Journal of Global Nutrition (JGN)

Volume 5 No 1 (2025) Month: page 533-550
ISSN: 2776-7051
Published by *Ikatan Sarjana Gizi Indonesia (ISAGI)* – The Indonesian Nutrition Scholars Association

Original Research

Development of Enteral Formula "KAMEKAMA" Based on Red Beans (*Phaseolus vulgaris L.*) and Cinnamon (*Cinnamomum verum*) for Diabetes Mellitus

Pengembangan Formula Enteral "KAMEKAMA" Berbasis Kacang Merah (Phaseolus vulgaris L.) Dan Kayu Manis (Cinnamomum verum) Untuk Diabetes

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Abstract: ***Introduction:*** *Treatment of diabetes mellitus in critical conditions using NGT can be done through the administration of enteral formulas, one of which is the KAMEKAMA enteral formula which has been developed with various modifications. Red bean flour and cinnamon flour as functional local foods can be developed into KAMEKAMA formula for diabetes mellitus.* ***Objective:*** *This study aims to develop an enteral KAMEKAMA formula based on red bean flour and cinnamon flour for diabetes mellitus using NGT.* ***Materials and Methods****: This type of research is experimental with a trial and error design. The final product is assessed based on organoleptic quality, viscosity and osmolarity, NGT hose flowability, color difference ratio (CDR), the selected development formula is carried out through an empirical test of the approach to energy and nutritional value according to RS standards. Organoleptic quality assessment with 20 moderately trained panelists and 10 trained panelists.* ***Results:*** *The best enteral formula according to the panelists was F4, which is the ratio of red beans to cinnamon (75:60), the content of the KAMEKAMA enteral formula is energy which is 1010.46 kcal, nutritional value of protein 37.29 grams, fat 39.10 grams, carbohydrates 145.32 grams, and fiber 34.77 grams. Viscosity 8 mPa's and Osmolarity 304 mOsm/L. Organoleptic quality in color, aroma, and texture did not have significant differences, but in taste and after taste there were significant differences.* ***Conclusion:*** *The utilization of red bean flour and cinnamon flour as functional local foods can be concluded as an alternative to the enteral formula of KAMEKAMA based on red beans and cinnamon for diabetes mellitus. Further research can carry out formula interventions in patients with diabetes mellitus and as well as formula glycemic index.*

Key word: enteral formula, diabetes mellitus, kidney beans, cinnamon

1. INTRODUCTION

Diabetes Mellitus is a disease that is the mother of all diseases in the human body. Diabetes Mellitus may result in various other types of diseases. Complications of this disease can arise from head to toe, ranging from heart disease and stroke, miserable kidney failure, to infections, especially in the legs that can continue with amputation and all can eventually take their lives. Person is said to have clinical diabetes mellitus if there are symptoms of diabetes mellitus, namely eating a lot, drinking a lot, urinating frequently and losing weight and getting the results of checking blood glucose levels during fasting >126 mg/dL or 2 hours after drinking a 75 g glucose solution, the blood glucose level is >200 mg/dL (1)

Judging from the gender category, IDF calculates that the prevalence of diabetes in women in 2019 was 9% while 9.65% was found in men. The International Diabetes Federation (2) stated that in 2021 the incidence of DM in the world in the age range of 20-79 years will be 537 million people and is predicted to increase to 643 million people in 2030 and 783 million in 2045. Three out of four people with DM are in poor and developing countries (3,4) WHO 2021 states that 1.5 million deaths occur in people with DM every year (4) In 2019, the number of DM sufferers in Indonesia reached 10.7 and is one of the highest prevalence in the world (4,5) This figure is predicted to increase to 16.6 million people with DM by 2045. Diabetes is the third highest cause of death in Indonesia (4,5) Indonesia ranks 4th in the world after China, the United States and India (6,7) DM disease can be controlled with proper management to prevent complications. DM management consists of pharmacological and non-pharmacological management. Long-term pharmacological treatment, the use of anti-glycemic drug preparations causes many side effects, so more effective and safe preparations such as herbal medicines derived from plants, one of which is red beans (8) and cinnamon (9) One of the factors that red beans can affect blood glucose levels is because of their low glycemic index of 26 (10) Previous research conducted in the non-hypertensive obesity group by giving red bean pudding for 14 days can reduce fasting blood sugar by - 6.33 ± 4.67 mg/dl (8) The fiber in red beans is higher than in soybeans which only contains 1.6 grams of fiber, and in green beans the fiber content is 1.5 grams per 100 grams. Red beans are a plant-based protein source food ingredient that can be given to patients who are not tolerant of cow's milk protein, with complex carbohydrate content, as well as good fiber to help control blood sugar, so it has the potential to become a basic ingredient in hospital enteral food (11)

Cinnamon is known to have anti-diabetic properties, in addition to being considered to have anti-oxidant, anti-inflammatory and anti-bacterial properties. The main constituents of cinnamon are cinnamaldehyde, cinnamate, cinnamic acid and many essential oils (12). According to research conducted by Nurhalina Sari et al., 2023, cinnamon can reduce blood glucose levels in people with Type 2 DM. People aged 40 years and older are 6 times more likely to develop type II diabetes (13) The process of swallowing makes patients experience difficulties in the process of receiving food which may occur due to weak muscles, natural tooth loss, and impaired coordination of movements that can cause difficulty eating (14) Modification of feeding in the form of liquid food can be used as an alternative to food selection (15) Feeding with a liquid consistency may be able to help patients who have difficulty consuming solid foods (16) In hospitals, feeding patients can be done through three main methods, namely orally, enterally, or parenterally, depending on the patient's condition. Especially for enteral feeding, this method can be done through various routes, such as direct feeding by mouth, using a *gastric tube*, nasogastric tube (NGT), or through a jejunum (17)

