НАУЧНИ ТРУДОВЕ НА
УНИВЕРСИТЕТ ПО ХРАНИТЕЛНИ
ТЕХНОЛОГИИ - ПЛОВДИВ
2016 г.
ТОМ 63, КНИЖКА 1

SCIENTIFIC WORKS OF
UNIVERSITY OF FOOD
TECHNOLOGIES
2016
VOLUME 63 ISSUE 1

Shelf Life of Zinc- and Selenium-Enriched Wheat Bread

Dana A. Stefanova[1*], Denka Y. Zlateva[1], Rosen M. Chochkov[2]

[1] *Department of Commodities Science, Faculty of Economics, University of Economics - Varna, Bulgaria*
[2]*Department of Technology of Grain, Fodder, Bread and Confectionary Products, Technological Faculty, University of Food Technologies, Plovdiv, Bulgaria*

***Corresponding author**: PhD candidate Dana Asenova Stefanova; Department of Commodities Science, Faculty of Economics, University of Economics - Varna, 77 Knyaz Boris I Blvd. BG-9002 Varna, Bulgaria, mobile: ++359 899 885325; E-mail: dana.stefanova@abv.bg*

Running title: **Shelf Life of Enriched Wheat Bread**

Abstract
It has been found that in human nutrition there is a deficiency of some essential microelements such as zinc and selenium. They are very important for the overall health and the normal functioning of the human body. An opportunity for overcoming their deficiency is enrichment of wheat bread with zinc and selenium. The aim of the present paper is to study the effect of zinc and selenium enrichment on the shelf life of bread made from wheat flour type 500. Water-soluble compounds were used - zinc sulphate heptahydrate ($ZnSO_4.7H_2O$) and sodium selenite pentahydrate ($Na_2SeO_3.5H_2O$). The amounts of the microelements added were calculated according to the recommended daily intake levels. The measurement of the deformation characteristics of bread crumb (total, plastic and elastic deformation) was performed after 24, 48 and 72 hours of storage. The sample enriched with zinc and selenium keeps its freshness for longer time and after 72 hours the total deformation of bread crumb is 19 % higher than the control sample. The results show that the enriched sample bread keeps for a long time elasticity and softness.

Practical applications
Wheat bread have short shelf life and it is a challenge to keep its freshness for longer time. It was found that addition of zinc sulfate heptahydrate ($ZnSO_4.7H_2O$) in the amount of 0,174 g / 1 kg of flour and sodium selenite pentahydrate ($Na_2SeO_3.5H_2O$) in the amount of 820,28 µg / 1 kg of flour can improve the biological value of bread and moreover after three days (72 h) of storing the enriched bread keeps its freshness better that control sample. These additives are readily available and don't need any changes of the technological process of bread making.

Key words: shelf life, staling, wheat bread, zinc, selenium, enriched bread

Introduction

During the storage of bread a number of processes occurring in it, which processes lead to a deterioration of its quality. These processes include the aging of bread and microbiological spoilage of the finished product. The microbiological spoilage of bread mostly comes down to the development of the Bacillus subtilis or mold growth arising during storage. The aging of bread is mainly associated with the changes occurring in the middlebread and most often boils down to the following: weakening of taste-flavoring properties of the bread, gradually hardening of the middlebread reduction of elasticity and increasing of its friability, alongside the crust becomes tough. All these changes are related to various factors including: recrystallization of starch, changes in the gluten fraction (Hug-Iten et al., 1999), redistribution of moisture in the bread volume (Baik et al., 2000; Ribbotta et al., 2007), and others. The aging of bread and the development of microbiological processes arising during storage have a negative impact on the quality of the finished product and significantly reduced its user value, while causing great economic losses. Opening up the opportunities to slow the aging of bread is a subject of many researches.There have been made various attempts to improve the keeping of the bakery products by using additives, changes in the recipes (Curti, 2016); in the technological process (Bosmans et al., 2007) or storage conditions (Rasminssen et al., 2001).

In this regard, the use of various additives in order to improve the shelf life is widely spread practice in the bakery. The inclusion of various hydrocolloids in the formulation gives good results. Guarda et al. (2004) investigated the effect of sodium alginate, xanthan, potassium carrageenan and hydroxypropylmethylcellulose in the concentration 0,1% ÷ 0,5% on the physical and sensory characteristics of bread. It is proven the positive influence that hydrocolloids have on the shelf life of bread, especially the addition of hydroxypropylmethylcellulose. Another aspect is the addition of various enzyme preparations. Cabbalero et al. (2007) studied the influence of some gluten binding enzymes (transglutaminase, glucose oxidase, etc.) along with the polysaccharide and gluten-degradable enzymes (alpha amylase, xylanase and protease). It is found that the changes in the middlebread are negatively affected by the addition of transglutaminase, while the presence of degrading enzymes slows the aging of bread.

