KEMAS 20 (2) (2024) 346-353

Jurnal Kesehatan Masyarakat

http://journal.unnes.ac.id/nju/index.php/kemas

Wisdom of Local Food Ingredients as an Enhancer to Food Supply for Diabetes Mellitus Prevention

Oktia Woro Kasmini Handayani[1*] ✉, Maisarah Hasbullah[4], Mardiana[2], Irwan Budiono[1], Efa Nugroho[3]

[1] Doctoral Program in Public Health Universitas Negeri Semarang

[2] Nutrition Study Program Universitas Negeri Semarang

[3] Public Health Study Program Universitas Negeri Semarang

[4]Department of Science and Technology Studies, Faculty of Science, Universiti Malaya

Article Info

Article History:
Submit: June 2024
Accepted: September 2024
Published: October 2024

Keywords:
head circumference growth; head circumference; stunting toddlers; zinc

DOI
https://doi.org/10.15294/kemas.v20i2.50329

Abstract

The increase in cases and prevalence of children with DM increased 70 times (2010 – January 2023). The dominant factor is the consumption of unhealthy food, which is exacerbated by the limited diversity of healthy foods on the market. The objectives of this research are: 1) obtaining local food ingredients and food products to be used, 2) obtaining product prototypes, and 3) obtaining selected products for DM prevention. The activities consist of: 1) Determining local food ingredients with a qualitative approach, 2) Getting selected product formulas for limited environmental tests, with formula tests through expert design, selected formula production tests, proximate tests, and organoleptic tests, 3) getting products to be ready for field tests, with hedonic tests, Anova tests, and Post Hoc tests. The results obtained: 1) the local food that will be used is a large white sweet potato (Ipomoea Batatas) with food products in the form of sweet potato pie. The selected products were F5 (45% sweet potato, 20% wheat, and 5% tapioca), based on the laboratory results of the lowest carbohydrate, total fat, and total energy content (average 47.82%, 21.23%, 397.89) and the highest fiber content (9.64%). In addition, there were differences in overall value (F:6.033, sig 0.003), color value (F:4.252, sig 0.016), aroma value (F:6.247, sig 0.002), and taste value (F:1.841, sig 0.162). Furthermore, the results of the Post Hoc test concluded that there were differences related to the overall value, color, aroma and taste between F5 and F6 products.

INTRODUCTION

Diabetes Mellitus (Diabetes) belongs to the group of non-communicable diseases (NCDs) and is also classified as a group of degenerative diseases, caused by impaired carbohydrate metabolism, due to insulin hormone insufficiency. In 2030, approximately 366 million adults will suffer from diabetes and by 2040 the number is estimated to reach 642 million, of which 75% are in developing countries (International Diabetes Federation, 2021). Indonesia ranks 6th with the highest number of diabetes cases, which is 10.3 million cases per year in 2017. Center for Indonesia's Strategic Development Initiative (CISDI) stated that the number of children with diabetes is increasing rapidly, this is reinforced by the Indonesian Pediatrician Association (IDAI), which states that the prevalence of children with diabetes has increased 70 times (2010 – January 2023).

The loss of Gross Domestic Product

✉ Correspondence Address:
Department of Science and Technology Studies, Faculty of Science, Universiti Malaya
Email: maisara@um.edu.my

pISSN 1858-1196
eISSN 2355-3596

(GDP) in the world due to diabetes from 2010 to 2030 is estimated at around 1.7 trillion dollars. Treatment is carried out throughout life, which results in an economic burden on the family, which can increase the severity of symptoms and complications in patients (Patil et al., 2017; Tol et al., 2013). Diabetes can also attack all organ systems of the body, reduce human resource performance, and cause premature death.

