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Iron Fortification and bioavailibility of homemade tempeh with sesame seed

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Abstract: Iron deficiency anemia is caused by the low intake of iron from foods. The purpose of this research was to make fortified tempeh using sesame seed with a high potential utility as iron fortificant. The iron bioavailability was carried out in vitro by simulating human digestion for raw and cooked tempeh. The iron fortificant added were 0, 10, 20, 25, 30 ,40 and 50% of sesame seed to substitute 100 grams of soybeans. The results of this study showed that the highest Fe content of 0.4539 mg was obtained by replacing 50% soybean with sesame seed. But after cooking, there is a decrease in boiled for 10, 20, 30,40,50% variants and increase in fried for 0, 10, 25, 30% variants.

Keywords: Anemia, Tempeh, Fortification, Sesame seed

1. Introduction

Iron is a micro mineral which has an essential role in the transport of oxygen from the lungs to the body's tissues. The lack of iron can cause disruption of biological processes in the body can cause anemia. Indonesia is one of the countries in the ASEAN which has serious problem in anemia. According to the 2013 Basic Health Research (Riskesdas, 2013), the prevalence of anemia in children, men aged 13 – 18 years, women aged 15 – 49 years, and pregnant women were 26.4; 12.4; 22.7; and 37.1%.

The treatment that has been done to reduce anemia levels is by using Supplementation (synthetic drugs) which have various disadvantage such as expensive prices, side effects caused, and discomfort in treatment (Musa et al. 2019). Fortification is the most appropriate strategy in reducing the problem of iron deficiency in the long term by adding one or more micronutrients to the food. Fermentation process in tempeh can reduce phytat/iron molar ratio which indicates the presence of iron availability inhibitor (Darlan, 2012). Utilization of foods and

fortificants are key components to consider in successful implementation of iron fortification programs. Fortificants that are commonly used are Fe-sulfate, Fe-EDTA, Fe-bisglycinate, Fe-fumarate, and Fe-succinate.

Ferrous bisglycinate more effective as fortificant than Fe-sulfate for tempeh and tofu sample (Trihartiani, 2013). Fe-EDTA is a better fortificant than iron fumarate, glycinate, and succinate which has the highest Fe content in tempeh sample at 5.0709 mg (Amin, 2014). The addition of Fe-EDTA in tempeh, tofu and soy milk samples has has a higher fortification effectiveness than Fe-fumarate (Adriana et al. 2015). The use of Fe-EDTA as iron fortificant in soy milk samples can increase Blood Iron Levels in Rat (*Rattus novergicus L.*) male Spraque Dawley strain (Anita and Agustino, 2016). However, The price of Fe-EDTA is high enough and less popular so that its implementation raises some doubts in community. Therefore, natural fortificant is needed to get a lower price and easily obtained from natural sources, especially in Indonesia which has 15.5% of the total flora in the world (Fathoni et al. 2019). Sesame seed have potential use as fortificant of natural iron. Fortification with sesame seed improved protein, crude fibre, and fat ini bread and biscuit samples (Ugwuona and Nwamaka, 2016), (Enzi et al. 2018). the present study had undertaken to produce fortified tempeh with sesame feed and evaluate its iron availibilty after cooking (frying and boiling).

2. Methods

2.1 Materials

The study was conducted at the chemical laboratory of Sekolah Tinggi Analis Kimia Cilegon in April – October 2020. The research samples were soybeans and sesame sees which were purchased from local market around Cilegon, Banten. The chemicals used in this research were pepsin, HCl, bile, pancreatin, and $NaHCO_3$.

2.2 Iron Fortification and Its Avalibility Test

Tempeh sample fortified and determined its iron content according to the method described by (Mahardika et al. 2020) with some modification, namely 100 grams of soybeans, 0.35 of tempeh yeast, and sesame seed at different levels of substitution (0%, 10%, 20%,25%, 30%, 40%, 50%) were used ini this research.

3. Results and Discussion

Fortified tempeh is made using three main ingredients: dry soybeans, tempeh yeast, and sesame seed. Homemade tempeh is the most suitable food for iron fortification because no additives were added which can cause degradation of some nutrients (Harefa and Silaban, 2020). Sesame seed was blended using a spice grinder and dried in oven at 80°C for 10 min to get a fine powder (Fig. 1a). As shown in the Fig 1b, the fortified tempeh has an identical form to unfortified (general). In this

research, In vitro techniques were used to determine the bioavailibilty of iron by simulating human digestion. Pepsin is stomach enzyme that made it into acidic by HCl solution because the human stomach also has acidic condition. The function of Pancreatin bile is to simulate gas secreted by the pancreas gland. The results of iron availability for each sample are shown in Table 1. The sample consisted of raw, boiled, and fried tempeh.

