Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 16, Issue 4, 2016
PRINT ISSN 2284-7995, E-ISSN 2285-3952

COMPARATIVE ANALYSIS ON THE QUALITY OF SEVERAL BREADS ASSORTMENTS AVAILABLE ON THE ROMANIAN MARKET AND ON THE TECHNOLOGICAL PROCESSES RELIABILITY

Radiana Maria TAMBA-BEREHOIU[1], Ciprian Nicolae POPA[2], Vasilica SIMION[1], Bogdan Ştefan NEDELCU[1]

[1]University of Agricultural Sciences and Veterinary Medicine, Bucharest, 59 Marasti, District 1, 011464, Bucharest, Romania, Phone: +40 21 318 25 64/232, Fax: + 40 21318 28 88, E-mails: radianatamba@yahoo.com; vsimion@hotmail.com
[2]S.C. Farinsan S.A., Grădiştea Village, Comana Commune, Giurgiu County, Romania, Phone:+40 727 27 78 40, Fax: +40318156038, Email: cipnpopa@yahoo.com

Corresponding author: cipnpopa@yahoo.com

Abstract

Our investigations have focused on the analysis of several bread assortments manufactured by the largest producer in Romania, in terms of key quality parameters. There were analyzed four breads assortments coming from a local producer, namely Vel Pitar, as follows: whole wheat bread (500g), white bread (300 g), intermediate bread (300 g) and dark bread (300 g). Of each assortment were taken 15 samples from different batches. For each sample were analyzed: Weight (W, g), Moisture (M, %), Acidity (A, grade), Porosity (P, %), Elasticity (E %), Water activity (aW), Length (cm), Width (cm), Height (cm). We have identified highly significant statistical differences between varieties of bread (Student test). We find that all the significant correlations formed have particularized bread assortments, because of the fact that the assortments of bread did not show significant correlations between the same quality parameters. It is highlighted in this way, the differences between recipes and technological process. To conclude, we can say that the whole wheat bread and dark bread are most alike, in terms of quality characteristics, given that both had an increased fiber content. It was also noted the similarities of quality parameters in white and intermediate bread. All observed differences, with varying degrees of significance, constituted peculiarities of bread assortments taken for analysis.

Key words**:** *bread, quality parameters, statistical evaluation, technological process*

INTRODUCTION

Bread is one of the most consumed foods in Romania. The average consumption of bread was estimated in 2015 to about 100.6 kg per capita [10]. Consumption is declining relative to the previous decade, but it is at a level about 25% higher than the European average [9]. Decreasing consumption of bread has forced manufacturers to invest in technologies and recipes that enable the increase of products added value, in order to maintain or increase profit margins. Generally, the diversification of products range aimed to satisfy consumer interest in diet products, with functional properties suitable to a healthy lifestyles [1].

The bread, traditionally eaten in Romania, is 300 grams white bread, obtained from 650 type flour [7]. Although its market is shrinking, it is the best sold product on the current market of bread.

Our investigations have focused on the analysis of several bread assortments manufactured by the largest producer in Romania, in terms of key quality parameters.

The aim of the study was to evaluate the quality profile of each assortment, to analyze the degree of quality parameters variability (as an indicator of the technological processes reliability) and to highlight the main distinguishing features between quality parameters, considered as purchase consumer criteria.

MATERIALS AND METHODS

There were analyzed four breads assortments coming from a local producer, namely Vel Pitar, as follows: whole wheat bread (it

contains whole wheat flour, ash > 1.4%), white bread (contains flour type 650, ash 0.65%), intermediate bread (contains a mixture of flour type 650 + flour type 1350) and dark bread (contains flour type 1350, ash 1.35%) [2]. Of each assortment were taken 15 samples from different batches. For each sample, there were analyzed the main quality parameters, according to the methods shown in Table 1 [2, 3, 11].

Table 1. Quality parameters and analytical methods used to analyze different assortments of bread

Parameter	Analysis method
Weight (W, g)	SR 91:2007
Moisture (M, %)	
Acidity (A, grade)	
Porosity (P, %)	
Elasticity (E %)	
Water activity (aW)	Aqualab Series 4 TE
Length (cm)	Direct measurement with the ruler
Width (cm)	
Height (cm)	

The results were statistically interpreted using the IBM SPSS Statistics 20 computer program.