Recently, widely spread practice is the introduction of various additives - vitamins, minerals, amino acids and others. (Tiong et al., 2015; Akhtar et al., 2011) in the bread in order to increase its biological value. In this respect the established deficit of some minerals in the dietary intake of the population turned our attention to study the possibility of enrichment of bread with zinc and selenium.

It is known that the cations and anions of various mineral salts affect the aggregation of the amylopectin of the starch and hence - to the aging of the bread. Interest is to establish how the salts of zinc and selenium affect the aging process of the enriched bread. In the literature review were not found any focused researches on the aging of the enriched with these salts bread.

The purpose of this study is to investigate the effect of added zinc in the form of zinc sulfate heptahydrate ($ZnSO_4.7H_2O$) and selenium in the form of sodium selenite pentahydrate ($Na_2SeO_3.5H_2O$), upon the storage of bread made from wheat flour type 500.

Materials and Methods

Materials

Obtaining wheat bread

It is used enriching additives in the form of water-soluble compounds in order to increase the biological value of the bread: zinc sulphate heptahydrate ($ZnSO_4.7H_2O$) and sodium selenite pentahydrate ($Na_2SeO_3.5N_2O$). The added amounts are calculated so that in the finished product to be achieved the levels similar to the recommended average daily dietary intake values which, according to Regulation № 23 / 19.07.2005, are: for zinc 11 mg / d; for selenium 55 μg / d.

From previous studies (Zlateva et al., 2016) it is found that the optimum amount of enrichment with zinc is 0,174 g ZnSO4.7H2O / 1 kg flour and for selenium 820,28 μg Na2SeO35N2O / 1 kg flour.

In the course of investigations the bread dough is obtained from wheat flour type 500 in the two-phase method. Initially it is kneaded a sample of flour and water in a ratio of 1:1. Beforehand in the water for kneading are dissolved the calculated amounts of additives of zinc and selenium. To the thus prepared mixture is added a certain amount of pressed yeast (0,9 %). Maturing at 37 °C for 6 hours. The sample is put in the kneading of the main dough (in ratio 40:60) with the addition of the remainder of the flour according to the recipe and cooking salt (1,3 %). The dough matures 50 min in a thermostat at 35 ° C, such as on the 25 minute it is re-knead. The bread is baked for 30-35 min at a temperature of 220 ° C (until the center temperature of the bread crumb reaches 96-98 °C).

Determination of the deformation characteristics of the middlebread

The freshness of bread is determined by penetrometer measurement of the deformation characteristics of the bread crumb. For the purpose, using an automatic penetrometer type AP-4/2. Measure the general, plastic and elastic deformation of the bread crumb (in penetrometer units) time: 24; 48 and 72 h after the bread baking. The measurement is made on a piece of the middle of bread (from the central part of the bread) with a thickness of 40 mm. The principle of determining the deformation characteristics is as follows: on the flat plane of the bread crumb is treated with a certain body weight, which is left for a certain time (5 s) to fall freely downwards. Under this occurs penetration of the body of the immersion in the bread crumb and the magnitude of sinking into the middle, determines its compressibility or total deformation (Dt). Then, the system of immersion is unloaded and the bread crumb due to the the elastic properties partially restores its height and then determines the plastic deformation (Dp). The difference between the total and plastic deformation constitutes the elastic deformation (De) on which to make conclusions about the freshness of the bread. Depending on the dimensions of the test piece of the definition takes place at three (or five) places at a distance of at least 30 mm from the crust of the bread.

Results

Changes in the deformation characteristics of the bread crumb can give a clear picture of the aging process of bread. In this regard are measured total deformation (Dt) plastic deformation (Dp) and elastic deformation (De) of the bread crumb.

Figure 1 presents the results that reflect the influence of the used additives (zinc sulfate heptahydrate and sodium selenite pentahydrate) on the total deformation (Dt) of the bread crumb.

From the obtained results it is seen that by increasing the duration of storage the softness of the bread crumb reduced and the values of the indicator naturally are amended in both samples.

