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Design and Application of Milk Fish Preserving Machine Using Liquid Smoke Method to Prevent Rotting Fish and Enhance Storability of the Fish

1st Agung Sudrajad
Department of Mechanical Engineering
Universitas Sultan Ageng Tirtayasa,
Indonesia Center of Execelenc for Food Security (I-CEFORY),
UNTIRTA (Local Food Innovation)
Serang, Indonesia
email: Agung@untirta.ac.id

2st Iman Saefuloh
Department of Mechanical Engineering
Universitas Sultan Ageng Tirtayasa
Serang, Indonesia
email: iman.saefuloh@untirta.ac.id

3rd Dhimas Satria
Department of Mechanical Engineering
Universitas Sultan Ageng Tirtayasa
Serang, Indonesia
email: Agung@untirta.ac.id

4th Haryadi Surname
Department of Mechanical Engineering
Universitas Sultan Ageng Tirtayasa
Serang, Indonesia
email: Agung@untirta.ac.id

5th Risky Abi Pangestu
Department of Mechanical Engineering
Universitas Sultan Ageng Tirtayasa
Serang, Indonesia
email: Agung@untirta.ac.id

6th Andi Abdillah
Department of Mechanical Engineering
Universitas Sultan Ageng Tirtayasa
Serang, Indonesia
email: Agung@untirta.ac.id

***Abstract*— Fish is well-known to be nutritious as it contains high quality protein, all types of essential amino acids, including lysine amino acids. Milkfish (Chanos-chanos forsk), known as *ikan bandeng* in Indonesian language, contains high rate of lysine amino acids, approximately 20% of its whole content of amino acids. However, milkfish is able to quickly rot both chemically and microbiologically if it does not get the right treatment. Various efforts to prevent the decline / damage of milkfish have been carried out, including the preservation process. One of the preservation processes is undertaken by smoking methods. Smoke can be used as a preservative because it contains antioxidant, antimicrobial components, for example phenol and acetic acid. Smoking can be done in two ways, namely hot smoking and cold smoking. Hot smoking is carried out on direct fire. This method causes the benzopyrene compounds, which are carcinogens, to stick on the smoked fish. Cold smoking is carried out by condensing smoke into liquid smoke, so that the bezopyrene compounds that prevail will precipitate and do not condense. Liquid resulted from the condensed smoke is diluted and can be used to preserve fish and other food. In the cold smoking method, the smoking process is carried out in room temperature. However, this method has a weakness, namely it takes a relatively long time for the smoke liquid to be absorbed by the fish pores. Therefore, a machine is needed to fasten the cold smoking process without degrading the quality of the resulted fish. This study focuses on the efforts of the researchers to design milkfish liquid smoking machine that is effective to prevent potential problems in the smoking process. The design consists of the first three parts of the machine: (1) smoke-producing machine, (2) a reservoir of liquid smoke, and (3) milkfish distribution to a liquid smoke tank storage and pickling process. All of the three machines are designed integrated.**

Keywords: component, formatting, style, styling, insert

I. INTRODUCTION

Fish as a food source is a source of high-quality protein with the advantages of providing all types of essential amino acids and the adequacy of providing the amino acids lysine, methionine, and histidine. The three amino acids are limiting amino acids which in the most vegetable matter are very small in number, as in corn, even in some other ingredients do not have them. In general, all types of fish contain 17-25% protein. The protein content of milkfish is 20%. Fish and its processed products are food ingredients that contain complete amino acids including 10 types of essential amino acids that cannot be synthesized in the human body [1-2].

However, fish have a disadvantage, such as they are quickly damaged both chemically and microbiologically if they do not get proper treatment. Various efforts to prevent the decline/damage of fish have been done, one of which is by the preservation process, and one of the fish preservation processes is by smoking method [3]. Smoke can be used as a preservative because it contains antioxidant, antimicrobial components, for example, phenol and acetic acid. Smoking can be done in two ways, namely hot smoking and cold smoking. Hot smoking is done by placing fish on a direct fire, while cold smoking is by immersing the fish in a liquid smoke solution from pyrolysis [4].

Smoking directly causes the following benzopyrene compounds which are carcinogens while cold smoking is carried out by condensing smoke into liquid smoke so that the benzopyrene compound will precipitate from not being condensed [4-5]. The diluted smoke obtained is used to preserve fish or other food ingredients. In the cold smoking process, the temperature is carried out at the open-air room. The disadvantage of liquid smoke is the process of absorbing liquid smoke from the pores of milkfish must be done for a long time, so it is necessary to design a machine

that can accelerate the liquid smoke process with a good quality of smoked fish.

