
Testing the Vitamin B12 Levels in Cassava Tapai

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Abstract

Anemia remains a major public health issue in Indonesia, including Central Kalimantan, and is often linked to vitamin B12 deficiency. Vitamin B12 is typically found in animal-based foods; However, certain microorganisms involved in the fermentation of plant-based foods, such as cassava tapai, can synthesize this vitamin. This study aims to determine the vitamin B12 content and its variation in cassava tapai from Palangka Raya City based on fermentation duration. A comparative descriptive study with a quantitative approach was conducted using 16 samples obtained through purposive sampling from four local tapai producers at Pasar Besar A. Yani, Palangka Raya. Vitamin B12 levels were measured using UV-Vis spectrophotometry at 361 nm, and organoleptic properties (color, aroma, taste, texture) were analyzed descriptively. The results showed that all samples contained vitamin B12 ranging from 453,736,666.67 to 1,588,180,000.00 mcg/100g, with levels increasing along with fermentation time (days 1–4). Organoleptic tests revealed non-white color, alcoholic aroma, slightly sweet to unsweet taste, and soft texture. In conclusion, cassava tapai produced by MSMEs in Palangka Raya contains high levels of vitamin B12 and holds promise as a potential local food source to help prevent vitamin B12 deficiency anemia.

Keywords: *Anemia, Cassava Tapai, Vitamin B12, UV-Vis Spectrophotometry, Organoleptic.*

INTRODUCTION

One of the causes of vitamin B12 deficiency is anemia, which remains a health issue in Indonesia. Anemia is a condition where the body experiences a decrease in the number of red blood cells below the normal limit (Ministry of Health of the Republic of Indonesia, 2025). Anemia is characterized by a decrease in hemoglobin (Hb) levels, namely ≤ 13.5 g/dl in men and ≤ 12 g/dl in women (Astuti, 2023). One type of anemia that is often found is megaloblastic anemia, characterized by the presence of megaloblasts, namely enlarged erythroblasts in the bone marrow, resulting in abnormal erythrocyte formation (Aini & Ningsih, 2022). Based on average blood volume, megaloblastic anemia is classified as macrocytic anemia (MCV >100) with the production of large and abnormally shaped red blood cells (Anis & Priyanka, 2023). Anemia due to vitamin B12 deficiency has more complex symptoms than other types of anemia (Gede Andhika, 2023).

Kalimantan has a higher prevalence of anemia than the national average, including Central Kalimantan at 12.7% (Fitriana & Kartika, 2023). In Palangka Raya City, anemia rates in children aged 5–14 years reached 16.3% and in children aged 15–24 years reached 15.5%, particularly among adolescent girls (Central Kalimantan Provincial Health Office, 2024a; Central Kalimantan Provincial Health Office, 2024b). Anemia also increased among pregnant women, reaching 48.9%, while in South Barito Regency the prevalence reached 26.14% (Health Research and Development Agency, 2019). Deficiency anemia is the most common form of anemia and can be caused by vitamin deficiencies such as vitamin B12 (Pamela et al., 2022). One natural source of vitamin B12 comes from fermented foods such as cassava tapai, because microorganisms in the fermentation process are able to produce vitamin B12 (Rahmawati et al., 2023).

Cassava is a tuber crop that grows easily in various regions of Indonesia and serves as a carbohydrate source to replace rice (Syafriani et al., 2022). Several cassava varieties include mukibat, emas, gajah, kuning, manggu, and kristal, with the crystal variety commonly used to make cassava tapai in Palangka Raya. Cassava tapai is a traditional fermented product popular as a snack and contains macronutrients (carbohydrates, protein, fat) and micronutrients (vitamins B1, B12, A, and C) (Yulia & Arman, 2022). The tapai fermentation process involves two stages: the conversion of starch

into simple sugars by the amylase enzyme produced by mold, and then the conversion of sugar into alcohol by yeast (Azzahra et al., 2022). This fermentation produces probiotics that can increase the number of good bacteria in the body and play an important role in the synthesis of vitamin B12, thus cassava tapai has the potential to support public health.

