

## Proposal for New Soybean Milk Extraction System

~In order to make delicious tofu and for stable tofu production~

### <Introduction>

As a standard to decide the quality of tofu, the method currently practiced in the tofu industry is via actual testing and sensory evaluation (such as evaluating the color, external appearance, and the taste of tofu, etc.), which has not departed from the evaluation of human sense yet.

This proposal provides the most essential meaning to the tofu industry.

1. The selection of raw material (soybeans)
2. The extraction of soybean milk from soybeans

It is considered that the previously mentioned two elements determine the greater part of tofu production; and this proposal is to propose "a system", aiming to evaluate the quality of tofu through scientific numeric analysis, and based upon the results, improvement should be made to the machines/ devices to rise the quality of tofu without relying on the aforementioned sensuous way of thinking. Furthermore, this proposal presupposes that no anti-foaming agent is used in tofu production.

Although the protein of soybeans solidifies and its structure forms via heat, the following elements have mutual interaction with each other, determining the quality of tofu.

- (1) The concentration level of protein
- (2) Heating temperature and time
- (3) The pH level of tofu/ soybean milk and salt (coagulants)

1. The selection of raw materials (soybeans)
  - (1) disuse of genetically modified soybeans
  - (2) soybeans from contracted farming (self-management)
  - (3) soybeans from organic farming and pesticide-free
  - (4) domestically produced soybeans

## 2. Regarding the protein of soybeans

### (1) Chemical composition of soybeans

*Water	12%
*Protein	35%
*Fat	20%
*Sugar	23%
*Fiber	4.3%
*Ash content	5%
*Calcium	0.2%
*Phosphorus	0.5%

### (2) Soybean globulin (the detailed explanation is described on another sheet)

(Glycyrin)	Molecular weight
	7S
	11S (7S and 11S account for 70%)
	2S
	15S

\*7S and 11S are the two main ingredients constituting soybean protein.

## 3. Whether it is boiling or not... (Regarding heating of unrefined soybean milk)

This process has the most significant meaning in tofu production.

i.e. Via boiling, protein, fat, and other ingredients of soybeans are sufficiently liquated, and additionally heat performs protein composition replacement. Depending on the quality of the composition replacement, it generates a difference in water holding ability and resilience. The most important point is to produce high quality of gel at this process. Apart from this, it is also effective in removing raw soybeans' grassy smell, inactivating trypsin inhibitor, improving the digestibility of soybean protein, and sterilizing the bacteria which attach the soybeans. Regarding the tofu produced from properly heated soybean milk, it possesses excellent resilience and waterholding ability. However, in case of insufficient heating, coagulation becomes unstable and cannot be expected.

The methods to confirm whether the above-mentioned boiling is properly performed or not are as follows.

- (1) The amount of SH groups: Ultracentrifuge sedimentation analysis
- (2) Read the wavelength of spectrophotometer

(3) Measuring its viscosity: if below 20cp–30cp, there is no problem.

#### 4. The concentration level of protein

<If pH level is close to neutral>

The borderline to whether hold the entire water and gelate or not is between 5%-10%. If the concentration level of protein is 6%, the soybean milk would coagulate. However, the physical characteristic of the formed gel would change into a firm structure along with the increase of protein. As an evaluation of tofu, the requirement for the solid content in soybean milk is 12% or higher.

If the concentration level is high (if the solid content in soybean milk is 12%-14%), the tofu would have a rich flavor. Furthermore, the best firmness for the texture is considered to be able to crush the subject by tongue.

If the concentration level of protein is raised, the following conditions would occur, which would become an hindrance to tofu production (from the taste, texture, and visual aspects).

- (1) Heat does not conduct easily and equally
- (2) The viscosity would increase
- (3) A large amount of bubbles would form and remain

With the “New Soybean Milk Extraction System”, via preheater to heat, screw press to extract soybean milk, and indirect heating and boiling down device to reheat during the heating and maturing process, the viscosity of soybean milk can be reduced. In addition to this, it is able to remove soybean milk’s residual oxygen via the use of deaerator (deflating equipment). As a result, it is possible to produce high quality soybean milk as well as to provide a stable and high-level tofu production.

#### 5. Regarding pH and salt (coagulants)

When gel’s pH value is 6.5 or higher, it possesses supple resilience and demonstrates high waterholding ability. For the gel with a pH value of 6.0 or less, not only is it extremely fragile and easily to break when pressure is applied, but it also spits water. During soybean milk production, if pH value changes at a range of 0.1–0.2, the concentration level of hydrogen ion would vary from 20% to 30%. Consequently, the chemical reaction caused by the gel and coagulants occurs, which would affect its waterholding ability and resilience. Taking momen (firm) tofu as an example, there would be a difference (a decrease in product’s weight) in squeezing during the pressing process, which would lead to loss.

## 6. Regarding SH groups (proportion of 7S and 11S)

The gelation of tofu (the transformation from liquid soybean milk state turning into solid tofu state) is due to the protein of soybeans, which accounts for approximately 35%. If the soybeans of tofu contain a large amount of protein, the tofu would be firm and solid. After conducting isoelectric precipitation to soybean protein with a pH value of 4.5, the substance is called glycinin, which would separate into 4 segments when an ultracentrifuge sedimentation analysis is performed. These segments, from lightweight in order, are called 2S, 7S, 11S, and 15S, of which the two, 7S and 11S, account for 70%-80% of the entire proportion. The influence of cultivar is larger than the growing environment of soybeans regarding the content of 7S and 11S.

\* 7S: Soft and pasty

\*11S: Firm and solid

Therefore, choosing a right cultivar of soybeans containing a small amount of 7S with a large amount of 11S (the values for 7S/11S are small) is the key to producing good tofu and having stable production.