

The Influence of Giving Bellforte Nuggets (Mullet Fish Tempe Formula) on Leukocyte Levels, Hemoglobin, Albumin and Body Weight in Tuberculosis Patients

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ABSTRACT

Tuberculosis (TB) is one of the leading causes of death worldwide. It can be prevented and its treatment supported through the consumption of simple foods containing functional ingredients that are affordable and easily accessible. These ingredients may serve as an alternative approach to aid the recovery process of TB patients, particularly by helping eliminate pro-inflammatory compounds. In this study, patients were treated with Bellforte Nuggets for 15 days, with a dosage of 2 pieces per day, each weighing 50 grams. Data analysis was conducted using the Kolmogorov-Smirnov test for normality, followed by a paired T-test. The results showed a statistically significant difference ($p = 0.001$) in all measured parameters before and after the intervention, indicating that Bellforte Nuggets effectively support the recovery process in TB patients.

Keywords: Bellforte Nuggets, Leukocytes, Hemoglobin, Albumin, Tuberculosis

INTRODUCTION

Tuberculosis is a disease caused by the bacterial infection *Mycobacterium tuberculosis*, transmission occurs through the air and soil contaminated with droplets inhaled by the patient, so the bacteria can enter the body and accumulate in the lungs, can multiply through the bloodstream or lymph nodes, especially in individuals with a weak immune system [1, 2]. Tuberculosis patients show symptoms such as prolonged cough (more than 3 weeks), night sweats, chest pain, decreased appetite, weight loss, fatigue, fever, and coughing up blood [3, 4]. The Global Tuberculosis Report of 2022 recorded 969,000 cases of tuberculosis or 354 cases per 100,000 people, with Indonesia ranking second highest after India. According to the Basic Health Research data in Indonesia in 2018, the incidence of tuberculosis in Indonesia between 2013 and 2018 reached 0.4%, while in North Sumatra Province it was 0.3% [5]. The number of tuberculosis cases in Deli Serdang Regency increased from 64.67% in 2020 to 66.32% in 2021 [6]. Anthropometric examinations that monitor body weight and complete blood biochemical analysis such as leukocytes, hemoglobin, and albumin as well as BTA (+) can be performed to assist in the diagnosis of tuberculosis. Leukocytes are a routine blood analysis to monitor the severity of pulmonary TB infection in a person [7, 8].

Hemoglobin (Hb) is a protein in blood help distributes oxygen throughout the body, which is important for pulmonary TB patients who have difficulty breathing [9]. Low albumin levels indicate the presence of protein degradation in the body due to the process of replacing damaged cells and the process of gluconeogenesis. Albumin, as a protein found in the blood, plays an important role in delivering medications to the injured parts of pulmonary TB patients. Utilizing body weight as an indicator of protein degradation can be a sign for someone suffering from pulmonary TB [10]. Weight loss in pulmonary TB patients is often assumed to be an indicator that the patient is experiencing tissue damage, which is evident through symptoms of coughing up blood and significant weight loss, so a high-

energy and protein diet should be provided. Meeting nutritional needs with a high-energy and protein diet management can reduce the risk of more serious diseases or prevent ongoing complications. Energy needs can reduce protein degradation, so the use of protein for energy can be minimized. This is because protein is intended to produce antibodies, reduce inflammation, and support the closure of wounds/lesions occurring in the lungs, which can be optimized through a high-energy and protein diet [11].

Meeting nutritional needs through high-energy high-protein dietary management can inhibit more severe disease or prevent the occurrence of ongoing complications. Energy needs can help reduce protein degradation, so the energy needs using protein will be minimized. This is because protein is intended to produce antibodies, reduce inflammation, and help close wounds/lesions that occur in the lung organs, which can be optimized through a high-energy high-protein diet [12]. Meeting protein and energy needs can be obtained from main foods as well as high-nutrition snacks. Bellforte nuggets are a combination of mullet fish and tempeh formula. Mullet fish (*Mugil cephalus*) contains animal protein nutrients, omega-3 fats, and minerals such as zinc and iron, which are known to have anti-inflammatory effects and can enhance immune system function. In 100 grams, it contains 83.9 kcal of energy, 14.8 grams of protein, 2.3 grams of fat, 12 µg of vitamin A, 9 mg of calcium, and 0.5 mg of zinc [13]. The completeness of amino acids in the nuggets should be combined with the addition of plant protein sources such as tempeh formula, which contains isoflavones as antioxidants. To improve the immune system, high fiber, especially soluble fiber, helps the digestion and nutrient absorption process. In 100 grams, it contains protein 46 g, fat 24.7 g, total carbohydrates 19.3 g, fiber 2.5 g, water content 2.3%, and ash content 7.7% [14]. Nugget Bellforte has been biochemically tested and has undergone organoleptic testing, making it suitable for consumption. The results of the examination by the Nutrition

