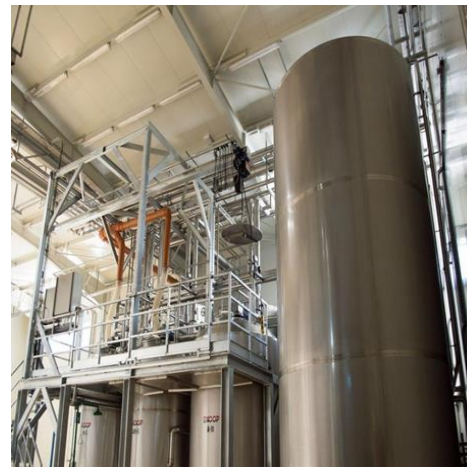


Chitosan Production Abstract

The following abstract considers the main aspects of chitosan production

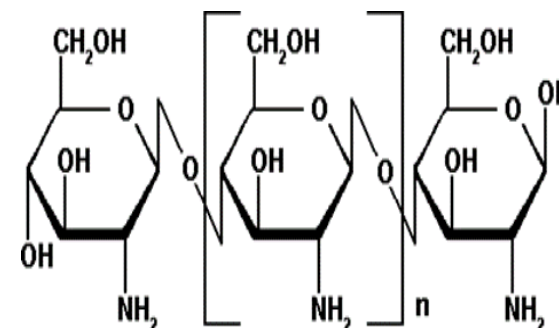


INTRODUCTION

Chitosan, a deacetylated derivative of chitin, is polysaccharide with an amino group, contained in the shells of Crustacea such as crab, shrimp, etc. Chitosan is a white to light-red solid powder, insoluble in water, soluble in organic acid, but indigestible by human digestive enzymes. Therefore, it is used as one of the so-called dietary fibers.

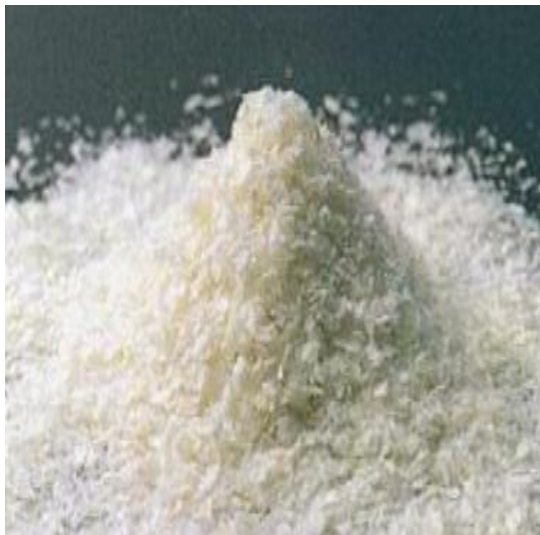
Chitin is one of the three most abundant polysaccharides in nature, beside to cellulose and starch. It ranks second to cellulose as the most plentiful organic compound on earth. Chitin and its derivatives have many properties that make it attractive for a wide variety of applications from food, nutrition and cosmetics to biomedicine and agriculture.

It's antibacterial, anti-fungal and anti-viral properties make it particularly useful for biomedical applications, such as wound dressings, surgical sutures and aids in cataract surgery and periodontal disease treatment. Chitin/chitosan is the most important additive and product from marine bio sources beside Calcium, Astaxanthin and Glucosamine. The middle extraction value of chitosan is about 5%. It strongly depends on the process and know how of which kind of extraction grade the production has to reach.



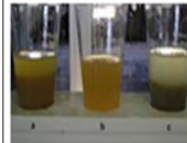
CHITOSAN APPLICATION

Commercial chitosan is usually offered as flakes or powder. The products of various companies differ in purity, granulation, color, DD, average molecular weight, and solubility. Depending on the grade chitosan gets used for various applications. The following illustration refers to the main applications.



