1281_02 (ENG)

Yeast
with reducing power

Abstract

Wheat quality is variable and conditions that of flour. Correctors have therefore proven necessary in helping to adjust the viscoelastic properties of flour formulations and remedy excess maturation in baker's dough. Of the flour treatment agents that can be used, yeast with reducing power has been found to be the most appropriate ingredient, since it naturally contains available glutathione, albeit generally in low doses. The selection of certain strains and the development of specific fermentation processes have made it possible to propose yeasts with a sufficiently high reducing power to be termed functional. The effects of yeast with reducing power are measurable at every stage in the breadmaking process, from mixing to rolling. To provide precise solutions to the specific constraints of millers and bakers, there is a broad array of biotech solutions available based on yeast with reducing power, developed *via* tests in baking applications and standardised for regular and stable effects. ■

Introduction

Yeast with reducing power is a breadmaking yeast (in other words a single-celled fungi belonging to the *Saccharomyces cerevisiae* species), which has undergone heat treatment to bring about its deactivation and explosion. This treatment triggers the release of the yeast's cell contents, which include glutathione (GSH), a tripeptide naturally present in the cell and whose action on a dough's gluten helps to reduce tensions between the proteins. Its reducing power makes dough more supple and less tough. Such yeast is therefore used to correct, improve or facilitate the manufacture of a given product. It is a constituent element of milling correctors or bread improvers.

1. Controlling variability in flours

1.1. Varying protein content depending on harvest

Varieties, culture conditions, the influence of geographical location, climatic variations: there are many factors likely to modify the profile of the harvested wheat and its protein content (*Lesaffre Technical Library* 1303. From soft wheat to flour baking properties).

Wheat proteins are classified into four categories (Osborne, 1907) (Figure 1):

- albumins and globulins (soluble);
- gliadins and glutenins (insoluble) the main components of flour and responsible for dough extensibility and elasticity.

Gliadins make up 30 to 40 % of total wheat proteins. Highly extensible when hydrated, gliadins are responsible for imparting viscosity to dough (fluidity, plasticity and extensibility) (Wieser, 2001). The gliadin content is influenced by nitrogen fertilization while in culture (Payne *et al.*, 1987): it increases linearly with the added nitrogen dosing.

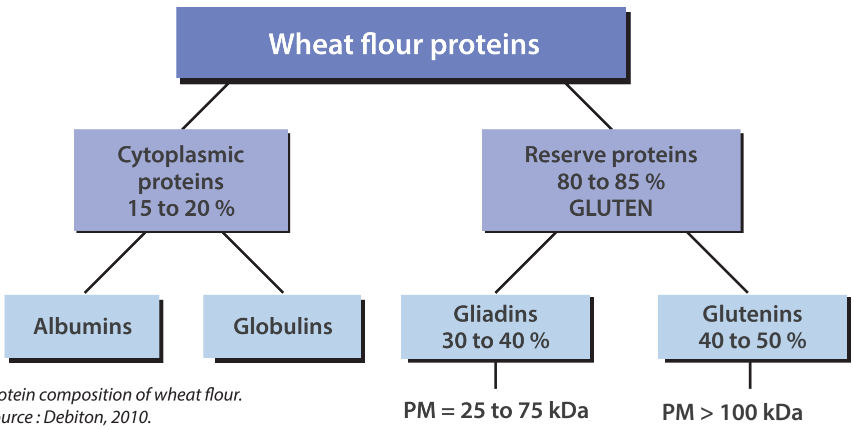
Glutenins make up 40 to 50 % of total proteins and are responsible for giving gluten its toughness and elasticity, cohesion and resistance to deformation (Wieser, 2001; Shewry, 2007; Singh, 1990). Glutenin content is essentially dependent upon the variety, although it can vary slightly according to the location and year. Nitrogen fertilization has little or no effect (Arvalis, 2013).

1.2. Essential correctors

Due to the rheological properties of wheat proteins, the gliadin/glutenin ratio conditions the baking quality of flour (Joye, 2009). It is chiefly an indicator of balance between elasticity (glutenins) and extensibility (gliadins) in the dough: the weaker the ratio, the tougher the dough.

Thus, to obtain breadmaking flour with a good viscoelastic balance, in other words the best compromise in terms of tolerance to fermentation and development in the oven, the miller will need to combine strong wheat flours with extensible wheat flours. However, it is generally necessary to add correcting ingredients, due to the fact that flours rarely possess all of the qualities required for breadmaking.

Figure 1. Wheat proteins.



