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The recovery of whey in some bakery products obtain technology

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Abstract

The current trend in the modern consumer orientation to new food products which satisfy both nutritional and sensorial requirements make to appear new products on the food market. The bakery industry takes an important place in commodity market because of the fact that bread is a very important food product which is consummated daily by people. Because of all these facts, the present study aims the recovery of some byproducts from milk and milk products industry (whey) in order to obtain new and improved bakery products. The studies that we made followed the sensorial, physical-chemical and rheological characterization of home made bread with whey addition. Using these additions we saw a major improving in dough workability and fermentation process.

Keywords: bakery products, compressive, whey

1. Introduction

Bread is one of the most necessary food product, of the most nourishing and wanted, and there are few regions on the globe in which bread is not known. Because of their nutritive quality, bakery products represents utile forms of flour valorification. Applying adequate recepies and technologies could be obtained various products which could satisfy the new requirements of food diets. The current trend in the modern consumer orientation to new food products which satisfy both nutritional and sensorial requirements make to appear new products on the food market. The bakery industry takes an important place in commodity market because of the fact that bread is a very important food product which is consummated daily by people.

A method of improving the properties of dough and the quality of bread is adding dough ingredients, ingredient mixture or dough additives or additive mixture. In bread baking, addition produces an effect that can result in many desirable benefits including increased extensibility, volume and improved crumb softness. In our days there is a permanent preoccupation for a efficient recovery of utile substances from byproducts from milk industry, especially in human nutrition. Research progress made possible a reevaluation of nutritional value of these products.

From the main technological processes from milk technology results three principal byproducts: non fat milk, whey from cheese obtaining technology and buttermilk from butter technology.

The high chemical oxygen demand (50 kg O_2/ton permeate) of whey makes its disposal a significant pollution problem. In order to minimize environmental impacts different uses for this waste material have been devised by the dairy industry [23]. In recent years, utilization of whey has been felt to be an inexorable necessity in view of the current requirements for alleviating environmental pollution as well as using available nutrients for feeding the malnourished segments of human population. Whey can be incorporated advantageously into various food formulation [12].

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Because of all these facts, the present study aims the recovery of some byproducts from milk and milk products industry (whey) in order to obtain new and improved bakery products. It is appreciated that just about 70% of proteins and milk lactose are find in final milk products and the rest are wasted, being destined to feed animals, to be transformed in technical products or wasted waters. By its composition whey could improve food nutritional substances flow. Minerals (nitrogen, phosphorus, potassium, sulphur, calcium, magnesium), lactose and proteins from whey could play this role.

The influence of whey content on rheological properties of bread was studied. Rheological characterization was made by compressive loading tests. To obtain the Young modulus of bread at low values of Cauchy strain the compressive test was used [8,9-14].

This fact has contributed to use rheological testes to observe the changes in bread and dough systems and its mechanical properties. There is a lack of information on the addition of dairy byproducts such as acid whey, sweet whey and soy milk comparable with whey protein concentrate and soy protein isolate in bakery products.

2. Materials and methods

Bread-making procedure. A straight dough process was carried out for preparing the bread samples. A home made bread formula, based on flour weight, was used: 1000 g flour (970g white wheat flour and 30g soybean flour), 58% water, 3% yeast, 2% salt, and different content of milk byproducts addition: whey (25%, 30%). Milk byproducts addition was ratio to the raw material (flour). Likewise, a witness bread sample without addition was obtained. The optimal technological parameters are: fermentation – 62- 65 minutes, fermentation temperature 40^0C, backing – 25-30 minutes, backing temperature 220^0C.

Whey is a by-product resulting from dairy industry especially cheese production. Whey was obtained from technological processing of cow milk (cheese technology). The majority of the globally produced whey is sweet whey produced as a by-product of cheese industry [1-7].

The whey obtained was analyzed physical-chemical through the following parameters: acidity, density, moisture, total dry substance content, fats [18-21].

All bread varieties obtained were analyzed from the point of view of humidity, acidity, volume, porosity, elasticity ratio high/diameter[22].

Rheological characterization was made by compressive loading tests and relaxation tests. Parallel to bread bottom a medium slice of about 3 cm was cut from bread, and 3 flat, cylindrical specimens were prepared from them using a cork borer, avoid the crust. The slices were cut from bread after 2 hours of room temperature storage. The specimens had a diameter of 20 mm and their height was adjusted at 15-25 mm. Further, compression and relaxation tests were performed. For each bread assortment, 2 replicates were performed. For the experimental study, a compression JTL Janz apparatus was used. The so obtained samples were compressed with a constant speed to 120 seconds, the compression force being read at every 5 seconds. After the 120 seconds the compression was stopped and began the bread crumb relaxation force reading, at every 5 seconds, too, until the value repeated 2 times in succession. At the third consecutive reading begins the reading performed at every 10 seconds until the value repeats 2 times in succession. The obtained data were interpreted in the ORIGIN 7.0 program.

