RESEARCH CONCERNING THE EFFECTS OF OXIDIZING AGENTS USED IN THE MILLER'S AND BAKING INDUSTRY

Lucica Nistor, Camelia Hodoşan, Andra Suler, Daniela Ianiţchi, Victoria Gratziela Bahaciu

University of Agronomical Sciences and Veterinary Medicine Bucharest, Romania

Abstract

In the milling and baking industry, the oxidizing agents are used to improve processes of dough rheology coming from weak gluten flour. These have the capacity to retain gases, allows to maintain dough shape after being modeling, and also the structure and the color of the inside bread. In this work, the effects of oxidizing agents on dough, has been plained.

Key words: oxidizing agents, dough rheology, gluten

INTRODUCTION

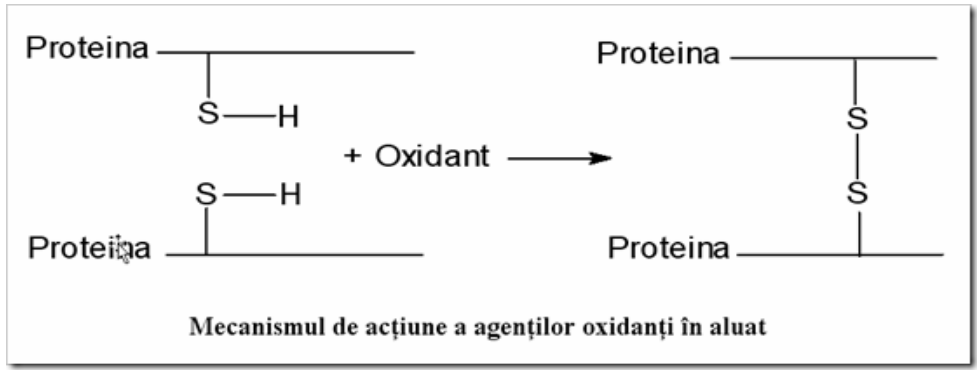
Oxidizing agents are used to improve the rheological quality of dough coming from wheat with little gluten. This increases the retention capacity for gases and allows the dough to maintain its form after shaping, with the end result having an increased volume, porousness, structure, and superior interior colour.

MATERIALS AND METHODS

The research that was carried out allowed the formulation of a reaction mechanism that explains the effects of oxidizing agents on dough. True to this, the oxidizing agent determines the oxidization of the SH groups that belong to protein molecules, with the formation of disulphidic points.

The two relevant proteins can be either nonglutenous proteins, in which case they come from sulphydryl-disulphide exchanges in favor of glutenous proteins, which bring about a dough that is more elastic and resists more to being rolled out. There can also be a molecule of nonglutenous protein and one that is glutenous, which causes an increase in the elasticity of the dough.

Diagram 1: The mechanism by which the oxidizing agents affect dough



Another mechanism is based on the direct oxidization of SH-groups in sulphonatic acids, being a considerably more desirable path for the oxidization to occur in conditions of extremely elevated levels of oxidants.

Both reactions affect the rheological quality of the dough. The added dose of oxidant is dependent on the quality and extraction of the flour, of the process by which the dough is prepared, and also of the mechanics of the intensity of the kneading action.

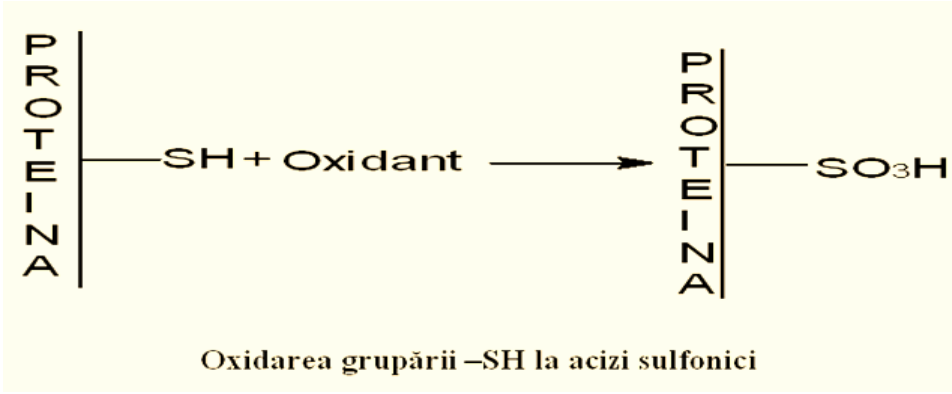


Diagram 2: Oxidization of the SH groups in sulphonatic acids

Research has shown that the oxidizing action of ascorbic acid on the remains of cysteine from the dough's proteinic molecules is brought about due to the L-dehydroascorbic acid in which the ascorbic acid is transformed through oxidization. According to the research, the improving action of the ascorbic action is due to an enzymatic mechanism in which this is oxidized through dehydroascorbic acid, in the presence of oxygen and ascorbic ozydase.