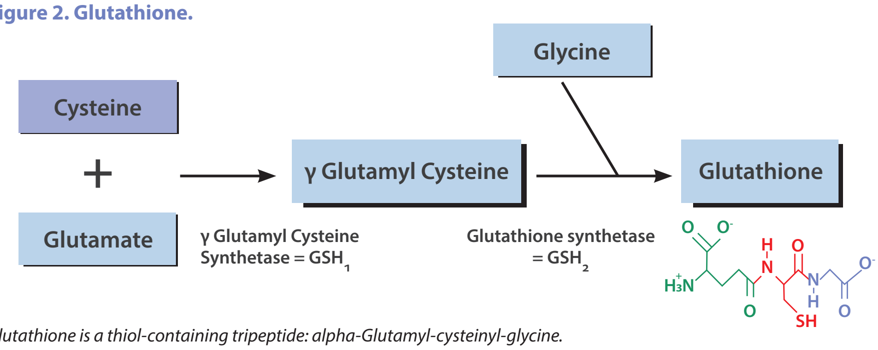
Protein composition of wheat flour.
Source : Debiton, 2010.

1.3. Reducing agents

Reducing agents are frequently a component of correctors. Several reducing agents are commonly in use (*Lesaffre Technical Library* 1280. Functional ingredients):

- $Na_2S_2O_5$ **sodium metabisulfite** (food additive E223) or $K_2S_2O_5$ **potassium metabisulfite** (E224): these may cause allergic reactions in sulfite-sensitive people;
- **L-cysteine** (E920): this sulphur-containing amino acid intercedes mainly in the synthesis of melanin (the natural pigment found in skin and hair). It may be produced by fermentation of sugars by bacteria;
- **yeast with reducing power**: a natural agent, stripped of its fermenting power as a result of heat treatment. No carbon dioxide or secondary metabolites are produced. The merit of these yeasts lies in the levels of glutathione contained therein. Glutathione is a tripeptide formed by the condensation of glutamic acid, cysteine and glycine (Figure 2). Glutathione, which exists in oxidised and reduced forms, helps to maintain the redox potential of cell cytoplasm. In breadmaking, it is sought after for its reducing effects on gluten. The heat treatment to which the cell is subjected makes the cytoplasmic walls permeable and brings about the release of glutathione and other cell components

Figure 2. Glutathione.



Glutathione is a thiol-containing tripeptide: alpha-Glutamyl-cysteinyl-glycine.

(Verheyen, 2015). These so-called "deactivated" yeasts, provide the peptide glutathione, the chief ingredient responsible for their reducing power, and probably other active cellular compounds, and in a form that is directly soluble in dough.

2. Glutathione, the main active ingredient in yeast with reducing power

2.1. Accelerates the formation of the gluten network

Glutathione impacts upon the final quality of bakery goods by interceding in wheat flour in three forms: reduced (GSH), oxidised (GSSG) and protein-GSH (PSSG). Its reduced form, GSH, acts on the disulfide bonds between gluten filaments, which in baking terms means that it results in a lower elastic resistance in dough, thereby making it more extensible (Figure 3).

In breadmaking, the formation of disulfide bonds is thought mainly to explain the viscoelastic properties of dough (Joye, 2009). The mechanical action of the mixer 'untangles' the gluten protein filaments and rearranges them in an ordered configuration thus constituting the structure of the dough (Weegel, 1997). When intermolecular disulfide bonds form (R-SS-R), protein instability can occur. Low molecular weight molecules containing free thiol groups (R-SH) are oxidised and contribute to disulfide interchange reactions (Pecivova, 2011). A spider-web network forms, thus lending elasticity to the dough and allowing gas retention.

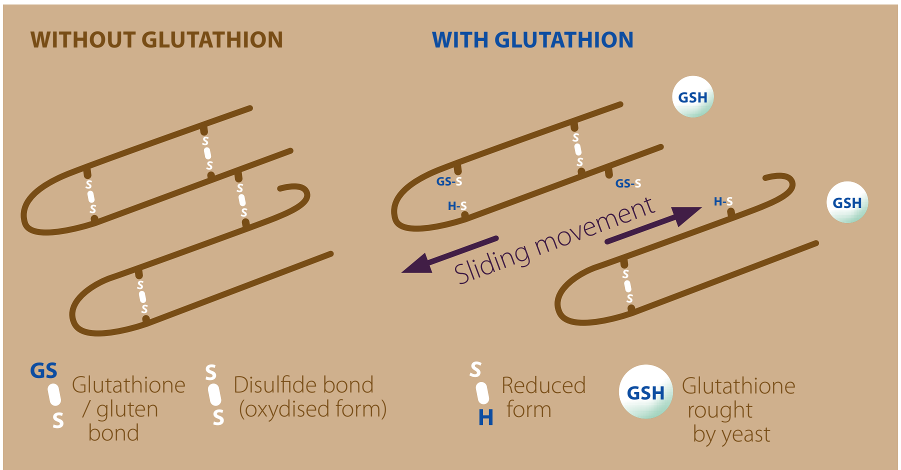
The addition of yeast with reducing power restores balance to the gluten network bonds and reduces this elasticity phenomenon without adversely affecting the gas retention (Dong, 1995). The presence of reduced thiol groups as a result of the reducing agent therefore leads to the development of a more supple dough during mixing.

