# THE EFFECT OF DAMAGED STARCH ON THE QUALITY OF BAKED GOOD

**"Starch damage will have a strong influence on most dough and baking processes. Therefore it will affect the quality of most finished product. Better knowledge of levels of damaged starch in flours is essential for better screening of flour and breeding lines."**

**Dr. Mahmoud RİAD**

**Secretary General**

**Egyptian Milling Society**

**INTRODUCTION**

The recovery of flour ingredients from wheat during processing is not without deleterious effects. High speed rollers and mechanical disruption of the wheat kernel bring about some damage to starch granules. While milling procedures are designed for maximum recovery of starch and the minimum inclusion of bran, they invariably result in a small but significant amount of starch damage. Regardless of what type of milling is used 5 to 12% of the starch granules are damaged (Viot 1992). This in turn changes flour characteristics in dough mixing and bread baking. This phenomenon is also true for the production of noodles and tortilla which are also sensitive to small changes in starch chemistry.

Starch is the chief storage form of carbohydrate in plants and the most important source of carbohydrate in human nutrition. A starch molecule is a polysaccharide assembled from the simple sugar glucose; chemically, starch is composed of two different molecules, amylose and amylopectin.

**WHAT IS DAMAGED STARCH?**

It is a starch granule that is broken up into pieces. Not only does it increase water absorption and affect dough rheology, it increases food supply to the yeast and is more susceptible to fungal alpha amylase. Starch represents 67-68% of whole grain wheat and between 78-82% of the flour produced from milling. The semi crystalline structure of the starch granule in the grain kernel can be damaged by mechanical operations, particularly the milling process. Damaged starch (DS) is important in bread making: it absorbs 4 times its weight in water as compared to 0.4 for native starch.

Damaged starch granules are also subject to preferential attack by specific enzymes (α and β-amylases). Some of these enzymes are incapable of attacking an intact granule because of the protective coating on the granules. The term "Damaged starch" is somewhat of a misnomer as the word "damaged" has a negative connotation implying something to be avoided.

**THE IMPORTANCE OF DAMAGED STARCH**

It increases water absorption and provides extra nutrition for the yeast. A high level of damaged starch would result in sticky dough that produces a weak side wall and a sticky crumb (if enough amylolytic enzymes are available). The level of starch damage directly affects the water absorption and the dough mixing properties of the flour and is of technological significance. Damaged starch absorbs 2 to 4 times more water than regular starch granules. Sticky doughs, high water absorption, longer proofing times, and red bread crust color are just some of the effects of damaged starch. Damaged starch granules are susceptible to enzymatic degradation in comparison to native starches.

Starch damage will have a strong influence on most dough and baking processes. Therefore it will affect the quality of most finished product. Better knowledge of levels of damaged starch in flours is essential for better screening of flour and breeding lines.

**EFFECTS ON BREAD QUALITY**

In fact, damaged starch (DS) should be optimized as it has both positive and negative effects on bread quality. Increasing damaged starch increases the water retention capacity of the flour; however, too much DS leads to sticky dough, strong proofing, and undesirable browning of crust. The optimum DS value varies with the use of the flour and is greatly dependent upon the flour protein content, the alpha amylase activity, and the type of bread to be made from the flour. Most baked products around the world have specifications in terms of quality and functionality of flour used, and DS is one of these specifications. Flour with high DS cannot be used for the same purpose as the one with a low DS content.

**Factors affecting the amount of damaged starch in the flour mill**

1. The type of wheat.

2. The amount of water addition in tempering.

3. Rolls surface and speed.

4. Rolls spiral and differential.

5. Degree of grinding in rolls.

6. Rolls temperature.

Millers can manipulate damaged starch (DS) content of flours through wheat choice, grain preparation and mill setup and adjustments. The wheat choice is based on the impact of the grain hardness: the more resistant to milling, the greater the DS. This “hardness” can be partly modified when preparing the wheat for milling. At milling particular attention is given to the moisture conditioning and tempering time for the grain to be milled. From a proper conditioning or selection of the wheat, it is possible to increase or decrease the DS at the mill. Furthermore, hardness is higher when the protein content is higher; thus, a direct correlation between the protein content and DS. Nevertheless, the mill set-up and adjustments are the major ways of influencing the end flour DS. This study focuses on those aspects.

