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RESEARCH

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FORMULASI BISKUIT BAYI PENDAMPING ASI DENGAN SUBSTITUSI KOMPOSIT PATI GARUT, TEPUNG KEDELAI, DAN UBI JALAR BERDAGING JERUK TEPUNG

FORMULATION COMPLIMENTARY FEEDING BABY BISCUITS WITH COMPOSITE SUBSTITUTION ARROWROOT STARCH, SOYBEAN FLOUR, AND ORANGE-FLESHED SWEET POTATO FLOUR

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ABSTRAK

Introduction: Complementary feeding baby biscuits with composite substitution arrowroot starch, soybeans flour, and orange-fleshed sweet potato flour is a public nutrition improvement effort through local food diversity approach. To analyze the effect of substitution of composite flour on the organoleptic, physical properties, nutrient content and digestibility values.
Methods: An experimental study with one factor randomized design that substitution of composite flour is K, P1, P2, and P3. Organoleptic analysis was tested using Friedman and Wilcoxon test, while physical properties, nutrient content and digestibility of protein using One Way ANOVA test.
Result: Substitution of composite flour have no significant effect on the organoleptic quality and increased levels of nutrients content, water absorption, and the level of hardness , while the carbohydrate content decreased. Calcium levels, kamba density and brew study are not significantly different from the control biscuits. Protein digestibility values in the formula biscuits is highest in treatment P3 (85.07%) and the lowest in P2 (77.98%).
Conclusion: Consumption 50 g of P3 biscuits able to fulfill 40.63% energy, 31.31% protein, 31.27% vitamin A, calcium 62%, and 18.75% zinc in infants.

Keywords: complimentary feeding, physical properties, nutrients content, protein digestibility, arrowroot starch, soybean flour, orange-fleshed sweet potato flour
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1. INTRODUCTION

Fulfillment nutrients in infants and toddlers are vital for growth and development. Growth and development that are not optimal in childhood can lead to children of short stature (stunting). Nearly a third of children under five in developing countries experiencing stunting and most of their deficiency are one or more micronutrients. Micronutrients associated with stunting are vitamin A, calcium, and zinc[1,2].

Based on the results of Basic Health Research (Riskesdas) in 2010 the prevalence of stunting in children under five nationally is 35.6%, although down 1.2% compared to 2007 (36.8%) but it has not reached the target nutritional improvement of the National Medium-Term Development Plan (RPJMN) 2015 by 20%. The incidence of stunting if visited by age group, the prevalence of stunting in infants 6-11 months is 32.1% and increased to 41.5% at age 12-23 months[3].

Factors affecting the growth disorders in infants 6-24 months based on results of a survey by Indonesian Ministry of Health are the low quality of complementary feeding and parenting discrepancy given that the adequacy of energy and some micronutrients such as vitamin A, calcium, and zinc are not met. Age 6-24 months is prone to malnutrition due to an increased need up to 24-30%. Therefore, in this period the child was introduced to complementary feeding (complimentary feeding). Provision of complementary feeding with micronutrient density and frequency of administration should be considered appropriate since children aged 6 months to prevent stunting[4,5].

One of the important nutrients in the complimentary feeding is the role of protein for growth and maintenance of body cells[6]. Ministry of Health has established requirements one of which is the nutrient content of protein that must be met in the 100g baby biscuits is 8-12 g[7]. Quality protein foods are not only determined by the protein content in the food, but also on its ease to be digested and absorbed (digestibility and absorpability) and amino acid composition contained therein. Scores of amino acids on the complimentary feeding is quite high around 70 Net Protein Utilization (NPU) or at least 60 NPU[8].

Efforts to improve public nutrition can be done with increased food consumption through food diversification approach[9]. Complementary feeding baby biscuits are usually made from wheat flour or rice flour. Substitution of wheat flour composite aims to increase the content of nutrients and improve the physical properties of materials[10]. Complimentary feeding heavily marketed in the form of porridge and biscuits. The shape of biscuits can train a baby to learn to grasp, have a bite, and able to rehydrate so it can be diluted into baby porridge[11].

Flour composites in this study are a mixture of arrowroot starch, soy, sweet potatoes and yellow. Arrowroot starch is chosen because it has the similar nature and content of nutrients with wheat flour or rice flour. High starch digestibility of 84.35% and protein digestibility of 86%. Nevertheless, the low protein content of arrowroot starch 0.4% and amylose content as low as 29.67 to 31.34%, and a high flower power 54% make softer biscuits, crisp, and easy to digest. However, with a low protein content, it needs to be supplemented by protein content so it can fulfill nutrients in complementary feeding[12].

