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UTILIZATION OF SNAKEHEAD FISH MEAL *(CHANNA STRIATA)* AND PUMPKIN FLOUR *(CUCURBITA MOSCHATA)* AS A FORMULA FOR ENTERAL DIABETES MELITUS

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ABSTRACT

Background: Diabetes is a group of metabolic diseases characterized by hyperglycemia resulting accompanied by carbohydrate, protein and fat metabolism disorders from defects in insulin secretion, insulin action, or both. High protein in snakehead fish and pectin in pumpkin are claimed to function as antioxidants, anti-diabetic and can control glycemic level. The purpose development enteral formula for patients diabetes mellitus from snakehead fish flour and pumpkin flour.
Method: This was an experimental study with a completely randomized design of the factors that formulation (formula 1, 2 and 3). Characteristics analyzed are energy, protein, carbohydrates, fat, dietery fiber, colour, viscosity, pH and total plate count. Statistical analysis was done by using friedman test.
Result: The Friedman test is conducted to determine whether one formula is significantly more preferred than the other formulas based on the rank scores provided by the respondents**.** Friedman test showed that formula F1 is the most preferred formula with the mean rank is 2.13. In 100 grams formula F1 contains total energy 134.09 kcal, 9.47% protein, fat 3.05%, carbohydrates 24.44%, dietery fiber 5.90%. Physical and microbiological characteristics formula F1 are colour test L (56.3), a (5.1) b (12.4), pH 5.95, viscosity 47.9 mPa.s and total plate count after incubation 2x24 hours that is 3.5 x 10^6 coloni/ml. **Conclusion:** The most preferred formula is Formula F1, with a mean rank of 2.13 according to the Friedman test. The enteral Formula F1 contains 5.90% dietary fiber. Based on microbiological testing, the total plate count after 2x24 hours of incubation is 3.5 x 10^6 CFU/ml.

Keywords: Diabetes mellitus; Enteral formula; Snakehead fish flour; Pumpkin flour

INTRODUCTION

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia accompanied by impaired carbohydrate, protein and fat metabolism due to impaired insulin secretion, insulin action or both. According to the World Health Organization (WHO), Indonesia has the fourth highest number of DM patients in the world after India, China and the United States, and it is estimated that by 2030 there will be an increase in the number of DM patients in Indonesia by 21.3 million (WHO, 2016).

Report on Result of National Basic Health Research (Riskesdas) 2018 shows that the prevalence of DM according to doctor's diagnosis at the age of over 15 years in Indonesia is 2%. While the prevalence of DM based on blood tests at the age of over 15 years is 8.5% (Ministry of Health RI, 2018). Based on data from the Central Bureau of Statistics of South Sumatra Province in 2019, Diabetes Mellitus is included in the 10 highest diseases suffered by the population of South Sumatra with a total of 71,031 cases. According to Tjekyan in his research, in 2010 the incidence of type II Diabetes Mellitus sufferers in 78 RTs of Palembang

Municipality was 401 (3.2%) sufferers out of 12,01 total population (Tjekyan, 2014).

Diabetics often have other disorders, such as hyperglycemia and hypoglycemia. In fact, there are often cases of patients with DM with gangrene disorders or diabetic ulcers. Hyperglycemia is a medical condition where there is an increase in blood glucose levels beyond normal limits, namely blood glucose levels > 300 mg/dl. One way to control blood glucose levels is to adjust the diet by eating foods that have a low Glycemic Index (GI) and are high in fiber (Soelistijo *et al*., 2015). Management of DM can be done by pharmacological and nonpharmacological management. Pharmacological management is in the form of intervention with antidiabetic drugs both orally and injections. While non-pharmacological management is the application of a healthy lifestyle, by carrying out medical nutrition diet therapy and physical activity (Marinda et al., 2016).

