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The effects of fortification with a commercial mixture of vitamins and minerals on bread characteristics

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Abstract
Modern milling removes the vitamins and minerals from refined flours, but the technological characteristics and sensory appearance is improved. Because of that the white bread becomes the favourite choice of consumers but brings little nutrients to them. Bread could be used as a vector for delivery of several nutrient to the population. The micronutrients included to bread formulation could influence the technological properties of dough and the final characteristics of bread. Ascorbic acid is a vitamin and is used in food formulation for vitamin fortification and also as additive, working as an antioxidant. In breadmaking ascorbic acid is working as an active and efficient oxidant. Different minerals could influence the dough rheology, depending on their form and concentration. The aim of this work is to find what is the impact of a commercial product for food fortification on the dough rheology and the characteristics of the final product.
Key words: breadmaking; nutrition; rheology; Mixolab

1. Introduction

Bread is a staple food in many countries [1] and brings to the human's diet carbohydrates, proteins, and other nutrients too. In the same work, Weegels affirmed that wholewheat bread should be considered as staple should because of its higher nutritional value. Bread is a source for vitamins from the group B[2]. White bread is preferred because of its superior sensory characteristics. White bread has a lower nutritional value than brown or wholewheat bread because many nutrients, from the outer layer of wheat kernel and germ, are removed during the milling process[3]. Processing of food could lead to another loss of nutrients, depending on the type and the parameters of processing[2,4].

To obtain a white bread with a higher nutritional content it is necessary to add some nutrients to white flour or to the dough during the process of breadmaking. Vitamins from the group B as niacin, pyridoxin and folic acid are important for the well function of human body, them influence the nervous system, energetic metabolism, DNA and proteins synthesis. Fortified wheat flour or fortified bread could be valuable sources of these nutrients[2].

The modern diet of humans, especially for some segments of population, lacks in some nutrients. The most important for health and most deficient in diet are iron, calcium, zinc, folic acid, vitamin D. Cereals and cereal products could be used a carrier for some nutrients because these foods are largely consumed. Wheat flour and bread could be used a vector for some nutrients targeting specific groups of population as children, pregnant women or elders [5]. Worldwide many countries chose to impose mandatory fortification of different product, mainly wheat flour and corn flour but rice too with different micronutrients. The most common nutrients added were thiamine, riboflavin, folate, iron, calcium, niacin, pyridoxin. Other nutrients

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were introduced too, in several cases (vitamin E, Vitamin D, vitamin A and Zinc). In Europe, only in two countries the fortification of bread is mandatory (UK and Moldova [4]. In Romania were made some steps for mandatory fortification of wheat flour. The main nutrients targeted were iron and folic acid. This project was abandoned under the pressure of national associations of millers and bakers and some groups of population.

In recent years population becomes more aware of importance and impact of food on health and begin to choose healthier products. People become take more care when choose the bread and regular white bread is not the first choose any more for many of them. Few fortified assortments of bread are present on the bakeries shelves and must be done efforts to produce them. It is needed to evaluate the efficiency of fortification but also the impact of the added nutrients on the breads' characteristics because the populations are looking for healthy food but tasty too. The efficiency of fortification was evaluated in many research. Breadmaking is a process which involve long term fermentation, exposure to oxidants, low pH, high temperature for long time. These processes have a great impact on nutrients, some of them are more sensitive than others. B-group vitamins thiamine, pyridoxine and riboflavin, showed a good resistance[6]5. In the case of thiamine was observed that an increase of concentration in the final product compared with the wheat flour due the fermentation. The thiamine content increase during the fermentation but decrease during the baking process [6,7]. In the case of cobalamin (vitamin B12) the biodisponibility after baking is 50% [8]. The positive effect of wheat flour fortification with folic acid was investigated and proved by several researches [9,10]. Other work [11] showed that for vitamins from group B the concentration decreased in the final product with 20-45% for thiamine, 25-50% for nicotinic acid, 45-65% for pyridoxal, 50% for riboflavin and 15% for pyridoxine. The bread samples were prepared considering a 50% degradation of vitamins and the final content of vitamins should ensure a 30% and 15% of Daily Reference Intake, according with EU regulation for labelling food product with the inscription "source of …" and respective "reach in …" [12,13].

