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THE COMPARATIVE EFFECT BETWEEN PELLETS AND PORRIDGE MADE FROM LOCAL INGREDIENTS ON BODY WEIGHT OF RATS WITH PROTEIN-ENERGY DEFICIENCY

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ABSTRACT

Protein-energy deficiency (PED) is a major infant health problem in developing countries with high mortality rate. Inadequate food intake and infectious diseases are the main factors for PED. In clinical setting, branded foods are commonly used to treat the PED but these foods are expensive. Canna (*Canna edulis Ker.*), catfish (*Pangasius sp*.), and red beans (*Phaseolus vulgaris*) are easily found in Indonesia and rich carbohydrates and protein. Therefore, this study aimed to compare the effect between pellets and porridge from canna, catfish, and red beans (GANIME) on the body weight (BW) of rats with PED.Ten male wistar rats, which aged 3 weeks and weighed 50-100 g, were used in this *in vivo* study. The rats model with PED was made by using the existing method through 40-60% gradual feed restriction for 14 days. Selected rats were randomly divided into 2 groups: G1 was given GANIME pellets and G2 was given GANIME porridge for 14 days. The rat BW each group routinely weighed every 7 days.The average BW of G1 rats was 78,00 ± 15,52 g, which was not significant different from the average BW of G2 rats was 70,50 ± 2,12 g (p= 0,64). In group G1 there was a greater increase than in group G2, namely 12.67 grams.Administration of GANIME pellets increases more body weight in rats with PED, compared to administration of GANIME porridge.

Keywords: body weight; canna; catfish; protein-energy deficiency; red bean

INTRODUCTION

Protein Energy Deficiency (PED) prevalence in toddlers has increased over the past ten years (Yue *et al.*, 2022). PED causes 45% of under-five deaths worldwide (WHO, 2021). Indonesia has 13.8% of toddlers with undernutrition and 3.9% of toddlers experiencing malnutrition (Kemenkes RI, 2018). Toddlers are at an elementary age during growth and development but are vulnerable to health problems (Atashbahar *et al.*, 2022). PED that lasts a long time causes a decrease in the quality of human resources and affects development, economy, and social and public health (Adebisi *et al.*, 2019). The leading causes of PED are inadequate food intake and infectious diseases, but lack of food intake is the main factor that dominates in developing countries (Erokhin *et al.*, 2021). Insufficient food intake in the long term triggers hunger in toddlers resulting in weight loss and impaired immunity (Daryanani *et al.*, 2023). Infectious diseases will quickly attack individuals with weakened immune systems (Islam *et al.*, 2021).

Protein Energy Deficiency is a chronic malnutrition category caused by inadequate energy and protein intake (Dukhi, 2020). Disorders of nutritional balance in the body impact changes in tissue and body mass, resulting in weight loss (Shenavar *et al.*, 2021). Small body size is one of the effects of PED on toddlers. Weight loss occurs because the body experiences a loss of muscle mass

(Schneider, 2022). Skeletal muscle is one of the most abundant tissues in the body and requires a lot of energy during activities (Zuccaro *et al.*, 2023). The nutritional status of toddlers with PED was assessed by anthropometric, biochemical, physical-clinical, and food consumption methods. Anthropometrically, toddlers with PED have a z-score <-3 SD and index BW/H or BW/BL <70% (Hendarto *et al.*, 2015). The biochemical examination of toddlers with PED shows the results of energy and protein metabolism. The protein often used as a PED biomarker is albumin (Harjatmo *et al.*, 2017). Toddlers with PED have clinical signs such as a thin body, edema, and other complications (Fitriyanto and Mahfudz, 2020). PED sufferers experience a decrease in appetite, so the body experiences a lack of intake of nutrients (Magdalena, 2017).

Toddlers with PED are a major public health problem that causes significant morbidity and mortality in the long term (Das *et al.*, 2020). Sensitive and specific nutritional interventions can reduce these risks and improve their health (Ruel and Alderman, 2013). Treatment for toddlers with PED depends on their health conditions and severity (Niken, 2015). As a developing country, Indonesia has implemented comprehensive toddlers with a PED management program (Rusmil *et al.*, 2018). The ongoing government program in handling PED provides additional food (PMT) in biscuits (Kemenkes RI, 2020). In addition, another critical effort in taking toddlers with PED is to improve food quality. Collaborative participation of various government sectors can reduce serious malnutrition problems. Activities can include increasing the availability of nutritious food, promoting agriculture that pays attention to nutritional aspects, and strengthening the health education system, such as education related to breastfeeding and balanced dietary nutrition (Yue *et al.*, 2022). An evaluation conducted by Ahmad et al., (2018) on PMT biscuits from the Ministry of Health showed low acceptability. It is due to the bitter taste, and the respondents are bored with consuming it (Ahmad and Rifqi, 2019). Therefore, innovation is needed regarding intervention for toddlers with PED.