Providing nutritional diet therapy for patients with DM can be done by providing enteral formula. Enteral formula therapy aims to maintain blood glucose levels close to normal and avoid acute complications. In addition, the administration of enteral formula should be considered when it is unsafe for DM patients to consume food orally or when oral intake is insufficient to meet nutritional needs. Enteral formula for diabetes mellitus in Indonesia is generally still widely available in the form of commercial enteral formula with a relatively expensive price, causing DM patients to incur large costs in treatment. In addition, there are still few hospitals enteral formulas that utilize local food ingredients that have potential as antidiabetics and antihyperglycemia. So, to solve these problems, innovation is needed in the development of local food-based diabetes mellitus enteral formulas.

The utilization of snakehead fish and pumpkin processed in the form of flour is still relatively unvaried, limited to making cookies, donuts, noodles and puddings. The development of enteral formulas made from snakehead fish flour is still relatively rare, previous research conducted by (Eny *et al*., 2018) snakehead fish was used as an extract for people with diabetes mellitus who have gangrene disorders, and the results showed that an increase in albumin and can accelerate healing in gangrene wounds (Eny *et al*., 2018). The results of previous research, enteral formulas made from pumpkin have a significant effect on blood glucose levels (Hawa & Murbawani, 2015). Based on previous studies, there is no enteral formula that combines the two ingredients into one formula intended for people with diabetes mellitus, so researchers are interested in conducting research with the title "Utilization of snakehead Fish Flour (Channa Striata) and Yellow Pumpkin Flour (Cucurbita Moschata) as a Diabetes Mellitus Enteral Formula". This study aims to determine the fomulation, physical characteristics, microbiological chemistry and acceptability test as well as the utilization of snakehead fish and pumpkin flour as enteral formula for diabetes mellitus.

METHODS

This type of research is a laboratory experimental research, with a non-factorial completely randomized design (CRD) experimental design.

Tabel 1. Diabetes Mellitus Enteral Formula Formulation

Material (g)	F1	F2	F3
Skim Milk Powder	140	140	140
Snakehead Fish Flour	55	60	57
Pumpkin Flour	60	55	58
Coconut Oil	20	20	20
Stevia	20	20	20
Maltodextrin	20	20	20
Total weight	315	315	315

Procedure for Making Snakehead Fish Meal

The making of snakehead fish flour was carried out using the modified method of (Hana, 2017) which is as follows, during the day, wash the fish and fish fillets, then soak the fish in lemon juice solution for 10 minutes.

Steam the fish for 30 minutes, after steaming, the fish is drained by leaving it in the open air. The fish is dried using an oven at 55° for 20 hours. The dried meat pulp is immediately pulverized and sieved to obtain fine fishmeal.

Procedure for Making Pumpkin Flour

Preparation of flour from pumpkin fruit was carried out using a modified method (Hendrasty, 2003) which is as follows, peel the pumpkin and wash it thoroughly. Thinly slice the pumpkin with a thickness of 22 mm, width of 3 mm, length of 50 mm. Next, drying was carried out at a temperature of 75° C for 7 hours. After that, pulverization is carried out using a blender and filtered using an 80 mesh sieve.

Procedure for Making Enteral Formula

Mix snakehead fish flour, pumpkin flour, skim milk powder, stevia leaves, and maltodextrin. Then stir until well combined using a mixer. Gradually add coconut oil while continuing to stir. After mixing, sift the powder mixture. The enteral formula is now ready to be brewed and tested for viscosity.

Data Collection, Processing, and Analysis

The formulation determination, enteral DM formula preparation, acceptance test, and pH and viscosity tests will be conducted at the Food Science and Technology Laboratory (THP) of the Department of Nutrition, Poltekkes Kemenkes Palembang. The proximate analysis test will be conducted at the Saraswanti Genetech Laboratory in Bogor, and the microbiological test will be conducted at the Agricultural KHP Laboratory of Sriwijaya University. The panelists used are semi-trained panelists, consisting of 25 students from the Department of Nutrition at Poltekkes Kemenkes Palembang. The panelists are given an evaluation form, which includes four criteria: color, taste, aroma, and texture/consistency. The evaluation uses a hedonic scale with the following ratings: very much like (4), like (3), dislike (2), and very much dislike (1).