Animal Feed

- Enhancement of performance and improving the immune function macroscopically



Coagulant

- One major application is the use as coagulant for example in water cleaning industry



Textile Industry

- Used for microbial growth purposes



Paper Industry

- Chitosan and its derivatives are used as strengthen additive, retention and drainage aids, size agent and flocculation agent



Agriculture

- Enhance disease resistance of plants, and decrease diseases
- Promote growth and increase yield
- Improve the quality of fruits and vegetables

CHITOSAN APPLICATION



Bio-Pharmaceutical Future Application

- chitosan for applications in vaccine delivery
- Also other applications using chitosan as transport agent are under development



Pharmaceutical Application

- chitosan has the property to enhance blood coagulating processes. Further it acts antibacterial-both properties make it a highly valuable intermediate for pharmaceutical applications in bandages, nasal stripes, plasters etc



Food supplements

- widely used in food supplements for weight management purposes



Cosmetics

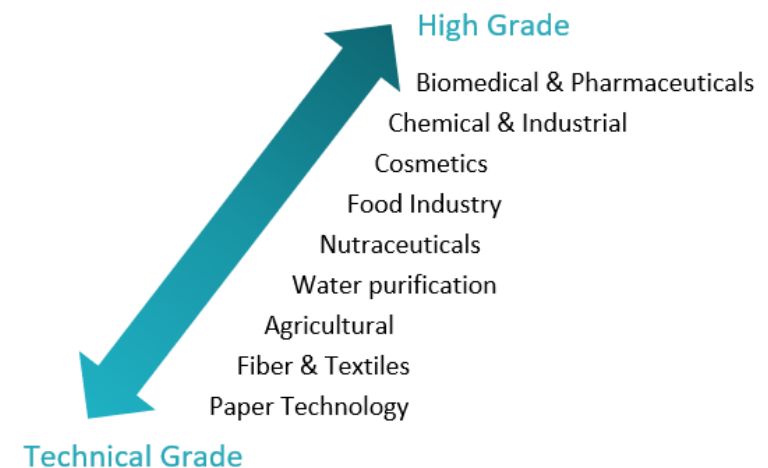
- used viscosity-building and antimicrobial properties, and its use in cosmetic emulsions and gels.



Food

- Japan produces dietary cookies, potato chips and noodles enriched with chitosan because of its hypocholesterolemic effect
- Chitosan gets also use because of its antimicrobial effect

The different product applications require different chitosan standards. The more sensitive the application (e.g. pharmaceutical use in bandages) the higher the standard. The value and the margins are positively related with the standard.

