CHAPTER I. INTRODUCTIONS

1.1 Background

Malnutrition is nutritional state with deficiency or excess (imbalance) of energy, protein and other nutrients that can lead to another disorder such as stunting (Soliman *et.al,* 2021). Indonesia is a country that has high in stunting prevalence (21,6%) and West Sumatera is one province with prevalence 4% higher (25.2%) than another pronvices in Indonesia (SSGI, 2021). According to UNICEF (2013), West Sumatera have relatively high prevalence of malnutrition (12%), including among children from the wealthiest households. Munawirah *et.al*, (2017) found 77% of people in Nagari Sijunjung, West Sumatera have stunting risk and under status of malnutrition.

Malnutrition is a health burden that requires urgent attention (Global *et.al,* 2022). It causes measurable adverse effects on tissue and body shape (size, composition), body function, and clinical outcomes (Soeters *et.al,* 2017). Malnutrition affects many children, according to Aryanti *et.al,* (2022), children in Indonesia are still at risk of double nutritional burden of malnutrition, namely risk of undernutrition and overnutrition. Malnutrition can occur since the baby is in the uterine and early days after birth or in the first 1000 days after birth. Malnutrition is having an impact on nutritional status both in the short term or long term risk.

Malnutrition has a significant impact on cognitive abilities, learning disabilities and mental retardation thereby increasing the risk of being easily infected with disease and risk of death (Alaverdashvili *et.al,* 2015; Woldehanna *et.al,* 2017; Forgie *et.al,* 2020). Chronic malnutrition can lead into stunting, and stunting are related with

cognitive function such as Intellectual Quotient (IQ). For instance, malnourished people in Nagari Sijunjung, West Sumatra have decreased cognitive function aproximately 42.1% (Munawirah *et.al,* 2017).

The condition of protein malnutrition in children increases the incidence of stunting 2.2 times higher than well-nourished children. Stunted children have a 9.2 times risk of having a low IQ and can lose up to 11 IQ points compared to children with normal nutrition (Solihin, 2013; UNICEF, 2013; Nurfadhilah *et.al,* 2023). In accordance of this evidence, protein malnutrition is highly close-related with cognitive function.

Feoli *et.al,* (2006) also reported that protein malnutrition causing higher oxidative stress both in cerebral cortex and cerebellum. Rats that induced by protein malnutrition shows higher oxidative stress parameters such as MDA (Malondialdehyde) and oxidative enzymes SOD (Superoxide dismutase) and CAT (Catalase enxyme). Bunatto *et.al,* (2006) stated the MDA of hippocampus and cerebral in juvenile rats treated with 8% protein is higher than rats treated with 25% protein.

Lima beans (*Phaseolus lunatus*) also known as paga beans or krotok beans are one of Indonesian commodity that abundant and available in Indonesian society (Sulistiani *et.al,* 2014). Lima beans is high in protein (14.24-24.92%) respectively (Ibeaubuchi *et.al,* 2019), and are rich in essential amino acids (FAO, 2016). Besides containing a high source of protein, lima beans are also rich in other good sources of carbohydrate, fiber and minerals such as calcium, phoporus and iron (Sotelo, 1995). The complex carbohydrate content of lima beans is quite high, 55-64% especially starch and dietary fiber (Betancur et. al, 2003).

Lima beans have many benefits and advantages, As it has high protein content, lima beans are a suitable substitute for soybeans. According to Hasan *et.al,* (2015), Indonesia have imported soybeans from United States approximately 2 millions ton per year. Using lima beans to substitute soybeans can reduce import cost for protein needs. In fact lima beans are more available in Indonesia and have a much more affordable price (Rini *et.al,* 2009). Even lima beans are not GMO crops compared to soybeans that may induce allergies and supress child development (Yu, 2021). From nutritional perspective, lima beans have similar protein content with soy beans (Messina, 1999). However, lima beans have similar effects with soybeans that can reduce latency time in Morris water maze and serve as good candidate substitute of soybeans in improving cognitive function (Yeh *et.al,* 2022; Maliza *et.al,* 2024).

Maliza *et.al,* (2024) reported malnourished rats treated with 50% kgbw lima beans flour had higher neuron density in the cerebral and increase in cognitive function than protein malnourished group. Because lima beans contains bioactive compounds such as Genistein that are reported can improve cognitive function in rats (Lopez *et.al,* 2018; Maliza *et.al,* 2024). By the states above, lima beans shows comprimising candidates for improving nutrition and cognitive function.

Patin fish or known as pangas fish are one of the biggest fisheries commodity in Indonesia. Ministry of Marine and Fisheries Indonesia (2021) reported patin fish production in Indonesia increase from 380.130 tons (2019) into 509.030 tons in 2021. Patin fish are rich in protein and omega-3 Polyunsaturated Fatty Acid (PUFA) such as DHA and EPA (Chakma *et.al,* 2022).

Patin fish has many advantages over other fish. Patin fish has higher protein content (15-19%) and omega 3 essential fatty acid namely DHA and EPA (9.96% and 2.48%) than other commercial fish such as catfish (*Clarias batrachus*), snakehead fish (*Channa striata*) and carp (*Cyprinus carpio*) (Alhana, 2011; Gultom *et.al,* 2015; Maisur, 2019; Pandiangan, 2021). Despite its lower protein content compared to baung fish (*Hemibagrus nemurus*) that have 25-28% protein content, patin fish is more abundant in production in Indonesia year after year and has been exported worldwide (Jacoeb *et.al,* 2015).

Roberts *et.al,* (2020) found that children above or below 4 years in malnutrition condition that treated with DHA + EPA can improving blood flow and complex brain cognitive function. This research is supported by findings on oil extract from patin fish can improving cognitive function in mice via passive avoidance test (Hidayaturrahmah *et.al,* 2016). Incorporating lima beans and patin fish can meet the nutritional needs of protein and essential fats towards malnutrition while improving cognitive function.

Therefore, this research is needed to examine the effectiveness of these local food from lima beans and patin fish in repairing cognitive function and brain structure that damaged as manifestation of protein malnutrition condition.

1.2 Problem Formulation

The Problem formulation in this study are:

1. How is the effectiveness of lima beans and patin fish flour feed formulation towards cerebral histopathology of protein malnourished rat brain?
2. How does lima beans and patin fish flour feed formulation affect cognitive function of protein malnourished rat brain?

3. How does lima beans and patin fish flour feed formulation affect brain malondialdehyde levels and brain weight of protein malnourished rat?

1.3 Research Purposes

The Research purpose of this study are:

1. Analyzing the effectiveness effects of lima beans and patin fish flour feed formulation towards cerebral histopathology of protein malnourished rat brain.
2. Analyzing the effects of lima beans and patin fish flour feed formulation on cognitive function of protein malnourished rat brain.
3. Analyzing the effects of lima beans and patin fish flour feed formulation affect brain malondialdehyde levels and brain weight of protein malnourished rat.

1.4 Benefits of Research

Increasing the value of lima beans incorporated with patin fish as new functional food with high macro and micronutritional value that can improving structural degenaration of cerebral cortex and reducing damage of the cerebral cortex function in cognitive and inflammation caused by MDA levels as manifestation of acute malnutrition