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Characteristics of Instant Baby Porridge With a Pre-Cooked Flour Formulation (White Rice, Yellow Corn, Red Beans and Snakehead Fish)

Untsa Qurrota Aina[1], *Rosida* [2*]

[1,2]*Food Technology Department, Faculty of Engineering, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya, Indonesia*

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CORRESPONDING AUTHOR

*E-mail: rosidaupnjatim@gmail.com

ABSTRACT

Stunting prevention can be done by providing Complementary Foods (MP-ASI) to babies aged 6 months and above. Baby porridge is generally made from rice, to increase the nutritional content of instant baby porridge, yellow corn is substituted. Red beans and snakehead fish have high protein content to increase the nutrition of instant baby porridge. The pre-cooking process on flour needs to be done to increase water absorption and solubility in instant baby porridge products. The purpose of this study was to determine the effect of differences in pre-cooked flour formulations (white rice, yellow corn, red beans and snakehead fish) on the physicochemical and organoleptic characteristics of instant baby porridge. The study used a simple Completely Randomized Design (CRD) with one factor, with treatments P1, P2, P3, P4, P5 and P6. Data analysis using ANOVA and further testing of 5% DMRT was carried out if there was a significant difference. Instant baby porridge with pre-cooked flour formulation P3, with a water content of 3.66%, ash content of 2.91%, fat content of 11.88%, the protein content of 21.64%, carbohydrate content of 59.88%, starch content of 28.41%, crude fibre content of 2.80%, bulk density of 0.49 g/ml, water absorption capacity of 222.75%, solubility of 28.88%, and organoleptic test of colour 3.44 (neutral), aroma 3.36 (neutral), taste 3.64 (like), and texture 3.76 (like).

1. INTRODUCTION

1.1 Research Background

Stunting is a growth disorder that occurs in children due to lack of nutritional intake which causes children to have a height that is not following their age. The cause of stunting in children is due to a lack of macro and micronutrient intake in children, most children who experience stunting have a pattern of nutrient consumption in the form of energy, fat, protein, carbohydrates, zinc and iron which tends to be low based on AKG [1]. MP-ASI can be porridge made from a mixture of ingredients such as cereals, tubers, nuts, milk, fish, fruit or other suitable ingredients [2].

1.2 Literature Review

White rice (Oryza sativa L.) is the main source of carbohydrates and is the most widely consumed in the world, especially in Indonesia [3]. White rice is a staple food in the world, especially in Indonesia. White rice has a carbohydrate content of 77.1g/100g [4]. The largest component of white rice is starch, which is around 80-85%. Rice starch has a composition of two carbohydrate polymers, including amylose (starch with a straight chain structure) and amylopectin (starch with a branched chain

structure) which are composed of several series of units (glucose) that are interconnected [3]. Based on its amylose content, rice is divided into 3 types, glutinous rice or rice with low amylose (8-20%), medium (21-25%) and high (>25%) [5].

Yellow corn is a cereal that has a high carbohydrate content after rice. The carbohydrate content in corn is 73-75% higher than the content of wheat and millet which is only 64%. The endosperm of corn seeds also contains calcium, phosphorus, iron, nasturtium and potassium [6]. Yellow corn is also rich in starch and vitamin A [7].

Red beans (Phaseolus Vulgaris, L.) are a type of legume that has been widely cultivated in Indonesia. Red beans are a type of bean that is rich in protein and fiber [8]. The protein content of red beans is lower when compared to soybeans and green beans. The protein content of red beans is lower (22.1%) compared to soybeans (40.4%) and green beans (22.9%). The advantage of red beans compared to other beans is their high iron content. Dry red beans per 100 grams contain 10.3 mg [4]. Red beans also contain fat components consisting of saturated fatty acids and unsaturated fatty acids. Saturated fatty acids in red beans are 19%, while unsaturated fatty acids are 63% [9].

Snakehead fish is a freshwater fish that has a high nutritional content. Snakehead fish have low collagen protein content. The low collagen protein in snakehead fish causes snakehead fish to have a more tender meat texture and has a digestibility of up to 90%. Snakehead fish has complete nutritional content including protein, albumin, complete amino acids, zinc, selenium, and iron [10]. Snakehead fish has a high protein content (22.5%) compared to other fish such as alum fish (9.7%), catfish (17.7%), carp (16%), and milkfish (20%) [10].

