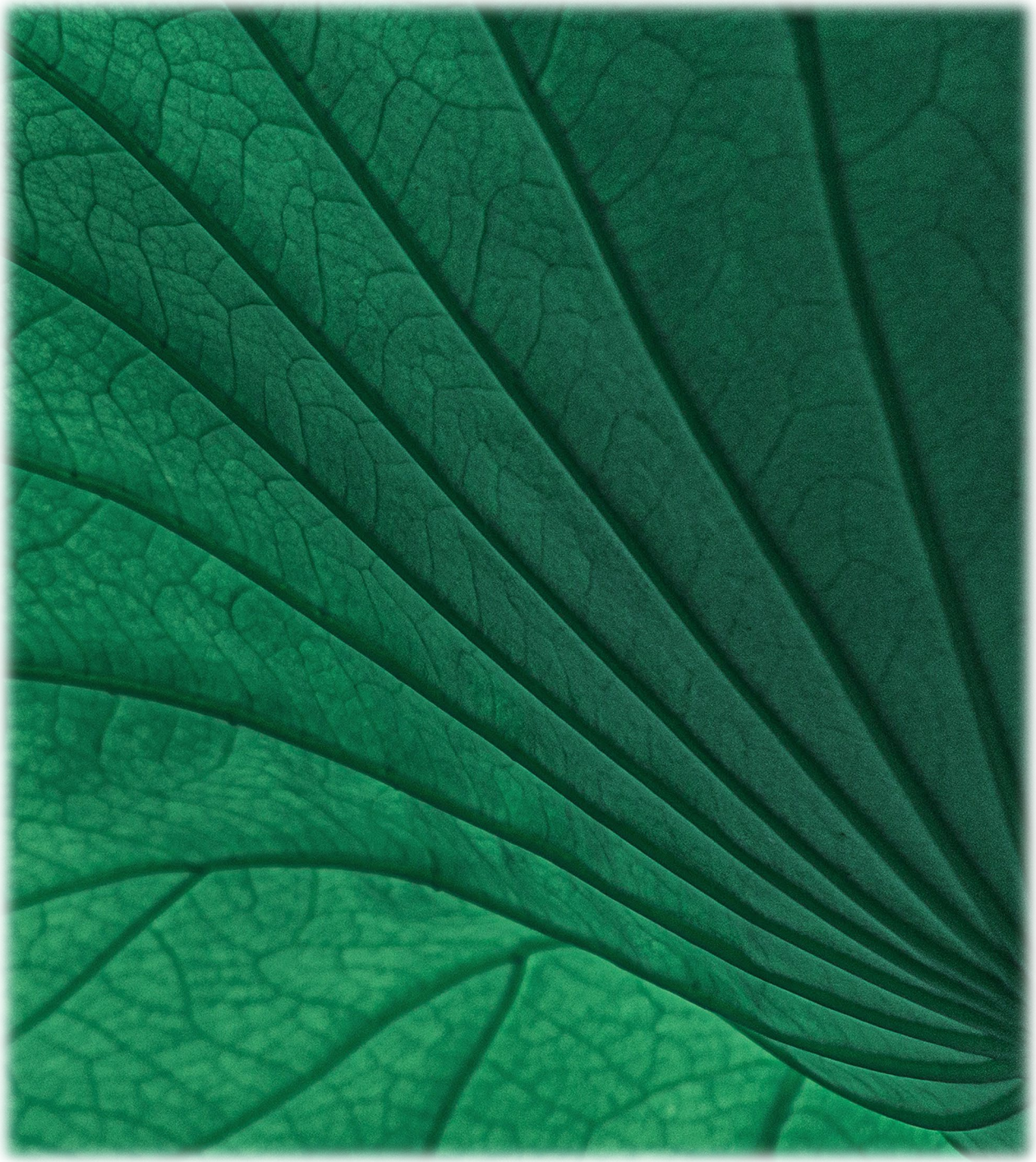


Efficacy study of glucosamine hydrochloride in bone and joint health

TSI Group

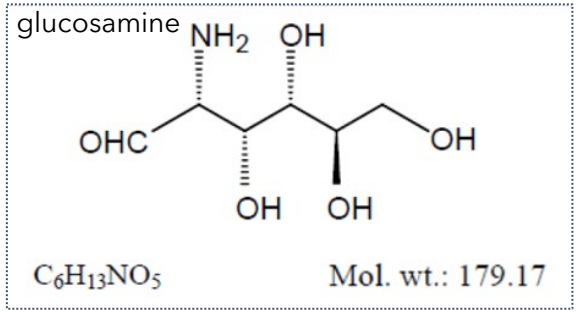
June 2022

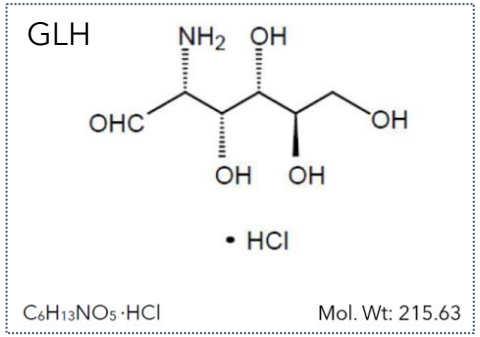
Glucosamine

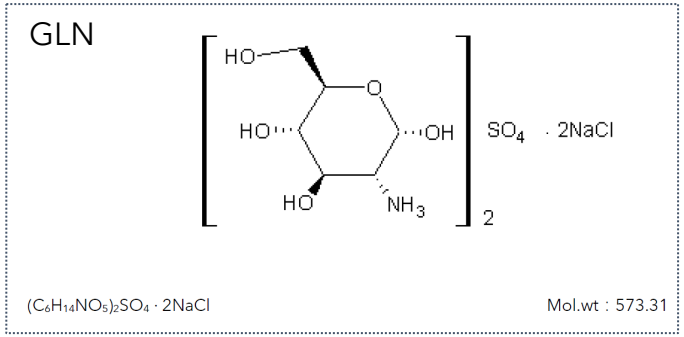
Common name of active substance： glucosamine (EN), glucosamina (PT)

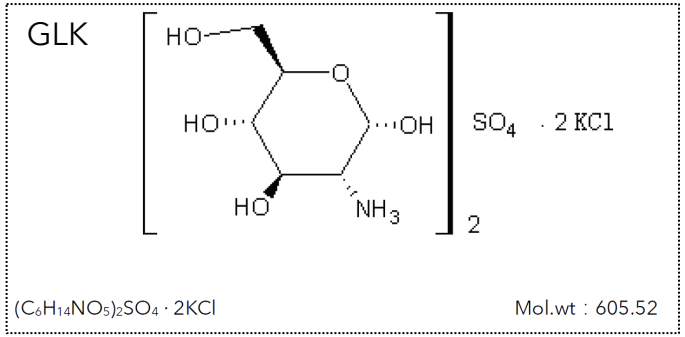
Source ingredients of bioactive substance：

Glucosamine Hydrochloride	Abbreviation: GLH
Glucosamine Sulfate Sodium Chloride	Abbreviation: GLN
Glucosamine Sulfate Potassium Chloride	Abbreviation: GLK









Glucosamine Hydrochloride

Which is better, glucosamine hydrochloride or glucosamine sulfate complex salt?

In terms of free-base glucosamine ($C_6H_{13}NO_5$) content, ***Glucosamine Hydrochloride (83.1%) has higher content*** than Glucosamine Sulfate Sodium Chloride (62.5%) and Glucosamine Sulfate Potassium