Designing and Fabrication of Integrated Soybean Machine (3 in 1 Process) to Optimize Tempe Producers Productivity

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ABSTRACT
This study aims to optimize the productivity of Tempe producers. Optimization is carried out through engineering research of the soybean machine 3 IN 1 process production capacity of 250 kg/hour to solve the problem of low productivity of stripping, solving, and separating the soybean husk. To guarantee the product's hygiene, the machine is made from food-grade material, namely stainless steel 304, to guarantee the effectiveness of production, the machine is designed with a production capacity of 250 kg/hr, to improve efficiency, the machine is designed using a low power electric mechanical motor by 350 watts and a transmission system using a V-belt. Engineering methods are carried out through the stages of design, manufacturing, assembly, function testing, analysis, discussion, and conclusions. The targeted research results are prototype design of Soybean Machine 3 IN 1 Process, the production capacity of 250 kg / h which is hygienic, effective, and efficient.

Keywords: *Soybean machine, Food grade, Hygienic.*

1. INTRODUCTION

Tempe is known as a healthy food that has high protein. Tempe is derived from soybeans. The easy manufacturing process makes Tempe entrepreneurs increase. According to the statistics of the Ministry of Trade and Industry in 2016, there were 115,000 Tempe entrepreneurs in Indonesia.

Soybean is one of the most nutritious foods consumed by people in Indonesia because it contains high protein. Soybeans are the raw material for food such as Tempe, tofu, soy sauce, tauco, and soy milk [1].

The process of making Tempe schematically can be seen in Figure 1. Based on Figure 1, the stages of the production process in making Tempe include the process of soaking, washing, boiling half-cooked, cracking and stripping soybean skin, separating soybean skin, boiling until cooked, cooling, soybean fermentation, packaging of fermented products (wrapped in plastic bags, wrapped in leaves, or spread on a table and covered with plastic or leaves), fermentation, Tempe and marketing. Soybean is the most important strategic commodity of agriculture in Indonesia besides corn and rice [2].

In making Tempe, the thing that determines and influences making Tempe is the separation of soybeans from the outer shell and the epidermis. The outer skin and epidermis in soybeans that will be processed into Tempe will affect the fermentation process [3].

Separating soybean from water skin aims to make the fermentation process distributed and produce good Tempe. Most of the Tempe craftsmen separate soybeans from the outer shell and epidermis using the manual method. This traditional stripping process has many disadvantages, it takes a long time, requires a lot of energy, is not hygienic and the stripping result is not [4], [5].

The quality of Tempe must meet SNI 3144: 2009 and always monitor the Indonesian Tempe House by reviewing the production process [6].

The soybean prices were fluctuating and affected the economic aspects of the sustainability of soybean farming. The result shows that income with a positive R/C value and the advantage achieved over the loan interest rate. The contribution of soybean farming was 18.87% of household income and the second from

37.77% of agricultural business income. The level of profit that can be obtained from household income gives the hope of sustainability of soybean farming [7].

The soybeans machine was constructed with stainless steel. It is made of hopper, bearing, components, pulley, belt, shaft, and spring. The machine's volumetric capacity 144 kg per day in five minutes. The machine 8.301 g/s in second and produce 0.0092 liters, it can produce 33.12 liters per hour [8].

Soybean milk machine design in China had some basic simple geometry with simple curves and curved faces. It is giving easy to achieve the art effect of simplicity, direct and clear. It is composed of a blender, heater, and control circuit. The motor is used to drive the blade to smash soybean into powder and heat water with 800C Temperature [9].

The research has shown results that real conditions can be observed into a model and performed a series of scenarios the decision to obtain best results using computer assistance showed that soybean production could be produced to the requirement of soybean demand in Indonesia for twenty years by increasing expansion of soil approximately 70% per year [10].

