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The Retention of Phytoestrogens (Daidzein And Genistein) on Tofu and Tempe due to fried and boiled treatments

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Abstract. Tofu and Tempe, as a soybean product, is a popular traditional food originally from Indonesia. Tofu and Tempe are not only a source of protein but also as functional food. Tofu and Tempe are usually consumed as processed by frying or boiling. The cooking process decreases the content of Phytoestrogen. Some compounds of Phytoestrogen are *daidzein* and *genistein*. Phytoestrogen is a vegetable hormone, usually in soybean. The function of Phytoestrogen is similar to estradiol in the body. The chemical compound of *daidzein* and *genistein* are similar to estrogen in the human body. **Aim:** To assess the retention of *daidzein* and *genistein* due to the cooking process. **Methods**: Tofu and Tempe got from Jakarta, Depok, and Sumedang area. Time to fry the food is 5 minutes, and to boil is 10 minutes. Analysis of *daidzein* and *genistein* is by HPLC. **Results**: The content of phytoestrogens (daidzein and genistein) in fried tofu decreased by 60.5% and boiled by 63.4%, in fried Tempe decreased by 41.6% and boiled by 17.1%. **Conclusions**: The retention of phytoestrogens *(daidzein* and *genistein)* on fried tofu was 24.2 mg (39.5%), and boiled tofu was 22.4 mg (39.6%), while the retention of Phytoestrogen on fried Tempe was 54.8 mg (58.4%), and boiled Tempe was 77.8 mg (82.9%).

Keywords: tofu, Tempe, Phytoestrogen, fried, boiled.

INTRODUCTION

Soybean fermented products (Tempe) have been widely used as foodstuffs that are beneficial in terms of nutrition and medical properties because they have primary, secondary and tertiary functions. Tempe is one of Indonesia's traditional foods, which is becoming a popular food in the world. The quality of Tempe as a result of fermented soybeans is better than soybeans [1].

Currently, tofu and Tempe are considered as functional foods because of their content of nutrients and active ingredients (as a tertiary function). Isoflavones, as non-nutritional ingredients in soybeans and their processing products (tofu and Tempe), are a rich source of potent antioxidants. In soybean, there are three types of isoflavones, namely daidzein, genistein, and glicitein [2,3]. Tempe contains antioxidant factor II (6,7,4 trihydroxy isoflavones), which have the strongest antioxidant [4,5].

Active substances in soy isoflavones have dual functions as antioxidants and phytoestrogens. The isoflavones are daidzein and genistein [6]. Isoflavones are also

called phytoestrogens because they have estrogenic activity [1]. Phytoestrogens are estrogens of vegetable origin (Phyto = plants) as antioxidants that function to reduce the free radical formation and play an important role in the aging process [7]. The antioxidative ability of isoflavones has two functions. The first is to overcome the excess of free radical compounds and ROS (reactive oxygen species) in cells. The second is a preventive defense system by breaking the radical reaction chain [8].

The 2002 Asian Food Information Center (AFIC) recommendation for the intake of isoflavones that have biological effects in humans is 30-50 mg per day. Sources of isoflavone intake for Indonesia are mostly obtained from tofu and Tempe. As much as 50% of soybean consumption is in the form of Tempe, 40% in the form of tofu and 10% in the form of other processed products [9]. The average consumption of tofu from 2002 to 2004 increased from 0.148 kg to 0.163 kg/capita/week. Tempe consumption decreased from 0.159 kg to 0.152 kg/capita/week, or the average consumption of soybeans and their processed products for Indonesia was 49.1 g /capita/day [18], which is equivalent to 22.0 mg of isoflavones [10].

The cooking process can affect the content of daidzein and genistein in soybeans and their processed products (tofu and Tempe) [11,5,12]. In general, Tempe and tofu are consumed after cooking them first by frying or boiling them. For this reason, it is necessary to know the retention of phytoestrogen content in tofu and Tempe, which is consumed after being processed, to provide information for the public, the amount of tofu and Tempe has a biological effect on health.