Laboratory of FKM Airlangga and FMIPA Chemistry of Brawijaya University in Malang City (2024) show that Nugget Bellforte contains nutrients including: protein 12.11 g, albumin 6.45 g, iron 0.153 g, and zinc 2.2 g. The uniqueness of Nugget Bellforte in this study is processed using little oil, with the recommended cooking method being grilling, thus avoiding the risk of coughing often experienced by tuberculosis patients [15]. The process of minimizing the use of cooking oil containing saturated fat will help prevent the formation of fat changes into cytokines that produce bradykinin, leukotrienes, and thromboxane [16]. In addition, the specialty of Nugget Bellforte is processed using easily obtainable food ingredients, affordable prices, and familiar to the community of tuberculosis patients who essentially have low purchasing power due to inadequate economic conditions [17, 18]. In Yuliati's [19] study, the combination of probiotic and selenium supplements caused an increase in the immune response neutrophil lymphocyte count ratio (NLR), hemoglobin, and albumin in the experimental rat group. Probiotics function to modulate the immune system, while selenium, as an antioxidant, supports immune system function by increasing cytokine production and immune cell activation. Meanwhile, Dwi Handayani's [20] study showed that the administration of snakehead fish and colored fruit increased iron and hemoglobin levels in HIV/AIDS patients. Fatmah's [21] research states that the intervention of tempeh date biscuits as a high-energy and high protein supplementary food shows that nutritional support in the recovery process nutritional support in acting on the recovery process and overall health of the community.

MATERIALS AND METHODS

Materials

Before making Bellforte Nuggets, forte is made with ingredients: tempeh, wheat flour, sugar flour, oil, salt, baking powder and ovalet. Forte is made by mixing boiled tempeh for 10 minutes, then draining and grinding it with wheat flour, sugar flour, salt, baking powder and ovalet, then dried using a cabinet dryer at 60°C. after that, it is ground into flour and sifted with an 80 mesh sieve [22]. The making of Nugget Bellforte uses the main food ingredients, namely 270 grams of mullet fish, 30 grams of tempeh formula, 92 grams of egg, and a mixture of 50 grams of wheat flour. The spices used include garlic, shallots, green onions, celery, and lime leaves, which are first ground.

Methods

Procedure for Making Nugget Bellforte

The nugget processing process begins with the preparation of ingredients, where the mullet fish is cleaned, washed, marinated, pre-cooked, and ground. Next, the mixture is combined with the tempeh formula, egg white, flour, and spices until homogeneous, then shaped, steamed, and cooled before going through the coating stage with wheat flour and coated with breadcrumbs, then baked at a temperature of 160-200°C for 20-30 minutes. The following table shows the results of Bellforte nugget testing at the Agricultural Laboratory of Brawijaya University, Malang, and their adequacy based on the Recommended Dietary Allowances.

Table 1: Distribution of Nutrient Content of Nugget Bellforte and Its Contribution to Pulmonary TB Patients Based on RDA 2019*

Nutrients	Check-up result	Based on the RDA of 2019					
		19-29 Years	%	30-49 Years	%	50-64 Years	%
Carbohydrates (g)	19,38	395	4,9	377,5	5,13	310	6,25
Protein (g)	12,11	62,5	19,3	62,5	19,3	62,5	19,3
Iron (Fe) (mg)	1,53	13,5	11,3	13,5	11,3	8,5	18
Zinc (Zn) (mg)	2,2	9,5	23,15	9,5	23,15	9,5	23,15
Albumin (g)	6,45						

RDA : Recommended Dietary Allowances

Procedure for Administration of Nugget Bellforte

The administration of Nugget Bellforte as treatment was conducted for 15 consecutive days starting from December 13 to December 27, 2024, at 09:00 to 11:30 WIB. Nugget Bellforte was given once a day weighing 100 grams (2 pieces). The distribution of Nugget Bellforte was carried out directly from house to house by the researchers with the assistance of 12 enumerator students from the 5th and 7th semesters of the nutrition department at Poltekkes Kemenkes Medan. The consumption of Nugget Bellforte was directly monitored by the researchers and enumerators as well as the staff of the communicable disease prevention and control program (P2PM) and nutrition experts.

Research Implementation Procedure

Entire population of pulmonary TB patients at the Lubuk Pakam Health Center, totaling 105 people, was used as a sample. All samples, before data collection, first filled out the Informed Consent (IC). The data collected included sample characteristics, leukocytes, hemoglobin, albumin, body weight, height, and food intake using the 24-hour food recall method over two days (before and after the intervention was conducted). Blood tests and measurements of weight and height in TB patients at Puskesmas Lubuk Pakam were conducted before and after the administration of Nugget Bellforte as treatment.

