Technical Article

Introduction to Konjac

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What is Konjac Flour

Konjac flour is obtained from the tubers (roots) of various species of *Amorphophallus*, a plant that belongs to the family of the *Araceae* and was originally from South East Asia. It is the source of a water soluble fibre and has been consumed for more than 2,000 years in China and Japan as an important part of oriental dishes. Konjac is called JU RUO in Chinese, and called KONNYAKU by the Japanese in accordance with the Chinese pronunciation for JU RUO.

Konjac plantation

Depending the species, dried crude konjac flour contains about 49-60% Glucomannan as the main polysaccharide, 10-30% starch, 2-5% fibre, 5-14% crude protein, 3-5% reducing sugars and 3.4-5.3% ash, it is low in vitamins and fat. Crude konjac flour is cream to light tan in colour with typical fishy odours.

In China, konjac has been used as a food and a medicine for over 2,000 years, it has also been used as a food in Japan for more than 1,500 years. Nowadays, konjac farming and processing in China and Japan has become a highly developed industry. Konjac flour has found many applications, such as in functional foods, a feed ingredient, gelling agent, water binder, thickener and particularly as a highly water soluble dietary fibre which can be used in non fat and low calorie diet food.

Structure of Konjac Glucomannan

The primary component in Konjac flour from Amorphophallus Konjac species is konjac glucomannan (KGM), a high molecular polysaccharide. The structure of KGM as residues of mannose and glucose, linked together by β-1,4 with a molar ratio of 1.6:1.0. It is a slightly branched polysaccharide having a molecular weight of 200,000 to 2,000,000 Daltons (actual molecular weight of KGM depends on the konjac variety, processing method and storage time of the raw material. Like all natural hydrocolloids, the molecular weight of KGM decreases by heating, duration time in processing and storage duration. Some glucose residues contain side chains composed of β-1,4 glucose residues linked at the glucose 3 positions along the backbone. One side chain occurs per 3,280 glucose residues, and on each side chain are several glucose residues. Acetyl groups along the Glucomannan backbone contribute to the solubility properties and are located, on average every 9 to 19 sugar units.

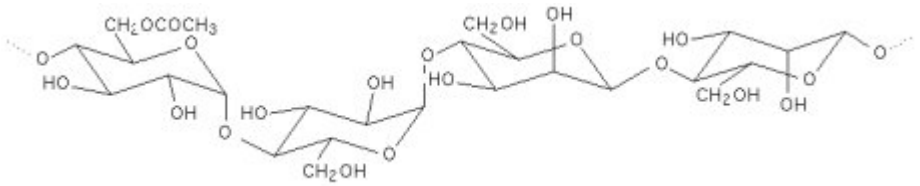

Figure 1. Konjac structure showing Glu-Glu-Man-Man units.

Cultivation and processing

Although there are more than 130 species of *Amorphophallus* defined, mainly from Africa and Asia. The most commercially important specie is *Amorphophallus konjac, K.Koch* which has been cultivated in China and Japan where the tubers of perennial *Amorphophallus Konjac*, commonly known as Konjac, have been made into a rubbery jelly and eaten as heath or diet foods.

Konjac bulbs

In the cultivation of konjac, the tubers are planted in about May. Rootlets begin to grow in large numbers from the upper half of the tuber, and from the centre of the top surface a single leaf appears. A thick, vertical stem is formed, and from this spread out an umbrella of leaves.

Konjac is generally grown in mountainous regions at relatively high altitudes (at average temperature of +14^{o}C (from May to October) and not higher than +31^{o}C (July to Sept) and at a height of 800 m above sea level. Rain fall level is about 200mm during through July to Sept. The Humidity is 80-85%. Seed tubers are planted in Spring and grow during the summer and have new tubers. In the later autumn, the plant stem and leaves die and the tubers are dug from ground around later October. Both weather and soil conditions affect the crop production.

Main Properties of Konjac

A gelling, thickening, suspending and film-forming agent.