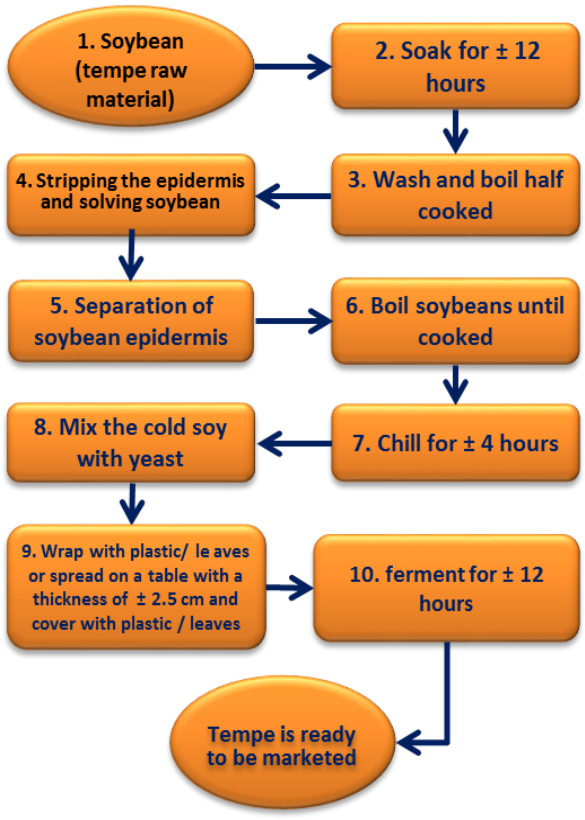

Figure 1 Flow chart of Tempe making process

The fermentation process for making Tempe is packaged in two ways, namely (1) a mixture of soybean and yeast that is ready to be fermented directly packed in a plastic bag or wrapped in a banana leaf, and (2) a mixture of soybeans and yeast that is ready to be fermented, sown and spread on the table which has been coated in plastic/banana leaf with a thickness of soybeans ± 3 cm and covered again with plastic or banana leaf. To speed up the fermentation process, then on top of a bed of soybeans that have been covered with plastic, are covered with wooden boards like Figure 2.

a. Soybean that has been mixed with yeast is packaged in a plastic bag for the fermentation process.

b. Soy that has been mixed with yeast wrapped in banana leaves for the fermentation process.

c. Soybeans that have been mixed with packaged yeast are spread on a table, covered in plastic, and covered with wood.

Figure 2 The process of fermentation in Tempe production

Based on the findings of this problem, the research team researched soybean processing production technology engineering that combines three production processes, namely the process of stripping, breaking, and separating the soybean husk into one production process, namely "3 In 1 Soybean Machine" to optimize the productivity of Tempe producers.

The purpose of this study is to produce a hygienic, effective and efficient 3 In 1 Soybean Machine. The machine is designed with the following specifications: (a) dimensions of length 850 mm, width 700 mm and height 120 mm, (b) Capacity of 500 kg/hr, (c) Full food-grade material; (d) 350-watt low power electric motor drive, and (e) Pulley and v-belt transmission systems.

The urgency of this research is that the process of stripping, splitting, and separating the husk of soybean at Tempe producers is currently done separately. The process of breaking and stripping the soybean husk is done by using a machine and the process of splitting the soybean husk is done separately through mining. The process of breaking and stripping the soybean husk using a production capacity of ± 150 kg/hour and the process of splitting the epidermis through mining the production capacity of ± 30 kg/hour. The average production capacity is 25 kg/hour with less than maximum product quality and less hygienic because the production equipment is not food grade. This has an impact on the need for more labor, longer time, higher production costs, and less hygienic products.

2. METHOD

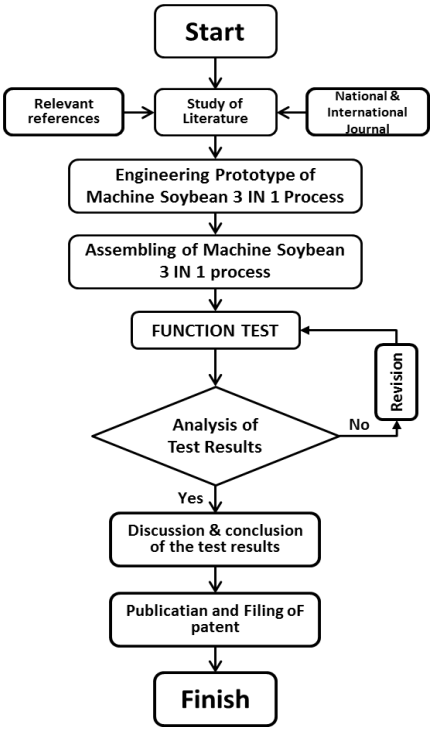

Figure 3 Engineering flowchart of machine 3 in 1 process

Engineering methods to design a "3 in 1 process soybean machine" used to increase the productivity of Tempe producers are shown in Figure 3.

2.1 Study of Literature

State of the art in the field under study and study relevant literature studies. This research aims to produce of production machine of stripping, cracking and separating soybean husk hygienic, effective and efficient to optimize the productivity of Tempe producers. The processof stripping, breaking, and separating the soybean husk which takes place all this time takes a long time, a lot of energy and high production costs, and the quality of the skin-stripping and breaking of soy is not good, because there are still many soybeans that have not broken and have not been peeled. This makes the productivity of Tempe producers less optimal so it does not develop. The solution to solve this problem is a soybean machine of 3 in 1 process, which is a soybean processing machine that unites the process of stripping, solving, and separating the soybean husk in one production machine. To support the success of this researchin designing a 3 in 1 process soybean engine, researchers conducted studies and traced relevant literature studies.