The administration of complete names was first conducted before and after the blood tests to avoid identification errors, followed by anthropometric measurements of weight and height. Blood sampling was scheduled between 09:00 and 12:00 WIB in a rotating system to avoid crowds and minimize the risk of transmission. Each patient entered the laboratory individually for sample collection and was allowed to go home after the procedure was completed.

The examination of leukocyte, hemoglobin, and albumin levels was conducted by taking 1-2 cc of blood from the upper left arm syringe pipette by laboratory personnel. The blood was then placed into a tube containing Ethyl Diamine Tetra Acetic acid (EDTA) solution to prevent clotting in the tube. The blood was taken and examined at the Prima Medan laboratory. The reading of albumin results using the Brom Cresol Green (BCG) method was performed with a Shima Dzu spectrophotometer, while leukocyte and hemoglobin levels were examined using cyanmethemoglobin with a spectrophotometer.

Data Analysis Procedure

This type of research is a Quasi Experiment with a pre and post-test one group design. Data is presented univariately and bivariately, and the data obtained a normal distribution using the method Kolmogorov Smirnov. Based on this data, an independent t-test was performed for data analysis with the 24-hour food recall method as a

control in the study and dependent t-tests to examine the effect of the alternative food provision of Nugget Belforte on leukocyte, hemoglobin, albumin levels, and body weight. This research has

obtained approval from the Health Research Ethics Commission issued by Poltekkes Kemenkes Medan with the number: 01.26 829 /KEPK/POLTEKKES KEMENKES MEDAN 2024, December 9, 2024

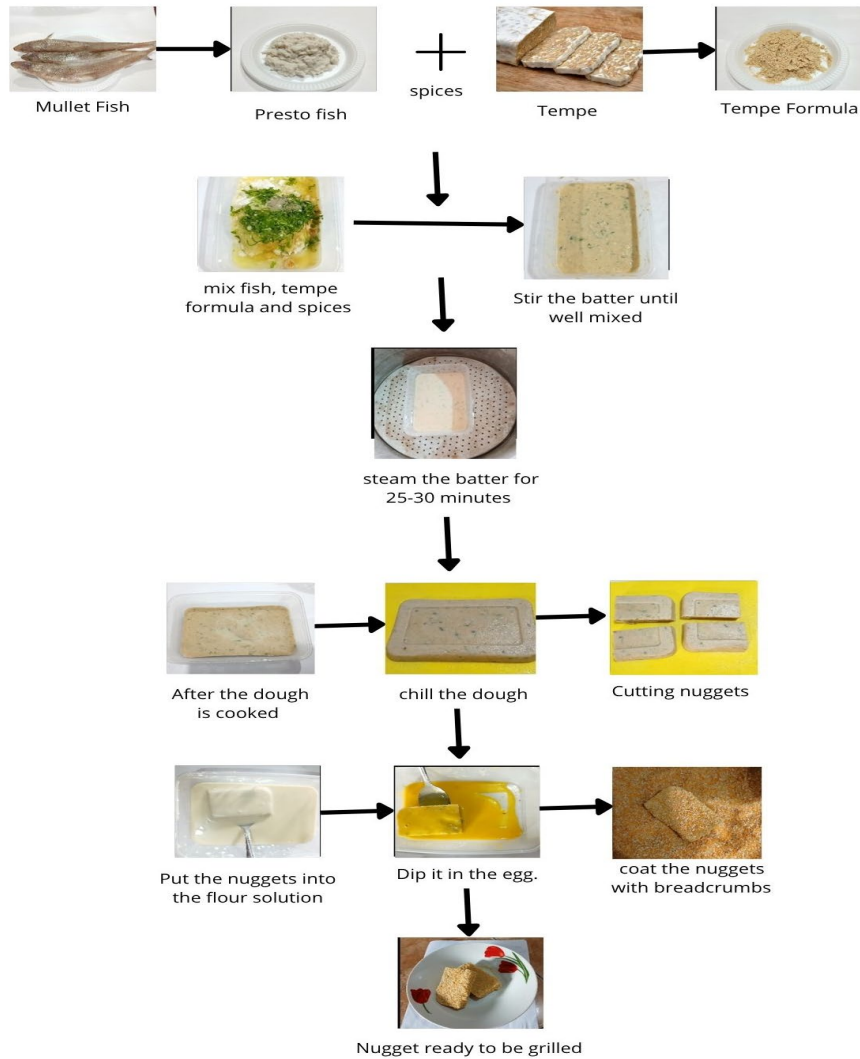


FIGURE 1: Image of the Belforte Nugget Production Procedure

Results

Sample Characteristics

The characteristics of the sample taken by the researcher consist of three variables, namely gender, age, and last education. Gender

classifies individuals based on biological and physiological differences, age indicates the duration of life that can be measured with a scale of years, and last education reflects the highest formal level that has been completed by an individual in the education system. The distribution of the sample based on characteristics can be seen in Table 2.