RESEARCH PURPOSES

Analyzing the content of phytoestrogens (daidzein and genistein) in tofu and Tempe due to frying and boiling treatment.

METHOD

The research design used was an experiment with frying and boiling treatment on tofu and Tempe. Tofu and Tempe are obtained from traveling traders in Jakarta (East Jakarta, Central Jakarta, and South Jakarta), Depok, and Sumedang, which are cities in Indonesia. The selected tofu is white (without additional coloring), the selected Tempe is wrapped in plastic and leaves.

The determination of moisture was carried out using the thermovolumetric (distillation) method. Protein content determination was carried out using the Kjeldahl method. Fat content was determined using the Soxhlet (total fat) method. Determination of the levels of daidzein and genistein using the HPLC method was carried out at the Integrated Laboratory of the Health Polytechnic of the Ministry of Health Bandung, in May 2009.

Sapporo Medical Journal

Volume 25, Issue 07, Agustus, 2020

RESULTS AND DISCUSSION

RESULTS

Moisture

Table 1. Moisture (%) in Tofu and Tempe by Frying and Boiling Treatment in Jakarta, Depok, and Sumedang

Region	Tofu			Tempe		
	uncooked	fried	boiled	uncooked	fried	boiled
Jakarta	79.8	55.5	89.5	66.1	48.4	78.1
Depok	77.8	54.2	87.5	65.4	45.6	73.6
Sumedang	82.4	57.6	92.6	65.6	45.7	73.7

Figure 1. Moisture Content (%) in Tofu and Tempe by Frying and Boiling Treatment

Based on Figure 1, the highest moisture is the processing of Tempe and tofu by boiling them.

Protein

Table 2.Protein Content (%) in Tofu and Tempe by Fried and Boiled Treatment in Jakarta, Depok, and Sumedang

Region	Tofu			Tempe		
	uncooked	fried	boiled	uncooked	fried	boiled
Jakarta	11.2	15.9	9.8	12.8	18.3	11.1
Depok	11.4	16.3	10.0	13.6	19.4	12.0
Sumedang	11.0	15.4	4.5	13.6	19.2	11.9

