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## **CHEMICAL AND ORGANOLEPTIC PROPERTIES OF COOKIES FROM CORN FLOUR AND MUNG BEAN AS A GLUTEN-FREE SNACKS**

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### **ABSTRACT**

*Autism disorders can reduce the ability to communicate, socialize, and respond to the environment. Some children with autism disorders are allergic to gluten. This study aims to analyze the characteristics of gluten-free cookies from corn flour and mung bean flour. The experimental design used was a Randomized Block Design. The formulation of corn flour: mung bean flour was 60%: 40%, 55%: 45%, 50%: 50%, 45%: 55%, 40%: 60%, each treatment was repeated 5 times. The best treatment is the formulation of 50% corn flour + 50% mung bean flour. The nutrient content of cookies (per 100g) was 18.47 kcal energy, 4.94 grams of protein, 6.93 grams of fat, 25.33 grams of carbohydrates. The serving size for autism children aged 4-6 years is 8 pieces ( $\pm$  80 grams) per day with 2 feeds.*

*Keywords: Autism, Cookies, Corn flour, Mung bean*

### **INTRODUCTION**

Autism disorder causes a decrease in the child's ability to communicate, socialize and give a response or feedback to the environment. The incidence of autism in the world is 0.20%. Children with autism reach 8,000 per year if the birth rate in Indonesia is four million per year (Mashab & Tajudin, 2010). About 70% of children with autism have digestive tract disorders that cause food allergies and inflammation of the digestive tract (Buie, 2013).

One of the allergens in autism disorder is gluten that is found on wheat, buckwheat, and barley. A gluten-free diet becomes one of the therapy diets to reduce autism symptoms. Gluten is commonly used in expanding and elastic products such as noodles and bread. Cookie's dough doesn't expand so it can use free gluten flour such as corn flour and mung bean flour.

The opioid-excess theory explains that the number of enzymes to hydrolyze casein and gluten in the digestive tract of the child with autism is low. As a result, protein can't be completely digested, which only produces peptides without amino acids. This condition causes increased permeability in the digestive tract so that peptides can be carried into the blood as toxins. The peptide towards opioid receptors disrupts the patient's behavior (Mulloy *et al.*, 2010). The gluten-free diet is needed as a therapy for autism. The examples of food ingredients that are recommended for consumption are corn and mung beans.

Corn and mung beans are easy and cheap food ingredients. Corn contains 9.8 % protein, 7.3 % fat and 69.1 % carbohydrates. Whereas mung beans contain 22.9 % protein, 1.5 % fat and 56.8 % carbohydrates (Kementerian Kesehatan Republik Indonesia, 2018).

Both of these ingredients can be processed into flour for making cookies. Cookies are the product of choice because they are durable, easy to make and preferred by children as a snack. Therefore, this study aimed to analyze the characteristics of gluten-free cookies from corn flour and mung beans flour with various formulations.

## METHODOLOGY

### Materials

The ingredients for making cookies are corn and mung beans from Situbondo, refined sugar “Mawar” branded and margarine “Blueband”. Materials that were needed for analysis are catalyst (Selenium reagent mixture), concentrated H<sub>2</sub>SO<sub>4</sub>, distilled water, 45% NaOH, 4% boric acid (saturated), MR-MB indicators, 0.1 N HCl. All ingredients are available at Food Analysis Laboratory, Politeknik Negeri Jember.

### Equipment

The equipments used in making cookies are scale, oven, and mixer. While the tools to analyze include analytical scales, destruction flasks, Kjeldahl heaters and distillators.

### Research Design

These researchs used a randomized block design with 5 treatments and 5 repetitions with one factor that is the ratio of corn flour and mung bean flour. The ratios are 60:40, 55:45, 45:55, 40:60.

Table 1. The formulation of the cookies

Samples (ratio of corn flour : mung bean flour)	Corn flour (g)	Mung bean flour (g)	Sugar (g)	Margarine (g)
A1 (60 : 40)	30.00	20.00	10	15
A2 (55 : 45)	27.50	22.50	10	15
A3 (50 : 50)	25.00	25.00	10	15
A4 (45 : 55)	22.50	27.50	10	15
A5 (40 : 60)	20.00	30.00	10	15

### Research Stages

#### 1. Corn flour preparation

Corn kernels are washed thoroughly, then soaked in lime water for 1 hour. The corn is washed again under the flowing water until there is no remaining lime water. Then, the corn is soaked for 24 hours in water. After that, the corn is steamed for 45 minutes until cooked, oven at 50°C for 24 hours and grinded until it becomes a fine flour and sieved with an 80 mesh (Hutajulu & Aviana, 2013; Widyastuti, 2015).