Based on these problems, the researchers try to do research on the design of milkfish liquid smoking machine by considering the problem factors as stated

II. THEORY

The product is the output obtained from a production process (transformation) and is the added value of the raw material (material input) and is a commodity sold by the company to consumers. Product design and development are all processes related to the existence of products which include all activities ranging from identification of consumer desires to fabrication, sales and delivery of products. Product design and development become a part of the innovation process that exists in the world of business [7]. Through product design and development, it is expected that new product innovations will be able to provide certain advantages in overcoming competition with competitors' products. Some of the main reasons underlying the need for continuous product design and development are financial goals, sales growth, response to competition, capacity advantage, product life cycle, and response to environmental changes.

The physical (hardcore) components make up the product into three main parts, they are the core component, the packaging component and the supporting service component (Figure 1). The core part is the part that must exist in the product that is the physical form and functional aspects of the product. While the packaging components include quality, price, trademark, design, packaging and price aspects. Besides the two parts of the product, a product has a supporting service section which includes delivery, warranties, spare parts, agencies, and repairs/maintenance [8].

The product design process can be broadly divided into generic design processes and technology push. Generic processes place market conditions as the basis for product design and development. A company will begin product development after seeing market opportunities and only then uses technology that is judged appropriate to provide satisfaction to customers in need. The resulting product comes from what consumers feel or complain about. So in the generic process, the market opportunity takes precedence only by seeing the utilization of the technology used. There is a strong relationship between market orientation and the success of a product [9]. Organizational climate is also indirectly related to product performance through market orientation. Slightly different from the results of previous studies, market orientation is not strongly related directly to product performance, but performance is influenced by market orientation through launching tactics [10].

From the engineering view [11], it is suggested that research on engineering design should be improved in terms of:

a. Relationships with markets, consumers and design information
b. Support the release of products in the market and
c. Equate product features with the value of the community (customer value) to ensure the continued level of return, especially in small industries.

Unlike the generic process, technology push places more emphasis on company innovation based on technology development. Unlike the generic process, consumers are only created after the goods are produced. Generally, the products produced by this process are products based on the development of science and technology. It was stated that the generic process of product development had five important stages [12] they are concept development, system-level design, detailed design, testing and refinement, and testing production process as follow:

1. Concept development: At this stage, the market needs (target) must be known, also need to build and evaluate alternative product concepts and ultimately the product concepts to be developed. Some of the activities included in this stage are the identification of consumer desires, analysis of product competition, determination of target specifications, concept development, concept selection, financial analysis, and product development project planning. Knowledge of consumer desires for products is one of the determining factors for product success. Five data collection methods that are frequently used are interviews, focus groups, observations, product clinics, and questionnaires. Analysis of competition is needed to see the position of the product in the market so that a product's excellence factor can be identified. This stage will produce a score of competition between products based on consumer desires and technical measurements. The results of this competition analysis are used to determine the target specifications. Some product design concepts are then raised by paying attention to the vision of product development and product specification targets. Concept generation can be done by searching from outside or within the organization. Ideas from outside are obtained from benchmarking, consumer complaints, experts, and literature. Some of the product concepts produced were then selected for further development. Financial analysis will be carried out on the chosen concept. Project planning is then carried out on the concept.
2. Level System Design: This stage includes defining the product architecture, dividing the product into its components, and defining the product assembly scheme. The output is in the form of components and product compilers, specifications of each product component and precedence diagrams that illustrate the interrelation of activities on the assembly line.
3. Detailed Design: This stage produces complete specifications regarding the geometric shape of the product and its components, the material used, and the size and tolerance of all components (parts) and products.
4. Tests and Improvements: At this stage, it involves making a prototype product to be evaluated before the production process is carried out.
5. Production Ramp-Up: This stage aims to train workers and to find out the problems that occur when the product is tried to be made.

III. METHOD

3.1 Mission Statement

Case studies were carried out in Serang City and Cilegon with respondents from fish smokers.

TABLE 1. MISSION STATEMENT

Mission Statement : milkfish liquid smoking machine	
Description of the Products	Operated by hands
Business Target	Marketed for the lower middle class industry
Main Market	People who work as fish grills
Secondary Market	Households and middle to lower scale restaurants
Assumptions	▪ Operated by hands ▪ Material made of aluminum, iron and wheels ▪ Using charcoal fuel ▪ Products are equipped with chimney, wheel, thermometer, push and handle attributes

3.2 Identification of Customer

Step 1. Collect raw data from customers

In identifying customer needs for fish smokers' products, the researchers collect data through several methods including interviews, observations and questionnaires. In selecting the customer, the writer determines the market segment and then determines the types of customers, then creates a customer selection matrix for the manufacture of fish smokers. The purpose of this matrix is to choose a variety of customers to be interviewed.