One of the local food sources of protein that can be used as a complementary feeding is soybean. Protein content is high at 35-38% and 41.7% in the form of flour. In addition, the amino acid content of lysine in soybean meal as high as 400 mg/g of flour so that it can complement flour that have low lysine content[13]. In addition to the high protein content, soybean also contains calcium and zinc that are sufficiently high to complement the nutrients in complimentary feeding[14]. High protein soybean meal increases the absorption of water on the biscuits so that biscuits are more resistant when stored. However, the increase in protein also causes hardness in biscuit texture. Previous studies showed that maximum substitution of soybean flour in biscuit for complementary feeding is 25%[15].

Levels of vitamin A in the complementary feeding can be improved by using the orange-fleshed sweet potato because its levels of ß-carotene are high. β-carotene is pro-vitamin A which usually found in plant foods, of which 6 mg ß-carotene is equivalent to 1 mg retinol (the active form of vitamin A)[16]. Orange-fleshed sweet potato flour containing ß-carotene around 250-500 µg/100 g. Previous studies showed that substitution of orange-fleshed sweet potato flour as much as 20% on sweet bread would increase β-carotene content of 12.1%. But protein content in sweet potato flour is low 0.5 g/100 with limiting amino acid leucine[17]. Substitution of orange-fleshed sweet potato flour in addition to increase the levels of vitamin A can also make biscuits soluble and easy to digest because the content of reducing sugar is hygroscopic[17,18].

Based on this background, the research in the organoleptic, physical properties, nutrient content, and *in vitro* protein digestibility of complementary feeding baby biscuits with the main ingredients flour composite arrowroot starch, soybeans, and orange-fleshed sweet potatoes flours.

2. METHOD

This research, based on scientific area, is carried out in the areas of food production. This study was conducted from June to September 2013 at the Laboratory of Food Science Soegijapranata Catholic University Semarang and Biochemistry and Microbiology Laboratory, Bogor Agricultural University PAU.

This study was an experimental study with a completely randomized design one factor substitution arrowroot starch (*Marantha arundiaceae L*), soybean flour (*Glycine max*) and orange-fleshed sweet potato flour (*Ipomoea batatas*) and the complementary feeding instant baby biscuits. There are four treatments in the form of biscuits control and biscuits with a combination of substitution of wheat flour with arrowroot starch, soy flour and sweet potato flour yellow. Percentage substitution arrowroot starch, soy flour and sweet potato flour yellow is determined by calculating the estimated total nutrient content of raw materials biscuits by considering the levels of protein, energy, vitamin A, calcium and zinc in the MP-ASI in accordance with the Decree of the Minister of Health No.: 224 /Menkes/SK/II/2007 using Nutrisurvey program for Windows 2005[7]. Each treatment was repeated 3 times and organoleptic measurement performed 1 time. The treatment in this study can be seen in Table 1.

Table 1. Formulation MP-ASI Biscuits Garut Substitution Starch, Soybean Meal, and Orange-fleshed sweet potato flour

Formulation	Material Type			
	Wheat flour	Arrowroot starch	Soy flour	Orange-fleshed sweet potato flour
K	100%	0%	0%	0%
P1	20%	40%	15%	25%
P2	20%	30%	20%	30%
P3	20%	35%	25%	20%

Preparation of complementary feeding baby biscuits with substitution arrowroot starch, soybean flour and orange-fleshed sweet potato flour made with cream method which begins by mixing the margarine, eggs and sugar until it forms a homogenous cream and flour then add milk and stir until dough is easy to shape produce. The composition of early complementary feeding baby biscuits before being substituted are egg yolk 12.9%, skim milk 12.9%, margarine 25.8%, refined sugar 12.9%, and wheat flour 55%. Arrowroot starch and soybean flour is derived from the product 'GASOL'. Orange-fleshed sweet potato flour used is the result flouring orange-fleshed sweet potato (*Ipomoea batatas*) from Sabrangan, Mount Pati, Central Java which is made by way of thinly sliced, aerated, dried 3 days, milled, and sieved with a 80 *mesh* sieve.

In this research, formulation and data collection is conducted on dependent variable. Data collected from the dependent variable, among others, the data organoleptic, physical properties, nutrients and protein digestibility value. Organoleptic assessment of color, aroma, texture, and flavor using a hedonic test with 3 A scale is 1 Dislike, 2 = Neutral, and 3 = Like. Organoleptic assessment was performed on 30 untrained panelists that is the baby's mother in the village Wonosari South Semarang. In organoleptic assessment, complementary feeding baby biscuits served in a ready meal.

