Isolating Greater Value from Food Processing

EBA chromatography – an enabling technology for protein isolation

High value functional proteins are regularly lost in the side-streams of industrial processes. Natalya Clark, Business Development Manager, Upfront Chromatography, discusses how recent research and development by Danish biotech company, Upfront Chromatography, has led to the creation of novel methods and approaches for the large-scale separation of functional proteins from process streams, providing additional revenue opportunities. Upfront's Rhobust processing platform, based on Expanded Bed Adsorption (EBA), is the only industrial-scale, patented chromatographic process that enables the separation of high-value proteins that are suitable for food and healthcare applications.

Previously, no one would have even dreamt about associating the delicate techniques of chromatography with the processing of large, industrial volumes," says Allan Lihme, Technical Director of Upfront. "Implementation of this technology, for example at the Solanic plant in Gasselternijveen, the Netherlands, has shown that EBA chromatography techniques can be used to isolate more than 1000 tonnes of high quality functional proteins per year. Applied on an industrial scale, Rhobust EBA chromatography has been proven to be an extremely cost-effective method that is applicable to today's ingredient manufacturers."

The market for protein ingredients — particularly, plant proteins — looks very promising. In 2005, it exceeded $13 billion and is projected to reach $18 billion by 2010, growing at a compounded rate of 5.73% in the coming years.[1] This upward global market trend has been triggered by a number of factors, such as scientific advances, the changing perceptions of the increasingly health-conscious public in the Western world, population growth and rising income levels in developing countries. With the Rhobust processing platform, food ingredient companies now have a proven solution that can help them to recover protein ingredients and significantly increase their revenues.

Untapped Revenues

Those sites that use corn and wheat as raw materials to manufacture starch and gluten best demonstrate the current utilization of process streams by food processing companies. The

Above: Pure concentrated proteins can be stored for several years after drying

conventional, low quality protein by-products from these process streams are mainly used as animal feed because the proteins cannot be extracted by other methods or are damaged during the harsh extraction processes. The continued use of these recovery processes means that food ingredient companies are failing to exploit the valuable source of untapped revenue from their side-streams.

The revenue increase from shifting from feed to food ingredients is significant. Current feed prices range from $1–1.5 per kg; however, food ingredient prices are substantially higher: the estimated food ingredient prices for whey protein isolate and potato protein fluctuate in the range of $8–10 per kg; for egg powder and caseinate, the range is $6–8 per kg; and soy proteins sell in the market for about $3–5 per kg.

Simple and Targeted

The Rhobust processing platform is an EBA-based chromatographic technique that provides a proven solution for recovering high-value active proteins in a pure concentrated form. EBA represents the most exciting development in the field of separation since the introduction of packed bed chromatography columns back in the 1950s. A key characteristic of EBA is the fact that the adsorbent media is allowed to expand inside the column, when the upward flow of liquid is applied. This enables the adsorbent media to fluidize in the feed stream, allowing particulate impurities in the feed stream to pass freely — and at very high flow rates — through the system without column blockage, pressure drop or channel formation. The EBA process offers a solution to eliminate the costly prefiltration steps of packed-bed implementations and has the potential to deliver significant cost savings for biomolecule manufacture.

Adsorbent design and the selection of appropriate ligand chemistries is central to achieving a separation with minimal change to process flow. Rhobust employs a proprietary adsorbent mixed ➔

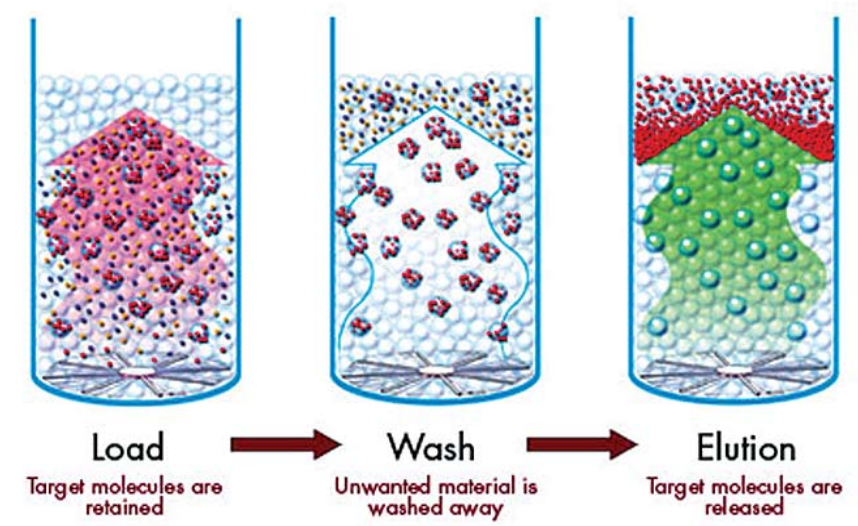

Figure 1: Basic principle of the EBA process.

