sourdough in this research caused the bread production to shorten in comparison to the classical technological process of whole-grain rye bread production. Nonetheless the bio-chemical processes occurring at this stage were comparable. The yeast and lactic acid bacteria can be observed to take effect. Shortly before the bread morsel formation its' correct structure is clearly spongy with thin walls and fine pores and its' consistency is quite compact (AMBROZIAK 1998, FLACZYK i in. 2006, LUBCZYŃSKA i in. 1996).

➢ Forming of the dough morsel:

Forming of the dough morsel using the baking equipment used in this research is a self-contained process. The equipment forms the shape of the dough morsel before the dough rises and is baked. Correct morsel formation greatly influences the quality of the ready-made product.

➢ Final growth of the dough and baking preparation:

During the morsel formation the structure of the dough is being affected, and the dough loses almost all of its' CO_2 contents. Because of that already shaped dough undergoes final fermentation stage also called the final dough growth. This type of fermentation takes place in the dough morsel and the gas that is being produced aerates the dough affecting its' volume (FALCZYK i in. 2006). Temperature suitable for this process should range between 30 and 40 degrees, relative air humidity should be between 75 and 85%. Higher air temperature speeds up the fermentation process, as well as the dough growth. High air humidity prevents the crust from drying but it can also cause the dough to stop growing and for the crust to crack during the baking stage (LUBCZYNSKA i in. 1996). The time allocated for the dough growth depends on many variables. Shorter growth time can for example be applied when:

- the dough consistency should be looser, the dough contains less salt, the dough was produced with the use of flour affected by the lichen,
- the dough that contains weaker form of gluten or higher yeast content.

The full biological maturity of the morsel can be determined on the basis of sensory recognition. Fully grown morsels before being baked undergo ennobling steps e.g. moistening the morsels, incising and puncturing the dough and applying the seeds (LUBCZYNSKA i in. 1996).

➢ Bread baking:

Bread morsel is baked in the 250-280 degrees Celsius. Warmth penetrates the dough quickly allowing the external part of the dough to become more extensible, the crust more elastic which prevents it from cracking and affects the bread growth. It also has a positive influence of affecting the dextrin creation. Dextrin improves the quality of the crust (AMBROZIAK 1996, FLACZYK i in. 2006).

Temperature on the surface of the morsel reaches around 180 degrees Celsius, while the temperature of the layer on the borderline of crumb and crust reaches 100 degrees Celsius and does not change until the end of the process. Temperature inside of the crumb rises to about 97 degrees Celsius which happens at the end of the baking process. It can indicate the process coming to an end.

During the dough baking the following processes can be observed: denaturation of protein, Hydrolysis of polysaccharides, Inactivation of enzymes, The so called process of un-enzymatic browning (AMBROZIAK 1998).

Due to baking and the above mentioned processes change of color as well as characteristic taste and smell is being achieved. The negative influence of the above processes is that they lower the contents of protein, through blocking of the free amino groups, especially lysine. Still they help in producing bread with nicely browned crust and specific smell and taste (AMBROZIAK 1996, FLACZYK i in. 2006).

- Bread cooling:

Bread, directly after baking, should be cooled down to room temperature. In the first stage of cooling there is a significant difference in temperature between crust and crumb. Crust temperature amounts to 180 degrees Celsius and the bread crumb temperature hovers around the 95-97 degrees Celsius. At this point the product quite quickly gives of heat. That is why, the conditions in the environment where this process is taking place, are extremely important.

- Confectioning of bread:

Bread confectioning, that is cutting and packing should take place directly after the cooling stage.

Below on the graph no 9.1 you can see the simplified scheme of production of the rye whole-grain bread.

