Effect of *Spirulina platensis* and *Kelp* algae on the content of thiamine and riboflavin in wheat bread

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Abstract

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Introduction. The purpose of the present study is to investigate the effect of some edible algae – *Spirulina platensis* and *Kelp* on the content of thiamine and riboflavin in wheat bread.

Materials and methods. Bread is obtained from wheat flour with the addition of *Kelp* and *Spirulina platensis* (powder) in the amount of 2 or 4% by the weight of flour. The vitamin content was evaluated by liquid chromatography with mass spectrometry (LC-MS) method.

Results and discussion. It was found that enrichment with *Kelp* and *Spirulina platensis* (in the amount of 2% and 4% by the weight of flour) leads to an increase in the content of thiamine and riboflavin in wheat bread. The two types of algae have different effects. The use of 2% *Kelp* leads to an increase of 7.35%, and of 4% – by 28.27% of the amount compared to that in the control sample. The most significant increase being observed with the addition of 4% *Spirulina platensis*. The amount of thiamine is 1533.75 µg/kg of bread, which is almost twice as high as in the control sample.

The content of vitamin B₂ in the control bread sample is 310.5 µg/kg. When *Kelp* in the amount of 2% is added, the increase is by 81.7 µg/kg, and at the higher dosage (4%) the increase is by 120 µg/kg compared to the control sample and by 38.3 µg/kg compared to the bread with 2% algae. The highest value was reported for bread enriched with 4% *Spirulina platensis*. The riboflavin content is almost 3 times higher than in the control sample; 2.37 times higher than in the 2% *Kelp* sample and 2.16 times higher than in the 4% *Kelp* sample.

Conclusions. Fortification of wheat bread with some edible algae – *Kelp* and *Spirulina platensis* (especially in the amount of 4% by the weight of the flour) is an effective approach for increasing the content of thiamine and riboflavin. The effect of *Spirulina platensis* on the vitamin content is more pronounced.

Introduction

The importance of vitamins for good health has long been known. Often, to ensure an adequate intake of vitamins, people (especially those on special diets for health reasons, vegetarians and vegans) consume foods fortified with vitamins derived from natural sources. Seaweed can be successfully used for this purpose. Honya et al. (1994) point out that fresh or dried seaweed is a traditional food of the diet in many coastal areas, especially on the Pacific coasts of Asia and South America. On the other hand, Boukid and Castellari (2021) outline a new trend – the use of algae in food formulation is positioning firmly in the food market in Europe. The number of food products containing algae has significantly increased during the period 2015–2019 (13,090 new food products containing algae were globally launched, of which 5720 – in Europe). However, most of the specific nutritional information on edible seaweeds concerns their protein content and favorable amino acid composition, but there are less researches on the vitamin content in micro- and macroalgae.

Fabregas and Herrero (1990) published results on vitamin content of various microalgal species. They noted that microalgae contained high concentration of provitamin A, vitamin E, vitamin B₁ and folic acid, compared to conventional food sources. They point out that *Dunaliella tertiolecta* is able to synthesize vitamin B₁₂ (cobalamin), vitamin B₂ (riboflavin), vitamin E (tocopherol) and provitamin A (β-carotene). Pawlak et al. (2014) point out that seaweed containing vitamin B₁₂ may be beneficial for people who follow a vegan diet who are at risk of vitamin B₁₂ deficiency (as it is found mainly in foods from animal origin). Because certain seaweeds are a valuable source of both fat- and water-soluble vitamins (Norziah and Ching, 2000) their use by the food industry and consumption by the general public is increasing. According to Kennedy (2016) seaweed is a good source of a number of water-soluble vitamins (B₁, B₂, B₁₂ etc.). Based on this, algae are of particular interest as food fortifiers due to the high content of biologically active ingredients (including vitamins). According to Kadam and Prabhasankar (2010), bakery products, which are the most widely consumed foods in the world, are best suited to include functional ingredients in the recipe to achieve good health, optimal duration and quality of human life. From this point of view, algae are a promising raw material for the bakery industry. Many authors study the influence of algae on the protein content (Achour et al., 2014), dietary fiber (Raman et al., 2019) and mineral content of wheat bread (Ak et al., 2016). Others pay attention to the effect of algae on the rheological properties of dough and bread (Rosell et al., 2001; Mamat et al., 2014), sensory properties and consumer acceptance of bread (Saharan and Jood, 2017), antioxidant activity (Różyło et al., 2017) and iodine content (Tsyganova et al., 2014). The effect of algae on the vitamin content of bread has been less studied.

