Phospholipids in baked goods

GERHARD HELMERICH INTRODUCED THE LATEST RESULTS OF HIS SCIENTIFIC WORK ON LECITHINS DURING A SCIENTIFIC MEETING IN JANUARY 2006

Due to their lipophilic and hydrophilic structure phospholipids act as emulsifiers and therefore influence the baking behavior of wheat doughs. This is the reason why lecithins, which are obtained on an industrial scale from animal or vegetable raw materials, are added to bread improvers used for the production of bread and small bakery items. Lecithin is a complex mixture of different polar and non-polar lipids. Next to glycolipids and sphingolipids, phospholipids are the main components in lecithins with a share of between 30 and 90%. The positive effect of lecithin on bakery products is known since 1951. Since then, there were many attempts to clarify the underlying technological effect. Until the start of this study by Helmerich and Koehler on the relationship between the chemical structure of phospholipids and their effect in baked goods, only the function of lecithin from egg, soy, rapeseeds and sunflower seeds as well as of individual lecithin fractions was known. Individual studies suggested that the phospholipids classes as well as the glycolipids contained in the lecithin might improve the baking behavior of wheat flour. There were up to then no studies looking into the systematic clarification of the effect phospholipids from lecithin have depending on their fatty acid and phosphatidyl derivatives.

The objective of Helmerich's practical work was to find the relationship between the structure of individual phospholipids and their technological effect in wheat doughs. The function of phospholipids during baking should be elucidated.

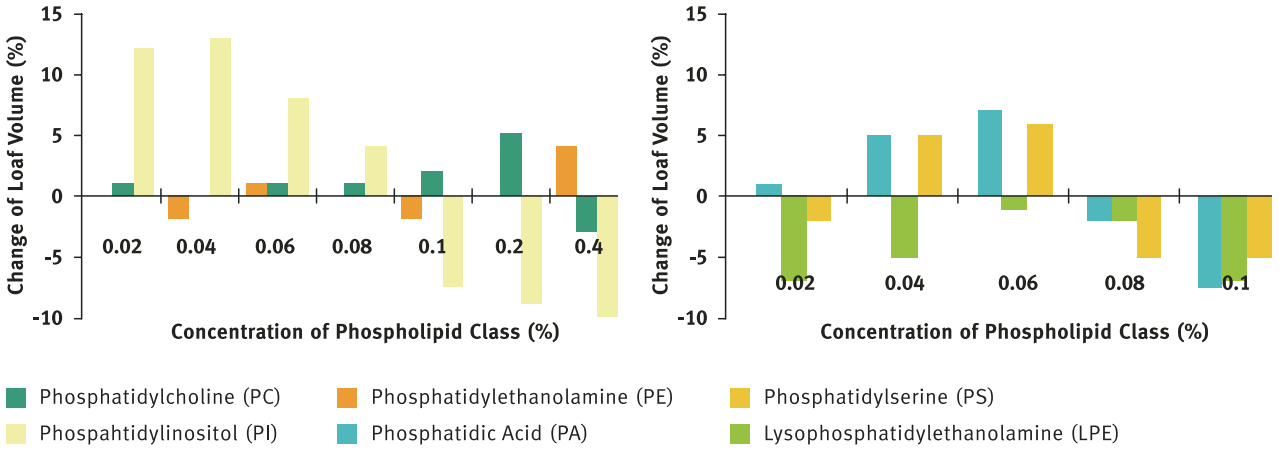
For the study, eight commercially available lecithins were used: Soy, rapeseed and sunflower seed lecithins in liquid and de-oiled form as well as lecithins from egg and oat.

The basic requirement for the analysis of the structure-function relationship of phospholipids in dependence on their quantitative composition in the lecithins used was the development of a powerful analysis method for quantitative determination of components present in phospholipids mixtures. Three analytical methods were developed based on TLC, HPLC and spectrometry.

For the investigation of the structure-function relationship of phospholipids in dependence on the phosphatidyl derivatives it was also necessary to isolate the different phospholipid fractions contained in the lecithins as purely as possible and in amounts that allowed the determination of the technological effect in micro-scale baking trials (0.5-2.0 g). Preparative TLC turned out to be the method of choice for the isolation of the individual phospholipids classes. Between 0.5 and 2.0 g could be isolated with a 99% purity (determined by thin-layer chromatography).

The dependence of the technological effect during baking on the fatty acid residues should be examined by synthesis of phosphatidyl choline (PC) as a model substance with defined fatty acids. For that PC isolated from egg lecithin by column chromatography was firstly saponified to remove the fatty acid mixture. Subsequently it was re-converted into PC with defined fatty acid anhydrides in the presence of an alkaline solution. The excess fatty acids, which were needed for esterification in a 10 times higher amount, were removed by esterification of the non-converted fatty acid with TMS-diazomethane and subsequent extraction with acetone. The synthesis included short-chain (C6:0) to long-chain (C18:0) and unsaturated fatty acids (C18:1).

Increasing of Loaf Volume Depending on Dosage of Phospholipids



++ Dr. Gerhard Helmerich

For determination of the technological and functional effects of the commercial lecithin preparation compared to the isolated phospholipids classes the following tests were made: micro-scale baking trials with 10 g flour, standard baking trials with 300 g flour, determination of kneading properties with the farinograph, tension tests with the extensograph, and the determination of firmness of the crumb in fresh condition and after some storage time. The measure for the technological effect during baking was the change in bread volume with and without added phospholipids.

Liquid soy lecithin and de-oiled soy and rapeseed lecithin added in the range of 0.2-1.0 g resulted in a comparable increase in bread volume despite different phospholipid concentrations. By recombination of the individual phospholipid classes it could be shown that the reason for that increase in bread volume lies in the qualitative and quantitative composition of the phospholipid fraction. The positive effect during baking is caused by the quantitative ratio of phosphatidyl inositol (PI)/phosphatidyl ethanolamine (PE)/phosphatidic acid (PA)/phosphatidyl serine (PS) which is the same in these three lecithins. The baking behavior of the lecithin decreased when the concentration of phosphatidyl inositol/lysophosphatidyl ethanolamine was increased or phosphatidyl serine was missing. This is also the reason why de-oiled sunflower seed lecithin has a significantly poorer effect during baking than soy or rapeseed lecithin despite the high total phospholipid content. Due to the use of individual phospholipid classes during this study it could be shown for the first time that only PI and PC in the concentration commonly found in lecithins have a positive impact during baking. On the example of PC with defined fatty acids it was shown that the technological effect of a phospholipid during baking could be increased by factor 5 with the integration of medium-chain fatty acids (C12:0).

Nevertheless, the influence of the fatty acids on the technological effect of the phospholipids in commercial lecithins is still very low because no lauric acid is contained in commercially available lecithins. Thus for the phospholipids in the lecithins used the parameter that determines the effect is the phosphatidyl derivative. These new findings regarding the qualitative and quantitative composition of phospholipid classes and the influence of medium-chain fatty acids on the technological properties of lecithins during baking allow optimizing the functional properties of lecithins in baked goods. +++

Contact: helmerich@yahoo.com

The work of Dr. Gerhard Helmerich and Dr. Peter Koehler is available from HUT-Verlag, Munich, Germany, for 42 euros. It is written in German language and titled: "Struktur-Wirkungsbeziehungen von Phospholipiden bei Backwaren" www.dr.hut-verlag.de/titelLebensmittelchemie.html +++