Spirulina platensis effect as protein supplement on rheological properties of dough and nutritional qualities of hot-dog rolls

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Abstract

Spirulina Platensis is the only green-blue commercially bred alga to be used in foods (as food). Its nutritional value derives from its high protein content and its natural property of chelating vitamins. Spirulina Platensis has effect against many toxic metals (e.g. mercury, copper). Numerous and various studies have been made on the commercial uses of microalgae, but not all of them have been turned into commercial applications. The present paper studies the influence of Spirulina platensis addition on rheological properties of a 650 flour (ash 0.65\%) and 1250 flour (ash 1.25\%) mix with a 60\%-40\% percentage, and on the quality of hot-dog rolls made from these flours. Different percentages of Spirulina platensis (2\%, 2.5\%, 3\%) were added in the flour. The samples were coded as follows: M for blank sample, V1 with Spirulina platensis 2\% addition, V2 with 2.5\% addition and V3 with 3\% addition. The blank flour and that containing different Spirulina platensis additions were tested in the laboratory. Besides the laboratory tests, baking samples were made, including volume and protein content analyses.

Key words: Alveograph curves, baking samples, sensorial analyses

1. Introduction

Nowadays consumers may influence the market trends, making the food industry give in these wishes and impose the use of innovative ingredients, rising the quality standard, without affecting the image of end products. Between the 1980s and 1990s in Japan there started the promotion of foods called functional foods containing compounds which participate in metabolic processes in the body, influence its physiological processes and protect its health. The research carried out in the medical and food field have focused more and more on the use of unconventional ingredients which help keep the body heathy and fit. Spirulina Platensis has been studied by more and more researchers.

Spirulina Platensis is the only green-blue commercially bred alga to be used in foods (as food). Its nutritional value derives from its high protein content and its natural property of chelating vitamins. Spirulina Platensis has effect against many toxic metals (e.g. mercury, copper). Numerous and various studies have been made on the commercial uses of microalgae, but not all of them have been turned into commercial applications. The research carried by specialists so far have shown that a daily intake of almost 3-6 g help the body fight against some diseases such as: diabetes, hypercholesteremia, ulcer, hepatic...
illnesses, etc. Alga biomass contains, irrespective of the environment it grows, up to 70-75% easy assimilable proteins. Profound studies on the influence of Spirulina Platensis addition on the rheological properties of flour and consequently on the properties of bakery products have not been made so far. Therefore, [4] studied the effects of Spirulina addition on some disfunctionalities induced by diabetes type1. Nejdet’s study [1] shows that Spirulina Platensis inhibits anaemia and leucopenia caused by lead and cadmium. [3] demonstrates that Spirulina Platensis addition in rabbits’ feeding has great effect on meat quality. Some researchers promotes new foods based on Spirulina- microalgae ingredients. Proteins obtained from marine algae are bio-functional as a recent study made by Kalpa suggests [2]. Spirulina Platensis has begun being promoted as an ingredient due to its functional extracts with germicidal and antioxidant activities.

The aim of this paper is to estimate the effect of Spirulina Platensis addition on the rheological properties of flour and further on the nutritional quality and volume of hot-dog rolls made from mixes.

2. Materials and methods

The flour used in the experiments consists of 60% flour with 0.65% ash and 40% flour with 1.25% ash mix. This is the blank sample where the following Spirulina platensis percentages were added to and the samples were noted as follows: V1 for 2% Spirulina platensis addition, V2 for 2.5% Spirulina platensis addition and V3 for 3% Spirulina platensis addition respectively. The flours were tested in the laboratory by alveograph method and afterwards baking samples were made, the hot-dog rolls being organoleptically and physico-chemically analyzed.

The flour has been analyzed from the point of view of its protein content by the Kjeldhal method SR ISO 1871/2002 and from the reological point of view by alveograph method SR EN ISO 27971:2008 and by mixograph method based on Chopin protocol.

The final products were analyzed from volume point of view (SR 91/2007) and from protein content by Kjeldhal method SR ISO 1871/2002.

The baking samples were made accordingly to a standard recipe calculated for 100 kg of flour M blank sample and shown in table 1. The products were baked in trays. Hot-dog-rolls were obtained and were coded as follows: M blank sample, V1 - variant 1 with 2% Spirulina platensis as against flour, V2 - variant 2 with 2.5% Spirulina platensis against flour, V3 variant 3 with 3% Spirulina platensis as against flour.