2. Material and methods

The Commercial white wheat flour type 650, yeast, salt and sunflower oil were used in experiments. A mixture of vitamins and minerals was used, Vitamin Calcium Premix F11095 (DSM Nutritional Products Sp., Poland). The declared composition is tocopherol (tocopherol equivalent 445.500÷544.500 mg/100g), niacin (594.000÷726.000 mg/100g), pantothenic acid (263.250÷321.750 mg/100g), pyridoxine (51.975÷63.525 mg/100g), biotin (1.856÷2.372 mg/100g), folic acid (8.775÷10.725 mg/100g), cyanocobalamin (126.563÷161.719 mg/100g) and calcium (27000÷33000 mg/100g). For fibre supplementation was used wheat fibre (JELUCEL® WF, JELU – WERK, Germany).

The bread samples were prepared using a sponge method. The formula and parameters are presented in Table 1.

Table 1. Bread recipe

INGREDIENTS	Sponge	Dough	Total
Wheat flower type 650	33.3	66.7	100.0
Water	19.6	41.8	61.3
Fresh yeast	1.1	-	1.1
Salt	-	1.8	1.8
Wheat fibres	-	0.7	0.7
Sunflower oil	-	0.7	0.7

The sponge and dough were mixed for 10 minutes each with a spiral mixer, sponge temperature 28°C for 120 minutes, the dough fermentation at 30°C for 30 minutes. After fermentation dough was divided in pieces of 600 grams, shaped and placed for fermentation in trays for 60 minutes at 40°C and 82% RH. Baking was done at 235°C for 30 minutes followed by cooling for 120 minutes. Two bread samples. S1 and S2, were prepared, with 1.3 and respective 2.6 grams of vitamin-mineral mix / 100 grams of flour. The same proportion was used for rheological test.

The rheological tests were done on MIXOLAB (KPM Analytics, France) device according to Method AACC 54-60.01[14]. The premix was added in the same manner as in the case of bread preparation. A supplementary test was done for a mix of flour and fibers, codded SF. The fibers were added in the same proportion as in the case of bread preparation, 0.7 g wheat fibers/ 100g of flour.

The breads were analysed after 24h. Bread characteristics were determined according to SR 91:2007 (specific volume by rapeseed displacement, humidity by drying at 130°C for 45 min, acidity by titration of crumb extracts and porosity as ratio between holes volume and total volume of crumb). Sensory analyses were done by trained personnel. The vitamin content of samples was determined through approved HPLC methods.

3. Results and Discussion

3.1. Sensory and physicochemical characterization of samples

The bread samples were analysed by trained personnel. They analysed the overall aspect, shape, crust aspect and colour, crumb's colour, porosity and texture, taste and smell. The samples characteristics were specific for the bread type and no differences could be observed through the three samples. The vitamin premix did not affect the sensory characteristics of bread. In figure 1 are presented the sections of control (S0) and sample with the maximum dose of vitamins.

The physicochemical characteristics of samples are presented presented in Table no. 2. The moisture of breads were similar, the moisture of sample with higher amount of premix was a little smaller. The water added at dough kneadineg was the same for all three samples. The differences could be caused by small differences in the bread preparations but probably was caused by the additional dry substances added to dough through used premix. In sample S1 1.6 g of premix was added to 100 g of flour and 2.6 grams/100 g of flour in sample S2. The dough porosity was very similar for the both samples and highe than the value imposed by Romanian Standard SR878/1996, 72%. The specific volume of samples was higher for the sample S2, showing that the suplementary premix influenced positively the gas retention during the breadmaking.

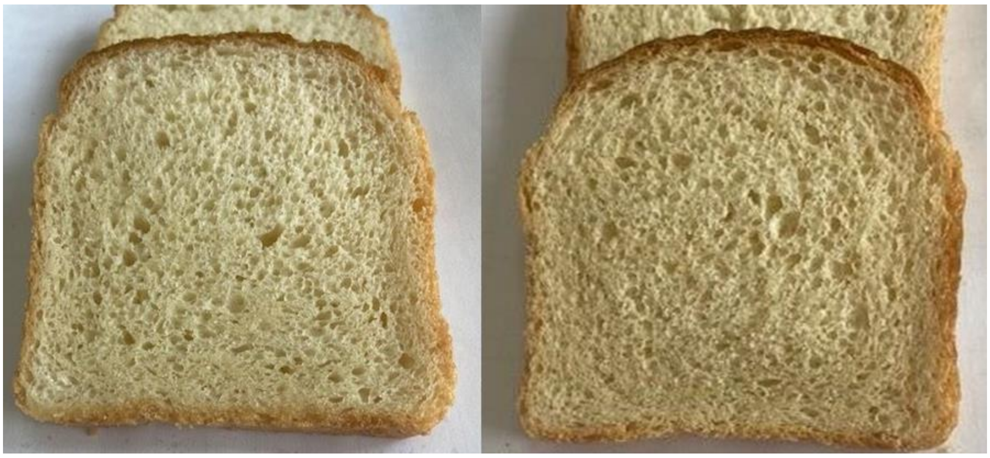

Figure 1. Sections through the control sample (S0) and sample with maximum dose of premix (S1)