#### 2. Mung bean preparation

Mung beans are washed thoroughly and then soaked in water for 12 hours. After soaking, the husk can be removed. Furthermore, the mung beans are boiled for 5 minutes, oven-dried at 20°C for 20 hours and grind until it becomes a fine flour and sieve with an 80-mesh sieve (Mubarak, 2005).

#### 3. Cookie's preparation

Corn flour and mung bean flour evenly mixed in the ratio (%) 60:40, 55:45, 45:55, 40:60. Blend flour, sugar and margarine into a homogenous dough. After that, the dough sheeted to a thickness of 1 cm. The dough was then cut with a circular cutter and baked in the electrical oven at 150°C for 15 minutes.

### Method

These researches used a randomized block design with 5 treatments and 5 repetitions with one factor that is the ratio of corn flour and mung bean flour.

### Analysis

Organoleptic test (Meilgaard, M., 1999), moisture content (AOAC, 1995), ash content (AOAC, 1995), protein (AOAC, 1995), fat (AOAC, 1995), and carbohydrates by different. The

assessment of hedonic test was (5) very like, (4) like, (3) like slightly (2) dislike and (1) dislike extremely. All data were analyzed using SPSS V22.0.

## RESULT AND DISCUSSION

### 1. Raw Materials Characteristic

The corn flour yield is 82%, has a dark yellow color, sweet corn aroma, and soft texture. The mung bean flour yield is 89.9%, has a cream color and mung bean aroma. The corn flour and mung bean flour proximate analysis is shown in Table 2.

Table 2. Proximate analysis of corn flour and mung bean (per 100 g)

Parameters	Corn flour	Mung bean flour
Carbohydrate (%)	75.71	69.13
Protein (%)	9.38	18.05
Fat (%)	3.81	2.07
Moisture (%)	9.91	7.51
Ash (%)	1.19	3.24

Data in Table 1 shows that mung bean flour has 18.05% protein content, higher than corn flour protein content (9.38%). Mung bean is a source of protein in these cookies. Corn flour contains higher carbohydrates than mung bean, it can be the source of energy. Low moisture in the flour (<10%) shows that the flour has long shelf life.

### 2. Chemicals Properties

In Indonesian National Standard 2011, the maximum moisture content in cookies is 5%. The cookies above have to qualify for all of the products that have moisture below 5%. The range of cookies protein contents is 10.94-13.48% (Table 3). Protein content in mung bean flour is a replacement protein from wheat flour. The higher mung bean flour, higher protein content in cookies. The protein intake of children with autism is very important to support the growth and metabolic processes. However, children with autism consume inadequate amounts of protein. One study results that 42.1% of children with autism consume inadequate amounts of proteins (interpreted as <77% of the daily recommended intake) (Attlee *et al.*, 2015).

Not all individuals with autism can digest all types of protein. Protein digestibility depends on many factors such as structure, amino acid sequence, size, charge, and post-translational modifications. Protein from plant has lower digestibility (only 70-85%) compared with protein from the animal. Furthermore, plant has anti-nutritional factors that reduce protein bioavailability such as phytates, tannins and protease inhibitors (Becker & Yu, 2013). Therefore, a method to improve the digestibility of protein by heat treatment is needed. Protein may lose the tightly structure, bring on increasing accessibility of the hydrolytic enzymes. Soaking and cooking process on beans, result in improved protein digestibility (Joye, 2019). However, heat treatment during production increased protein digestibility in cookies with bambara groundnut protein concentrate (Kiin-Kabari & Giami, 2015). Giving these cookies is expected to increase protein intake in children with autism. Individuals with autism on specific and restricted protein diets (free gluten and dairy products) have significantly lower intestinal permeability than those on unrestricted diets (De Magistris *et al.*, 2010).

Besides protein, these cookies also contain fat and carbohydrate. The range of fat content is between 17.21-17.31%. While the range of carbohydrate content is between 62.26-64.82%. Ash describes the mineral content in cookies ranges 2.13-2.39%. The ratio of corn flour: mung bean flour (%) was significantly different in all proximate analysis.