Root crops are often found in Indonesia as potential sources (Hadistio and Fitri, 2019). Ganyong tuber (*Canna edulis* Ker.) is a type of tuber plant that contains higher carbohydrates (88.2%) than other tubers (Noriko and Pambudi, 2014). Carbohydrates in the form of starch found in canna have many benefits so that they can be developed into functional food ingredients (Muchsiri *et al.*, 2021). Carbohydrates are essential nutrients toddlers with PED need because they produce glucose as the primary energy source. If the body experiences a lack of carbohydrate intake, then fat reserves will be used and reduced, affecting children's growth and development (Nurhayati *et al.*, 2020). Indonesia is a maritime country that is rich in fishery potential. One type of fish that is cheap and easy to find is catfish (Ningrum *et al.*, 2017). Catfish (*Pangasius sp.*) is a type of freshwater fish that is high in protein. The protein content in fresh catfish reaches 17%, higher than goldfish (Direktorat Gizi Masyarakat, 2018). Protein is a macro-nutrient that the body needs as a building material, maintains cells and body tissues, and helps the immune system's metabolic processes (Diniyyah and Nindya, 2017). Protein is very much needed by toddlers with PED to repair damaged tissue due to the breakdown of protein into energy so that it helps the healing process (Widya *et al.*, 2019).

Red bean (*Phaseolus vulgaris* L) is a local Indonesian plant often found in several areas but has not been widely used by the community (Syaiful *et al.*, 2022). Red beans act as a source of vegetable protein which complements the deficiency of amino acids for metabolism in the body. Red beans are one legume often consumed worldwide, including in Indonesia. The protein content

in red beans is 22.1% (Direktorat Gizi Masyarakat, 2018). Vegetable protein from red beans contains high levels of the amino acids lysine and leucine, which are suitable for health (Kusuma and Herawati, 2022). Protein plays a role in the formation and regeneration of cells in the body. Amino acids play a role in improving decreased gastrointestinal function in toddlers with PED (Selimoglu *et al.*, 2021). This study aimed to compare the effect between pellets and porridge from canna, catfish, and red beans (GANIME) on the body weight (BW) of rats with PED.

METHOD

This research is an experimental laboratory study with *a pre-post test group randomization design* carried out at the Integrated Laboratory Technical Services Unit of Experimental Animals at Sebelas Maret University from February to April 2023. This research was carried out after obtaining ethical approval from the Health Research Ethics Commission, Faculty of Medicine, University Eleventh March, with number 33/UN27.06.11/KEP/EC/2023. Ten male Wistar rats aged three weeks weighing 50-100 grams were obtained from a supplier located in Klaten, Central Java. The flow of the research started with ordering rats, and then the new rats were adapted for seven days. Randomization was performed before modeling and intervention of the rats with PED. Albumin levels were measured before modeling by taking blood from the rat retroorbital. The rats were weighed regularly every seven days. Rats with PED using standard feed restriction techniques. Feed restriction starts from 30% and 40% each for four days, followed by 50% and 60% restriction each for three days. The percentage of feed given was based on the results of multiplying the rat's body weight on the previous day. On the 14th day of modeling, an evaluation of the albumin and body weight of the rats was carried out. Rats that experienced a weight loss of ≥10% were used as research subjects. The rats with PED were divided into groups of 5 each and were named G1 (fed with the GANIME pellet intervention) and G2 (provided with the GANIME slurry intervention). Intervention feeding was based on the calculation of 10% weight of rats which was carried out every day at 08.00 WIB for 14 days.The research data were processed using IBM SPSS Statistics 26. Analysis of differences in the average body weight of each treatment group used the *One Way ANOVA* test ($p \leq 0.05$), then continued with the *LSD* test if there was a significant difference between groups.

RESULTS AND DISCUSSION

Sample Characteristics

After statistical tests were carried out on the weight of the rats before the intervention, significant results were obtained (*0.507*). Based on these tests, the rat samples divided into two groups were homogeneous and met the inclusion criteria.

Changes in the Condition of Rats During the Study

During acclimatization, the rats received sufficient food so that rats after acclimatization looked active and healthy. On the 9th day of modeling, all rats experienced a weight loss of up to 7%. The condition of the rats that day was crumpled, their fur fell out and looked yellow, but their movements were still active. After 14 days of modeling, the rats' body weight decreased by 23%. It is indicated that the rats met one of the PED criteria. Biochemically, the examination results of the average rat albumin level were 3.24 mg/dL, which was below normal (3.80 mg/dL). Physically, the activity of the rats looks less active, and their body is thin. The rats met PED criteria based on observations from anthropometric, biochemical, and physical aspects after 14 days of modeling. The condition of the rats began to improve, and their movements seemed active after three days of

intervention. From the eighth day to the 14th day of the intervention, residual rat feeds were in pellets or powder. Rats that had been intervened for 14 days experienced an increase in body weight in both the G1 group (fed with GANIME pellets) and G2 (fed with GANIME porridge).

