



Tempeh consumption patterns in Indonesian family and contribution nutritional adequacy

Pola konsumsi tempe pada keluarga Indonesia dan kontribusinya terhadap kecukupan zat gizi

Trina Astuti^{1,2*}, Marudut Sitompul^{3,4}, Amirah Faadhilanisyah⁵

¹ Persatuan Ahli Gizi Indonesia, Jakarta, Indonesia. E-mail: trina_astuti@yahoo.com

² Jurusan Gizi, Poltekkes Kemenkes Jakarta II, Indonesia.

E-mail: trina_astuti@yahoo.com

³ Persatuan Ahli Gizi Indonesia, Jakarta, Indonesia.

E-mail: mrdtsitompul2015@gmail.com

⁴ Jurusan Gizi, Poltekkes Kemenkes Jakarta II, Indonesia.

E-mail: mrdtsitompul2015@gmail.com

⁵ Persatuan Ahli Gizi Indonesia, Jakarta, Indonesia.

E-mail: amirahfadh@gmail.com

* Correspondence Author:

Persatuan Ahli Gizi Indonesia, Grand Centro Bintaro, Unit B2, Jl. Raya Kodam Bintaro, Pangsararahan, Jakarta Selatan, Indonesia.

E-mail: trina_astuti@yahoo.com

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Abstract

Tempe is one of the original Indonesian traditional foods since the 16th century consumed as a snack, side dish, and vegetable. This research aimed to study consumption patterns, perceptions, and the contribution of tempeh nutrients to protein adequacy in Indonesian society. The study design is a cross-sectional study conducted online in October 2022 with 387 subjects from 34 provinces, taken purposively. Data was collected through online questionnaires. Tempe consumption data was analyzed using TKPI and compared with the RDA 2019. Data on characteristics, consumption patterns, and perceptions about tempeh are presented descriptively. Results, the average number of family members who consume tempeh is $4,3 \pm 1,04$ (minimum three and maximum 8) people, the frequency of consumption of tempe is $4,1 \pm 1,7$ times/week, the type of soybean tempeh (87,5%) with fried preparations (35%) and tempeh or crushed chili sauce (20,0%). The large portion of one meal is 50 grams. The average individual consumption is $41,75 \pm 27,22$ grams/capita/day. The eastern region is lower than the western and central regions. Consumption of tempeh contributes to the adequacy of protein by 10,27% - 14,6% and 30,25% to the adequacy of vitamin B12. 86,5% of subjects stated that tempeh was beneficial for heart health, anti-cancer, and antioxidants, but 14,5% of subjects stated that tempeh could increase uric acid and cholesterol, thyroid disorders, and allergies. The conclusion is that the average daily consumption of tempeh contributes one-sixth to the adequacy of protein and one-third to the adequacy of vitamin B12.

Keywords: Consumption pattern, perceptions, tempeh

Abstrak

Tempe merupakan salah satu makanan tradisional asli Indonesia sejak ke 16 yang dikonsumsi sebagai camilan, lauk nabati dan sayur. Tujuan penelitian untuk mendeskripsikan pola konsumsi, persepsi, dan kontribusi zat gizi tempe terhadap kecukupan protein pada masyarakat Indonesia. Desain studi adalah cross-sectional yang dilakukan secara online pada bulan Oktober tahun 2022 dengan 387 subjek yang berasal dari 34 provinsi diambil secara purposive. Data dikumpulkan melalui kuesioner online. Data konsumsi tempe dianalisis menggunakan TKPI dan dibandingkan dengan AKG 2019. Data karakteristik, data pola konsumsi dan persepsi tentang tempe disajikan secara deskriptif. Hasil, rerata jumlah anggota keluarga yang mengkonsumsi tempe $4,3 \pm 1,04$ (minimal 3 dan maksimal 8) orang, frekuensi konsumsi tempe $4,1 \pm 1,7$ kali/minggu, jenis tempe kacang kedelai (87,5%) dengan olahan digoreng (35%) dan sambal tempe atau digeprek (20%). Besar porsi sekali makan 50 gram. Rerata konsumsi individu $41,75 \pm 27,22$ gram/kapita/hari, wilayah timur lebih rendah dari barat dan tengah. Konsumsi tempe memberikan kontribusi terhadap kecukupan protein sebesar 10,27% - 14,6% dan 30,25% terhadap kecukupan vitamin B12. Sebesar 86,5% subjek menyatakan tempe bermanfaat untuk kesehatan jantung, anti kanker dan antioksidan, namun terdapat 14,5% subjek menyatakan tempe dapat, meningkatkan asam urat

dan kolesterol, gangguan tiroid serta alergi. Kesimpulan, rata-rata konsumsi tempe sehari memberikan kontribusi seperenam kecukupan protein dan sepertiga kecukupan vitamin B12.