Dietary management that is in accordance with the fulfillment of the body's needs related to nutrition needs needs to be carried out to prevent morbidity from malnutrition. The basic principle of nutritional fulfillment by providing food orally and if it is not met, then liquid or enteral food can be given (18) Enteral formulas can be given to patients who are unable to eat orally, such as in conditions of decreased consciousness, swallowing disorders or dysphagia, and other clinical conditions or in patients who have complaints that the oral intake is inadequate. Proper enteral nutrition in patients can prevent hospital malnutrition, stabilize liver/liver function, reduce the incidence of infection complications, reduce the number or frequency of hospital admissions and the length of hospital stay (19) Liquid hospital formula based

on the indications for administration consists of hospital formula with milk that can be given to patients who have normal digestion, blender food for patients who need additional fibrous foods, hospital formula with low lactose can be given to patients who are not lactose intolerant, and hospital formula without milk for patients who are intolerant or allergic to milk protein (20)

Plant-based proteins can be used as a substitute for animal protein sources such as milk and as an affordable source of energy (21) Based on this description, the researcher is interested in researching and studying enteral formulas based on local foodstuffs, namely red bean flour and cinnamon flour as an innovation in enteral nutritional support or liquid food supplements for DM patients with a comparison of the enteral formula of DM RS. Based on observations in the hospital for approximately 6 months, the enteral formula used in the hospital has low acceptance, especially in terms of aroma, protein and fiber contained, which are 7 grams and 3.84 grams per serving, and there is still a lack of research related to the alternative selection of local ingredients as a commercial enteral formula for diabetes mellitus.

2. METHODS

Research Design, Time, and Place

This type of research is research on the development of new food products. Product formulation is carried out with an ingredient substitution approach to basic prescriptions used in hospitals. Product development is carried out by changing materials and compositions by *trial and error* , namely changing the composition of the constituent materials so as to produce nutritional value content in accordance with the standard DM enteral formula and examining the potential of enteral formulas based on red bean flour and cinnamon powder on NGT hose flow ability, sensory quality / organoleptic quality, energy and nutritional value, viscosity and osmolarity, and *color different ratio* by comparing the enteral formula of DM RS. The research was carried out from November 2024 to January 2025 at the Laboratory of Food and Processing Science at the Malang Health Polytechnic. *Ethical clearance* was obtained from the Research Ethics Commission of Yatsi Madani University Tangerang with Number 322/LPPM-UYM/XII/2024.

Research Population and Sample

The subjects in this study are 20 rather trained panelists who conduct sensory quality assessments using hedonic methods, and 10 trained panelists who determine the best level of treatment. The inclusion criteria for moderately trained panelists include students of the Nutrition Department of the Health Polytechnic of the Ministry of Health Malang who have received the Food Ingredient Science / Food Technology Science / Acceptability Test course, are willing to become panelists, panelists are in good health, not under the influence of alcohol and drugs, do not have allergies to the main ingredients for making enteral formulas. The exclusion criteria of the moderately trained panelists included having disorders such as a sense of smell, suffering from diseases related to decreased immune function and body metabolism. The inclusion criteria for trained panelists include having an education with a background in S1/S2/S3 Nutrition, and being willing to be a panelist. The sample used in this study was the KAMEKAMA enteral formula based on the substitution of red bean flour and

cinnamon powder to the enteral formula with a ratio of the proportion of red bean flour: cinnamon powder, namely F1 (90:45), F2 (85:50), F3 (80:55), F4 (75:60).

Tools and Materials

The tools used in this study include *a food processor* (branded "Philips Cucina HR7633, China"), filters, plastic basins, plastic plates, aluminum pots, gas stoves, mercury thermometers (GEA Alcohol Thermometer -10 to 150), porcelain cups, Teflon, sutil, spoons, scales, and measuring cups, NGT *Feeding Tube* "TERUMO" Hose size Fr.16 size 125 cm long and *Syringe* Syringe Tip (Sonde) Catheter "HEXA CARE" 50 cc, Organoleptic questionnaire and stationery, Analytical balance, *soxlet,* condenser, fat flask, decigator and oven, NDJ-8s *Digital Rotary Viscometer machine*, mercury thermometer and *stopwatch*, Cup, SONY ILCE-6400 or Alpha 6400 digital camera and *mini studio box*. The composition and specificity of the ingredients used are obtained from online stores. The materials used can be seen in table 1.

Table 1. Ingredient Composition of Enteral Formula

Material	Treatment level (ratio of red bean flour to cinnamon flour)			
	F1 (90:45)	F2 (85:50)	F3 (80:55)	F4 (75:60)
Red bean flour (g)	90	85	80	75
Cinnamon flour (g)	45	50	55	60
Skimmed milk powder (g)	50	50	50	50
Coconut oil (ml)	25	25	25	25
Canola oil (ml)	10	10	10	10
Granulated sugar (g)	15	15	15	15
Maltodextrin (g)	10	10	10	10

Description: proportion of red bean flour : cinnamon flour, F1 (90:45), F2 (85:50), F3 (80:55), F4 (75:60).

