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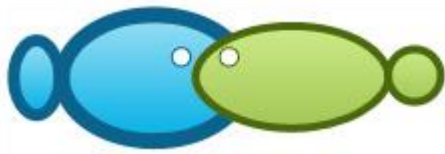
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The amino acid profiles of *Telmatherina bonti* from Lake Towuti, South Sulawesi, Indonesia

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Abstract. Lake Towuti is a habitat for several endemic fish species. Endemic fish is a fishery resource with important economic and ecological value. Endemic species consumed in Lake Towuti include *Telmatherina bonti*. Therefore, the purpose of this study was to investigate the essential and non-essential amino acid profiles of *T. bonti* from Lake Towuti, South Sulawesi, Indonesia. The trap net was used to collect fish samples from the lake. The data were analyzed descriptively. The essential amino acid compositions include lysine > leucine > threonine > valine > isoleucine > phenylalanine > methionine > histidine > tyrosine. Meanwhile, the non-essential amino acid compositions include glutamic acid > glycine > aspartic acid > alanine > arginine > proline > serine > tryptophan > cystine.

Key Words: endemic fish, essential and non-essential amino acid, glutamic acid, lysine.

Introduction. Indonesia's aquatic biota is diverse, with about 8,500 species spread across ±5.8 million km² of sea and ±0.53 million km² of freshwater. Furthermore, the country has a total of 440 endemic freshwater fish species, placing it in 4th position after Brazil (1,716 species), China (888 species) and the United States (593 species), and more than 140 endemic marine fish species (FAO 2020). Consequently, Indonesia has a strategic value in the fishery sector, providing world fish food sources. The endemic fish found in the country, such as Orientalis fish in the Sunda shelf (Sumatra, Java, Bali, and Kalimantan), Australian type in the Sahul shelf (West Papua and Maluku Islands), and the transitional type in the Wallace area (Sulawesi and Nusa Tenggara) (Hutama et al 2016), have different characteristics (Said & Hidayat 2015). There are 17 endemic fish species in Lake Towuti, which is located in the Wallace area (Hadiaty 2018; Jayadi et al 2021), in East Luwu, South Sulawesi. Lake Towuti has been an important habitat for several endemic freshwater fish (Kottelat et al 1993; Parenti 2011; Parenti & Ebach 2013). Residents around the lake catch endemic fish for consumption, ornamental purposes and animal feed ingredients (Kartamihardja 2014).

Endemic fish of the Telmatherinidae family were identified in Lake Towuti, namely: Paratherina, *Telmatherina* and Tominanga. Species of the genus Paratherina are *Paratherina striata*, *Paratherina wolterecki*, *Paratherina cyanea*, and the genus *Telmatherina* is represented by *Telmatherina celebensis*, *Telmatherina bonti*, *Telmatherina opudi*, and the genus Tominanga is represented by *Tominanga sanguicauda* (Jayadi et al 2019; Jayadi et al 2021). *Telmatherina* is known by the community as the opudy fish. The opudy fish is consumed by the community around the Lake Towuti and it is appreciated as a delicious protein source. Endemic fish species in Lake Towuti, such as *T. bonti*, are not found anywhere else in the world (Hadiaty 2018). The fish population includes endangered species (IUCN 2003; Kottelat et al 1993). For example, *T. bonti* requires immediate attention to its survival. The fish population is threatened by human activity, particularly the overfishing in the Lake Towuti area, which has resulted in

damage to the lake's habitat (Nasution et al 2015; Jayadi et al 2019). This is exacerbated by introducing invasive fish species into the Lake Towuti (Prianto et al 2014).

Studies on *T. bonti* have been conducted on topics like: distribution (Hadiaty & Wirjoatmodjo 2002), ecology (Jayadi et al 2018), genetics (Jayadi et al 2019), fecundity and egg diameter (Nursyahran et al 2021). Also, the chemical composition of *T. bonti* is important, because it serves as a basis for understanding the body's biochemical composition in the development of domestication, particularly in feeding management (Jayadi et al 2016). The chemical composition of endemic freshwater fish is important for determining their nutritional value for human consumption. Therefore, the purpose of this study was to investigate the essential and non-essential amino acid compositions of *T. bonti* from Lake Towuti, Luwu Timur District, South Sulawesi, Indonesia.