At the beginning of the storage period the values of the control sample were 91.33 penetrometer units, while in the same period of storage in the enriched sample these values are 10.66 units lower. Of interest is the dynamics of the change in the values. The change in the values of the indicator between the first and the second day is significantly less than that between the second and third day of storage. This trend is manifested in both samples, but in the control sample this process is appear more pronounced. At the end of storage, the total deformation is reduced 2 times, and in the enriched sample by 1.5 times compared to the beginning of storage. It follows that the bread enriched with zinc and selenium, retains its freshness longer for the defined period of storage.

The results obtained in determining the plastic deformation of the bread crumb, are presented in Figure 2.

In the control sample of bread 24 hours after baking the plastic deformation was 71.33 penetrometer units, and at the end of storage it decreased 2-fold. The data indicate that more intensive decrease was observed between the 48 th and 72 hours than in the initial stage.

The values of this parameter in the enriched sample bread are amended more smoothly throughout the entire period of storage compared to the control sample, after 72 hours it keeps the value by 9.33 units higher. By results of these may be noted that the introduction of specific mineral elements leads to the preserving the freshness of bread for a long time.

Table. 1 presents the values characterizing the elastic deformation of the bread crumb.

The results indicate that by increasing the duration of the storage of bread the elasticity of bread crumb decreases in both analyzed samples, but the dynamics of the change in this indicator is different. 24 hours after baking, the value of the elastic deformation of the control sample is 20 penetrometer units, and at the last measurement (72 hours after baking) it decreases by 11 units. Considering the values of that parameter in the enriched sample, we found a smooth change, as from the beginning to the end of the storage the elastic deformation decreases by 6.33 units. 72 hours after baking the bread enriched with microelements zinc and selenium, is distinguished by a high elasticity of the bread crumb and retains better it freshness.

Discussion

Increasing the time of storage logically the values of the deformation characteristics expressed in the penetrometer units at both tested samples decreased. At the beginning of the period of storage, the identified by us values in the enriched sample are lower than those of the control one, but at the end of the storage, it changes and the values at the enriched sample are higher than those of the control one. This is probably due to the impact of the added salts on the moisture retention and on the aggregation of amylopectin during the storage period. Consequently, addition salts of zinc and selenium contribute to keep the softness of the bread crumb for a longer period than that in the control sample.

Conclusions

The bread prepared with the addition of zinc sulfate heptahydrate and sodium selenite pentahydrate is distinguished by a higher softness of the bread crumb at the end of storage (72 h later) compared with the control sample prepared without additives. From the results it is found that the dynamics of change in the total, plastic and elastic deformation is smoother compared to the control sample and it enables for the period of storage the bread be with better preserved freshness. The results of this study indicate that the mineral supplements of zinc and selenium, used to increase the biological value of the bread made from wheat flour type 500, do not affect its keeping quality. In the enriched sample the hardening of the bread crumb occurs more slowly.

References

Akhtar, S., F. Anjum, M. Anjum (2011). Micronutrient fortification of wheat flour: Recent development and strategies. *Food Research International*, **44**: 652-659.

Baik, M., P. Chinachoti (2000). Moisture redistribution and phase transition during bread staling. *Cereal Chemistry*, **77** (4): 484-488.

Ribbotta, P., A. Le Bail (2007).Thermo-physical assessment of bread during staling. *LWT*, **40**: 879-884.

Bosmans, G., B. Lagrain, E. Fierens, J. Delcour. (2013). The impact of baking time and bread storage temperature on bread crumb properties. *Food chemistry*, **141**: 3301-3308.

Caballero, P., M. Gomez, C. Rosell (2007). Improvement of dough rheology, bread quality and bread shelf-life by enzymes combination. *Journal of Food Engineering*, **81**: 42-53.

Curti, E., E. Carini, A. Diantom, E. Vittadini (2016). The use of potato fibre to improve bread physico-chemical properties during storage. *Food chemistry,* **195**: 64-70.

Guarda, A., C. Rosell, C. Benedito, M. Galotto (2004). Different hydrocolloids as bread improvers and antistaling agents. *Food Hydrocolloids*, **18**: 241-247.

Hug-Iten, S., S. Handschin, B. Conde-Petit. F. Escher (1999). Change in starch microstructure on baking and staling of wheat bread. *LWT*, **5**: 255-260.

Rasminssen, P., A. Hansen (2001). Staling of bread stored in modified atmosphere. *LWT*, **34**: 487-491.

Tiong, S., M. Chandra-Hioe, J. Arcot (2015). Thiamin fortification of bread-making flour: Retention in bread and levels in Australian commercial fertified bread varieties. *Journal of Food Composition and Analysis*, **38**: 27-31.