Kata Kunci: Pola konsumsi, persepsi, tempe

Introduction

Tempeh is a popular traditional food in the form of a compact white cake, the result of fermented boiled soybeans with a starter culture of the mold species *Rhizopus* (Dimidi et al., 2019; Shurtleff & Aoyagi, 2001). Tempeh can also be made using other nuts (star fruit, velvet bean), lamtoro, corn, and even tofu pulp (tempeh gembus) and coconut pulp (tempe bongkrek). There are more than thirty varieties of tempeh that can be grouped into five types, namely tempeh legumes (including traditional Indonesian varieties made from soybeans); tempeh serelia (grain) plus soybeans; tempeh cereals; tempeh oilcake; and non-legume seed tempeh (Badan Standarisasi Nasional, 2012).

Tempeh has been consumed by Indonesians as the main affordable source of protein, especially in Java and Bali, for more than 300 years (Ariani, 2015). The protein content of tempeh can compete with other food protein sources. Fresh soybean tempeh, namely market tempeh, contains protein by 14%, and the protein content in pure soybean tempeh (20,8%) is higher than other protein sources such as fresh beef with moderate fat content (18,8%), fresh chicken meat (18,2%), fresh chicken liver (27,4%), fresh beef liver (19,7%), fresh skipjack fish (19,6%), fresh tilapia fish (18,7%), fresh cob fish (13,7%), fresh chicken eggs (12,4%), and fresh native chicken eggs (10,8%) (Shurtleff & Aoyagi, 2001).

Another advantage of tempeh is that it contains functional components consisting of probiotics and prebiotics, soluble fiber, fatty acids, omega-3-polyunsaturated fatty acids, linoleic acid conjugation, antioxidants, vitamin B12 and minerals, proteins, bioactive peptides, and amino acids, as well as phospholipids (Chalid et al., 2019; Chatterjee et al., 2018). The content of 100 grams of steamed tempeh contains 16,85 grams of protein (Kementerian Kesehatan RI, 2018a). The dominant amino acid in tempeh is arginine, which is 6,58 grams (Indrawati & Maimaznah, 2020).

The most widely consumed processed soybeans in Indonesia, especially by residents aged 19 and over, are tempeh, tempeh chips, and

tempeh snacks. The 2014 Individual Food Consumption Survey (Survei Konsumsi Makanan Individu/SKMI) showed that 92,9% of the beans and preparations consumed by the average Indonesian population per person per day were soybeans, and the processed product was 52,7 grams of soybeans from 56,7 grams of all nuts per person per day (Kementerian Kesehatan RI, 2019). Subjects who consumed soybeans processed the majority in the age group over 55 years, which is 65,7 grams. By region, the highest consumption of nuts and processed nuts is in East Java (96,9%), Central Java (89%), DI Yogyakarta (79,5%), DKI Jakarta (66,9%), West Java (64,8%), and Lampung (61,2%). Soybean and processed consumption in Indonesia is classified as having a low-legume diet, only as much as 52,7 grams per day per person (Studi Diet Total, 2014).

The Central Statistics Agency (Badan Pusat Statistik/BPS) in the national socioeconomic survey reported that there are three provinces in Java, namely: D.I. Yogyakarta, East Java, and Central Java, with the highest consumption of tempeh in the community among other provinces in Indonesia. The available BPS data on tempeh consumption is in grams of protein and not grams of tempeh, so determining the amount of weight of tempeh consumption is needed using the Indonesian Food Composition Table in 2018. Protein consumption derived from tempeh per capita a day in 2021 for the three provinces was 3,61 grams, 3,59 grams, and 3,44 grams, respectively, or around 17,4 grams, 17,3 grams, and 16,5 grams of fresh tempeh (Kementerian Kesehatan RI, 2018b). When compared in 2020, the three provinces with the highest tempeh consumption remain the same (Badan Pusat Statistik, 2021b, 2021a).