The acceptance test results of the selected formulation are then analyzed for nutritional content using proximate analysis (energy, protein, fat, carbohydrates, and dietary fiber) in the laboratory. Additionally, the selected formulation undergoes physical tests, including color analysis, pH, and viscosity. The acceptance test data are input and processed using statistical software with univariate analysis and the Friedman test. The acceptance data, nutritional values, and physical properties are presented in tabular form and graph.

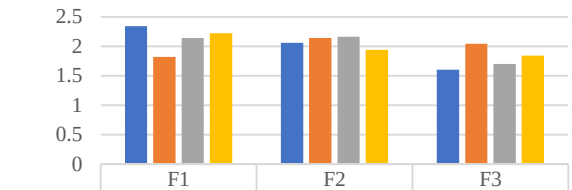
RESULTS AND DISCUSSION

RESULTS

Organoleptic Test Results for Enteral Formula with Snakehead Fish Flour and Pumpkin Flour

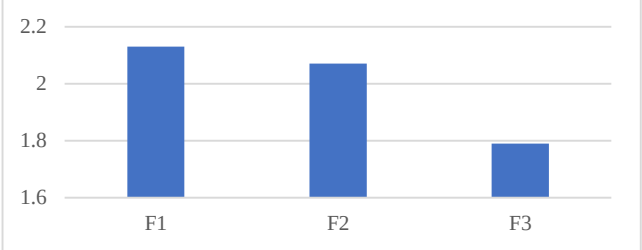
The results of the organoleptic acceptance test for the enteral formula with snakehead fish flour and pumpkin flour, which underwent Friedman test analysis, can be seen in Graph 1.

Graph 1.
Mean Rank Formulasi Formula Enteral



	F1	F2	F3
Colour	2.34	2.06	1.6
Taste	1.82	2.14	2.04
Aroma	2.14	2.16	1.7
Texture	2.22	1.94	1.84

Graph 1. Mean Rank Formulation Formula Enteral



Graph 2. Average Ranking Scores of Enteral Formula with Snakehead Fish Flour and Pumpkin Flour

The highest overall preference rating (F1) was achieved with the addition of 55 grams of snakehead fish flour + 60 grams of pumpkin flour. This was followed by enteral formula F2 (60 grams snakehead fish flour + 55 grams pumpkin flour) and enteral formula F3 (57 grams snakehead fish flour + 58 grams pumpkin flour). It can be observed that higher additions of snakehead fish flour tend to decrease the overall acceptance of the enteral formula. This trend is influenced by the appearance, aroma, taste, and texture overall.

Proximate Analysis Results of Enteral Formula with Snakehead Fish Flour and Pumpkin Flour

Proximate analysis conducted includes examination of protein, fat, carbohydrate, and dietary fiber content. Research results on the nutritional content of enteral formula from snakehead fish flour and pumpkin flour are shown in Table 2.

Table 2. Comparison of Proximate Analysis Results of Enteral Formula with Snakehead Fish Flour and Pumpkin Flour with Standards

Parameter	Formula F1	Standard
Total Energy (kcal/100g)	163.09	-
Protein (%)	9.47	8.5-10[a]
Fat (%)	3.05	8-9.7[a]
Carbohydrates (%)	24.44	22-25.4[a]
Dietary fiber (%)	5.90	2.4-5 [a]
Energy Density (kal/ml)	0.55	0.5-2.0[b]

Source: [a]) (ASPEN, 2014) and [b]) (Rolfes *et al*., 2006)

Measurement Results of Physical Properties of Enteral Formula with Snakehead Fish Flour and Pumpkin Flour

Table 3. Comparison of Characteristics of Enteral Formula with Snakehead Fish Flour and Pumpkin Flour with Standards

Characteristics	Formula F1	Standard
Colour	L 56.3 a 5.1 b 12.4	-
pH	5.95	>3,5[a]
Viscosity (cP)	47.9	1-50[b]

Source: [a]) (Nilesh *et al*., 2011) [b]) (ADA, 2002)

Measurement Results of Microbiological Properties of Enteral Formula with Snakehead Fish Flour and Pumpkin Flour

The enteral formula with snakehead fish flour and pumpkin flour was diluted to 10^{-6}, then cultured in agar media. The bacterial count was measured after incubation for 2x24 hours, resulting in 3.5×10^6 colonies/ml. This indicates that the bacterial count does not meet the requirements according to the SNI 2009 standard, which is $5 \times 5 \times 10^4$ colonies/ml.