The pre-cooking process is a physical modification carried out to improve the characteristics of flour. The principle of pre-cooking is to cook starch above its gelatinization temperature and then dry it, so that when exposed to water the starch will easily dissolve in water without the need to cook it again. Pre-cooking treatment can improve the functional properties of flour. Pre-cooked flour has properties that are easily dispersed by water and can form a stable suspension. In addition, pre-cooked flour also has high digestibility and solubility [11].

1.3 Research Objective

Red bean flour has a higher protein content when compared to other flours [12]. The protein content of instant baby porridge with arrowroot flour increases with the addition of red bean flour [13].The addition of snakehead fish flour to instant baby porridge can increase the protein content of the porridge. The more substitutions of snakehead fish flour, the higher the protein content of the instant baby porridge [14].

Therefore, in this study, instant baby porridge was made with a formulation of pre-cooked flour (white rice and yellow corn) as a source of carbohydrates, and pre-cooked flour (red beans and snakehead fish) as a source of protein in instant baby porridge to prevent stunting. With the addition of these ingredients to baby porridge, it is expected to increase the nutritional content of the porridge and can meet the nutritional needs of toddlers to reduce the risk of stunting in infants and children.

2. MATERIALS AND METHODS

2.1 Materials

The materials used in this study were white rice variety IR64, yellow corn variety Pertiwi 3, red beans and snakehead fish obtained from Babat market, Babat District, Lamongan Regency. katuk leaf powder, skim milk powder, soybean oil, refined sugar, and salt. The materials used for analysis were distilled water, petroleum benzene, catalyst, H2SO4, NaOH, boric acid, BCG-MR indicator, HCl, 80% ethanol, 10% alcohol, 80% and 95%, filter paper, K2SO4, iodine solution, and 1% starch.

2.2 Research procedure

This study used a simple Completely Randomized Design (CRD) with 1 factor. Each treatment was repeated 3 times. The data obtained were analyzed by the ANOVA test of variance (Analysis of Variance) with a confidence interval of 5%. If there is a real difference between treatments, a further DMRT test is carried out using a level of 5%. The formulation of instant baby porridge can be seen in the following **Table 1.**

Table 1: Instant Baby Porridge Formula (%)

Material	Formulation					
	P1	**P2**	**P3**	**P4**	**P5**	**P6**
White Rice Pre-cooked Flour	30	25	20	15	10	5
Yellow Corn Pre-cooked Flour	5	10	15	20	25	30
Red Bean Pre-cooked Flour	25	20	15	10	5	0
Pre-cooked Snakehead Fish Flour	0	5	10	15	20	25
Katuk Leaf Flour	5	5	5	5	5	5
Skim Milk Powder	20	20	20	20	20	20
Soybean Oil	10	10	10	10	10	10
Fine granulated sugar	4	4	4	4	4	4
Salt	1	1	1	1	1	1

2.3 Making Instant Baby Porridge

The process of making instant baby porridge refers to Tamrin & Pujilestari (2016) which has been modified. The first stage in making instant baby porridge is mixing the ingredients according to the treatment and diluting the dough. Then the porridge mixture is poured onto a baking sheet lined with baking paper. The porridge mixture is dried with a cabinet dryer at a temperature of 60^{o}C for 3 hours. The dry porridge mixture is smoothed with a blender on a scale of 1-2, for ± 5 minutes. The dry baby porridge is sieved with a size of 80 mesh.

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2.4 Analysis of Physical, Chemical, and Organoleptic Characteristics of Instant Baby Porridge

The process of making instant baby porridge refers to [13] which has been modified. The first stage in making instant baby porridge is mixing the ingredients according to the treatment and diluting the dough. Then the porridge mixture is poured onto a baking sheet lined with baking paper. The porridge mixture is dried with a cabinet dryer at a temperature of 60ºC for 3 hours. The dry porridge mixture is smoothed with a blender on a scale of 1-2, for ± 5 minutes. The dry baby porridge is sieved with a size of 80 mesh.

3. RESULT AND DISCUSSION

3.1 Chemical characteristics of instant baby porridge

Table 2: Proximate analysis results of instant baby porridge

Formulation	Water Content (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrates (%)
P1	4.03 ± 0.142^{a}	2.39 ± 0.286^{e}	10.74 ± 0.186^{e}	15.12 ± 0.015^{f}	67.71 ± 0.349^{a}
P2	3.74 ± 0.136^{a}	2.74 ± 0.274^{cd}	11.19 ± 0.164^{d}	18.35 ± 0.045^{e}	63.98 ± 0.563^{b}
P3	3.65 ± 0.116^{ab}	2.91 ± 0.229^{c}	11.88 ± 0.216^{c}	21.67 ± 0.025^{d}	59.88 ± 0.066^{c}
P4	3.25 ± 0.339^{bc}	3.68 ± 0.133^{b}	13.69 ± 0.279^{b}	24.42 ± 0.035^{c}	54.94 ± 0.526^{d}
P5	3.17 ± 0.336^{c}	4.16 ± 0.267^{a}	14.58 ± 0.142^{a}	29.10 ± 0.032^{b}	48.99 ± 0.206^{e}
P6	2.65 ± 0.221^{d}	4.28 ± 0.258^{a}	14.87 ± 0.061^{a}	31.92 ± 0.025^{a}	46.27 ± 0.143^{f}

