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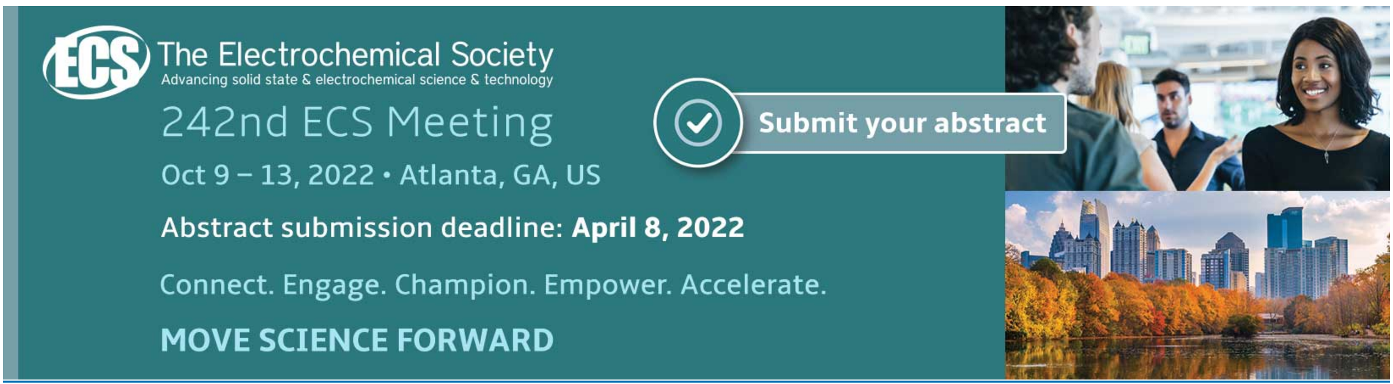

Organoleptic analysis of saga seeds (*Adenanthera pavonina*) fermented for feasibility raw material of making tempe

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Abstract. Indonesia soybean imports reached 1.27 million tons in 2019 due to the low productivity of local soybean production, so that it is unable to keep pace with the public's demand in terms of making tempe. Based on this fact, other locally produced raw materials are needed for making tempe. This study tested the feasibility of saga seeds as raw materials as substitution of soybean in terms of organoleptic properties. The method used in this research is a literature study and experimental manufacture of tempe saga with 3 variations of yeast (2, 4, and 6 grams) and 3 variations of time (12, 36, and 72 hours). Based on organoleptic analysis that have been done, this study showed the influence of yeast variation and time variation in texture, aroma, color, and millennium formed of tempe from saga seeds. This influence can occur because of the interaction between yeast and the content contained in saga seeds such as contenct of nutritional, antioxidants, and fibre. With the use of saga seeds as a tempe-making product, it is expected to increase the added value of local products to fulfil public demand for tempe.

1. Introduction

Indonesia is an agricultural country where most of the people's livelihood is in the food sector. Food is an important commodity to meet the basic needs of the Indonesian people [1]. One of the foods that have high productivity in Indonesia is tempe [2]. There are 81 thousand businesses that produce 2.4 million tons of tempe per year in Indonesia [3]. The high productivity is based on the high demand from the community for tempe. It is known that the average daily consumption of tempe reaches 4.4 g to 20.0 g for each person, and is expected to increase every year [4]. The high demand for tempe requires the use of raw materials for making tempe which has high productivity as well [2].

The raw material for making tempe usually uses soybeans. Reporting from the Badan Pusat Statistik, soybean imports in Indonesia in 2019 reached 1.27 million tons or around Rp. 7.52 trillion [5]. This data shows that local soybean productivity is still not able to keep up with the high demand for tempe. According to [6], low local soybean productivity is caused by the higher selling price of local soybeans than imported soybeans. This is reinforced by Haile et al. [7], which stated that soybean production tends to be relatively more expensive than other crops such as corn and rice, so that farmers focus more on agricultural land to non-soybean crops.

Based on these problems, an alternative raw material for making tempe is needed which has a cheaper production cost with a protein content equal to or more than soybeans. One of the plants that has the potential to be used as raw material for making tempe is the saga seeds (*Adenanthera pavonina*) plant. Saga seeds are able to produce protein-rich seeds and have low production costs [8].

