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Nutritional Characteristic of Snack bar Formulation Based on Snakehead Fish-Sorghum Flour Flakes and Kidney Beans

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Abstract

Proving supplementary food such as snack bar from high in energy, protein and iron local foods (snakehead fish flour, sorghum and kidney bean) can be used as specific nutrition intervention for CED and anemia in pregnant women. This study aimed to analyze and nutritional characteristic of snakehead fish-sorghum flour flakes and kidney bean snack bar. The experimental method was Completely Randomized Design (CRD) with four ratios of snakehead fish flour-sorghum flakes and kidney beans, namely F1 (50%:50%), F2 (60%:40%), F3 (70%:30%) and F4 (80%:20%). Nutritional characteristic of snack bar was analyzed using One Way ANOVA and Duncan's further test. The results showed that the difference ratios of snakehead fish flour-sorghum flakes and kidney beans had significant effect on energy, moisture, carbohydrates, fat, protein, zinc, iron and calcium of snack bar ($p<0.05$). The nutrient content of snack bar F2, F2, F3 and F4 were energy (432,04 kcal; 433,77 kcal; 4329,49 kcal; 437,56 kcal), ash content (3,21%; 3,24%; 3,29%; 3,24%), moisture content (14,46%; 14,71%, 13,35%; 13,72%), fat (20,54%; 21,11%, 19,21%; 21,08%), protein (16,87%; 16,97%; 19,63%; 18,57%), carbohydrates (44,93%; 43,98%; 44,53%; 43,41%), zinc (2,07 mg ; 2,04 mg; 2,07 mg, 2,18 mg), iron (4,35 mg; 6,02 mg; 6,23 mg; 6,76 mg) and calcium (114,21 mg; 130,27 mg; 123,41 mg; 131,83 mg). F4 potentially used as alternative supplementary food for pregnant women with CED and anemia because can be claimed as source of protein and iron product based on food label reference for pregnant women.

Keywords : Anemia, Chronic Energy Deficiency, Kidney Bean, Snakehead Fish Flour, Sorghum Flour

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I. INTRODUCTION

Chronic Energy Deficiency (CED) is a major nutritional problem that occurs in pregnant women in developing countries, including Indonesia, caused by chronic or long-term lack of nutrition, especially energy and protein. CED is characterized by (BMI) <18,5 kg/m2 (underweight) and mid upper arm circumference (MUAC) <23,5 cm (Ministry of Health of the Republic of Indonesia, 2013). Based on the results of Basic Health Research (Riskesdas), the incidence of pregnant women experiencing CED in 2013 was 24,2% and decreased in 2018 by 17,3% (Ministry of Health of the Republic of Indonesia, 2013; Ministry of Health of the Republic of Indonesia, 2018). Even though it has decreased, this shows that Indonesia still has a public health problem in the moderate level category (10-19%) for pregnant women who are at risk of CED. According to WHO (2019), the threshold for public health problems for pregnant women at risk of CED and anemia is <5%. The high prevalence of CED can be influenced by the number of pregnant women who experience a relatively high energy consumption deficit. Based on nutritional status monitoring data, more than half of pregnant women, namely 53,9%, still experience energy deficiency and 51,9% of pregnant women are protein deficient.

CED in pregnant women are at risk of maternal complications, namely anemia with a prevalence of around 48.9% in 2018 (Ministry of Health of the Republic of Indonesia, 2018). CED and anemia in pregnant women interfere with fetal growth, contributing to 800.000 neonatal deaths and 400.000 fetal deaths, as well as 20% of stunted children in the first 2 years of life (Black et al., 2013). CED and anemia in pregnant women can also cause risks and complications for the mother, including not gaining weight normally, bleeding, and contracting infectious diseases (Obai et al., 2016). Meanwhile, the influence of CED on the birthing process can result in premature birth, stillbirths, and babies with low birth weight (LBW) (Patel et al., 2018). In addition, CED in pregnant women can affect the growth process of the fetus and can cause miscarriage, abortion, anemia in babies, intrapartum asphyxia (death in the womb), congenital defects and neonatal death (Mukkadas et al., 2021).

