STUDY ON THE QUALITY OF TOAST BREAD ASSORTMENTS FROM A ROMANIAN PROFILE UNIT AND CONSUMERS´ SAFETY

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Abstract

The consumption of bakery products has increased due to the diversity of assortments, preparation technology and taste which determined the existence of a very large range of breads with high nutritional value. The objectives of the present study were: determining the quality parameters of the toast bread, emphasizing the statistically significant differences and correlations between the quality parameters and evaluation of nutritional aspects. Four assortments of toast sliced bread-Toast Integral (T.I.), Toast Classic (T.C.), Toast Graham (T.G.) and Toast with Rye (T.R.) were analyzed. The analyzes included: weight, humidity, acidity, porosity, elasticity, water activity. Also, the nutritional profile (content of fats, saturated fatty acids, carbohydrates, sugar, protein, fiber and salt) was evaluated and the results were compared with the values declared on the label. The assortments with higher fiber content, respectively T. I., T.G. and T.R. had higher humidity than T.C. The acidity was significantly increased in the assortments of fiber-rich breads (T.I., T.R., T.G.) compared to sliced white bread (T.C.). Except for the pair T.I. - T.R., the porosity constituted an element of statistical differentiation for all the other pairs of investigated assortments. Basically, the highest porosity was T.C. (87.13%), followed by T.R., T.I. and T.G. In T.I., the increase in weight was correlated with the decrease in porosity. This can be an effect of baking in the tray, so in conditions of constant volume (r = -0.627). The T.C. products with higher humidity were also characterized by higher elasticity (r = 0.582). The analyzed products were characterized by lower fat contents and saturated fat actions compared to the values written on the package. The quality parameters of the investigated products were characterized by low values of coefficients of variation, which suggests that technological processes are controlled, repeatable. It is necessary to revise the labels in order to correct the nutritional information provided to the consumer.

Key words: quality parameters, statistical evaluation, toast

The present document is arranged so that it can be used as a model. It is also a template on which you can work directly by replacing the corresponding paragraphs.

Bread is one of the most important foods in the diet of the European population, its economic, alimentary, cultural and symbolic value being indisputable. Having its origin in the mixture of grain and water consumed in prehistoric times, the evolution of this product was synchronous with the evolution of human civilization. From sun-dried cakes, to cakes leavened by means of spontaneous flora and then to bread obtained by fermentations provided by selected yeasts, bread has evolved into an overwhelming number of forms, accumulating a multitude of techniques and technologies. Modern bread, obtained on industrial, automated lines, is characterized by new ingredients and shelf life of weeks (Cauvain S.P., 2012; Galanakis C.M., 2020).

The consumption of bakery products has increased due to the diversity of assortments, preparation technology and taste which determined the existence of a very large range of breads with high nutritional value (Gonciorov M. *et al*, 2004 Murariu O *et al*, 2022a,b).

Nowadays, the main characteristic of these products is related to the fact that they have a long shelf life (21 days), compared to fresh bread which has a maximum shelf life of 24-48 hours (Stear C.A, 2012). Long shelf life is achieved by pre-packaging in polypropylene film, use in preservative recipes (sorbic acid and calcium propionate), anti-aging enzymes (maltogenic amylases), the use of ingredients with an effect on water mobility (palm fat) and sprinkling with ethyl alcohol (Banu C, 2010, Petcu C *et al*, 2007, Petcu C *et al*, 2019).

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The laboratory analyzes were carried out in the industrial laboratory of the factory and followed five objectives:
- determining the quality parameters of the four types of bread and analyzing their variability in order to evaluate the constancy of the technological processes;
- highlighting the significant statistical differences between the quality parameters of the four types of bread;
- calculating the correlations that are established between the quality parameters, for each variety of bread;
- drawing up the regression curves for the pairs of parameters between which correlations with significant correlation levels were observed.
- the evaluation of some nutritional and food safety aspects of the four types of bread based on the profile analyzes carried out by the manufacturer at third-party laboratories.