Unhealthy lifestyle behaviors, overweight, abdominal obesity, lack of physical activity, and unhealthy diet, are risk factors for Diabetes that can arise due to the socio-cultural environment, which can be improved (Harding et al., 2004; Hu et al., 2012; Teixeira-lemos et al., 2011; Handayani et al., 2021). Unhealthy lifestyles formed by habits, low knowledge, environment, and lack of healthy food offered, including lack of facilities and policy support are important factors in the increase in Diabetes cases in the community (Al-sejari, 2017; Aye et al., 2014; Handayani et al., 2020; Silva, 2012). The availability of low-sugar foods and drinks is still limited at the hawker level and receives little serious attention (it is mixed with others, making it difficult to find, with a limited number of types) (Raharjo et al., 2016; Nugroho et al., 2023). Results of other research obtained local food wisdom, including the existence of several foods with a low Glycemic Index (IG), such as bran flour (Bran), sweet potato (Ipomoea batatas), Arrowroot (Maranta arudinacea), and kidney beans (Phaseolus vulgaris) (Al-sejari, 2017; Patil et al., 2017; Silva, 2012; Tol et al., 2013). The content of the resulting product is influenced by the formula of the staples and the cooking process (Handayani, Kurnia, et al., 2021; Handayani, Mardiana, et al., 2021; Handayani, Nugroho, et al., 2021).

One of the solutions to improve behavior related to healthy eating consumption is the environment related to the availability of healthy food in the environment, in terms of the type or variety and quantity. This activity will also utilize the wisdom of existing food ingredients into functional food for DM prevention and collaborate with MSMEs from the research process to the production process to be marketed later, as well as collaborate with vendors/shops for marketing. The purpose of the research is to: 1) obtain local food ingredients and food products to be used, 2) obtain product prototypes 3) obtain selected food enrichment products for diabetes prevention.

METHOD

The research was conducted in Semarang City, considering that the number of Diabetes cases increased from 2016 – 2019 (Semarang City Health Department), which is an area for the development of food availability in the market and policy development as a pilot that can be carried out. The stages of the research carried out are: Determine the potential profile of local food ingredients for the prevention of diabetes and food preference trends in the community in the research area. Carried out with qualitative approaches, the informants were the health resources of the Semarang DKK, health center nutrition officers, posyandu heads, chairmen, and members of the PKK, the target community was determined by purposive techniques, with an initial number of 22 people. Then additional informants from the target community were added with the snowball technique so that the total number of informants was 32 people. The data was obtained by in-depth interviews and FGD, and analyzed with the Miles and Huberman model.

Get product prototypes and get selected food enrichment products for diabetes prevention, based on the results of the activity: (1) Test the Formula through expert design. (2) Test the production of selected formulas (7 formulas) carried out with MSMEs. (3) Chemical assessment and analysis (proximate analysis) to obtain moisture and ash content (oven method), protein content (Mikro Kjeldahl), fat content (method Soxhlet), carbohydrate content (Carbohydrates by Difference), Analysis of dietary fiber content (Asp et al., 1983). (4) Organoleptic test in the trained panelists aged 25-40 years, as many as 5 men and 5 women, using a quality scale of 9 points. (5) Products for limited environmental testing (3 formulas) with improvements based on input from organoleptic test results. (6) Hedonic test to get the preferred product. The assessment by consumer panelists was 50 people, provided that the panelists were 20-40 years old, healthy, and willing to be panelists.

Techniques for determining informants Quota Sampling, with an acceptability test on a scale of 1 – 9 (Lamusu, 2007). The different tests were carried out with the Anova test and the Post Hoc test.

RESULTS AND DISCUSSION

Qualitative data obtained through FGD, and filling out questionnaires concluded that the food to be developed is large white sweet potatoes (Ipomoea Batatas), this is based on the results of taking questionnaire data to the target target of 30 people (15 adolescents and 15 young adults) and FGD conducted to 12 people (1 from DKK Semarang, 1 Nutrition Officer of the Health Center, 2 Posyandu Cadres, 3 representatives from PKK, 3 target communities, 2 representatives of partner MSMEs), and by considering the results of research that has been carried out previously where large white sweet potatoes are a food ingredient with low IG and are preferred by the community and used as a DM Preventive Support (International Diabetes Federation, 2021; Patil et al., 2017).