DISCUSSION

Color

Most panelists preferred the F1 treatment because its color and appearance most closely resembled milk. In the F2 and F3 treatments, the color of the enteral formula was slightly darker. The enteral formula with snakehead fish flour and pumpkin flour had a yellowish-white color with a slight greenish-black tint. As the proportion of snakehead fish flour and pumpkin flour increased, the resulting enteral formula became whiter and more yellow. The white color is influenced by skim milk and maltodextrin, while the yellow color is influenced by pumpkin flour and snakehead fish flour, which undergo color changes due to the drying process. The greenish-black color comes from stevia powder.

Taste

Most panelists preferred the taste of the enteral formula in the F2 treatment compared to the F1 and F3 treatments. This is because the enteral formula in the F2 treatment had a more ideal taste compared to F1 and F3. The F1 and F3 treatments still had a slightly off-flavor, due to a higher pumpkin flour content compared to snakehead fish flour. The taste of the enteral formula with snakehead fish flour and pumpkin flour had a sufficient level of sweetness because the proportions of stevia powder and maltodextrin in the F1, F2, and F3 formulas were the same. This formula has a unique taste due to the pumpkin and snakehead fish, which are generally consumed as dishes and rarely as beverages.

Aroma

The enteral formula with snakehead fish flour and pumpkin flour has a distinctive aroma derived from skim milk, snakehead fish flour, pumpkin flour, stevia powder, and Virgin Coconut Oil (VCO). The VCO and

stevia powder add a rich aroma to this formula. The F2 formula was the most preferred because it had a lower proportion of pumpkin flour compared to the F1 and F3 formulas. Pumpkin flour has a distinctive and slightly off aroma, so an increase in its proportion leads to a decrease in the panelists' preference.

Texture

The texture of the enteral formula with snakehead fish flour and pumpkin flour is in powder form with medium particle size, and when dissolved, the formula becomes homogeneous, though with some fine sediment from the stevia powder. Skim milk and maltodextrin also influence the texture of the enteral formula with snakehead fish flour and pumpkin flour.

Protein

The protein content of the enteral formula with snakehead fish flour and pumpkin flour is 9.47% of the total calories. This indicates that the formula meets the requirements for a diabetes enteral formula, which according to ASPEN (2014), should be 8.5-10% of the total energy. This enteral formula is formulated to be high in protein. The protein in the enteral formula with snakehead fish flour and pumpkin flour comes from snakehead fish, which is rich in essential amino acids and contains albumin. The albumin in snakehead fish is of higher quality compared to albumin in eggs. The high protein value in this formula is beneficial for diabetic patients experiencing hypoalbuminemia caused by gangrene, as they require a substantial protein intake (Sayuningsih *et al*., 2018).

Fat

The fat content of the enteral formula with snakehead fish flour and pumpkin flour is 3.05% of the total calories. This indicates that the formula does not meet the requirements for a diabetes enteral formula, which according to ASPEN (2014), should be 8-9.7% of the total energy. This is because snakehead fish is a type of fish that has high protein content and low fat. The fat in the enteral formula with snakehead fish flour and pumpkin flour comes from Virgin Coconut Oil (VCO). Virgin Coconut Oil can help manage hyperglycemia and improve glucose tolerance because it has antioxidant effects that enhance insulin secretion (Iranloye *et al*., 2013).