Nationally, per capita protein consumption per day derived from tempeh has increased by 4,2% protein, or about 0,5 grams of fresh tempeh protein, between 2020 and 2021, which are 2,4 grams and 2,5 grams, respectively. Meanwhile, DKI Jakarta Province, with a population consisting of various tribes, is the fourth-highest province in terms of tempeh intake, namely in 2021 at 2,71 grams of protein; this figure increased from the

previous year's figure of 2,66 grams of protein (Badan Pusat Statistik, 2020, 2021b, 2021a).

The amount of tempeh intake in the four provinces exceeds the average consumption of tempeh nationally, which is 2,4 grams of protein in 2021, or equivalent to 11,54 grams of tempeh. Meanwhile, the lowest provinces of tempeh consumption are the provinces of Maluku and North Maluku, with each province amounting to 0,89 grams of protein, or equivalent to 4,28 grams of tempeh, and 0,43 grams of protein, or equivalent to 2,06 grams of tempeh per capita in 2021 (Badan Pusat Statistik, 2021b, 2021a).

Tempeh as a food source of protein is relatively cheaper when compared to other food sources of protein, which may be one of the factors that contribute to tempeh consumption (Dinar, 2013). However, this information cannot be explained by tempeh consumption data from BPS. In addition, the available data does not specifically explain how much weight (in grams) of tempeh is consumed per capita per day, but the available data is in grams of protein consumption. Therefore, it is important to obtain more complete information about tempeh consumption in the community, such as "How is the distribution of tempeh consumption in families? Are only adults consuming tempeh?"

Interesting information also needs to be obtained from the nutritionist profession, which provides advice on diet and food intake in order to live a healthy life and also provides education about diet to sick people. This is because nutritionists know more than the general public about the advantages of tempeh, which is relatively superior compared to vegetable food sources of protein. "Can tempeh consumption affect family food consumption?" and "How does the nutritional contribution of tempeh intake to nutritional adequacy provide useful information from nutritional, economic, and production aspects?"

In light of the description above regarding the lack of nationally available information on tempeh consumption in the community, it is necessary to conduct limited research on the nutritionist profession covering all provinces in Indonesia, which aims to study the consumption patterns, perceptions, and contributions of tempeh nutrients to protein adequacy in people in Indonesia.

Methods

The research design is cross-sectional and was carried out in October 2022. The population of this study is families of nutritionists in 34 provinces in Indonesia, preferably from the Regional Leadership Council of the Indonesian Nutritionist Association (DPD PERSAGI) and the Branch Leadership Council of the Indonesian Nutritionist Association (DPC PERSAGI), with a purposive sampling method whose inclusion criteria are to live in the province for at least 3 years, be members of PERSAGI (Indonesian Nutritionist Association), have a family, and have children aged five years and over. Meanwhile, the exclusion criterion is not being specifically abstained from nuts. The number of subjects in this study was 387 families.

Data was collected using questionnaires on *kobo.humanitarianresponse*, which included data on respondent and family characteristics, tempeh consumption patterns, respondents' perceptions of tempeh, and tempeh's contribution to nutritional adequacy.

Data on the frequency of tempeh consumption were obtained from family information in one week, then added and divided by the number of subjects. Data on the type of tempeh is obtained through family information according to living conditions about the type of tempeh most often consumed by the family, while the type of processed tempeh is most often consumed according to the available options.

Data on the average consumption of tempeh (grams/capita/day) is calculated based on the size or portion of tempeh (in grams) consumed by the subject's family at each meal by calculating the frequency of eating tempeh per day divided by the number of family members.

Data on respondents' characteristics, tempeh consumption patterns, perceptions of tempeh, and the amount of tempeh consumed were analyzed descriptively. Data on the contribution of tempeh intake nutrients to nutritional adequacy were processed using the Indonesian Food Composition Table (Tabel Komposisi Pangan Indonesia/TKPI 2018) and compared with the Recommended Dietary Allowances (RDA) for protein, vitamins B, Fe, and calcium. Research has obtained ethical clearance from the Health Polytechnic Ethics Commission of the Ministry of Health Jakarta II with Number LB.02.01/I/KE/L/1022/2022.