Bakery products under the form of hot-dog rolls of 60 grams/item were made, which further on were physico-chemically and sensorial analyzed. A mix of 60% flour 650 and 40% flour 1250 – M sample (with a medium content of 11,3% protein dry substance), spirulina (with a 62 % protein content dry substance), yeast, iodate salt, water were used as raw materials. The indirect manufacturing method based on standard recipe according to table 1 was used.

All the experimental data obtaining were statistical analyses by ANOVA method.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Blank sample rolls</th>
<th>Spirulina- added rolls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>V1</td>
</tr>
<tr>
<td>M (60% flour 650 and 40% flour 1250), kg</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Yeast, kg</td>
<td>3,88</td>
<td>3,88</td>
</tr>
<tr>
<td>Spirulina platensis, kg</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Iodate salt, kg</td>
<td>1,25</td>
<td>1,25</td>
</tr>
</tbody>
</table>
Table 2. *Spirulina platensis* - Addition influence on physico-chemical parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Spirulina quantity</th>
<th>Fischer’s Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>V1</td>
</tr>
<tr>
<td>Moisture</td>
<td>43.41a</td>
<td>42.64c</td>
</tr>
<tr>
<td>Proteins</td>
<td>9.03c</td>
<td>9.28b</td>
</tr>
</tbody>
</table>

a,b,c,d - statistically homogenous groups
ns-insignificant (P>0.05), *P<0.05, **P<0.01, *** P<0.001

Table 3. Volumes obtained from baking samples for P4 *Spirulina platensis* addition flour

<table>
<thead>
<tr>
<th>Sample</th>
<th>Volume, cm$^3$/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>M</td>
<td>420</td>
</tr>
<tr>
<td>V1=M+ 2%</td>
<td>405</td>
</tr>
<tr>
<td>V2=M+ 2.5%</td>
<td>390</td>
</tr>
<tr>
<td>V3=M+ 3%</td>
<td>350</td>
</tr>
</tbody>
</table>

3. Results and discussion

3.1 *Spirulina platensis* influence on rheological properties of dough. Alveograph curves for the flour with and without *Spirulina platensis* addition were analyzed in order to establish the optimum percentage of *Spirulina platensis* both from the point of view of the protein intake and the rheological one.

The analysis of the alveograms above shows that the exogenous intake of *Spirulina platensis* does not influence significantly the rheological behavior of samples.

As compared with the flour blank sample M, the 2% *Spirulina platensis* addition decreases W energy by 21.5%, that of 2.5% addition by 22.86% and by 3.14% for 3% addition respectively.
The ratio P/L increases by 29,4% in 2% Spirulina platensis addition sample, by 40,4% in 2,5% addition sample and by 43,3% in 3% addition sample.

The 2%, 2,5% and 3% Spirulina platensis addition decreases extensibility by 27,45%, 35,29% and 29,4%. Spirulina platensis addition to the flour leads to the decrease of W energy and L extensibility and increase of the ratio P/L.

Then the mixograph curves were analyzed for the flour with and without Spirulina platensis addition in order to establish the optimum percentage of Spirulina platensis both from the point of view of the protein intake and the rheological one (figure 2).

The study of the mixograms up above shows that together with the Spirulina platensis addition the development time increases by 0,5.... 1 minute as against P4 sample. Stability decreases by 22,7% in the 2% addition Spirulina platensis sample, 18,18% in the 2,5% addition Spirulina platensis sample and by 31,8% in the 3% one respectively. So the best stability is got by the 2,5% addition Spirulina platensis.

As regards flour moisture of 14%, there are not significant differences in the hydration capacity.

It can be noticed that the decrease in W energy leads to reduction of deterioration time of C2 proteins. As against the blank sample M one can see that there is a decrease of C2 point by 0,69% for a percentage of 2% Spirulina platensis, 1,44% for a percentage of 2,5% and by 2,25% for a percentage of 3% Spirulina platensis addition to flour.