Some research results that have been conducted by researchers and other relevant journals of researchers are used by the researcher as literature in designing the soybean machine of 3 in 1 process among others: Yunus [11] research report examines the application of a semi-manual soybean skin peeler and peeler. driven by foot stamping, Yunus [12] a research report on action research through a community service program about the engineering and application of the electric soybean skin-breaking andpeeling machine for electric motor with the direction of the outlet turning sideways, Yunus [13] report on the results of the design of the breaking machine and Peel the soybean skin to increase the quantity and quality of the breaking and stripping of the soybean skin in the small industrial group ofmechanical electric Tempe motors with a straight-down outlet to reduce water consumption, Rofiq, et al. [14] superior research journal of the university which has the title "Boosting the Creative Home Industry of the Community Through the Implementation of Multifunctional Soybean Food Processing Machine Based on Multicultural Character Building in the Merapi Volcano Disaster Region in the Special Region of Yogyakarta", Wisnujati, A. [1] journal of skin peeling research ari screw type soybean, Wardjito, Suyadi [15] design of the epidermis and skin separator design in one work process of the electric motor mechanic, Muchayar & Aris Munandar [16] engineering machinery forbreaking and peeling the soybean ari skin, Muliatna [17] service report to the public about increasing the quantity and quality of soybean peel in the small Tempe industrial group through the design and application of soybean peeling machines.

Similar research was also carried out by Arsana, the results of this study were obtained at the performance of machine design particularly in meatball forming machine accommodated meatball with larger capacity. Used 3 blades can produce 232 meatball/minutes [18]

The study of engine design that has been designed has almost the same constraints, low tool efficiency, small tool capacity, high percentage of crushed soybeans, and machinesmade for one type of material. In addition, engineering machines designed only can peel soybeans and break down soybeans, bran and broken soybeans are still mixed, so breaking soybean husks must be carried out through a mining process in a water pool. The mining process requiresa long time, a lot of energy, and high production costs [So it is necessary to develop to overcome the obstacles from the design work that has been done. This research produces a production machine for peeling, cracking, and separating soybean husks into one production process, namely "3 In 1 Process Soybean Machine" to optimize the productivity of Tempeh producers.

From the studies of several reports and research journals above, it shows that engineered machinery only can peel the soybean husk and break the soybean, the epidermis and the broken soybean are still mixed sothat the process of splitting the soybean husk must be done separately through the mining process in water pool. The mining process requires a long time, a lot of energy, and highproduction costs. To solve this problem, it is very urgent to research the engineering of soybean processing technology production of Tempe raw materials that can carry out the process of stripping, solving, and separating the skin of soybean, to optimize the productivity of Tempe producers.

2.2 Engineering Prototype of Machine Soybean 3 IN 1 Process

To simplify the manufacturing process, variables to be identified for the design of Soybean Machine in of "3 in 1 Process. Determining Variable Engineering Data of Soybean Machines 3 In 1 Process that have been identified are presented in Table 1.

After the determinant variable data for engineering is identified, the next step is making the soybean engine design a 3 in 1 process. The design of the soybean 3 in 1 process produced can be seen in figure 4.

Table 1. Determining variable data for the engineering of soybean machine 3 in 1 process

Determinant Variable	Information	Output
Machine frame and 3 in 1soybean engine components	Stainless steel 304	Sturdy, attractive (aesthetic) appearance, Food grade
Energy sources	Low power electric motor 0.5 HP	Energy saving
Mechanical systems	Electric motor drive	Fine / not noisy
Transmission system	Pulley and V-belt	Fine / not noisy
Soil-breaking jaggedcurved plate	Soybean reflective and anchoring	Soybean broke
Cylinder of Bordes Patterned	Activator, suppressor of soybean and soybean epidermis	Soybean broke and fell on a clean soybean outlet the epidermis attaches to the landing cylinder
Rubber anchoring/pressing	Soybean presses and soybean husk into cylinders	
Rubber epidermis sweeper	The epidermis on the cylinderis swept away and falls on theoutlet of the soybean epidermis	The soybean husk comes out through the soybean husk outlet
The slope angle of thesoybean inlet hopper	soybean intake	The speed/capacity of soybean flow into the machine
The slope of the soybean outlet	Clean soybean outflow speed	Soybean production capacity
Tilt angle of the soybean epidermis outlet (outlet of thesoybean epidermis)	Speed of outflow of soybean epidermis	Soybean husk production capacity
Size & distance bordermotif	Soybean drive& soybean separator fromthe epidermis	The most effective production capacity

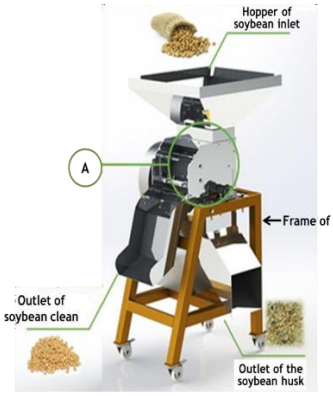

Figure 4 Soybean machine 3 in 1 process

Detailed descriptions of soybean processing components can be seen in Figure 5.