Providing supplementary food to pregnant women with CED provides good results in increasing the size of the mother's mid upper arm circumference (MUAC) and body weight (Pastuty et al., 2018). One way that can be done to optimize these nutrients is to provide supplementary food products designed for pregnant women (Damajanti, 2015; Dewey, 2016). Providing balanced energy-protein supplementation (energy from protein <25%, maximum 20%) can increase birth weight and reduce the risk of stillbirth and small babies during pregnancy (Carducci et al., 2021; Liberato et al., 2013). During pregnancy, mothers need protein intake which plays a role in fetal growth and development. Protein plays an important role in iron transport in the body so that a lack of protein intake results in hampered iron transport (Paputungan, 2016). Potential food ingredients that contain protein are snakehead fish meal and kidney bean flour. Every 100 grams of snakehead fish flour contains 9 mg of iron and 76,9 grams of protein (Nadimin & Lestari, 2019). Hasanal (2017) states that snakehead fish (*Channa striata*) is a source of high protein and contains complete amino acids, zinc, selenium and iron, so it can help increase the body's hemoglobin levels . The protein content in snakehead fish is 79,35 g/100 g (Swandyani et al., 2016). The results of the analysis carried out by Mahardika (2017) show that the nutritional value of

snakehead fish protein is 86,13 g and the nutritional value of iron is 4,43 mg/ etc. Other research showed results in the form of an increase in respondents' hemoglobin levels after being given snakehead fish extract for 14 days (Polibara et al., 2020). The research results of Safitri et al., (2023) also stated that cookies with the addition of yellow pumpkin and snakehead fish had an effect on increasing hemoglobin levels in kidney failure sufferers undergoing hemodialysis.

Sorghum is a type of cereal that is gluten-free, and has a high protein, fiber and iron content. Sorghum flour contains 10,6 g of protein, 3,4 g of fat and 5,4 mg of iron in 100 g (Wahyani & Rahmawati, 2021). Kidney beans are also a source of other nutrients such as fat (15,80%), dietary fiber (3,60%), carbohydrates (49%), and several important minerals, one of which is quite high in iron (Zhang et al., 2023). In research conducted by Wahyani & Rahmawati (2021) the highest iron was in P5, namely using 80% sorghum flour with 2,40 mg iron. In the research of Pasune et al.,(2019) the highest addition of red spinach was 30% in F3 with 5,6 mg iron. In research by Sukmawati et al., (2021), the formulation between sorghum flour and green spinach that can meet iron consumption is F2 40%: 10% with iron per 100 grams of 21,1 mg. According to Yandamuri & Yandamuri (2013) consumption of nuts, including kidney beans, accompanied by consumption of other food sources of iron can improve hemoglobin levels in women who suffer from anemia. The results of research by Umrah and Dahlan (2018) also state that there is an effect of consuming kidney beans on the treatment of anemia in pregnant women. Based on these problems, this research aims to develop a snack bar formulation as an additional food for pregnant women with CED and anemia using snakehead fish flour, sorghum flour and kidney beans, to determine their effect on nutritional characteristics of snack bar products (energy, moisture, ash, carbohydrates, fat, protein, zinc, iron and calcium).

II. METHOD

1. Design, Location and Time

This study was conducted using a completely random design (CRD) with three repetition. The snakehead fish flour and sorghum which used in making this snack bar are processed into flakes and the boiled kidney beans are coarsely chopped to optimize the texture and sensory properties of the product. There were four treatments for developing snack bar with a ratio of snakehead fish flour-sorghum flakes and kidney beans, namely F1 (50%: 50%), F2 (60%: 40%), F3 (70%: 30%) and F4 (80%: 20%). This study was held between June to September 2023 in Nutrition Laboratory of the Faculty of Health Sciences, Universitas Kusuma Husada Surakarta for product development and Saraswanti Indo Genetech (SIG) Laboratory, Bogor for nutrient analysis. This research was conducted after obtaining valid ethical approval from the Dr. Moewardi Surakarta Hospital Research and Health Ethics Commission No. 1.672/VIII/HREC/2023.

2. Material and Tools

This research used several snack bar processing equipment, namely food scales, copper, basins, spatulas, spoons, oven, baking sheets, hand gloves, whisk, knives, cutting boards, and baking paper. Meanwhile, analyze the nutritional content using relevant laboratory equipment. The ingredients for

making flakes consist of snakehead fish flour, sorghum flour, cornstarch, tapioca flour, milk powder (full cream), sugar, salt, vanilla powder, palm oil and moisture. The raw materials used for snack bar consist of dry ingredients such as snakehead fish-sorghum flour flakes, boiled kidney beans, milk powder (full cream), salt, sugar, dates, pumpkin seeds, sunflower seeds, cocoa powder and wet ingredients such as egg white, margarine, melted dark chocolate, peanut butter, coconut milk, liquid vanilla as well as relevant materials used to analyze nutritional content in the laboratory.