Description: Numbers followed by different letters indicate significant differences ($p \leq 0.05$)

3.1.1 Water Content

The increasing pre-cooked flour (white rice and red beans) increases the water content in instant baby porridge, and vice versa. This is due to the high levels of crude fiber in white rice and red beans. [15] stated that the main role of fiber in food is to bind water. Fiber has a high water absorption capacity because it has a large polymer size, a complex structure and hydroxyl groups (Southgate, 1982). All treatments of instant baby porridge formulations meet SNI quality requirements. The quality requirements for water content in instant baby porridge based on SNI 01-7111.1-2005 are a maximum of 4%.

3.1.2 Ash Content

The higher proportion of yellow corn pre-cooked flour and also the increasing proportion of snakehead fish pre-cooked flour causes the ash content of instant baby porridge to increase. The high ash content of instant baby porridge is due to the ash content of pre-cooked flour (yellow corn and snakehead fish) which tends to be higher. The ash content of yellow corn pre-cooked flour is 1.02% [11], while the white rice pre-cooked flour is 0.25% lower [16]. The ash content of snakehead fish pre-cooked flour is 5.96% [17], while the red bean pre-cooked flour is 4.94% lower [18]. In general, instant baby porridge treatments P4, P5 and P6 do not meet SNI quality requirements. The quality requirements for ash content of instant baby porridge based on SNI 01-7111.1-2005 are a maximum of 3.5%.

3.1.3 Fat Content

The fat content of instant baby porridge decreases with increasing pre-cooked white rice flour. Pre-cooking white rice can reduce the ability of rice to absorb fat. This can be caused by the ability of gelatinized starch granules to retain water in the dough during the drying process, thereby reducing water evaporation and oil penetration into the product [19] The increasing proportion of pre-cooked snakehead fish flour increases the fat content of instant baby porridge. This is due to the high-fat content of snakehead fish flour 2.31% [20]. The fat content of instant baby porridge from the analysis ranges from 10.74-14.87%. This is also similar to the results of [21] research which obtained a fat content of 11.96-12.12%.

3.1.4 Protein Content

The higher proportion of yellow corn pre-cooked flour and also the increasing proportion of snakehead fish pre-cooked flour causes an increase in the protein content of instant baby porridge. This is due to the protein content in the raw materials, the protein content of yellow corn pre-cooked flour is 7.56% [11], while white rice pre-cooked flour is lower at 5.78% [16]. The protein content of snakehead fish pre-cooked flour is 76.9% [17], while red bean pre-cooked flour is lower at 13.98% [18]. The higher the protein content, the lower the water content in instant baby porridge. [22] stated that during the drying process, water molecules bound to food ingredients will be released by protein. In general, instant baby porridge treatments P4, P5 and P6 do not meet SNI quality requirements. The quality requirements for the protein content of instant baby porridge based on SNI 01-7111.1-2005 are 8-22%.

3.1.5 Carbohydrate Content

Carbohydrate content increases with an increasing proportion of white rice pre-cooked flour accompanied by an increase in the proportion of red bean pre-cooked flour). This is due to the carbohydrate content of white rice pre-cooked flour 96% [23] which is higher than yellow corn 80.26% [11]. The carbohydrate content of red bean pre-cooked flour 65.88% [18] is also higher than snakehead fish pre-cooked flour 3.53% [17]. The carbohydrate content is similar to the results of the study by [13] which obtained a carbohydrate content of 63.02-66.82%.