Although vitamin B12 is generally found in animal products, the fermentation process allows this compound to appear in plant foods, including cassava tapai. Cassava production in Indonesia reaches around 21 million tons per year, and most of it is processed into products such as cassava tapai (Rahmatin, 2017). This potential presents a significant opportunity both nutritionally and economically because cassava tapai is readily available, affordable, and popular with the public. However, quantitative research on the vitamin B12 content in cassava tapai is still limited, so its contribution to meeting the daily vitamin B12 requirement of 2.4–4 micrograms for anemia prevention cannot be ascertained. Therefore, this study was conducted to determine the vitamin B12 levels in cassava tapai as a basis for developing nutritious and functional local fermented foods. This study aimed to determine the vitamin B12 levels in cassava tapai.

RESEARCH METHODS

This study employed a descriptive comparative quantitative design aimed at analyzing the vitamin B12 content in fermented cassava (*tapai singkong*) produced by local SMEs in Palangka Raya. Samples were collected purposively from four local producers at A. Yani Central Market and production sites, with each sample consisting of 650 ml of *tapai singkong* stored in polypropylene containers (Supriyanto, 2020). The inclusion criteria included fresh *tapai singkong* (less than five days after fermentation), locally produced without additives, and free from contamination. The main research variables were vitamin B12 levels, sensory (organoleptic) characteristics, and fermentation duration (SNI, 1992). Operationally, vitamin B12 levels were measured using the European Pharmacopoeia 11.0 (2022) method with UV-Vis spectrophotometry at a wavelength of 361 nm. Organoleptic characteristics color, taste, aroma, and texture were assessed using a subjective rating scale evaluated by human senses (Rahmawati, 2021). Data collection included drying, grinding, and sieving of samples before chemical analysis, while sensory data were obtained through direct panel evaluation. The data were processed using Microsoft Excel and IBM SPSS software through several steps: data entry, cleaning, editing, tabulation, and univariate analysis, which described the distribution, mean, median, and standard deviation of vitamin B12 concentrations (Santoso, 2022). The research was conducted from August to October 2025 at the Integrated Laboratory of the University of Palangka Raya for vitamin B12 testing and at BPOM Palangka Raya for organoleptic assessment.

RESULTS AND DISCUSSION

Organoleptic Characteristics of Cassava Tapai

Based on organoleptic assessments (color, taste, aroma, and texture) conducted on 16 samples of cassava tapai at the Palangka Raya Food and Drug Monitoring Agency (BPOM), the following data were obtained:

Table 1. Results of Organoleptic Assessment of Cassava Tapai

Manufacturer	Organoleptic Assessment	Frequency of Measurement Results		
		1	2	3
Producer 1	Color	-	-	4
	Flavor	2	1	1
	Aroma	-	-	4
	Texture	4	-	-

Producer 2	Color	-	-	4
	Flavor	-	2	2
	Aroma	3	1	-
	Texture	4	-	-
Producer 3	Color	-	-	4
	Flavor	1	-	3
	Aroma	3	1	-
	Texture	3	-	1
Producer 4	Color	-	-	4
	Flavor	-	2	2
	Aroma	-	-	4
	Texture	1	1	2

Note: Color 1 = White, 2 = Slightly white, 3 = Not white; Taste 1 = Sweet, 2 = Slightly sweet, 3 = Not sweet; Aroma 1 = Alcoholic smell, 2 = Slightly alcoholic smell, 3 = No alcoholic smell; Texture 1 = Soft, 2 = Slightly soft, 3 = Not soft; and 4 = Number of samples.

