Autolysed yeast – modern solution for baking from strong gluten wheat flour

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Abstract. This research is based on baking improver development using yeast autolyzate from brewer’s wastages which contains reduced glutathione (GSH). It is one of the most common tools to improve the quality of the wheat flour. This study shows the influence of yeast autolyzate to property of the strong wheat flour, dough, and bread quality. The most significant indicator of wheat flour quality is the amount of wet gluten which were increased from 29,4 to 34,8% due to adding yeast autolyzate. Moreover, ratio P/L from Alveograph was changed from 3,16 to 1,68 in the presence 0.07% autolyzed yeast. Also, dough stability and specific bread volume were improved. In this research, modern methods based on rheological data and traditional ones are used.

1. Introduction

Each baking manufactory will produce defected goods if the flour quality is low. Most of the causes analysis shows that strong gluten provides a great numbers of defects in baking goods. Baking and brewers’ yeast (Saccharomyces cerevisiae) as an inexpensive source of various biological active substance is an attractive object for studying for the last decades. The latest research shows that additives obtained from yeasts have positive influence on food products [1-2]. The mostly used type of yeast concentrate is autolyzate. It is produced from lysed cells and saved a lot of water-soluble compounds. Also, scientific interests are focused on the GSH which can be found in autolyzed yeast. GSH is the most important antioxidant thiol tripeptide. GSH can be used in different ways like flavor, feed additive and pharmacological precursor. Further, influence of methods, technical parameters and cultivation types on GSH extraction from yeast cells are shown in full details at the review by Meledina et al. [3]. As well known, glutathione provides the same dough properties as L-cysteine. Inside of the dough system GSH is involved in SH- / S=S interchange reactions, along with interchain disulfide bonds cleavage in the glutenin protein. Thus, one assumes that the addition of the GSH to the dough will result in higher elasticity and lower resistance to extensibility, especially for strong gluten flour [4].

Nevertheless, using GSH should depend strictly on flour properties and type of final product, because in some cases reducing agents can provide lower baking goods quality [5-6]. Bakers have more advantages using GSH instead of using L-cysteine. This is equal to the amount of publications based on development of the dough and bread improvers by adding glutathione [7]. First, GSH is based on E-free labels, according to the modern trends. Moreover, autolyzed yeast, produced from food wastages (in this case wastage brewers’ yeast), has a low cost and correspond to the solutions for WHO’s goals to save our world by reusing food-acceptable materials.
The main aim of this study is to approve using GSH from autolyzed brewers’ yeasts in producing baking goods from the strong gluten wheat flour.

2. Materials and methods

2.1 Materials.

Wheat flour (11.7% moisture, 0.55% ash, GOST 26574-2017) with strong gluten was obtained from Kirova Mill (Saint-Petersburg, Russia). Fresh yeast, salt, margarine, sugar, milk powder were purchased from a local market. All ingredients quality is regulated by Russian National State Standards (GOSTs). Autolyzed yeast was produced from wastage brewers’ yeast (*Saccharomyces cerevisiae*) by the BioTech specialists, ITMO University. All other chemicals had analytical grade.

2.2 Autolyzed yeast.

The GSH quantity was determined by iodometric titration based on sulfhydryl group oxidation by potassium iodate. Titration was carried out until the blue color formation [8].

2.3 Wet gluten properties.

Wet gluten quantity was measured by manual method according to GOST 27839-2013. Wet gluten quality was determined by the laboratory system IDK-3M (Plaun, Moscow, Russia). 4g of the wet gluten was ball-shaped by hand and placed in cool water (18±2°C) for 15 min. After the resting time piece of the wet gluten was placed at the platen center of the IDK-3M. Load pressure on the wet gluten ball was generated by this equipment. The parameter obtained from the IDK-3M is firmness units [IDKU] described as gluten deformation index (as softer gluten, then higher IDKU). Wet gluten extensibility and elasticity were determined using ruler and resulted in centimeters [cm]. The measurement data were obtained from three parallel tests. Gluten hydratation capacity (HC) was accurately measured in accordance with GOST 28797-90 by drying wet gluten sample at 130°C, calculated as:

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HC = \frac{m(WG) - m(DG)}{m(DG)} \times 100\%
\]  
(1)

There m(WG) – weight of wet gluten [g], m(DG) – wight of dehydrated gluten [g].