MATERIAL AND METHOD

The study took place in a bread factory, located in the Prahova area between February-March 2021. Four assortments of toast sliced bread-Toast Integral (T.I.), Toast Classic (T.C.), Toast Graham (T.G.) and Toast with Rye (T.R.) were analyzed. Three samples from 15 consecutive production batches of each bread assortment were analyzed and for each sample, the average value of the analyzed parameters was retained. The analyzes included: weight, humidity, acidity, porosity, elasticity, water activity according to SR 91/2007. Also, the nutritional profile (content of fats, saturated fatty acids, carbohydrates, sugar, protein, fiber and salt) was evaluated and the results were compared with the values declared on the label. The results were processed and interpreted using the professional program: IBM SPSS Statistics 20 using the T-Student test.

RESULTS AND DISCUSSIONS

The results obtained reveal the importance of permanent quality parameters monitoring and the stability of the technological flow. It can be seen that the average values of the investigated quality parameters were within the limits of variation provided in the technical specifications. The coefficients of variation characterizing the average values are less than 10%, which shows that the technological production process is well controlled.

In table 1, the averages for all analyzed quality parameters are presented in a comparative way.

Table 2 shows that the weight parameter did not differ significantly between the analyzed products. The average value of the weight of the products made is in favor of the consumer, but it raises a series of problems for the producer because at the production volumes made at the level of a year, they can turn into significant economic losses. There are very significant differences related to moisture between pairs of bread varieties. It is observed that the assortments that contain more fibers, namely T.I., T.G and T.R, had higher moisture content than T.C. This is because the fibers retain more water. The acidity was very significantly increased in the varieties of bread rich in fiber (T.I., T.R. and T.G.), compared to sliced white bread (T.C). This is explained by the fact that the flours from which they come have higher acidity, due to high extractions. No significant differences were observed between the acidity of T.I. and T.R Except for the pair T.I. – T.R., porosity was an element of statistical differentiation for all other pairs of varieties investigated. Practically, T.C. had the highest porosity (87.13%), followed by T.R., T.I. and T.G. In this case, the differences in porosity can be attributed to the fiber content but also to the average sizes of their particles. Practically, the lowest porosity value is reached in the case of the product obtained from Graham flour, a coarsely ground wheat flour.

Regarding the elasticity parameter, T.I. had a significantly lower value in relation to all other types of bread. Also, the elasticity of the T.C. was significantly higher than that of the T.G. And in this case, the elasticity of the products seems to be modulated by the fiber content and moisture.

The water activity aW did not differ significantly between bread varieties. This can be attributed to a relative homogeneity of the recipes used to obtain the bakery products used, except for the type of flour used, all other ingredients with a potential impact on this parameter being used in similar quantities.

Table 1

Means of quality parameters

Parameter	Toast Integral	Toast Classic	Toast Graham	Toast with rye
Weight (g)	609.39 ± 7.60	611.23 ± 8.09	609.32 ± 4.15	612.72 ± 6.85
Moisture (%)	43.52 ± 0.68	42.30 ± 0.48	43.85 ± 0.57	44.46 ± 0.42
Acidity (°)	2.98 ± 0.19	1.3 ± 0.15	2.63 ± 0.28	3.04 ± 0.12
Porosity (%)	82.28 ± 1.63	87.13 ± 0.95	80.49 ± 1.10	83.28 ± 1.15
Elasticity (%)	91.06 ± 1.47	98.21 ± 1.65	95.20 ± 2.27	96.87 ± 2.64
aW	0.930 ± 0.02	0.93 ± 0.023	0.94 ± 0.02	0.94 ± 0.02