Dulinski et al. (2018) conduct a study to design a functional rye bread enriched with algae extracts (*Ascophyllum nodosum*, *Arthrospira platensis*) and to analyze the content of its selected bioactive ingredients: phenolic acids and vitamins B₁ and B₂. As part of the research, an attempt was also made to estimate the absorbable pool of these compounds by using an in vitro procedure simulating digestion in the human digestive tract. It was found that the addition of algae at the stage of mixing the rye dough significantly contributed to the increase of the available pool of B vitamins in bread, especially riboflavin. The analysis shows that the tendency to increase the vitamin content applies to bread samples enriched with *Arthrospira platensis*. Relatively high in vitro bioavailability of vitamin B₂ in bread was found (45-62%). The authors attribute this to the beneficial effect of hydrocolloids present in its biomass on the absorption of bioactive ingredients. In the case of thiamine, such large increases in the content of this vitamin with the addition of the algae component were not observed, nevertheless the trends noted in the case of riboflavin were confirmed.

There are relatively limited publications on the effects of different types of algae on the content of thiamine and riboflavin in bakery products. Both vitamins are sensitive to the influence of temperature, light and other factors which the cereal grains are subjected to. Technological processes in breadmaking can partially degrade these biocomponents in the range from 25% (thiamine) to even 50% (riboflavin) of their initial level in the raw material (Mihhalevski et al., 2013; Wolak et al., 2017). For this reason, many industrially produced grain products are fortified with B vitamins to restore their original levels. There is a significant gap in our knowledge about the effect of different types of seaweed on thiamine and riboflavin content of wheat bread.

Therefore, the purpose of the present study is to investigate the effect of *Spirulina platensis* and *Kelp* (in the amount of 2 % and 4 % by the weight of flour) on the content of thiamine and riboflavin in wheat bread.

Materials and methods

Materials

For the preparation of the bread samples, the following materials were used:

- Commercial wheat flour type 500 with the following properties: moisture content – 12.8 %; gluten content – 27.07 %; release of gluten – 6 mm; titratable acidity – 2 °H;
- Water – according to ISO 6107-1:2004;
- Commercial yeast (Lesafmaya);
- Salt – according to Codex Standard for Food Grade Salt CX STAN 150-1985;
- *Spirulina platensis* powder (average chemical composition: protein 64 g/100 g; fat 8.2 g/100 g of which saturated 3.42 g; carbohydrates 16.1 g/100 g, of which sugars 0.52 g, fiber 7 g/100 g).
- *Kelp* powder (average chemical composition: protein 5.3 g/100 g; fat 4.2 g/100 g of which saturated 0.9 g; carbohydrates 12.0 g/100 g, of which sugars 0.5 g, fiber 1.25 g/100 g).

Methods

Dough and bread composition

The composition of the bread samples is presented in Table 1.

Table 1

Bread samples composition

Ingredients	Bread samples				
	Control sample	Sample S2 - with 2 % <i>Spirulina platensis</i>	Sample S4 - with 4 % <i>Spirulina platensis</i>	Sample K2 – with 2 % <i>Kelp</i>	Sample K4 – with 4 % <i>Kelp</i>
Wheat flour , g	250	245	240	245	240
Water, cm ³	140	145	155	145	155
Yeast, g	3.37	3.37	3.37	3.37	3.37
Salt, g	3.25	3.25	3.25	3.25	3.25
<i>S. platensis</i> , g	–	5	10	–	–
<i>Kelp</i> , g	–	–	–	5	10

Bread preparation

Bread is obtained from type 500 wheat flour by a two-phase method. Initially, knead the yeast, flour and water dough in a 1:1 ratio in kneading machine (Labomix 1000, Hungary). Pre-mixed *Spirulina platensis* and *Kelp* algae (powder) in the amount of 2 % or 4 % by the weight of flour are added to the mixing water (combinations K2 and K4, for the breads prepared with *Kelp* and combinations S2 and S4, for the breads prepared with *Spirulina platensis*, respectively). The control sample was prepared only with wheat flour. The dough thus prepared matures for 4 hours at 33°C and then mix the dough to obtain a homogeneous mass by adding the remainder of the flour according to the formulation and salt (1.3 kg/100 kg flour). The bread dough divides (440 g) and forms, matures for 55 minutes at 38°C (Tecnopast CRN 45–12, Novacel ROVIMPEX Novaledo, Italy). After the final fermentation, the pieces of dough were put into an electric oven (Salva E-25, Spain) pre-heated to 200–220°C. The baking time is 24 min, until the temperature in the center of the bread crumb reach 96–98°C. After baking, the bread is allowed to cool down for 3 h at room temperature.