2.4 Farinograph analysis.

Water absorption of wheat flour, dough developing time, stability and degree of softening during mixing were measured by Farinograph-E (Brabender, Duisburg, Germany) in accordance with ICC-Standard no. 115/1. The dough was prepared in the kneading chamber by mixing 300g of the wheat flour (in the basis of moisture) and the distill water with temperature 30°C. The amount of water for the measurement was determined as function of dough consistency obtained in Farinograph Units [FU]. Software automatically calculated appropriate dosage of water. Dough was mixed for 20 min. The parameters obtained from the Farinograph curve are : water percentage (for the flour basis) for developing 500±20 FU maximum dough consistency [%], time of reaching the maximum dough consistency [min], time of saving dough consistency (stability) [min], degree of dough softening [mm-FU].

2.5 Alveograph analysis.

Rheological characteristics of the dough as elastically-deformation properties were determined by Alveograph-NG (Chopin, Villeneuve-la-Garenne Cedex, France) in accordance with ICC 121. The dough was prepared in Alveograph kneading chamber by mixing 250g wheat flour and 2.5% salt solution (in the basis of flour moisture) for 8 min. After preparing 5 calibrated pieces of dough each sample was put into resting chamber at 25°C and 80% humidity. At the end of the resting time dough pieces one by one were measured by air inflating the dough bubble until bursting. Measured data was registered automatically by Alveograph software as air pressure and total amount of fed air. The results were expressed as dough tenacity (aptitude to resist deformation) P [mmH2O], dough extensibility (maximum volume of air that the bubble is able to contain) L [mm], ratio (configuration of the curve) P/L, and dough baking strength (surface under the curve) W [10E-4J].

2.6 Breadmaking.
The model dough recipe and technological conditions used for this experiment are presented in table 1 and table 2. There was a simple one-step technology used for the wheat bread producing in this experiment. The dough was mixed in a kneader (Sigma, India), proofed in a fermentation cabinet (Miwe, Germany) and baked in a rotation oven (Revent, Sweden) with steam. For the further analysis breads were cooled at room conditions for 16 h.

2.7 Dough characterization.

For degree of dough weakening determination the basic dough recipe was used as the one used for the breadmaking. After mixing, the dough was divided into 50g pieces, rounded, and proofed in a fermentation cabinet (Miwe, Germany) at 30°C and 80% humidity. Radiuses of three dough pieces per batch were measured every 30 min in centimeters [cm]. Degree of weakening was describing as ratio first value to next ones [%].

2.8 Bread volume and form stability.

The bread specific volume sV and form stability (HD) were determined in accordance with GOST 27669-88. sV was measured by the milletseed displacement [cm³] and weight method [g]. Ratio high level [cm] to diameter [cm] of bread loafs was determined as HD and showed dough tension capacity.

| Table 1. Model recipe of the wheat bread. | Table 2. Conditions for the wheat bread producing. |
|-----------------------------------------|-----------------------------------------------|
| Raw material                            | Operating name       | Value                     |
| Wheat flour                             | Mixing time, min     | 3 – 1<sup>st</sup> speed |
|                                        | 5 – 2<sup>nd</sup> speed |
| Fresh yeast                             | Dough temperature, °C | 28±1                      |
| Salt                                    | Resting time, min    | 10                        |
| Water                                   | Weight of the piece of dough, g | 300                       |
|                                        | Proofing time, min   | 60                        |
|                                        | Proofing temperature, °C | 30                       |
|                                        | Proofing humidity, % | 80                        |
|                                        | Baking time, min     | 25                        |
|                                        | Baking temperature, °C | 220 falling to 200       |