Zlateva, D., D. Stefanova (2016). Enhancing the nutritional value of bread through fortification with zinc and selenium. *20 th IGWT Symposium, Commodity science in a chanching world. September 2016, Varna, Bulgaria,* 553-559.

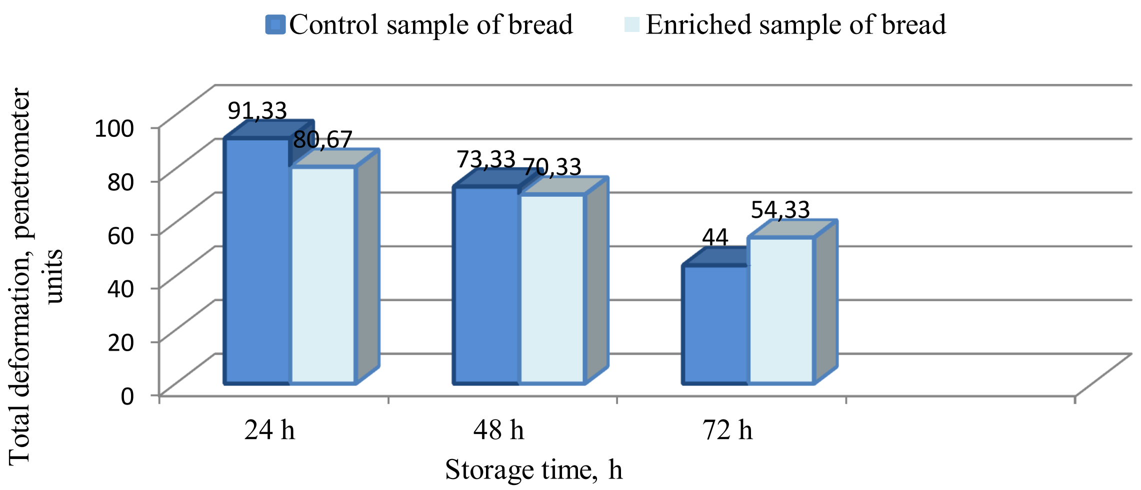

Figure 1. Total deformation of the bread crumb, (Dt)

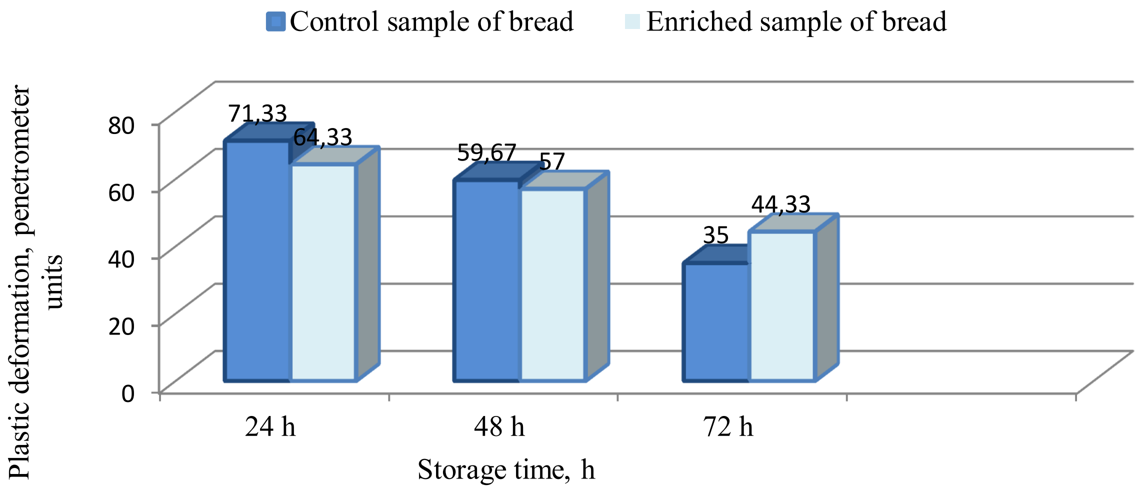

Figure 2. Plastic deformation of the bread crumb, (Dp)

Table 1. Elastic deformation of the bread crumb, (De)

Sample	**Elastic deformation, penetrometer units**		
	24 h	**48 h**	**72 h**
Control sample of bread	20,00	13,67	9,00
Enriched sample of bread	16,33	15,33	10,00