Determination of vitamin B₁ and vitamin B₂ content

Sample extraction. 5 g of each sample of bread were weighted into a 50 ml centrifuge tube using an analytical balance. 25 ml of doubly distilled water were added and the samples are dispersed with a Polytron apparatus for 10 minutes. The resulting suspensions were centrifuged at 4000 rpm for 15 minutes. The upper layer was decanted into a centrifuge tube. The precipitate was dispersed twice more with 10 ml of doubly distilled water. After each dispersion, the suspensions were centrifuged and the lower layers were combined, then filtered through a quantitative filter (syringe filter with a pore size of 0.45 µm). About 1 ml was taken from the filtrate and stored at up to 4°C for chromatographic analysis.

Analytical methods. In the samples thus prepared, the content of water-soluble vitamins B₁ (thiamine) and B₂ (riboflavin) was examined on a liquid chromatograph with a high-resolution mass-selective detector (LC-MS). The chromatographic system was equipped with M510 and M45 pumps (Waters Associates), Rheodyne M-7125 injector and scanning fluorescent detector. The mobile phase was methanol/water/acetic acid (31/68.5/0.5) containing 5 mM sodium hexasulfonate. The determination of the chromatographic peaks was carried out by comparing the retention times of the pure substances for chemical analysis (certified reference material for vitamin B₁ and vitamin B₂) with that of the tested samples. The qualitative identification of the analytes was based not only on the retention times of each component, but also on the secondary mass spectrum of the characteristic result ions of the studied vitamins.

Data on the amount of vitamins tested in bread samples were processed by the integrated software of the liquid chromatograph with mass detector used.

Results and discussion

Effect of *Spirulina platensis* and *Kelp* on the content of vitamin B₁ in wheat bread

The human body needs a minimum of 0.33 mg of thiamine for every 1000 kcal it consumes (Osiezagha et al., 2013). According to Harper (2006), many population groups worldwide suffer from vitamin B₁ (thiamine) deficiency and are at risk of severe neurological diseases. Vitamin fortification of daily consumed foods (such as bread) is an effective and

easily achievable measure to improve public health, thanks to which it can overcome their deficiency in all groups of the population.

Some authors (Batifoulie et al., 2006), aim to study by means of HPLC the content of vitamin B₁ in nine varieties of wheat, as well as in the flour and bread obtained from them. It has been found that vitamin B₁ content ranging from 2.60 to 6.13 µg/g dry matter in the different wheat varieties. This reveals that the vitamin content is genetically determined and should be an important factor to consider when selecting different varieties of wheat. After grinding, only 43% of thiamine present into low-ash flour (compared to 80% for wholemeal flour). After baking, the amount of thiamine decreases by 37% in white bread and by 31% into wholemeal bread.

It's well known that bread made from flours, which contain less particles from the peripheral layers of the grain, has a lower vitamin content. This is due to the fact that thiamine is unevenly distributed in the anatomical parts of the wheat grain – the aleurone layer and the germ are much richer in this vitamin than the endosperm. In addition, the high temperature effect during baking leads to the thermal destruction of a significant part of the vitamins. That is why wheat bread from flour type 500 is not a good source of vitamins for the human body. The effect of algae *Spirulina platensis* and *Kelp* on the content of vitamin B₁ in wheat bread is presented in Figure 1.

Figure 1. Effect of *Kelp* and *Spirulina platensis* algae on vitamin B₁ content in wheat bread.

The content of vitamin B₁ in wheat bread from flour type 500 is 773.75 µg/kg. Our data on thiamine content are almost identical to those published by Tiong et al. (2015), which found an amount of 1.0 ± 0.028 mg/100 g of product, but expressed the dry matter result (and the data presented by us are of fresh product). Other authors (Umelo et al., 2014) found lower amounts of vitamin B₁ in wheat bread – ranging from 0.034 mg/100 g to 0.044 mg/100 g. In this case, both the genetic and varietal characteristics of the wheat and the specific technological parameters of bread preparation (such as the type and quantity of yeast, the duration of fermentation process) have an influence.