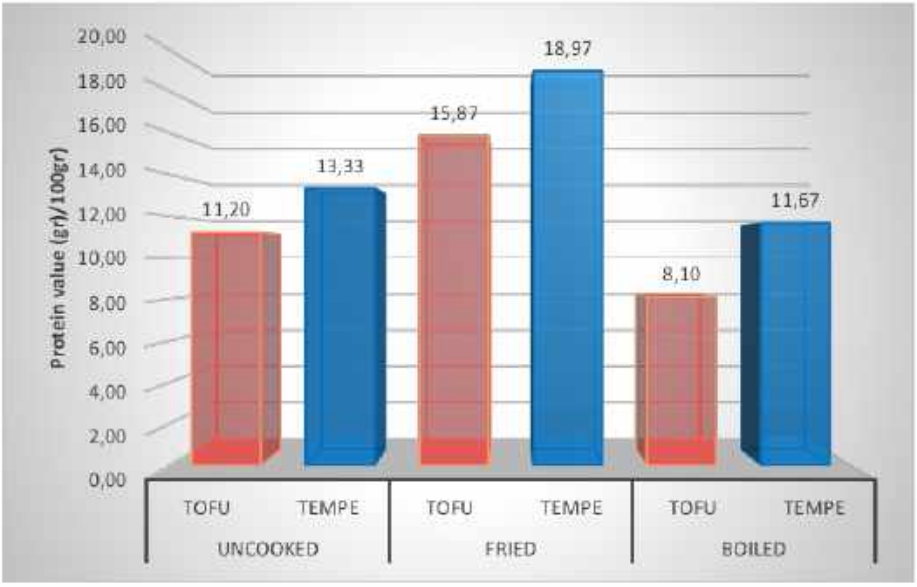


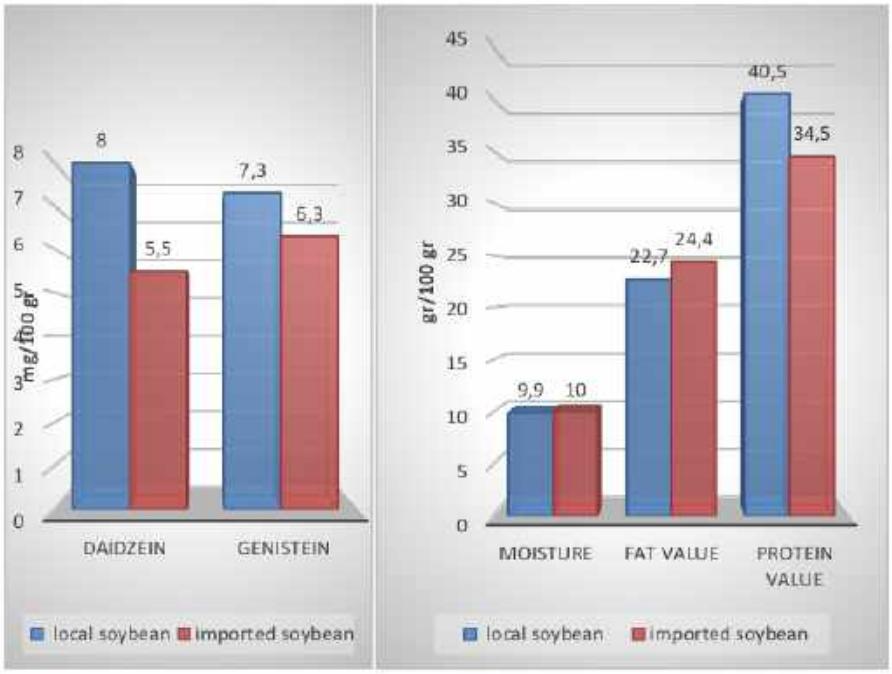
Figure 2. Protein Content in Tofu and Tempe by Fried and Boiled Treatment

Based on figure 2, the highest protein content of Tempe and tofu is food processing by frying. The lowest protein content is boiled.

Sapporo Medical Journal

Volume 25, Issue 07, Agustus, 2020

Levels of Daidzein, Genistein, Moisture, Fat and Protein in Local and Imported Soybeans



Graph 3. Levels of Daidzein, Genistein, Moisture and Protein and Fat in Local and Imported Soybeans

Based on Figure 3, the levels of Daidzein, Genistein, and protein in Indonesian Tempe and tofu products are compared to imported products. Still, the moisture and fat content is higher in imported products than Indonesian products.

Daidzein and Genistein levels

Table 3. Daidzein and Genistein levels in Tofu and Tempe by Fried and Boiled Treatment in Jakarta, Depok, and Sumedang

Region	Tofu								
	Daidzein (mg/100g)			Genistein (mg/100g)			Deidzein+Genistein (mg/100g)		
	uncooked	fried	boiled	uncooked	fried	boiled	uncooked	fried	boiled
Jakarta	32.9	13.1	11.8	25.4	9.9	9.5	58.3	23.0	21.4
Depok	52.3	20.9	18.8	30.4	11.8	11.4	82.7	32.7	30.2
Sumedang	26.6	10.6	9.6	16.2	6.3	6.1	42.7	16.9	15.6
Rata-rata	37.3	14.9	13.4	24.0	9.3	9.0	61.2	24.2	22.4
	Tempe								
Region	Daidzein (mg/100g)			Genistein (mg/100g)			Deidzein+Genistein (mg/100g)		
	uncooked	fried	boiled	uncooked	fried	boiled	uncooked	fried	boiled
Jakarta	69.0	41.0	56.5	67.5	38.8	56.9	136.5	79.7	113.4
Depok	61.1	36.3	50.0	57.8	33.2	48.7	118.9	69.5	98.7
Sumedang	19.6	11.7	16.1	6.3	3.6	5.3	25.9	15.3	21.3
Rata-rata	49.9	29.6	40.9	43.9	25.2	36.9	93.8	54.8	77.8