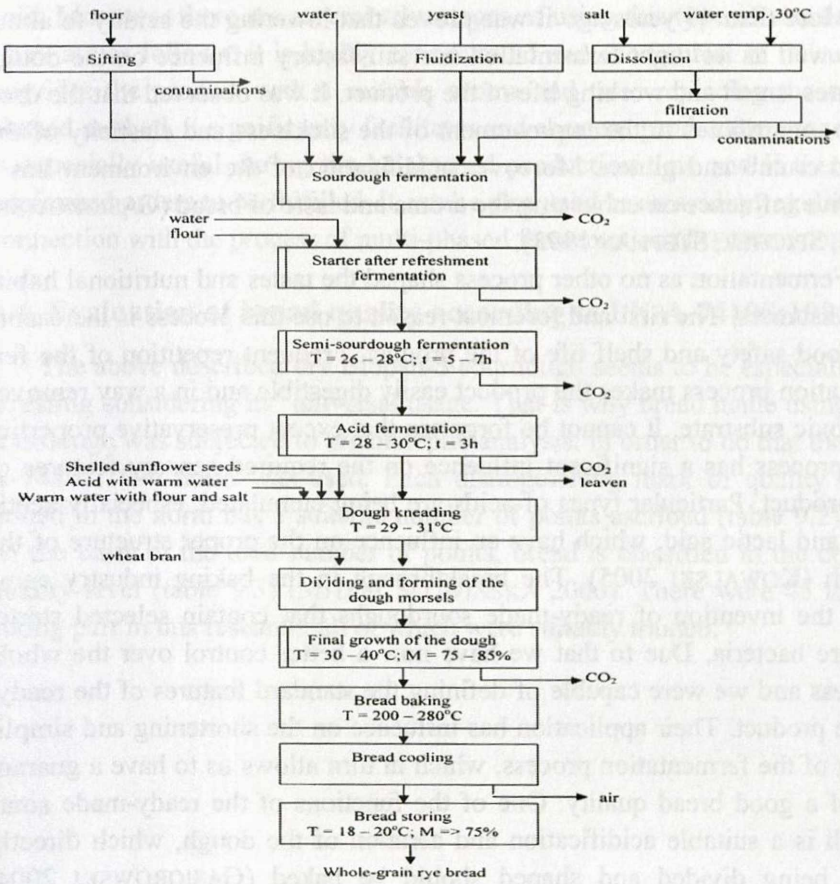


Fig. 9.1. Idea scheme of the technological process of production of rye whole grain bread made with shelled sunflower.

Source: Personal study based on technological description and materials suplied by companies.

9.3. Characteristics of the dry Biopan-S sourdough use

For the last several years we could observe a battle for maintaining the traditional features of bread, for that reason there was an intention to introduce and disseminate a new assortment of bread produced using sourdough.

More than 40 years ago it was proven that lowering the acidity to about 5, as well as its' light fermentation has satisfactory influence on the dough features, smell and working life of the product. It was observed that the drop in Ph. contributes to the improvement of the stickiness and elasticity of the bread crumb and gluten. Moreover acidification of the environment has a positive influence on enhancing the aroma and taste of bread (GĄSIOROWSKI 2004, SPICHER, STEPHAN 1993).

Fermentation as no other process shaped the tastes and nutritional habits of consumers. The first and foremost reason to use this process is increasing the food safety and shelf life of the product. Frequent repetition of the fermentation process makes the product easily digestible and in a way removes the toxic substrate. It cannot be forgotten that except preservative properties this process has a significant influence on the required sensory features of the product. Particular types of acids are being cumulated, especially acetic acid and lactic acid, which have an influence on the proper structure of the dough (KOWALSKI 2005). The breakthrough in the baking industry came with the invention of ready-made sourdoughs that contain selected starter culture bacteria. Due to that we have now a better control over the whole process and we were capable of defining the standard features of the ready-made product. Their application has influence on the shortening and simplifying of the fermentation process, which in turn allows us to have a guarantee of a good bread quality. One of the functions of the ready-made sourdough is a suitable acidification and aeration of the dough, which directly after being divided and shaped should be baked (GASIOROWSKI 2004, KOWALSKI 2005).