The physical properties include Kamba density which is the ratio between the weight and volume of biscuits, water absorption is determined by the difference in wet weight by the initial weight of the sample weight compared at 14% moisture content, brew study is the amount of water needed for rehidrate biscuits, and the texture test in this study analyzes the biscuits level of hardness using texture analyzer[19]. Nutritional content includes levels of a protein with the *Kjeldahl* method[20], fat with Soxhlet method, calculating carbohydrate with the method of carbohydrates by difference, biscuits energy obtained by converting the amount of protein, fat, and amount of carbohydrates into energy, ß-carotene were analyzed using spectrophotometer method, and calcium and zinc using Atomic Absorption Specthrophotometer (AAS)[21]. Meanwhile, serving size is determined based on the fulfillment of third adequacy of protein intake in a single baby. Contributions per serving complementary feeding baby biscuits are determined based on the results of the analysis of the levels of energy, protein, calcium, and zinc compared with the RDI (Recommended Daily Intake) of 7-12 months baby[22,23]. Value biscuits protein digestibility were analyzed using in vitro with multienzyme method.[13]

Data were analyzed using SPSS 16 for Windows. Effect of variation in the percentage of substitution arrowroot starch, soybean flour and sweet potato flour yellow using *Friedman* test and *Wilcoxon* test further. Meanwhile, the data of physical properties, nutrient content and digestibility of the protein value of complementary feeding baby biscuits tested with *One Way Anova* with a degree of confidence of 95%, followed by the *Tukey Test Posthoc* to know the difference of protein digestibility values between treatments.

3. RESULTS AND DISCUSSION

3.1 Organoleptic

Organoleptic biscuits with composite substitution arrowroot starch, soybean and orange-fleshed sweet potato flour using hedonic test (level A) with 30 untrained panelists from the infant's mother in South Semarang Wonosari area. The results of the analysis of the reception of color, aroma, texture, and flavor biscuits substitution arrowroot starch, soy flour, and orange-fleshed sweet potato flour are presented in Table 2.

Tabel 2. Mean Acceptance of Color, Aroma, Texture and Flavor Biscuit Starch Substitution Garut, Soybean Meal, and Orange-fleshed sweet potato Flour.

Formulation	Color		Aroma		Texture		Flavor	
	Mean	Info	Mean	Info	Mean	Info	Mean	Info
K	2.60 ± 0.56	Like	2.60 ± 0.56	Like	2.50 ± 0.50	Like	2.50 ± 0.57	Neutral
P1	2.50 ± 0.57	Neutral	2.60 ± 0.50	Like	2.43 ± 0.63	Neutral	2.30 ± 0.60	Neutral
P2	2.53 ± 0.63	Like	2.50 ± 0.63	Neutral	2.43 ± 0.63	Neutral	2.37 ± 0.67	Neutral
P3	2.47 ± 0.68	Neutral	2.67 ± 0.48	Like	2.40 ± 0.68	Neutral	2.23 ± 0.77	Neutral
	p = 0,50		p = 0,54		p = 0,86		p = 0,26	

3.1.1 Color

Based on data analysis, the most preferred color biscuits are biscuits control (K), although the results of the analysis showed substitution biscuits arrowroot starch, soy flour, and orange-fleshed sweet potato flour was not significantly different compared to control biscuits (p = 0.50). In addition to control biscuits, biscuit color with 20% substitution of soybean meal, orange-fleshed sweet potato starch and arrowroot starch 30% 30% (P2) is also preferred. Meanwhile, P1 and P3 biscuit color is neutral when assessed by panelists. All biscuits are acceptable by the panelists.

Substitution of arrowroot starch, soy flour, and orange-fleshed sweet potato flour produces biscuits with the color of yellow until golden brown. Acceptance of color in biscuits with various substitution percentages between arrowroot starch, soybean flour, and orange-fleshed sweet potato flour biscuits is not significantly different from controls. This is because the color of soybean flour is light yellow, while the color of orange-fleshed sweet potato is pale yellow. However, arrowroot starch has a white degree similar to flour which is 74.2%[12]. The higher the percentage substitution of soy flour and orange-fleshed sweet potato flour biscuits, it will produce increasingly brownish yellow.

The color brown is also generated from the Maillard reaction is the result of non-enzymatic browning between the amino acid lysine in soybean meal with a hydrolysis group of reducing sugar contained in the orange-fleshed sweet potato flour in heat causing foodstuffs to turn brown in color. Maillard reaction may occur due to the biscuit baking process with temperatures above 115 ° C[24].

3.1.2 Aroma

Aroma control biscuits, biscuits with P1 and P3 formulation preferred by the panelists while the biscuits with the formulation P2 rated neutral by panelists. Based on the analysis of data, formulation substitution biscuits with arrowroot starch, soybean flour, and orange-fleshed sweet potato flour biscuits are not significantly different from controls (p = 0.54).

Baby biscuits have a fragrant aroma. Making biscuits in this study using vanilla to reduce the unpleasant aroma derived from soybean flour. The process of soaking and heating during the making of soybean flour can also disable the lipoxygenase enzymes that cause unpleasant odors in soybean[25]. Aroma that is generated from arrowroot starch is neutral[26]. Result from organoleptic test showed that the higher the number of substitutions in the orange-fleshed sweet potato flour, the lower the panel like it as fragrant aroma of biscuits is reduced.

