

Comparing Macronutrient Compositions and Sensory Characteristics of Jackfruit Nugget Formulations and Commercially Available Chicken Nugget

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Abstract—Jackfruit (*Artocarpus heterophyllus*) is well known as good source of carbohydrates and fibers. Jackfruit has high phenolic content which could prevent the onset of cardiovascular disease. Jackfruit has large size and low shelf-life, so modifications are needed to made it commercially available. On the other hand, the high consumption of junk food such made prevalence of non-communicable diseases became steadily increased. This research tried to develop new formulation of nugget which has lower fat content and similar sensory quality compared to the commercially available chicken nugget. This study did macronutrient analysis and sensory evaluation to four Jackfruit nugget formulations and one commercially available nugget. The formulations divided into four ratios of jackfruit/chicken which were F I (1/0), F II (1/3), F III (1/1), and F IV (3/1). All of it were compared to a commercially available nugget which won five times top brand awards in Indonesia. F I had lowest fat and calories content but highest carbohydrate and water content. The F I also had quite similar sensory characteristic and could not be distinguished easily from another formulations. The F IV had lower fat and similar protein content. The sensory characteristics of F IV also closer to the commercially available nugget.

Keywords—jackfruit nugget, chicken nugget, lower fat content

I. INTRODUCTION

In Asia, diabetes and cardiovascular prevalence are rising. This were due to the rapid economic transition which came with increasing adoption of new technologies. Most of the new technologies made live easier, while increasing sedentary lifestyle and convenience foods consumption which seen in both high and low income households [1,2]. Convenience foods are usually identical to highly processed food, known of

its high saturated fats and energy, increasing the risk of cardiometabolic diseases, including metabolic syndrome, diabetes, and cardiovascular diseases [3,4].

In Indonesia the story is the same, there were changes in food consumption pattern and declining physical activities. People which used to eat traditional food high in fiber content, were replaced by convenience foods high in fat and sugar [5]. This changing pattern also affected by peoples' spending preferences, which shifting from traditional markets toward supermarkets and convenience stores [5–7]. Consumption of convenience foods were rising even so far into the deeper part of Amazon, where the chicken nuggets already replacing fish and bushmeat [8].

Despite of the nutrition knowledge, people still buying convenience foods. This is due to fact that convenience food is easier and faster to cooks [9]. Basically, convenience foods were differentiated into four types: (1) highly processed food products (e.g., meal in a can), (2) moderately processed food products (e.g., ready to eat sandwiches), (3) single components (e.g. nuggets, fish sticks), and (4) salads (e.g., fresh fruit salad). There are few healthier choices among convenience food, but most of them are unhealthy and related to weight gain and insulin resistance [10]. People wish to stay slim but wanted to eat delicious and easy to cook foods [11].

Chicken nugget is one of the most popular and widely used convenience foods. It is tasty, has long shelf life, and easy to be made into different kind dishes. Nugget were made from trimmed and deboned chicken, different kind of functional ingredients, salt, and mixed spices [12]. The biggest problem of nugget is its high saturated-fat and trans-fat content [4].

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Because of its popularity despite of its high fats content, there are some research which tried to create healthier nugget. There are several research tried to change and tweak the composition of nugget to make it healthier by reducing the fat content by baking it or by changing the batter into something other than wheat [11,12].

This study aimed to develop new formulation of nugget which has lower fat content and similar sensory quality compared to the commercially available chicken nugget. The new formulation included jackfruit which has many functional components and has similar sensory properties as chicken [15,16]. Jackfruit not only widely available at reasonable prices on most traditional market and supermarket in Indonesia, but also common in most Javanese home gardens [17].

II. MATERIALS AND METHODS

This study was using true experimental design, divided into three phases. The first phase was developing nugget formulation which was done in Nutrition Laboratory, Public Health Science Department, Universitas Negeri Semarang. The second was macronutrient composition analysis which conducted by Center for Food and Nutrition Studies (CFNS), Universitas Gadjah Mada. The last phase was sensory evaluation, which also carried out in Nutrition Laboratory, Public Health Science Department, Universitas Negeri Semarang.

The ingredients of the nugget formulation were: young jackfruit, chicken breast, flour, breadcrumbs, egg, garlic, shallot, pepper powder, ice cube, palm oil, and salt. Ingredients for all of the nugget is identical, except for the chicken and jackfruit ratio. This study used four ratios of jackfruit/chicken which respectively: 1/0, 1/3, 1/1, 3/1. Those ratio were chosen after careful preparation and considering another study [18]. There was one control, Champ® Chicken Nugget which was a product by P.T. Charoen Pokphand Indonesia. This product was chosen because it won top brand award from 2015 – 2019, in other word it is the most popular nugget in Indonesia [19].

For the macronutrient composition analysis, the researcher was cooperating with CFNS to conduct the analysis in Food Chemistry and Biochemistry Laboratory. The analysis for water, ash, and lipid content were using Gravimetry method. The protein analysis was using Kjeldhal method, and the carbohydrate analysis was using by different. All of the analysis was following the standard of Official Methods of Analysis of AOAC International.

