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Features

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No More Boiling of Hair – The Answer Now Lies in Biotechnology: Cysteine from the Bio-Reactor

In many places, the amino acid cysteine is nowadays still extracted from human or animal sources: from hair, feathers and pig bristles. WACKER is capable of replacing this process with a clean biotech method, and thereby providing the pharmaceutical, cosmetic and food industries with a whole new source of an indispensable raw material.

What expectorants and baking ingredients have in common

Winter is usually associated with colds and flu. All over the place, we hear people coughing and spluttering to free their bronchial tubes of phlegm. Many turn to established drugstore remedies that contain an active ingredient called acetylcysteine, which liquefies phlegm and makes it easier to cough up. However, hardly any of these sufferers know they have swallowed a substance that started life as something they meet everyday in many other forms: in breakfast rolls and pizzas, in hair salons and in the artificial meat flavoring contained in vegetarian food. For acetylcysteine, which is based on the amino acid cysteine, is one of the 20 building blocks that make up the protein alphabet.

Cysteine in hair, feathers and nails

What makes cysteine unique is the sulfur-containing molecular group that is present in no other amino acid: a sulfhydryl group consisting of sulfur and hydrogen that is highly reactive. Cysteine is therefore able to form disulfide bridges, which lend proteins much of their stability and create, for example, the strength in strands of hair, wool and feathers, nails, hooves and

horns. A large proportion of keratin, the protein in these materials, is cysteine.

Breaking open glutinous proteins

Bakeries are totally reliant on this amino acid, using cysteine-based ingredients to break open the sticky gluten contained in flour. The dough then becomes much easier to knead. Expectorants also make use of the highly-reactive cysteine and its derivatives, including acetylcysteine: acetylcysteine breaks open the mucous proteins in the bronchial phlegm and liquefies the stubborn secretion. In Japanese hair salons, cysteine is used to prepare hair for a “perm” instead of the pungent thioglycolic acid currently favored in Europe for this purpose. Cysteine is also employed in health products, where it intercepts the free radicals that cause cell damage and renders them harmless.

The hair-gathering industry

However, there is one problem with using this sulfur-containing amino acid for such a wide range of applications. Until recently, it was one of the few amino acids that had to be obtained from animal or human “raw materials,” examples being hair, feathers, pig bristles and hooves. In Asia, this is a real industry: every year in China’s hair salons, professional hair gatherers sweep up thousands of metric tons of hair and take it to cysteine manufacturers to be boiled with activated carbon and concentrated hydrochloric acid to yield the prized amino acid. One metric ton of hair produces approx. 100 kilograms of cysteine.

“When you consider that the pharmaceutical, cosmetic and food industries worldwide require up to 4,750 metric tons of cysteine per year, you realize how much of these raw materials is needed,” states Dr. Markus Busold, responsible for Cysteine at

4,750 metric tons for pharmaceuticals, cosmetics and foodstuffs

WACKER FINE CHEMICALS. Unusually, improved efficiency and environmental compatibility were not the key reasons for seeking an alternative method of production. What was more important for many applications was the quality of the end product, explains Busold. “For pharmaceutical companies, for example, it is crucial to eliminate the possibility of dangerous contaminations, such as the pathogens responsible for BSE, SARS or Avian flu – and our processes do just that.”

No BSE, no SARS, no Avian flu

“We are the only company in the world capable of producing the highest-purity cysteine from bacteria using a fermentation process,” says Busold. The starting material is the “pet” of many biotechnologists, special strains of Escherichia coli cultivated in the laboratory. In nature, these bacteria synthesize cysteine from sugar, salts and trace elements – but only as much as they need for their own metabolism.

Non-stop cysteine production

Employing specific mutation and selection techniques, WACKER researchers have managed to disable the so-called regulator proteins known to slow down cysteine synthesis in the bacteria. The result: the bacteria produce cysteine non-stop, flushing the surplus amino acid they produce through their cell membrane into the nutrient medium in the fermenter tanks. The amino acid or required derivatives can be obtained by filtering and the use of small quantities of acid and alkali. This method has several advantages:

Very high yields

- It is highly-efficient: 90 percent of the bacterial cysteine ends up in the final product, compared with the 60 percent yield of the conventional method of extraction from hair. It also requires much less hydrochloric acid: one kilogram of

hydrochloric acid for every kilogram of cysteine – the hair method requires 27 kilograms of hydrochloric acid to produce just one kilogram of cysteine.

High-purity end product

- It avoids undesirable contamination. Because sugar, salts and trace elements are the only starting materials, the end product cannot possibly contain pathogens, for example. “Our product is at least 98.5 percent pure cysteine and meets all the standards imposed by the food and pharmaceutical industries,” explains Busold.

No genetic engineering

- Also, because no foreign genes are used, the E.coli strain employed is not considered a genetically modified organism, and this has been confirmed by the Central Commission for Biological Safety at the Robert-Koch Institute in Berlin. “The bacteria used are among the most harmless micro-organisms there are – similar to lactic acid bacteria,” says Busold.

Vegetarian and kosher

Because the end product is pure vegetarian or inorganic, the WACKER cysteine is also an ideal solution for vegetarian food, producing artificial meat flavorings for example. If cysteine is combined with a sugar such as ribose, flavorings that taste like meat are produced on heating. “This process recreates a natural flavoring,” explains Markus Busold. “When we roast a chicken, natural cysteine reacts with sugars in the flesh to create the aroma we associate with it. It's no different with our cysteine.” The purity and vegetarian origin of the WACKER cysteine has also won over Jewish and Muslim associations. They have awarded the amino acid produced by biotechnology with Kosher and Halal certificates, which means that the product can now

also be sold in the relevant countries.

Demand for high quality is rising

In 2006, several hundred metric tons of cysteine were produced by WACKER's unique patented method and distributed worldwide from its Burghausen site – predominantly to customers in the pharmaceutical, food and cosmetics industries, all of which attach high importance to premium quality. “The demand for our cysteine has grown dramatically and we shall therefore certainly be expanding this business in the future,” stresses Busold.

But we won’t be making the Asian hair gatherers redundant just yet: Some 80 percent of the global cysteine demand are still being extracted by the conventional method – although market shares will start to shift. Customers interested only in the lowest price and not in the product’s origin are, for example, dog and cat food manufacturers, who want to “enhance” their products with various meat flavorings. Such markets will without doubt continue to be served by the old method for a long time to come.

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The company in brief:
WACKER is a globally active chemical company with some 14,700 employees and annual sales of around €3.34 billion (2006).
WACKER has 22 production sites and over 100 sales offices worldwide.

WACKER SILICONES
Silicone fluids, emulsions, rubber and resins; silanes; pyrogenic silicas; thermoplastic silicone elastomers

WACKER POLYMERS
Dispersible polymer powders and dispersions for applications in the construction industry; PVAc-solid resins; VC copolymers; polyvinyl butyrals and acetates

WACKER FINE CHEMICALS
Fine chemicals, biologics and other biotech products, such as cyclodextrins and cytokine

WACKER POLYSILICON
Polysilicon for the semiconductor and photovoltaics industries

SILTRONIC
Hyperpure silicon wafers and monocrystals for semiconductor devices