3.1.3 Texture

Texture control biscuits and biscuits with substitution formulation arrowroot starch, soybean flour, and orange-fleshed sweet potato flour rated neutral by panelists. Based on the analysis of data, biscuits substitution arrowroot starch, soy flour, and orange-fleshed sweet potato flour are not significantly affect the biscuit texture (p = 0.86). Acceptance among biscuit texture substitution arrowroot starch, soy flour, and orange-fleshed sweet potato flour biscuits are not significantly different, including visual control because the control biscuits and biscuit texture with formulation substitution arrowroot starch, soy flour, and orange-fleshed sweet potato flour are all the same.

Biscuit produced both control and biscuits with various formulations have dense and crunchy texture. It is influenced by the fat that has the effect of shortening in baked goods such as biscuits, pastries, and bread to be crisper. Fat content in biscuits comes mostly from butter and egg yolks. In addition, the fat content of the flour, soybean, arrowroot starch and sweet potato starch yellow sequentially is 1%, 16.7%, 0.2%, 2.01%.[13,18] Fat will break its structure then coat the starch and gluten, so that the resulting biscuits were crunchy. Fat can improve the physical structure such as development, softness, texture, and aroma. In addition, products with high protein content also require high fat to prevent a decrease in water absorption. If the water absorption decreases, it will produce a product with a hard and dense texture[27].

In addition, the texture of biscuits produced is sandy and soft. It is also influenced by the degree of fineness of arrowroot starch, soybean flour, and orange-fleshed sweet potato flour. Soybean flour and arrowroot starch is a product of the brand of food 'GASOL' with a 100 *mesh* sieve, while the orange-fleshed sweet potato flour used 80 *mesh* sieve. Based on organoleptic test, the higher the substitution of soybean flours in biscuits, the lower the panelists' preference. This because the biscuits will be denser in texture and less crisp which is due to the high protein content that can affect density of biscuits.

3.1.4 Flavor

Flavor of control biscuits and biscuit baby with formulation substitution arrowroot starch, soybean flour, and orange-fleshed sweet potato flour rated neutral by panelists. Based on the analysis of data, formulation substitution arrowroot starch, soybean flour, and orange-fleshed sweet potato starch as raw material substitution baby biscuits are not significantly affect the taste preferences of biscuits ($p = 0.26$). However, biscuits with 25% substitution of soybean meal, orange-fleshed sweet potato flour 20% and 35% arrowroot starch (P3) showed significant difference with control biscuits because the resulting flavor is rather bland.

Baby biscuits produced either control or biscuits with various formulations have sweet and savory flavors. The taste can be caused by several factors such as the use of support material as well as the taste of the raw material itself. In this study, the addition of the type and amount of support material for the third formulation is the same baby biscuits. The resulting flavor of arrowroot starch is bland[28]. The usage of margarine in the making produce savory biscuits while the usage of sugar baby can produce a sweet taste. In addition, it can also improve aroma, color, and texture of the biscuits. Organoleptic test data showed that the more orange-fleshed sweet potato flour substitution in baby biscuits, the increasing fondness for the taste by panelists as it is sweeter.

3.2 Physical Properties

The biscuits physical properties were analyzed by Kamba density, water absorption, brew study and test textures. The results of the analysis of biscuit physical properties can be seen in Table 3 below

Tabel 3. The mean MP-ASI Physical Properties Baby Biscuit Starch Substitution Garut, Soybean Meal, and Orange-fleshed sweet potato Flour

Formulation	Mean physical properties			
	Water Absorption (%)	Texture Test (gf)	Kamba Density (gml)	Brew Study (ml)
K	110.00 ± 3.43^{b}	508.00 ± 100.80^{b}	0.63 ± 0.06	35 ± 5
P1	112.73 ± 7.48^{b}	935.97 ± 210.35^{a}	0.61 ± 0.02	30 ± 5
P2	122.27 ± 5.07^{b}	1024.24 ± 95.79^{a}	0.63 ± 0.03	25 ± 5
P3	138.03 ± 5.48^{a}	1155.02 ± 14.85^{a}	0.62 ± 0.04	35 ± 5

Description: numbers followed by different superscript letters (a, b, c, d) indicate significant difference ($p < 0.005$)

Based on Table 3 above, the substitution of arrowroot starch, soybean flour, and orange-fleshed sweet potato flour significantly increase water absorption and hardness of biscuits. Water absorption and protein content influenced the level of hardness in the biscuits. Water absorption is one of the hydration properties of proteins which is the protein's ability to hold water in a food system. The higher the protein content in the biscuits, it will increase water absorption. The physical properties associated with the shelf life of biscuits. Good quality biscuits are biscuits with high water absorption so that the biscuits are more durable when stored[15]. Substituted arrowroot starch, soybean flour, and orange-fleshed sweet potato flour significantly increase water absorption. Biscuits P3 with the highest protein content (10.02%) have the highest water absorption which is 138.03%.