3. Research Procedure

a. Snack Bar Formulation

Snack bar formulation which obtained based on modification recipe from Elnovriza et al., (2019) and Nurhusna et al., (2020) through trial and error which shown in Table 1.

Table 1. Formulation of snack bar

Ingredients (g)	F1 (50%:50%)	F2 (60%:40%)	F3 (70%:30%)	F4 (80%:20%)
Snakehead fish-sorghum flakes	75	90	105	120
Kidney beans	75	60	45	30
Milk powder (*full cream*)	20	20	20	20
Salt	2	2	2	2
Egg white	60	60	60	60
Sugar	20	20	20	20
Dates	40	40	40	40
Pumpkin seed	30	30	30	30
Sunflower seed	30	30	30	30
Margarine	25	25	25	25
Dark chocolate	50	50	50	50
Chocolate powdered	10	10	10	10
Peanut butter	30	30	30	30
Coconut milk	10	10	10	10
Liquid vanilla	5	5	5	5
Total	482	482	482	482

b. Nutrient Analysis

All formula of snack bar were analyzed for nutritional properties that is moisture and ash analysis using Gravimetric method, protein analysis using Titrimetric method, lipid analysis using Weibull method, total carbohydrate analysis using by difference method, mineral analysis (iron, zinc and calcium) using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). Energy content was calculated based on the total of kcal/g of protein, fat and and carbohydrates.

4. Data Analysis

The data analysis were processed using computer statistical data processing software. Nutrient analysis result were showed in mean and deviation standard. Nutritional properties data were analyzed using One Way ANOVA (normally distributed based on Shapiro-Wilk test) and further analyzed using Duncan test. The level of statistical significantly different was at $p<0,05$.

III. RESULTS

Table 2. Nutritional characteristics

Nutrient content	F1 (50%:50%)	F2 (60%:40%)	F3 (70%:30%)	F4 (80%:20%)	*p-value*
Energy (kcal)	432,04±1,39^{a,b}	433,77±2,17^{b}	429,49±1,02^{a}	437,56±2,49^{c}	0,05*
Energy from fat (kcal)	184,86±4,41^{b}	189,99±4,59^{b}	172,89±2,34^{a}	189,68±3,38^{b}	0,02*
Ash (%)	3,21±0,06^{a}	3,24±0,05^{a}	3,29±0,56^{a}	3,24±0,06^{a}	0,336
Moisture (%)	14,46±0,21^{c}	14,71±0,15^{c}	13,35±0,13^{a}	13,72±0,10^{b}	0,000*
Carbohydrate (%)	44,93±0,55^{a}	43,98±0,39^{a,b}	44,53±0,01^{b,c}	43,41±0,51^{c}	0,011*
Fat (%)	20,54±0,49^{b}	21,11±0,51^{b}	19,21±0,27^{a}	21,08±0,38^{b}	0,002*
Protein (%)	16,87±0,21^{a}	16,97±0,22^{a}	19,63±0,33^{c}	18,57±0,23^{b}	0,000*
Zinc (mg/100g)	2,07±0,01^{b}	2,04±0,01^{a}	2,07±0,01^{b}	2,18±0,01^{c}	0,000*
Iron (mg/100g)	4,35±0,15^{a}	6,02±0,01^{b}	6,23±0,15^{c}	6,76±0,25^{d}	0,000*
Calcium (mg/100g)	114,21±0,41^{a}	130,27±0,09^{b}	123,41±0,20^{c}	131,83±0,42^{d}	0,000*

Note:
*Significant difference based on the One Way ANOVA test (p<0,05)
^{a,b,c,d} Average values followed by different letters on the same line show significant differences (p<0.05)

Based on Table 3, the energy content of snack bars was 429 kcal – 437 kcal. The highest energy content was F4 (437,56 kcal) and the lower energy content was F3 (429,49 kcal). The moisture content of snack bars ranged from 13,35% - 14,71%. The highest moisture content was F2 (14,71%) and the lowest moisture content was F3 (13,35%). The ash content of snack bars ranged from 3,21% -3,29%. The highest ash content was F3 (3,29%) and the lowest ash content was F1 (3,21%). The protein content of snack bars ranged from 16,87% -19,63%. The highest protein content was F3 (19,63%) and the lowest protein content was F2 (16,87%). The fat content of snack bar ranged from 19,21% - 21,11%. The highest fat content was F2 (21,11%) and the lowest fat was F3 (19,21%). The carbohydrate content of snack bar ranged from 43,41%-44,96%. The highest carbohydrate content was found F1 (44,96%) and the lowest carbohydrate content was F4 (43,41%). The mineral content of snack bar consist of zinc (2,04 mg – 2,18 mg), iron (4,35 mg – 6,76 mg) and calcium (114,21mg – 131,83 mg). The highest zinc content was F3 (2,18 mg) and the lowest zinc content was F2 (2,04 mg). The highest iron and calcium content was F3 (6,76 mg ; 131,83 mg) and the lowest iron and calcium content was F1 (4,35 mg; 114,21 mg).