Data Collection Techniques

The research process is presented in the flow diagram figure 1 (22)

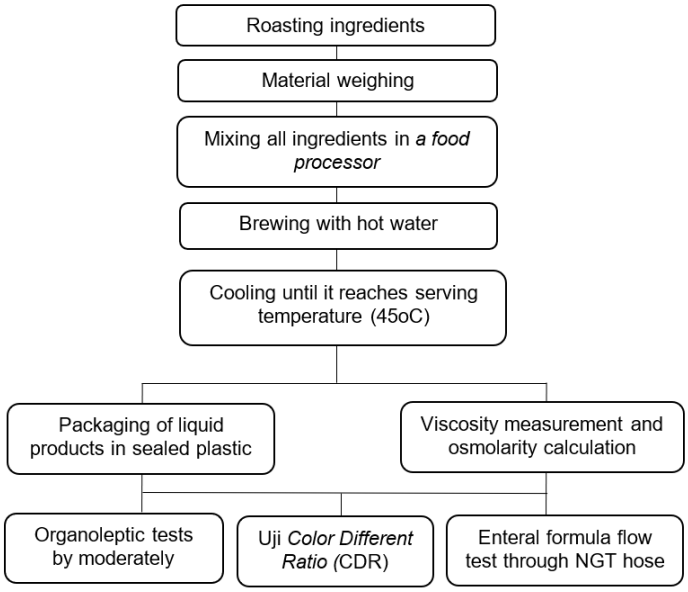


Figure 1. Research Process Flow Chart

Data on energy and nutrient content are obtained from *the TKPI (Indonesian Food Composition Table)* food database (23) and *the United States Department of Agriculture* (24) It was analyzed by comparing the results of the calculation and testing of the selected formula sample against the target needs standard, namely diabetic mellitus patients. Subjectively testing the flow ability of NGT tubes for enteral formula liquid food using NGT *Feeding Tube* "TERUMO" size Fr.16 size 125 cm long and *Syringe* Tip Catheter (Sonde) "HEXA CARE" 50 cc when the enteral formula is still warm with the application of a formula temperature of 40-45oC.

The testing of the hedonic quality of the KAMEKAMA enteral formula was carried out descriptively using hedonic quality with 20 moderately trained panelists. Panelists were presented with 4 different formulas. Before the test, the researcher will explain to the panelists the purpose and procedure of the research conducted. Once the panelists understand and are willing to engage in the research, the panelists are asked to sign *an informed consent* sheet. Furthermore, panelists were invited to conduct a hedonic test on organoleptic parameters for ± 5 minutes with 1 minute to neutralize the tongue using mineral water. Assessment through a questionnaire with parameters of color, taste, aroma, texture and *after taste* is in accordance with the assessment scale determined by the researcher on a score of 1 (strongly disliked), 2 (disliked), 3 (somewhat disliked), 4 neutral, 5 (liked), 6 (somewhat liked), 7 (strongly liked).

The determination of the calculation of the best treatment used the effectiveness index of the De Garmo method (25,26) The method is carried out by measuring several variables that affect the quality of enteral formulation products such as energy content, nutrient content and organoleptic quality. The best level of treatment is the level of treatment that has the highest Productivity (NP) value. Panelists were asked to determine the ranking of variables that according to the panelists affect product quality and give values to these variables. Panelists can give the same value to variables that are considered to have an equally important influence on the quality of the formulation product. The subjects for the organoleptic test in this study used a rather trained panelist of 20 Nutrition students of the Malang Health Polytechnic who met the

inclusion criteria and 10 expert / trained panelists for the calculation of the best treatment.

Viscosity testing using the NDJ-8s *Digital Rotary Viscometer* and *spindle* No. rotor 2 *speed* 60 RPM. Measurements were carried out 2x for each sample at room temperature. The viscosity reading is done after the rotor is stable or 25 seconds. The viscosity value is read on the panel when the value has stabilized, the result is reported in Pa's units and the temperature of the material (Pa's & 21°C). While osmolarity is calculated based on the results of viscosity with osmolarity of the standard formula. The color test of the formula was made by *the Color Different Ratio* (CDR) method (27) In the enteral formula obtained with a digital camera (SONY ILCE-6400, Sony corp, Japan) the product image was taken at a resolution of 350 x 350 dpi, 24 bit, with a 16 mm camera lens, f/4, ISO 100. The image of the KAMEKAMA enteral formula was taken in a closed laboratory room using *a mini studio box* with 1 tube-type electric lamp illumination on the front of the top side of the *box*. Image capture was carried out from a distance of 10 cm. The color profile in the enteral formula is determined based on the image histogram. The RGB channels (*Red, Green, Blue*) of the analyzed images begin to be separated. Then, in each channel, the maximum possible area obtained from the image (*Region of Interest* / ROI) is determined with a round shape according to the product container. Image processing in color analysis was carried out with *ImageJ* software version 1.54k (28)

Data Analysis

The data analysis used was univariate and bivariate analysis. Univariate analysis to find out the descriptive picture of the characteristics of each variable. Bivariate analysis to obtain differences between treatments (Dahlan, 2011). Initial data testing was carried out using a normality test (*Saphiro-wilk* test) to determine the level of distribution or distribution of data. Organoleptic data showed normal undistributed data ($p<0.05$) (29) Data that are not normally distributed are followed by the *Kruskal-Wallis* test to determine the differences between groups using *statistical software* (JASP version 0.19.2.0) (30) Another program used in the data processing process is *ImageJ* version 1.54k (28) for color test assessment or CDR (27)

3. RESULTS

Energy and Nutrient Content

Based on calculations using an empirical approach, the values of protein, carbohydrate, and fiber in the development of KAMEKAMA enteral formula based on red bean flour and cinnamon flour (F1, F2, F3 and F4) increased, while energy and fat decreased compared to *the hospital-made* formula. The energy content and nutrients of the KAMEKAMA formula based on red bean flour and cinnamon flour can be seen in Table 2.