Table 2

Significance of the difference between the means of the quality parameters

Pairs of bread assortments	The difference of mean	p
Meaning of mass difference		
T.I.– T.G.	0.07	0.031 ns
T.I.-T.R.	-3.33	1.260 ns
T.C.-T.G.	1.91	0.813 ns
T.C.-T.R.	-1.49	0.544 ns
T.G.-T.R.	-3.4	1.644 ns
Meaning of humidity difference		
T.I.– T.C.	1.22	5.677***
T.I. – T.G.	-0.33	1.440 ns
T.I.- T.R.	-0.94	4.555***
T.C. – T.G.	-1.55	8.056***
T.C. – T.R.	-2.16	13.116***
T.G. – T.R.	-0.61	3.337*
Meaning of acidity difference		
T.I. – T.C.	1.68	26.879***
T.I. – T.G.	0.35	4.000***
T.I. - T.R.	-0.06	1.034 ns
T.C. – T.G.	-1.33	16.216***
T.C. – T.R.	-1.74	35.082***
T.G. – T.R.	-0.41	5.213***
Meaning of porosity difference		
T.I. – T.C.	-4.85	9.956***
T.I. – T.G.	1.79	3.525**
T.I- T.R.	-1.00	1.941 ns
T.C. – T.G.	6.64	17.693***
T.C – T.R.	3.85	9.996***
T.G – T.R.	-2.79	6.790***
Meaning of elasticity difference		
T.I. – T.C	-7.15	12.531***
T.I. – T.G.	-4.14	5.929***
T.I.- T.R.	-5.81	7.445***
T.C. – T.G.	3.01	4.154***
Meaning of water activity difference		
T.I. – T.C.	0	0
T.I. – T.G.	-0.01	1.369 ns
T.I.- T.R.	-0.01	1.369 ns
T.C. – T.G.	-0.01	1.271 ns
T.C. – T.R.	-0.01	1.271 ns
T.G. – T.R.	0	0

* significant - p < 0,05; ** distinctly significant p < 0,01; *** very significant – p < 0,001

The correlations that are established between the quality parameters of the types of bread also represent particularities of the respective assortment. *Table 3* shows all the significant correlations between the quality parameters of each individual type of bread

Table 3

Correlation coefficients (r) for pairs of quality parameters for the types of bread investigated

Parameter	Weight	Moisture	Acidity	Porosity	Elasticity	aW
T.I.						
Moisture (%)	-0.016	1				
Acidity (°)	0.084	-0.179	1			
Porosity (%)	**-0.627**	0.279	-0.275	1		
Elasticity (%)	-0.238	-0.210	0.285	0.06	1	
aW	0.09	0.212	0.405	0.256	0.008	1
T.C.						
Moisture (%)	-0.216	1				
Acidity (°)	0.418	-0.486	1			

Porosity (%)	-0.263	-0.354	0.212	1		
Elasticity (%)	-0.350	**0.582**	-0.342	-0.213	1	
aW	-0.462	-0.212	-0.372	0.088	-0.127	1
T.G.						
Moisture (%)	0.133	1				
Acidity (°)	-0.056	0.012	1			
Porosity (%)	-0.456	0.172	0.069	1		
Elasticity (%)	-0.040	-0.026	0.215	0.172	1	
aW	0.413	0.013	-0.216	-0.241	-0.351	1
T.R.						
Moisture (%)	0.368	1				
Acidity (°)	0.091	0.132	1			
Porosity (%)	-0.125	-0.323	0.418	1		
Elasticity (%)	-0.068	-0.185	-0.415	-0.243	1	
aW	-0.346	-0.083	-0.178	-0.279	0.229	1

From the table above it can be seen that the only significant correlations identified were observed for the pairs of parameters Elasticity – Weight in the T.I. (-0.627*) and Elasticity – Moisture in the T.C (0.582). In T.I., the increase in mass was correlated with the decrease in porosity. This may be an effect due to baking in the pan, so under constant volume conditions. Practically, semi-finished products with a higher weight, due to the lack of the possibility of expansion, are forced to keep their volume during baking due to the reduction of porosity (increasing the density of the core). Practically, about 39% of the variation in the porosity of the T.I. can be explained by the variation in the mass of the finished product (*figure 1*). In T.C., the products with higher moisture were also characterized by higher elasticity. This relationship can be attributed to a better hydration of the components that form the pore walls of the core (*figure 2*). About 34% of the variation in the elasticity of the T.C. product can be attributed to the variation in the moisture parameter.