RESULTS AND DISCUSSIONS

Table 2 shows the quality parameters descriptive statistics of the four assortments of bread.

The results revealed that **whole wheat bread** did not exceed the limits set by the laws in force, concerning pre-packaged products (500 ± 15 g). Constant weight overcoming is in favor of the purchaser, but in time it will increase the production costs.

At the same time, whole wheat bread acidity was significantly lower compared to the limit, making the bread to be more vulnerable to infection with microorganisms. It is however noted that the elasticity and porosity are very good, as aW and bread dimensions.

Variation coefficients are within the permitted limits (under 12%), that which characterizes a normal distribution for quality parameter values. This reflects the fact that the technology of whole wheat bread production is sustainable and provides industrial process repeatability. We note, however, that the largest variation was presented in whole wheat bread acidity (CV = 9.59%).

Table 2. Descriptive statistics of the quality parameters (n = 15)

Para-meter	Assortments of bread	Li-mits	X±s	CV %
Weight (g)	Whole wheat bread	500 ± 15	509.39 ± 7.60	1.49
	White bread	300 ± 9	**311.23 ± 6.05**	1.94
	Intermediate bread	300 ± 9	**309.29 ± 4.14**	1.33
	Dark bread	300 ± 9	**310.62 ± 5.55**	1.78
Moisture (%)	Whole wheat bread	46	45.52 ± 0.63	1.38
	White bread	43	42.60 ± 0.38	0.89
	Intermediate bread	44	43.52 ± 0.47	1.07
	Dark bread	44	44.46 ± 0.42	0.94
Acidity (degrees)	Whole wheat bread	3	**1.98 ± 0.19**	9.59
	White bread	2.8	**1.16 ± 0.10**	8.62
	Intermediate bread	3	**1.63 ± 0.18**	11.0
	Dark bread	3	**2.04 ± 0.12**	5,88
Porosity (%)	Whole wheat bread	min. 80	82.28 ± 1.63	1.98
	White bread	min. 80	85.13 ± 0.86	1.01
	Intermediate bread	min. 83	85.49 ± 1.10	1.28
	Dark bread	min. 83	82.28 ± 1.15	1.39
Elasticity (%)	Whole wheat bread	min. 90	97.06 ± 1.47	1.51
	White bread	min. 90	99.21 ± 1.77	1.78
	Intermediate bread	min. 90	98.20 ± 2.57	2.61
	Dark bread	min. 90	97.87 ± 2.64	2.69
Water activity	Whole wheat bread	max. 0.95	0.93 ± 0.02	2.15
	White bread	max. 0.95	0.93 ± 0.019	2.04
	Intermediate bread	max. 0.95	0.94 ± 0.02	2.12
	Dark bread	max. 0.95	0.94 ± 0.02	2.12
Length (cm)	Whole wheat bread	29-30	29.67 ± 0.89	2.99
	White bread	29-30	**27.41 ± 0.40**	1.45
	Intermediate bread	27-28	27.36 ± 0.50	1.82
	Dark bread	26-27	26.26 ± 0.36	1.37
Width (cm)	Whole wheat bread	11-12	11.26 ± 0.43	3.81
	White bread	12-13	**10.07 ± 0.33**	3.27
	Intermediate bread	9,5-11	10.30 ± 0.31	3.00
	Dark bread	9-10,5	9.68 ± 0.30	3.09
Height (cm)	Whole wheat bread	7.5 – 8.5	7.76 ± 0.31	3.99
	White bread	> 8	**7.06 ± 0.16**	2.26
	Intermediate bread	max. 7	7.18 ± 0.26	3.62
	Dark bread	> 6,5	6.74 ± 0.19	2.81

Source: Own calculations.

That means that the influence of external factors on the proofing process had a greater extent than on other parameters [5, 8].