Based on ANOVA test results, the difference ratios of snakehead fish flour-sorghum flakes and kidney beans had a significant effect on energy, moisture, carbohydrate, fat, protein, zinc, iron and calcium of the snack bars (p<0.05). Duncan's further test results showed that the energy content of F1 was different from F4, F2 was different from F3 and F4, F3 was different from F2 and F4 and F4 was different from all treatment groups. Moisture content test results, F1 was different from F3 and F4, F2 was different from F3 and F4, F3 and F4 were different from all treatment groups. Carbohydrate test results, F1 was different from F3 and F4, F2 was different from F4, F3 was different from F1, F4 was different from F1 and F2. The results of the fat content test, F3 were different from all groups, while F1, F2 and F4 showed no significantly differences. The results of the protein content test, F1 and F2 did not show significantly differences but were different from F3 and F4, F3 was different from F4. The test results for zinc levels, F1 and F3 did not show significantly differences, but were different from F2 and F4, F2 and F4 were different from all treatment groups. The test results for iron and calcium levels showed that there were significant differences in each treatment F1, F2, F3 and F4.

The result showed that snack bar F4 (80% of snackhead fish – sorghum flour flakes : 20% of kidney beans) was chosen as the best treatment based on the nutritional content analysis by considering the needs of specific group such as pregnant women. The nutritional contents of snack bar compared to the standard of supplementary food for pregnant women are shown in Table 4 below.

Table 4. Comparison between nutritional content of snack bars (F4) and supplementary food standard for pregnant women

Nutrient content	Amount per 100 g	Supplementary food standard for pregnant women (per 100 g)*	Supplementary food standard for pregnant women with CED (per 100 g)**	Supplementary food biscuit for CED (per 100 g)*	Food Label Reference	% Food Label Reference
Energy (kkal)	437,56	Min.270	Min.450	487	2510	17,43
Ash (%)	3,24	-	-	-	-	-
Moisture (%)	13,72	-	Maks. 5	2.39	-	-
Carbohydrate (g)	43,41	-	-	-	345	12,58
Fat (g)	21,08	Min.12	Min.20	20,89	84	25,09
Protein (g)	18,57	Min.6	Min. 10	10,14	76	24,43
Zinc(mg/100g)	2,18	-	-	10,41	16	12,50
Iron(mg/100g)	6,76	-	11-18	11,42	34	19,88
Calcium (mg/100g)	131,83	-	250-450	277,53	1300	10,14

Source : * Ministry of Health of the Republic of Indonesia (2017), ** Ministry of Health of the Republic of Indonesia (2016)

Based on Table 4, F4 contains 437,56 kcal of energy, 3,24% of ash, 13,72% of moisture, 43,41 grams of carbohydrates, 21,08 grams of fat, 18,57 grams of protein, 2,18 mg/100 g of zinc, iron 6,76 grams/100 g and calcium 131,83 mg/100g. The energy, fat and protein content fulfil the standards for supplementary food for pregnant women (Ministry of Health of the Republic of Indonesia, 2017). Moreover, the fat and protein content also fulfil the standards for supplementary food for pregnant women with CED, but the moisture, energy, iron and calcium content does not fulfil the standard (Ministry of Health of the Republic of Indonesia, 2016). Snack bar products can be claimed as a source of protein (>20%) and iron (>15%) based on the food label reference per 100 grams for pregnant women (BPOM RI, 2016).

