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# Development of Tofu Processing Machine for 300-Mesh Soybean Micro Powder

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**Abstract**

*Tofu is one of the foods processed using soybeans in Korea, Japan and China that contains vegetable oil and abundant high-quality protein. Tofu production can be done manually or by using technology (machinery). Tofu manufacturing procedures consist of soaking, grinding, filtration, boiling, coagulation, and shaping. Tofu processing itself is also known to greatly affect the taste, quality, and texture of tofu produced. Therefore, in its processing, the process must be considered properly, include the machine used. Tofu production is also generally known still to cause environmental pollution due to waste products produced, okara. Okara causes environmental pollution due to protein damage and loss of water-soluble amino acids. In order to overcome that problem, the development of a tofu processing machine based on soybean micro-powder was carried out in this study. Micro powders were predicted can be used as one of the solutions to remove Okara. The tofu processing machine procedures were developed consist of mixing soybean powder, boiling process, coagulation, packing, up to sterilization. The system developed in the machine including the mixing and boiling vessels that are separated to increase the production speed; coagulation device; packing system consisted of plastic pack dispenser, film holder, sealer, cutter, motor and chain; and also sterilization system (at 85°C for 30 minutes). The machine developed in this study did not use a press system like making tofu in general. The result of this study showed that tofu obtained had a softer texture than pressed tofu. This is likely due not only to the omission of the physical pressing process during the manufacturing of tofu, but also to the coagulators used and the content of soluble dietary fibers.*

***Keywords:*** *Tofu, Machine development, Production, Micro powder, Soybean*

## 1. Introduction

Tofu is known as one of the foods processed using soybeans from Korea, Japan and China. Soybeans itself is known to contain high quality protein with 40% protein and 20% fat, and are highly nutritious because they can increase the digestibility of the protein. The total grain of cooked soybean digestibility was 65%, soybean oil made from soybean oil could reach 85% after soymilk prepared with soy protein degeneration after coagulation, digestion and up to 92%

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-98% absorption [1]. Because of that, tofu is also known as 'vegetable meat' because it contains vegetable oil with abundant of high-quality protein. Tofu also contains many micro-elements needed by the human body, including calcium, phosphorus, potassium and iron.

Tofu is actually known as the first produced from soybean porridge or milk. During the process, okara will be obtained as an insoluble residue after soymilk filtration. As a rule, one pound of dry beans is made from soy milk or tofu, which produces about 1.1 pounds of okara with about 80% moisture. It contains high levels of fiber and significant amounts of oils and proteins and is reported for its health-promoting functions such as antioxidant activity, hypolipidemia and hypoglycemic effects.

Okara presents a promising source of DF. Insoluble dietary fiber (IDF) is the dominant fraction of okara DF (> 90 g / 100 g). Cellulose and hemicellulose along with pectic substances are the main fractions of okara IDF, which make up bulk of dry matter content at 40–60%. In general, okara is used as feed or fertilizer [2]. However, during tofu production, okara also causes environmental pollution due to protein damage and loss of water-soluble amino acids. More than 90% of the water used to make tofu is wasted. Some of the problems that can be caused by coagulant wastewater in the manufacture of tofu are ecosystem damage, water degradation and many others [3]. To remove okara from tofu and prevent wasting coagulants, micropowders should be used.

As demand for tofu increases, demand for cheap tofu processing machines will increase. In general, tofu manufacturing procedures are including soaking, grinding, filtration, boiling, coagulation, and shaping [4][5][6]. This tofu processing procedures is known to be one important thing that needs attention. The taste, quality and texture of tofu prepared are greatly influenced by the processing parameters [7].

Soymilk is prepared using soybean powder, heat-treated, and soybean and coagulant are sprayed at one time. Compared to the conventional tofu production, the processing process is simpler and more economical, and it is always possible to manufacture homogeneous high-quality instant packaging tofu and to make various tofu products by adding raw materials.

## 2. Materials and methods

### 2.1. Materials

In order to ensure the functionality and price-competitiveness of the resulting product, a domestic species with high isoflavone content, low production cost, and price-competitiveness compared to imported soybeans, was selected for use in the experiment. In order to improve the yield rate while maintaining the soft flavor, soybean tofu was manufactured using soybeans micro pulverized to 300mesh. During the whole soybean tofu manufacturing process, natural bittern (prepared seawater magnesium chloride) and TG (transglutaminase, Ajinomoto Korea Inc.), were added to the soybean milk as coagulants with concentrations up to 0.9% of the soybean milk to strengthen the resilience of the whole soybean tofu.

### 2.2. Production flow of whole soybean tofu

The concept of production process for whole soybean tofu can be seen in [Figure.1]. The steps of tofu production in this study were chosen by following the standard process of tofu production while still following the adjustment of the raw materials used. The soybean tofu samples were commissioned and manufactured by Jayeondleae, Inc. The raw soybeans were passed through a cutting machine to make fine powder to 300-mesh. The resulting soybean powder was mixed with water to a concentration of 14°Bx and then heated for 30 minutes at 103°C to make warm soymilk. After finish, a 2:1 mixture of MgCl2 and Transglutaminase was added to the warm soymilk as a coagulant at a concentration of up to 0.9% of the total amount of the soybean milk, then packed and sterilized for 30 minutes at 85°C.

