# Livestock Byproducts and Seafood Wastes Contain Valuable Ingredients

*Animal byproducts are used to manufacture pharmaceuticals with a wide range of applications. Advances in biotechnology have resulted in the development of transgenic animals, which may be used in the future as a source of drugs and organs for human transplants. Chitin, isolated from seafood waste, has numerous industrial and food applications.*

Many animal byproducts have a vast range of human and industrial applications, which are unknown to most people. In addition, scientific advances, especially biotechnology, are increasing potential uses.

**Animal Glands and Byproducts Have Medicinal Value**

Numerous pharmaceuticals derived from animal byproducts aid in the treatment of diseases and injuries and facilitate patient recovery. For example, the thyroid gland produces thyroxine, which controls the rate of chemical reactions in the body. Thyroxine from animals is often used to regulate chemical reactions in humans with damaged or diseased thyroid glands. Shortages of thyroxine can bring on lymphatic swellings known as myxedema. Excess secretions can cause resources insomnia, tachycardia, loss of weight, and digestive disturbances.

The pituitary gland produces adrenocorticotrophic hormone (ACTH). ACTH from animals is used to treat rheumatic disorders such as arthritis, rheumatoid arthritisand rheumatic heart disease; collagen diseases like lupus erytheinatosus; various skin diseases; allergic conditions such as bronchial asthma and chronic bronchial asthma; and ulcerative colitis.

Insulin is probably the most well known pharmaceutical derived from animal byproducts. In 1921, Dr. Banting (University of Toronto) established that the failure of the pancreas to supply insulin leads to diabetes, a disease causing damage to blood vessels, eyes, kidneys, and other organs. Two years later, Banting and Dr. Best discovered a method of mass-producing insulin. Since then, progress has been made to improve and develop new sources of insulin from animals. Currently, it requires on average the pancreases of 35 beef cattle or 130 hogs to provide enough insulin for one diabetic for one year.

Animal byproducts are also used to treat circulatory ailments. For example, heparin prevents blood clot formation, growth, and movement. It is extracted from cow lungs and pig intestines. Discovered in 1915 and used since 1938, heparin is essential in open heart surgery, kidney dialysis, and catheterization. And, hog heart valves are widely used to replace defective valves in hum'an hearts. It is estimated that over 30,000 heart valves from pigs have been implanted into humans.

Blood albumin is used as a reagent in testing for Rh factor, as a nutrient in tissue culture media, and as a stabilizer in vaccines. Albumin is generally made from "edible" blood. Edible blood comes from the carcasses of wholesome animals that havepassed USDA inspection, and the blood is collected and stored in a **sanitary** manner. Two percent salt is usually added to the blood to preserve and keep it from thickening.

Blood plasma is obtained by centrifuging whole-beef blood and adding an anti-coagulate to prevent clotting. After centrifuging, the plasma is frozen to manufacture thrombin. Thrombin is a concentrated plasma, capable of clotting **blood** in a matter of seconds. It is supplied as a sterile, dry powder and applied to bleeding **areas** in a saline solution. It is used in several types of surgery, skin grafting, and dentistry.

In comparison, "inedible" blood is used in the manufacture of shoe polish and in the sizing of leather. Furthermore, it is used as a feedstock for glues and in animal feeds. Dried blood contains about 87-percent protein. It can also be used by calico printers in fixing certain pigment colors in cloth.

Other pharmaceutical uses of animal byproducts include:

- Pepsin is a digestive ferment obtained from the lining of the pyloric end of pig stomachs and used to aid protein digestion;
- Rennin is a digestive ferment obtained from the fourth stomach of suckling calves, which is used extensively as a milk coagulant in cheese making;
- Peptones of different kinds are prepared from lean muscle tissue and are easily assimilated as proteins or are used in culture media; and
- Thromboplastin is made from the brains of cattle and is used as a blood coagulant.

**Genetically Engineered Animals Are a Future Trend**

Some of the first animals to be genetically manipulated were mice and rats. More recently, research has been conducted on pigs. Scientific study of these animals is useful because they have physiologies very similar to our own. Thus, they can be used to test potential cures for various diseases, such as AIDS, sickle cell anemia, cystic fibrosis, heart disease, and many other human ailments. Moreover, scientists believe that in the future they will be able to genetically alter animals to supply transplant organs for humans.

Around the world, genetic modification of rodents has become commonplace. Modifications have become so frequent 'and widespread that a system for cataloging each of the various traits is being established at Oak Ridge National Laboratory. When completed, a scientist can locate rodents with a particular human gene or set of genes.