It appears that the weight limit (300 ± 9 g) of **white bread** is exceeded, on average with 2.23 g and acidity is also much lower compared to the limit. The dimensions of white bread did not conform, being smaller than those set by limits. Moisture, porosity and elasticity meets the standard for this type of bread. Coefficients of variation are normal, but higher concerning acidity parameter (CV = 8.62%).

It is noted that in the case of **intermediate bread**, weight exceeded the limit provided in the specifications, while the acidity did not reach the value needed for the bread to stand

in front of microbial contamination, if not quickly consumed. Basically, low acidity decreases storage stability of the product. Intermediate bread porosity, elasticity and dimensions enrolled within limits, as well as the variation coefficient. Acidity registered the higher variation coefficient (CV = 11.04%) at
intermediate bread, compared to other assortments.

Although the process showed consistency and repeatability, however we can say that the most vulnerable stage and less easily controlled was the proofing stage, that influenced acidity levels.

Dark bread weight and acidity did not comply with manufacturing limits, similar to other bread assortments. Thus, the weight exceeded the limit with 1.62 g and the acidity was lower below the permissible limit, but less lower than to the other bread assortments. Porosity, elasticity, aW and dimensions were compliant. Variation coefficients of the dark bread quality parameters were low, so the techological process of bread obtaining is reliable and sustainable. We should mention that CV% of acidity parameter (5.88%) had the lowest value of CV% values of other bread assortments. Water activity was similar for all assortments of bread and enrolled within limits (max. 0.95).

The four bread assortments presented features to be highlighted by the Student test (t), respectively the significance of quality parameters mean difference (Table 3).

Table 3. Significance of quality parameters mean

Pairs of bread assortments	Mean difference	t
Significance of mean difference for moisture		
white – dark	-1.86	**-12.059*** **
white – intermediate	-0.91	**-4.880*** **
white – whole wheat	-2.92	**-16.934*** **
dark – intermediate	0.94	**6.112*** **
dark – whole wheat	-1.06	**-4.579*** **
intermediate – whole wheat	-2.01	**-8.196*** **
Significance of mean difference for acidity		
white – dark	-0.88	**-17.963*** **
white – intermediate	-0.47	**-8.122*** **
white – whole wheat	-0.81	**-14.764*** **
dark – intermediate	0.41	**7.503*** **
dark – whole wheat	0.06	1.254
intermediate – whole wheat	-0.35	**-5.426*** **
Significance of mean difference for porosity		
white – dark	2.84	**7.212*** **
white – intermediate	-0.36	-1.356
white – whole wheat	2.85	**6.010*** **
dark – intermediate	-3.21	**-6.746*** **
dark – whole wheat	0.01	0.016
intermediate – whole wheat	3.1	**6.206*** **
Significance of mean difference for elasticity		
white – dark	1.34	1.491
white – intermediate	1.01	1.464
white – whole wheat	2.15	**3.456***
dark – intermediate	-0.33	-0.0321
dark – whole wheat	0.81	0.989
intermediate – whole wheat	1.14	2.131
Significance of mean difference for aW		
white – dark	-0.01	-0.729
white – intermediate	-0.01	-1.039
white – whole wheat	0.01	0.525
dark – intermediate	-0.002	-0.387
dark – whole wheat	0.01	1.604
intermediate – whole wheat	0.01	1.448
Significance of mean difference for lenght		
white – dark	1.15	**9.289*** **
white – intermediate	0.05	0.275
white – whole wheat	-2.26	**-9.113*** **
dark – intermediate	-1.11	**-8.090*** **
dark – whole wheat	-3.41	**-15.868*** **
intermediate – whole wheat	-2.31	**-8.582*** **
Significance of mean difference for width		
white – dark	0.39	**4.465** **
white – intermediate	-0.23	**-2.598***
white – whole wheat	-1.19	**-7.724*** **
dark – intermediate	-0.63	**-6.028*** **
dark – whole wheat	-1.58	**-10.076*** **
intermediate – whole wheat	-0.09	**-6.217*** **
Significance of mean difference for height		
white – dark	0.32	**4.125*** **
white – intermediate	-0.13	-1.456
white – whole wheat	-0.70	**-8.228*** **
dark – intermediate	-0.45	**-5.399*** **
dark – whole wheat	-1.02	**-10.048*** **
intermediate – whole wheat	-0.57	**-5.143*** **

Recipe and technological process differences between bread assortments is seen by large differences in quality parameters. There are significant differences related to **moisture**, between pairs of bread assortments. It is noted that bread assortments which contained more fibers, respectively whole wheat bread and dark bread had higher moisture, because the fibers retained more water.

