



## INTRODUCTION

Including of barley grains in human nutrition is particularly valuable for diabetic patients and humans of risk group because its ability to lower glycemic index.

Naked barley cultivars compared to hulled have increased nutritional value, especially content of protein,  $\beta$ -glycans and soluble dietary fibre and are free from the pales therefore it could be excellent raw material for functional food production.

One of main products used in daily diet is bread, unfortunately, barley is not popular for bakery products due to its poor baking properties and lower sensory acceptance of the products, it does not contain gluten which is necessary in bread making process.

Bread producers are increasingly returning to simple raw materials and older technologies. Old processes, such as fermentation, are perceived as natural, and easier to understand than modern processes. The use of sourdough in the baking technology has been established as a traditional and potential process worldwide. Most of the positive effects on the texture and shelf life of the bread attributed to sourdough fermentation are caused by the produced metabolites. The incorporation of naked barley in wheat bread and using different bread production methods strongly affects the quality of bread and is a possibility to increase bread nutritional value.

Therefore, the aim of research was to evaluate nutritional characteristics, overall acceptability and storage possibility of bread enriched with naked barley grains or flour.

## MATERIALS AND METHODS

### Raw materials

Grains and whole wheat flour of a new naked barley variety 'Kornelija' (Stende, Latvia) characterised by high protein and  $\beta$ -glycans content and wheat flour Type 812 were used as main the raw materials.

Table 1

Chemical composition of raw materials

| Nutrients, g per 100 g | Naked barley grain<br>KORNELIJA | Wheat flour<br>Type 812 |
|------------------------|---------------------------------|-------------------------|
| Protein                | 20.80                           | 13.4                    |
| Fat                    | 2.11                            | 1.30                    |
| Ash                    | 2.63                            | 0.70                    |
| Starch                 | 47.90                           | 66.0                    |
| $\beta$ -glycans       | 6.15                            | 0.60                    |

Table 2

Dough composition

Ingredients, g

| Samples | Wheat flour type |                                    |                     | Water |
|---------|------------------|------------------------------------|---------------------|-------|
|         | 812              | Naked barley flour                 | Naked barley grains |       |
| C       | 1000             | –                                  | –                   | 705   |
| D30     | 700              | 300                                | –                   | 700   |
| D40     | 600              | 400                                | –                   | 695   |
| G30     | 700              | –                                  | 300                 | 690   |
| G40     | 600              | –                                  | 400                 | 690   |
| S30     | 700              | 150 <sup>1</sup> /150 <sup>2</sup> | –                   | 690   |
| S40     | 600              | 200 <sup>1</sup> /200 <sup>2</sup> | –                   | 670   |

1- naked barley flour in sourdough

2- naked barley flour in dough

Additional ingredients for all bread recipes were 30 g sugar, 30 g salt and 30 g fresh baker's yeast

### Dough formulations and bread making

Bread was made using different methods: direct method was used for a control – wheat bread (sample C) and samples D30 and D40, where wheat flour was replaced with barley flour as showed in Table 2. For samples G30 and G40 wheat flour was replaced with 300 g and 400 g soaked barley grain, respectively. The added sourdough used in samples S30 and S40 was made from barley flour using Böcker (Germany) sourdough starter.

### Determination of loaf volume

Loaf volume was measured by small seeds displacement method.

### Determination of bread hardness during storage

Hardness (N) of bread crumb samples was tested 24 h, 72 h and 96 h after baking using Texture Analyser – TA.HD. plus

### Sensory evaluation

Wheat bread with naked barley flour and grain was evaluated by 39 panellists, with an average age of 38 years. A 7-point unstructured line scale was used for rating bread sensory attributes – colour, aroma, porosity, hardness and sour taste – intensity. The format of the evaluation sheet, data collection and interpretation of data were processed with FIZZ Aquisition Ver.2.51 software (Biosystemes, France).