Result and Discussion

Subject Characteristics

The subject's gender is mostly female (78,8%), with a bachelor's education level or above (82,9%), still actively employed (97,2%), and the type of work is mostly civil servants (87,9%). The average number of family members was 4,52±1,039 (min 3 and max 9), while the average number of family members who consumed tempeh was 4,34±1,044 (minimum 3 and maximum 8 people). Detailed characteristic data can be seen in Table 1.

Table 2 shows that the highest average age of subjects was in the central part of Indonesia 46,13±7,44 (27-67), while the lowest age was in the eastern part of Indonesia 39,73±8,07 (27-58).

Tempeh Consumption Frequency

The survey results showed that the average frequency of Indonesian family tempeh consumption was 4,1±1,7 / week, the lowest 1 time and the highest 8 times. The frequency category of tempeh consumption can be seen in Table 1.

The frequency of Indonesian family tempeh consumption is greater than the frequency of family consumption in West Java in 2014, which was 2,3-2,9 times/week (Jayati *et al.*, 2014), but smaller than family consumption in Bandar Lampung in 2019, which was 18.08 times/week (Azhar *et al.*, 2019).

Table 1. Consumer characteristics of tempeh (n= 387)

| Characteristic | n | % |
|---|-----|------|
| Gender | | |
| Man | 82 | 21,2 |
| Woman | 305 | 78,8 |
| Education Level | | |
| Diploma I/II/III (DI/DII/DIII) | 66 | 17,1 |
| Diploma IV/Sarjana (DIV/SI) | 161 | 41,6 |
| Master (S2) / Doctoral (S3) | 160 | 41,3 |
| Working Status | | |
| Work | 376 | 97,2 |
| Not Working | 11 | 2,8 |
| Types of Jobs | | |
| Civil servants | 340 | 87,9 |
| Private Employees | 32 | 8,3 |
| Self employed | 3 | 0,8 |
| Pensioner | 8 | 2,1 |
| Housewives | 4 | 1,0 |
| Number of Family Members | | |
| ≤ 4 persons | 207 | 53,5 |
| > 4 persons | 180 | 46,5 |
| Number of Family Members Who Consume Tempeh | | |
| ≤ 4 persons | 233 | 60,2 |
| >4 persons | 154 | 39,8 |
| Tempeh Consumption Frequency | | |
| 1-2 times / week | 61 | 15,8 |
| 3-5 times / week | 247 | 63,8 |
| ≥ 6 times / week | 79 | 20,4 |

Table 2. Age distribution by 3 regions

| Region | n | Average ± SD | Minimum - Maximum |
|-------------------|-----|--------------|-------------------|
| Eastern Indonesia | 46 | 39,73±8,07 | 27 - 58 |
| Central Indonesia | 129 | 46,13±7,44 | 27 - 67 |
| Western Indonesia | 212 | 44,89±8,71 | 24 - 62 |
| Indonesian | 387 | 43,58±8,07 | 26,00 - 62,33 |

Types of Tempeh Consumed

The types of tempeh consumed are soybean tempeh (87,5%), tempeh gembus (7,9%), tempeh green bean/red bean (2,0%), tempeh bean (1,1%), lamtoro (0,2%), bongkrek (0,7%), and oilcake tempeh (0,5%). This type of soybean tempeh is generally consumed by families living in eastern, central, and western Indonesia. Other tempeh, besides pure soybean tempeh, is also consumed by families living in the three regions of Indonesia but is generally Javanese.

Tribe or ethnicity has an important role in tempeh consumption. Javanese are the ethnicity that consumes the most tempeh and tofu (Azhar *et al.*, 2019). This is in line with a study in Bandar Lampung City that shows that most tempeh consumers (70,67%) are Javanese (Prasetyo *et al.*, 2019). Many sources say tempeh comes from the island of Java, which is the center of people's consumption and daily food patterns. According to data from BPS in 2020 and 2021, the highest tempeh consumption is still occupied in Java, namely Yogyakarta, East

Java, and Central Java, compared to other provinces in Indonesia (Badan Pusat Statistik, 2020, 2021a).

This cannot be separated from the past history of the historical development of tempeh in Indonesia. In the 19th century, the animal menu changed to tempeh due to the very high population, and coupled with the expansion of colonial plantations and forced cultivation, foodstuffs such as tempeh became very vital as a savior of population health (Shurtleff & Aoyagi, 2001).

