Q. Could you discuss **phytic acid** in **whole wheat flour**?

A. *Phytic acid* is one of those compounds present in all seeds, including wheat grain; it is made up from the vitamin *inositol* and the mineral phosphorus in the form of *phosphate*. Hence another name: *inositol hexaphosphate*.

When seeds come in contact with moisture the seed enzyme *phytase* springs into action to break down phytic acid, with the stepwise release of phosphate and eventually inositol. Seeds seem to use the release of phosphate as a signal for the production of many other enzymes involved in seed germination.

In the wheat grain, the phytic acid is mostly present in the bran and aleurone fractions (Williams, 1970). Phytase is found concentrated in the germ and aleurone fractions, but it is also present diluted in the endosperm (Peers, 1953). Both are spread throughout whole grain flour as a result of stone milling wheat grain to whole wheat flour. Single pass stone milling is likely to further distribute the phytase throughout the flour quite effectively, because the germ is soft and spreads onto all the particles of flour during milling. Variations in the milling process will result in corresponding alterations in this distribution pattern.

A particular property of phytic acid is that it binds mineral ions of potassium, calcium, magnesium, iron and zinc, which are naturally present in the wheat grain, sometimes in association with protein. The loss of just one the six phosphates from phytic acid is enough to prevent the binding. This means that unless the phytic acid in whole wheat dough is broken down by phytase, all these minerals and some protein remain bound to the phytic acid so that they cannot be assimilated during digestion. The inositol and phosphate in the phytic acid, are also unavailable for digestion. Like people and farm animals, bread fermentation microorganisms are better nourished if these minerals, proteins and the inositol and phosphate are made available. Because of these effects of breaking down phytic acid, the enzyme phytase acts as whole wheat bread improver.

Fortunately wheat is particularly rich in the enzyme phytase, so that if favorable conditions are provided in whole wheat dough, then phosphate, inositol, the minerals potassium, calcium, magnesium, iron, zinc and bound proteins are all released.

The usual whole wheat dough temperature range is from 68 – 86ºF (20 – 30ºC), which allows a slow but steady action of the phytase. However the action of the phytase is much faster when the dough is somewhat acidic due to the activity of sourdough lactic bacteria. At pH 4.5 at 86ºF (30ºC), practically all the phytic acid is removed from whole wheat dough by phytase in 4 hours (Fretzdorff, 1992; Leenhardt, 2005). Approximating from this, it will take 8 - 12 hours at 68ºF (20ºC) and at pH 4.5 for all the phytic acid to disappear from whole wheat dough.

In practice a small amount of sourdough leavening (10% bakers per cent) in whole wheat dough, might begin at pH 5 and reach pH 4.5 after 5 - 6 hours at 77ºF (25ºC) , and then reach pH 4 by the time it is ready to bake after a further 2 - 3 hours. This regime produces mild flavored bread that has wider appeal than a distinctly sour bread dough brought to pH 3.5, before baking.

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Perhaps the only way to know how much phytic acid remains, is to test the bread for phytic acid. After finding the dough conditions that consistently remove the phytic acid, if you choose to label your bread as *phytic acid at least 85% reduced,* then regular testing would be needed to back up your claim. In whole wheat there is approximately 1% phytic acid and the lowest level of detection is approximately 0.14% on a dry basis, making it hard to know when bread is completely *phytic acid free*.

Previously there has been emphasis on the idea that actually sprouting the grains would generate a lot more of the enzyme phytase. Indeed this appears to be relevant for beans and other legumes, which do not naturally contain such a rich supply of phytase as wheat or rye. The definitions for sprouting and germination vary. Some researchers have shown that when seeds and grains are covered with water, i.e. when they are soaked, the phytase activity is not increased (Egli 2002). In a true sprouting situation the seeds are always in contact with moisture, but can still breathe. Making use of the phytase already present in wheat grain seems more economical in time, than waiting for the increase during wheat sprouting.

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