Based on the results of organoleptic assessments of four cassava tapai producers in Palangka Raya City, all samples were not white in color. In terms of taste, most cassava tapai had a slightly sweet to not sweet taste, although some samples from producers 1 and 3 still showed a sweet taste. In terms of aroma, the majority of samples from the four producers showed a strong alcoholic odor, indicating that the fermentation process was running optimally. Meanwhile, in terms of texture, most cassava tapai from producers 1, 2, and 3 had a soft texture, while several samples from producer 4 showed a slightly soft to not soft texture. Overall, these results illustrate that the organoleptic characteristics of cassava tapai from various producers are relatively uniform with the characteristics of a non-white color, alcoholic aroma, a slightly sweet to not sweet taste, and a texture that tends to be soft.

Results of Vitamin B12 Level Testing with a UV-Vis Spectrophotometer

The results of the vitamin B12 level test obtained data from 16 samples from 4 cassava tapai producers and based on the fermentation time. The steps in this study were carried out sample preparation until the determination of vitamin B12 levels using a UV-Vis spectrophotometer BRQ-UV20A with a wavelength of 361 nm and Cyanocobalamin (Biochemical CDH Fine). After the test was carried out, the absorbance value of vitamin B12 levels in cassava tapai was determined and a standard curve measurement of cyanocobalamin was obtained.

Table 2. Cyanocobalamin Standard Curve (Note: ppm= mg/L)

Absorbance (361 nm)	Concentration (ppm)
0.239	15
0.409	25
0.553	35
0.787	50
0.930	60

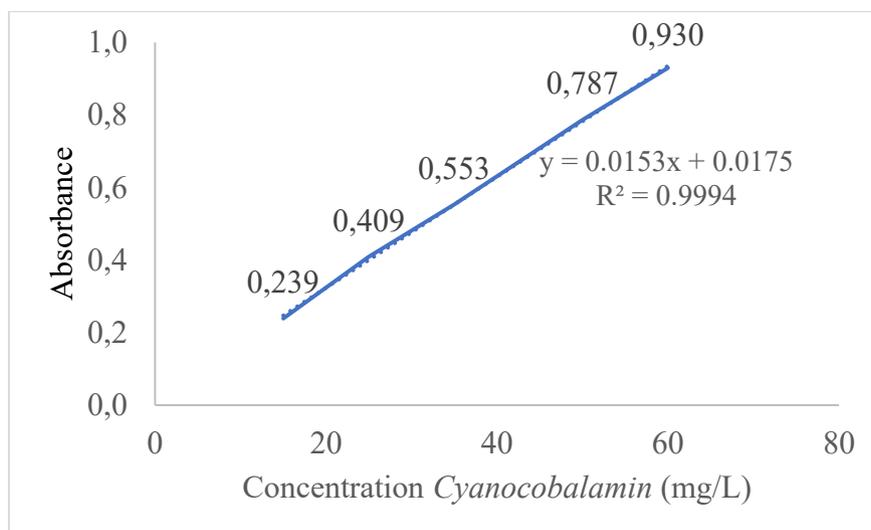


Figure 1. Cyanocobalamin Standard Curve

Determination of Vitamin B12 Levels in Cassava Tapai

After obtaining the absorbance value of each cassava tapai sample, the vitamin B12 content (ppm) was determined based on the standard curve of -the BRQ-UV20A UV-Vis spectrophotometer. The vitamin B12 content (ppm) was then converted to mcg/100 g. The working principle of the UV-Vis spectrophotometer in determining vitamin B12 content follows the Beer–Lambert Law as follows :

$$Y = 0.0153x + 0.0175$$

Information:

Y = Absorbance

X = Concentration (mg/L)

For conversion use the formula:

$$\text{Vitamin B12 level (mcg/100g)} = \text{Vitamin B12 level (ppm)} \times 100$$

Description:

$$\begin{aligned} \text{mg/L} &= \text{mg/kg} = \text{mg/100g} \\ 1000 \text{ mcg} &= 10/1000\text{g} = 10 = \\ &\text{mcg/100g} \times 100 \end{aligned}$$

Table 3. Results of Determination of Vitamin B12 Levels in Cassava Tapai Producer 1 Based on Fermentation Time