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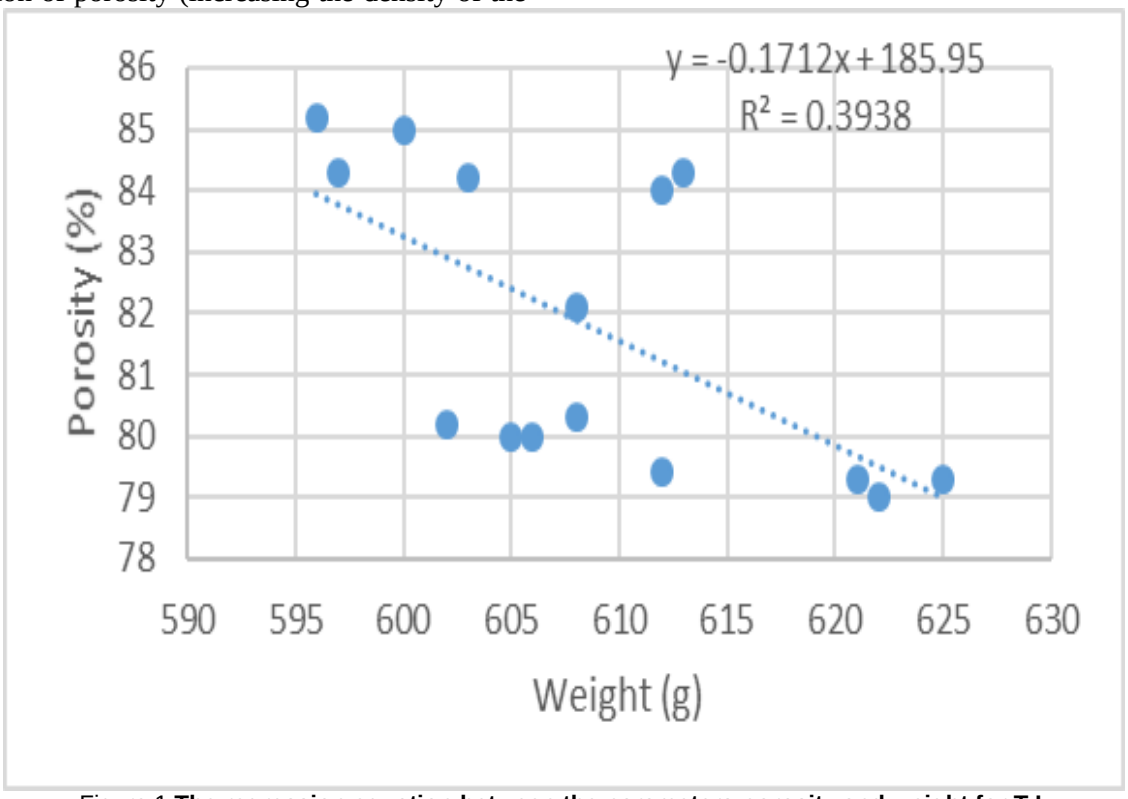

Figure 1 **The regression equation between the parameters porosity and weight for T.I.**