Chloride (59.2%). Many studies have shown that the only biologically active substance among various glucosamine compounds is free-base glucosamine. (Block JA. et al., 2010)

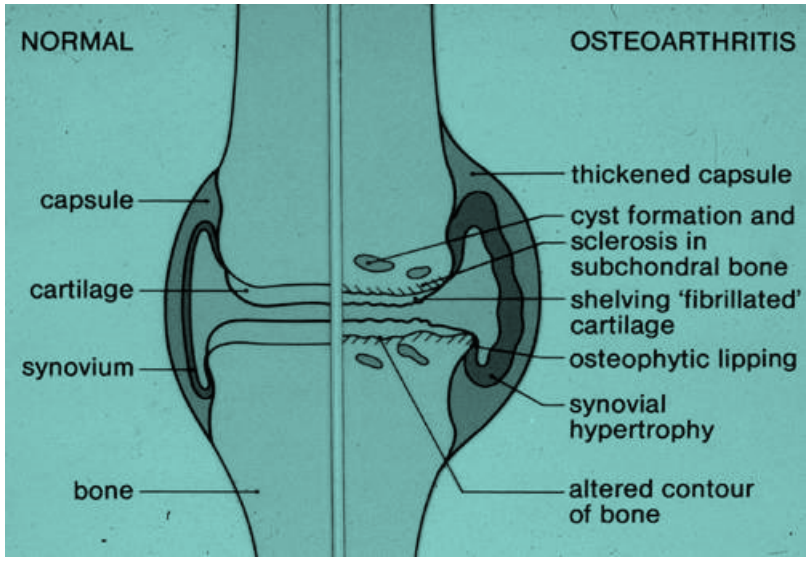
Glucosamine sulfate has more clinical effectiveness studies than Glucosamine Hydrochloride. However. in 2006, the European Medicines Agency (EMA) published an Assessment Report on Glucomed 625 mg glucosamine hydrochloride , which concluded that there was a favorable risk/benefit ratio for the glucosamine hydrochloride product, on the basis of submitted literature on glucosamine sulfate, as the formulations are not considered to be different in terms of safety or efficacy. Therefore, it can be considered that a precedent was set whereby ***clinical data for glucosamine sulfate are also applicable to the evaluation of glucosamine hydrochloride***. (Bertin P. et al., 2014)