Acidity is very significantly increased in

whole wheat bread and dark bread assortments, compared to white bread and intermediate bread assortments. The fact is explicable as the whole wheat bread and the dark bread contained high extraction flours, which had higher acidities (whole wheat flour and 1350 flour). Between white bread and intermediate bread or whole wheat bread and dark bread there are no significant differences concerning acidity.

The same is found in **porosity**. There were established significant differences in porosity between white bread or intermediate bread, and whole wheat bread or dark bread. Bread with a higher amount of fibers (whole wheat and dark bread) had a lower porosity, while white bread and intermediate bread showed porosities over 85% and higher volumes.

Elasticities are very good in general and did not significantly differ between bread assortments, except the elasticity of white bread, which is significantly increased compared to elasticity of whole wheat bread (t = 3.456 *). The **water activity** aW did not differ significantly between the assortments of bread.

The **dimensions** of bread assortments are significantly different from each other, but this is naturally, because we must take into account the technical specifications.

Intermediate bread and white bread did not differ on the length or height, but differed significantly (2.598 *) on width.

All these reported differences, with varying degrees of significance, represent peculiarities of bread assortments taken for analysis.

The correlations established between quality parameters of bread assortments, are also characteristics of the respective assortments.

Concerning **whole wheat bread** there were established between pairs of quality parameters, the following correlations: weight-porosity significant negative correlation (correlation coefficient r = - 0.606*), lenght-aW significant positive correlation (r = 0.632 *), width-porosity significant positive correlation (r = 0.551 *), width-elasticity significant negative correlation (r = - 0.524 *) and height-moisture significant negative correlation (r = - 0.573 *).

Concerning **white bread** there were established: a significant positive correlation elasticity-moisture (r = 0.573 *), a distinct significant positive correlation high-acidity (r = 0.666 **) and a height-length positive correlation (r = 0.517 *).

Some quality parameters of **intermediate bread** established a significant positive correlation (r = 0.626 *), namely height and porosity.

The quality parameters for **dark bread** did not correlate to each other, except the significant negative correlation between width and aW (r = - 0.541 *).

We find that all the significant correlations formed have particularized analyzed bread assortments, because of the fact that the assortments of bread did not show significant correlations between the same quality parameters. It is highlighted in this way, the differences between recipes and technological process.

Length-aW regression analysis of **whole wheat bread** must proceed from the factors that determine the elongation of bakery products during the technological process of bread obtaining. The essential factor in determining the bread length is the size of dough roller when final molding (before proofing).

However, subsequent to this stage, the dough roller undergoes a series of size changes (including stretching) at the proofing stage.

Dough proofing is a process that involves its increase in volume, due to accumulation of gas from fermentation. The increase in volume takes place in all three dimensions of bread (width, length, height), so an increase of the length during fermentation is normal. It is reasonable to believe that this increase in volume causes a decrease in the amount of soluble carbohydrates in the aqueous phase of the dough, because carbohydrates turns into CO_2 through fermentation by yeast metabolism [4]. The water activity of a product is dependent on the amount of substances solubilized in the aqueous phase, therefore decrease of water activity may increase water mobility in the product. At the same time, the increase in bread volume can be correlated with the increase of its internal surfaces, the surfaces to which the product is

able of exchanging substance (water) with the environment [6].
Therefore, increasing the exchange surfaces with the environment, can lead to an increase in the quantity of exchanged substances (mainly water). This phenomenon leads to the increase of the vapor pressure at the surface of the product, namely the relative humidity (Fig. 1).