3. Results

3.1 GSH content in autolyzed yeast.

Determination of autolyzed yeast as baking improver was the first step of this research. GSH content was accurately calculated for both types of autolyzed yeast powder and liquid. The results, highlighted in Table 3, showed that autolyzed yeast dosage for baking should be applied from 23 to 93 cm³ per kg of the flour in complying with the basic GSH dosage: 0.005 – 0.01 %.

| Table 3. Autolyzed yeast properties. |
|---------------------------------------|
| Solid content, % | GSH content, mg/ml (auolyzate) | Density, g/cm³ | GSH content, mg/g (auolyzate) | Autolizate dosage, ml/kg (flour) |
|------------------|-------------------------------|----------------|-------------------------------|---------------------------------|
| 15               | 2.5                           | 1.07           | 16                            | 23 – 93                         |

3.2 Native wheat gluten proprieties.

The content of wet gluten in wheat flour and gluten quality were measured using different methods. These parameters strongly correlated with the final product quality, especially with bread volume and form stability. Autolyzed yeast levels were set as 0.023, 0.046, 0.07 and 0.093% (l/kg, flour basis). Reference was wheat flour without treatment. As showed at the table 4, adding autolyzed yeast to wheat flour resulted in increasing gluten hydration capacity and therefore wet gluten content. Also, gluten deformation index and extensibility were increasing due to GHS, presented in autolyzed yeast
and provided gluten softening. There are great number advantages and high-quality final product expansions exhibited by relaxing strong gluten for millers and bakers.

Table 4. Wheat gluten properties in the absence or presence of autolyzed yeast.

| Autolyzed yeast dosage, % | Wet gluten, % | Gluten hydration capacity, % | Gluten deformation index, IDKU | Gluten extensibility, cm |
|---------------------------|--------------|-----------------------------|--------------------------------|--------------------------|
| -                         | 29.4         | 138                         | 45                             | 7                        |
| 0.023                     | 29.6         | 140                         | 50                             | 8                        |
| 0.046                     | 31.5         | 149                         | 56                             | 9                        |
| 0.070                     | 33.5         | 152                         | 62                             | 11                       |
| 0.093                     | 34.8         | 160                         | 74                             | 13                       |

3.3 Wheat dough stability.

Besides of the gluten, bakers are looking forward to great dough stability during fermentation and baking. Moreover, the radius of oven-bottom bread should be on appropriative level. Strong gluten provides ball-formed bread due to excessive dough stability. Results (Figure 1) shows increased degree of dough weakening in the presence of autolyzed yeast. By adding 0.093% autolyzed yeast this parameter was 102% at 120 min of fermentation in face to 78% for control sample.

Figure 1. Degree of dough softening in the presence of different levels of autolyzed yeast.

3.4 Bread quality.

The wheat gluten properties play an essential role in determining the dough viscoelastic properties, resulting in the volume and the form stability of bread. The most indicial flour test for millers and bakers is the laboratory breadmaking test. The control samples exhibited a minimum specific volume of 2.78 cm$^3$/g, while the addition of 0.07% autolyzed yeast significantly increased this value by 14% (table 5). The increase in degree of dough softening and the enhancing gluten extensibility described in Sec. 3.2 and 3.3 also indicated this reducing trend in the bread volume. In the case of 0.093% dosage HD was on the poor level (0.5), because the baking optimum rate are 0.7>great quality>0.5,
also specific bread volume was the lower (2.98 cm$^3$/g) then for 0.07% dosage (3.17 cm$^3$/g). For the next experiments level 0.07 % autolyzed yeast was applied as the most convenient for baking. Another’s bread quality parameters as moisture, acidity and organoleptic quality were on the acceptable level for every batch.