Step 2 Interpret Raw Data into Customer Needs

Step 3 Organizing Needs to Become Hierarchical

Table 2. Matrix of customer selection for a smoked fish project

Market segments		
Households	0	6
Professional fish grills (very often use)	8	0
Restaurant / Mid-Range Restaurant	0	5

The following is a hierarchical list of primary, secondary and tertiary needs for fish smoker machine. From the results of grouping cards based on similarity of expressed needs, the following data is produced:

- Heaters are able to preserve fish in large quantities (effective)
- This machine uses hot coals so that the heat produced is more stable
- This machine has a working principle that is air conditioning through the help of the room flowing smoke from the combustion
- The resulting air circulation causes conditions in the absorption chamber to obtain relatively the same temperature
- Equipped with ash disposal to avoid dirty around the heater
- Prices are relatively cheap so they can be affordable by the middle to lower classes
- The quality of material made of Stainless Steel allows the selection of this lighter tool to easily be moved but able to resist rust
- In terms of ergonomics, it is tired-free, because after the embers ignite, this machine can be left and work alone by itself
- The safety of using this machine is quite good because the model is closed so it does not cause a spark
- Maintenance is relatively easy because the principle works is simple but with maximum results
- Charcoal as fuel is cheap and easy to get
- Equipped with a grip (hand-handle) to push the machine to move
- The main function is to reduce the water content contained in fish, so that fish are more durable
- To view and control temperature, equipped with a temperature thermometer
- Because it can accommodate fish with a lot of capacity, the energy expended for one preservation will be more/equal with the capacity
- Because the production capacity is more produced then the profit obtained will be increased

TABLE 3. PRODUCT NEEDS HIERARCHY

List of Needs	Needs		
	***	**	*!
Able to produce liquid smoke in large quantities	p\Produce liquid smoke in large quantities		
Use liquid smoke	The fish is smoked with liquid properly and when it is opened it doesn't burn		
Air conditioning/smoke condensation	Smoke is condensed and after it turns into liquid smoke it is held in a container	Equipment cleanliness is maintained	
Use liquid smoke	Temperature is not too high so it does not damage the milkfish		
Air circulation in the oven	Temperature evenly		
Material Quality	Safe for processed food products		
Does not cause fatigue	Does not use human manual labor/erosion by hands		Embers of the process of
			processing liquid smoke continues to ignite
Harga Produk olahan hasil pengasapan cair	The price of milkfish has remained stable compared to before it was smoked liquid		
Safe	The results of smoking are safe from chemical compounds that are harmful to the human body		
Maintenance	Easy to maintain and safe to use by users/operators		
Handling	Easy to operate		

Step 4 Establish the relative importance

Every Need of the hierarchical list does not provide information about the relative importance that customers receive from different needs. Meanwhile, the development

team must prioritize and allocate natural resources to design the product.
Step 5 Reflecting Results and Process
The final step is the approval of customer needs. The team must complete the results to prove with the knowledge and intuition that has been developed through a long period of interaction with the customer.

3.3 Determination of Product Specifications and Targets
The purpose of product specifications is made is to explain the things that must be done by a product. The specifications consist of metrics and metric values. The average time to make a fish absorber is metric and less than 10 days is a metric value.
Step 1 Prepare the Metric List with the QFD (Quality Function Deployment) method
Step 2 Gather Information about competitors
Step 3 Establish ideal and marginal target values that can be achieved for each metric
Step 4 Reflect on results and processes.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Reducing the heat of the oven by placing the fire in the combustion chamber	Provided several shelves that match the size and type of fish	When smoking is keep to a minimum	Made from materials that are resistant to corrosion	Simple and practical form	How to connect using bolts so that it is easily removed	The standard height is according to the height of Indonesian people	The legs are given wheels for easy removal of the position of the tool	Tool dimensions (height and width)	wheel size	Provided for charcoal as a burning material	easy and inexpensive fuel available	Able to hold a load	Feasibility test	even temperature and good air circulation
1	Reducing the heat conditions during the liquid smoking process	•														
2	Increase production capacity		•													
3	Get the results of fogging evenly and responding to fish															•
4	Light / easy to move tools				•	•			•		•					
5	Able to optimize / reduce excessive fuel usage	•														
6	Durable and resistant to corrosion			•	•											
7	Easy process of replacing spare parts						•	•		•						
8	Easy To treatment					•					•					
9	Has a long tool life						•									
10	Safe to use						•							•		
11	Cheap and affordable												•	•		
12	Easy to use and operate					•		•		•					•	

Figure 1. Matrices of the need for liquid smoked fish preservatives with the QFD method

After the target is determined the team starts working to produce concept solutions. The target specifications can be used to assist the team in choosing a concept of a fish smoker