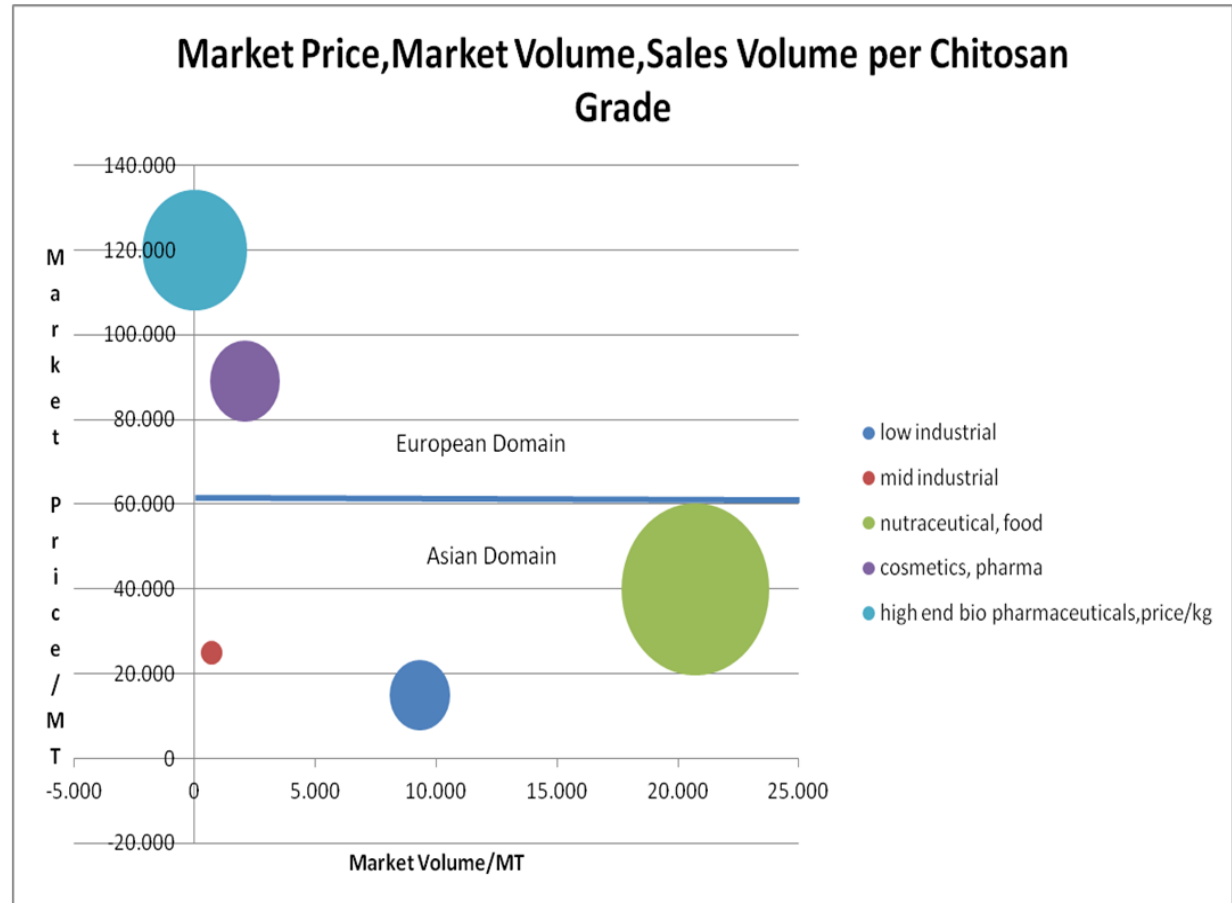


CHITOSAN MARKET

The natural polymer, chitin, and the increasing number of useful products derived from chitin such as chitosan, its derivatives, oligosaccharides and monosaccharides (e.g., glucosamine) continue to attract commercial development. Prices for chitin and chitosan range from below \$20 to more than \$1,000 per kilogram depending on product quality.

The table on the right shows the average price of chitosan for different qualities and applications.

Further the size of the bubbles shows the estimated relative market volume per application grade.



CHITOSAN PRODUCTION PROCESS

Shellfish processing results in large quantities of waste materials which can be processed into chitin, or its more valuable derivative, chitosan. The amount of chitin present in the shell may be affected by a number of factors, such as type of shell (e.g. shrimp, lobster, crab), Shell freshness, and portion of the shell used. Typically shell portions with

high calcium concentrations are low in chitin. Shrimp shells generally have a higher content of chitin than crab offal. The chitin/chitosan process involves the crushing and drying of crab shell or other suitable species of crustaceans such as shrimp shell waste. The product is processed with acid and alkaline in order to remove protein and

calcium. The product is then further dried, grinded, and packaged as a finished or semi-finished product. A plant set-up will involve a complex equipment for grinding or particularization, drying, acid and alkaline treatment, packaging and effluent treatment.