2.2. Performance measured by natural reducing power (NRP)

The performance capabilities of yeast with reducing power are expressed in terms of their 'natural reducing power', or NRP. This does not exclusively reflect the glutathione content, since it depends on the strain, culture conditions of the yeast cell and the deactivation procedure it undergoes.

The NRP, measured using an indirect redox dosage method (iodometry), estimates, in

Fig. 3. Glutathione action mechanism of yeast with reducing power.



Due to the increased glutathione resulting from the addition of yeast with reducing power, the gluten protein chains can slide more easily past each other, thereby promoting dough development and reducing shrinkage.

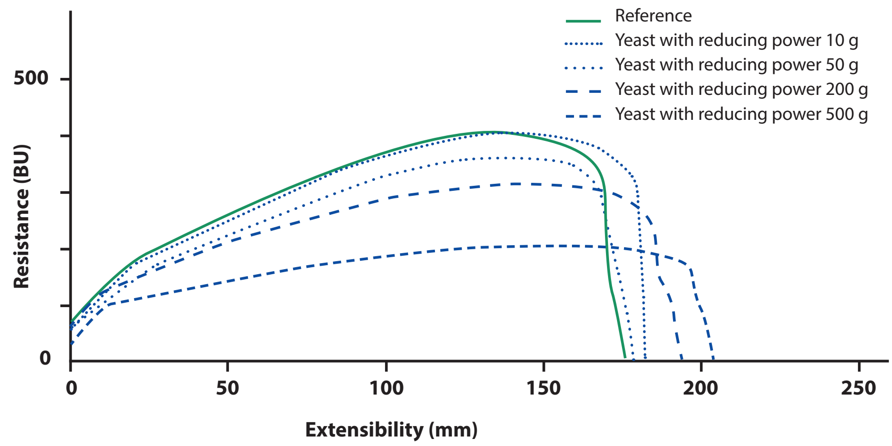
Multiple applications

Yeasts with reducing power are recommended for all types of breadmaking presenting risks of excess dough maturation, especially those requiring the lengthy elongation of dough pieces during shaping, either by pressing or rolling. They are now in widespread use in applications as varied as French baguettes, pizzas, gressini, wheat tortillas, pitta, brioche, doughnuts and Viennese pastries including croissants, flaky pastry and biscuits.

There are also partly deactivated yeasts with reducing power, which therefore retain a certain fermentation capacity. This is the case of active dry yeast with reducing power used for pizzas. The dough obtained with this type of slow fermentation yeast is firm, and characterised by little moisture and little mixing; as a result, it is often tough. With this type of yeast, the released reducing power facilitates rolling, by preventing shrinkage in bread dough and misshapen pizza bases.

terms of reducing efficiency, the equivalent amount of L-cysteine monochlorhydrate (in ppm) needed to obtain the same effect as the 1 % deactivated yeast under study.
For example:
- a yeast with an NRP of 10 means that 1% of this yeast is equivalent to 10 ppm L-Cysteine;
- a yeast with an NRP of 100 means that 1% of this yeast is equivalent to 100 ppm L-Cysteine.
Deactivating a commercial breadmaking yeast gives an NRP that does not exceed 20. However, there are a number of strains obtained using optimised fermentation procedures that will give yeasts with a high reducing power (of 100 to 200).

Figure 4. Variations in resistance and extensibility, measured in an extensograph, dependant upon the concentration of yeast with reducing power (NRP 200).



Source : Future of Flour, 2006

3. Results measured at every stage of the breadmaking process

• Mixing
Controlled mixing is essential for a successful loaf. Yeast with reducing power accelerates dough smoothing, which helps to reduce the mixing time in most production processes and thus prevents oxidisation, stickiness and loss of properties (Figure 4). This advantage also applies in dough containing a large amount of egg, sugar, butter and yeast.