This is because the planting of saga plant does not require special land because it can grow on critical land, it does not need to be fertilized or intensive care. In addition, pests and weeds are minimal so they do not require pesticides, so they are environmentally friendly because they can be planted with other plants [9].

According to Mumpuni [8], the protein nutritional content of saga seeds is greater than that of soybeans, which is 48.2%. Meanwhile, soybeans only contain 34.9% protein. Table 1 below shows the results of testing the nutritional composition of saga seeds with other seeds.

Table 1. Nutritional composition of Saga, soybeans, green beans, peanuts, and winged bean

Seeds [8]	Protein (%)	Fat (%)	Carbohydrate (%)	Water (%)
Saga	48.2	22.6	10.0	9.1
Soybean	34.9	14.1	34.8	8.0
Green bean	22.2	1.2	62.9	10.0
Peanut	25.3	42.8	21.1	4.0
Winged bean	32.8	17.0	36.5	10.0

Based on these tests, saga seeds have the highest protein and fat content compared to other seeds. This makes saga seeds very potential to be used as raw materials for making tempe.

Currently, saga seeds in Indonesia are only used as shade plants, while the seeds are only considered as garbage [10]. Whereas saga seeds should be an alternative to soybeans as a raw material for making tempe because its production costs are relatively cheaper and its protein content is greater than soybeans. Therefore, this study will examine organoleptically saga seeds (Adenanthera pavonina) which are processed into tempe. Organoleptic testing has an important role in the application of tempe product quality. Organoleptic testing can give an indication of rot, quality deterioration and other damage of tempe products. Thus, it can increase the use value of saga seeds as well as a solution to the demand for tempe needs in Indonesia.

2. Material and Methods

2.1. Data collection

The method of data collection was carried out by literature studies and also experiments, namely giving treatment to the samples studied. The research was conducted with the variables of fermentation time, tempe yeast weight, and physical characteristics. The data were analyzed seen from the results of the test parameters. The tools and materials used in the study were saga seeds, tempe yeast, plastic wrap, and newspapers.

2.2. The Process of Making Tempe from Saga Seeds

2.2.1. Operating Conditions. Making tempe from the seeds of the saga is carried out at a temperature of 25°C and a pressure of 1 atm. The independent variable used was yeast with variations of 2 grams, 4 grams, and 6 grams. While the fixed variables used were 100 grams of saga seeds and 3 days of fermentation time.

2.2.2. Treatment Process. The manufacturing process begins with soaking 100 grams of saga seeds for 3 samples using clean water to soften the skin essence and remove dirt. The immersion process is carried out for 24 hours. Furthermore, the soaked saga seeds were heated at 100°C for 3 hours to soften the texture of the seeds and maintain sterilization. Then the seeds of the saga are peeled clean, and rinsed with water. After that, it is allowed to cool and dry before being given the tempe yeast.

2.2.3. Fermentation Process. Dried saga seeds of 100 grams were put into plastic wrap as many as 3 samples and given tempe yeast for the fermentation process with variations of 2 grams, 4 grams, and 6 grams. Then the saga seeds in plastic are tightly covered with newsprint for 3 days.

2.3. Analysis Data

To determine the quality of tempe saga, an analysis of the product was carried out in terms of content (nutrient content, antioxidant content, and fiber content) and organoleptic physical characteristics. Product analysis in terms of content will be carried out based on literature studies, while organoleptic analysis of physical characteristics is carried out by testing raw tempe saga and cooked tempe saga in terms of color, aroma, taste, and texture.

3. Result and Discussion

3.1. The nutritional content of tempe from the saga seeds

Table 2 shows that some of the content of saga seeds that have been made into tempe has increased. According to [1], the increase in water content is due to the catabolic activity of yeast that produces energy, as well as by-products in the form of carbon dioxide and water. The longer the fermentation process, the higher the water content in tempe. Meanwhile, the protein content of saga seeds increased when made into tempe. According to Budiono [10], the fermentation process can remodel the substrate protein by molds into amino acids so that in quality there is an increase in protein quality. The increase in protein quality in fermented saga seeds will have an impact on the organoleptic characteristics of saga seeds, such as in terms of texture [1] and amount of mycelium [10]. However, in quantity, the protein does not change because it only transforms from a complex to a simpler form.