A high amount of protein can caused an imbalance in flour to bind water, thus disrupt the gelatinous process. The result is a hardened product. The protein sources in the biscuits mostly come from soybean flour with 41,7 g/100 g protein. Soybean flour usage is restricted to a maximum of 25% because it harden the biscuits. Hardeness of the biscuits related to the crispiness. Crispiness of the biscuits decreased with the increasing hardeness. Baby biscuits with hardeness of 948-1196 gf have a moderately hard texture and is not easily shattered, earning its place as a finger food. P3 biscuits 25% substituted with soybean flour have the highest hardeness by 1155,02 gf and still fulfill the hardeness rate of baby biscuits. Seen from its water absorbance and hardeness rate, P3 biscuits have a good physical because they are more durable when stored and doesn't crushed easily so it can be used as a finger food. But, seen from the kamba density and brew study of the cracker P3 isn't differ than control.

Kamba density showed a comparison of the weight to the volume. Complementary breast feeding for the baby should be kamba so that the baby doesn't gorged easily because of a small stomach capacity. P1 biscuits substituted with 40% arrowroot flour have the smallest kamba density, 0,61 g/ml. Arrowroot flour are easily expand , 54% so that the baby biscuits have a large volume. The more arrowstrach substituted, the more volume of the biscuits, which lowered the kamba density of the biscuits.

Brew study is a definition of ratio between water added with the amount of food in every servings. P2 biscuits need the least water to be added, 25 ml/. The amount of water added should not be too much because it can make the baby quickly gorged before the energy filled. The lower the solubility of the biscuits, the least water used to rehydrate.

Solubility of the biscuits can decreased because of the higroscopically reducing sugar. Orange-fleshed sweet potato contain 43,89% reducing sugar. P2 biscuits with a substitution of 30% orange-fleshed sweet potato need less water than P1 biscuits with a substitution of 25% orange-fleshed sweet potato and P3 with a substitution of 20% orange-fleshed sweet potato. This result showed that the higher substitution percentage, the lower solubility of biscuits the least water needed to rehydrate biscuits.

3.3 Nutrient Content

The analyzed nutrient content are protein, fat, carbohydrate, calorie, calcium, ß-karoten, and zinc. The result from analyzing content of nutrient in biscuits that substitute with arrowroot, soybean and orange-fleshed sweet potato can be seen on table 4 below

Table 4. Average Nutrient Content of Complementary Breastfeeding with Baby Biscuits subsituted with Arrowroot, Soybean, and Orange-fleshed sweet potato Flour

Nutrient Content	Formula			
	K	P1	P2	P3
Protein (%)	8,61 ± 0,21^{c}	9,10 ± 0,04^{bc}	9,50 ± 0,31^{ab}	10,02 ± 0,38^{a}
Lemak/Fat (%)	26,13 ± 0,31^{b}	27,59 ± 1,36^{ab}	28,18 ± 0,60^{a}	28,98 ± 0,07^{a}
Karbohidrat (%)	57,04 ± 0,99^{a}	55,22 ± 2,03^{ab}	53,11 ± 0,52^{b}	52,86 ± 0,49^{b}
Energi (kkal/100 g)	497,77 ± 1,36^{b}	505,53 ± 4,62^{a}	504,08 ± 2,41^{ab}	512,30 ± 3,27^{a}
β-karoten (mg/100 g)	0,033 ± 0,004^{c}	0,099 ± 0,020^{b}	0,153 ± 0,027^{a}	0,064 ± 0,016^{c}
Kalsium (mg/100 g)	247,33 ± 26,65	266,67 ± 37,43	287,67 ± 82,04	310,00 ± 67,64
Zinc (mg/100 g)	0,80 ± 0,12^{c}	0,90 ± 0,12^{bc}	1,29 ± 0,23^{ab}	1,50 ± 0,17^{a}

Note: numbers followed by a different superscript letters (a,b,c,d) showed a real difference ($p<0,005$)

Based on table 2, the subtitution flour from arrowroot, soy bean, and yellow potato on complementary breast feeding baby biscuits significantly increase protein, fat, and zinc whereas lowering the carbohydrate content. Calcium content in all the subtitution biscuits not significantly different from the control biscuits. P3 biscuits have the highest content of protein, fat, calorie, calcium, and zinc, however P3 have the least content of carbohydrate and ß-karoten than P1 and P2.