IV. DISCUSSIONS

The study showed that the average energy content of the snack bar had lower energy than snack bars made from sorghum flakes and nuts (red beans and black soybeans), namely 447 kcal and greater than the bilih fish flour fish bar namely between 327-329 kcal (Elnovriza et al., 2019; Nurhusna et al., 2020). Based on the Ministry of Health of the Republic of Indonesia (2016 and 2017), F4 fulfil the minimum energy content of supplementary food for pregnant women of 270 kcal, but does not fulfil the minimum energy content of supplementary food for pregnant women with CED of 450 kcal. This condition can be caused by most of the food ingredients that make up F4, which are high fiber ingredients so that the product's food fiber content is high and carbohydrates that can be digested to be converted into energy by the body tend to be lower, apart from that, 172,89 kcal of energy comes from fat. Hence,

energy content of the snack bar in this study were equal for 17,43% of per 100 g based on the food label reference for pregnant women with energy requirement 2510 kcal (BPOM RI , 2016). The amount of energy content of food depends on other nutrient contents such as protein, fat and carbohydrate. Energy in the body is produced by macronutrients which are converted into energy. Energy is also needed to help the process of muscle movement of the digestive tract. This movement helps the digestive tract to process of iron absorption in the intestine. Lack of energy in pregnant women cause small intestinal microvilli weak so that reduce the iron absorption and raises the risk of iron deficiency anemia in pregnancy (Angraini, 2023).

The moisture content of snack bar in this study of snack bars was range from 13,35% - 14,71%. The standard maximum product which contains 5% moisture and existing supplementary food for pregnant women with CED has a moisture content of 2,39% (Ministry of Health of the Republic of Indonesia, 2016). The research results of Nurhusna et al., (2020) shows that snack bars made from sorghum flakes and nuts (red beans and black soybeans) have a moisture content of 8,93%. The moisture content of fish bars made from bilih flour is higher, namely 28,01%-28,28% (Elnovriza et al., 2019). The condition shows that the results of the analysis of the product's moisture content are higher than the supplementary food standard for pregnant women with CED and biscuits for pregnant women with CED which can be caused by the use of liquid ingredients such as melted chocolate, egg whites, coconut milk, liquid vanilla. In addition, the use of chopped boiled kidney beans contributes to increasing the moisture content. Boiled kidney bean contain 63,1 grams of moisture per 100 grams (Ministry of Health of the Republic of Indonesia, 2018). Moisture content also influences the quality of a food, it is very important in determining the shelf life of a food because it affects the physical, chemical properties, microbiological changes and enzymatic changes. The high moisture content in fish bars produced in all treatments causes this food product to not last long and is easily damaged, this is related to its aw (moisture activity) level. The relationship between moisture content and aw is linear, shown by the tendency that the higher the moisture content, the higher the aw value (Leviana & Paramita, 2017). Food ingredients that have a high aw content or value generally deteriorate quickly, either due to microbial growth or due to certain chemical reactions such as oxidation and enzymatic reactions.

Ash content is one of the factors that determine the quality of food. Determination of ash content, apart from showing the mineral content of food, also aims to determine whether something is good or not processing, knowing the type of ingredients used, as a parameter for the nutritional value of food ingredients (Kartika, 2014). In this study, it shows that the higher the proportion of snakehead fish-sorghum flour flakes, the higher the ash content of the snack bars, which in line with the increase in the mineral content. Compared to Nurhusna et al., (2020), the ash content of snack bar of this study was higher than the snackbar made from sorghum flakes is around 1.82% and lower than the research by Elnovriza et al., (2019) shows the fish bar ash content is 3.34-4.44%. This condition shows that the ash content is not much different from similar bar products.

The protein content of snack bars in this study ranged from 16.87% -19.63%. The minimum protein content for supplementary food for pregnant women of 6 grams and supplementary food for

pregnant women with CED of 10 grams per 100 grams (Ministry of Health of the Republic of Indonesia 2016 and 2017). In addition, the snack bar product in this study had a higher protein content than biscuit products as supplementary food for pregnant women with CED, a protein content of 10.14 grams per 100 grams. The other research results of shows that the protein content in snack bar products made from sorghum flakes and nuts (red beans and black soybeans) contains 15.26% protein (Nurhusna et al., 2020). On the other hand, the fish bar product produced protein levels of 17.30%-22.75% (Elnovriza et al., 2019). This condition shows that the protein content is not much different from similar bar products. Snack bar products can be claimed as a source of protein because they fulfil 20% of the food label reference per 100 grams of product in solid form (BPOM RI, 2016). The protein level depends on the amount of protein rich source added. Protein is needed by the body for growth, building body structures, antibodies and as enzymes to break down amino acids. Protein plays an important role in the transportation of iron in the body. Absorption mainly occurs in the upper part of the small intestine (duodenum) with the help of special protein transporters, namely transferrin and ferritin. Therefore, inadequate protein intake will affect iron transport in the body and cause pregnant women to be at risk of suffering from iron deficiency anemia in pregnancy (Kusumawati & Rahardjo, 2022).