The United States Patent and Trademark Office issued patents in December 1992 to three organizations for their discoveries on "transgenic" mice. Transgenic animals incorporate a gene from another organism and are able to pass that gene to offspring. This is invaluable for studying how normal genes function and how defective genes cause inherited diseases or lead to other diseases, such as cancer and AIDS. These patents were issued to Harvard University for a mouse that develops an enlarged prostate, a common problem in older men; Gen Pharm for a mouse without a working immune system, developed primarily for AIDS research; and Ohio University for a virus-resistant mouse for use in developing agricultural livestock that are less vulnerable to disease.

Some scientists believe that therapeutics from transgenic animals could be available as soon as 1996. Between 1983 and 1985, researchers showed that transgenic animals could be produced. In 1988 and 1989, transgenic production of livestock was proved possible. Clinical trials began in 1993. Examples of transgenic animals include:

- Genetically engineered pigs are yielding milk containing a complex human protein that prevents blood clotting. With this source, large supplies can be attained more quickly and less expensively than from human sources.

- DNX Corporation (Princeton, NJ) has created pigs with human hemoglobin, which they hope to begin testing in humans as a blood substitute next year. This new supply of human-quality blood will help reduce the cost of collecting blood from humans and eliminate potential disease problems in the blood supply.

- A new blood substitute, called Hemopure, has been developed by Biopure Corporation (Boston, MA) from an extract of cow's blood.

**Chitin--A Versatile Product from Seafood Waste**

Chitin is a naturally occurring biopolymer, whose most common source is the tough outer shell of crustaceans, such as crabs, shrimp, and crawfish. Chitosan is the deacetylated derivative of chitin, which is a linear polymer of acetylamino-D-glucose. While chitin is used in some applications, chitosan is the preferred material for most uses.

Chitin is the second most commonly occurring organic compound next to cellulose. Even tllough it is found in plankton and mushrooms, commercial applications will most likely come from shellfish wastes.

The United States is a major harvester of crustaceans. In 1992, over 624 million pounds of various crab species were landed. The biggest proportion of these were snow crabs, 350 million pounds, and blue crabs, 192 million pounds. Another large source of chitin would be the 338 million pounds of marine shrimp landed domestically in 1992. **A** third domestic source would be the fresh water crawfish industry. Louisiana annually produces approximately 100 million pounds of crawfish. Over half of this is farm-raised and the rest comes from wild harvests.

The tonnage of domestic crustacean shells available for chitin extraction would be considerably less than the 1 billion plus pounds of landings noted for crabs, shrimp, and crawfish. First, shells are a relatively small portion of the total landed weight. Second, a fairly large percentage of these species are sold to retail markets and restaurants with the shell intact.

The only economic and logistically viable source of chitin would be from facilities where crustaceans are processed in large quantities for meat. While the domestic supply of crustacean shells for chitin extraction is considerably less than total landings, there would still be a substantial amount of raw material available. Since the shells are normally considered a waste product, acquisition costs should be relatively low. Plants would likely be located close to the raw material source because of transportation costs, perishability, and bulk.

To produce chitin, the raw shells are first coarsely ground and then treated with sodium hydroxide to remove proteins. Next, the shells are demineralized in hydrochloric acid. The demineralized shells are dried and ground to the desired size. Chitosan is derived by treating chitin with a strong caustic solution. After this procedure the material is rinsed, ph-adjusted, and dehydrated.

Due to its chemical versatility, chitin or chitosan is used or is being tested for a wide variety of applications. Powdered chitin is used in waste water treatment, while most chitosan is used in food and medicinal applications.

In the industrial area, the major use for chitosan is as a flocculating agent. Chitosan greatly increases the rate at which materials precipitate out of waste water. It is used to treat sewage effluent and the waste water from paper mills. In textile plants, powdered chitosan is being tested to see if it can absorb dyes before the waste water is discharged.

Another major industrial use takes advantage of chitosan's chelating properties. It is used to remove metals from waste materials at metal-finishing facilities. The ability to chelate iron, combined with its flocculating properties, make chitosan especially well suited for use in water-treatment applications.

Moreover, films of chitosan are being evaluated as edible food coatings to prolong the shelf life of fruit products and to keep food ingredients separate during storage. The Army has also evaluated chitosan coatings as a biodegradable packaging wrap.

Currently, the largest agricultural use for chitosan is as a seed coating, primarily wheat. Chitosan protects the seed by activating the seed's natural defenses. Chitosan is also being used to recover soluble proteins from agricultural processing wastes. Still another use is as a binder in pelletized fish feeds.

Developing new uses for chitin and chitosan could also help solve waste problems in the seafood industry. The raw material for chitin production has traditionally been a waste product that was either dumped at sea or disposed of in a landfill. By developing these new uses, shellfish processors will be able to greatly reduce their waste disposal costs. [Donald Van Dyne (314) 882-4512 and David Harvey (202) 219-0085]