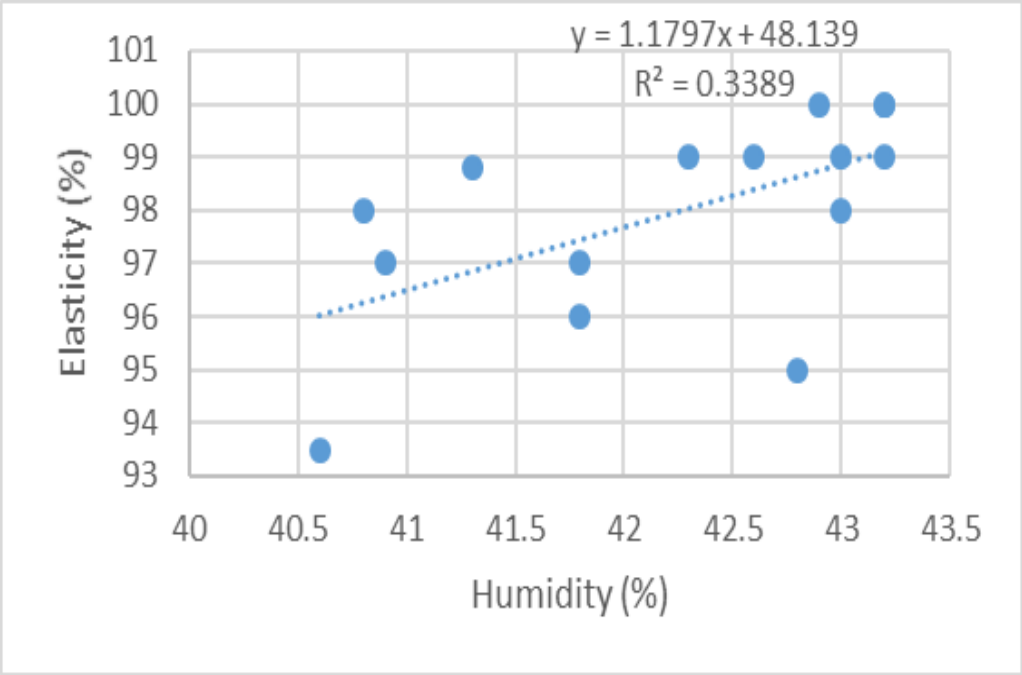

Figure 2 **The regression equation between the parameters elasticity and moisture for T.C.**

In the case of bakery product recipes, due to the variation of the hydration capacities of the flours used, the amount of water added to obtain them can vary significantly from one batch to another. Added to this aspect is the natural variation in the chemical composition of the flours depending on the wheat lots from which they come. It is therefore expected that the nutritional profile of bakery products will vary to some extent from batch to batch.

Table 4 shows the results of the analyzes carried out by the manufacturer in the case of T.I. regarding the main components of the nutritional profile over a period of 2 years (at 6-month intervals). In *tables 5*, *6* and *7* are shown the nutritional results for T.C., T.G and T.R.

Table 4

Statistical descriptors of nutritional parameters for Toast Integral

Parameter	The value indicated on the label	minimum	maximum	X±s	CV %
Fats (%)	4.8	0.58	1.3	1.02 ± 0.32	31.37
Saturated fatty acids (%)	2.2	0.21	0.39	0.295± 0.08	27.12
Carbohydrates (%)	47.0	41.8	44.0	42.93 ± 1.04	2.42
Sugars (%)	2.4	1.2	1.9	1.06 ± 0.32	30.19
Protein (%)	8.6	8.6	9.1	8.95 ± 0.24	2.68
Fiber (%)	5.1	3.9	5.8	4.92 ± 0.78	15.85
Salt	1.2	1.36	1.51	1.45 ± 0.07	4.83
Energy value (kcal/kj)	274/1157				

Table 5

Statistical descriptors of nutritional parameters for Toast Classic

Parameter	The value indicated on the label	minimum	maximum	X±s	CV %
Fats (%)	3.6	1.16	1.49	1.28 ± 0.14	10.94
Saturated fatty acids (%)	1.5	0.18	0.59	0.45± 0.19	42.22
Carbohydrates (%)	47.0	42.1	46.0	44.05 ± 1.60	3.63
Sugars (%)	2.1	1.5	2.6	2.02 ± 0.48	23.76
Protein (%)	8.9	7.9	8.7	8.3 ± 0.34	4.10
Fiber (%)	4.4	1.5	2.0	1.77 ± 0.26	14.70
Salt	1.2	1.1	2.01	1.60 ± 0.39	24.37
Energy value (kcal/kj)	266/1122				