Table 3. Proximate analysis of cookies from corn flour and mung bean flour (per 100g)

Corn flour : mung bean flour (%)	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)
60 : 40	4.89 ± 0.19 <sup>c</sup>	2.13 ± 0.03 <sup>a</sup>	10.94 ± 0.05 <sup>a</sup>	17.21 ± 0.04 <sup>a</sup>	64.82 ± 0.06 <sup>e</sup>
55 : 45	4.78 ± 0.05 <sup>bc</sup>	2.22 ± 0.02 <sup>b</sup>	11.63 ± 0.05 <sup>b</sup>	17.29 ± 0.02 <sup>b</sup>	64.07 ± 0.05 <sup>d</sup>
50 : 50	4.69 ± 0.52 <sup>ab</sup>	2.30 ± 0.26 <sup>c</sup>	12.35 ± 0.17 <sup>c</sup>	17.33 ± 0.03 <sup>bc</sup>	63.32 ± 0.21 <sup>c</sup>
45 : 55	4.61 ± 0.05 <sup>a</sup>	2.39 ± 0.23 <sup>d</sup>	12.77 ± 0.43 <sup>d</sup>	17.34 ± 0.05 <sup>c</sup>	62.90 ± 0.98 <sup>b</sup>
40 : 60	4.57 ± 0.19 <sup>a</sup>	2.28 ± 0.99 <sup>d</sup>	13.48 ± 0.90 <sup>e</sup>	17.37 ± 0.03 <sup>c</sup>	62.26 ± 0.10 <sup>a</sup>

Data are presented as mean values ± standard deviation (n = 5); Different superscript along the same column indicates there is significant difference according ANOVA test ( $\alpha \leq 0.05$ )

### 3. Organoleptic Properties

The organoleptic properties including aroma, texture, taste, and color cookies were assessed by 60 panelists.

Table 4. Organoleptic properties of cookies

Attributes	Criteria	Percentage (%)				
		A1	A2	A3	A4	A5
Aroma of mung bean	None	33.33	20.00	13.33	10.00	8.33
	Trace	48.33	60.00	46.67	18.33	10.00
	Strong slightly	18.33	20.00	31.67	55.00	46.67
	Strong	0.00	0.00	8.33	16.67	31.67
	Very strong	0.00	0.00	0.00	0.00	3.33
	Mean rank	98.52 <sup>a</sup>	112.68 <sup>a</sup>	145.07 <sup>b</sup>	185.46 <sup>c</sup>	210.78 <sup>d</sup>
Color	Deep brown	0.00	1.67	1.67	0.00	1.67
	Light brown	18.33	16.67	5.00	25.00	25.00
	Deep yellow	15.00	16.67	38.33	18.33	15.00
	Brownish-yellow	63.33	63.33	53.33	56.67	55.00
	Light yellow	3.33	1.67	1.67	0.00	3.33
	Mean rank	160.44	156.49	150.54	139.78	145.25
Texture	Very hard	1.67	0.00	0.00	0.00	0.00
	Hard	6.67	8.33	0.00	3.33	1.67
	Few crunchy	33.33	30.00	30.00	35.00	35.00
	Crunchy enough	48.33	56.67	65.00	55.00	50.00
	Very crunchy	10.00	5.00	5.00	6.67	13.33
	Mean rank	142.31	145.23	158.62	150.55	155.79
Taste	Very tasteless	0.00	0.00	0.00	0.00	1.67
	Tasteless	13.33	3.33	3.33	8.33	5.00
	Few sweet	50.00	51.67	30.00	25.00	25.00
	Sweet	35.00	43.33	65.00	65.00	66.67
	Very sweet	1.67	1.67	1.67	1.67	1.67
	Mean rank	120.40 <sup>a</sup>	134.68 <sup>a</sup>	168.05 <sup>b</sup>	164.78 <sup>b</sup>	164.59 <sup>b</sup>

Different superscript in mean rank row indicates there is significant difference according Mann Whitney test ( $\alpha \leq 0.05$ ). A1 = 60% corn flour + 40% mung bean flour; A2 = 55% corn flour + 45% mung bean flour; A3 = 50% corn flour + 50% mung bean flour; A4 = 45% corn flour + 55% mung bean flour; A5 = 40% corn flour + 60% mung bean flour (Table 4)

The texture is one of the most important attributes of organoleptic in cookies. Organoleptic data shows (Table 4 and Table 5) that panelists stated that the aroma of mung beans was less strong in the addition of up to 50% of mung beans. The use of green bean flour up to 55% can improve the strength and preference for the aroma of cookies.