In addition, the election also considers the results of other research that has obtained local food wisdom including the existence of several foods with a low Glycemic Index (IG), which can be an option such as bran flour (Bran), sweet potato (Ipomoea batatas), Arrowroot (Maranta arudinacea), and kidney beans (Phaseolus vulgaris) (Harding et al., 2004; Teixeira-lemos et al., 2011; Tol et al., 2013). The results obtained related to the data of food products to be developed were concluded to be sweet potato pie with considerations based on the most proposals and the level of feasibility by MSME partners. Based on the Formula Test through expert design, with variables consisting of large white sweet potato staples, wheat, tapioca flour, and fixed variables consisting of eggs, honey, baking powder, and margarine (Table 1), so that 15 formula designs are produced, and the top 7 formulas will be used for further processed selected formula production tests. Product processing is carried out in collaboration with MSMEs by 1) preparing ingredients and weighing the ingredients to be used, 2) white sweet potatoes are steamed, crushed until smooth, and filtered, so that they form a pulp, 3) mixing all ingredients according to the formula into one dough that can be formed, 4) making fla which is a mixture

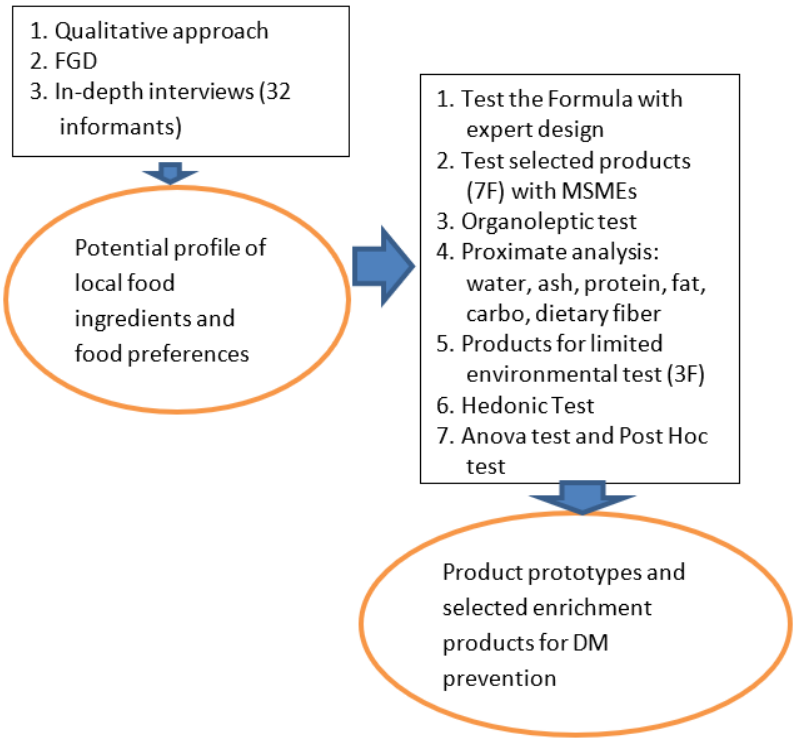

Figure 1. Research flow

Figure 2. White Sweet Potato, Ingredients, and Sweet Potato Pie Products.

Table 1. Basic Formula

Changed Variable: 70%		
Sample (Material)	Upper limit	Lower limit
Large White Sweet Potato	30	60
Wheat	10	20
Tapioca	5	15

Fixed variable: 30%	
Material	Amount (%)
Margarine	15
Honey	7
Egg	7
Backing Powder	1

of 300 ml sweetened condensed milk, 30 gr cornstarch, 8 bh egg yolk, 400 ml water and 1 tsp liquid vanilla. 5) Then it is formed in a pie mold, at the top of the fla pie filling, 6) baked over medium heat for 40 minutes.