This reaction is followed by the reduction of dehydroascorbic acid through ascorbic acid in the presence of dehydroascorbant reductase and of a hydrogen donor represented by the redused gluthathione.

This mechanism is contined by the system of redused gluthathione – oxidized gluthathione and the gluthathione reductase enzyme. The reaction is finalized through the SH-group oxidization through proteins in the presence of specific dehydrogenases and of the NADH + H+ ↔ NAD system.

The effect of ascorbic acid could be due to intermediary products of the nonenzymatic oxidization such as superoxidant radicals.

In this way the oxidization of ascorbic acid through dehydroascorbant acid would happen through the release of an electron towards the molecular oxygen and the intermediary roamtion of an monodehydroascorbic acid and of a superoxidant radical (O2-.). This radical is quickly reduced to hydrogen dixoide through an enzymatic reaction of displacement, helped by the formation of a hydroxiperoxil radical. This oxidizes the thiolane radical (RS.), forming disulphidic bonds. The reaction is mediated by copper and iron ions.

In bread manufacturing azodicarbonamide is used in doses of 5-20 ppm; larger quantities are used for wheats with larger extractions or for technological processes that require a large rate of oxidization, such as those that use frozen or refrigerated dough.

A series of studies has shown the existence in baking products, obtained through the use of flour treated with azodicarbonamide, a larger quantity of urethan (a carcinogen) compared to products obtained from untreated flour. Based on this research, it has been established that the maximum dose of azodicarbonamide should not exceed 45 ppm.

The chlorine is used in a gaseous form to whiten and ripen the flour destined for cookie factories as well as flour to be used in pastry making, which contains a large quantity of sugar.

Experiments have shown that only a part of the chlorine used in flour is retained by that flour and that the proportion of retained chlorine is dependent on the total quantity of chlorine added to the flour.

It has been ascertained that doses smaller than 1250 ppm of chlorine increase the dough's stability, while large doses reduce it, increasing its softness. These effects are considered to be due to the oxidizing and hydrolytic action of chlorine on flour proteins.

Chlorine doses of 650-1250 ppm are capable of improving the volume, texture, and colour of the pastry's center, while doses that are larger than these parameters make it poorer.

Tabel 1
The primary chemical additives used in the miller's and baking industry.

Names	Allowed Quantities	Observations
Ascorbic acid	10-100 ppm	-
Potassium iodate	0,003 %	-
Potassium bromate	10-40 ppm	Not allowed in Romania
Nitric oxides	-	brings about a slight colour lightening
Calcium iodate	10-75 ppm	mild oxidant
Mix of $(NH_4)2S_2O_8$ and Ca $(H_2PO_4)_2$	0,04%	-
Mix of chlorine with nitrous chloride and nitric trichloride	1-20 g/100 kg	-

RESULTS

The effect of ascorbic acid is dependent on the dough's temperature, the intensity of kneading, and the presence of certain oxidants. Thus, the maximum effect of ascorbic acid is reached at the 25-260 C in case of intensive kneading along with the simultaneous addition of potassium bromate.

Both reactions effect the dough's rheological quality. The added dose of oxidant is dependent on the quality and extraction of the flour, the procedure used to prepare the dough, and also on the mechanical intensity of the kneading action.

Treatment with chlorine increases the flour's hydration capacity, probably due to the increased capacity of the grains of flour to absorb water.

Chlorine is an efficient whitening agent up to doses of 1250 ppm, acting on the flour's carotenoidic pigments. The optimal level of added chlorine depends on the destination, quality, and graininess of the flour. Chlorine can be used in doses of 25-500 ppm.

REFERENCES

Journal articles

[1] Bettge, A., Rubenthaler, G.L., Pomeranz, Y., 1989, *Alveograph Alghoritms to Predict Functional Properties of Wheat in Bread and Cookie Baking,* Cereal Chem, vol. 66, No. 2, 81-86.

[2] Gaines, C.S., 2. Fregeau Reid, J., Vander Kant, C., Morris, C.F., 2006, Comparision of Methods for Gluten Strenght Assessment, Cereal Chem., 83(3):284-286.

[3] Koppel, Reine, Ingver, Anne, 2004, *Investigation of components of baking quality of wheat in Estonia*, International Workshop on Modelling Quality Traits and their Genetic Variablity for Wheat: A satellite meeting of the VIII ESA Congress, INRA; Clermont-Ferrand, France. 18-21 July.

[4] Kostyukovsky, M., Zohar, D., 2004, *Sunn Pest Eurygaster integriceps Put. And Wheat Quality in Israel*, International Quality Grains Conference Procedings