Biospan-S sourdough used in this research is a dry sourdough that is used for a quick production of mixed rye bread. It is used as a means of fermenting the dough which gives it its 'characteristic organoleptic features, typical for the natural dough fermentation. This kind of sourdough has to be dosed in the amount of 2% in relation to the amount of rye flour used to make the dough. It can be also used as an additional means of introducing acidity to the dough already treated with natural acids, which positively influences the acidity of the product. The quality of bread produced using Biopan-S is comparable to the quality of bread produced using traditional

acid. Moreover there are several advantages of using this type of sourdough. They are as follows: it is highly concentrated and economical in its' use, it provides the product with a suitable aroma and taste replacing the multi-phased method, it significantly facilitates and shortens production process. It is especially useful during the heightened production time and if there are unplanned orders to be fulfilled. It can be also used as an acidity regulator in connection with the process of multi-phased fermentation (INFORMATOR).

9.4. Evaluation of bread quality according to PN-A-74108:1996

The above described dry Biopan-S sourdough seems to be especially interesting considering its' universal usage. That is why bread made using this sourdough was subjected to organoleptic analysis. In order to do that the PN-A-74108:1996 norm was used. Each distinguishing mark of quality mentioned in the norm has a suitable number of points ascribed (table 9.2), and on the basis of the total number of points, bread is classified in the correct quality level (table 9.3) (MITEK, SLOWINSKA 2006). There were 45 testers taking part in this research, all of which were suitably trained.

Table 9.2. Organoleptic evaluation of bread according to the PN-A-74108:1996

Distinguishing mark of bread quality		Properties	Amount of points	Properties	Number of points	Properties	Number of points	Properties not consistent with the norm	Number of points
Exterior Appearance		Specific for this kind of bread	5	Fully risen with minimal deviations from the norm	4	Fully risen with minimal deviations from the norm	0	Not well risen, deformed.	-35
Crust	colour	Typical for this type of bread	3	Slightly darker or lighter	2	Slightly uneaven or darker	0	Very dark or very light	-35
	thickness	Typical for the well baked bread	4	Suitable for the fully baked bread	3	Suitable for sufficiently baked bread	0	Very thin characteristic of not properly baked bread	-35
	Other features	Typical very well formed crust characteristic of this type of bread	4	Typical for this type of bread, slightly cracked	3	Deviations that do not disqualify the product	0	With dark blisters, peeling away and cracked	-35
Bread Crumb	Elasticity	Very good	4	good	3	suitable	0	Not suitable	-35
	porosity	Good, even	3	Quite even, with bigger pores in-between smaller ones	2	Slightly uneven with thin walls	0	Pores dense or very big	-35
	Other features	Evenly coloured, dry to touch	3	Well coloured, easy to cut	2	With slightly varied colouring	0	Slightly slack-baked, crumbly	-35
Taste and smell		Aromatic and mild characteristic to this kind of bread	6	Characteristic for this kind of bread	5	Slightly different from the characteristics of this kind of bread	0	Not typical for this kind of bread, bitter and insipid	-35
Physical and chemical indicators	Volume 100g [cm^3]	Compatible with the norm	3					Not compatible with the norm	-35
	Moisture content [%]	Compatible with the norm	2					Not compatible with the norm	-35
	Acidity [°]	Compatible with the norm	3					Not compatible with the norm	-35
	Sugar contents in dry substance [%dry substance]	Compatible with the norm	-					Not compatible with the norm	-35
	Fat content [%dry substance]	Compatible with the norm	-					Not compatible with the norm	-35
Mass of the bread		Compatible with the norm	-					Not compatible with the norm	-35

On the basis of the average number of points calculated using table number 3, examined bread will be classified into suitable quality level (table 4).

Table 9.3. Level of bread quality according to PN-A-74108:1996 norm.

Level of bread quality	Number of points
I	40-36
II	35-31
III	30-26
IV	25-8
Bread that received less than 8 points should be disqualified	

Source: (PN-A-74108:1996)

9.5. The results of the tests conducted on the basis of standard specific norm

- In the graph number 2 you can see the evaluation of the exterior appearance of the examined bread.