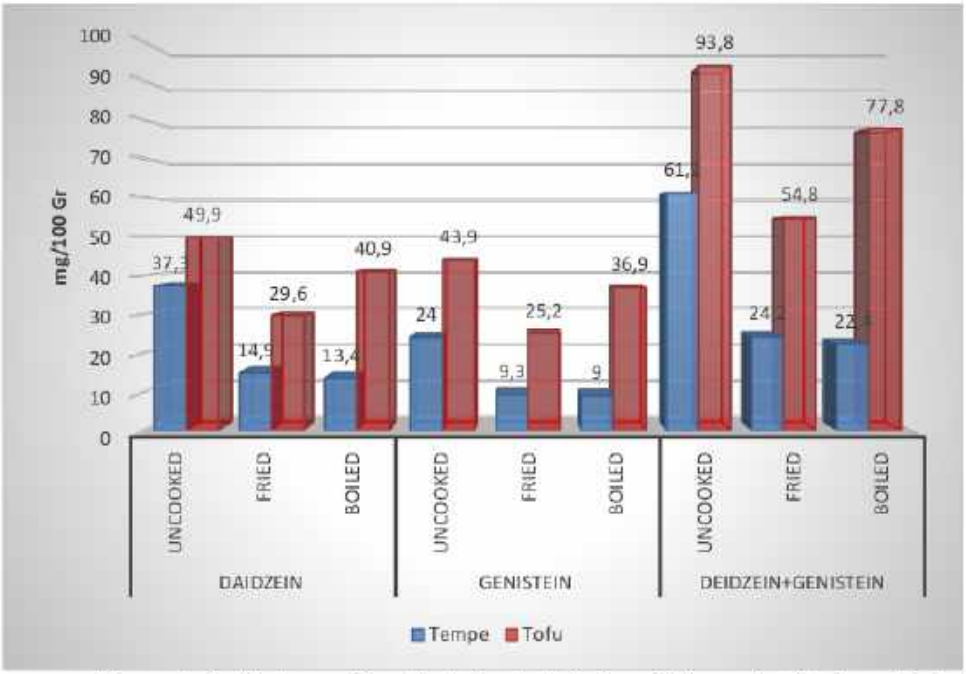


Figure 4. Daidzein and Genistein levels in Tofu and Tempe by Fried and Boiled Treatment

Based on Figure 4, the levels of Daidzein and Genistein in Tempe are higher than tofu by processing food by frying, boiling, or still raw.

Sapporo Medical Journal

Volume 25, Issue 07, Agustus, 2020

Retensi Daidzein dan Genistein

Table 4. Daidzein and Genistein Retention in Tofu and Tempe by Fried and Boiled Treatment in Jakarta, Depok, and Sumedang

Tofu						
Region	Daidzein (%)		Genistein (%)		Deidzein+Genistein (%)	
	Retention Fry	Retention Boil	Retention Fry	Retention Boil	Retention Fry	Retention Boil
Jakarta	39,82	35,87	38,98	37,40	39,45	36,71
Depok	39,96	35,95	38,82	37,50	39,54	36,52
Sumedang	39,85	36,09	38,89	37,65	39,58	36,53
Rata-rata	39,95	35,92	38,75	37,50	39,54	36,60
Tempe						
Region	Daidzein (%)		Genistein (%)		Deidzein+Genistein (%)	
	Retention Fry	Retention Boil	Retention Fry	Retention Boil	Retention Fry	Retention Boil
Jakarta	59,42	81,88	57,48	84.3	58.4	83,08
Depok	59,41	81,83	57,44	84.2	58.4	83,01
Sumedang	59,69	82,14	57,14	83.9	58.9	82,24
Rata-rata	59,32	81,96	57,40	84.1	58.6	82,94

Figure 5. Daidzein and Genistein Retention in Tofu and Tempe by Fried and Boiled Treatment

Discussion

Tofu has a higher moisture compared to Tempe so that daidzein and genistein are bound to more water molecules in tofu than in Tempe. In foods derived from soybeans, 1 gram of protein contains 1-2 mg of genistein [3]. In this study, the genistein content in unprocessed tofu and Tempe had slightly higher levels of genistein (2.7 mg / g). This difference can be caused by differences in the types of processed food ingredients from soybeans.