**Figure 1.** Influence of Spirulina Plataensis added on rheology of dough by alveograph curves
Taking into consideration that there is a positive correlation between C2 and W, we may say that flour proteins are not stable throughout the technological process when *Spirulina platensis* is added, this fact leading to the choice of making small grams products.

As a consequence of the results registered by Chopin alveoconsistograph and Chopin mixolab, in order to establish the optimum percentage of *Spirulina platensis*, baking samples were also made.

### 3.2 Check and validation of *Spirulina platensis* percentage by statistical data analyses

To check and validate the percentage of *Spirulina platensis* chosen, the results obtained by ANOVA multifactorial method were statistically analyzed.

The confirmation of the *Spirulina platensis* addition influence of different percentages on the physical-chemical characteristics of end products, namely hot-dog rolls, is shown in table 2.

The results analyzed from the point of view of ANOVA variance show that *Spirulina platensis* addition has a significant influence (P<0.05) for the following physico-chemical parameters: moisture, proteins.

### 3.3 Check and validation of *Spirulina platensis* percentage by sensorial analysis of baking samples

Three baking samples for each variant were made in order to validate sensorially the optimum percentage of *Spirulina platensis*. The products were organoleptically tested and their volumes were determined. The sensorial profile of hot-dog rolls was established in order to choose the best *Spirulina platensis* addition variant. The aspect of hot-dog rolls obtained from the baking samples can be seen in figure 3.
The volume of samples obtained was determined for the analysis to be as objective as possible (table 3). From the analysis of data in table 3 one can see that *Spirulina platensis* addition to flour determines a 3 % decrease in the volume of 2% *Spirulina platensis* hot-dog rolls, a 5 % decrease in the volume of 2,5% *Spirulina platensis* hot-dog rolls and a 13% decrease in the volume of 3% *Spirulina platensis* hot-dog rolls. The baking samples were sensorially analyzed: a greenish colour was noticed in the case of end products, less usual in bakery products, obviously stronger in the case of V3 variant with 3 % *Spirulina platensis* addition as against the flour. Sensorial qualities of food products play an essential role in consumers’ reaction to foods, in accepting or rejecting them. Therefore, the study on *Spirulina platensis* product continued with the sensorial analysis of bakery products, being tested by 20 tasters in order to make up the sensorial profile.

In the case of bakery products, and not only, sensorial analysis plays a decisive role in carrying on experiments to establish the optimum percentage of *Spirulina platensis* exogenous intake.

Scores were taken into consideration and given for the attributes: colour, core, smell, softness, uniformity, size, pores, basic taste (sweet), residual (small bran particles between teeth).

The sensorial attributes of the 3 samples with exogenous *Spirulina platensis* intakes as against the blank sample were graphically represented in order to make a complex evaluation.

As can be seen from the sensorial analysis made above, from the sensorial point of view, the attributes are relatively close in the samples with exogenous *Spirulina platensis* intakes and generally in the inferior limit of acceptability.

4. Conclusion

1. From the analysis of rheological properties of flours with different (2%, 2,5%, 3%) *Spirulina platensis* additions, of baking samples and from the sensorial analysis of the end product, samples of hot-dog rolls with 2,5% *Spirulina platensis* addition were selected.

2. The results, for the product added by 2,5% *Spirulina platensis*, analyzed from the point of view of ANOVA variance, show that *Spirulina platensis* addition has a significant influence (P<0,05) on the following physico-chemical parameters: moisture, proteins.

3. One can notice that there is an increase in the protein percentage from 9,07% to 9,54% as against 100 grams of product. As against the blank sample M, the increase in the protein percentage in the case of variant V1, is of 3,2%, in V2, is of 4,72%, and in V3, is of 4,92%.

4. The operating process was established to obtain the product under the form of hot-dog rolls with 2,5% *Spirulina platensis* addition and high nutritional value, confirmed by the increase in the protein content.
5. The product’s testing by consumers emphasized high acceptance of sensorial characteristics (taste, smell, core softness, uniformity of pore size, masticability). Less appreciated was the greenish colour, which is not specific to this type of product. Having in view that this is a special high nutritional value product there were no objections to this sensorial characteristic.

Compliance with Ethics Requirements: Authors declare that they respect the journal’s ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human and/or animal subjects (if exists) respect the specific regulations and standards.

References