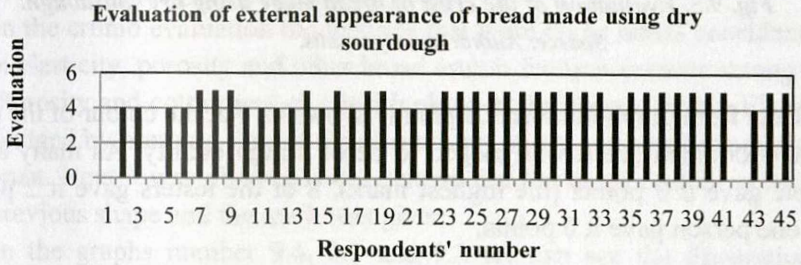


Fig. 9.2. Evaluation of the exterior appearance of the bread made using dry sourdough.

Source: Author's study results

As it can be seen in the graph number 9.2, maximum number of points (that is 5) was awarded by 27 respondents which constitute only 60% of the respondents taking part in the research.

-Evaluation of the crust:

It encompasses defining of the colour, thickness and other features such as the appearance of the surface, elasticity and crispiness. Colour and surface

features are determined by examining it in daylight. Elasticity is checked through applying pressure and crispiness by biting through the crust. Thickness of the crust was measured in mm and the measurements were taken from the outside surface to the place were a difference in colouring between the crust and the crumb could be observed (SZOLTYSEK 2001, MITEK, SLOWINSKI 2006).

Graphs number 9.3, 9.4, and 9.5 illustrate the obtained scores.

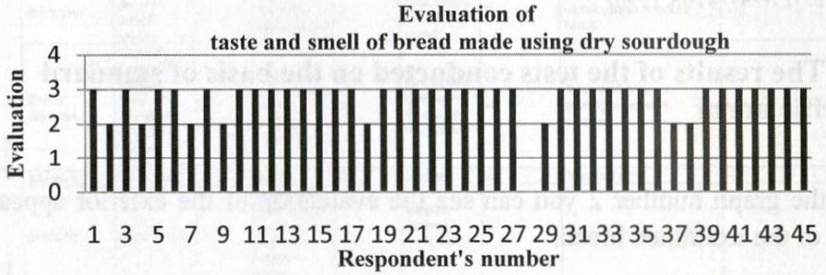


Fig. 9.3. Evaluation of the crust of bread made using dry sourdough.
Source: Author's study results.

Data from graph number 9.3 plainly shows us that the colour of the crust of the examined bread was judged to be of a high quality. As many as 36 people gave it 3 points (the highest mark), 8 of the testers gave it 2 points and one person gave it 0 points.

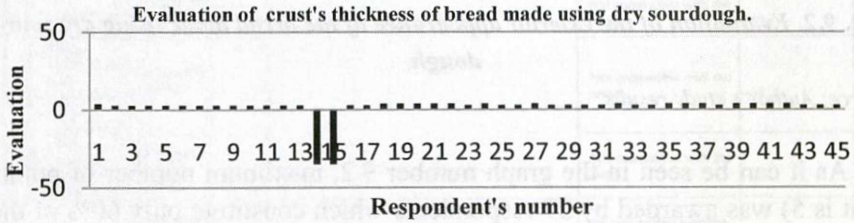


Fig. 9.4. Evaluation of the crust's thickness in bread made using dry sourdough.
Source: Author's study results.

Graph 9.4 informs us that the thickness of crust was judged to be of poor quality. Maximum number of points (4) was given only by 16 testers. There were also two negative marks.

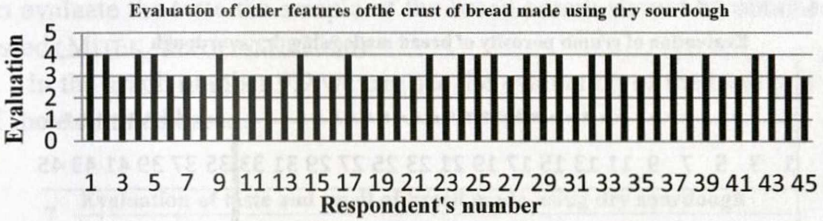


Fig. 9.5. Evaluation of other features of the crust of bread made using dry sourdough.