Table 2. Energy and Nutrients of KAMEKAMA Enteral Formula

Nutritional Value	Unit	RS	F1	F2	F3	F4
Energy	With	1210,8	1030,50	1023,82	1017,14	1010,46
Protein	g	37,2	40,12	39,18	38,23	37,29
Fat	g	48	39,53	39,39	39,25	39,10

Carbohydrates	g	138	142,69	143,57	144,44	145,32
Fiber	g	19,2	27,39	29,85	32,31	34,77

Description: proportion of red bean flour : cinnamon flour, F1 (90:45), F2 (85:50), F3 (80:55), F4 (75:60).

The addition of kidney beans and cinnamon flour to the formula did not result in a significant increase in energy ($p>0.05$). The increase in energy content and nutritional value of enteral formula is related to the content of energy, carbohydrates, proteins, fats, and fiber in enteral formulas. The increased consumption of kidney bean flour and cinnamon flour resulted in increased levels of carbohydrates, proteins and fiber in enteral formulas. Therefore, the proportion of red bean flour and cinnamon flour of F4 (75 : 60) causes higher carbohydrate, protein, and fiber content than F1 (90 : 45) with the use of lower red bean flour and cinnamon flour. The energy content and nutritional value at all levels of treatment have met the standards

Ability to Flow in NGT Hose

KAMEKAMA enteral formula is flow-tested using an NGT hose to ensure the smooth flow of formula provided through the hose, prevent blockages, and minimize the risk of complications. The ability to flow in the NGT hose of KAMEKAMA formula based on red bean flour and cinnamon flour can be seen in table 3.

Table 3. Flowability in NGT

Parameter	Formula Enteral KAMEKAMA			
	F1	F2	F3	F4
Description (flow)	flow	flow	flow	flow
Volume (ml)	50	50	50	50
Time (seconds)	76	46	34	17
Suhu (^{oC})	31	31	31	31

Shellfish: proportion of red bean flour : cinnamon flour, F1 (90:45), F2 (85:50), F3 (80:55), F4 (75:60).

Table 3. shows that all KAMEKAMA enteral formulas can flow, the KAMEKAMA F4 enteral formula has a faster flow velocity according to time parameters than the KAMEKAMA F1 enteral formula.

Viscosity and Osmolarity

The viscosity or viscosity level of the liquid in the enteral formula of KAMEKAMA, RS, and Commercial is measured using a viscometer. The viscosity was read at 00:25 seconds. The viscosity and osmolarity results of the KAMEKAMA formula based on red bean flour and cinnamon can be seen in table 4.

Table 4. Viscosity and Osmolarity Measurement

Parameter	F1	F2	F3	F4	RS	KOMERSIAL
Suhu (^{oC})	21	21	21	21	30	30
No. Spindle (#)	2	2	2	2	2	2
Viscositase (mPa's)	41,50	22,00	16,00	08,00	05,00	09,00
Osmolaritas (mOsm/L)	1577	836	608	304	190	342

Shellfish: proportion of red bean flour : cinnamon flour, F1 (90:45), F2 (85:50), F3 (80:55), F4 (75:60).

Based on the viscosity and osmolarity values, the development of the KAMEKAMA formula based on red bean flour and cinnamon F4 has almost the same value as the commercial formula and meets the osmolarity standard, while F1 has a greater value than other formulas and does not meet the osmolarity standard of RS formula nutritional supplementation products.**Hedonic**

Quality

The assessment of the preference scale in the KAMEKAMA enteral formula is based on red bean flour and cinnamon flour, namely the sample selected F4 with a comparison of red bean flour: cinnamon flour (75 : 60) to determine the acceptability and level of preference for the product in 20 rather trained panelists. The results of the hedonic quality analysis of the KAMEKAMA formula based on red bean flour and cinnamon can be seen in table 5.

Tabel 5. Mutu Hedonic Formula Enteral KAMEKAMA

Group	Rerata (*Mean±SD)*				
	Color	Aroma	Taste	Texture	*After Taste*
F1	4.15 ± 1.531 ^{a}	3.95 ± 1.504 ^{a}	3.35 ± 1.694 ^{a}	3.95 ± 1.468 ^{a}	2.75 ± 1.209 ^{a}
F2	4.40 ± 1.569 ^{a}	3.80 ± 1.361 ^{a}	3.70 ± 1.658 ^{b}	4.45 ± 1.701 ^{a}	3.20 ± 1.508 ^{b}
F3	4.60 ± 1.429 ^{a}	3.60 ± 1.569 ^{a}	3.60 ± 1.231 ^{b}	4.85 ± 1.599 ^{a}	3.90 ± 1.373 ^{b}
F4	4.70 ± 1.418 ^{a}	4.15 ± 1.461 ^{a}	4.65 ± 1.348 ^{b}	5.10 ± 1.410 ^{a}	4.30 ± 1.380 ^{b}
p	0.661	0.685	0.041	0.107	0.003

Shells: Different notations in the same column indicate that comparisons are made between formulas or rows.

Table 5. shows that the color, aroma, and texture of the formula development using red bean flour and cinnamon in the formulation of the enteral formula produced insignificant hedonic quality ($p>0.05$) So it can be seen that there is no significant difference in terms of color, aroma, and texture between the four enteral formulas. Meanwhile, the taste and after taste of the formula development using red bean flour and cinnamon in the formulation of the enteral formula produced a significant hedonic quality ($p<0.05$), so it can be seen that there are significant differences in terms of color, aroma, and texture between F1 and F4 enteral formulas.