Table 3: Results of crude fiber and starch analysis of instant baby porridge

Formulation	Crude Fiber (%)	Starch (%)
P1	3.28 ± 0.006^{a}	34.15 ± 0.692^{a}
P2	3.09 ± 0.010^{b}	31.61 ± 0.626^{b}
P3	2.80 ± 0.015^{c}	28.41 ± 0.390^{c}
P4	2.61 ± 0.010^{d}	27.48 ± 0.391^{d}
P5	2.45 ± 0.010^{e}	24.18 ± 0.352^{e}
P6	2.28 ± 0.010^{f}	22.69 ± 0.176^{f}

Description: numbers accompanied by different letters indicate significant differences ($p \leq 0.05$)

3.1.6 Crude Fiber Content

The increasing proportion of pre-cooked white rice flour results in increasing crude fiber content in instant baby porridge. Generally, the crude fiber content in pre-cooked white rice flour is lower than the crude fiber content of pre-cooked yellow corn flour. However, the crude fiber content in instant baby porridge continues to increase, due to the combination of the increasing proportion of pre-cooked red bean flour. The increasing proportion of pre-cooked red bean flour results in increasing crude fiber content in instant baby porridge. This is because the crude fiber content in pre-cooked red bean flour is high (6.82%) ([24], when compared to pre-cooked snakehead fish flour which does not have crude fiber content.

3.1.7 Starch Content

The increasing proportion of pre-cooked white rice flour results in increasing starch content. Likewise, increasing the proportion of pre-cooked red bean flour results in increasing starch content in instant baby porridge. Starch content is generally directly proportional to carbohydrate content, where instant baby porridge starch increases along with increasing carbohydrate content. This is supported by the statement of Ref. [21] that starch content is directly proportional to carbohydrate content, so if the starch content in food ingredients is high, then the carbohydrate content contained in food ingredients is also high.

3.2 Physical characteristics of instant baby porridge

Statistical analysis of the formulation showed that the formulation treatment had a significant effect ($p \leq 0.05$) on the density of the kamba, water absorption capacity, and solubility of instant baby porridge.

3.2.1 Bulk Density

Table 4. shows that the higher proportion of pre-cooked flour (white rice and red beans) increases the density value of instant baby porridge. As the water content increases, it affects the increase in the density value of instant baby porridge. The higher the water content in food products, the higher the density value of the material and the decreasing density of the material [25]. The density value of the material in this study is in accordance with previous research by Ref. [26] which ranges from 0.46-048 g/ml.

Table 1: Results of physical analysis of instant baby porridge

Formulation	Bulk Density (%)	Rehydration (%)	Solubility (%)
P1	0.52 ± 0.006^{a}	205.49 ± 0.132^{f}	26.95 ± 0.144^{e}
P2	0.50 ± 0.006^{b}	215.31 ± 0.320^{e}	27.16 ± 0.208^{e}
P3	0.49 ± 0.006^{b}	222.75 ± 0.189^{d}	28.25 ± 0.229^{d}
P4	0.48 ± 0.015^{bc}	233.48 ± 0.098^{c}	28.99 ± 0.072^{c}
P5	0.47 ± 0.010^{cd}	243.39 ± 0.352^{b}	29.64 ± 0.160^{b}
P6	0.46 ± 0.006^{d}	251.63 ± 0.145^{a}	30.82 ± 0.188^{a}

Description: Numbers followed by different letters indicate significant differences ($p \leq 0.05$)

3.2.2 Rehydration Capacity

The water absorption capacity of instant baby porridge increases with the increasing addition of pre-cooked yellow corn flour and snakehead fish). As the protein content increases, it affects the increase in the water absorption value of instant baby porridge. [27] stated that food ingredients with high protein content have high water absorption capacity. The absorption of water is caused by the carboxyl group in the protein. The more protein contained in the food ingredient, the more carboxyl groups there are and the more water is absorbed[28]. The water absorption capacity in this study was higher than the results of the study by [29] which ranged from 157-175%. This can be caused by the pre-cooking process in the flour raw materials used, according to [30] cooking in starch causes the amylopectin fraction to stretch and release when there are broken hydrogen bonds and a lot of water is absorbed into the granules and water molecules form hydrogen bonds with starch, so that the structure of the starch granules becomes more open which causes swelling of the starch granules and increases the volume of starch. The disturbance in the structure of the starch granules causes gelatinized starch to have instant properties, namely, it can absorb water [31].

3.2.3 Solubility

The solubility of instant baby porridge increases with the increasing addition of yellow corn pre-cooked flour which is also accompanied by an increase in the proportion of snakehead fish pre-cooked flour. The increase in solubility value is directly proportional to the water absorption capacity. This is following the statement of [32] who also explained that the solubility of a product is directly proportional to its water absorption capacity. A decrease in water absorption capacity tends to be in line with a significant decrease in the solubility value, and vice versa.