Source: Author's study results

Other features of the crust (graph 9.5) were given top mark by 21 respondents; remaining testers gave it 3 points.

In the crumb evaluation the features that were taken under consideration were: elasticity, porosity and other bread crumb features (colour among others).Porosity and colour was checked looking at the slice of bread. Elasticity was judged by pressing fingers simultaneously on the top and bottom part of the crust. Next it was observed how quickly did the bread crumb go back to its' previous shape and the mark was given.

In the graphs number 9.6, 9.7 and 9.8 we can see the illustration of evaluation of the bread crumb features.

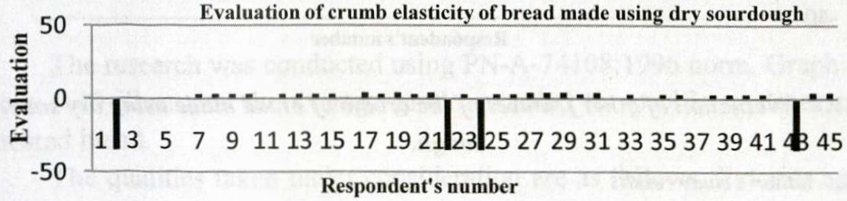


Fig. 9.6. Evaluation of other features of the crust of bread made using dry sourdough.

Source: Author's study results

From graph number 9.6 we can deduce that the bread crumb of the examined bread is not of a satisfactory quality. Only 9 respondents gave it a very good mark, 21 gave it a good mark and 11 marked it as sufficient, there were also 4 negative marks (-35).

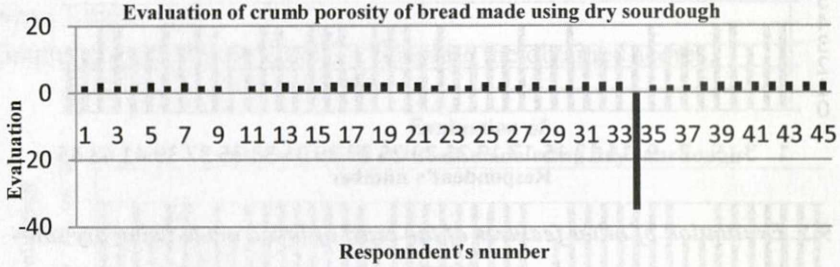


Fig. 9.7. Evaluation of crumb porosity of bread made using dry sourdough.

Source: Author's study results

Analysis of graph number 9.7 shows us that despite the fact that two of the respondents gave it a low mark, that is one of them gave it (-35) and the other one (0) we can claim that the porosity of the crumb was judged very highly . As many as 24 testers gave it a maximum number of points.

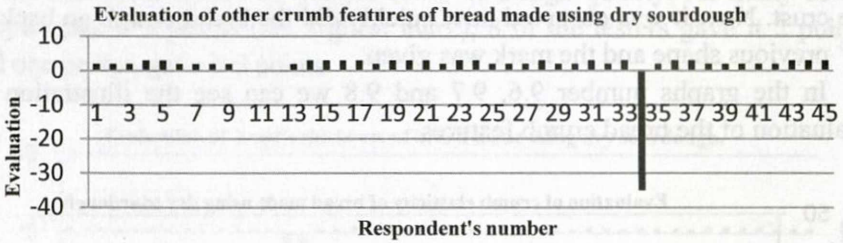


Fig. 9.8. Evaluation of other features of the crumb of bread made using dry sourdough.