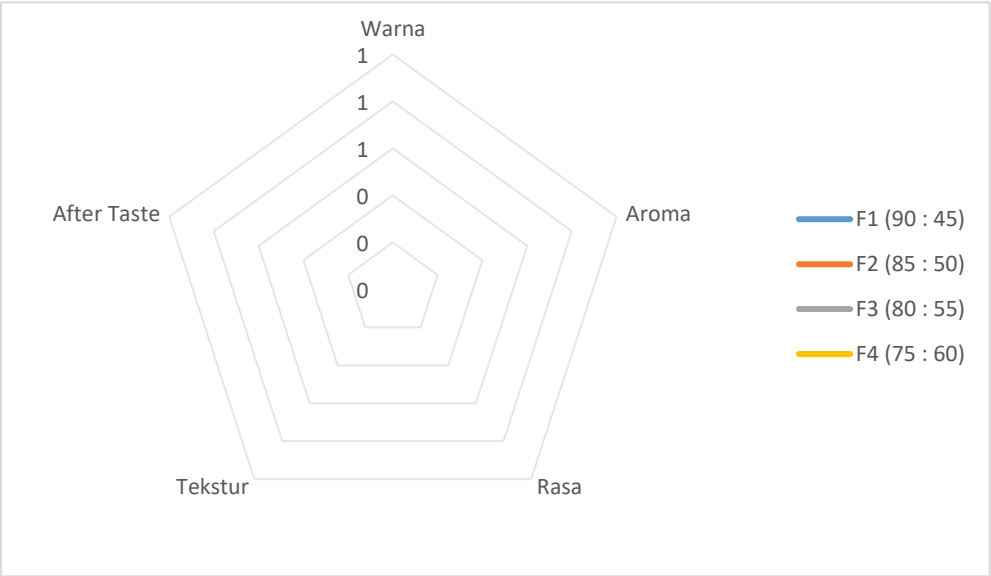
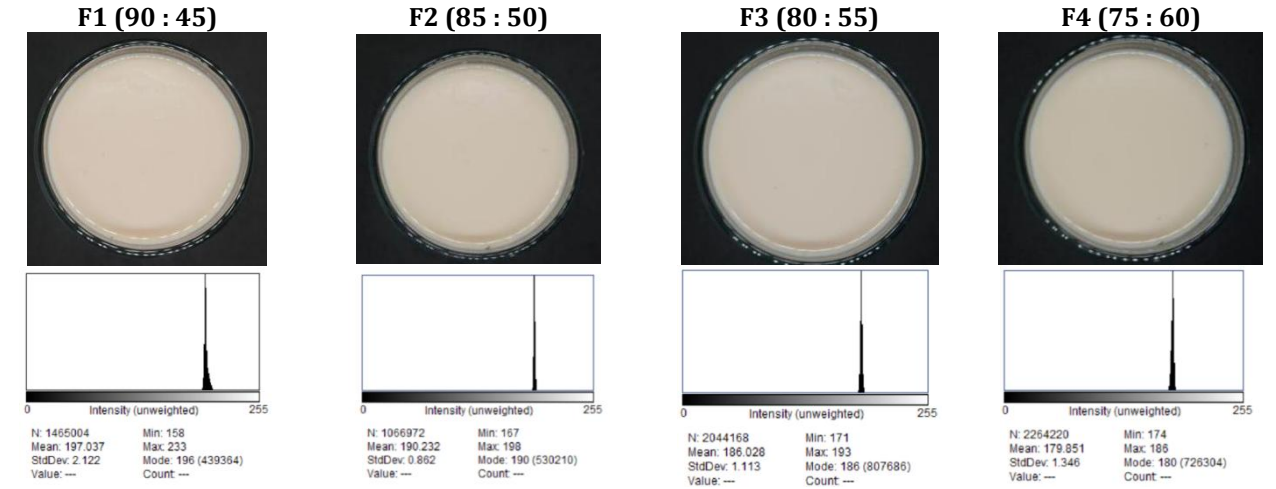


Figure 2. Hedonic Quality of KAMEKAMA Enteral Formula

Colour Different Ratio (CDR)

Digital image capture in the development of the KAMEKAMA formula based on red bean flour and cinnamon flour using a digital camera and *mini studio box* has a slightly darker color characteristic compared to the home-made RS formula. The use of kidney bean flour and cinnamon flour causes the formula color to be less brown. The results of *the color different ratio* (CDR) test of the KAMEKAMA enteral formulation formula are presented in Figure 3.



R = 212, G = 197, B = 182 | R = 203 , G = 191 , B = 175 | R = 196 , G = 187, B = 175 | R = 191, G = 182, B = 166

Figure 3. Enteral Formula Color Image and Histogram

Table 6. Difference / Comparison of KAMEKAMA Enteral Formula

Formula	R	G	B
F1	212 ± 1.570	196 ± 2.409	181 ± 2.790
F2	203 ± 0.900	191 ± 0.833	175 ± 1.051
F3	197 ± 1.065	187 ± 1.284	175 ± 1.770
F4	191 ± 1.445	183 ± 1.555	166 ± 1.652

Source: Primary Data, 2024

Figure 3. Showing the color intensity on the histogram indicates that the graph tends to be close to 0, the color intensity will be darker. It can also be observed based on the decrease in RGB color intensity from formula 1 (F1) to formula 4 (F4) with the use of more cinnamon flour can give the color intensity to be darker or more intense.