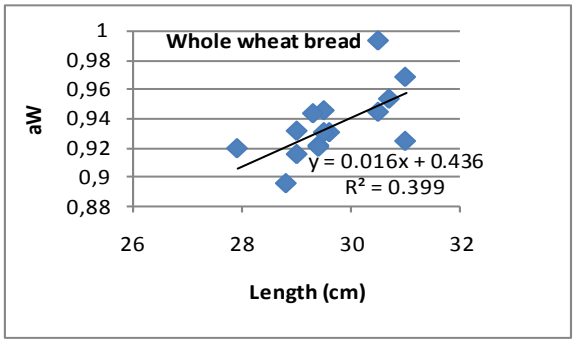

Fig. 1. aW-lenght regression

The porosity of the bread is a measure of the volume of product displaced by the air. This contributes to the total volume of the bread and the product width is one of the three-dimension of the volume. Therefore, the correlation is normal, the porosity represent the internal volume occupied by air, and the total volume of the product (whose one of the components is the width) includes the volume of air (Fig. 2).

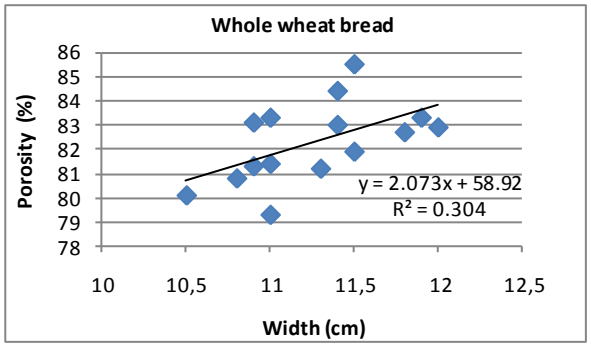

Fig. 2. Porozity-widht regression

The elasticity of bread crumb was smaller to the products with larger width. It is very likely that this is an effect due to raw material quality or applied technology.
The trend of bakery products flattening may be the result of using a weak gluten flour or an excessive proofing. In both cases, the elastic properties of the crumb became worse, due to the degradation of protein matrix and to the degree of starch retrogradation in the cumb (Fig. 3).

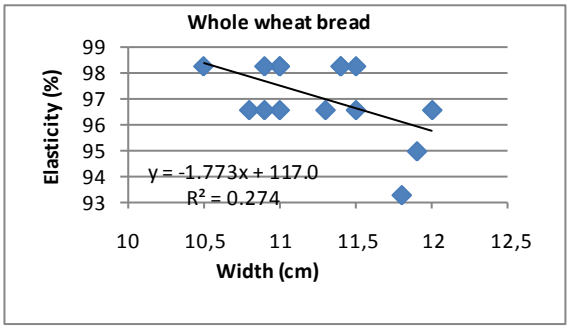

Fig. 3. Elasticity-widht regression

Increase of the bread height accelerates moisture loss in the product, due to volume growth (increase of the exchange surfaces with environment) (Fig. 4)

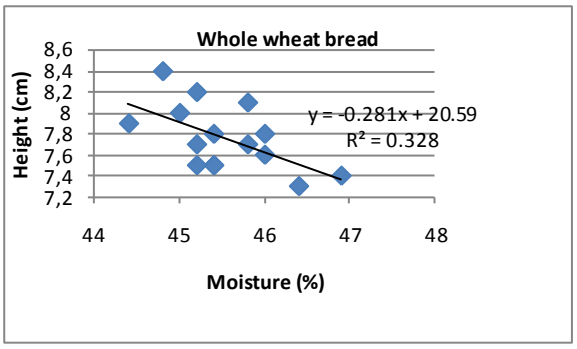

Fig. 4. Height-moisture regression

The porosity of the crumb shows the degree of its compaction. Therefore, breads with heavier weight had a lower porosity (Fig. 5).