• First rise
Yeast with reducing power minimises dough maturation.

• Division
Yeast with reducing power makes dough easier to elongate and shape, thereby ensuring a consistent weight and regular repeatable results. For the automated production line, this regularity guarantees a smoother passage through the volume and weight chambers.

Figure 5. Industrial automatic production line.

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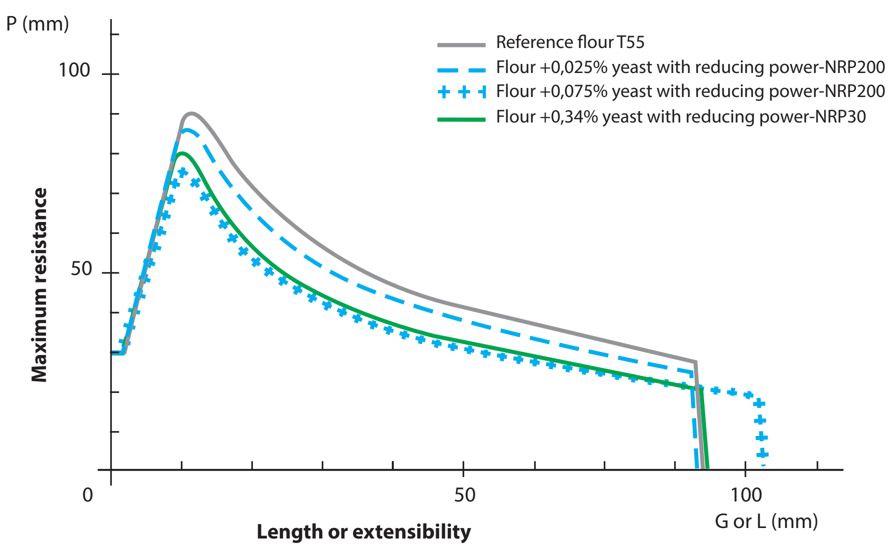
Figure 6. Effect of yeast with reducing power (in three concentrations) on resistance measured in alveograph.



Yeast with reducing power PRN30 used at 0,34% gives results comparable to those obtained with yeast PRN200 used at 0,05%

Source : Lesaffre, 2016

• Shaping
At the shaping stage, yeast with reducing power prevents the dough pieces from tearing and improves their machinability on industrial production lines. Its use makes it easier to remove the rollers from the shaping machine and gives rise to a finished product with a characteristically larger number of air holes. Furthermore, yeast with very high reducing power leads to greater regularity in the shaping results from the start to the end of a mixed batch. In dough that is naturally overly tough, the dough pieces produced are more regular in weight, which improves their machinability on industrial production lines (Figure 5).

• Final proofing
In the presence of yeast with reducing power, dough elasticity is increased by tempering the phenomenon of post-shaping shrinkage. This phenomenon is closely linked to the decrease in elastic resistance measured in the alveograph (Chopin, 1998) (Figure 6).

• Rolling
Sensitivity in either leavened (croissants) or non-leavened (pastry shells) dough is reduced through the addition of yeast with reducing power (Figure 7). Resting times between rolling operations are also reduced.

• Elimination of shrinkage and deformation in pizza bases
Pizza dough is characterised by a low rise and fast mixing. It remains especially firm and therefore the use of yeast with reducing power has some effect on rolling out. Preparation conditions in a traditional or industrial pizzeria present many constraints for dough. For the craft baker, the resting time between rounding and elongation can vary from one to three hours from the time of taking the order to the moment of preparation, as well as from the start to the end of preparation. The dough ball undergoes fermentation to varying degrees during this time. At the end of preparation, it is not uncommon to have to round a dough ball again due to the excess fermentation having taken place. Even in such cases, studies show that yeast with reducing power also presents the advantage of a producing a more tolerant dough (Figure 8).
On the industrial production line, the merits manifest themselves in terms of more regular results in the outgoing products.

Figure 7. Industrial automatic production line.