Selected Development Formula

The development formula was selected through the assessment of the best treatment level of the De Garmo (1984) method formula(26) The results of the analysis at the best treatment level of the formula can be seen in Table 7. Table 7. shows that the best treatment using the De Garmo (1984) method (26) was obtained in the F4 practice. The results of the best treatment test showed the highest value of treatment or the best value, namely F4 with the highest productivity value (NP) of 1.543 so that the results of determining the treatment level of the selected formula were determined.

Table 7. Selected Development Formula

Peremeter	***Ranking***	**Weight**	**Treatment**							
			F1 (90:45)		**F2 (85:50)**		**F3 (80:55)**		**F4 (75:60)**	
			NE	**NP**	**NE**	**NP**	**NE**	**NP**	**NE**	**NP**
Color	4	0,1	0,00	0,00	0,45	0,05	0,82	0,08	1,00	0,10
Aroma	2	0,3	0,00	0,00	0,45	0,14	0,82	0,25	1,00	0,30
Taste	3	0,2	0,00	0,00	1,00	0,20	0,71	0,14	3,71	0,74
Texture	1	0,4	0,00	0,00	0,43	0,17	0,78	0,31	1,00	0,40
Total		1,00	0,00	0,000	2,344	0,556	3,133	0,783	6,714	1,543

In the treatment of the F4 formula with the comparison of red bean flour: cinnamon flour (75 : 60) that was selected, the calculation of nutritional content (energy, protein, fat, carbohydrates, water and dietary fiber) was carried out based on *the food database*, then compared with the standard formula of the hospital. The results of anaZlysis comparing the nutritional content of KAMEKAMA formula in 100 grams of formula ingredients can be seen in table 8.

Table 8. Comparison of Nutritional Content Between KAMEKAMA Formula and RS Standard Formula

Parameter	Red Bean Flour Formula : Cinnamon Flour (F4) 100 g	Formula Standart (RS) 100 g
Energy (kcal)	412,43	550,36
Protein (grams)	15,22	16,91
Fat (grams)	15,96	21,82
Carbohydrates (grams)	59,31	62,73
Dietary Fiber (grams)	14,19	8,73
Water (ml)	5,74	-

Description: Proportion of red bean flour : cinnamon flour F4 (75:60)

Table 8. shows that the nutritional value of the development of the KAMEKAMA enteral formula (F4) based on *the* empirical formula database has a higher dietary fiber value compared to the DM RS enteral formula.

4. DISCUSSION

Energy and Nutrient Content

Table 2. shows that the energy of the enteral formula made of red bean flour and cinnamon flour is in the range of 1030.50 kcal/ml – 1010.46 kcal/ml. It meets the energy density requirements on the enteral formula. Enteral formulas made from red bean flour and cinnamon flour in addition to having excess nutritional value of carbohydrates, proteins, and fiber, are also functional local foods that are easy to reach. The nutritional content is equivalent to the *standard formula of the hospital* and is easily accessible, so enteral foods made from red bean flour and cinnamon flour can be recommended as an alternative to enteral foods for patients with diabetes mellitus. This is in line with the statement of the energy content of powdered drinks with raw materials such as yellow pumpkin flour, catfish meal and red bean flour obtained by converting protein, fat, and carbohydrate levels into energy. The high total energy value comes from yellow pumpkin flour, catfish meal and flour kacang merah, susu skim, gula, maltodextrin dan minyak kelapa sebagai bahan penyusun minuman serbuk (31).

The results of protein analysis showed that the comparison of red bean flour and cinnamon flour had a real effect on the protein content of KAMEKAMA enteral formula. The protein content of KAMEKAMA enteral formula obtained from this study ranged from 40.12 (g) – 37.29 (g) (Table 2.). This is in line with the statement that the lowest protein content value of spring cake was obtained from the P0 treatment (100% wheat and 0% red bean flour) while the highest protein content value of spring cake was obtained in the P4 treatment (20% flour and 80% red bean flour). The increasing concentration of red bean flour also increases the protein content of semprit cakes, this is because the protein content of red bean flour is higher than that of wheat (32)

Based on the results of the fat content analysis, the higher the proportion of red bean flour used, the higher the fat content produced, this is because the fat content of F1 red bean flour is higher than that of F4 red bean flour (Table 2). The addition of other ingredients such as coconut oil and skim milk also affects the fat content in the enteral formula so that it becomes higher (32) Vegetable oil is an oil made from plants that can be used as an ingredient for cooking. Some commonly used types of vegetable oils are palm oil, olive oil, soybean oil, coconut oil and sunflower seed oil (11) (31) In this formula, the oil used is coconut oil.

The results of carbohydrate analysis showed that the comparison of red bean flour and cinnamon flour F1 and F4 had a real effect on the carbohydrate content of enteral formula. The carbohydrate content of the enteral formula obtained from this study can be seen in table 2. The lowest F1 carbohydrate content value was obtained from the treatment of red bean flour and cinnamon flour (90 : 45), while the highest F4 carbohydrate content value was obtained in the treatment of red bean flour and cinnamon flour (75 : 60). The results of carbohydrate content increased along with the increase in the proportion of red bean flour used, this was due to the higher carbohydrate content of red bean flour (43.33%) compared to wheat (24.17%) (Table 2). According to Putri *et al.,* (2022), carbohydrate levels calculated by *difference* are influenced by other nutritional components (water content, protein, ash and fat), the lower the other nutritional components, the higher the carbohydrate content, on the other hand if the higher the other nutritional components, the lower the carbohydrate content.