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3.3 Organoleptic characteristics of instant baby porridge

3.3.1 Color

Table 5. shows that there was no significant effect ($p \geq 0.05$) in all formulations on the color of the instant baby porridge produced. Formulation sample P6 with pre-cooked flour treatment (5% white rice: 30% yellow corn: 0% red beans: 25% snakehead fish) produced the color of the brew that was most preferred by the panellists with a value of 3.72 (like). There was no significant effect of all instant baby porridge formulations on the color produced because each formulation produced almost the same color which was dominated by green which was thought to come from the addition of katuk leaf flour. The addition of katuk leaves with the same concentration caused the color of the instant baby porridge to be not significantly different. According to [33], katuk leaves contain chlorophyll pigments that can provide a natural green color to food products that are safe and beneficial to health.

Table 5: Results of the analysis of the organoleptic characteristics of instant baby porridge

Formulation	Color (%)	Aroma (%)	Flavor (%)	Texture (%)
P1	3.20 ± 0.866^{a}	2.80 ± 0.816^{a}	2.80 ± 0.913^{a}	3.16 ± 0.850^{a}
P2	3.28 ± 0.678^{a}	3.04 ± 0.611^{ab}	3.32 ± 0.945^{b}	3.60 ± 0.678^{a}
P3	3.44 ± 0.821^{a}	3.36 ± 0.860^{b}	3.64 ± 0.860^{b}	3.76 ± 0.821^{a}
P4	3.36 ± 0.700^{a}	3.28 ± 0.792^{b}	3.44 ± 0.583^{b}	3.20 ± 0.700^{a}
P5	3.32 ± 0.852^{a}	3.20 ± 0.707^{ab}	3.24 ± 0.723^{ab}	3.32 ± 0.852^{a}
P6	3.72 ± 0.792^{a}	3.48 ± 0.963^{b}	3.24 ± 0.913^{ab}	3.28 ± 0.792^{a}

Description: Numbers followed by different letters indicate significant differences ($p \leq 0.05$)

3.3.2 Aroma

The results of the organoleptic test of the aroma of instant baby porridge showed significant differences ($p \leq 0.05$) in all treatments. The instant baby porridge sample with the highest value was obtained in the P6 formulation (3.48) and the sample with the lowest value was obtained in the P1 formulation (2.80). The higher the addition of pre-cooked flour (yellow corn and snakehead fish) tends to produce a high value. This is because the panellists like the aroma of the added snakehead fish. The addition of red beans that are too high produces a stale aroma and is not liked by the panellists.

3.3.3 Flavor

The results of the organoleptic test of the taste of instant baby porridge showed significant differences ($p < 0.05$) in all treatments. The instant baby porridge sample with the highest value was obtained in the P3 formulation (3.64) which was caused by the sample formulation having a taste that tended to be more balanced between the taste of red beans and snakehead fish or the taste of white rice and yellow corn. The sample with the lowest value was obtained in the P1 formulation (2.80), this was because the red beans that were too high produced a stale taste and were not liked by the panellists.

3.3.4 Texture

Table 5. shows that there is no significant effect ($p \geq 0.05$) in all formulations on the texture of the instant baby porridge produced. This is because each formulation produces almost the same texture. After all, the sieving process in each formulation is carried out with the same sieve size, namely 80 mesh. One of the criteria for the quality of powdered products permitted by SNI 01-3751- 2006 is that at least 95% must pass an 80 mesh sieve. The results of sieving instant baby porridge with a fineness level of less than 80 mesh tend to produce a sandy texture in instant baby porridge [35].

4. CONCLUSION

formulation of pre-cooked flour (white rice, yellow corn, red beans and snakehead fish) in instant baby porridge showed a significant effect ($p \leq 0.05$) on water content, ash content, fat content, protein content, carbohydrate content, crude fiber content, starch content, cacao density, water absorption capacity, solubility, and taste and aroma scores, and did not have a significant effect ($p \geq 0.05$) on color and texture preference scores.

The best formulation of instant baby porridge was obtained in the P3 formulation with pre-cooked flour treatment (20% white rice: 15% yellow corn: 15% red beans: 10% snakehead fish) with a water content of 3.66%, ash content of 2.91%, fat content of 11.88%, protein content of 21.64%, carbohydrate content of 59.88%, starch content of 28.41%, crude fiber content of 2.80%, bulk density of 0.49 g/ml, water absorption capacity of 222.75%, solubility of 28.88%, and organoleptic test of color 3.44 (neutral), aroma 3.36 (neutral), taste 3.64 (like), and texture 3.76 (like).

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