At present, more and more countries in the EU have updated the active ingredient of the marketed glucosamine sulfate & glucosamine hydrochloride medicines to more scientific free-base glucosamine.

Nutritional and effectiveness studies of glucosamine in patients with osteoarthritis

Efficacy summary：

- *Relief of symptoms in mild to moderate osteoarthritis of the knee*
- *Helps to relieve joint pain associated with osteoarthritis*
- *Helps to relieve pain associated with osteoarthritis of the knee*
- *Helps to protect against the deterioration of cartilage*
- *A factor in maintaining healthy cartilage and/or joint health*



Representative studies from the past years are summarized. You can *click to download* the full document, see Chapter 1.1.

Nutritional and effectiveness studies of glucosamine in healthy adult

Efficacy summary：

- *Helps to maintain healthy cartilage/joint health*
- *Supports knee movement (bending and stretching) and reduces knee discomfort*
- *Improve the quality of life related to the knee joint*
- *A factor in maintaining healthy cartilage and/or joint health*

Representative studies from the past years are summarized. You can view chapter 1.2 of the full document downloaded on the previous page.

Nutritional and effectiveness studies of glucosamine——Research Beyond Bone and Joint Health

Efficacy summary：

- *Anti-aging*
- *Extending life span*
- *Reduce mortality*

- *Affect gut flora*
- *Reduce symptoms of enteritis*
- *Provided functional gut health benefits*

- *Anti-tumors and anti-cancer, Cardio-protection, Beauty and personal care, Drug delivery*

Representative studies from the past years are summarized. You can view chapter 1.3-1.5 of the full document downloaded on the previous page.

Glucosamine Frequently Asked Questions (FAQs) and Answers

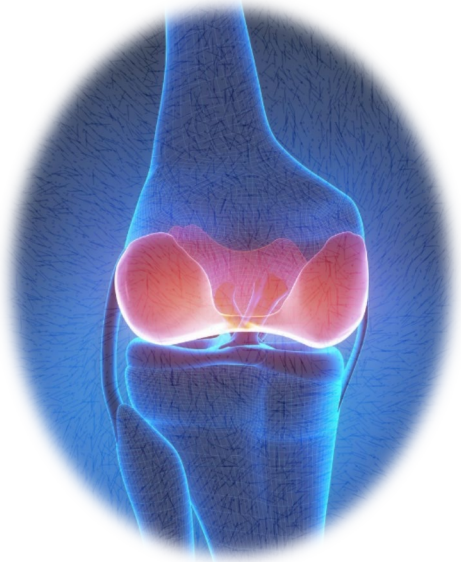
You can view chapter 2 of the full documentation downloaded on the previous page.

Indications, nutrition and function claims

Glucosamine has been used to treat and relieve symptoms of osteoarthritis since the 1960s, and was widely used worldwide at the end of the 20th century. The "Other anti-inflammatory and antirheumatic agents" class of drug ingredients, ATC code M01AX05, is usually indicated for *pain relief and improvement of symptoms of mild to moderate osteoarthritis.*

Glucosamine is evaluated as safe and low risk of use in the United States, Japan, Canada, Australia, and other regions, and it is used as a dietary supplement ingredient, not as a pharmaceutical ingredient. Among them, the nutrition and function claims of food supplement ingredients approved in Korea, Canada and Australia mainly include:

- *May help to maintain healthy joint and cartilage*
- *Helps to maintain healthy cartilage/joint health*
- *Helps to relieve joint pain associated with osteoarthritis (of the knee)*
- *Helps to protect against the deterioration of cartilage*
- *A factor in maintaining healthy cartilage and/or joint health*
- *Maintain/support joint health*
- *help enhance/promote joint health*
- *help maintain/support joint cartilage health*
- *relieve symptoms of mild arthritis*
- *relieve mild joint aches and pains*
- *support joint mobility, and so on*