Factors that influence differences in isoflavone content in soybeans as the basic material for making Tempe and tofu include differences in soybean varieties, location, season, fungal infection, and response to disease attacks in plants [13,3].

Tempe fermented with the addition of micrococcus luteus, the level of isoflavones increased from 1.91 mg / 100 g to 4.62 mg / 100 g. If added with brevibacterium epidermidis, it becomes 38.67 mg / 100 g [14]. Tempe produced with market yeast or LIPI's yeast contains daidzein and genistein, which increases with the incubation time, and both Tempe from the yeast have an increase in the content of daidzein which is higher than that of genistein [15]. Muljati's research (2003) found differences in the content of daidzein and genistein in Tempe in different areas (Yogya and West Sumatra), namely between 11-25 mg / 100g [12]. As raw materials for Tempe and tofu, the content of daidzein and genistein in soybeans is different due to treatment (Temperature and heating time) [11]. Utari et al. (2010) found that two times the boiling process in making Tempe has a higher isoflavone content compared to one-time boiling [16].

In this study, there is no information on the use of yeast in making Tempe. The results of the analysis of the different content of daidzein and genistein between regions (Jakarta, Depok, and Sumedang) (table 3) may be due to differences in yeast and heating processes and different varieties of raw material (soybeans).

Tofu is also rich in isoflavones. At the time of making tofu, the isoflavones of daidzein and genistein are in bond with soy protein. Tofu contains 31 mg / 100 g of isoflavones, while in Tempe, it contains more; namely, 100 g of Tempe contains 59 mg of isoflavones [17]. In this study, the isoflavone content in tofu was higher at 61.2 mg / 100g, as well as the higher content in Tempe, which was 93.8 mg / 100g. The difference is probably due to the different manufacturing processes in tofu and Tempe.

As a source of content, isoflavones (active soy isoflavones) from Tempe and tofu can change due to cooking. With the difference in time and frying technique in this study, the reduction in daidzein and genistein levels in tofu and Tempe was 60.5% and 41.4%, respectively, lower than the Karmini study (2003). Karmini (2003) reported the highest reduction in daidzein and genistein content (79.3%) in dry fried Tempe and the lowest decrease (4.8%) in Tempe cooked by boiling [5].

Fried tofu has higher levels of daidzein and genistein than boiled because the moisture content in the tofu will evaporate first, leaving only a layer of oil on the tofu. Daidzein and genistein in tofu will not dissolve in oil. In boiled tofu, the water molecules in tofu and boiled water will bind easily, thus making it easier to penetrate the daidzein and genistein molecules, which are dissolved in the boiled water.

Tempe that is boiled has higher levels of daidzein and genistein than fried because Tempe has low moisture so that the ingredients will absorb the boiled water, as a result, the daidzein and genistein molecules are stuck in the Tempe ingredients. Conversely, in

fried Tempe, the oil molecules will be absorbed by the Tempe material so that daidzein and genistein come out of the material along with the water molecules that come out.

As a source of isoflavones, the content of daidzein and genistein (active soy isoflavones) from Tempe and tofu can change due to cooking. In practice, Tempe and tofu are not consumed raw but need to be cooked first.

CONCLUSION

Phytoestrogen retention (mg / 100 g) in fried tofu was 24.2 mg (39.5%) and boiled was 22.4 mg (36.6%). In Tempe with fried treatment of 54.8 mg (58.4%) and boiled 77.8 mg (82.8%). Minimum intake of phytoestrogens (30 mg/day) is obtained from consuming 2-4 pieces of Tempe or 25 grams per piece and consume 3-5 tofu or 50 grams per day.

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