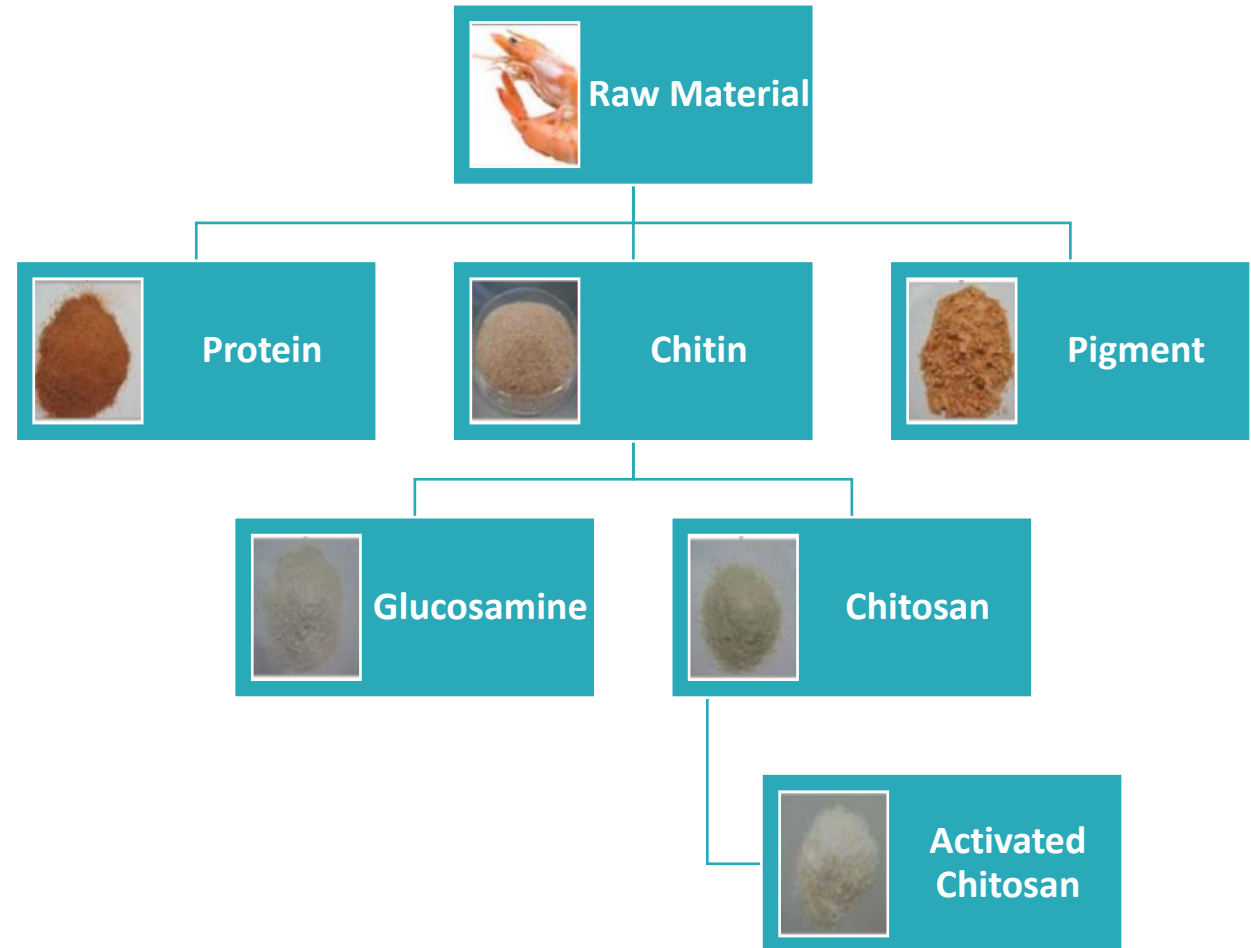
CHITOSAN BY-PRODUCTS

Shrimp waste can be processed into five different products and by-products.

Shrimp waste contains:

- < 15% chitin (<9% Chitosan)
- 11% Protein
- 14% Ash
- 55-60% Water
- <5% Lipids/Pigments

The chitosan derivatives market is rapidly growing with an average of about 15% per year!



DIFFERENT PRODUCTION PROCESS

There are two different technologies and processes to produce chitin, chitosan

- The chemical process that is the regular way and process worldwide.
- The second option is the chemo-enzymatic process that is an advance, eco and energy friendly technology. In our process we don't use any organic solvent and it's a Zero waste cycle. For the production of chitin we use non organic and biological process it is already at industrial scale but for chitosan process step it is first in the pilot phase.
- Also a combination as a chemo enzymatic process is techno-financial feasible process.



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