## RESULTS AND DISCUSSION



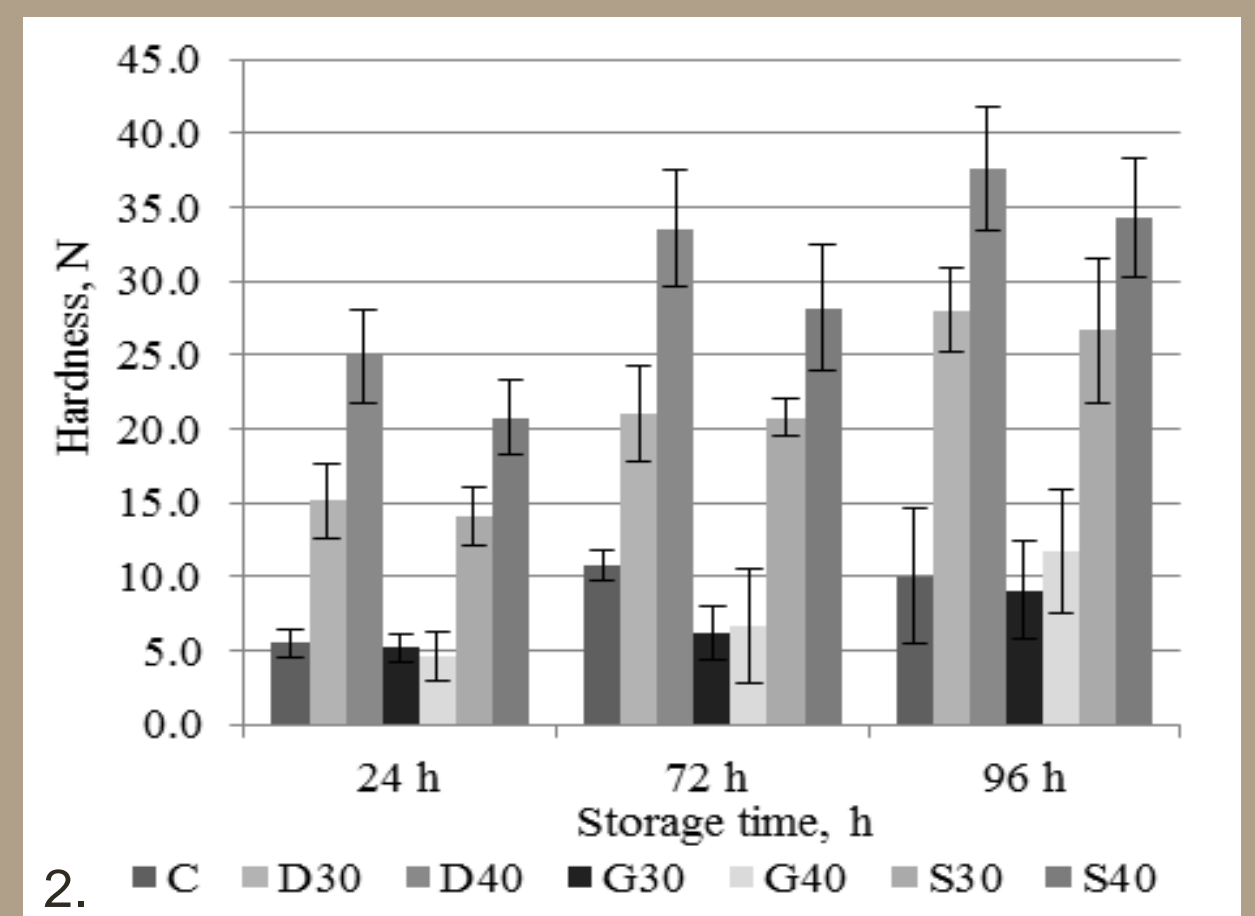
C – 100% wheat bread; D30 – 30% naked barley flour; D40 – 40% naked barley flour; G30 – 30% naked barley grains; G40 – 40% naked barley grains; S30 – 30% naked barley flour in sourdough; S40 – 40% naked barley flour in sourdough

Results of loaf volume measurements confirmed that high barley concentration led to decrease in loaf volume. Volume of samples D30 with 30% naked barley flour was determined higher – 811±11 mL than volume of samples D40 – 711±9 mL (Table 3 and Figure 1).

The negative changes of bread volume could be the result of an increased amount of dietary fibre and the presence of non-starch polysaccharides affecting gluten network weakening and lowering gas retention in the dough in consequence.