Organoleptic analysis was carried out to determine the best product based on color, texture, taste, and aroma carried out by trained panelists, and obtained the 4 highest orders, namely F6, F5, F4, F3, then a proximate test was carried out and the results obtained were as illustrated in Table 2.

Based on the results of the proximate test, it was concluded that the product selected for the limited environmental test was in F3, F5, and F6 based on the consideration of carbohydrate content, total fat, total energy, and dietary fiber content with an improvement note that it is necessary to add a cornstarch mixture to the custard to get even lower carb content and add Emplex to get the crispiness of the product. This conclusion considers the results of previous research which stated that the content of the products produced is influenced by the formula of the staples and the cooking process (Aye et al., 2014). The data from the hedonic test in a limited scale test was conducted on 50 respondents and tested on 3 selected formulas (F3, F5, and F6) with aspects assessed related to color, aroma, texture, taste, and overall.

The conclusion based on the number of hedonic test assessments is that the superior is in F5 with the highest total score (1455) and superior in the overall aspect, aroma, and taste. The results of testing local food ingredients based on color, aroma, texture, taste, and overall in formula 3, formula 5, and formula 6 with the F test obtained the following results:

1)The assessment of the respondents based on the overall F value was obtained with

Table 2. Proximate test results F3, F4, F5, and F6.

Formula	Total energy (Kcal/100g)	Energy from fat (Kcal/100g)	Ash content (%)	Moisture content (%)	Carbohydrates (%)	Total fat content (%)	Protein content (%)	Dietary fiber (%)
F3								
Simplo	409.72	193.68	1.17	23.30	49.87	21.52	4.14	8.26
Duplo	413.76	200.88	1.21	23.25	48.95	22.32	4.27	8.08
F4								
Simplo	407.58	189.18	1.19	23.19	50.53	21.02	4.07	5.79
Duplo	401.32	181.08	1.23	23.59	50.83	20.12	4.23	5.94
F5								
Simplo	396.44	187.56	1.16	25.78	48.26	20.84	3.96	9.42
Duplo	399.34	194.58	1.20	25.99	47.38	21.62	3.81	9.86
F6								
Simplo	433.78	219.42	1.19	20.84	49.44	24.38	4.15	7.11
Duplo	440.05	226.89	1.15	20.35	49.00	25.21	4.29	7.02

Table 3. Results of the Number of Hedonic Test Assessments.

Product	VALUE					
	Overall	Color	Aroma	Texture	Flavor	Total
Formula 3	272	269	290	255	283	1369
Formula 5	301	286	303	267	298	1455
Formula 6	293	289	274	270	293	1419

a calculated F value of 6.033 with sig = 0.003. So it can be concluded that there are differences in local food products based on the overall formula 3, 5, and 6.

2)The assessment of respondents based on color obtained an F value of 4.252 with sig = 0.016. So it can be concluded that there are differences in local food products based on color in Formula 3, 5, and 6.

3)The assessment of respondents based on aroma obtained an F value of 6.247 with sig = 0.002. So it can be concluded that there are differences in local food products based on the aroma of Formula 3, 5, and 6.

4)The assessment of respondents based on texture obtained an F value of 2.161 with sig = 0.119. So it can be concluded that there is no difference in local food products based on the texture of Formula 3, 5, and 6.

5)The respondent's assessment based on the feeling obtained an F value calculated at 1.841 with sig = 0.162. So it can be concluded that there is no difference in local food ingredients based on taste in Formula 3, 5, and 6.

Table 4. Results of Post Hoc Tests of Local Food Ingredients Based on Overall Value, Color, Aroma.

