The potential effect of high flavonoid soybean diversification products through tempe flour substitution.

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Abstract. Nowadays, overconsumption of junk food and sedentary lifestyle lead to the development of various diseases. Legumes intake has been known to support one’s health since it’s contain various nutrients and bioactive compounds that’s beneficial for health. One of the most consumed legumes is soybean. In Indonesia, soybean usually consumed as tempe and tahu (tofu). Tempe contain numerous nutrients, for example carbohydrates, fats, proteins, minerals, dietary fibers, vitamins, and antioxidants. Therefore, tempe can be eaten as it is or added to other food or to create a new food product through diversification. This study aims to characterize the diversification product of tempe on antioxidant and nutritional content. The diversification products are tempe flour (TF), tempe meatball (TM), chocolate tempe (CT), tempe moringa (TM), and tempe onion (TO). The new products still have the same basic flavor as before, but the chemical tests show there are a number of flavonoid compounds increasing with highest concentration found in TF. In conclusion, TF can be use in the future for further diversification to create tempe-based food with high antioxidant content.

1. Introduction
The high prevalence and incidence rate of non-communicable chronic diseases such as type 2 diabetes mellitus (T2DM), stroke, hypertension, and cancer are the main cause of death in Indonesia [1]. Those diseases can simply be prevented by implementing a healthier lifestyle, physically more active, and eating balanced nutrition. Consuming food-specific-components that’s proven to be beneficial for certain disease can also contribute for slowing or reducing its morbidity [2].

Legumes has been widely known for its role in human nutrition. It is high in protein, carbohydrate, and dietary fibre. It is also low in cholesterol and fat. In developing countries such as Indonesia, legumes, especially soybean, play an important role in providing protein. Soybean, especially in the form of tempe, has been around since the 1700s mainly in Central Java and has been a part of the diet ever since [3,4].

Tempe is a solid fermented soybean product using *Rhizopus oligosporus*. It has several beneficial health effect especially for T2DM, dyslipidemia, and also breast cancer [5-8]. Tempe is a cheap protein source and high in nutritional content and also contain high level of polyphenols, especially flavonoids, which has been proven to act as a strong antioxidant [9-10]. In Indonesia, tempe is usually consumed for main dish in the form of cooked tempe, either fried or steamed. It is uncommon to eat tempe as a snack. Therefore, it is needed to explore further the possibility of developing tempe not only as a staple
food, but also as a healthy snack. The aim of this study was to create and measure the flavonoid and nutritional content of several diversification products of tempe.

2. Methods
The flow diagram for this experiment can be seen in Figure 1. The origin tempe, tempe flour, and each new food product were tested for their nutritional, flavonoid content using spectrophotometry method.

This is an observational experiment in which tempe was diversified into several new products. The steps of this experiment was divided into two main parts: a) adding different compounds during tempe making process (tempe garlic and tempe moringa), b) adding tempe flour to make new food product (tempe meatball and chocolate tempe) (Figure 2,3,4,5).

![Tempe fermentation technology](image)

**Table 1. Tempe diversification product name**

| No. | Food product | Addition    | Amount added | New food product       |
|-----|--------------|-------------|--------------|------------------------|
| 1.  | Beef meatball| Fresh tempe | 20 %         | Tempe meatball         |
| 2.  | Tempe        | Moringa     | 2.5 %        | Tempe moringa          |
| 3.  | Tempe        | Garlic      | 1 %          | Tempe garlic           |
| 4.  | Chocolate    | Fresh tempe | 20 %         | Chocolate tempe        |

**Figur 1.** The process of making tempe
Figure 2. The framework of this experiment

Figure 3. The process of making garlic and moringa tempe
3. Results and Discussion
The addition of new compounds such as garlic and moringa into tempe didn’t change its physical appearance, texture, and aroma. Moreover, addition of tempe flour into meatball and chocolate candy also didn’t change its physical characteristics compared to their original product (Table 1). The nutritional value of each product can be seen in Table 2. Non-meat ingredients such as soy flour, tapioca starch, and other starches can be used as substitution material for meatball [11-12]. According to Purnomo and Rahardiyan (2008), addition of 10–15% tapioca starch produce meatball in optimum quality in term of moisture and texture [11]. On the other hand, 5% addition of wheat flour in meatballs
gave better quality and general acceptability compared to other treatments [13]. In this experiment, we added 20% of fresh tempe as well as 10% tapioca starch to get the best product.

### Table 2. Nutritional value of each product

| No. | Product       | Water (%) | Ash (%)     | Fat (%)     | Protein (%) | Carbohydrate (%) |
|-----|---------------|-----------|-------------|-------------|-------------|------------------|
| 1.  | Tempe         | 60.435±0.221 | 1.196±0.062 | 7.098±0.491 | 18.494±2.109 | 12.777±2.543     |
| 2.  | Tempe flour   | 6.702     | 3.228       | 19.682      | 29.816      | 40.571           |
| 3.  | Tempe garlic  | 59.853±1.191 | 1.117±0.091 | 7.098±1.077 | 19.696±3.458 | 12.496±3.481     |
| 4.  | Tempe moringa | 59.522±1.367 | 1.099±0.035 | 6.844±0.272 | 15.057±0.693 | 18.071±1.764     |
| 5.  | Meatball tempe| 60.767     | 2.107       | 2.209       | 7.086       | 27.830           |
| 6.  | Chocolate tempe| 2.196     | -           | -           | -           | -                |

Flavonoids are important compounds in food because flavonoids-containing foods are said to be functional foods. High flavonoid products were found in tempe meatballs at 538.54 mg/100 gr, tempe moringa 461.305 mg/100 gr, tempe garlic 114.75 mg/100 gr, chocolate tempe 2329.98 mg/100 gr and tempe flour has 17835.01 mg/100 gr. Moreover, tempe addition to chocolate can increase its protein level as well as its antioxidant capacity. Study about the utilization of tempe for snack making purpose is still scarce although some researchers has already used black soybean for making snack bar as an alternative for healthy snack for breastfeeding mothers [14]. Furthermore, tempe flour has high potency as additional ingredient for numerous food products and to increase the final protein level. Future experiment will include the utilization of tempe flour to create chocolate tempe and meatball tempe using no more than 25% of tempe flour inclusion as suggested by Ivievie et al. [13].

### 4. Conclusion

The diversification product of tempe using compounds mentioned above have positive impact on the nutritional component and also flavonoid content on new food product.

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