Table 2. Protein Content of Tempe from Saga Seeds

Nutritional content [9]	Saga seeds (%)	Saga tempe (%)	Percentage change (%)
Water	188.87	205.55	+8.83
Ash	3.76	3.73	-0.78
Fat	39.87	37.61	-5.67
Protein	26.41	29.77	+12.72
Carbohydrate	29.96	28.89	-3.57

3.2. The Antioxidant Content of Tempe from Saga Seeds

Table 3 shows that an increase in the antioxidant capacity of tempe made from saga seeds. The total phenol obtained was 57.14%. According to Qurnaini et al. [11], the increase in phenol in the tempe fermentation process is due to the activity of yeast that produces phenolic components to be bound by organic compounds of saga seeds, resulting in free phenolic compounds. Meanwhile, DPPH activity increased significantly by 300%. This is because during fermentation, free radicals are correlated with the total phenol content, resulting in intensive DPPH activity [9]. Increased levels of antioxidants in fermented saga seeds will have an impact on the organoleptic characteristics of saga seeds, such as in terms of aroma [12].

Table 3. Tempe Antioxidant Capacity of Saga Seeds

Antioxidant capacity [9]	Saga seed	Saga tempe	Percentage change
Total Phenol (mg/100 g sample)	0.21	0.33	+57.41%
DPPH Activity (%DPPH/ mg sample)	0.03	0.12	+300%

3.3. Fiber Content of Tempe from Saga Seeds
Table 4 shows that the decrease in fiber content of saga seeds that have been made into tempe. According to Amalia et al. [13], the decrease in substrate fiber content in the fermentation process is due to the hydrolysis reaction of fiber components by yeast during tempe fermentation into simple sugars, so that the fiber content decreases. The decrease in fiber content in fermented saga seeds will have an impact on the organoleptic characteristics of saga seeds, such as in terms of color [8].

Table 4. Fiber Content of Tempe from Saga Seeds

Fiber content [9]	Saga seeds	Saga tempe	Percentage change
Insoluble dietary fiber, %	1.62	0.81	-50%
Soluble dietary fiber, %	2.46	1.78	-27.64%
Total dietary fiber, %	4.08	2.57	-37%

3.4. Organoleptic Tempe from Saga Seeds
Organoleptic was carried out on tempe made from 100 grams of saga seeds as many as 3 samples with variations of the yeast Tempe I (2 grams), Tempe II (4 grams), and Tempe III (6 grams). The following description below is the observations that have been made.

Table 5. Information Observation of Tempe Saga

Variables	+	++	+++	++++
Texture	Not hard	Little hard	Hard	Very hard
Aroma	Not pungent smell	Little pungent smell	Pungent smell	Very pungent smell
Color	Brown	Brownish white	White	Very white
Miselium	Not much	Little much	Much	Very much

3.4.1. Organoleptic results on day 1 (12 hours)

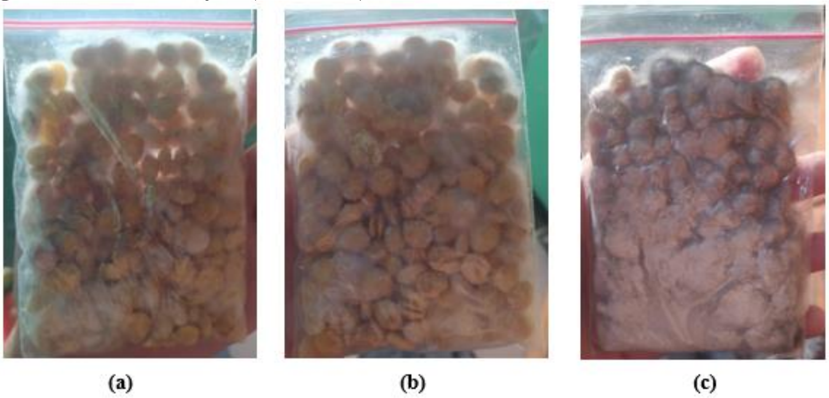


Figure 1. Saga Seed Tempe on Day 1 (12 hours), (a) Tempe I, (b) Tempe II, (c) Tempe III