From the data presented in Figure 1, it is clear that the addition of algae in the recipe of wheat bread leads to an increase in the content of vitamin B₁. Both types of aquacultures affect the amount of thiamine to varying degrees. *Kelp* cause an increase in its content to a lesser extent. The use of 2% biomass from algae leads to an increase of 7.35%, and of 4% – by 28.27% of the amount compared to that in the control sample. These results are expected, considering that brown algae contain relatively high amounts of thiamine. According to Sánchez-Machado et al. (2004) vitamin B₁ content vary from $0,14 \pm 0,02$ to $0,40 \pm 0,13$ g /g dry matter. Therefore, the replacement of a relatively small portion of wheat flour (2% and 4%) with these brown algae reflects this way on the content of vitamin B₁ in bread.

When *Spirulina platensis* is added to the recipe of wheat bread, the effect on the amount of thiamine is much more pronounced. The addition of 2% caused an increase in the amount of vitamin B₁ 1.65 times compared to the control sample. The reported result is 1277.5 µg/kg of bread. This amount is 1.54 times higher than in the sample enriched with 2% *Kelp* algae. When using 4% *Spirulina platensis*, the thiamine content is 256.25 µg/kg higher. The value obtained of 1533.75 µg/kg of bread is almost twice as high as for the control sample; 1.85 times higher than for the 2% *Kelp* sample and 1.55 times higher than for the 4% *Kelp* sample. The high efficiency of enrichment with these algae stems from the fact that they have a very high content of thiamine, which, however, shows strong seasonal variations. Babadzhyanov et al. (2004) published the following data on thiamine content in *Spirulina platensis*: 11.6% of dry matter in biomass collected in winter; 15.4% in biomass collected in the spring; 0.8% in biomass collected during the autumn and summer seasons. According to these data the biomass grown in spring-summer had a high vitamin content. This shows a clear seasonal fluctuation in the vitamin content of algae. In order to increase the vitamin content of wheat bread, the biomass of *Spirulina platensis*, intended for enrichment, should be harvested during the spring-summer season. In addition, the amounts to enrich the bread and achieve adequate intake must be calculated according to the amount of thiamine in the biomass.

According to Yusuf et al. (2016) the thiamine content of *Spirulina platensis* ranges from 34 to 50 mg/kg. There is a significant difference between the results published by the two authors. This is due to the fact that the composition of algae is not constant and varies depending on their species, geographical regions and harvesting season (Wells et al., 2017).

To get a better idea of the enrichment effect, a comparison was made between the recommended daily intake of thiamine and the extent to which the bread samples tested satisfies it.

The need to determine adequate vitamin B₁ intake arose decades ago. As early as 1967, the World Health Organization set a recommended intake of thiamine 0.4 mg/1000 kcal. Therefore, an adult male consuming 3200–3300 kcal per day needs a daily intake of 1.3 mg of thiamine, while a woman consuming an average of 2300 kcal needs to take 0.9 mg of thiamine per day. In 1989, the National Council for Research in the United States recommended a daily intake of 0.5 mg/1000 kcal for adults, and the total daily intake not less than 1.0 mg even for those consuming less than 2000 kcal daily (World Health Organization, 1999).

In Bulgaria, Ordinance №1/2018 of the Ministry of Health differentiates the recommended thiamine intake depending on gender and age of the population. For men in the age range of 19 to 60 years, the recommended daily intake of thiamine is 1.2 mg, while for women of the same age – 1.0 mg. The degree to which the daily amount of bread consumed from the tested samples satisfies the recommended daily intake is presented in Figure 2.

Figure 2. Effect of *Kelp* and *Spirulina platensis* on the degree of satisfaction of the recommended daily intake of vitamin B₁ in men and women aged 19 – 60 years

As can be seen from the figure, the average daily amount of wheat bread consumed in Bulgaria provides less than 15% of the adequate intake of thiamine for men and 17.40% of the adequate intake for women in the specified age range. We must take into account the fact that thiamine may not be properly absorbed by people who have liver problems; there are also some components in food that impair the absorption of thiamine (eg tannins in coffee and tea).