Material and Method

Collection of fish samples. Samples of *T. bonti* were collected from Lake Towuti, Luwu Timur district, South Sulawesi, Indonesia. In addition, the trap net was used to catch fish and sampling was conducted on March 2021. The samples (1.5 kg) were packaged in separate labeled polythene bags and stored in a cool box with ice to keep the temperature cool during their transportation to the laboratory of fishery products processing technology, Agricultural Polytechnic State of Pangkep. Furthermore, the samples were cleaned with water and dried in the sun for ± 12 hours (the estimated moisture content was $< 10\%$ depending on the intensity of the sun) (Hasnidar & Tamsil 2020). The water content determination of samples was carried out by weighing the fish after drying (fish sample weight after drying from 1,500 to 750 g). The freeze dried powder meat samples were stored until used to detect amino acids.

Amino acid composition analysis. The amino acid compositions were determined using an amino acid analyzer (Shimadzu, Japan), which detected 14 amino acids. First, a sample of 0.5 g was taken and made into a paste using 50 mL of 6N HCl by mortar and pestle, and then filtered. The filtrate was hydrolyzed for 22-24 hr in a hydrolyzing apparatus (SYKAM 57130 Analyzer). Then the filtrate was evaporated 3-4 times in a water bath with distilled water, to remove HCl. The solution was made up to 25 mL in a volumetric flask using 0.1N HCl, at the end of the evaporation. Afterwards, the stock solution was used to determine the amino acid concentration in High Performance Liquid Chromatography (HPLC) using the method of Abdullah et al (2013).

Data analysis. The amino acids data of *T. bonti* were analyzed descriptively.

Results and Discussion. Figures 1 and 2 show the results of the essential and non-essential amino acids composition, respectively. The quality of a protein is determined by its amino acid composition. Protein is an important macronutrient for humans, obtained from food. Therefore, protein quality is determined by assessing the amino acid content, hence serving as a basis for determining their potential nutritive value (Mohanty et al 2014). Fish protein provides essential amino acids required by humans in the quantity needed (Chasanah et al 2019). Amino acids and protein are key factors for growth (Goudoever et al 2014). Amino acids are the building blocks of protein, which act as a precursor of many enzymes, hormones, neurotransmitters, nucleic acids, and other molecules essential for life (Saad & Alim 2015). Also, amino acids play important roles in cell signaling and act as regulators of gene expression and protein phosphorylation cascade, nutrient transport and metabolism in animal cells, and innate and cell-mediated immune responses (Mohanty et al 2014). Essential amino acids are nutrients the body requires but cannot produce, hence they are obtained from outside sources, such as food. Fish is a food high in essential amino acids. Figures 2 and 3 show that the total amount of essential and non-essential amino acid is $196490.37 \text{ mg kg}^{-1}$ and $315034.27 \text{ mg kg}^{-1}$, respectively.

Essential amino acid contents. The essential amino acid compositions include lysine > leucine > threonine > valine > isoleucine > phenylalanine > methionine > histidine > tyrosine (Figure 1).