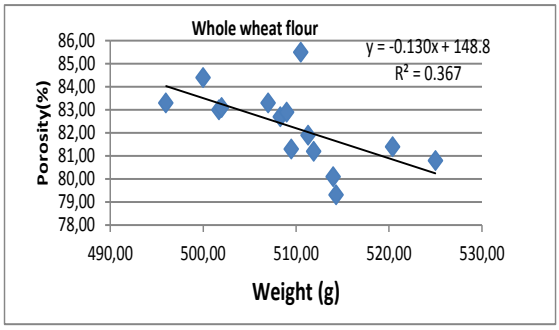

Fig. 5. Porozity-weight regression

The elasticity of **white bread** crumb is influenced by the retrogradation of starch in product, because the retrogradation (the transition from the gel state to the crystalline

state) occurs through water loss. Accordingly, the rate of starch retrogradation in the crumb is influenced by the product moisture (specific phenomenon of bread aging) (Fig. 6)

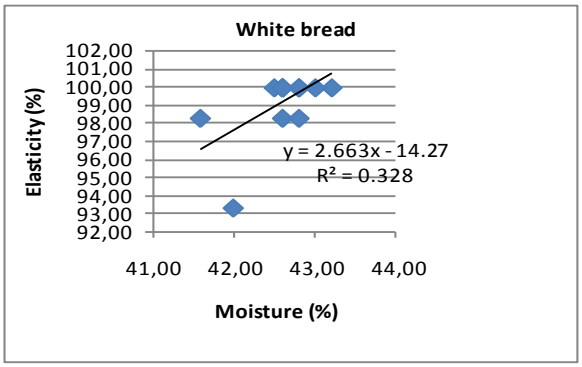

Fig. 6. Elasticity-moisture regression

The product acidity is higher in a greater height bread. The height of the final products is the result of their ability to hold a larger amount of fermentation gas. Bread acidity is the direct result of sugars fermentation by yeasts. Advanced fermentation can be correlated with a better volume of finished products (and implicitly with a larger height) (Fig.7.).

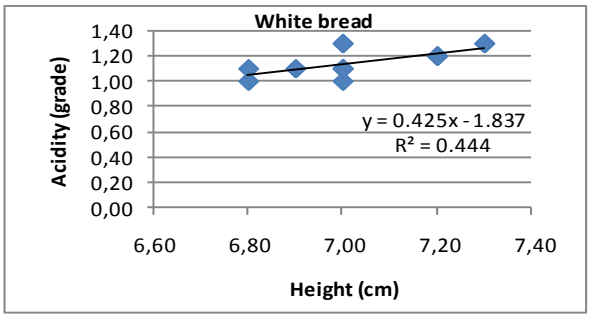

Fig. 7. Acidity-height regression

Porosity-height correlation in **intermediate bread** describes the increase of the porosity due to the increase of the bread volume (Fig.8.).

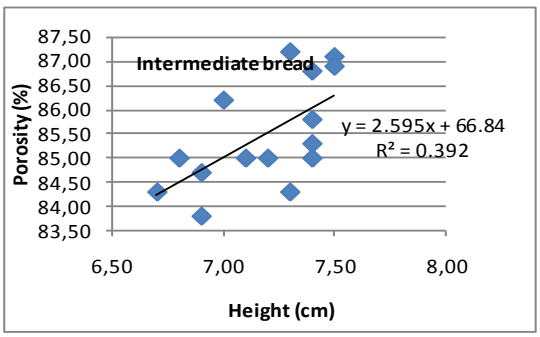

Fig. 8. Porozity-height regression

aW-width regression in **dark bread** can be explained in the same way as it is explained the regression aW-length in whole wheat bread (Fig.9.).

Dough proofing is a process that involves increasing in volume, due to accumulation of fermentation gas. But the increase in volume takes place on the growth of the three dimensions of the bread, accordingly, including width.

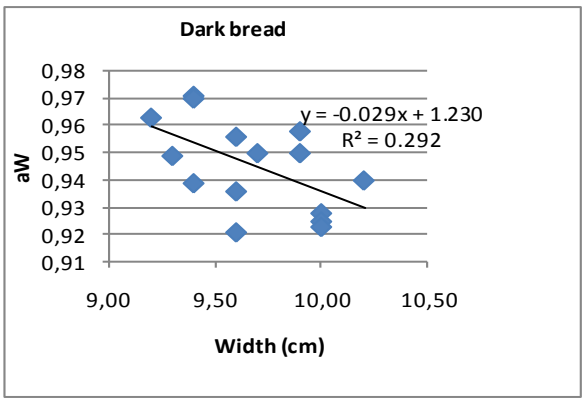

Fig. 9. aW-width regression

CONCLUSIONS

All bread assortments have constantly exceeded the weight provided by recipe, leading to economic harm and increased production costs.