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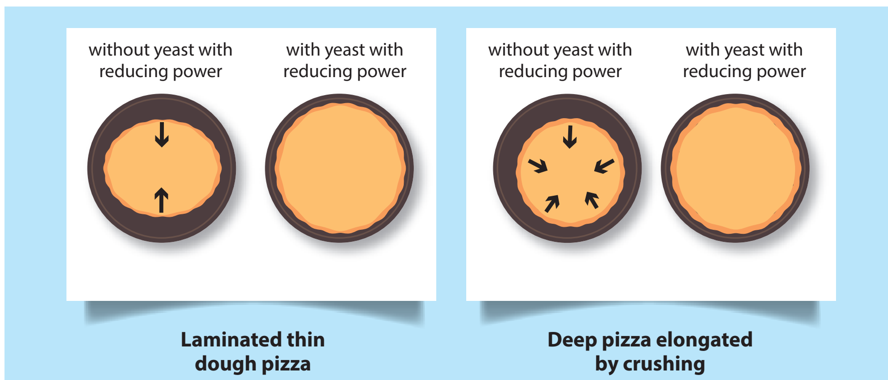
Figure 8. Effects of yeast with reducing power on pizza diameter and on ovality risk.



Conclusion

In order to develop regular flours guaranteeing optimum dough extensibility and minimal excess dough maturation, the use of yeast with reducing power proves effective. For this reason, Lesaffre has developed yeasts with reducing power that can be adapted to the different processes and types of breadmaking. These yeasts provide a natural means of compensating for the problem of weak flours, and of correcting dough by making it more supple under normal breadmaking conditions, thereby increasing tolerance on automated production lines. The effects are measurable at each stage in the breadmaking process, from mixing to rolling. Apart from facilitating the baker's production process, the use of yeasts with reducing power influences the aromatic potential of flour, as well as the aromas and flavours that develop during fermentation. The addition of such yeasts contributes to the development of a different sensorial profile from that of a dough without such an addition. In terms of the finished product, the reducing effect results in a greatly improved visual aesthetic: the crumb is dense in colour (cream) and the structure is well aerated.

Bibliography

Arvalis Institut du végétal. Décembre 2013 Teneur en protéines des blés : relever le double défi agronomique et économique.

Debiton C. Identification des critères du grain de blé (*Triticum aestivum L.*) favorables à la production de bioéthanol par l'étude d'un ensemble de cultivars et par l'analyse protéomique de lignées isogéniques waxy. Sciences du Vivant [q-bio]. Université Blaise Pascal - Clermont-Ferrand II, 2010. Français

Chopin. Influence de la levure désactivée sur le comportement des pâtes. Note d'application n°8, Janvier 1998.

Dong W, Hoseney RC. Effects of certain breadmaking oxidants and reducing agents on dough rheological properties. *Cereal Chemistry*. 1995; 72: 58–64.

Joye I, Lagrain B, Delcour J. Endogenous redox agents and enzymes that affect protein network formation during breadmaking – A review. *Journal of Cereal Science*. 2009; 50 (1):1-10.

Lechevallier V, Béague S. La levure désactivée. *Industries des Céréales* n°145. 2005; 29-37.

Osborne T. The proteins of the wheat kernel. 1907. Published by the Carnegie Insitution of Whashington. Publication n°84.

Payne P, Nightingale M, Krattiger A, Holt L. The relationship between HMW glutenin subunit composition and the bread-making quality of British-grown wheat varieties. *Journal of the Science of Food and Agriculture*. 1987; 40:51-65.

Pečivová P, Pavlínek V, Hrabe J, Valášek P, Bouda L. Impact of reducing and oxidising agents on the wheat flour dough dynamic rheological properties. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*. 2011; 59(1):191-8.

Shewry PR, Halford NG, Belton PS, Tatham AS. The structure and properties of gluten: an elastic protein from wheat grain. *Philosophical Transactions of the Royal Society B Biological Sciences*. 2002; 357(1418):133-42.

Singh NK, Donovan GR, MacRitchie F. Use of Sonication and Size-Exclusion High-Performance Liquid Chromatography in the Study of Wheat Flour Proteins. II. Relative Quantity of Glutenin as a Measure of Breadmaking Quality. *Cereal Chemistry*. 1990; 67:161-70.

Verheyen C, Albrecht A, Herrmann J, Strobl M, Jekle M, Becker T. The contribution of glutathione to the destabilizing effect of yeast on wheat dough. *Food Chemistry*. 2015; 173:243-9.

Weegels PL, Hamer RJ, Schofield, JD. Depolymerisation and Re-polymerisation of Wheat Glutenin During Dough Processing. II. Changes in Composition. *Journal of Cereal Science*. 1997; 25(2):155-63.

Wieser H, Kieffer, R. Correlations of the Amount of Gluten Protein Types to the Technological Properties of Wheat Flours Determined on a Micro-scale. *Journal of Cereal Science*. 2001; 34(1):19-27.

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1303 *From soft wheat to flour baking properties*

Contact : Stéphan Béague • *+ 33 3 20 81 61 00* • *s.beague@lesaffre.com*

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