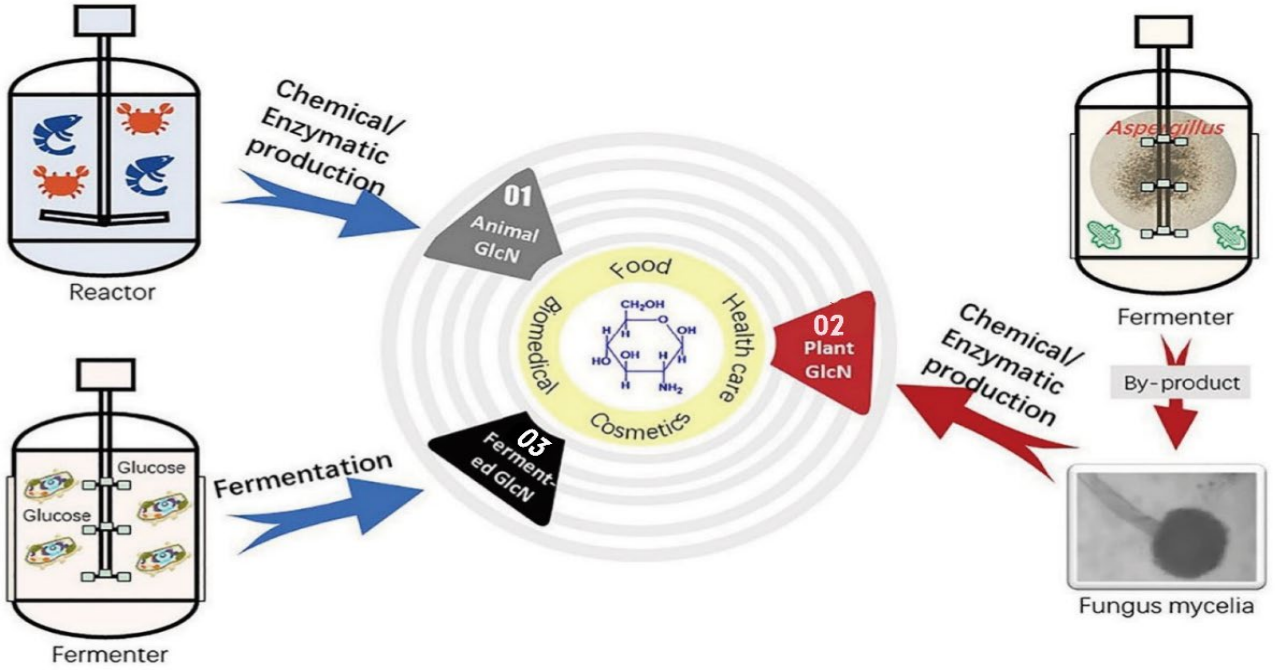
Source and Production process

Production source：

1st generation glucosamine: Animal glucosamine, The chitin extracted from the shells of crustaceans is hydrolyzed with acid or biological enzymes

2nd generation glucosamine: Plant glucosamine, The chitin extracted from mycelium of fungal organisms is hydrolyzed with acid or biological enzymes

3rd generation glucosamine: Direct Fermented glucosamine, Using glucose derived from corn as a culture medium to carry out direct fermentation



The 3rd generation glucosamine
Direct Fermented glucosamine (GlucosaGreen®)

The advantages of the direct fermented glucosamine are:

- No allergens such as shrimp and crab (Non-shellfish)
- Vegetarian (corn source)
- Environmentally friendly (Lower wastewater and solid waste [1])
- Sustainable (lower carbon emissions [2])
- Non-GMO [3]
- Bioequivalence [4]
- Multinational Safety Certifications and Approvals [5]
- High Quality Guarantee [6]

1. For details, please refer to the website: https://glucosagreen.com/learn-more/
2. For details, please refer to the website: https://glucosamineexperts.com/glucosagreen-contributes-to-global-carbon-neutrality/
3. Although some people believe that this production method has risks of genetic modification, expert opinions from European regulatory authorities and the United States have fully demonstrated that E. coli is only used as a processing aid in the fermentation production, and the final product is highly refined 100% glucosamine. Since Escherichia coli and GMO content are negative, the final product is not classified as GMO. Brazil's competent authority ANVISA, has also assessed direct fermented glucosamine as a non-GMO food supplement ingredient.
4. Multinational expert and competent authority assessments demonstrate that the glucosamine product produced direct fermentation processes is bioequivalent to the glucosamine derived from shellfish, including physical and chemical structure, nutritional value, metabolism.
5. US, EU, AU, Brazil approved
6. ISO22000, HACCP, HALAL, Kosher