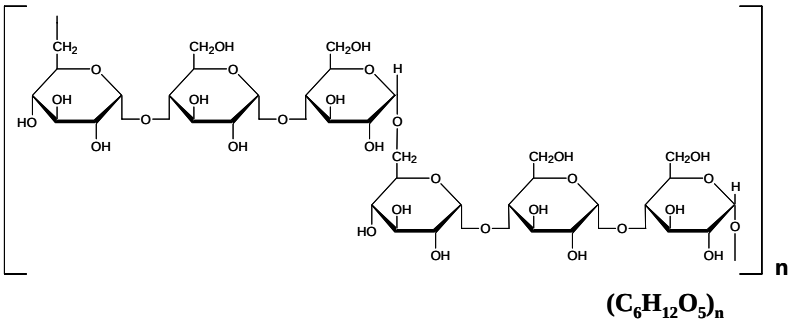
PULLULAN

Pullulan is natural water-soluble polysaccharide, produced from starch by fermentation. Available as a white powder it is odorless, flavorless, and highly stable. Pullulan consists of glucose units linked through α 1,6- glucosidic bonds.



$(C_6H_{12}O_5)_n$

Pullulan has many proven uses in the pharmaceutical industry:

Non-animal capsules
Tabletting Excipient
Tablet coating
Powder agglomeration

Non-animal capsules

NPcaps™
Non-animal Polymer Capsules

Pullulan is used by Capsugel to manufacture NPcaps™ an all-natural, two-piece non-animal capsule suitable for addressing a variety of cultural and dietary requirements, including those of vegetarians, diabetics and patients with restricted diets.

Pullulan is very stable and well-characterized, and has achieved wide regulatory acceptance with its proven safety record. It has been in commercial production for more than 25 years, having numerous uses in the food and pharmaceutical industries.

Capsugel offers its high-performing NPcaps capsules when a non-animal, all natural capsule is preferred.

Perfectly Suited for Pharmaceutical Applications

NPcaps are designed to support non-animal formulation initiatives, as well as address patients' dietary and cultural requirements. Made from all natural pullulan, NPcaps offer similar stability, dissolution and disintegration, machinability, appearance and manufacturing dimensions as Capsugel's popular Coni-Snap® gelatin capsules.

Chemical Stability

- Non-cross-linking
- Compatible with all major excipients, including: lactose, maize starch, sorbitol, magnesium stearate, pre-gelatinized starch, microcrystalline cellulose and carboxymethylcellulose

Mechanical Stability

- Similar to gelatin, moisture control assures flexibility of the capsule shell
    - Studies show 0% broken capsules at standard manufacturing conditions (50% RH)

Dissolution

- *In vivo* studies confirm that disintegration occurs quickly in the stomach, similar to gelatin
- *In vitro* studies with acetaminophen closely match the dissolution profile of gelatin across the entire pH range

Machinability

- NPcaps capsule dimensions are identical to gelatin
- Machinability tests have been successfully conducted with major CFM manufacturers

Appearance

- Side by side, gelatin and NPcaps are virtually identical and utilize similar colorants
- To assure patient compliance, NPcaps capsules match the look and feel of gelatin, with the same lusterous sheen and smooth capsule surface

The Natural Balance Between Health and Technology

With the trend moving towards healthier lifestyles, consumers are becoming more and more selective. That's why Capsugel is one step ahead of the development curve with NPcaps – a highly effective encapsulation option for dietary supplement products.

NPcaps are odorless, tasteless, and completely biodegradable two-piece capsules made from the completely natural, vegetable-derived polysaccharide, pullulan. Because pullulan is the capsule material most impermeable to oxygen transmission, NPcaps are highly recommended for encapsulating oxidation-sensitive ingredients to provide enhanced protection.

For more information on NPcaps, visit Capsugel's web site at **www.capsugel.com**.

CAPSUGEL®
Quality
People and Products Working Together

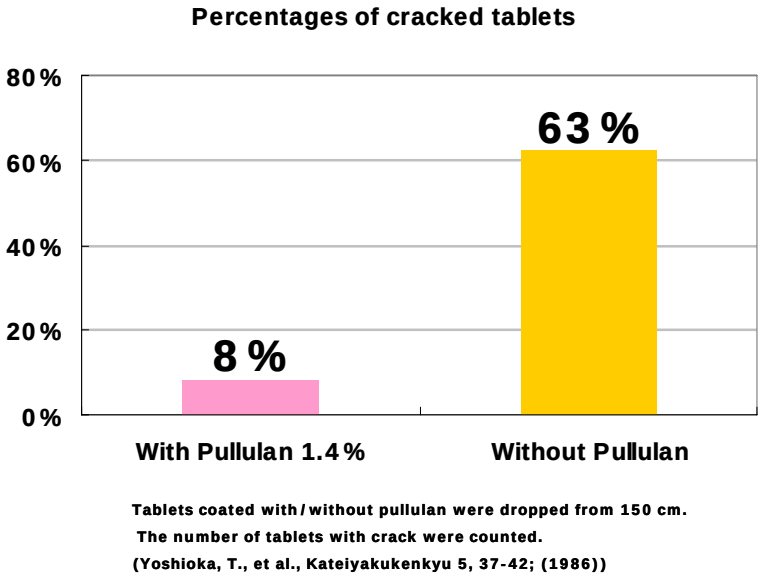
Tabletting Excipient

Granular pullulan can be used as a tabletting excipient to improve the tabletting performance of excipients and actives.

Tablet coating

Pan coating performance can be improved by using ingredients that improve adhesion and shine without increasing the viscosity of the coating syrup. In these respects Pullulan with its excellent adhesive properties and extremely low viscosity is ideally suited for pan-coating chewing gum, chocolate and candies. When used in a base coat, Pullulan provides improved coating adhesion when compared to gum arabic.

When used in a top coat, Pullulan's adhesive properties significantly increases the strength and resilience of the coating reducing damage during transport and distribution.



Tablets coated with / without pullulan were dropped from 150 cm.
The number of tablets with crack were counted.
(Yoshioka, T., et al., Kateiyakukenkyu 5, 37-42; (1986))

Powder agglomeration

Pullulan has about double the adhesive strength of food starch. This property combined with its lack of flavor enables it to be used effectively in typical agglomeration processes.