Table 2. Physicochemical characteristics of bread samples

Sample	Moisture [%]	Porosity [%]	Specific volume [mL/100g]	Crumb elasticity [%]	Acidity [mL NaOH 1N/100g]
S0	41%	80.1	265	95	1.2
S1	40.04	80.3	277	95	0.89
S2	38.19	80.4	311	88.3	0.68

Crumb elasticity of sample S2 was lower than the one for sample S1 showing that the higher dose of mineral-vitamin premix negatively influenced the texture of the crumb. It possible that the supplementary amount of Ca increased the alfa-amylase activity, and a higher amount of starch was hydrolysed. The rheological test showed that the consistency of dough at the end of cooking is smaller in the case of sample S2 comparing with sample S1 (see the graph below).

Crumb acidity was low for both samples despite the sponge preparation method used. That is explained by the minerals present in vitamin-mineral premix.

3.2. Rheological effects

Mixolab was used for rheological characterization of dough during the mixing and cooking process. The results are presented in Table no. 3 and Figure 2.

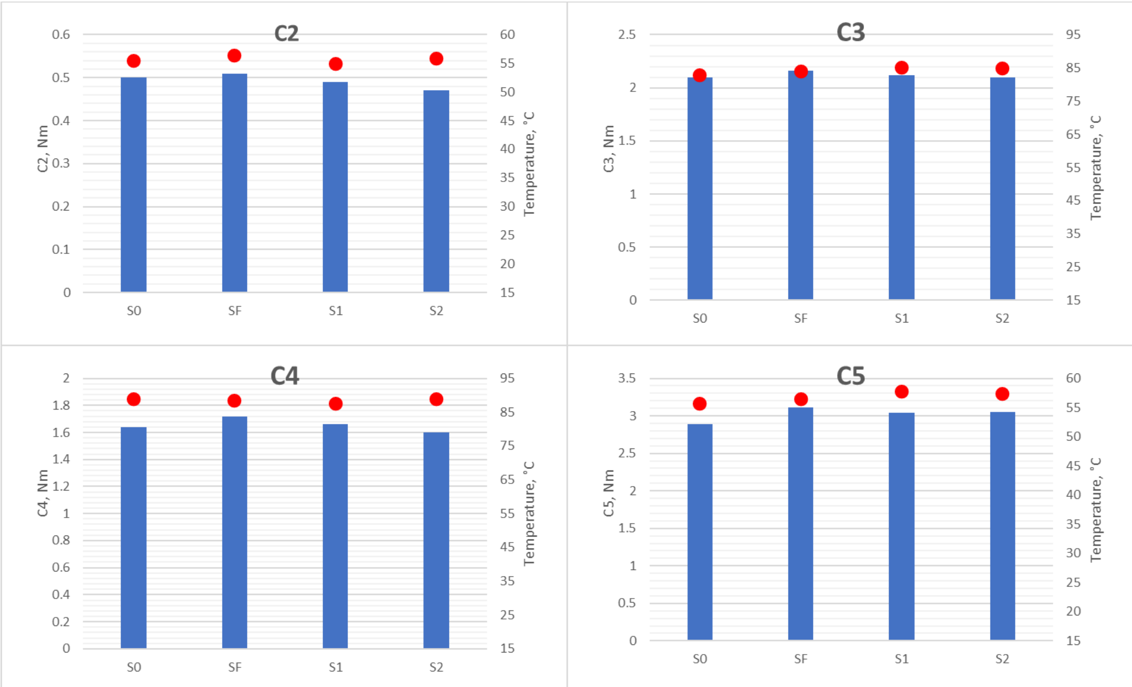

Figure 2. Dough rheology during the cooking – cooling stages
(blue boxes represent dough consistency and red dots represent the temperature of the dough in the moment of consistency measurement)