Table 1: Distribution of Samples Based on Characteristics of Pulmonary TB Patients

Indicator	n (person)	%
Jenis Kelamin		
Man	67	63,8
Woman	38	36,2
Age (years)		
20-29	48	45,7
30-39	25	23,8
40-49	18	17,2
50-58	14	13,3
Last Education		
Elementary School	36	34,3
Junior High School	32	30,4
Senior High School	16	15,2
D-III	13	12,3
S-1	8	7,6
Amount	105 person	100%

Table 2 shows that the characteristics based on gender are dominated by male samples, totaling 67 people (63.8%) compared to female gender, totaling 38 people (36.2%). This study consists of a sample aged 20-58 years, with the majority in the age group of 20-29 years, totaling 48 people (45.7%), which falls into the productive age category.

The prevalence of pulmonary TB patients with a primary school education level is the highest, namely 36 people (34.3%). Nutritional intake of the sample was conducted as a control to avoid bias while also helping to ensure the homogeneity of the sample. Intake was assessed 1 day before the treatment was given and 1 day after the

treatment ended. The average food intake values before and after the administration of Nugget Bellforte are presented in Table 2.

Average Nutrient Intake Before and After the Study in Pulmonary TB Patients

Data bias can be minimized by looking at the nutritional intake of the sample acting as a control while also helping to ensure the homogeneity of the sample. Intake was assessed 1 day before the treatment was given and 1 day after the treatment ended. The average food intake values before and after the administration of Nugget Bellforte are presented in Table 3.

Table 3: Average Nutrient Intake of Pulmonary TB Patients (n=105 people)

Nutrients	Before Treatment		After Treatment		P-value
	Average	SD	Average	SD	
Carbohydrates (g)	285,69	14,65	287,37	13,10	0,383
Protein (g)	46,91	2,50	47,00	2,48	0,782
Zinc (mg)	7,32	0,46	7,36	0,43	0,55
Iron (mg)	8,48	0,57	8,50	0,53	0,822

*SD = standard deviation

Table 3 shows that the results of the independent t-test for macro and micro nutrient intake in the sample did not show any differences with a p value >0.05. When looking at the average numbers, there is an increase in the intake of carbohydrates, protein, zinc, and iron, but not significantly different. Furthermore, when reviewed from the Recommended Dietary Allowance (RDA) of 2019 based on the age of 20 to 58 years, the protein adequacy of pulmonary TB patients is 62.5 grams, which is only met at 75.2% (deficient), and when viewed from the high protein energy diet requirement (ETPT I) of 100 grams, it is very deficient (47%). The carbohydrate requirement of 360 grams/day is met at 79.4%. The zinc requirement of 9.5 mg/day is only met at 77%. The iron requirement of 11.84 mg/day is only met at 71.62%.

Average Levels of Leukocytes, Hemoglobin, Albumin, and Body Weight of Pulmonary TB Patients

Blood biochemical examination is one of the measurements to determine nutritional status. The number of leukocytes can provide an overview of the body's immune response to the bacterial infection bacteria. Hemoglobin levels are important for assessing the presence of anemia, which is often associated with chronic diseases such as pulmonary TB. The level of albumin in the blood can reflect nutritional status and liver function, both of which can be affected by

tuberculosis infection and systemic inflammatory processes. Body weight serves as an indicator of nutritional status, which can indicate malnutrition that often occurs in pulmonary TB patients due to significant weight loss. The distribution of average, minimum, and maximum values of leukocyte levels, hemoglobin, albumin, and body weight can be seen in Table 4. Table 4 shows that on the average levels of leukocytes, hemoglobin, albumin, and body weight showed significant differences, with changes before and after the administration of Bellforte Nuggets in TB patients (p value < 0.05). In the leukocyte level indicator, there was an increase in the average of 626.66 cells/μl, the hemoglobin level increased by an average of 0.471 g/dl, the albumin level increased by an average of 0.925 g/dl, and body weight increased by an average of 0.638 kg. The normal values for each variable are as follows: normal leukocyte count 4,000 - 10,000 cells/μl, normal hemoglobin level 13 - 18 g/dl for males and 12 - 16 g/dl for females, and the normal reference value for albumin level 3.5 - 5 g/dl, as well as the normal body weight range (BBN) based on ideal body weight (BBI), which is determined by calculating BBI (kg) = [height (cm) - 100] - [(height (cm) - 100) x 10%], then calculate 10% of BBI as an adjustment value. The lower BBN (BBI - 10% BBI) and upper BBN (BBI + 10% BBI).