Adequacy of proteins is a major consideration to determine serving, because protein is needed for growth. Serving determine by biscuits P3 with highest protein content, 10,02%. Serving biscuits P3 meet 1/3 protein that needed (16 g) that is 50 g (2 pcs biscuits). Contribution per serving complementary breast feeding baby biscuits determined from analizing the results calorie, protein, calcium, and zinc content compared to AKG (Angka Kecukupan Gizi) 7-12 month old baby. Contribution per serving complementary breast feeding baby biscuits subtituted by arrowroot, soybean, and yellow potato flour, can be seen from table 5 below:

Tabel 5. Contribution per servings of complementary breast feeding baby biscuits with a substitution from arrowroot, soy bean, and yellow potato flour to nutritional adequacy in 7-12 months baby

	Formulation	K	P1	P2	P3
Energy	Amount per serving (kkal)	248,88	252,76	252,04	253,94
	AKG (kkal	625	625	625	625
	% nutritional adequacy	39,82	40,44	40,32	40,63
Protein	Amount per serving (g)	4,3	4,55	4,75	5,01
	AKG (g)	16	16	16	16
	% nutritional adequacy	26,87	28,44	29,68	31,31
Vitamin A	Amount per serving (µg)	122,5	128	132,55	125,11
	AKG (µg)	400	400	400	400
	% nutritional adequacy	30,62	32	33,14	31,27
Calcium	Amount per serving (mg)	123,66	133,33	143,83	155
	AKG (mg)	250	250	250	250
	% nutritional adequacy	49,46	53,33	57,53	62
Zinc	Amount per serving (mg)	0,4	0,45	0,64	0,75
	AKG (mg)	4	4	4	4
	% nutritional adequacy	10	11,25	16,12	18,75

Protein content of all biscuits meet the spesification of complementary breast feeding baby biscuits, equal to 8-12%. The protein comes from soybean flour that have 41,7 g/100 g. The more soybean flour used to subtitute, the protein content will be higher. P3 biscuits with a subtitution of 25% soybean flour have the highest content of protein which is 10,02% compared to P1 biscuits with a subtitution of 15% soybean flour and P2 biscuits with a subtitution of 20% soybean flour.

The quality of protein in food product not only seen from the content of protein but also from the content of essential amino acid. Amino acid that separate between soybean flour, cereal and tuber corps (arrowroot and yellow potato flour) is lysine, methionine, and leucine. Biscuits with subtitution of arrowroot, soybean, and yellow potato flour compared with FAO reference as a standard content amino acid in food product can be seen in Table 6 below[13,31].

Tabel 6. Amount of amino acid Lysin, Methionin, and Leucyn in complementary breast feeding baby biscuits with a substitution of from arrowroot, soy bean, and yellow potato flour compared with FAO pattern

Amino Acid	Formula				FAO Pattern
	K	P1	P2	P3	
Lisin (Lycin)	234,37	267,97	276,58	285,19	270
Metionin (Methionin)	138,47	118,11	118,66	119,29	144

Leusin (Leucyn)	433,75	384,96	395,38	405,81	306

Based on table 5, the content of lysin and leucine in biscuits with a subtitution arrowroot, soybean and orange-fleshed sweet potato is higher than FAO pattern, whereas methionine lower. P3 biscuits have content of amino acid lysine, methionine, and leucine higher than biscuits P1 and P2. However the content of methionine and leucine lower than control biscuits. This happens because the content of methionine and leucine from tuber corps is lower than flour made of cereals.

Total energy from a food product are affected by fat, protein, and carbohydrate content in biscuits. Fat can be converted to 9 kcal, protein and carbohydrate can be convert to 4 kcal each. All the fat content in all biscuits is 10-18% higher than the fat content on complementary breast feeding baby biscuits. This caused by the content of margarine that is 25,8%. Fat in the biscuits function as shortening for making the texture and the savory of the biscuits, therefore reducing the content of fat can make the biscuits tough and lose it's savory.

Ingredients to make biscuits with a high fat content aside margarine is egg yolk and soybean. The margarine and egg yolk that is used were all in same amount for all of biscuits formula, therefore the escalation of fat content can be affected by percentage of substitution soybean flour. 15% soybean flour substitution on composite flour formula with 20% arrowroot flour in making noodles, resulting in an increased protein and fat content but a decrease in carbohydrate content. P3 biscuits with highest protein and fat content have the lowest carbohydrate content which only 52,86%. Although having the carbohydrate decrease, the total calories of baby biscuits still meet the requirement complementary breast feeding baby biscuits by 400 kcal/100g.

P3 biscuits have the highest energy which is 507,89 kcal/100g. Total energy P3 biscuits per serving contribute 40,63% energy sufficiency. Based on WHO research breast feed on 7-12 month baby contributes an energy of 413 kcal so that sufficient energy can be met by the provision of breast feeding and 2 serving of biscuits.