mode ligand chemistry that is optimized to process operations. It is possible to control the capture and release of target molecules using simple pH changes, which can be readily implemented in large-scale production facilities and retain the biological activity of the product. Ligands in Upfront's library are selected for their suitability for industrial processing and, in particular, for their stability during 1M NaOH high temperature cleaning, their low toxicity and their very low adsorbent-leakage properties. The technology offers operational robustness and versatility for both primary capture processes and the fine purification of a broad range of functional proteins.

A key advantage of the Rhobust platform is that it can be used directly with crude feedstock; the chromatographic adsorbent captures protein molecules in one simple downstream process. The EBA process offers a solution that eliminates costly prefiltration steps and has the potential to deliver significant cost savings for biomolecule manufacture. Usually done as a batch process in an industrial environment, a number of columns are combined to enable the continuous flow of new materials so that the separation process fits within the parameters of the process streams (Figure 1).

Pioneered with Whey and Potatoes

The dairy industry is a good example of how the implementation of the Rhobust processing platform can boost revenues and create new product applications. For many years, whey was looked upon as a troublesome waste product that was frequently dumped in the sea, sprayed on fields or returned to farms for use as animal feed. However, with the advent of new and more efficient separation technologies, this situation has changed. Although the production of whey powder and lactose has taken place for many years, it was the implementation of the Rhobust processing platform that created the possibility of producing a wide range of new products, including functional food ingredients and products for the healthcare industry. Dairy Farmers, one of Australia's largest dairy co-operatives, pioneered the refinement and development of new by-products using Rhobust. The company commissioned a large-scale plant based on Upfront's EBA technology for the isolation of five active whey proteins: lactoferrin, lactoperoxidase, immunoglobulin, alpha-lactalbumin and beta-lactoglobulin.

Another company that immediately saw the huge profit potential in Rhobust was AVEBE. For many years, the potato starch industry has been trying to find a way to separate food-grade proteins from potato juice. Solanic, the protein business unit of AVEBE, has opened an industrial processing plant in Gasselternijveen, the Netherlands, to recover highly functional proteins from the side-stream of potato processing — using Rhobust technology. The installation at the Solanic plant employs Upfront's proprietary mixed mode ligand chemistry to enable the isolation of functional proteins without using traditional heat coagulation methods. The functional proteins isolated using this process have a wide range of functionalities that are comparable with high-grade proteins, such as egg and milk proteins. The plant currently has the capacity to produce 1000 tonnes of functional protein per year and Solanic aims to produce 10,000 tonnes of protein per year in a second phase. This will be the world's largest industrial protein chromatography installation by far! Commenting on the plant, Frank Groovaerts, Director of Commerce at Solanic, said: "The installation at Solanic is a huge success, allowing us to extract previously inaccessible proteins from our waste stream, thereby opening up a previously untapped source of revenue and enabling us to make major energy savings."

The Future is Here

The Rhobust processing platform can work with any type of raw material that contains soluble proteins, such as grain, wheat, soya, fish, canola, oats, peas, corn, egg and milk. "We have recently obtained some interesting results with wheat and soya, and I foresee great potential with other crops. I imagine Rhobust would also be of interest to the food ingredient houses that are building bioethanol plants, as they can start producing food ingredients instead of feed, and move to the upscale by-product markets," says Upfront's Technical Director Allan Lihme. He is convinced that the era of innovative by-products has just begun.

Reference

1. Global Industry Analysts, Inc., *Protein Ingredients – A Global Strategic Business Report* (5645 Silver Creek Valley Road, San Jose, California 95138, USA, 2006).

For more information

Upfront Chromatography A/S
Lersø Parkallé 42
DK-2100 Copenhagen, Denmark.
sales@upfront-dk.com
www.upfront-dk.com