Table 5. Preference organoleptic of cookies

Attributes	Criteria	Percentage (%)				
		A1	A2	A3	A4	A5
Aroma	Dislike extremely	0.00	0.00	0.00	0.00	0.00
	Dislike	1.67	1.67	0.00	0.00	1.67
	Like slightly	76.67	78.33	20.00	20.00	61.67
	Like	21.67	20.00	80.00	80.00	36.67
	Very like	0.00	0.00	0.00	0.00	0.00
	Mean rank	144.21 <sup>a</sup>	141.74 <sup>a</sup>	143.60 <sup>b</sup>	166.41 <sup>c</sup>	156.54 <sup>d</sup>
Color	Dislike extremely	0.00	0.00	0.00	0.00	0.00
	Dislike	0.00	0.00	0.00	0.00	0.00
	Like slightly	45.00	46.67	53.33	61.67	63.33
	Like	55.00	53.33	46.67	38.33	36.67
	Very like	0.00	0.00	0.00	0.00	0.00
	Mean rank	164.00	161.50	151.50	139.00	136.50
Texture	Dislike extremely	0.00	0.00	0.00	0.00	0.00
	Dislike	5.00	1.67	0.00	6.67	3.33
	Like slightly	75.00	76.67	78.33	53.33	65.00
	Like	20.00	21.67	21.67	35.00	31.67
	Very like	0.00	0.00	0.00	11.67	0.00
	Mean rank	141.38	147.54	149.42	154.00	160.17
Taste	Dislike extremely	0.00	0.00	0.00	0.00	0.00
	Dislike	0.00	0.00	0.00	0.00	0.00
	Like slightly	53.33	50.00	36.67	38.33	41.67
	Like	35.00	36.67	53.33	58.33	50.00
	Very like	11.67	13.33	10.00	3.33	8.33
	Mean rank	140.98 <sup>a</sup>	145.46 <sup>a</sup>	165.63 <sup>b</sup>	150.31 <sup>b</sup>	150.12 <sup>b</sup>

Different superscript in mean rank row indicates there is significant difference according Mann Whitney test ( $\alpha \leq 0.05$ ). A1 = 60% corn flour + 40% mung bean flour; A2 = 55% corn flour + 45% mung bean flour; A3 = 50% corn flour + 50% mung bean flour; A4 = 45% corn flour + 55% mung bean flour; A5 = 40% corn flour + 60% mung bean flour

The color of all cookies is uniform brownish-yellow. However, the majority of the panelists liked the brownish-yellow color when using 60% mung bean flour. The brown color is related to the Maillard reaction, the reaction between reducing sugar and amino acid from mung bean. The higher of adding a source of protein such as catfish flour will increase the brown color intensity of the products (Imandira, 2012). Additionally, the Maillard reactions can improve the taste of food. The majority of panelists stated that they like the texture of all the cookies that is crispy. The higher addition of mung bean flour increases the sweetness and preference of the panelists.

Children with autism (4-6 years) need snacks to increase energy and essential nutrients and prevent malnutrition. Conditions on a gluten allergy cause malnutrition because many snacks are made from wheat flour containing gluten. Suggested consumption of these cookies for children aged 4-6 is 8 pieces a day with 2x feed. The gluten-free diet would have potentially

been helpful for children with celiac disease, food allergy to gluten products, or maldigestion of these food products (Buie, 2013). Gastrointestinal co-morbidities are common in children with autism and affect 9–91% of patients (Sanctuary *et al.*, 2018).

### CONCLUSIONS

The comparison of corn flour and mung bean flour has a significant effect on the moisture, ash, protein, fat, carbohydrate content, and organoleptic of cookies. The majority of the panelists liked the aroma of green beans a bit strong, brownish-yellow color, crunchy texture and sweet taste of cookies with a higher amount of mung bean flour. These cookies can be consumed by children with autism because they do not contain gluten.

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