The results of the post hoc test of local food products based on the overall in formula 3 with formula 5 and formula 3 with formula 6 have a significance value of < 0.05 so it can be concluded that there are differences in local food products in formula 3 with formula 5 and formula 3 with formula 6 based on the whole. Local food products in formula 5 and formula 6 have a significance value of > 0.05 so it can be interpreted that there is no difference in local food products in formula 5 and formula 6 based on the whole. The results of the post hoc test of local food products based on color in formula 3 with formula 5 and formula 3 with formula 6 have a significance value of < 0.05 so it can be concluded that there are differences in local food products in formula 3 with formula 5 and formula 3 with formula 6 based on color. Local food products in formula 5 and formula 6 have a significance value of > 0.05 so it can be

Table 4. Results of Post Hoc Tests of Local Food Ingredients Based on Overall Value, Color, Aroma.

Multiple Comparisons

Overall						
		Mean Difference		Sig.	95% Confidence Interval	
(I) Formula	(J) Formula	(I-J)	Std. Error		Lower Boun	Upper Bound
Formula 3	Formula 5	-.58000*	.17247	.001	-.9208	-.2392
	Formula 6	-.42000*	.17247	.016	-.7608	-.0792
Formula 5	Formula 3	.58000*	.17247	.001	.2392	.9208
	Formula 6	.16000	.17247	.355	-.1808	.5008
Formula 6	Formula 3	.42000*	.17247	.016	.0792	.7608
	Formula 5	-.16000	.17247	.355	-.5008	.1808
Color						
		Mean Difference		Sig.	95% Confidence Interval	
(I) Formula	(J) Formula	(I-J)	Std. Error		Lower Bound	Upper Bound
Formula 3	Formula 5	-.34000*	.14795	.023	-.6324	-.0476
	Formula 6	-.40000*	.14795	.008	-.6924	-.1076
Formula 5	Formula 3	.34000*	.14795	.023	.0476	.6324
	Formula 6	-.06000	.14795	.686	-.3524	.2324
Formula 6	Formula 3	.40000*	.14795	.008	.1076	.6924
	Formula 5	.06000	.14795	.686	-.2324	.3524
Aroma						
		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
(I) Formula	(J) Formula	(I-J)			Lower Bound	Upper Bound
Formula 3	Formula 5	-.26000	.16438	.116	-.5849	.0649
	Formula 6	.32000	.16438	.053	-.0049	.6449
Formula 5	Formula 3	.26000	.16438	.116	-.0649	.5849
	Formula 6	.58000*	.16438	.001	.2551	.9049
Formula 6	Formula 3	-.32000	.16438	.053	-.6449	.0049
	Formula 5	-.58000*	.16438	.001	-.9049	-.2551

*. The mean difference is significant at the 0.05 level.

interpreted that there is no difference between local food products in formula 5 and formula 6 based on color.

The results of the post hoc test of local food products based on aroma in formula 3 with formula 5, and formula 3 with formula 6 have a significance value of > 0.05 so it can be concluded that there is no difference in local food products in formula 3 with formula 5 and formula 3 with formula 6 based on aroma. Local food products in formula 5 and formula 6 have a significance value of < 0.05 so it can be interpreted that there is a difference in local food products in formula 5 and formula 6 based on aroma. Data analysis concluded that there were differences in local food products F3, F5 and F6 from the overall assessment (F calculated as 6.033 with sig = 0.003), color (F calculated as 4.252 with sig = 0.016) and aroma ((F calculated as 6.247 with sig = 0.002)), but there was no difference in terms of texture and taste. If analyzed in more detail, it is concluded that there is a difference in local food products between F3, F5, and F6 related to the overall assessment and color, but there is no difference between F5 and F6 regarding the overall assessment and color.