Compression curves obtained, $\tau = f(\varepsilon)$, express the dependence of compression stress $\boldsymbol{\tau}$ by Cauchy strain $\boldsymbol{\varepsilon}$ [14-16].

3. Results and Discussion

In order to determine dough and bread with whey addition quality indicators of the products obtained in this experiment was done also a whey characterization. Comparing whey composition with the one of the cow milk from which the whey is obtained as a byproduct, it could be seen that 50-60% of total dry substances from milk was found in whey. Also, fats amount was found and protein compounds, table 1. Proteic compounds from whey are especially lactalbumin, which is the most nourishing natural proteic substance.

Chemical composition of whey could guide the technology of recovery of these byproducts to the bakery industry. Thus, the dough obtained by replacing a part of aqueous phase with whey could led to obtain bakery products with a high content of diet fiber and high nutritional value.

Table 1. A comparison between the composition of cow milk and whey

Compounds	Cow milk	Whey
Acidity (°T)	19	62
Water (%)	87.35	93.15
Density (g/cm^3)	1.0270	1.0120
Total fat (%)	3.26	1.05
Total dry substance (s.u.t.), (%)	12.65	6.85

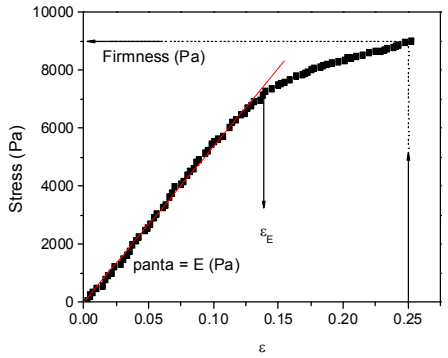

Figure 1. Dependence between compressive stress-strain

A sigmoid compressive stress-strain relationship is a characteristic of the bread. A linear decrease with duration of fermentation for dough Young modulus was established (figure 1). The relaxation data could be fitted by equations that derived from generalized Maxwell model and by normalization and linearization of the experimental force relaxation curves.As it can be observed there is a sigmoid dependence, being similarly with compressive stress-strain curves obtained for rye bread [17]. From the slope of the first part of the experimental curve ($\varepsilon_c < 0.2$) the compression modulus or Young modulus (E) was calculated. It was ascertained that the bread crumb is not uniform. That is why, the rheological characteristics obtained from the compression curve (compression modulus and the mechanical work needed for 12 mm compression) are very different. Graphically, the compression curve for the witness sample is showed in figure 2. The obtained values for E and L for the two samples, and the average values too, are showed in table 2. It can be seen the influence that the whey content has on all studied rheological characteristics.

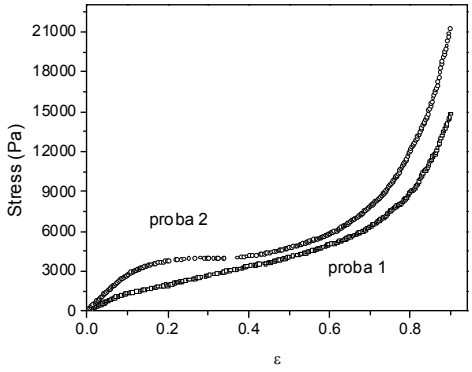

Figure 2. Compressive curve for bread control sample

Table 2. Rheological characteristics of bread samples calculated compression curves

Sample	ε_E	E (kPa)	Firmness (kPa)	L (J · m^{-3})
Control 1	0.085	22.98	4.01	613.0
Control 2	0.095	22.33	3.56	557.4
	0.090±0.007	**22.66±0.46**	**3.79±0.32**	**585.2±39.3**
Whey addition 25%	0.122	14.72	2.36	349.0
Whey addition 25%	0.094	27.79	3.95	678.3
	0.108±0.020	**21.26±9.24**	**3.16±1.12**	**513.6±232.8**
Whey addition 30%	0.129	18.18	2.90	467.4
Whey addition 30%	0.090	21.64	2.79	500.8
	0.110±0.027	**19.91±2.45**	**2.85±0.08**	**484.1±23.6**

Table 3. Characteristics of bread samples

Sample	Humidity (%)	Volume (cm^3)	Porosity (%)	Ratio high/diameter
Control	41.48	346	65.77	0.481
Whey addition 25%	41.32	321	78.48	0.493
Whey addition 30%	41.2	312	75.78	0.485

It can be seen that is a sigmoid dependence for $\tau = f(\varepsilon)$, for all bread assortments. The first part of the sigmoid for $\varepsilon < 0.2$ may be a result of the elastic compression of the bread crumb. On this portion that is for small deformations the bread crumb behaves as an elastic material with spongy structure (like a sponge). Having in view these specifications, the compression modulus of the bread crumb for the tested assortment, was calculated from the slope of this portion approximated as linear (figure 3, 4).
Data from table 2 shows that the values for firmness decrease from 3.79kPa to 2.85 kPa. The highest value was obtained for control sample and the lowest value was obtained for bread with 30% whey sample.

