we are experts in emulsifiers and stabilizers for bakery, confectionery, dairy, ice cream, margarine and fine foods - and we are happy to share our expertise. our company values can be defined in just three words: loyalty, responsibility and commitment. we aim to be the preferred partner and supplier of quality products, application service and know-how to regional and multi-national food companies. Palsgaard loyalty means that we act as a reliable and honourable business partner for our customers; we treat information confidentially and know how to keep a business secret. Palsgaard responsibility means caring about the environment, being aware of our corporate social responsibility; we have a goal to be CO2 neutral by 2020 and are members of SEDEX and RSPO. Palsgaard commitment means we are dedicated to getting the best results for our customers' products - to the benefit of their customers. we care about our employees and have a declared aim that Palsgaard must be a pleasant place to work. Palsgaard know that our most important resource is the know-how and dedication found in our employees. Heart work is the best way to achieve success - let us help you do so. Palsgaard heart working people heart work is the best way to achieve success - let us help you do so. our products are produced according to the strictest quality criteria. we are experts in emulsifiers and stabilizers and we are happy to share our expertise with you. let our pilot plants help you shorten the step between idea and your new product. heart work is the best way to succeed - let us help you do so.
In industrial production of soy milk and soy beverages from soy beans the first step is the extraction of soy milk base which is then followed by standardisation and further processing into for instance a UHT drink.

The installation of a pilot plant for soy extraction in Palsgaard’s application facilities in Singapore opens for optimization of composition, stabilisation and processing parameters for the complete course of development of consumer products from soy beans.

This article examines all the steps needed in manufacturing delicious soy milk.

Soy beans have been used for human nutrition for more than 5000 years and soy milk has been known in China for at least 2000 years. Today, soy beans are an important source of protein and oil in human nutrition, especially in Asia. In other parts of the world, soy based foods are consumed merely due to its healthy image. Several health benefits have been found in soy proteins e.g.:

- Cardiovascular health
- Bone health
- Menopausal symptoms
- Cancers
- Cognition
- Glycemic Index
- Weight loss/control

Within soy products an increasing consumption around the world is seen in soy products resembling dairy products like for instance milk, yoghurt and ice cream. These products also make up a valuable alternative for people allergic to cows milk.

Soy beans
The cultivated soy bean Glycine max is a member of the Leguminosae family and related to clover and peas. It’s an annual and non-frost tolerant plant. The seeds are contained in pods. Depending on the variety the seed size is 3600 – 8000 seeds/kg. The mature bean normally has a light yellow colour and has a moisture content of 13-14%. If the water content is higher than 13.5% the beans must be dried prior to storage; otherwise enzyme activity is leading to oxidation of the fats.

Soy beans have approximately 40% protein, 35% carbohydrates and 20% oil calculated on the dry matter. Further, it is rich in vitamins and minerals. Soy beans contain all the essential amino acids making it a valuable protein source in human nutrition.

Soy milk
Soy milk is a water extract from whole soy beans. It is an emulsion containing water soluble proteins, carbohydrate and oil droplets. Soy milk was traditional produced in small shops where the soy beans were soaked, grinded, filtered and cooked. These products have a short self life. However, today’s consumers, and the modern lifestyle, request products with a longer shelf-life and which remain safe and stable during the complete storage period.

For production of such soy milks and beverages utilization of the UHT technology is obvious. Hereby shelf-life from several months and up to a year can be obtained, depending on the composition of the product. Further, the right
choice of emulsifiers and stabilizers is necessary for ensuring a homogeneous product without creaming and sedimentation during the entire shelf-life.

**Industrial production of soy milk base**
The first step in the production of soy milk, or for that matter yoghurt, desserts and ice cream from whole soy beans is the production of soy milk base. During this process the proteins, soluble carbohydrates and oils are separated from the fibre material, the so-called okara. This base is then further formulated and processed into the desired soy product.

The soy base can be produced in several ways by applying or omitting various processing steps. The choice of processing determines the chemical, nutritional as well as sensory properties of the soy base; such as the content of oligosaccharides causing flatulence, trypsin inhibitors influencing protein digestion and off-flavour components. A typical soy milk base has 45% protein, 20% oil, 17% carbohydrates and 8% ash calculated on the dry matter. Below the steps in soy base production are described:

**The steps in soy base production**
The starting point for the soy base production can be either whole or dehulled soy beans. By dehulling, some of the bitter tasting components are removed and further the level of oligosaccharides is decreased, resulting in a better digestion of the final soy product. Further alkali blanching improves the inactivation of the trypsin inhibitors. From a processing point of view alkali blanching is an advantage as it depresses foam formation during production.

Hydration of the beans prior to grinding improves the grinding efficiency and takes place during soaking or continuous blanching. Soaking promotes the formation of a beany flavour in the soy product, which is desired in some parts of the world, for instance in many of the Asian countries. During blanching lipoxidases and trypsin inhibitors are inactivated. The presence of lipoxidases in the product results in development of beany flavour.