Table 4: Average, Minimum and Maximum Values of Leukocytes, Hemoglobin, Albumin, and Body Weight of TB Patients

Indicators		n (person)	Min	Max	Mean	SD	P-value
Leukocytes (cells/ul)	Before	105	2.600	10.100	5.942,86	1822,34	0,001*
	After	105	3.100	9.000	6.569,52	1523,67	
	Difference				626,66		
Hemoglobin (g/dl)	Before	105	9,6	15,2	12,650	1,22	0,001*
	After	105	10,1	15,5	13,121	1,25	
	Difference				0,471		
Albumin (g/dl)	Before	105	2,7	4,5	3,690	0,42	0,001*
	After	105	3,3	5,1	4,615	0,40	
	Difference				0,925		
Body Weight (Kg)	Before	105	39,82	68,11	52,864	5,56	0,001*
	After	105	40,13	68,72	53,502	5,61	
	Difference				0,638		

(*) Paired T test, significant p-value = 0.001

Table 5: Distribution of Leukocyte, Hemoglobin, Albumin, and Body Weight Levels Based on Categories Before and After Treatment in TB Patients

	Leukocytes (cells/ul)				Hemoglobin (g/dl)				Albumin (g/dl)				Body Weight (Kg)			
	Before		After		Before		After		Before		After		Before		After	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Normal	84	80	100	95,2	78	74,3	85	81	76	72,4	93	88,6	81	77,1	81	77,1
Abnormal	21	20	5	4,8	27	25,7	20	19	29	27,6	12	11,4	24	22,9	24	22,9

Based on the categories listed in Table 5, leukocyte count obtained with the percentage of the not normal category decreasing from 20% to 4.8%. Meanwhile, the hemoglobin levels in the not normal category also decreased, from 25.7% to 19%, and the albumin levels in the not normal category also decreased, from 27.6% to 11.4%. However, for the body weight indicator, there was no significant change and it remained stable.

Discussion

Sample Characteristic

Pulmonary TB based on gender characteristics are more commonly found in males, with a total of 67 individuals (63.8%) compared to females with 38 individuals (36.2%). The research by Sunarmi [22] in 2019 supports this, indicating that the incidence of pulmonary TB in males is higher due to heavy workloads, smoking habits, and alcohol consumption that can lower the immune system. Thus, it is reasonable that smokers and alcohol drinkers are often referred to as agents of pulmonary TB, where smoking is one of the contributing factors to the occurrence of pulmonary TB. Based on the sample characteristics by age, the age range of the sample is 20 to 58 years, with the largest group being in aged 20-29 years old, reaching 45.7% (48 individuals), which falls into the productive age category. The research by Sikumbang [23] in 2022 indicates that individuals in the economically productive age group (15 to 50 years) experience pulmonary TB at around 75% and have a 5-6 times higher risk of developing pulmonary TB. The fact shown that in the productive age group, individuals tend to engage in many activities, are more often active outdoors, and interact with others, which increases the risk of exposure to the *Mycobacterium tuberculosis* bacteria, and also dormant bacteria in the body can become active again due to repeated infections. The prevalence of pulmonary TB patients according to education level shows that the group with elementary school education has the highest number, which is 36 individuals (34.3%). The research by Emir [24] in 2019 supports this, showing a difference based on education level with a p-value of 0.048. Low education levels are at a risk of 1,390 times exposure to tuberculosis. This causes education level to also affect understanding of conditions or requirements regarding healthy home criteria, knowledge about tuberculosis, and prevention or treatment [25]. A higher level of education can change one's mindset, making it easier to absorb various information; they know about prevention methods by gathering a lot of data that leads to awareness of personal and family health and also affects their income level. This indirectly influences the improvement of nutritional status [26].

Effect of Treatment Administration Bellforte Nuggets

Leukocyte Levels

Leukocytes the body's defense process against infection to the *Mycobacterium tuberculosis* bacterial infection, the main causative agent of pulmonary TB. In patients with pulmonary TB, there is a complex interaction between the pathogenic bacteria and the immune system, which is often reflected through changes in leukocyte levels in the blood. In the early phase of infection, the body may show an increase in the number of leukocytes, especially neutrophils and lymphocytes, as a manifestation of the inflammatory response and defense mechanism to eliminate the bacteria. However, as the disease progresses or in conditions where immunity is impaired, the leukocyte response can become ineffective or even show a decrease, making the