Enriching wheat bread with seaweed leads to a higher degree of satisfaction with adequate thiamine intake. The impact of both the type and the amount of aquaculture input is clear. *Kelp* algae have a less pronounced effect. When 4% of them are added to bread, its daily consumption provides 18.6% of the adequate intake of vitamin B₁ for men and 22.3% of the adequate intake for women.

The impact of the other type of algae is more pronounced. Consumption of bread with 2% *Spirulina platensis* covers almost 24% of the recommended intake for men and almost 29% for women. If the amount of aquaculture is 4%, the highest degree of satisfaction of the needed intake of vitamin B₁ is achieved. Consumption of the usual daily amount of bread provides 28.8% of the required amount for men and over a third (34.5%) of the required amount for women aged 19 to 60 years. Replacing only 4% of wheat flour with *Spirulina platensis* makes bread twice as effective a source of thiamine for the human body (compared to the control sample).

For pregnant women and nursing mothers, a slightly higher adequate daily intake of thiamine was determined – 1.3 mg. Consumption of wheat bread provides 13.38% of this amount, and consumption of bread enriched with 4% *Spirulina platensis* – 26.5%.

Effect of algae *Spirulina platensis* and *Kelp* on the content of vitamin B₂ in wheat bread

Riboflavin deficiency can cause vision problems, particularly cataracts. This disease is the result of abnormal aggregation of proteins in the lens, which causes it to become cloudy. In the elderly, the risk of cataract is increased due to riboflavin deficiency (Skalka and Prchal, 1981). Vitamin B₂ deficiency is found in about 80% of cataract patients. Riboflavin intake of 400 mg/day has a preventive effect against the development of age-related cataracts (Buehler, 2011). People who adhere to a special diet due to health problems (diabetes, peptic ulcer disease, weight loss), as well as smokers, alcoholics and women using certain types of birth control (Škrovánková and Šikarová, 2010) are at increased risk of riboflavin deficiency.

Thus presented literature data show that insufficient intake of vitamin B₂ can affect health status in many different ways. The human body cannot synthesize this vitamin and therefore it must be absorbed through food through absorption in the small intestine. The results on the effect of *Spirulina platensis* and *Kelp* on the content of vitamin B₂ in wheat bread are presented in Figure 3.

As can be seen from the figure, the content of vitamin B₂ in the control bread sample (from wheat flour type 500) is low – 310.5 µg/kg. Similar results were published by Martinez-Villaluenga et al. (2009). According to them the amount of vitamin B₂ in wheat bread is 45.48 ± 0.22 µg/100g dry matter. If this value is recalculated for fresh product, it would mean 272.88 µg/100g. Regarding the content of vitamin B₂ in bread, decisive factors are: its quantitative content in the flour, the duration of fermentation, pH, high temperature exposure, exposure to ultraviolet radiation and others (Ahmad et al., 2004). Whole meal bread is a better source of this vitamin, as it is concentrated mainly in the germ and aleurone layer. The inclusion of *Kelp* seaweed in the bread recipe leads to an increase in the amount of riboflavin, but not very significantly. When the aquaculture is in the amount of 2%, the increase is by 81.7 µg/kg, and at the higher dosage (4%) the increase is by 120 µg/kg compared to the control sample and by 38.3 µg/kg compared to the bread with 2% seaweed.

Figure 3. Effect of *Kelp* and *Spirulina platensis* algae on vitamin B₂ content in wheat bread

When *Spirulina platensis* is added to wheat bread, the effect on the amount of riboflavin is much more pronounced. In the sample with the addition of 2% of the algae content was reported 2.44 times higher than in the control sample and 1.93 times higher than in the bread with the same amount of *Kelp*. The highest value was reported for bread enriched with 4% *Spirulina platensis*. The riboflavin content is almost 3 times higher than in the control sample; 2.37 times higher than in the 2% *Kelp* sample; 2.16 times higher than in the 4% *Kelp* sample. If we compare the result with that for bread containing 2% *Spirulina platensis* – the increase is almost 23%. This proves that enriching wheat bread with *Spirulina platensis* is effective and leads to a significant increase in vitamin B₂ content.