The grinding results in a colloid solution of the soy beans in water, also called soy slurry. The concentration of the slurry and hence the protein concentration in the soy base is determined by the bean to water ratio at the inlet to the grinders. The soy base containing proteins, soluble carbohydrates and oils now has to be separated from the fibre material, okara. This is done by means of a decanter centrifuge. The efficiency of the decanter is important for the yield as well as for the quality of the soy milk. For optimized yield the moisture content in the okara should be low. Likewise, the amount of sediment in the slurry should be low to avoid chalkiness caused by insoluble particles in the final soy product. An efficient decanter removes up to 99.8% of the sedimentable solids.

For removal of undesirable volatile off-flavours giving beany
flavour, the soy base is exposed to direct steam infusion heating to 140°C followed by flash cooling and vacuum desodorisation. This process not only removes the volatile off-flavours, it also inactivates the trypsin inhibitors and any enzymes not yet inactivated and which might have led to formation of off-flavour during storage. Further, it removes air from the product which otherwise could have caused oxidation in the product.

The soy base is now ready for standardization to the desired protein content and composition by adding water and other ingredients and further processing into for instance soy milk, soy drink, yoghurt and ice cream.

Production of soy milk
The first step in the production of soy milk is standardization and formulation of the soy milk base. Basically, two different types of soy milk are produced:

The Western style resembles dairy milk when looking at the protein content, as soy milk is seen as an alternative to cow's milk. The product typically contains approx. 3% protein, 2% oil and 2% carbohydrates. It may be fortified with e.g. calcium and vitamins. It is used for drinking as well as for cooking, which is challenging the technological properties of the product. Further, flavoured versions such as chocolate and vanilla soy milk are often seen.

The Asian style soy milk is more of a beverage with lower protein content, down to 1% and higher sugar level; 5-10% added sugar is quite common. As for the Western style, the beverages may be fortified as well as flavoured.

Nowadays, a large part of the industrially produced soy milk is produced by means of the UHT process and aseptic filling, thereby obtaining a long shelf-life at room temperature. This puts a great demand to the stability of the product as a homogeneous product throughout the entire shelf-life is necessary for the consumer's acceptance of the product. Direct as well as indirect UHT systems may be applied. From a stability as well as from a sensory point of view direct systems are preferred. Direct systems result in less chemical changes in the product due to a lower total heat load and extraction of oxygen from the product in the vacuum chamber. The indirect system is, however, often preferred due to lower investment and running costs.

Whichever UHT system is used, application of emulsifiers and stabilizers in soy milk and soy milk beverages is necessary. The products are emulsions of oil in water and for ensuring optimal emulsion stability, i.e. reducing creaming, during the entire shelf-life, not only proper homogenization but also addition of selected emulsifiers and stabilizers is necessary. Further, the stabilizers improve the stability of the proteins minimizing sedimentation during storage of the soy product.

The functionality of the emulsifiers and stabilizers are described below.

Emulsifiers for soy products
Mono- and diglycerides of fatty acids are commonly used as emulsifiers in liquid soy products. Mono- and diglycerides are emulsifiers produced by the reaction of edible vegetable fats and oils and glycerol. The result is a molecule with a hydrophilic and a lipophilic part and consequently it will locate at the interface between the fat/ protein and water. This happens during homogenization of the soy milk. The mono- and diglycerides complex with the soy proteins, making the fat globule membrane more resistant towards coalescence. Hence, they reduce the...
creaming or fat separation in the product. However, they do also reduce the net charge of the fat globule and thereby increase the flocculation of the fat globules forming a three-dimensional network improving the creaminess in the drink.

**Stabilizers for soy products**

Carrageenan is by far the most commonly used stabilizer in soy milk. Carrageenan is extracted from seaweed. The carrageenan forms a helix with negatively charged sulphate groups turning outwards. This helix interacts to some extent with the protein particles preventing sedimentation in the product. In a chocolate drink a 3 dimensional network formed by the carrageenan keeps the cocoa particles in suspension. Combined with mono- and diglycerides carrageenan ensures a stable and homogeneous soy milk during the entire shelf-life.

**Integrated blends of emulsifiers & stabilizers**

For use in soy milk and soy drinks Palsgaard has developed the integrated emulsifier and stabilizer system Palsgaard® RecMilk 122. RecMilk® 122 includes mono- and diglycerides and carrageenan as the main stabilizer. If the soy milk contains particles, as for instance in soy chocolate milk and soy chocolate drink, which has to be dispersed Palsgaard® ChoMilk 199 has to be used. Palsgaard® ChoMilk 199 also includes mono- and diglycerides and carrageenan, however the composition is adjusted to stabilize the particles in the drink.

**Pilot plant for soy base**

Palsgaard produces blends of emulsifiers and stabilizers suitable for soy milk and soy milk beverages. With the soy pilot plant provided by SPX in Palsgaard’s application centre in Singapore, which is already equipped with a fully flexible UHT pilot plant, equipment for yoghurt production and a continuous ice cream freezer, Palsgaard offers soy milk manufacturers a unique opportunity to test and define the optimal processing parameters of the soy milk base as required for the further treatment into new recipes of end products with improved sensory qualities as well as storage stability. All the way from the whole soy bean to the final consumer product.

For further information on how Palsgaard can help manufacturers of soy milk, yoghurt and ice cream please visit [www.palsgaard.com](http://www.palsgaard.com) or contact Product Manager Hanne K. Ludvigsen at hkl@palsgaard.dk or Tel. +45 7682 7682.