Table 6

Statistical descriptors of nutritional parameters for Toast Graham

Parameter	The value indicated on the label	minimum	maximum	X±s	CV %
Fats (%)	3.1	1.16	1.89	1.46 ± 0.32	21.92
Saturated fatty acids (%)	1.1	0.48	0.86	0.63± 0.16	25.40
Carbohydrates (%)	41.0	43.6	45.0	44.27 ± 0.78	1.76
Sugars (%)	2.6	1.8	2.37	2.09 ± 0.23	11.00
Protein (%)	7.2	9.26	9.65	9.3 ± 0.44	4.73
Fiber (%)	8.9	4.89	6.31	5.39 ± 0.63	11.68
Salt	1.1	1.05	1.50	1.36 ± 0.21	15.44
Energy value (kcal/kj)	240/1014				

Table 7

Statistical descriptors of nutritional parameters for Toast with Rye

Parameter	The value indicated on the label	minimum	maximum	X±s	CV %
Fats (%)	2.9	0.8	1.5	1.15 ± 0.29	25.2
Saturated fatty acids (%)	1.7	0.15	0.5	0.29 ± 0.15	51.70
Carbohydrates (%)	44.0	42.0	45.0	43.5 ± 1.29	2.96
Sugars (%)	3	1.2	1.6	1.37 ± 0.21	15.33
Protein (%)	6.7	8.0	8.6	8.26 ± 0.25	3.03
Fiber (%)	8.0	3.2	4.2	3.7 ± 0.42	11.35
Salt	1.2	1.33	1.52	1.44 ± 0.09	6.25
Energy value (kcal/kj)	257/1084				

Table 4 shows that the nutritional values of the product are affected by significant variations in the parameters: fat content, including its component of saturated fatty acids and sugars. The average values of the biochemical parameters that form the nutritional profile of the product show significant differences compared to the values indicated on the label. Thus, the average fat content had values more than four times lower than the value written on the packaging, and the amounts of saturated fatty acids about 7 times lower. Likewise, the average content of carbohydrates and sugars is significantly lower than the value provided by the label (42.93% versus 47.0 and 1.06% versus 2.4, respectively). From the perspective of these parameters, the nutritional presentation on the label gives a disadvantage to the Toast Integral product because it is perceived as a dietary product. Basically, the actual values of the parameters fat and saturated fatty acids correspond to a dietary product, while the values provided by the label do not. The protein and fiber content provided by the product is close to the values written on the label. From the perspective of the legislation in force, the product can be labeled as a fiber source, providing a quantity greater than 3 g/100 g of fiber product. The amount of salt provided by the product is higher than the one claimed on the label, and it is advisable to adjust its amount in the recipe. The actual energy value of the product was significantly lower than that provided by the product's nutritional information (226.5 kcal versus 274 kcal). We definitely recommend reviewing the respective nutritional information and taking advantage of the product's dietary potential.

Table 5 shows that the nutritional parameters characterized by the greatest variations were: saturated fatty acids, sugars and salt content. And in the case of Toast Classic, the actual fat content is significantly lower than the value claimed on the label (more than twice). The product provides more than twice as much fiber and more than 33% more salt than the indications provided on the label. The product also provides smaller amounts of protein and carbohydrates. The energy value of the food is significantly lower than the listed value (224 kcal instead of 266 kcal). All these elements lead to the need to revise the nutritional information provided on the packaging, even more so as some of them may constitute key acceptance criteria in the consumer's purchase decision (lower content of fat and saturated fatty acids, lower energy value etc).