Fig 1. (a) Sesame Seed Powder (b) Fortified Tempeh

Table 1.
Tempeh Sample Test with Fortified Variations

Amount of Substitution	Raw	Boiled	Fried
Sesame Seed (%)	(mg)	(mg)	(mg)
0	0.1241	0.2247	0.1969
10	0.1962	0.1878	0.2334
20	0.3837	0.2363	0.1866
25	0.2454	0.3024	0.5016
30	0.2788	0.1580	0.3325
40	0.3810	0.2797	0.2626
50	0.4539	0.1258	0.1220

Table 1 showed that the substitution of sesame seed there was an increase in Fe levels compared to without the substitution of fortified substances (0%). Fortification of raw tempeh with 10% sesame seed has increased in iron level by 58.09% (from 0.1241 to 0.1962mg). The highest Fe content of 0.4539 mg was obtained by replacing 50% sesame seed to raw tempeh with 3.6 times higher than unfortified tempeh. But after the cooking process, there is a change in boiled and fried tempeh. Boiling resulted in decrease of iron level in the most of amount substitution (10, 20, 30, 40, 50) because iron dissolved in boiled water during heating process (Sundari et al. 2015). Meanwhile, for fried tempeh with the substitution of sesame seed has iron level lower than raw tempeh in the most of amount substitution (0, 10, 25, 30). It may be because cooking oil has already an average iron content of 0,6 mg per 100 grams

(USDA, 2020). Raw soybeans have iron content about 2 – 15 mg/100 grams and as shown in Table 1 iron content was lower than 1 mg because the presence of inhibitor and the use of NaOH which cause the formation of Iron (III) hydroxide precipitate.

Test results on the iron availability with variations in the amount of forticant, in general, can be seen in Fig 2 which shows that the cooking process such as boiling and frying can change the levels of iron fortified. Boiling can reduce and frying can increase iron content. This unmatch the research of (Astuti et al. 2012) and (Mahardika et al. 2020) which states that boiling and frying can decrease iron content in fortified tempeh. Heat treatment can affect the iron absorption through bond breaking use of some minerals (Palupi et al. 2007).

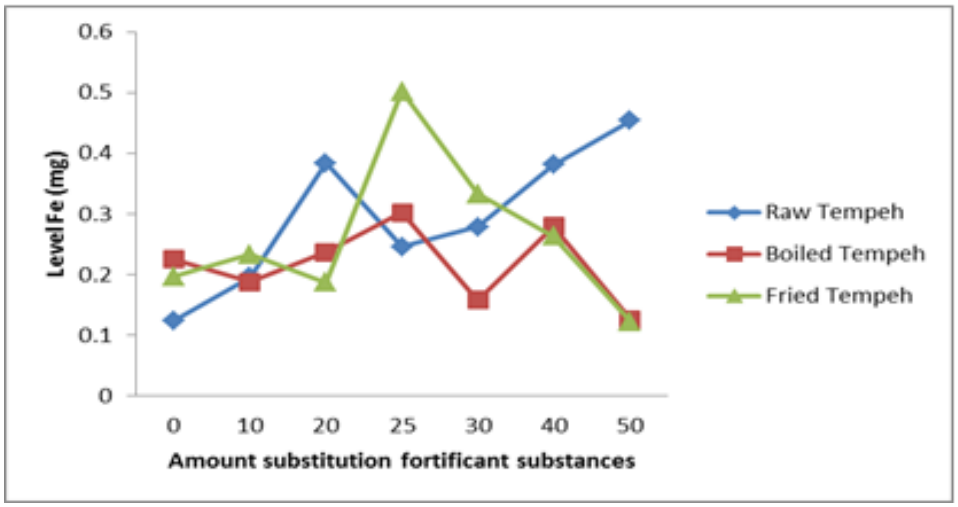

Fig 2. Iron availability on tempeh with various treatments

4. Conclusion

Fortified tempeh with seseame seed has been produced and evaluated its iron availability for raw, boiled, and fried tempeh. In average, raw tempeh has higher iron content than boiled tempeh and has lower iron content than fried tempeh.

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