**Table 5. Measured bread quality.**

| Autolyzed yeast dosage, % | Specific bread volume, cm$^3$/g | Bread form stability (HD) |
|---------------------------|---------------------------------|---------------------------|
| -                         | 2.78                            | 0.72                      |
| 0.023                     | 2.85                            | 0.61                      |
| 0.046                     | 2.98                            | 0.58                      |
| 0.070                     | 3.17                            | 0.52                      |
| 0.093                     | 2.98                            | 0.50                      |

3.5 Flour rheological properties.

Autolyzed yeast influence on the wheat dough was measured by methods described at the Sec. 2.4 and 2.5. Farinograph and Alveograph trials should confirm the positive effect from adding 0.07% autolyzed yeast. Data obtained from curves (figure 2) shows dough relaxing by adding autolizate. Dough stability was significantly increased from 10.5 (a) to 16.0 (b) min which amounts 52.4%. Other parameters as dough development time, water absorption and degree of softening were unchanged. Moreover, highlights obtained from Alveograph are the same as the previous results (Figure 3). Dough extensibility (L) and, consequently, dough energy (W) were significantly increased due to autolyzed yeast. Ratio P/L which the most obvious parameter was changed from 3.16 to 1.68.

![Figure 2. Farinograms for untreated flour (a) and flour with 0.07% autolyzed yeast (b).](image)

4. Conclusion

This study identified that the flour treatment by autolyzed yeast is the modern and cheap solution for bread technologies, especially for the great dough relaxing. Adding the 0.07% of autolyzed yeast to the flour basis of the strong gluten wheat flour results in increasing of:

- Wet gluten content
- Gluten hydratation capacity
- Gluten extensibility
- Specific bread volume
- Dough stability (by Farinograph)
- Dough energy and extensibility (by Alveograph)
Moreover, this study could encourage researchers to bread improver developing based on autolyzed yeast. The observation and the study of the raw material resource-saving sources are the modern and important topic nowadays.

References
[1] Harbah R, Agembo E O, Meledina T V, Kritchenkov A S and Ivanova V A 2020 Extraction of crude Mannan oligosaccharides from yeast and their uses. *Journal of International Academy of Refrigeration* 1 46–51
[2] Marukhnenko S, Gerasimov A, Ivanova V, Golovinskaya O, Antontceva E, Pokatova O, Morozov A and Shamtsyan M 2020 Saccharomyces cerevisiae yeasts β-glucan influence on wheat dough rheological properties. *E3S Web of Conferences* 203 04010
[3] Meledina T V, Morozov A A, Davydenko S G, Ternovskoy G V 2020 Yeasts as a Glutathione Producer. *Food Processing: Techniques and Technology* 50(1) 140–148
[4] Popper L, Schafer W and Freund W 2006 Future of Flour. A Compendium of Flour Improvement. *Agrimedia* 419
[5] Guo L, Xu D, Fang F, Jin Z and Xu X 2020 Effect of glutathione on wheat dough properties and bread quality. *Journal of Cereal Science* 96 103116
[6] Guo L, Fang F, Zhang Y, Xu D, Xu X, Jin Z 2020 Effect of glutathione on gelatinization and retrogradation of wheat flour and starch *Journal of Cereal Science* 95 103061
[7] Chizhikova O G, Tilindis T V, Korshenko L O, Abdulaeva N N 2012 The development of a powder semi-processed product for baking production. *Food Processing: Techniques and Technology* 2 (25) 96A-101
[8] Schleikin A G, Scvortsova N N and Blandov A N 2016 Biochemistry. Laboratory practicum. Part 2. Proteins. Enzymes. Vitamins. *ITMO Univerisy* 106
[9] Verheyen C, Albrecht A, Herrmann J, Strobl M, Jekle M and Becker T 2015 The contribution of glutathione to the destabilizing effect of yeast on wheat dough. *Food Chemistry* 173 243–249
[10] Verheyen C, Albrecht A, Becker T and Jekle M 2016 Destabilization of wheat dough interrelation between CO2 and glutathione *Innovation Food Sci. Emerg. Technol.* 34 320–325