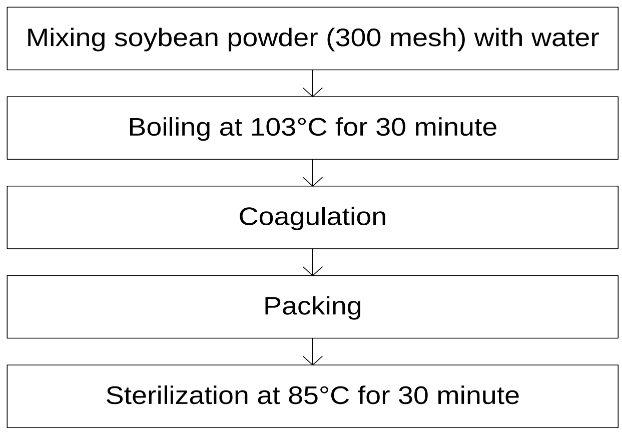



Figure 1. Production process of whole soybean tofu by using 300-mesh micro powder

## 3. System developments

In addition to the use of 300-mesh micro powder as raw material for making tofu, this study also developed the tofu production machines to produce higher quality tofu without causing environmental pollution. As it is known, every process in making tofu will also affect the quality of the tofu that is produced later. The 300-mesh micro soybean powder was obtained from the crushing process of soybean using a crusher developed by Pratama et al. [8] in his study. In the development of machines carried out in this study eliminated the process of pressing tofu at the end of manufacture. The system development carried out in this study can be seen below.

### 3.1. The design of mixing and boiling vessels

The mixing and boiling vessels as shown in [Figure 2] consists of two vessels, two pumps, two-valve, and heater. The vessels made of stainless steel with a capacity of 50L. Mixing and boiling vessels are separated to increase production speed. Therefore, the mixing process of the next round can be done while boiling the previous round.

The mixing pump was used to circulate the mixture during the mixing process and transfer the mixture from mixing vessel to boiling vessel after the mixing process finished. The boiling pump was used to circulate the warm soymilk during the boiling process and transfer it from the boiling vessel to a coagulation device. Valves were used to control the direction of the mixture. The boiling process was done by hot steam produced by the heater.

### 3.2. The design of coagulation

The coagulation device as shown in [Figure 3] works by mixing the coagulant to the warm soymilk. This part consists of a coagulant storage tank, pneumatic suction, valves, and outlet. The coagulant is stored in a storage tank. The capacity of this tank is 5L and the pressure was controlled by an air compressor. The pneumatic suction pulls in the exact amount of soybean milk and coagulant. 320g of soybean milk was mixed with 3 ml of coagulant to obtain a desirable texture. The tofu then ejected through the outlet to the plastic pack.

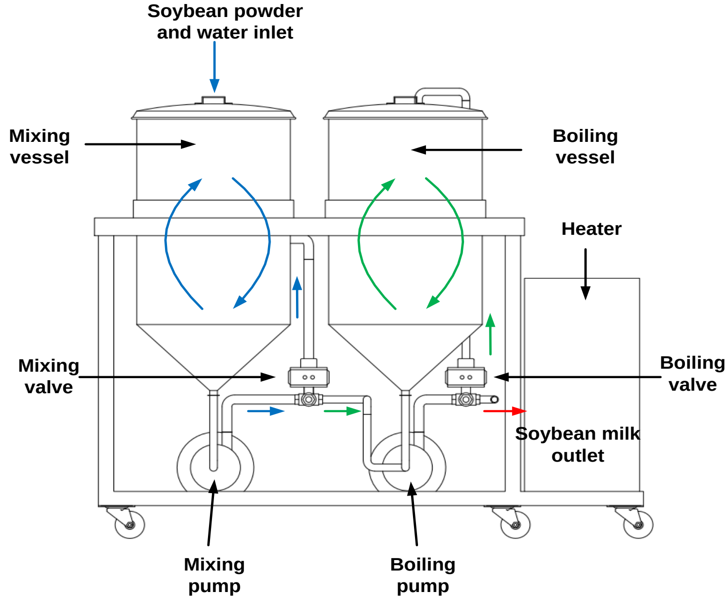



Figure 2. Mixing and boiling diagram

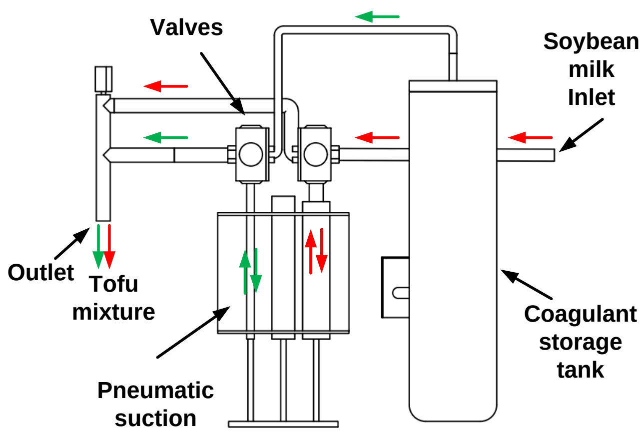



Figure 3. Coagulation system in the machine

### 3.3. The design of packing system

The design of the packing system was shown in [Figure 4]. It consists of plastic pack dispenser, film holder, sealer, cutter, motor, and chain. Firstly, the plastic pack dropped by a plastic dispenser then carried by chain. The chain was powered by DC motor. The tofu mixture then discharged into a plastic pack from the coagulation outlet. The plastic pack then covered by film and sealed using the heater. The film then cut using the cutter.