- Water solubility: readily dissolves in water and it can absorb 100-times its own volume in water.
- The solution is a pseudo-plastic liquid. The viscosity of a 1% solution can be as high as 35,000 cps (1% sol by Brookfield
  viscometer at 12 rpm), higher than any other natural thickening agent. Konjac flour also shows a synergistic effect with xanthan gum, the addition of 0.02-0.03% to 1% xanthan gum will raise its viscosity by 2-3 times under heating.
- Acid stability: konjac remains stable without precipitation even if the pH drops to a level below 3.3.
- Salt tolerance: Konjac solutions are tolerant to higher levels of salts.
- Gelling ability: As a gelling agent, konjac is quite unique for its ability to form thermo-reversible and thermo- irreversible gels under different conditions.
- Thermo-irreversible gels: konjac solution does not form gel because its acetyl group prevents the long chains of Glucomannan from approaching each other. However, it does form gel by heating to 85^{o}C with mild alkali condition (pH 9-10) . This gel behaves stable to heat and it will remain stable under repeated heating at 100^{o}C or even at 200^{o}C. This property has been used to make a great variety of healthy/slim foods in Asian countries such as Konjac cakes, noodles, chips, imitating dishes for vegetarians (vegetarian shrimps, hams, steaks), bread, cookies, edible films, a fat replacer in hams, sausages, meat balls. Thermo-reversible gels: a

combination of xanthan gum with konjac can form a gel at any pH although xanthan alone does not form a gel. At a pH of
5, the two gums show the greatest synergistic effect with a ratio of 2:3, konjac has a gelling ability very similar to carob gum but much more pronounced. Konjac is synergistic with Kappa-carrageenan to form strong water gels at very low dosages. It has been used for soft candy, water jelly, jam, ham, yogurt, puddings, ice cream, pet food to replace carob gum and gelatin. It has also been used in fruit/vegetable juice as suspending agent. It also as some interaction with starch.

Safety and health claims

Konjac is not only used as a traditional food in China, Japan and South-east Asia; it is also registered for food usage in USA and, more recently, in the EU.

The Food Chemicals Codex lists the current uses of konjac flour in the United States as a gelling agent, thickener, film former, emulsifier. and stabiliser. USDA recently accepted the use of konjac as a binder in meat and poultry products. It is especially effective in emulsified meat products such as hot dogs and bologna, pepperoni, and summer sausage. In the EU, konjac flour has been granted E425. See the official EU gazette dated Nov.4,1999 : No.L295127, E-425, and Maximum dosage 10g/kg.

In fact, konjac flour has a long history of safe use. Its use as a food has been deeply rooted in the lives and customs of the people of China and Japan for centuries, Historically, konjac, the alkali treated konjac flour, was believed to cleanse one's digestive tract of irritating and poisonous substances and keep one's internal organs clean. The konjac tuber was introduced into Hawaii in 1858 and konjac was commonly eaten by the Japanese community on Hawaii.

The major component of konjac flour is Konjac Glucomannan. Feeding studies with rats and dogs indicate that there was no observed ill effects for glucomannan at 2.5% of the diet. There are several studies which deal with the effects of glucomannan on aspects of the biochemical dynamics of cholesterol, triglyceride, phospholipid, bile acid, glucose and insulin in experimental animals, while none of these studies can be called a safety study, they provide, some information on the safety of the glucomannan, in that they do not mention any adverse toxicological effects associated with the administration of glucomannan. These studies, in total, demonstrate that glucomannan has the ability to lower serum cholesterol levels and to delay glucose absorption.

Studies using glucomannan have been performed on humans, principally to study its influence on cholesterol and glucose absorption from the gastrointestinal tract. These studies indicate that glucomannan has the ability to lower serum cholesterol and may lower serum triglyceride and bile acid levels as well. Glucomannan may also have an influence on glucose tolerance and glucose absorption. These findings have also been seen in the animal studies, mentioned above.

Supplementation of appropriate amounts of Konjac in the diet can help prevent diabetes and aid gradual weight loss. Studies also indicate Konjac lowers Cholesterol levels. Konjac is ideal for weight reduction since Konjac forms a jelly like material and expands to about 30-50 times in volume in the digestive system and gives the feeling that the stomach is full. Recently, the food industry has started paying attention to Konjac flour as a replacement for conventional starch in formulations since Konjac is lower in calories and can help lower fat levels without sacrificing texture and taste.

Konjac has a very low calorific value (3Kcal/100g).