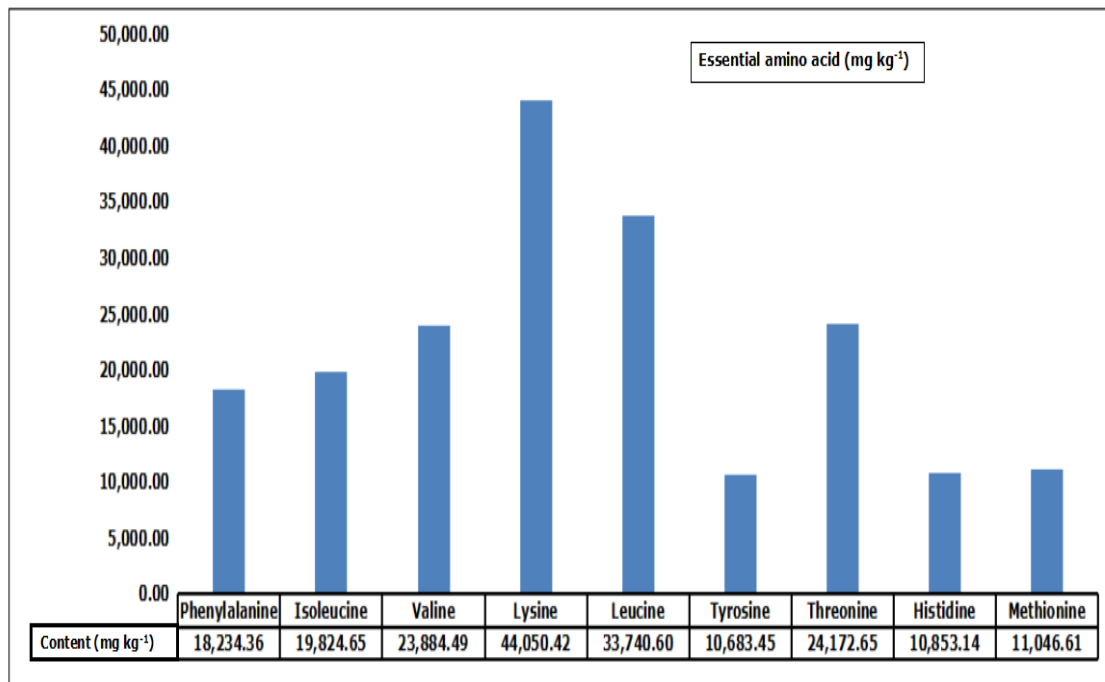


Figure 1. The profiles of essential amino acid in *Telmatherina bonti*.

Lysine was found to be the highest in *T. bonti* with 44,050.42 mg kg⁻¹. Also, it acts as an antibody, accelerates the circulatory system, lowers blood triglyceride levels, part of the basic composition of antibodies, strengthens circulation, and maintains cell growth (Suryaningrum et al 2010). Furthermore, it is required for optimal growth, and the deficiency of this acid leads to immunodeficiency (Rahman & Chowdhury 2018). Lysine serves as the building block for blood antibodies, strengthens the circulatory system, maintains the growth of normal cells with proline and vitamin C to form collagen networks, and reduces excess blood triglyceride levels (Abdullah et al 2013). According to the WHO (1985), the body requires 0.66% of lysine.

Leucine lowers blood sugar levels, boosts brain function, increases muscle energy, accelerates the healing of postoperative wounds and trauma (Vijayan et al 2016), and maintains the immune system (Edison 2009). In addition, it is the only dietary amino acid that can stimulate muscle protein synthesis (Etzet 2004). According to the WHO (1985), the body requires 0.93% of leucine.

Threonine is used to treat various nervous system disorders, including spinal spasticity, multiple sclerosis, familial spastic paraparesis, and amyotrophic lateral sclerosis (Hyland 2007). According to the WHO (1985), the body requires 0.43% threonine. Valine prevents muscle breakdown by supplying extra glucose for energy production during intense physical activity (WHO 2006). Furthermore, it is a branched-chain amino acid that functions as a glucogenic precursor, for the growth and maintenance of muscle tissue, and stimulate mental abilities, promote muscle coordination, repair damaged tissue, and maintain nitrogen balance (Abullah et al 2013). According to the WHO (1985), the body requires 0.55% of valine.

Isoleucine is a branched-chain amino acid, essential for muscle formation and growth (Charlton 2006). Also, it is an amino acid known for its ability to increase endurance, heal and repair muscle tissue, and accelerate blood clotting in body wounds (Abdullah et al 2013). Meanwhile, phenylalanine serves as a precursor for tyrosine synthesis (Fernstrom & Fernstrom 2007), hence it forms the hormones thyroxine and epinephrine (Afifudin et al 2014). According to WHO (1985), the body requires 0.72% of phenylalanine. Methionine is used to treat liver disorders, wounds, depression,

alcoholism, allergies, and Parkinson's disease (Mischoulon & Fava 2002). Also, it is an amino acid important for fat metabolism, maintaining liver health, preventing fat accumulation in the liver and main arteries, and allergies and osteoporosis prevention (Suryaningrum et al 2010). According to the WHO (1985), the body requires 0.42% of methionine.

Histidine affects DNA and protein synthesis by participating in one-carbon unit metabolism (Li et al 2008). Therefore, it plays a role in maintaining the osmoregulatory process, energy production, and other metabolic pathways during emergency conditions (WHO 1985). Also, it plays multiple roles in protein interaction (Liao et al 2013). According to the WHO (1985), the body requires 0.26% of histidine. Tyrosine is a precursor for several biologically active substances including catecholamine, neurotransmitters, hormones, and melanin skin pigments (Saad & Alim 2015). According to the WHO (1985), the body requires 0.72% of tyrosine.

Non-essential amino acid contents. The non-essential amino acid content includes glutamic acid > glycine > aspartic acid > alanine > arginine > proline > serine > tryptophan > cystine (Figure 2).