However, along with its development, tempeh is not only known on the island of Java but in almost all corners of Indonesia and can be called a national food that can be consumed by all people with different ethnic backgrounds.

Types of Processed Tempeh Consumed

Most types of processed tempeh (35%) are fried tempeh that uses flour or not, followed by tempeh sauce or a type of tempeh geprek (20%), stir-fried tempeh (16%), dried tempeh and tempeh vegetables (14% and 1%), and other preparations such as tempeh sticks and satay, bacem, nuggets, tempeh cakes, and some consume raw soybean tempeh.

The results of this study are in line with Azhar et al.'s (2019) research explaining that the

majority of people choose to process tempeh by frying (38,3%) or stir-frying (36,7%) because it is easy and fast to do. This finding also shows that it is in accordance with the culture of processing tempeh in Indonesian society, which is dominated by frying.

However, in general, if you look at the variety of processed tempeh, it is more widely found in Central Java, D.I. Yogyakarta, and East Java, which have socially known tempeh since the 16th century (Shurtleff & Aoyagi, 2001), so it is more diverse in processed tempeh in various ways and uses many spices.

Tempeh Portions and Individual Consumption

The portion of tempeh consumed by Indonesian families is mostly (74,7%) tempeh with a size of 50%, and the rest (25,3%) consumes a size of 25 grams. The average daily consumption of individual tempehs by region is shown in Table 2. Nationally, the average consumption of individual tempeh is 41,75 + 27,22 (lowest 3,57 and highest 171,43) grams per capita per day, which is slightly below the average tempeh consumption of the Indonesian population in 2021, which is 43,42 grams per capita per day (Badan Pusat Statistik, 2021a, 2021b).

Table 3. Average consumption of tempeh (grams/capita/day)

| Region | n | Average ± SD | Minimum – Maximum |
|-------------------|-----|--------------|-------------------|
| Eastern Indonesia | 46 | 37,31±25,71 | 3,57 – 171,43 |
| Central Indonesia | 129 | 41,83±25,72 | 3,57 – 133,93 |
| Western Indonesia | 212 | 42,67±28,43 | 5,71 – 171,43 |
| Indonesian | 387 | 41,75±27,22 | 3,57 – 171,43 |

Table 3 shows that the average consumption of individual tempeh in the Western and Central regions is relatively the same, while the Eastern region is slightly lower. The results of this study are greater than the findings in West Lampung, which showed an average consumption of tempeh of 29,6 grams per capita per day (Damora, 2008) and in Tanggamus Regency of Lampung of 28 grams per capita per day (Prasetyo et al., 2019).

The Contribution of Tempeh Consumption in Fulfilling Nutritional Adequacy

Tempeh has advantages, including high nutrients in protein, vitamin B, and the minerals iron and calcium. In every 100 grams of tempeh,

there are 201 calories, 20,8 grams of protein, 4 mg of Fe, 155 mg of calcium, and 0,19 mg of vitamin B1, 0,59 mg of vitamin B2, 4,9 mg of vitamin B3, and 72,45 mg of vitamin B12.

Referring to Table 3, the average consumption of Indonesian family tempeh is 41,75 grams/capita/day, which can contribute to the adequacy of protein, Fe, and vitamin B1 and B2 in the female group by 14,46% and 9,27%, 7,3% and 22,7%, respectively, while the contribution in the male group is 10,27%, 18,5%, 6,7%, and 19,23%. The average contribution of tempeh intake to adequacy in the female group and the male group was the same for calcium, vitamin B3, and vitamin B12,

respectively: 5,39%, 12,75%, and 30,25% (Table 4). These results are in line with studies by Ahnan-Winarno et al. (2021), Bintari et al. (2021), and

Romulo & Surya (2021), which state that tempeh is a potential and superior source of nutrients in protein, iron, calcium, and vitamin B complex.