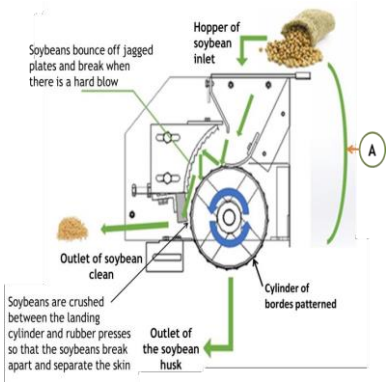

Figure 5 Detailed description of soybean processing components

2.3 Manufacture and assembly of soybean machines 3 in 1 process

After the engine design is complete, the next step is the manufacture and assembly of engine components based on the design, until a hygienic, effective and efficient 3 in 1 soybean machine is produced. The process of making the components of the engine and assembly takes a long time. It is targeted that within 2.5 months the machine will be finished. If there are problems in the manufacturing or assembly process, they will use the services of a public workshop or hire a handyman to complete the manufacturing of the machine, but researchers believe they can make their machines

2.4 Function Test

Function test stage. After the 3 in 1 soybean machine design process is complete, a function test is performed. Function tests are carried out to determine the optimal performance of the 3 in 1 process soybean machine as designed. The function test is performed by simulating varying engine speed settings and other related component settings. This function test is intended to obtain data about the best quality and quantity of stripping production, breakdown, and separation of soybean husk. The quality of the peeler is said to be good if all the peel is peeled off, the quality of the breakdown is said to be good if the soybean breaks in half (not destroyed) and the quality of the separation of the soybean husk is good if all the husk is separated from soybeans.

2.5 Analysis of Test Results

This stage is carried out after the engine function test is carried out. At this stage, the machine work system will be analyzed, both from the movement, the stability of the machine, and the shape of the perfection of processing results. If the machine does not match what was designed, failure analysis and revision action must be performed.

3. RESULTS AND DISCUSSION

The process of stripping, breaking, and separating the soybean husk at Tempeh producers is currently carried out separately. The process of breaking and stripping the soybean husk is done by using a machine and the process of splitting the soybean husk is done through the mining process. The process of breaking and stripping the soybean shell using a production capacity of ± 150 kg/hour and the process of splitting the epidermis through the mining process of the production capacity of ± 30 kg/hour, so that the average production capacity of stripping, splitting and separating the soybean shells is 25 kg/hour. The process of stripping, breaking, and separating the soybean husk which is done separately is ineffective and inefficient because it requires more labor, longer time, higher production costs, and the quality of the product produced is less than the maximum because there are still many epidermis soybeans are left behind in soybeans and are less hygienic because their production equipment is not food grade. Based on these data, it shows that the productivity of Tempeh producers is not yet optimal. To optimize the productivity of these Tempeh producers, engineering "3 in 1 Soybean Process Machine" was carried out. Soybean machines designed are as follows: (1) engine dimensions (850 x 700 x 1200) mm, (2) production capacity of 250 kg/hour, (3) 350-watt electric motor, (4) v-belt pulley transmission, (5) hopper inlet power holds 5 kg, (6) accuracy of breaking soybean shells ± 95% of the total capacity of the engine, and (7) all engine components that come in contact with soy are made from food-grade materials. The process of separating the soybean husk is done automatically when the soybean is put into the machine. Soybean enters the engine is dragged by a revolved cylindrical pattern borders, and held by a toothed arch plate. Soybean is peeled off and broken when there is pressure on the soybean by pressing rubber on the cylinder wall borders. The broken soybean falls in and out through the soybean

outlet and the soybean epidermis sticks to the walls of the landing cylinder and is swept by rubber sweepers and falls on the epidermis outlet. This process takes place continuously.

4. CONCLUSION

Soybean Machine 3 in 1 process of mechanical an electric motor produced from this engineering has dimensions (850 x 700 x 1200) mm, a production capacity of 250 kg/h, 350-watt electric motor power and transmission using a v-belt pulley. This 3 in 1 Soybean Machine can increase production capacity 10 times compared to peeling, crushing, and separating the soybean husk separately. Machine production capacity can beincreased by increasing the size of the machine dimensions. By using this machine, efforts to optimize the productivity of Tempe producers can be realized.

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