Table 3. Dough characteristics during the mixing process

	S0	SF	S1	S2
C1 (Nm)	1.13	1.07	1.06	1.05
Dough elasticity (Nm)	0.11	0.1	0.11	0.1
Dough stability (min)	9.13	10.05	10.17	9.83
Temperature T1 (°C)	30.1	31.7	30.6	30.4

During the first stage of the test with Mixolab the mixing process is evaluated. The process is set to be realized at 30°C but the device cannot ensure a precise temperature. For this reason, in Table 3 are presented the temperatures too. The temperature of the dough influences its consistency, higher temperature decreases the dough consistency [15]. The dough consistency is negatively affected by the addition of fibers and mineral-vitamin premix. The negative effect of flour supplementation could be explained through flour dilution with ingredients, the same amount flour-premix was used as in the case of control sample. The supplements diluted the gluten in the samples. Even fibers addition decreased the dough consistency but must be considered that the dough temperature was higher (31.7°C compared with 30.1°C in the case of control). The higher temperature explained the lower consistency of sample with only fibers added. In the case of sample S1 and S2, which were prepared with fibers and premix too, the dough consistency decreased even more compared with the sample SF despite the dough temperatures were similar with the control. These results showed that the components of the premix have a negative effect on dough consistency. The premix negatively influenced the dough stability and dough elasticity. The fibers had a positive effect on dough's stability, but the premix had an opposite effect.

The dough consistency varies during the cooking and cooling process and these changes reflects the transformations which occurs in the dough in different stages of baking. After mixing the dough for 8 minutes at 30°C the temperatures is increased at 90 °C. First components of the dough affected by temperature are proteins. The denaturation of proteins decreases the dough consistency. The fibres added to the flour in the sample SF reduced this effect of temperature and the lowest consistency of the dough (C2) was higher than any other cases, 0.51 Nm. The added fibres bound some water in the dough and that influenced the dough consistency. As in the case of dough consistency during kneading stage (C1) the smaller consistency of S1 and S2 (0.49 and, respectively, 0.47Nm) could be explained by gluten dilution in the sample with the mineral-vitamin premix. The lowest consistency during the heating was observed for the higher dose of premix.

After reaching the minimum consistency (C2) the temperature continues to increase till 90 °C and higher temperature induce the starch gelatinisation and dough consistency increases. The maximum consistency of the dough was very close for al samples, higher value was observed in the case of sample with only fibres added (2.16 Nm compared with 2.1 Nm in the case of control). We can conclude that premix reduced the maximum consistency. We observed that the maximum consistency was reached at higher temperature in the case of supplemented samples.

3.3. Nutritional value

The content of vitamins and minerals of the supplemented samples are presented in table Table 4. In the last column are presented the values corresponding to 30% of Daily Reference Intake (DRI). Could be observed that even in the case of the lowest dose of premix the content of added nutrients is higher than 30% of DRI. The content of vitamin B12 and tocopherols is almost twice higher than 30% of DRI. These numbers prove that even at lowest dosage the target of 30% of DRI is ensured and the phrase "source of" could be used for product labelling.

Table 4. Mineral and vitamin content of supplemented samples

Nutrients	S1	S2	30% of DRI
Ca (mg/100 g)	273 ± 66	524 ± 126	240
B12 (μg/100 g)	1.40 ± 0.28	2.13 ± 0.43	0.75
B3 (mg/100 g)	7.3 ± 1.5	7.9 ± 1.6	4.8
B5 (mg/100 g)	2.99 ± 0.60	3.94 ± 0.79	1.8
B6 (mg/100 g)	0.56 ± 0.18	0.99 ± 0.33	0.42
B7 (μg/100 g)	18.7 ± 3.7	33.3 ± 6.7	15
B9 (μg/100 g)	89.9 ± 18.0	142 ± 28	60
Tocopherols (mg/100 g)	6.7 ± 0.9	10.4 ± 1.5	3.6

4. Conclusion

Bread supplementation with minerals, vitamins and fibre improves the nutritional value of bread and fortified bread is a valuable source of nutrients for population. Test should be done to investigate the final content of nutrients in bread due the loses during the baking process. Some nutrients will influence the baking process by modification the dough rheology and will influence the properties of final products too. Minerals could reduce the acidity of final product leading to a higher pH. High pH will not offer protection against moulds and rope disease and the durability of final should be tested or must be added preservatives.

Compliance with Ethics Requirements

Authors declare that we respected the journal's ethics requirements. Authors declare that we have no conflict of interest and no procedure involving human and/or animal subjects was used in research. Authors declare that we present our own literature survey and results/discussion/conclusion in the article.

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