**QUANTITY OF DAMAGED STARCH PRODUCED IN MILL STREAMS**

We cannot get into details of the milling diagram and the codification, but let us take a 150t/d mill with 4 breaking streams (BK), 1 sizing (SIZ) and 7 middling and second quality streams (converting/reduction) (MID) and ancillary equipment for an all-purpose flour (US Grade, French type 55). 51%, about half of the damaged starch produced into this milling diagram is on 1st and 2nd middling (1M and 2M), 1rst sizing (S1) and 3rd middling. They are the main streams where we should focus our attention.

The modern flours mills are all taking advantage of features such as computerized, Grinding gap adjustment, and, as seen, this can be particularly efficient in terms of damaged starch creation when applied to the head reduction streams (1st and 2nd middling (1M and 2M), 1st Sizing (S1) and 3rd middling (3M), representing 50% of the DS produced. Those streams must be considered as central to the final quality of the flour and their variation may have the greater impact in the way of predicting the DS.

**EFFECTS OF DAMAGED STARCH ON THE FINAL PRODUCT**

Water absorption by starch that becomes damaged can improve baking properties up to a critical level above which properties of flour are negatively affected. Alongside with the action already determined on hydration, starch damage has an action on dough plastic characteristics, Proofing and Bread crust color. Effects on proofing characteristics can be shown if we know that amylases can't attack a native starch granule. More damage more attacks are possible. Breaking the granule molecules liberates water, Simple sugar are present and create: Intense yeast activity (a lot of CO2) Coloration possibility higher.

Higher input of water allows keeping the loaf fresh longer. But Simple sugar release provokes a very red crust. If intense, damaged starch can be responsible for: Sticky crumb, No volume bread and too red bread.

Procedures for controlling the quantity of damaged starch: If I do not have enough starch damage I can set the mill differently, choose a harder type of wheat or both of them. If I have too many starch damage I can Take care of amylases content (falling number), add gluten to increase rheological properties. Set differently the mill, and we can also Change wheat for a softer one.

**The impact of the starch damage onthe rheological behavior of dough's:**

The damage Starch has an impact on the alveo graph curve and the rheological properties. The Mixolab® analyses carried out on the flour show that an increase in the damaged starch content results in an increase in the water absorption capacity (approximately 0.5% hydration for each additional UCD); a decrease of the viscosity of the starch paste obtained during the gelatinization process and reduced stability under heat (increased liquefaction) ;indicating higher amylasic activity. Decrease of the starch retrogradation indicating better shelf life.

There is a clear explanation. The damaged starch presents a water absorption capacity ten times greater than the native starch, and greater sensitivity to enzymes (the amylases in particular). The action of the amylases occurs more quickly and in a more intensive manner. The damaged starch action impacts the whole bread-making process. It is essential to adapt and quantify damaged starch content in accordance with the desired end use. The SDmatic / Mixolab® couple is perfectly suited to this challenge.

For good quality breads, there has to be a balance between the amounts of water used in the kneading, protein content of the flour, the amount of damaged starch and α-amylase activity. These values also differ in different bread making methods. In fast bread processes, with short resting time, the effect of damaged starch in providing substrate is minimal, but with long fermentation processes the effect is substantial. It has been determined that the level of damaged starch is less important in whole meal bread than in white bread. Except for some biscuit and cake types, wheat with low DS is preferred in cake making (POMERANZ 1988).

Relationship between DS, protein content and desirable tolerances for the final product: End products are classified according to the DS and protein content. Knowing that information, a flour mill laboratory can use the DS according to the purpose of their flours for, as an example: Baking target:

• French type (Baguette) : 16 – 20 UCD

• Pan bread : 19 – 23 UCD

• Biscuit/cookies target: 14 – 16 UCD

**CONCLUSIONS**

• The damaged Starch cannot be avoided during the milling process.

• The damaged Starch can be controlled at the mill level.

• It has a positive influence on the water absorption.

• It can lead to disastrous results during bread making.

• Enzymatic methods are not simple.

• However, it is necessary to find the optimum.