The source of ß-caroten on biscuits come from yellow potato flour with 250-500 μg/100 g. P3 biscuits with 20% yellow potato flour have lower ß-carotene content than P1 biscuits with 25% yellow potato flour and P2 biscuits with 35% substitution. P2 have the highest ß-carotene content which is 153,33 μg/100 g. The higher the amount of yellow potato flour, the higher ß-carotene content in baby biscuits.

ß-carotene content can be reduced and spoiled from the making process. The double bond structure of ß-carotene is easy to oxidated because of the heating process. The process of making bread with a substitution of yellow potato flour with a baking process on ±160 °C for 15 minutes reduce ß-carotene by 68,5%. The reduction is greater if there is an increase in temperature and time of baking.

ß-carotene is a provitamin A found in plant foods, where 6 μg β-carotene same as 1 μg retinol (active form of vitamin A). β-carotene content in all biscuits haven't met the requirement complementary breast feeding baby biscuits which must met 250-266,7 μg/100 g, Vitamin A source not only come from ß-carotene in plant foods but also retinol from animal based food, which in this research couldn't analyzed because the research only measured ß-carotene. Retinol source in biscuits comes from skimmed milk, egg yolk and margarine with ratio 12,9%, 12,9% and 25,8%. Based on secondary data, retinol content on three food ingredients are 39 μg, 606 μg, 606 μg/100 g. The total of retinol from three ingredients are 239,55 µg/100 g. The summarize of retinol comes from the conversion of ß-carotene with retinol from the three ingredients. The total of retinol in biscuits can be seen on table 7 below.

Table 7. Total retinol in complementary breast feeding baby biscuits

Formulasi	Retinol dari konversi β-karoten (µg/100 g)	Total retinol biskuit µg/100 g*
K	5,45	245
P1	16,45	256
P2	25,55	265,1
P3	10,67	250,22

Note : * the total sum of retinol in the conversion of β-karoten with retinol from skim milk, egg yolk, and margarine (239,55 µg/100 g)

Based on Table 6 above, the level of vitamin A in biscuit P3 had already met the specification of a baby biscuit as a complementary breast-feeding that is a minimum of 250 µg/100 g. Levels of vitamin A per serving in biscuits P3 contributed 31.27%. A contribution of vitamin A from the complementary breast-feeding is at least 60% of the RDI, which is 400 µg/100 g[7]. Consumption of two servings of biscuits have met the adequacy levels of vitamin A for a baby.

All biscuits can meet the specifications of a baby biscuit as the complementary breast-feeding calcium levels that is 200-400 mg/100 g. Meanwhile, the composite flour substitution significantly increases the levels of zinc in biscuits. Although zinc levels increase, it has not met the specifications of complementary breast-feeding baby biscuit that is 2.5-3.0 mg/100 g[7].

Calcium and zinc in the biscuits come from skim milk, egg yolk, and soy flour. The amount of skim milk and egg yolks that used are equal in all formulations thus that affects the increase of calcium and zinc is soy flour. Soy flour has 346 g/100 g of calcium and 4 g/100 g of zinc[14]. The higher substitution levels of soy flour in biscuits increases the level of calcium and zinc. Biscuits P3 with 25% soy flour substitution had the highest levels of calcium and zinc that are 310 mg/100 g and 1.50 mg/100 g. Calcium and zinc per serving biscuits P3 contributed 62% and 18.72% of adequacy. Consumption of two servings of biscuits had adequate levels of calcium for a baby, while zinc was not fulfilled. This is due to the substitution of soy flour in biscuits is limited because it can make the baby biscuit texture hard. Maximum substitution of soy flour in composite flour to have an acceptable texture by consumers is 25%[1].

Soybeans contain anti-nutrition factors such as antitrypsin and phytic acid that can bind to minerals, especially calcium, zinc, iron, and magnesium so its bioavailability is low. Anti nutrition can be decreased by the heating process. The decrease of anti nutrition in soybean can reach 20% in the heating process with a temperature of 121°C for 5 minutes, anti nutrition levels will continue decreasing with the increase in processing time. Therefore, anti nutrition factor is not an issue in the soybeans usage as a source of protein and calcium and zinc supplies on complementary breast-feeding[13,14].

3.4 Protein Digestibility Value

The analysis results of baby biscuits protein digestibility values with substitution of arrowroot starch, soy flour and orange-fleshed sweet potato flour can be seen in Table 8.