The difference in this machine system compared to the general tofu production was also on this step. Tofu mixture obtained after coagulation was then immediately continued to the packaging and sterilization process without the pressing process. This development was carried out due to reduce the factor of product damage because of the pressing process.

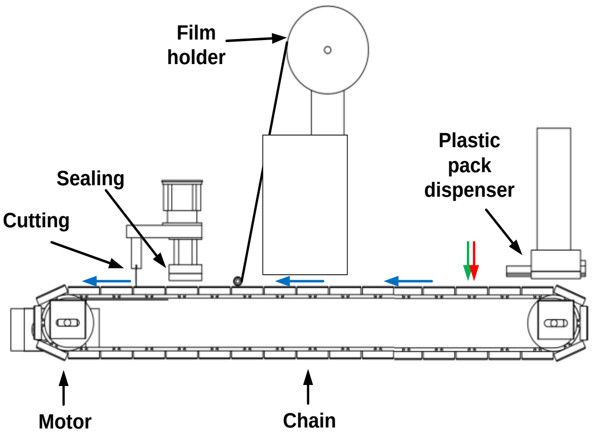
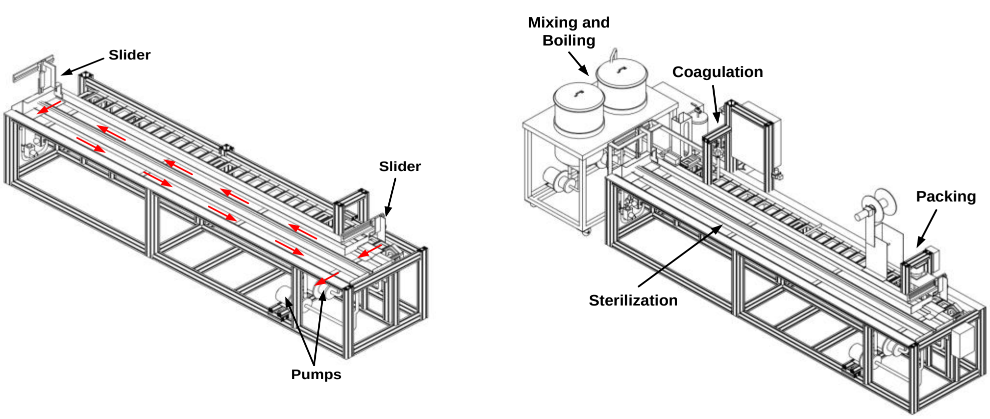



Figure 4. Packing system

### 3.4. Sterilization system

The design of the sterilization system was shown in [Figure 5 (a)]. It consists of two sliders, two pumps, and two ducts. After been packed the tofu was sterilized for 30 minutes at 85°C. The sterilization was done after being moved by a slider for the first time. The total assembly of the proposed tofu machine was shown in [Figure 5 (b)] as follows:




(a) Sterilization diagram

(b) Total assembly diagram

Figure 5. Sterilization assembly system

## 4. Results and discussion

The whole soybean tofu ingredient was shown in [Figure 6 (a)]. The powder was finely ground to size of 300-mesh. The tofu produced by proposed machine was shown in [Figure 6 (b)].

(a) Raw soybean powder 300mesh

(b) Final product of tofu

Figure 6. 300-mesh soybean powder and final product of tofu obtained

Compared with pressed soybean tofu, only the hardness value of whole soybean tofu was significantly reduced, whereas the springiness, cohesiveness, adhesiveness, and chewiness were all similar. Therefore, this result indicates that whole soybean tofu has a softer texture than pressed soybean tofu. This is likely due not only to the omission of the physical pressing process during the manufacturing of whole soybean tofu but also to the coagulators used and the content of soluble dietary fibers. Nowadays, consumers prefer soft properties and the softness of whole soybean tofu provides excellent distinctiveness for developing diet products and various whole soybean tofu products not restricted to side dishes.

## 5. Conclusion

The use of 300-mesh soybean powder can be used as an alternative to making tofu with a softer texture, but without producing okara. Whereas the engine system development that can be done was by modifying the separation of mixing and boiling vessels, direct connection with coagulation device, packing systems, and sterilization systems (at 85°C for 30 minutes), without going through the pressing process. In order to make it more convenient for families to use, it can also be developed in a small volume, with product moderation and easy-operation.

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