The fiber content in the KAMEKAMA enteral formula ranges from 27.39 grams to 34.77 grams and the RS standard formula is 19.2 grams, where the KAMEKAMA fiber enteral formula is in accordance with the standard enteral formula, which is 20-35 grams. The high dietary fiber content in the KAMEKAMA enteral formula is due to the use of red bean flour and cinnamon flour, both of which contain quite high fiber. This makes kidney beans a high contributor of fiber, kidney beans have a higher type of soluble fiber. The results of a study by Tanaka et al., (2013) which examined the relationship between dietary fiber and the risk of cardiovascular disease in DMT2 patients stated that soluble fiber has a higher influence in reducing the risk of stroke in patients with diabetes mellitus than insoluble fiber (33) This is in line with the statement of the results of the study showing that there is a relationship between fiber intake and blood glucose levels, namely high fiber consumption can help control blood glucose levels so that this snack bar can be a suitable distraction for consumption by DM sufferers (33)

Ability to Flow in NGT Hose

KAMEKAMA enteral formula products are measured by flow test on NGT hoses to determine the speed or time required for liquid food to flow in NGT hoses when given to patients using NGT (34) The ability to flow in the NGT hose in the non-dairy liquid food formula (based on red bean and cinnamon flour) is in accordance with the flow test commercial milk formula in the NGT hose. This happens because the formula of non-dairy liquid food based on red beans appears to be thicker compared to commercial milk formula. There are several factors that affect the viscosity of liquid food products, namely protein content, fat, type of protein, processing temperature, moisture content and water activity (Faidah et al., 2019). The flowability in the NGT hose helps to evaluate whether the enteral formula has the appropriate viscosity for use with NGT, so that nutrients can be delivered without any mechanical resistance to the NGT hose and ensure that the formula does not cause irritation or damage to the hose, which can affect patient comfort and safety. This process is important in patient care to meet the nutritional needs of diabetes mellitus.

Viscosity and Osmolarity

Viscosity is an important thing that must be considered in the manufacture of enteral formulas because it shows the power and flow in the enteral formula. Viscosity is affected by temperature, solution concentration, solute molecular weight and pressure (35) Viscosity or viscosity level is an important thing that must be considered in making enteral formulas. The viscosity of the enteral formula greatly affects the smooth

entry of the enteral formula into the hose, the method of feeding, and determining the size of the tube used. The higher the viscosity of the formula, the more difficult it will be to drain and increase the risk of blockages in the hose. On the other hand, enteral formulas with low viscosity can cause diarrhea or vomiting, which can reduce the fulfillment of nutritional needs.(35) (36) In this study, a flow test has been carried out on a size 16 NGT hose in accordance with the needs of the hose for adults. Table 4 shows that the osmolarity of F1, F2, F3 does not meet the standard formula, but F4 has the same osmolarity as the commercial standard formula of 304 mOsm/L.

Hedonic Quality

Color is the first factor that panelists pay attention to when evaluating a product. Color differences that are not in accordance with standards are often used as a sign to evaluate the quality of the product. (Negara et al., 2016) (37) Color is the first impression because it uses the sense of sight. Attractive colors will increase the taste of panelists or consumers to taste the product. Color is one of the visual forms that attract consumers (38) This is in line with the statement that the color change is caused by the baking process at high temperatures, in this process the glycosidic bonds of sucrose are broken so that glucose and fructose are produced. Food browning is caused by an enzymatic reaction of foods that contain phenolic compounds. Browning food causes a Maillard reaction that affects the color result of muffin products (Indrayanti et al., 2021) (38)

The characteristics of the KAMEKAMA enteral formula which contains the proportion of red bean flour and cinnamon flour, resulting in a light brown color that was preferred by the panelists. This light brown color gives a more attractive and appetizing visual impression, because it is similar to the brown enteral formula color commonly found in commercial products. This color is produced from the Maillard reaction, which is a chemical reaction between the amino groups of proteins and reduced sugars during the roasting process. This reaction produces a melanoidin compound that gives the enteral formula its brown color. This is in line with the statement (37) Damayanti (2020) who explained that red beans contain high enough protein and carbohydrates, so that they can trigger a maillard reaction when mixed with other ingredients.

Aroma is an important factor in determining consumer acceptance of a food ingredient. In general, people can judge the deliciousness of food by its aroma so that it arouses the appetite. A good aroma can increase the panelists' preference for food. The onset of food odor is caused by the formation of volatile compounds due to enzymes or without the help of enzymes. Aroma is the result of the reaction of the sense of smell to the smell produced by a food. (Yanti et al., 2019) (38)(37) This is in line with research that states that the aroma of muffins is influenced by the combination of cinnamon combined with other ingredients. The more cinnamon is added, the more distinctive the aroma produced (Rachmawati et al., 2021) (38)

The combination of red bean flour and cinnamon flour in the enteral formula produces a distinctive and attractive aroma. The sweet aroma of cinnamon flour combined with the sweet and earthy aroma of red beans creates a complex and appetizing aroma. Meanwhile, the aroma characteristics of enteral formulas that use a larger amount of red bean flour cause an increase in the smell of the enteral formula along with the increase in the amount of red bean flour. As a result, the panelists' acceptance of the aroma of cookies is decreasing. This is in line with research conducted by Damayanti (2020) which states that the more bran flour and red bean flour are added, the stronger

the smell of the cookies will be. The smell of red beans is caused by the activity of the lipoxygenase enzyme that is generally present in beans. This enzyme hydrolyzes unsaturated fatty acids into volatile compounds such as aldehydes and ketones (Irmawati, 2014) (37)Taste is one of the main sensory aspects of food products. Consumers tend to choose food based on the quality of the taste offered (Wahdah et al., 2020) (37) While the KAME KAMA F1 formula based on taste parameters has the lowest value, this is due to the addition of more and more red bean flour. This is in line with the research of Damayanti et al. (2020) (37) which stated that the more red bean flour is added, the lower the panelists' acceptance of the cookie flavor. Red beans can affect the taste of cookies by giving them a bitter taste, which is caused by acrylamide compounds that form in kidney beans during the baking process.