Table 4. The contribution of tempeh consumption to fulfilling nutritional adequacy

| Nutrients | Sum | Adequacy | | % Contribution | |
|-------------------|-------|----------|---------|----------------|-------|
| | | Man | Woman | Man | Woman |
| Energy (kcal) | 84,00 | 21,50 | 21,50 | 3,90 | 3,90 |
| Fat (g) | 3,67 | 60,00 | 60,00 | 6,11 | 6,11 |
| Protein (g) | 8,68 | 65,00 | 60,00 | 10,27 | 14,46 |
| Fiber (g) | 0,58 | 30,00 | 30,00 | 1,90 | 1,90 |
| Vitamin B1 (mg) | 0,08 | 1,20 | 1,10 | 6,70 | 7,30 |
| Vitamin B2 (mg) | 0,25 | 1,30 | 1,10 | 19,23 | 22,70 |
| Vitamin B3 (mg) | 2,04 | 16,00 | 16,00 | 12,75 | 12,75 |
| Vitamin B12 (mcg) | 1,21 | 4,00 | 4,00 | 30,25 | 30,25 |
| Iron (mg) | 1,67 | 9,00 | 18,00 | 18,50 | 9,27 |
| Calcium (mg) | 64,70 | 1200,00 | 1200,00 | 5,39 | 5,39 |

Table 5. Indonesian family's perception of tempeh

| Benefits of Tempeh | Negative Effects of Tempeh |
|--|------------------------------|
| High fiber | Causes allergies |
| Anti-inflammatory | Increase uric acid |
| Anti-cancer | Causes thyroid disorders |
| Anti diarrhea | Increases the risk of cancer |
| Anti cholesterol | |
| Anti-tumor | |
| Antioxidant | |
| Anti Aging | |
| Good for digestion | |
| Good for the intelligence of babies and children | |
| Functions as a prebiotic and probiotic | |
| Prevents cardiovascular disease | |
| Prevents anemia | |
| Lowers the risk of osteoporosis | |

Indonesian Family's Perception of Tempe

The perception of the family in question is the perception of tempeh in terms of benefits and negative effects on health. The survey results showed that most subjects (86,5%) stated that tempeh has benefits for heart health, anti-cancer, antioxidants, diarrhea, and others. However, there are still subjects (14,5%) stating that there are negative effects on tempeh such as allergies, increasing uric acid, thyroid disorders, cholesterol, and increasing the risk of cancer. Details of the benefits of tempeh and the negative effects of tempeh consumption can be seen in Table 5.

The subject's perception of the benefits of tempeh is in line with the results of research by Ahnan-Winarno et al. (2021), which states that

tempeh is proven to have potential health benefits in the intestine, anti-cancer, cognitive function, lungs, heart health, liver, bones, anemia, recovery for malnourished children, and as an antioxidant in the body. Most of these health benefits are related to its content, including isoflavones, proteins, minerals, prebiotics, and probiotics.

But on the other hand, there are still negative effects about tempeh stated by the subjects, including causing allergies, thyroid disorders, and increasing the risk of cancer. However, until now, there has been no research that proves that tempeh can cause these disorders. It is possible that the cause of this is the raw material of tempeh, namely soybeans.

Pure soy protein is a very widely used source of protein. Soybeans contain isoflavones consisting of genistein and daidzein. Isoflavones are phytoestrogens that have a structure resembling 17- β -estradiol, a hormone found in women. Isoflavones are able to imitate (mimic) the work of estrogen in certain organs by binding and activating estrogen receptors so that estrogen production decreases. The process can reduce the growth of cancer cells, especially breast cancer, through independent inhibition of estrogen receptors from DNA topoisomerase and tyrosine kinase (Hirano et al., 1989; Pagliacci et al., 1994).

The opinion that soy protein can cause cancer is not entirely true. According to Boutas et al. (2022), in their meta-analysis, the isoflavones contained in soybeans and their preparations are actually beneficial for breast cancer prognosis and reduce the risk of breast cancer. Women who consume a lot of soy (isoflavone levels >15 mg/day) have a lower risk of cancer compared to women who do not consume soy.

100 grams of soybeans contain 125 mg of isoflavone (Yulifanti et al., 2018). This study shows the average consumption of tempeh per individual in Indonesia is 40 g/person/day, or equivalent to 50 mg isoflavones/person/day.

Conclusion

The frequency of consumption of Indonesian family tempeh is more than three times a week, depending on the type of soybean tempeh being processed and fried. Consumption of tempeh a day contributes to protein intake between 10 and 14% of the requirement and 30,25% of vitamin B12. Some Indonesian families claim tempeh has benefits for heart health and anti-cancer. However, a small number of families state that there are negative effects such as allergies, gout, and cancer risk.

It is necessary to carry out continuous promotion of the benefits of tempeh and various types of processed tempeh throughout Indonesia, especially in the eastern region.

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