Initially, the high protein content and favorable amino acid composition of algae aroused interest among researchers. Subsequently, it was found that they are a good source of other biologically active substances, including – vitamins (Wells et al., 2017). In fact, the literature on analytical methods and the content of riboflavin in biomass (fresh or dried) from *Spirulina* is contradictory. It has been reported that the content of riboflavin in *Spirulina platensis* varies from 37 to 45 µg/g dry matter (Andrade, 2018; Bishop and Zubeck, 2012). Edelmann et al. (2019) examined four varieties (different brands with different countries of origin) of *Spirulina* algae and found results ranging from 33.6 to 40.9 µg/g in the different samples. In the same publication, a comparison was made between the amount of riboflavin in the algae *Spirulina platensis*, *Chlorella* and *N. gaditana* powder. The author points out that of all the aquaculture studied, the best source of riboflavin is the algae *Spirulina*. This reveals the good potential for the use of *Spirulina platensis* as a supplement to increase the content of vitamin B₂ in wheat bread. A much lower content of riboflavin (2-9 µg/g) in *Spirulina platensis* has been reported by Babazhanov et al. (2004). Probably this is due to the variation in the amount of vitamins depending on the region and the water basin of aquaculture development, the season of their harvest and others.

Škrovánková and Sikorová (2010) point out that the recommended daily intake of riboflavin depends on protein and energy intake and varies from 1.2 to 1.7 mg per day. According to Ordinance №1/2018 of the Ministry of Health in Bulgaria, the recommended intake of riboflavin for men in the age range from 19 to 60 years is 1.3 mg, while for women of the same age is 1.1 mg. The degree to which the daily amount of bread consumed from the various tested samples satisfies the recommended daily intake is presented in Figure 4.

As can be seen from the figure, the average daily amount of bread from the control sample provides a very small portion of the recommended intake – only 5.38% for men and 6.35% for women. If the diet includes other foods rich in riboflavin, this would compensate for its low content in bread. But for people for whom wheat bread has been a staple food for a long time, there is a risk of hypovitaminosis.

When *Kelp* is included in the bread recipe, the average daily amount of bread consumed covers the recommended intake to a higher degree. The impact of aquaculture is stronger when the amount is 4% by the weight of flour (respectively 7.45% of adequate intake for men and 8.80% of adequate intake for women).

The effect of algae *Spirulina platensis* is much more pronounced. If used in an amount of 2%, the daily amount of bread consumed covers 13.10% of the adequate intake of riboflavin in men and 15.50% in women. These values are almost 2.5 times higher than those found in the control sample. To the greatest extent, the amount of thiamine obtained from bread is close to the recommended intake when 4% *Spirulina platensis* is included in the recipe. The daily intake of bread provides 16.1% of the required amount of riboflavin in men and almost one-fifth of the required amount in women. Thus enriched bread is three times more effective than the control sample and 2.16 times more effective than bread containing 4% *Kelp* in terms of meeting the recommended intake of vitamin B₂.

Figure 4. Effect of *Kelp* and *Spirulina platensis* on the degree of satisfaction of the recommended daily intake of vitamin B₂ in men and women aged 19 – 60 years

For pregnant women, the recommended daily intake of this vitamin is 1.4 mg. The control sample of bread yields only 5% of this amount, and the bread with 4% *Spirulina platensis* – 14.9%. The highest norms for daily requirement of vitamin B₂ are set for women who are breastfeeding – 1.6 mg. In this case, wheat bread provides only 4.4% of the required amount of riboflavin, while fortified bread – 6% when using *Kelp* and 13% when using *Spirulina platensis* (in the amount of 4%).

Conclusion

1. From the results obtained in the present study, it was found that the fortification of wheat bread with *Kelp* and *Spirulina platensis* algae (in the amount of 2% and 4% by the weight of flour) is a good opportunity to increase the content of thiamine and riboflavin.
2. The effect of *Spirulina platensis* is more pronounced, as the highest values for both vitamins were found when adding 4% of the algae to the raw materials for bread making.
3. By including biomass of algae *Kelp* and *Spirulina platensis* in the bread recipe, a significantly higher degree of satisfaction of the recommended daily intake of thiamine and riboflavin is achieved. This approach would allow prevention of deficiency of these vitamins in some groups of the population and improvement of the health status.

These data show that enriching wheat bread with *Kelp* and *Spirulina platensis* is a successful approach to increasing the content of thiamine (vitamin B₁) and riboflavin (vitamin B₂) in bread. This way a large part of the population could achieve an intake of these vitamins, much closer to the adequate.

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