Sample Code	Sample Weight (mg)	Absorbansi	Mean Absorbance	Vitamin B12 Content (ppm)	Vitamin B12 Content (mcg/100g)
T1.H1	120	0,215 0,214 0,215	0,215	5,37	537
T1.H2	120	0,351 0,35 0,35	0,350	9,06	906
T1.H3	156	0,613 0,611 0,613	0,612	12,46	1.246
T1.H4	172	0,725	0,724	13,42	1.342

Sample Code	Sample Weight (mg)	Absorbansi	Mean Absorbance	Vitamin B12 Content (ppm)	Vitamin B12 Content (mcg/100g)
		0,723 0,723			
Mean					1.008
Median					1.076
Standard Deviation					365

Note: T1.H1= Tapai Cassava producer 1 on day 1; T1.H2= Tapai Cassava producer 1 on day 2; T1.H3= Tapai Cassava producer 1 on day 3; T1.H4= Tapai Cassava producer 1 on the 4th day.

Table 4. Results of Determination of Vitamin B12 Levels in Cassava Tapai Producers Based on Fermentation Duration

Sample Code	Sample Weight (mg)	Absorbansi	Mean Absorbance	Vitamin B12 Content (ppm)	Vitamin B12 Content (mcg/100g)
T2.H1	143	0,279 0,279 0,278	0,279	5,97	597
T2.H2	168	0,598 0,598 0,598	0,598	11,29	1.129
T2.H3	154	0,634 0,632 0,633	0,633	13,06	1.306
T2.H4	178	0,749 0,749 0,749	0,749	13,43	1.343
Mean					1.094
Median					1.217
Standard Deviation					334

Note: T2.H1= Tapai Cassava producer 2 on day 1; T2.H2= Tapai Cassava producer 2 on day 2; T2.H3= Tapai Cassava producer 2 on day 3; T2.H4= Tapai Cassava producer 2 on the 4th day.

Table 5. Results of Determination of Vitamin B12 Levels in 3 Cassava Tapai Producers Based on Fermentation Duration

Sample Code	Sample Weight (mg)	Absorbansi	Mean Absorbance	Vitamin B12 Content (ppm)	Vitamin B12 Content (mcg/100g)
T3.H1	178	0,373 0,372 0,373	0,373	6,52	652
T3.H2	172	0,620 0,620 0,621	0,620	11,45	1.145
T3.H3	183	0,759 0,759 0,759	0,759	13,24	1.324
T3.H4	207	0,869	0,868	13,43	1.343

Sample Code	Sample Weight (mg)	Absorbansi	Mean Absorbance	Vitamin B12 Content (ppm)	Vitamin B12 Content (mcg/100g)
		0,868 0,868			
Mean					1.116
Median					1.234
Standard Deviation					322

Note: T3.H1= Tapai Cassava producer 3 on day 1; T3.H2= Tapai Cassava producer 2 on day 2; T3.H3= Tapai Cassava producer 3 on day 3; T3.H4= Tapai Cassava producer 3 on the 4th day.

Table 6. Results of Determination of Vitamin B12 Levels in 4 Cassava Tapai Producers Based on Fermentation Duration

Sample Code	Sample Weight (mg)	Absorbansi	Mean Absorbance	Vitamin B12 Content (ppm)	Vitamin B12 Content (mcg/100g)
T4.H1	188	0,412 0,410 0,411	0,411	6,84	684
T4.H2	169	0,622 0,620 0,620	0,621	11,66	1.166
T4.H3	203	0,848 0,849 0,848	0,848	13,38	1.338
T4.H4	214	0,900 0,902 0,903	0,902	13,50	1.350
Mean					1.134
Median					1.252
Standard Deviation					312

Note: T4.H1= Tapai Cassava producer 4 on day 1; T4.H2= Tapai Cassava producer 4 on day 2; T4.H3= Tapai Cassava producer 4 on day 3; T4.H4= Tapai Cassava producer 4 on the 4th day.