Table 6. Observations of Tempe Saga on day 1 (12 hours)

Variables	Tempe I	Tempe II	Tempe III
Texture	++++	+++	++
Aroma	++++	+++	++
Color	+	++	+++
Mycelium	+	++	+++

3.4.2. Organoleptic results on day 1 (36 hours)

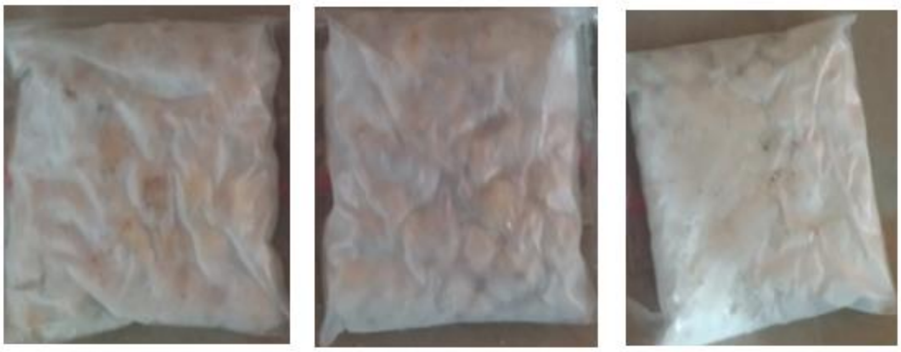
(a) (b) (c)

Figure 2. Saga Seed Tempe on Day 2 (36 hours), (a) Tempe I, (b) Tempe II, (c) Tempe III

Table 7. Observations of Tempe Saga on day 2 (36 hours)

Variables	Tempe I	Tempe II	Tempe III
Texture	++++	++	+
Aroma	+++	++	+
Color	++	++++	++++
Mycelium	++	+++	++++

3.4.3. Organoleptic results on day 3 (48 hours)



(a) (b) (c)

Figure 3. Saga Seed Tempe on Day 3 (48 hours), (a) Tempe I, (b) Tempe II, (c) Tempe III

Table 8. Observations of Sage Tempe on day 3 (48 hours)

Variables	Tempe I	Tempe II	Tempe III
Texture	+++	+	+
Aroma	+++	+	+
Color	++	++++	++++
Mycelium	+++	++++	++++

3.5. Analysis Organoleptic of Saga Tempe

3.5.1 Based on its texture. Based on the observed data, Tempe I was the slowest in softening the texture with the least yeast conditions. While Tempe III is the fastest in softening the texture. As stated, during the fermentation process yeast will show catabolic activity by producing energy, as well as byproducts in the form of carbon dioxide and water [1]. Thus, as more yeast is used, it will increase the water content a lot, so the texture will soften faster. This is also in line with research of Putri et al. [14] which made tempe from black soybeans that the more yeast added, the softer it becomes.

3.5.2 Based on its aroma. Based on the data that has been observed, Tempe I is the most difficult to remove the pungent odor. While Tempe III is the easiest to remove the pungent odor. The pungent odor that arises comes from the saga seeds itself. The pungent odor will disappear in proportion to the concentration of yeast used in the fermentation process. This is also in line with research of Qurnaini et al. [11] which made tempe from Biji Jali (*Coix lacryma-jobi L.*) that the more yeast added, the more the pungent odor will disappear.

3.5.3 *Based on its color and mycelium*. Based on the data that has been observed, Tempe III shows a bright white color change and the fastest. While Tempe I is the most difficult to be white and late. The white color is produced due to the formation of mycelium in tempe. According to Budiono [10], during the fermentation process, yeast will show catabolic activity by breaking down the protein substrate. This catabolic activity makes yeast thrive to form white hyphae (mycelium). Thus, the amount of yeast used makes the number of hyphae threads formed, so the tempe will turn white.

4. Conclusions

The conclusion of this study is that the saga seeds as raw material for making tempe can be done. Based on the organoleptic analysis of 100 grams of saga seeds, there were effect of yeast and time variations on the texture, aroma, color, and mycelium formed. This is due to the phenomenon of increased nutrient content, antioxidants, and decreased fiber content of saga seeds after fermentation. With this research, it is expected to increase the use value of saga seeds to meet public demand for tempe products.

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