Rat Feed Intake

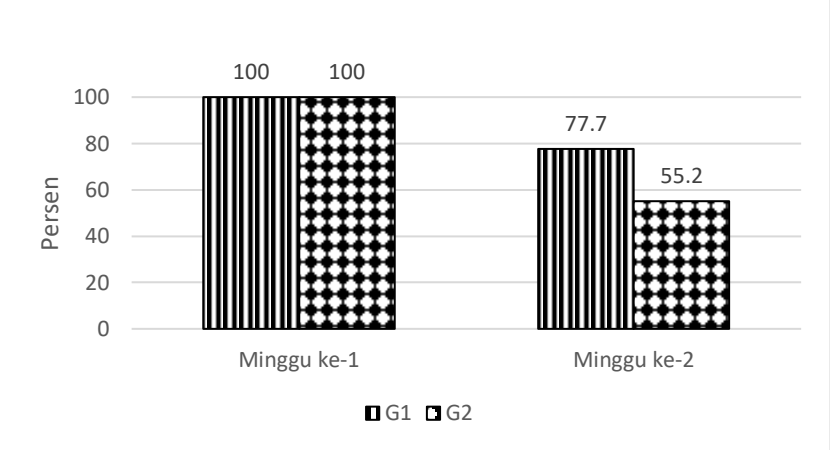

Figure 1. Rat Feed Intake

The amount of rat intervention feed consumption per week is presented in Figure 1. Rat feed consumption on the 8th day tended to decrease. It was indicated by the presence of leftover feed in the G1 and G2 group rats. The decrease in feed consumption during the intervention was because the rats would limit their food intake when their energy needs were met (Sukria *et al.*, 2020). The GANIME formula feed is thought to contain high sugar so that it can affect the satiety center in the hypothalamus. The high sugar content in food can affect the ventromedial sensor which causes a decrease in appetite so that the level of food consumption decreases (Wijaya *et al.*, 2016).

The average remaining meal for rats during the intervention was in G1 as much as 5.2 g/day and in G2 as much as 9.4 g/day. The average intervention feed consumed by rats for 14 days was at G1 as much as 18.9 g/day and at G2 as much as 15.6 g/day. Dry food that rats can consume in a day is 10% of their body weight (Haidar *et al.*, 2022). A mixture of canna, fish, and kidney beans in the KEP model rat intervention formula became a feed that was thought to be suitable for rats. The addition of plant food to rat feed is effectively used as an intervention feed for research rats (Laeto *et al.*, 2023).

Rats Model With PED Body Weight Gain

Table 1.
Weight change before and after GANIME feeds

Body Weight (BW)	G1	G2	*p value*
	Average(±SD)		
Pre[a)]	65,33±4,50	63,00±5,65	0,639
Post[b)]	78,00±15,52	70,50±2,12	0,565
Δ Body Weigh[c)]	12,67±13,32	7,50±3,54	0,644
	(*p*=0,241)	(*p*=0,205)	

Information:
[a)]The average body weight of the rats before the intervention,

[b)]The average body weight of the rats after the intervention,
[c)]The difference in the average body weight of the rats before and after the intervention,

The body weight of the rats changed after the intervention. The homogeneity test performed on the rats' body weight before the intervention showed a p-value = 0.507 (p>0.05), meaning the data is homogeneous. The distribution of post-intervention body weight data tested using Shapiro Wilk showed a p-value = 0.893 (p>0.05), meaning the data is normally distributed. The body weight of the rats in the G1 and G2 groups experienced an insignificant increase after being tested using the paired sample t-test with respective p values of 0.241 and 0.205 (p>0.05). The average body weight of the rats model with PED increased in both the G1 and G2 groups. This weight gain is thought to be due to the intake of feed consumed based on canna, catfish, and red beans to meet the daily nutritional needs of the rats model with PED. This research is in line with Reski *et al.*, (2021), who informed that giving catfish oil could increase the body weight of malnourished rats (Reski *et al.*, 2021). It is also supported by research by Utami *et al.*, (2016), which showed a significant increase in body weight for pregnant women after intervention with a red bean formula drink (Utami *et al.*, 2017).

The weight gain in the G1 group was more significant than in the G2 group. The average weight gain of rats in the G1 group until the 14th day was 12.67 g/head. Rats in the G2 group experienced an average weight gain of 7.50 g/head. There was no significant difference between the rats in the G1 and G2 groups with a p = 0.565 (p>0.05). The weight gain of the G1 group rats was more significant because they consumed more feed and received more nutrients. Rats prefer dry feed to wet feed, so GANIME composite flour, made into pellets, is consumed more by rats. The nutritional needs of rats are energy of 68.6 kcal per day, protein 3.27 g/day, fat 0.59 g/day, and carbohydrates 12.53 g/day (Wijaya *et al.*, 2016). This nutrient content is found in standard rat feed by giving as much as 10% of its body weight (Upa *et al.*, 2017). Research conducted by Karim *et al.*, (2022) showed that rats given catfish oil experienced a significant increase in body weight. Based on this, it is strongly suspected that the protein content of catfish is the leading cause of weight gain in the rats model with PED (Karim *et al.*, 2022).

CONCLUSION

This preliminary study is conducted to determine the most appropriate form of feed for the intervention of rats model with PED. Rats more effectively consume the state meal in pellets than in porridge. It was evidenced by a more significant weight gain in the group of rats fed GANIME pellets, although this was not significantly different. A more extended intervention period is needed to detect significant changes in body weight. Future studies are expected to conduct clinical trials of the GANIME formula in humans

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