In the aroma assessment, it was concluded that there was no difference between F3, F5, and F6 local food products, but there was a difference between F5 and F6. Products from F5 and F6 are competing products in terms of overall assessment, color, and aroma. This can be caused by the content of staples or fixed ingredients in the form of sweet potatoes, wheat flour, and tapioca from the three formulas tested, namely F3 (40%, 20%, and 10%), F5 (45%, 20%, and 5%), and F6 (35%, 20%, and 15%). The content of the sweet potato used will affect its crude fiber levels, affecting the speed of the glucose metabolism process in the digestive system. The selected products from the limited environmental test will be continued for large-scale testing in the

second year of this series of research activities, namely in Formula 5 (F5) based on laboratory results from the nutritional content in the form of carbohydrate content, total fat, and total energy content are the lowest (average 47.82%, 21.23%, 397.89) and with the highest dietary fiber content which is an average of 9.64%. In addition, based on the hedonic test with the highest scores on the overall aspect, aroma and taste as well as conclusions from the results of statistical tests. The statistical conclusion states that there is a difference in the overall value (F: 6.033, sig 0.003), values based on color (F 4.252, sig 0.016), values based on aroma (F 6.247, sig 0.002) and values based on taste (F 1.841, sig 0.162). Furthermore, the results of the Post Hoc test concluded that there were differences related to the overall value, color, aroma, and taste of F5 or F6 products with F3, and there was no difference between F5 and F6 products.

The conclusion of the selected formula is also based on the consideration of the results of previous studies that the content of nutrients in processed foods from sweet potatoes (Ipomoea Batatas) has an impact on the Glycemic Index (GI) with a low category, so it is eligible for blood sugar level control. GI is the progression of an increase in blood sugar levels after consuming food equivalent to 50 g of carbohydrates (Wezel et al., 2016). Based on the GI, food ingredients are classified into three categories, namely food ingredients with a low GI of <55, medium GI of 55-70, and high GI of >70 (Taiwo Betty et al., 2016). The effect of lowering blood glucose levels in sweet potatoes is related to an increase in adiponectin, an adiposity hormone that functions in the process of insulin metabolism (Taiwo Betty et al., 2016; Rahati et al., 2014). The carbohydrate content of sweet potatoes has a Low Glycemic Index (LGI 51) value, so Consumption of boiled sweet potatoes can minimize postprandial blood glucose spikes, therefore it can be utilized in the management of type 2 diabetes (Asp et al., 1983). This is due to the formation of AGEs (Dietary advanced glycation end products), which are part of normal metabolism, but if the levels of AGEs are too high it can become a pathogen that will bind to the surface of receptor cells or cross-link with body proteins, altering their structure and function.

The pathological effects of AGEs are related to their ability to increase oxidative stress, which is linked to the epidemic of DM and cardiovascular disease. Sweet potato contains high antioxidants to neutralize the malignancy of free radicals that cause various degenerative diseases such as cancer and heart. Other nutrients that are abundant in sweet potatoes are energy, vitamin C, and vitamin B6 which play an important role in maintaining immunity. The mineral content in sweet potatoes such as phosphorus, calcium, manganese, iron, and fiber is soluble to absorb excess fat in the blood (Handayani, Mardiana, et al., 2021).

CONCLUSION

The food to be developed is a large white sweet potato (Ipomoea Batatas), in the form of a sweet potato pie. The selected products from the limited environmental test will be continued for large-scale testing in the second year of this series of research activities, namely in F5 (45% sweet potato, 20% wheat flour and 5% tapioca flour), based on laboratory results from the nutrient content in the form of the lowest carbohydrate, total fat and total energy content (average 47.82%, 21.23%, 397.89) and with the highest dietary fiber content which is an average of 9.64%. In addition, based on the hedonic test with the highest score in the overall aspect, aroma, and taste as well as the conclusion of the statistical test results.

ACKNOWLEDGMENT

Thank you to the Ministry of Education, Culture, Research, and Technology through the DRTPM Program, for the research funding provided, to LP2M Universitas Negeri Semarang for the permission and support, assistance, and administrative support, to the Pawon Sunda MSME Partners and Dapur Amila Ungaran Semarang Regency, and the informants and respondents involved in this research.

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