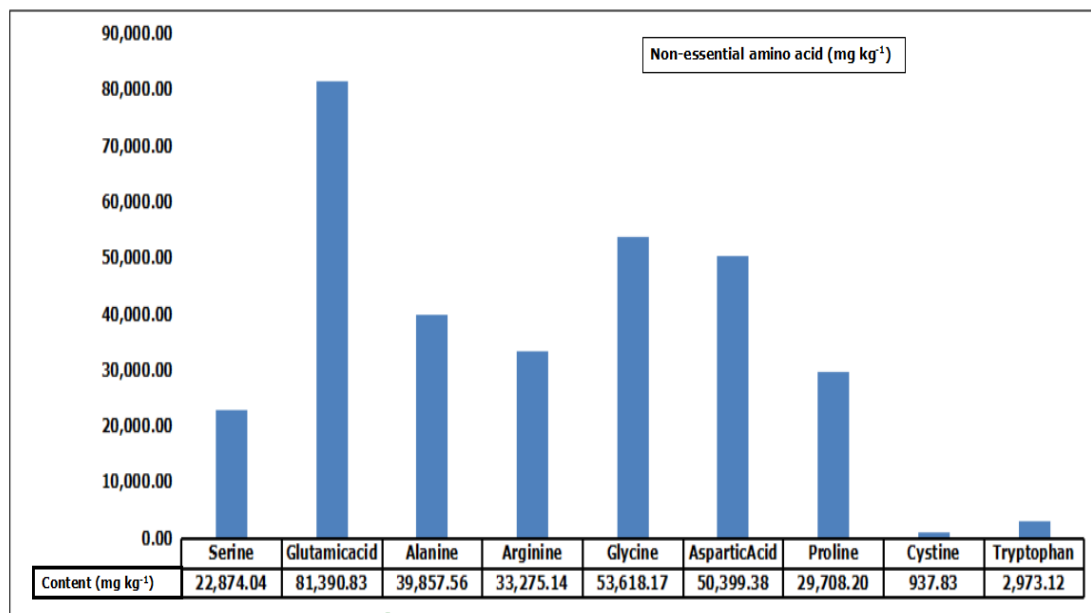


Figure 2. The profiles of non-essential amino acid in *Telmatherina bonti*.

Glutamic acid plays an important role in sugar and fat metabolism. Also, it is used as a medicinal agent in treating epilepsy, mental retardation, muscular dystrophy, ulcers, hypoglycemic coma, and side effects of insulin drugs for diabetes (Nurhikma et al 2017). Furthermore, a high amount of the acid contributes to the sweet flavor of the fish (Charlton 2006).

Glycine stimulates growth hormone release, wound healing, muscle development and growth, and lowers stomach acidity (Sulistyawibowo et al 2013). Also, it is involved in metabolic regulation, enhancing anti-oxidant activity, promoting protein synthesis, and wound healing (Saad & Alim 2015). Aspartic Acid is the precursor of methionine, threonine, isoleucine, and lysine hence it regulates the secretion of important hormones (Wu 2010). Alanine is the major glucogenic precursor and energy substrate for fish (Li et al 2008). Meanwhile, arginine is an essential amino acid the body requires to make seminal fluid (semen) and strengthen the immune system (Villanueva et al 2004). It is useful in increasing endurance or lymphocyte production, increasing the production of human growth hormone (HGH), and male fertility (Sari et al 2017). Also, it plays an important role in cell division, wound healing, immune function blood clotting, and maintenance of blood pressure (Mohanty et al 2014). Proline is an amino acid hydroxylated to hydroxyproline in presence of vitamin C (Akram et al 2011). Serine is the

precursor of glycine, cysteine, and tryptophan, and is involved in cell signaling (Saad & Alim 2015). Tryptophan is an essential amino acid with a dole ring in its structure and it is also an important part of some proteins (Akram et al 2011). Meanwhile, cystine affects animal growth performance, including food intake, body weight gain, and feed efficiency (Yin et al 2015).

Conclusions. Lysine, leucine, threonine, valine, isoleucine, phenylalanine, methionine, histidine, and tyrosine are essential amino acids, while glutamic acid, glycine, aspartic acid, alanine, arginine, proline, serine, tryptophan, and cystine are non-essential amino acids. The highest essential and non-essential amino acid content was observed for the lysine and glutamic acid, respectively. The results of this study provided useful information to consumers and are important for the sustainability of endemic fish populations in Lake Towuti.

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Conflict of interest. The authors declare no conflict of interest.

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