Taste can be determined by tasting and oral stimulation. The structure and composition of the ingredients affect the taste produced by the food product. Texture and consistency will affect the taste caused by the ingredient, and taste has an important role in the quality of a food. Changes in the texture or viscosity of food ingredients can change the flavor that arises because it can affect stimulation of olfactory acceptor cells and salivary glands (38)

Texture is one of the factors in food products that affect consumer acceptance. In terms of the texture of the F4 enteral formula based on red bean flour and cinnamon flour, the less red bean flour is used in the formulation, the more liquid the texture of the enteral formula produced. This is because the content of red bean flour is lower than the content of cinnamon flour, which is 75 grams and 60 grams per 245 grams of ingredients, respectively. In the formulation of the F4 enteral formula, the amount of red bean flour used is inversely proportional to the use of the F1 enteral formula formulation, so that it affects the starch content which affects the viscosity.

Texture is an organoleptic test of functional nails of the structural, mechanical and surface properties of food ingredients that can be detected through the senses of sight, hearing, taste, and kinesthetics. The average range of organoleptic test results on texture is a benchmark that evaluates the quality of foodstuffs by touch and touch. This is in line with research that the texture of muffins is influenced by their moisture content, the amount and concentration of fats, carbohydrates, and proteins that make them up and is influenced by the standard ingredients used.

The aftar taste in the KAMEKAMA enteral formula based on red beans and cinnamon is at an average value of 2.75 – 4.30 which means that it is not liked to neutral. The comparison of KAMEKAMA enteral formula where the proportion of red beans is decreasing and the proportion of cinnamon is increasing with each treatment resulting in *a decreasing after taste*. This is in line with research that the addition of red ginger extract can reduce the level of sweetness and disguise the smell of langu in samples (after taste of peanuts) (39) Meanwhile, research (40) shows that the increasing ratio of cinnamon powder with each treatment results in a stronger bitter aftertaste. Research by Anggraini *et al.,* (2015) stated that the content of polyphenol compounds in cinnamon essential oil can provide a bitter *aftertaste* caused by the content of polyphenol compounds in essential oils (41).

Colour Different Ratio (CDR)

The difference in product color intensity to the KAMEKAMA formula was determined by *the color difference ratio* (CDR) method (27) The histogram moves further to the left side closer to zero, interpreting that the resulting enteral formula is getting darker. On

the contrary, the movement of the histogram to the right side is closer to the number 255, interpreting that the resulting enteral formula is getting lighter (27) (28) KAMEKAMA's enteral formula is slightly brownish-white. The enteral formula based on red bean flour and cinnamon flour is easy to lighten, along with the increase in the amount of cinnamon flour used, the color of the biscuits becomes darker. The brown color of biscuits is due to a non-enzymatic browning reaction or Maillard reaction that occurs during heating in roasting. Verma et al. (2020) (42) said that the Maillard reaction of the lysine amino acid group occurs with the presence of reduced sugars such as glucose which results in the binding of the e-N-de-Soxyfructocyl-I-lysin protein which produces a brown color. Based on this, the higher the protein in the enteral formula means more amino acids. This amino acid will react with the sugars in the starch of red bean flour, so that with the increase in temperature in roasting the *Maillard* reaction takes place.

Selected Development Formula

The selected enteral formula based on red bean flour and cinnamon flour is F4 with the proportion of red bean flour: cinnamon flour (75:60) which has the content of nutrients (energy, protein, fat, carbohydrates, and fiber), the ability to flow in NGT hoses, organoleptic, viscosity and osmolarity that have met the standard formula of the hospital and in accordance with the requirements of the enteral formula. The effectiveness of the best treatment level shows the highest value of the treatment or the best value, namely F4 as a result of determining the treatment level of the selected formula. The best nutritional value is taken because F4 is designed for patients who need a DM diet that requires not only high protein but also high fiber.

5. CONCLUSION

The use of kidney bean flour and cinnamon flour in the formulation of KAMEKAMA enteral formula significantly increases the carbohydrate and fiber content without a significant decrease in energy, protein, and fat nutrients and in accordance with hospital standards. The effect of the use of red bean flour and cinnamon flour in the formulation of KAMEKAMA enteral formula on taste and *after taste* parameters had significant differences, while there was no significant difference in color, aroma, and texture parameters. Red bean flour and cinnamon flour cause a more brownish discoloration that can be clearly observed by digital image analysis. The use of flour improves sensory quality, the panelists were able to accept the enteral formula of red bean flour and cinnamon flour well. The recommended enteral formula of KAMEKAMA F4 for diabetes mellitus is made using the proportions of red bean flour and cinnamon flour (75:60). The formula with this comparison produces a product that complies with the RS standard. The advantage of this research is that the products produced use local and affordable materials so that they reach the lower middle class. The ability of enteral formula to pass through the NGT hose can flow in 17 seconds with viscosity and osmolarity as standard. It is hoped that a formula with the use of local food can be developed for diabetes mellitus. For the next researcher, to be able to carry out formula interventions in patients with diabetes mellitus and as well as formula glycemic index.

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