Table 3  
Nutritional value and energy value of bread samples

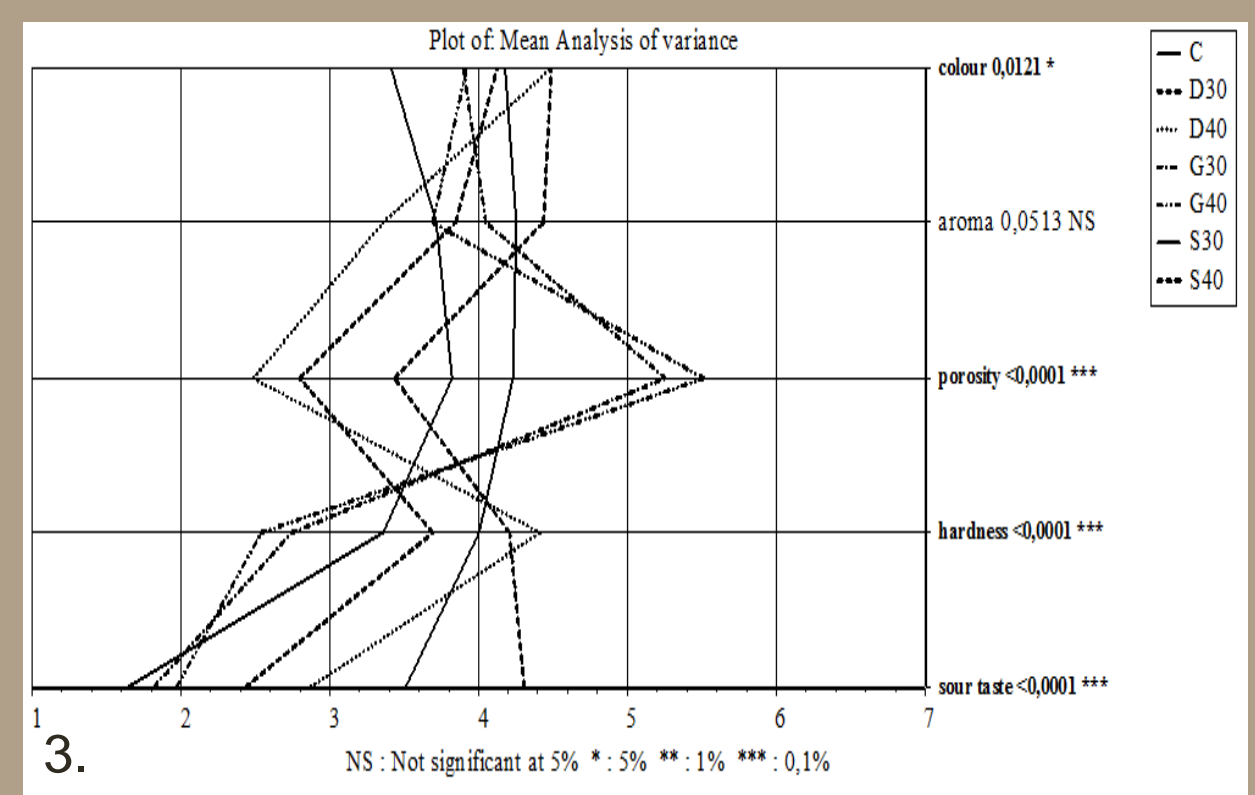
| Parameters                             | Bread samples |               |               |
|--|---------------|---------------|---------------|
|  | C             | D30; G30; S30 | D40; G40; S40 |
| Energy value, kcal                     | 218           | 212           | 210           |
| Energy value, kJ                       | 923           | 898           | 889           |
| Protein content, g 100 g <sup>-1</sup> | 8.4           | 9.8           | 10            |
| Fat content, g 100 g <sup>-1</sup>     | 0.8           | 0.95          | 1.00          |
| Carbohydrates, g 100 g <sup>-1</sup>   | 43            | 39            | 38            |
| Dietary fibre, g 100 g <sup>-1</sup>   | 2.9           | 3.5           | 3.6           |
| – including $\beta$ -glycans           | 0.4           | 1.7           | 2.1           |



Bread enriched with barley grains had significantly higher dietary fibre content including  $\beta$ -glycans content ( $p < 0.05$ ) and insignificantly higher protein and fat content ( $p > 0.05$ ).

Hardness of samples with barley flour was significantly higher than hardness of samples with barley grains or wheat flour ( $p < 0.05$ ). Comparison of samples with the same amount of barley flour showed advantages of sourdough method because hardness of samples D30 determined higher (15.1±2.6N) than hardness of samples S30 (14.1±2.0N) similar in samples with 40% barley flour content.

Sensory evaluation results showed, that the addition of naked barley (flour, grains or sourdough) did not affect ( $p = 0.0513$ ) the bread aroma intensity (Figure 3). There were no significant differences ( $p > 0.05$ ) in the intensity of bread crumb colour intensity between control (C) and bread with 30 and 40% barley grains (samples G30 and G40), but the crumb colour intensity influenced naked barley flour and sourdough – it became darker. The addition of sourdough from naked barley has a significant effect ( $p < 0.05$ ) on the sour taste of the analysed bread samples, resulting from the action of lactic acid bacteria of starter.



## CONCLUSION

Bread enriched with barley grains has significantly higher dietary fibre, including  $\beta$ -glycans, higher protein and fat content. Increase of barley content in flour composition results in decrease in carbohydrates and total energy value.

Results confirmed that high barley amount in dough led to decrease in loaf volume of bread. Higher loaf volume of bread determined when barley included in dough as grains. Comparison of samples with same amount of barley flour showed advantages of sourdough method – higher loaf volume and smaller hardness in storage time.

Though adding naked barley grains to 30% and 40%, it is possible to obtain bread with good porosity, but addition of sourdough increased the sour taste of bread.

## ACKNOWLEDGMENT

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