From table 6 it can be seen that the values of the coefficients of variability are relatively small, higher values of these coefficients affecting only the content of fats and saturated fatty acids. In the case of this product, there is also a tendency to overestimate the fat content claimed on the label, the real value being about 50% lower. The actual carbohydrate and protein contents of the product were higher than the value claimed on the label (44.27% vs. 41.0% and 9.3% vs. 7.2%, respectively). Also, the fiber content was significantly lower (5.39% vs. 8.9%). The actual

salt content provided by the product was significantly higher than the value stated on the label (1.36 versus 1.1) The actual energy value of the product was in the same range as that offered on the packaging (238 kcal, compared to 240 kcal).

And in the case of the Toast with Rye product, the variability of the values of the nutritional parameters was manifested at the level of fat and saturated fatty acid content. The actual amounts of fat and fiber provided by the product were lower than those expressed on the label (1.15% vs. 2.9% and 3.7% vs. 8.0%, respectively). In contrast, the protein content was higher (8.26% versus 6.7%). Also, the amount of salt provided by the product was higher than the value shown on the label (1.44% versus 1.2%). The energy value of the food was significantly lower than the value shown on the label (225 kcal versus 257 kcal).

The results obtained in terms of nutritional evaluation suggest the need for an immediate review of the labels in order to correct the nutritional information provided to the consumer, but also to capitalize on the dietary potential of certain products. Thus, the analyzed products were characterized by lower contents of fat and saturated fatty acids compared to the values written on the packaging. This suggests that they can be used in diets that aim to reduce the content of calories introduced into the body, especially since the energy values of the products were significantly lower than those written on the packaging of these products. Also, the content of saturated fatty acids was significantly lower than the values written on the labels, which reflects the fact that the manufacturer uses a quality fat source (non-hydrogenated) in the recipes.

CONCLUSIONS

In general, the quality parameters analyzed for the studied products were characterized by low values of the coefficients of variation, which suggests that the technological processes are controlled, repeatable, with a low impact of unforeseen factors.

The weights of the analyzed bakery products tend to be higher than the quantities claimed on the label, an aspect which, although it is in favor of the consumer, can mean significant economic losses for the producer.

The assortments that had a higher fiber content, namely Toast Integral, Toast Graham and Toast with Rye, had higher moisture content than Toast Classic.

The acidity was very significantly increased in the varieties of bread rich in fiber (Toast Integral, Toast with rye and Toast Graham), compared to sliced white bread (Toast Classic). This is explained by the fact that the flours from which they come have higher acidity, due to high extractions.

Except for the pair T.I. – T.R., porosity was an element of statistical differentiation for all other pairs of varieties investigated. Practically, the T.C. had the highest porosity (87.13%), followed by T.R., T.I. and T.G.

Water activity (aW) did not differ significantly between bread varieties. This can be attributed to a relative homogeneity of the recipes used to obtain the bakery products used, except for the type of flour used, all other ingredients with a potential impact on this parameter being used in similar quantities.

In Toast Integral, the increase in mass was correlated with the decrease in porosity. This may be an effect as a result of baking in the tray, so under conditions of constant volume ($r = -0.627^*$).

In Toast Classic, products with higher moisture were also characterized by higher elasticity. This relationship can be attributed to a better hydration of the components that form the pore walls of the core ($r = 0.582^*$).

The analyzed products were characterized by lower contents of fat and saturated fatty acids compared to the values written on the packaging. Also, the content of saturated fatty acids was significantly lower than the values written on the labels, which reflects the fact that the manufacturer uses a quality fat source (non-hydrogenated) in the recipes.

The main problem identified in our study is related to the salt content which is significantly higher than the value claimed on the packaging in the case of all the analyzed products.

In general, the analyzed products constitute a significant source of dietary fiber (over 3 g/100 g product), provided on feeding matrices characterized by reasonable energy values for the class of bakery products.

The immediate revision of the labels is required in order to correct the nutritional information provided to the consumer, but also to capitalize on the dietary potential of these products. We also recommend reviewing the amounts of salt in recipes in order to align them with the values shown on the label, but also with public health policies in the field, policies aimed at reducing the salt content in food.

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