Discussion

This research was conducted at the Integrated Laboratory of Palangka Raya University with 16 samples of cassava tapai from four producers sold at the A. Yani Palangka Raya Market. Vitamin B12 levels were tested using UV-Vis spectrophotometry BRQ-UV20A at a wavelength of 361 nm as described by Sari and Billa (2021). Determination of vitamin B12 levels is based on the Lambert-Beer law to accurately determine absorbance (Wahyuni et al., 2022; Hermawan, 2022). The test results showed an increase in vitamin B12 levels in each producer as the fermentation period increased from the first to the fourth day. The average vitamin B12 levels ranged from 1,008–1,134 mcg/100g, with a standard deviation of 312–365 mcg/100g. This proves that the fermentation process significantly increases vitamin B12 levels in cassava tapai.

The consistent increase in vitamin B12 levels across all producers indicates the role of microorganisms during fermentation. This process aligns with research by Apriyanto et al. (2021), which explains that microbes such as *Saccharomyces cerevisiae* and lactic acid bacteria can synthesize vitamin B12 during fermentation. These microorganisms convert starch in cassava into simple sugars, which are then used to produce secondary metabolites, including vitamin B12. During the exponential growth phase of microbes, vitamin B12 biosynthesis reaches its maximum level. The increasing mean

and median vitamin B12 levels strengthen the relationship between fermentation duration and microbial activity. Thus, fermentation duration is a major factor in increasing vitamin B12 content in cassava tapai.

The daily requirement for vitamin B12 for adults is 2.4 mcg, while for pregnant and lactating women it is 2.6 mcg and 2.8 mcg, respectively (Office of Dietary Supplements, 2022). In comparison, the vitamin B12 levels in cassava tapai in this study were very high, possibly due to interference from other compounds or technical factors during spectrophotometric measurements. Research by Tsafakidou et al. (2020) showed that fermented cereal products contain only 0.16–8 µg/100g of vitamin B12, while Lüthi et al. (2025) reported levels in beef and tuna of 1.8 and 2.8 µg/100g, respectively. These findings indicate that the cassava tapai in this study has a much higher vitamin B12 content than other food sources. However, this difference can be explained by variations in microbes and fermentation conditions. Thus, cassava tapai has the potential to become an alternative source of local vitamin B12 that is economical and easily accessible to the public.

Vitamin B12 is a water-soluble vitamin that plays a vital role in DNA synthesis and erythrocyte formation in the bone marrow (Gede Andhika, 2023). Excessive consumption of this vitamin is generally safe because it is excreted in the urine without causing toxic effects (SAINSBERTEK, 2022). Vitamin B12 deficiency can cause megaloblastic anemia, characterized by enlarged erythrocytes and symptoms such as fatigue, dyspnea, and neurological disorders. The increased levels of vitamin B12 in cassava tapai indicate its potential benefits in helping meet daily nutritional needs. With an optimal fermentation process, cassava tapai can become a functional food that supports the prevention of anemia caused by vitamin B12 deficiency. This supports the development of local fermentation-based foods to improve the nutritional status of the Indonesian people (Apriyanto et al., 2021).

CONCLUSIONS AND SUGGESTIONS

Based on the research conducted at the Integrated Laboratory of the University of Palangka Raya for vitamin B12 analysis and at BPOM Palangka Raya for organoleptic assessment, it can be concluded that *tapai singkong* from four local producers in Palangka Raya contains measurable levels of vitamin B12 ranging from 537 mcg/100 g to 1,350 mcg/100 g, with higher concentrations observed in samples with longer fermentation durations. This indicates the potential of *tapai singkong* as a plant-based source of vitamin B12 to help prevent megaloblastic anemia. Organoleptic evaluation revealed consistent color (non-white) and aroma characteristics, while taste and texture changed progressively with fermentation from sweet to slightly sour and from firm to softer demonstrating optimal fermentation characteristics. Future studies are recommended to perform independent analyses directly by trained researchers to improve control and minimize bias, utilize High Performance Liquid Chromatography (HPLC) for more accurate measurement, and focus on developing standardized fermentation processes suitable for small-scale producers to ensure consistent vitamin B12 content and sensory quality.

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