monitoring of leukocyte levels in pulmonary TB patients important. Obtaining information regarding infection status, the level of inflammation that occurs, as well as the immune response of patients to disease progression and the treatment interventions provided [1]. In this study, the administration of Nugget Bellforte can increase leukocyte levels in pulmonary TB patients, as in 100 g of the material there is protein contributing to an achievement of 19.3%, iron 23.15%, and zinc 18%. The mullet fish, which comes from animal products mixed with plant products, the tempe formula, can complement the amino acid profile that is the nutrition forming protein. The nutritional content in this nugget formulation, namely protein, iron, and zinc is a nutrient that acts as the body's immune response and evident from changes in leukocyte levels. Protein, as the main component, is very important for the formation and function of immune cells, including leukocytes. Adequate protein intake is necessary for the synthesis of antibodies and cytokines that function against the bacterial infection *Mycobacterium tuberculosis*, containing a complete spectrum of essential amino acids that are greatly needed by the body to build and repair tissues, including immune cells. Iron and zinc are also crucial micronutrients in regulating the immune system. Iron functions the proliferation and maturation of immune cells, as well as the synthesis of crucial enzymes in the performance of the immune system. Iron deficiency is often correlation with weakened immune response and increased risk of infection. Zinc also plays a crucial role in various aspects of the immune system, including the development and function of leukocytes, cytokine production, and Natural Killer (NK) cell activity. Zinc deficiency can lead to a decrease in the number and role of lymphocytes, as well as impaired immune responses to pathogens [27]. The process of leukocyte formation in the blood has a half-life of about 14 to 21 days after consuming nutrients such as protein, iron, and zinc. Leukocytes are a crucial component of the immune system, and their role is vital for patients with pulmonary TB. When the bacteria *Mycobacterium tuberculosis* invades the body, leukocytes become the first line of defense that actively moves to address this threat. Various types of leukocytes work together in a complex immunological orchestration. Initially, cells such as macrophages and dendritic cells will detect and eliminate TB bacteria through phagocytosis. After neutralizing the bacteria directly, these cells also play an important role in initiating a more specific adaptive immune response. They show T helper cells activating B cells so that antibodies are formed to target TB bacteria. Additionally, cytotoxic T cells directly attack and destroy body cells infected by TB bacteria, preventing further spread of the infection. The success of the body's system in controlling and overcoming TB infection is greatly determined by the ability of leukocytes to carry out these functions effectively and in a coordinated manner. An effective and appropriate leukocyte response will help reduce lung tissue damage and support the recovery of tuberculosis patients. This is related to the adequate intake of protein, iron, and zinc found in Nugget Bellforte, which significantly contributes to increasing leukocyte levels in the blood. This study is in accordance with Siahaan, s [28] research in 2021, which examined the impact of administering snakehead fish nuggets and colored fruit juice on health indicators such as CD4 count, leukocyte levels, and Total Lymphocyte Count (TLC) in individuals living with Human Immunodeficiency Virus (HIV), showing positive effects that can enhance immune responses with food components containing nutrients such as protein, albumin, and bioactive substances [29]. In line with these findings, Yuliati's [19] research in 2019, combination

of probiotic supplements and selenium increases the ratio of immune response neutrophil lymphocyte count ratio (NLR), Hemoglobin, and Albumin in Experimental Rat Groups. probiotics work to modulate the immune system, while selenium, as an antioxidant, supports immune system function by increasing cytokine production and activation of immune cells.

Hemoglobin Levels

Hemoglobin is a protein found in and functions in the transport of oxygen in the human body. A small amount of hemoglobin causes reduced oxygen delivery to tissues, which is very concerning for pulmonary TB patients who may already have respiratory problems. Anemia is a side effect of human infection with pulmonary TB, characterized by low hemoglobin levels below the normal limit. This indicates that monitoring hemoglobin levels in TB patients is very important. Low hemoglobin levels can worsen TB symptoms and hinder recovery [30]. In this study, the consumption of Bellforte Nuggets can increase hemoglobin levels in pulmonary TB patients, due to the content of 100 g of ingredients that have protein with a contribution of 19.3%, iron 23.15%, and zinc 18%. The content of protein, iron, and zinc function a crucial role in the synthesis and increase of hemoglobin levels in the blood. Protein serves as the basic material for hemoglobin formation along with iron (Fe) atoms that form heme groups. Therefore, protein adequacy has a significant impact on hemoglobin levels. In addition, protein functions in the transport of iron in the body, so a lack of protein intake can disrupt iron transport and result in iron deficiency and decreased hemoglobin levels. This is in line with Mafaza [31] research showing that protein consumption levels have a strong relationship with hemoglobin levels. High-protein foods, especially those from animal sources, also contain a lot of iron that contributes to increased hemoglobin levels. Iron is a fundamental component of hemoglobin, necessary for heme synthesis, a non-protein part that functions in various metabolic pathways and is a component of many important enzymes. Iron found in hemoglobin plays a role in distribute oxygen from the lungs to all of the body. Iron deficiency in the diet is one of the main causes of anemia, where low iron levels are associated with an increased risk of anemia. In Dwi's [20] study, the administration of snakehead fish combined with colored fruit has the potential to form iron levels, thereby increasing the immunity of HIV/AIDS patients through increased hemoglobin. Zinc function supporting role in various enzymatic processes essential for overall health and optimal immune system function, and has a vital role in hemoglobin formation. Zinc supports the enzyme carbonic anhydrase in stimulating the production of hydrochloric acid (HCl) in the stomach, which contributes to increased hemoglobin levels. Sari [32] research with a p-value of (0.02) shows a significant relationship between zinc and the incidence of anemia. Zinc also plays a role in synthesis of albumin, thus when protein intake is sufficient, zinc absorption increases and supports the increase in hemoglobin levels. Fulfillment intake of nutrients such as protein, iron, as well as zinc has a significant influence on the prevention of anemia and the increase of blood hemoglobin levels. Protein functions as the raw material for hemoglobin formation and helps in the transportation of iron in the blood. Iron plays a key role in hemoglobin synthesis and the distribution of oxygen to body tissues. In addition, zinc aids this process by increasing protein absorption and stimulating the production of enzymes that contribute to hemoglobin formation. The combination of these three nutrients found in Nugget Bellforte is a

