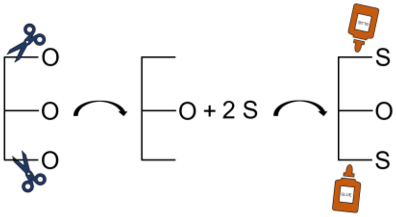
Popular science summary

Almost all food products we eat contain fat. Fat is an energy-giving nutrient needed to build and repair cells, create hormones and absorb fat-soluble vitamins. Besides being required for human health and well-being, fat also contributes to the product's taste, texture and consistency. A well-known example of this is the role of fat in chocolate. The chocolate gets its glossiness, distinct snapping sound when broken and characteristic melting properties so that it melts in the mouth but still offers some chewing resistance thanks to the unique properties of the cocoa butter. The composition of the fat governs the properties. Fats mainly consist of triacylglycerols, formed of a glycerol molecule with three fatty acids. The fat will behave differently depending on which fatty acids and where on the glycerol molecule the fatty acids sit.

Within the food and pharmaceutical industry, there is an increased need for fats with specific properties to meet the demand for new products with positive health effects. Unfortunately, fats with the desired properties are rarely found in nature. In addition, climate change is expected to reduce agricultural productivity, leading to a shortage of raw materials with unique properties, such as cocoa butter for chocolate. There is thus a need for a method for producing fats with a specific composition and properties, so-called structured triacylglycerols (STAGs).

STAGs are created by replacing one or more fatty acids in a fat molecule with another fatty acid until the desired composition is achieved. This is best performed using enzymes. Enzymes are nature's catalysts that make reactions go faster without being consumed. In nature, there are many different enzymes able to catalyze almost any type of reaction. A group of enzymes called lipase is used for the production of STAGs. The natural function of lipases is to break down fats, and they are therefore important in our digestion. However, under certain conditions, lipases can also do the reverse reaction, meaning that they can build bonds in fats. This is used during the production of STAGs, which takes place in two steps. In the first step, the lipase acts like a scissor and removes unwanted fatty acids on the original fat molecule. In the second step, the lipase acts as a glue that attaches the new fatty acids to give a fat with the desired properties.



The lipase acts like a scissor in the first step and like glue in the second to remove the undesired and attach the desired fatty acids to the triacylglycerol.

The work in this dissertation has been carried out in a collaboration between Lund University and AAK. We have investigated several important aspects in the development of a process for the production of STAGs. First, a method for efficient and precise analysis of the fat composition and, thus, the lipase's ability to produce the desired product was developed. The new method facilitated the performance of the succeeding research.

Lipases are effective catalysts but very small and, therefore, difficult to handle. They are often also expensive and can contribute to a significant part of the production cost. To facilitate the handling and re-use of the lipase and to lower the lipase cost, they can be attached to a larger support material in a process called immobilization. We have investigated how different support materials affect the catalytic ability of the lipase to try to understand which is the best in this process. Highly hydrophobic materials, that is, materials that repel water, were found to be best for achieving a high degree of immobilization and high activity of the lipase. We succeeded in creating new immobilized lipases with higher activity and selectivity than commercially available preparations.

Many other parameters affect the formation of the desired product. This dissertation investigated the effect of water, temperature and the ratio between the original fat and the new fatty acid. All parameters were found to be important. We then tried to find the optimal combination for maximum product formation in the shortest possible time. The aim was to make the process as efficient as possible. We developed a process using immobilized lipase from *Rhizopus oryzae* with high lipase activity, high yield and low byproduct formation. This resulted in exceptionally high product purity and productivity compared to previously obtained results.