Source: Author's study results

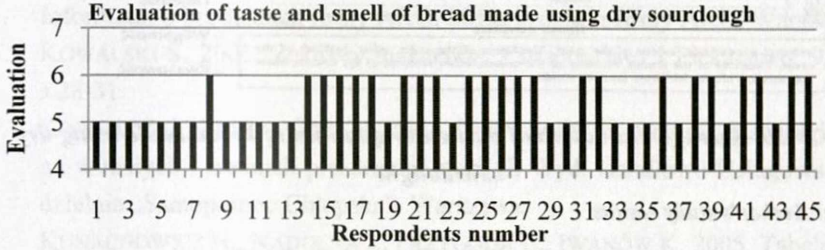
Graph number 9.8 shows us that other features of the bread crumb were mostly judged as sufficient but it should be stated that among 45 of the re-

spondents one of them gave it the mark of (-35) and three others gave it the mark of (0).

-Taste and smell evaluation:

Taste and smell has to be characteristic to the kind of bread being baked. To evaluate the taste the sample of the bread crumb should be obtained and tasted (MITEK, SLOWINSKI 2006)

In the graph number 9.9 we can see the evaluation of the taste and smell of the examined bread.



Pic. 9.9. Evaluation of taste and smell of bread produced using dry sourdough.

Source: Author's study results

Graph number 9.9 acknowledges the fact that; smell and taste of the examined product were considered to be of high quality. Those features were awarded the highest marks, that is 23 of the testers gave it 6 points and 22 gave it 5 points.

9.6. Conclusions

The research was conducted using PN-A-74108:1996 norm. Graph number 9.10 illustrates the average grade awarded to specific qualities of the tested bread.

The qualities taken under consideration are as follows: Exterior appearance, Colour, thickness and other crust features, Elasticity, porosity and other crumb features, Taste and smell as well as Volume, moisture and acidity.

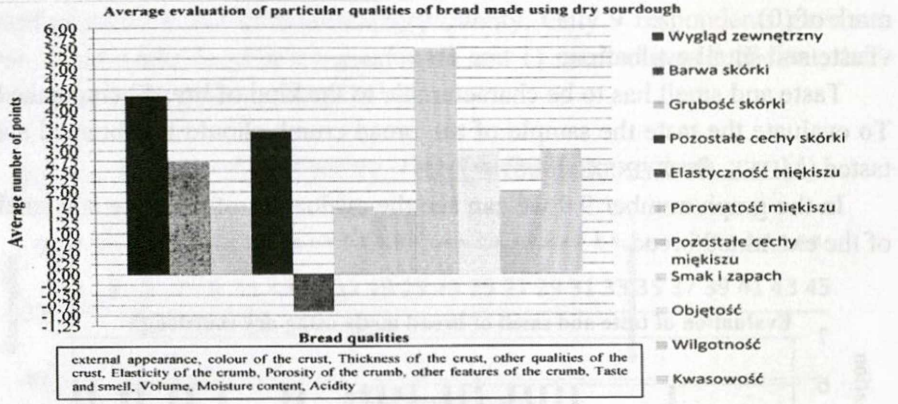


Fig. 9.10. Average evaluation of particular qualities of bread made using dry sourdough.

Source: Author's study results

Graph number 9.10 allows us to conclude that smell and taste are the features that greatly distinguish the examined bread made using dry Biopan-S sourdough. It was also stated that it's physical and chemical features that are as follows: moisture content and acidity, are in compliance with the set requirements. Data in graph number 4 helps us to classify this type of bread into the 3rd quality level that requires bread to accumulate 26 to 30 points.

Taking into consideration the fact that the aim of the research was to attempt using the dry Biopan-S sourdough in the whole-grain rye bread production, it is worth to remember about the economical aspect of doing so. Dry sourdough is significantly cheaper which does not mean that it is of a worse quality. It also has other advantages such as increasing the quality of taste and smell both of which were given a very good evaluation. It has to be said that those are the qualities that are very important to consumers. Moreover the dry sourdough should be used when bread has to be produced quickly as it facilitates and speeds up the production process. Its' use is also advised when there is an increase in production or if there are unexpected orders.

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