Carbohydrate

The carbohydrate content of the enteral formula with snakehead fish flour and pumpkin flour is 24.44% of the total calories. This indicates that the formula meets the requirements for a diabetes enteral formula, which according to ASPEN (2014), should be 22-25.4% of the total energy. The low carbohydrate content in this enteral formula follows the principles of diabetic enteral nutrition, which emphasizes low-carbohydrate intake. The main source of carbohydrates in this enteral formula is pumpkin flour. The polysaccharides in pumpkin flour can increase insulin levels and improve glucose tolerance, thereby reducing blood glucose levels. This is supported by research conducted by Zhang et al. (2013).

Dietary Fiber

The dietary fiber content of the enteral formula with snakehead fish flour and pumpkin flour is 5.90% of the total calories. This indicates that the formula meets the requirements for a diabetes enteral formula, which according to ASPEN (2014), should be 2.4-5% of the total energy. The fiber in this enteral formula comes from pumpkin flour. It is known that pumpkin contains soluble fiber such as pectin, which is believed to help control glucose absorption (Hartono, 2004).

Energy density

The energy density of the enteral formula with snakehead fish flour and pumpkin flour is 0.55 calories/ml. This indicates that the formula meets the requirements, as according to Rolfes et al. (2006), the recommended range is 0.5-2.0 calories/ml. Energy density is calculated by dividing the energy content by volume. Low energy density is beneficial for

diabetic patients with obesity. Each serving of the enteral formula with snakehead fish flour and pumpkin flour consists of 75 grams of the formula dissolved in 200 ml of warm water, providing 122.3 calories per serving.

Color

The color analysis results of the enteral formula with snakehead fish flour and pumpkin flour showed an L value of 56.3 for brightness. This is due to the dark color of the pumpkin flour and the addition of stevia powder, which makes the enteral formula slightly darker. The a value, indicating the intensity of red color in the enteral formula with snakehead fish flour and pumpkin flour, is 5.1. The red color in the formula comes from the pumpkin flour. The b value, indicating the intensity of yellow color in the formula, is 12.4. The yellow color is produced by the pumpkin flour, due to the drying temperature used in the process of making the pumpkin flour.

pH

The pH value of the enteral formula with snakehead fish flour and pumpkin flour is 5.95. This indicates that the formula meets the requirement according to (Nilesh *et al*., 2011), which states that the pH should be >3.5. The enteral formula with snakehead fish flour and pumpkin flour is acidic in pH, influenced by the skim milk content that contains lactose. The conversion of lactose to lactic acid occurs naturally due to the activity of microorganisms, which produce lactic acid and lower the pH (Umar, 2014).

Viscosity

The viscosity value of the enteral formula with snakehead fish flour and pumpkin flour is 47.9 mPa.s. This indicates that the formula meets the requirement according to ADA (2002), which suggests a range of 1-50 cP (centipoise). Viscosity measurement was conducted using an ndj-8s viscometer. Viscosity can be influenced by the composition of the enteral formula with snakehead fish flour and pumpkin flour, which contains pectin as a thickening agent (Wakita *et al*., 2012).

Microbiology

During the process of making the enteral formula, researchers followed the manufacturing procedure and storage guidelines. Temperature is one of the factors that can affect the growth of food spoilage microbes. According to research by Annisa *et al*. (2020), most microbes thrive between temperatures of 20°C to 45°C. The enteral formula is prepared at 70°C, and then stored, allowing the temperature to decrease, which can result in the formula being unfit for consumption if more than one hour passes after preparation. In studies such as Vieira et al. (2018), non-commercial diets have shown higher microbiological contamination and lower adherence to microbiological standards.

CONCLUSION

The enteral formula with snakehead fish flour and pumpkin flour, containing snakehead fish flour, pumpkin flour, virgin coconut oil, stevia, and maltodextrin, can be recommended as a supplementary food or meal replacement for diabetic patients. The most preferred formula is Formula F1, it offers high fiber content low carbohydrate content high protein content and low-fat content

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CONFLICT OF INTEREST

All authors declare that there is no conflict of interest.

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