The four assortments of bread showed significantly lower acidity compared to the range considered optimal.

It was found that elasticity, porosity and aW fall within the limits set by the production standards.

The dimensions of bread assortments were compliant, except white bread, where the length, width and height have been constantly lower than the minimum.

Variation coefficients have not exceeded 10%, whatever the parameter taken into consideration. This fact proves that the technological processes of bread preparing are well controlled and the results are reproducible.

The bread assortments had different characteristics regarding humidity (differences significantly different) and acidity (differences significantly different), except the pair dark bread - whole wheat

bread to which no significant differences in acidity were registered.

Porosity was very significantly different between white and whole wheat or dark bread and between intermediate and whole wheat or dark bread, but did not differ between white and intermediate bread and also between whole wheat and dark bread.

There were significant differences in terms of elasticity between white bread and whole wheat bread.

The water activity aW showed no significant differences between bread assortments.

The dimensions of bread assortments were mostly very significantly different.

No similar significant correlations were established between quality parameters of the four bread assortments. The significant correlations formed are different for each assortment of bread and represent a peculiarity.

Notable linear regressions were observed, such as: aW-length- porosity-width, elasticity-width, height-moisture, porosity-weight, in whole wheat bread, elasticity-moisture, acidity-height, in white bread, porosity-height in intermediate bread and aW-width in dark bread.

It is noted the regression acidity-height in intermediate bread, where the variation of one parameter is influenced by the variation of other in proportion of 44% (r2 = 0.44).

To conclude, we can say that the whole wheat bread and dark bread are alike, in terms of quality characteristics, given that both had an increased fiber content. It was also noted the similarities of quality parameters in white and intermediate bread.

All observed differences, with varying degrees of significance, constituted peculiarities of bread assortments taken for analysis.

REFERENCES

[1]Bordei, D., 2005, Tehnologia moderna a panificaţiei, Ed. Agir, Bucureşti.

[2]Banu, C., Nour, V., Vizireanu, C., Mustaţă, G., Resmeriţă, D., Rubţov, S., 2002, Calitatea şi controlul calităţii produselor alimentare, Editura AGIR, Bucureşti.

[3]Bordei, D. et al., 2007, Controlul Calităţii în industria panificaţiei, Ed. Academică Galaţi

[4]Popa, N. C., Tamba-Berehoiu, R. M., Huţan, A. M, Popescu, S., 2014, The significance of some flour quality parameters as quality predictors of bread, Scientific Bulletin. Series F. Biotechnologies, Vol. XVIII, pp. 135 – 140.

[5] Snedecor G. W., Cochran W. G., 1967, Statistical methods. Iowa state, University Press, 327, 12.

[6]Tamba-Berehoiu, R. M, Popa, N. C, Vişan L., Popescu, S., 2014, Correlations between the quality parameters and the technological parameters of bread processing, important for product marketing, Biotechnological Letters Vol.19, No.3, 2014, pp. 9442 – 9447.

[7]Tamba-Berehoiu, R. M, 2015, Chimia alimentului, Vol I, II, Ed. Ştef, Iaşi.

[8]Wallenstein, S. Y., Zucker, C. L., Fleiss, J. L., 1980, Some statistical methods useful in circulation research. Circulation Research, *47*(1), 1-9.

[9]Zanirato, S., 2013, Wheat flour standards in European Union, TFIF International Grain Congress on "Wheat, Flour, Climatic Changes and New Trends, 7 – 10 march Antalya.

[10]*** Institutul Național de Statistică al României, 2015 „Coordonate ale nivelului de trai în România. Veniturile şi consumul populaţiei în anul 2015" http://www.insse.ro/cms/sites/default/files/com_presa/com_pdf/comunicat_venituri_si_cheltuieli_2016_0.pdf

[11]***SR 91:2007, Pâine şi produse proaspete de patiserie. Metode de analiză.