nutritious food alternative that can help improve hemoglobin status in tuberculosis (TB) patients and prevent anemia, which often occurs alongside the disease.

Albumin Levels

Serum albumin in individuals is often associated with nutritional status and protein reserves, having more complex implications in the context of pulmonary TB pathophysiology. Although protein intake, especially essential and non-essential amino acids, is the main precursor for hepatic albumin synthesis, the acute phase reaction due to chronic inflammation occurring with *Mycobacterium tuberculosis* infection can result in decreased albumin levels. The liver prioritizes the production of acute phase proteins such as C-reactive protein (CRP), which can sacrifice albumin synthesis. Additionally, increased endogenous protein catabolism due to infection also plays a role in the occurrence of hypoalbuminemia [32]. In this study, the administration of Nugget Bellforte was able to increase the leukocyte levels of pulmonary TB patients, as this product contains 6.45 g of albumin and zinc with a contribution achievement of 18% in 100 g of the material. The mullet fish, which comes from animals and is mixed with plant-based tempeh products, can complement the amino acids that are nutrients for albumin formation. The clinical implications of understanding albumin dynamics in pulmonary TB patients are significant. The interpretation of albumin levels should not be viewed solely as an indicator of malnutrition but must take into account the impact of systemic inflammation and protein catabolism. Monitoring albumin levels periodically can provide long-term information regarding patients' reactions to TB treatment and their nutritional conditions. Nutritional interventions focusing on providing high-quality protein with a complete amino acid profile in the supportive management process for TB patients. This strategy is expected to enhance albumin synthesis, maintain muscle mass, and improve immune capacity, which will overall contribute to better clinical outcomes [33]. Zinc is an essential mineral trace element function on various biological functions, such as immune response and forming proteins that supports the immune system. In pulmonary TB patients, the body responds to infection by altering protein production, where zinc contributes to protein synthesis such as albumin when zinc levels are sufficient, thus supporting normal albumin synthesis. Pulmonary TB often causes inflammatory reactions that can lower albumin levels, but the anti-inflammatory properties of zinc can help regulate this response and positively impact albumin levels. Additionally, zinc also plays a role in reducing oxidative stress that increases in pulmonary TB patients, thereby protecting tissues and maintaining normal physiological function including albumin production. This indicates that the role of zinc in increasing albumin levels in pulmonary TB patients is multifaceted, including immune function, protein synthesis, inflammation modulation, nutritional status, and management of oxidative stress [34]. Nutritional substances of albumin are essential proteins in the body that function to regulate inflammation, act as antioxidants, and help bind various compounds in the blood, including medications. In pulmonary TB patients, low albumin levels often occur and are associated with increased levels of inflammatory cytokines, among them interleukin 1 beta (IL 1 β). This cytokine is known to trigger inflammation and worsen the prognosis of pulmonary TB patients. The decrease in albumin levels in pulmonary TB patients is caused by several factors, including insufficient nutritional intake, anorexia, increased catabolism reaction. Increased consumption of nutrients containing albumin can

enhance the effectiveness of anti-tuberculosis drugs by improving binding and transportation in the blood, thereby reducing inflammation and accelerating recovery from the disease. Ria [35] in his research, stated which found that the administration of 100 grams of snakehead fish nuggets and 250 ml of colored fruit per day for 24 days could improve clinical manifestations, body mass index (BMI), total leukocyte count (TLC), and CD4 levels in Rehabilitation Center in Medan especially people with HIV infection (ODIV), with a p -value < 0.05 . This indicates that dietary intervention can improve nutritional status and overall health outcomes for PLWHA, which is crucial considering the catabolic processes that occur due to HIV/AIDS, leading to decreased protein levels in the blood. Another study is the research by Restiana [36], which aimed to assess the impact of snakehead fish extract (*Channa striata*) on albumin levels and nutritional status in HIV/AIDS patients undergoing antiretroviral therapy (ARV). This study involved 25 patients divided into two groups: one group received fish extract supplementation, while the other group followed a standard hospital diet and received nutritional education. Research indicates a correlation in various health indicators in the intervention group, such as body mass index (BMI), upper arm circumference (UAC), energy consumption, protein intake, and serum albumin levels, with p -values indicating statistical significance after five weeks of treatment [37].