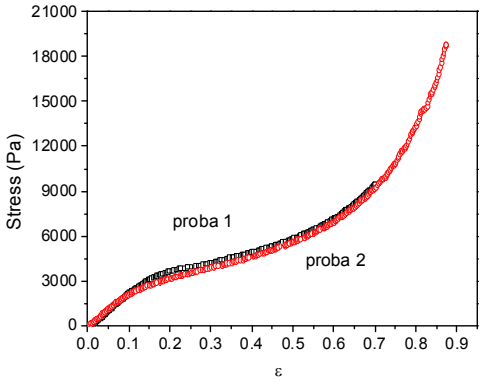

Figure 3. Compressive curve for bread with 25% whey sample

Also, from table 2 it can be seen that, the 30% whey supplemented bread has the lowest compression modulus, which means that this bread assortment is the most elastic. The second portion, more flattened, situated around values $\varepsilon \in (0.2 - 0.6)$, corresponds to the compression domain, in which ruptures of the gas bubbles walls from inside the bread crumb appear. The start of this portion corresponds to the breaking point, which has the coordinates ε_r and τ_r. The ε_r values from figure 3 and 4 suggest also, that the samples with 30% whey have the highest elasticity, because the first ruptures into the bubbles walls, appear at $\varepsilon_r \cong 0.23$.

The obtained bread samples were characterized from the point of view of humidity, volume, porosity and ratio high/diameter and the resulted were shown in table 3.

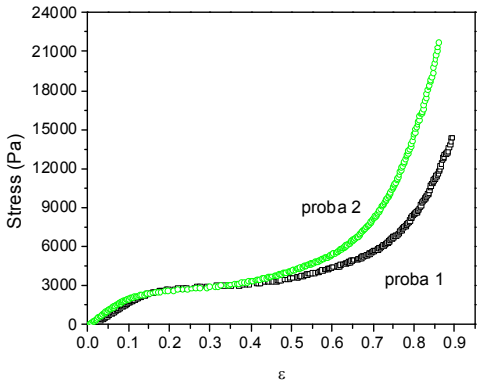

Figure 4. Compressive curve for bread with 30% whey sample

Obtained data were sintetizated and we could say that in the cases we added whey the products obtained had good proportions, were in the product range, the volume was smaller than control sample, but the products weren`t flattened or excessive bulging. The volume of whey addition bread samples was smaller than the one of the control sampler because of the big content of fat, fact that slowed down the dough fermentation process, reduced the gas quantity and made a smaller volume of the whey addition bread.

The color of the crumb was uniform, golden yellow because of the Maillard compounds formed during baking stage. It was darker for bread with whey samples because of the higher content of carbohydrates.

In the case of porosity, this parameter had values of 78.48 % and 75.78 % for the samples with whey addition besides the control sample`s porosity which was 65.77%. Also, the elasticity was bigger than the control sample because of the chemical processes which take place in dough and because of the bigger content of protein and lactose.

4. Conclusion

The milk byproducts addition (whey) to bread improves it's rheological and nutritional qualities, acting not only on the content, but also on the bread texture.

Also, upon whey addition to bread, the A,B,C vitamins, magnesium, sodium and especially potassium content increases. Thus, a new range of bread with high energy and vitamin value is obtained.

By whey supplement in the bread obtained with a classical method, results a bread assortment with high nutritional value as a result of the vitamins, mineral salts and fat contribution brought by this addition.

Beside improving the processing features, the advantages of milk byproducts addition, as a secondary helping ingredient of the bread, are: rising the bread volume, improving the crumb structure and increasing its "shelf life", as a result of the natural sugars protein and lactose content.

Also, 30% whey addition has the best influence on the dough rheological features improveing the elastic properties of the bread crumb.

Thus, the experimental data suggest that whey addition can be successfully used in bakery. Besides improving rheological parameters could be obtained new assortment of bread. As a future part of this study could be made a market study for these new assortments of bread and their impact on consumers.

The replacement of a part of water with whey makes to decrease the amount of technological water.

Whey had been a major world-wide disposal and pollution problem for the dairy industry.

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