Table 8. The analysis results of baby biscuits protein digestibility values

Treatment	Protein Digestibility Value (%)
K	85,64 ± 1,45 a
P1	81,84 ± 1,63 ab
P2	77,98 ± 3,60 b
P3	85,07 ± 2,13 a
	p = 0,014

Note: a different letter behind the figure shows a different real with Tukey test α=0.05

Based on the data analysis, substitution treatment of arrowroot starch, soy flour and orange-fleshed sweet potato flour significantly affected protein digestibility values in baby biscuits (p = 0,014) . Statistically, P1 and P3 biscuits protein digestibility values were not different from the control biscuits (K), while the protein digestibility value of biscuits with substitution of 30% arrowroot starch, 20% soy flour and 30% orange-fleshed sweet potato flour (P2) which is 77.98% significantly different from the control biscuits (K). Protein digestibility values in baby biscuits with substitution of arrowroot starch, soy flour and orange-fleshed sweet potato flour can be influenced by several factors, such as anti-nutrition factors and food material processing[13].

Anti-nutrition in substituted biscuits by arrowroot starch, soy flour and orange-fleshed sweet potato flour may still exist such as antitrypsin and phytic acid, although anti-nutrition can be decreased by the heating process. Decrease of antitrypsin contained in soy may reach 20% in the heating process for 5 minutes at a temperature of 121°C, while phytic acid can be reduced by 13% in the process of soaking and heating soy flour. Similarly, trypsin inhibitor in soybean and orange-fleshed sweet potatoes can be decreased when boiled, baked, and process with heat and pressure. The decrease in trypsin inhibitors can reach 20% on heating for 30 minutes and then will continue decreasing with the increase of processing time[34]. Arrowroot starch substitution did not affect the protein digestibility value for protein digestibility value of arrowroot starch is 86%, but it contents only 0.4 % of protein[12]. Therefore, protein digestibility value were lower in the treatment biscuits because anti-nutrition derived from soy flour and orange-fleshed sweet potato flour had not completely disappeared.

Meanwhile, biscuits with substitution of 30% arrowroot starch, 20% soy flour and 30% orange-fleshed sweet potato flour (P2) had the lowest digestibility value 77.98% as biscuits P2 had the highest percentage of orange-fleshed sweet potato flour substitution. Orange-fleshed sweet potatoes contain high reducing sugar as a result of the gelatinization process during the starch production process. Hydrolysis of starch became reducing sugar has happened during gelatinization process. During processing, 42-95% starch contained in orange-fleshed sweet potato changed to 72-99% maltose and the rest changed to dextrin. In addition there are also other sugars such as fructose, glucose and raffinose[35]. Reducing sugar contained in the orange-fleshed sweet potato could bind to soy flour amino acid called Maillard reaction.

Maillard reaction starts with the reaction between amino acids and reducing sugars to form an unstable Schiff bases. Products unstable Schiff bases will undergo a series of Melanoidin reactions produce a fairly stable of Amadori product. Therefore, the Maillard reaction plays a role in the decrease of protein digestibility value.

In addition, the Maillard reaction will also cause discoloration of the product and flavor[13]. Discoloration due to Maillard reactions on baby biscuits substitution of arrowroot starch, soy flour and orange-fleshed sweet potato flour could be proved from the change of them becoming more brown as the increasing substitution of soy flour and orange-fleshed sweet potato flour biscuits like P2 biscuits. The higher substitution of orange-fleshed sweet potato flour in baby biscuits would cause the higher Maillard reaction and the decrease of protein digestibility values.

4. CONCLUSION AND SUGGESTION

4.1 Conclusion

a. The panelists can accept color, aroma, texture, and taste of the instant baby biscuits with substitution of arrowroot starch, soy flour and orange-fleshed sweet potato flour.
b. Consumption of two servings of biscuits with substitution of 35% arrowroot flour, 25% soybeans, and 20% orange-fleshed sweet potatoes can meet the nutritional adequacy of infant except zinc. In addition, the biscuits have good physical properties for water absorption and the level of solidity.
c. Substitution of arrowroot starch, soy flour and orange-fleshed sweet potato flour significantly affect protein digestibility values of baby biscuits. Biscuits with protein digestibility values similar to the control biscuits are biscuits with substitution of 25% soybean meal, 20% orange-fleshed sweet potato flour, and 35% arrowroot starch (P3). However, the value of the protein digestibility with substitution of arrowroot starch biscuits is 30%, soy flour is 20% and sweet potato flour yellow 30% (P2) which 77.98% significantly different from the control biscuits (K).

4.2 Suggestion

1. Biscuits that recommended as complementary of breast-feeding are biscuits with substitution of 35% arrowroot flour, 25% soybeans, and 20% orange-fleshed sweet potato with a serving of 50 g (2 biscuits). Biscuits are divided into two servings when babies consume only breast milk.
2. It is required biscuit processing techniques with the optimal temperature and time in order to obtain an acceptable baby biscuits by panelists with high nutrient content and high protein digestibility values and with good physical properties.

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