Body Weight

The relationship between body weight and pulmonary TB is very significant, as changes in body weight can indicate the severity of the disease and the effectiveness of treatment. Common characteristics of pulmonary TB are usually marked by unexplained weight loss. This weight loss is associated with malnutrition and increased metabolic needs of the body during infection. These changes in body weight can reflect how severe the disease is and how effective the treatment being undertaken is, making early treatment of pulmonary TB and management of comorbidities very important to support weight gain and improve overall treatment outcomes [38]. Pulmonary TB patients require higher energy intake increased due to the use of protein as an energy source (gluconeogenesis process), which plays a role in maintaining body function and supporting the process of fighting infection. Energy deficiency in patients can risk significant weight loss, making adequate protein intake crucial because it functions in the repair of body tissues and supports the immune system. A deficiency of protein can hinder the recovery process and worsen the condition of weight loss in pulmonary TB patients. Pulmonary TB also often causes a decrease in appetite and digestive disorders, which leads to food intake being lower than needed. The combination of decreased food intake and increased energy expenditure exacerbates the risk of malnutrition in patients. Nutritional intervention with a high-calorie and protein diet is highly recommended; this diet provides a higher intake of calories and protein compared to a normal diet, helping to maintain nutritional status and facilitate the recovery of damaged lung tissue, supporting weight gain and strengthening the body's ability to fight infections. In addition to being obtained from main meals, it can also come from snacks, which can be an alternative, usually consumed within 2-3 hours before the main meal is consumed [39]. In this study, the provision of Bellforte Nuggets as a snack can thus change the weight of pulmonary TB patients, as in 100 g of the product contains carbohydrates with a contribution of 6.25% and protein 19.3%. The mullet fish, which comes from animal products mixed with plant products from tempeh, can indeed perfect the amino

acid profile that is a nutrient for protein formation. The nutrients contained in this nugget formula are protein and carbohydrates. Adequate carbohydrate consumption can form the basis of nutritional management for individuals suffering from pulmonary TB. Carbohydrates are the main source of energy needed by the body and individuals with TB, who often experience increased energy expenditure due to infection, sufficient carbohydrate intake is very important to meet this energy requirement. Without adequate carbohydrate intake, the body may switch to glycogenesis, which is the conversion of glucose into glycogen for storage, potentially leading to an energy deficit. Pulmonary TB can cause tissue damage, thereby affecting the body's muscle mass, a condition known as cachexia. Adequate carbohydrate intake supports the maintenance of muscle mass by supplying the energy needed so that the body does not break down protein for energy. This is very crucial because protein is able to boost the body's immune function such as the recovery process. A deficiency in carbohydrate intake can lead to malnutrition, which is a major risk factor for the transition from latent TB to active TB. Nutritional deficiencies can reduce the body's resistance and increase the risk of infection.

Carbohydrates are also crucial for balancing them with fats and proteins. A diet that is very high in carbohydrates without adequate protein and fat intake can result in an imbalance that impacts the health of TB patients. Therefore, a comprehensive approach to nutrition is necessary for effective TB management. The same study by Nadiyah [40] in 2020, which examined the impact of providing turmeric, egg white, and milk supplements for 7 days involving 33 pulmonary TB patients. The study showed that all participants in the treatment group experienced significant weight gain after receiving supplementation, with a p -value < 0.01 . The average weight gain in this group was between 1 to 2 kg [41]. In line with Ria's [35] research in 2022, which examined the impact of dietary intervention, especially snakehead fish nuggets and colored fruit, on health indicators of people living with HIV. Recent research results show a significant increase in clinical manifestations, BMI, TLC and CD4 levels after consumption of snakehead fish nuggets and colored fruit [40]. This study is also supported by research by Durry [41] research in which reveals that omega-3 supplements (treatment regimen, have anti-inflammatory properties) and zinc have potential benefits for improving nutritional status, which can help in increasing body weight in patients experiencing tuberculosis.

Conclusions

The administration of Bellforte Nuggets as an alternative snack food for patients with pulmonary TB given 100 g/day for 15 consecutive days is effective in increasing leukocyte levels, hemoglobin, albumin, and body weight.

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