The fat content of this study fulfil the minimum fat content for supplementary food for pregnant women of 12 grams and does not fulfil the fat requirement for supplementary food for pregnant women with CED of 20 grams (Ministry of Health of the Republic of Indonesia, 2016 and 2017). Apart from that, biscuit products as supplementary food for pregnant women with CED contain total fat of 20,89 grams per 100 grams. This condition shows that the fat content in the research bar products is not much different from existing supplementary food products. The fat content in snack bar products made from sorghum flakes and nuts (red beans and black soybeans) contains 21,38% fat (Nurhusna et al., 2020). Research by Elnovriza et al., (2019) on the fish bar product from bilih, produced a fat content of 10.70%-11.99%. Fat source ingredients in product include margarine, coconut milk, peanut butter, chocolate, and full cream milk. Then, snackhead fish are good sources of unsaturated fatty acid. The most biologically active omega-3 fatty acids are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which important for the mother's health in order to meet the needs of foetal growth and development (Coletta et al., 2010)

Carbohydrates are the main source of energy for the human body, providing 4 calories of food energy per gram. Carbohydrates have an important role in determining characteristics of food ingredients, such as taste, color, texture, etc. (Fitri & Fitriana, 2020). The carbohydrate content of this study is lower than snackbar in the study by Nurhusna et al., (2020) which is 48,38% carbohydrates. However, thus is higher than other research which is 32.06%-40.57% (Elnovriza et al., 2019). The more snackhead fish-sorghum flour flakes added, the lower the carbohydrate in the snack bar. Based on the food label reference , the carbohydrates requirement for pregnant women is 345 g (BPOM RI 2016), the total carbohydrate content of 100 g of the snack bars is equal to 12,58% of it.

The results of the analysis do not fulfil the standards for supplementary food for pregnant women with CED and are lower than mineral content of biscuit products as supplementary food for pregnant women with CED (the Ministry of Health of the Republic of Indonesia 2016). This condition can be

caused by food sources of minerals being used in smaller quantities than other food ingredients. Apart from that, the snack bar does not use a fortification premix which is enriched with vitamins and mineral as used in previous CED pregnant women's supplementary food biscuit products. The decrease in mineral availability can be caused by sorghum and beans containing anti-nutritional substances such as phytate which can bind with important minerals to form complex compounds. However, the research results show higher mineral levels than research by Nurhusna et al., (2020) namely iron (2.3 mg/100 g), zinc (1.32 mg/100 g), and calcium (33.06 mg/100 g). Besides, this result is lower than the mineral content of bilih fish bar, i,e 3.29-4,58 mg/100 g (zinc) and 597,61 to 922,23 mg (calcium). Snack bar products can be claimed as a source of iron because they fulfil 15% of the food label reference per 100 grams of product in solid form (BPOM RI, 2016).

Iron is one of the important minerals that the human body needs. During pregnancy, iron needs to increase substantially to support fetoplacental development and maternal adaptation to pregnancy. To meet these iron requirements, both dietary iron absorption and the mobilization of iron from stores increase (Fisher & Nemeth, 2017). Zinc is stored in the liver as zinc-binding protein (metallothionein), to meet the fetal demands and to protect the fetus from zinc deficiency during the immediate postnatal period. During pregnancy, zinc plays a significant role in healthy embryogenesis. Taking zinc during pregnancy helps to slightly reduce preterm births, but does not prevent other problems such as low birthweight babies (Iqbal & Ali, 2021). Calcium is one of micronutrients that plays an important role in pregnancy. Calcium offers modest benefit in terms of preventing preeclampsia and preterm births and improving maternal and infant bone health during pregnancy (Kumar & Kaur, 2017).

V. CONCLUSION

The results showed that the difference ratios of snakehead fish flour-sorghum flakes and kidney beans had significant effect on moisture, carbohydrates, fat, protein, zinc, iron and calcium of snackbar ($p<0.05$). The selected formulation (F4) has potential as supplementary food alternative for pregnant women with CED and anemia which fulfill minimum nutrient standard for supplementary food for pregnant women with CED, contain higher protein that other commercial supplementary food for pregnant women with CED. Snack bar F4 can be claimed as source of protein and iron product. However, snack bar F4 still not fulfill daily mineral requirement especially iron, zinc, and calcium as snacks. For suggestion, fortificant premix addition into the product are necessary to increase mineral content.

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