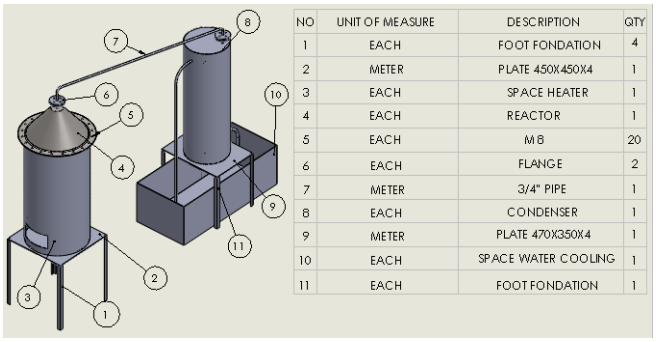
Designing Product Concepts. The following are five steps for displaying the method
Step 1. Clarifying the problem from the breakdown of data on identifying customer needs and product specifications, the team collects additional information to explain and measure needs such as fuel and material selection, work processes, etc. These basic needs are then translated into target product specifications.
Step 2. Search externally by interviewing key users, consulting experts, looking for patents, searching published literature, analyzing (bencmarking) related products.
Step 3. Search internally
Step 4. Search systematically from step 2 and step 3
Step 5. Reflect on the results of the process

IV. Result and Discusion

4.1 Principle of Working Tool

The working principle of the fish preservative method: Charcoal is burned and produces smoke then the smoke is condensed into liquid smoke using a pyrolysis machine, after that liquid smoke produced from the pyrolysis, it is used to soak the fish, then the fish is taken to the oven to absorb smoke liquid to the surface and inside of the fish.

4.2 Image of Fish Preservatives with Liquid Smoke
A. The smoke pyrolysis apparatus becomes liquid smoke



NO	UNIT OF MEASURE	DESCRIPTION	QTY
1	EACH	FOOT FONDATION	4
2	METER	PLATE 450X450X4	1
3	EACH	SPACE HEATER	1
4	EACH	REACTOR	1
5	EACH	M8	20
6	EACH	FLANGE	2
7	METER	3/4" PIPE	1
8	EACH	CONDENSER	1
9	METER	PLATE 470X350X4	1
10	EACH	SPACE WATER COOLING	1
11	EACH	FOOT FONDATION	1

Figure 2. The smoke pyrolysis machine becomes liquid smoke

B. Oven

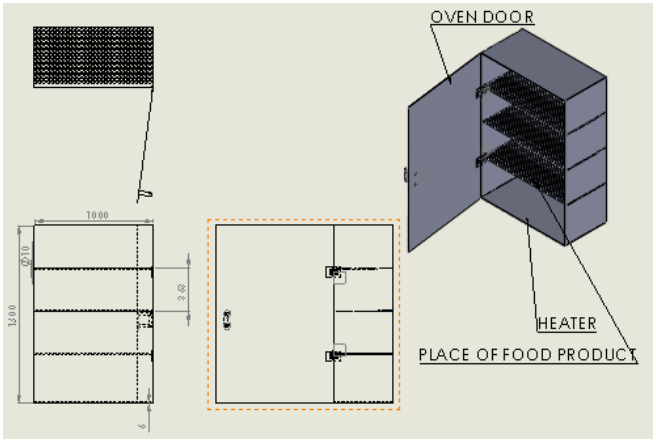


Figure 3. Fish oven

4.2 Choosing Concept of Product

Table 5. Choosing Concept of Product

No	Description	Satay Grill	Available Tool	Fish preservative with liquid smoke method
1	Ease of handling	-	0	+
2	Ease of use	0	0	0
3	Ease of reading the capacity	-	0	0
4	Capacity measurement accuracy	-	+	+
5	Durability	-	-	+
6	Ease of manufacturing processes	-	0	0
7	Easy to carry	+	+	+

Total +	1	2	3
Total 0	1	3	2
Total -	4	1	0
Final score	-4	1	4
Rank	3	2	1
Continue	No	Combined	Yes

Remarks : (+) : better
: equal
(-) : worse

4.3 The advantage of using liquid smoked fish preservatives

The expected benefits of using fish preservatives with this liquid smoke method are long-lasting fish, no fishy odor, light brown fish color and the inside of the fish is still fresh, dry, clean and the machine is safer and more comfortable, the protein content is still maintained, easy to operate, suitable for the community of small and medium entrepreneurs, environmentally friendly, easy and widely available fuel, cheap price, spare parts are also easy to be obtained.

V. CONCLUSION

The product of fish smokers is made by taking into many aspects. These include aspects of design, ergonomics and product anthropometry. The expected benefits of using this product are long-lasting fish, no fishy odor, light brown fish color, and the inside are well-cooked, dry, clean and the machine is safer and more comfortable.

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