The sensory evaluation was conducted using standard method and 32 semi-trained panels [20]. The inclusion criteria for semi-trained panels were: (1) 18 – 23 years old. (2) healthy, did not smoke, did not drink alcohol, and did not have color blindness (3) had good marks in food science course in the last 5 years (4) did not have excessive fondness for the food tested. There were also the exclusion criteria: (1) be in the care of a physician or undergo surgery within the last 6 months. (2) cannot be present when the sensory evaluation began. The nugget sample were completely randomized and the panelist is blinded to minimize bias.

The data collected from both phases were analyzed using univariate and bivariate method. All of the data were entered by the researcher, coded, cleaned, and then descriptively presented. The sensory characteristic was than chosen one that has the most answers.

III. RESULTS AND DISCUSSION

The formulations used in this study could be seen on the table 1. The formulations were arranged according to its chicken content, to make it easier to read. Formulation of formula V was acquired from the packaging label.

TABLE I. NUGGET FORMULATION

Nugget Formulation	Ingredients		
	Chicken Ratio	Jackfruit Ratio	Other Ingredients
Formula I (F I)	0%	100%	Flour, breadcrumbs, egg, garlic, shallot, pepper powder, ice cube, palm oil, salt
Formula II (F II)	25%	75%	Flour, breadcrumbs, egg, garlic, shallot, pepper powder, ice cube, palm oil, salt
Formula III (F III)	50%	50%	Flour, breadcrumbs, egg, garlic, shallot, pepper powder, ice cube, palm oil, salt
Formula IV (F IV)	75%	25%	Flour, breadcrumbs, egg, garlic, shallot, pepper powder, ice cube, palm oil, salt
Formula V* (F V)	100%	0%	Water, vegetable oil, breadcrumbs (containing tartrazine, yellow FCF, ponceau), batter flour, vegetable protein, flour, sugar, spices, chicken spices, MSG, salt

*= control

A. Macronutrient Composition

TABLE II. MACRONUTRIENT COMPOSITION

Nugget Formulation	Macronutrient Content per 100 g					
	Water (%)	Ash (g)	Fat (g)	Protein (g)	Carb. (g)	Energy (kcal)
F I	54.44	1.59	5.01	4.26	34.68	200.93
F II	48.45	1.72	7.95	7.43	34.44	239.07
F III	48.60	1.63	7.79	6.74	35.23	237.99
F IV	45.03	1.82	8.82	9.84	34.48	256.70
F V*	44.26	1.77	23.94	9.30	20.72	335.54

*= control

Carb. = carbohydrate

Result of the macronutrient analysis were shown on table 2. The water content was highest in F I (54.4%), and the lowest was the F V (44.26%). The highest ash content was the F IV, and the lowest was F I. The fat content in F V was more than fur time higher than the fat content in F I. The protein content of F IV and F V only has slightly different, but more than twice compared to F I. The carbohydrates content of F I to F IV was pretty much similar, 30% higher than carbohydrates in F V.

The energy content of F V was the prominent compared to the others, and the lowest one was the F I.

The table 2 showed that there were distinct different between F I with the other formulations. F I had the lowest calorie, protein, and fat content with relatively high carbohydrate and water. This composition was pretty much the same with a snack developed for those with diabetic nephropathy, which snack contained 200 kkal energy, 5 g protein, 6.7 g fat, 30 g carbohydrate, and 2.8 g fiber [21]. It still needed thorough research but it was a good starting point.

The F II, F III, and F IV generally had similar macronutrients content. It mostly containing water 45.03% - 48.60% and carbohydrate 34.44 g – 35.23 g. The highlight was its protein content, in which F II and F III has 7.43 g and 6.74 g respectively, but the F IV surprisingly had 9.64 g of protein. It was the highest from all of the formulas, even a little bit more than those in the commercially available nugget (F V).

The result for F II, F III, and F IV actually had some differences with the previous research. At that research, the water, ash, fat, protein, and carbohydrate content of the 30% jackfruit and 70% chicken nugget were 37.41%, 4.52 g, 23.48 g, 8.93 g, and 25.66 g [18]. The noticeable differences were on the higher water content, lower fat content, and higher carbohydrate content of the new nugget compared to the later. Unfortunately, the researcher could not find the recipe of the later nugget. The suggestions was, that this nugget exclusively used chicken breast which known as the leanest part of the meat, hence the fat content was substantially lower [22].

Other research which tried to developed fat free and gluten free chicken nugget, also had different macronutrient composition compared to this nugget. That particular nugget, substituted flour with amaranth flakes , which made the protein content soared up between 21.37% - 27.22% [14]. Another researcher tried to developed nugget from crickets and jackfruit, in which the carbohydrate content skyrocketed to 65.347% and the protein content dropped down into 0.0443% [23]. Researcher from USA did autopsy to chicken nuggets and found that it had low protein content and high fat content [24]. It was the same with this research, which found that commercially available nugget (F V) had highest fat content.

B. Sensory Characteristics

TABLE III. SENSORY CHARACTERISTICS

Sensory Attributes	Nugget Formulation				
	F I	F II	F III	F IV	F V*
Colour	brown yellow	brown yellow	brown yellow	brown yellow	yellow
Chicken aroma	quite strong	quite strong	quite strong	strong	very strong
Jackfruit aroma	none	none	none	none	none
Odor	fresh	fresh	fresh	fresh	fresh
Chicken flavor	quite strong	quite strong	quite strong	strong	very strong
Jackfruit flavor	none	none	none	none	none
Spice flavor	strong	moderate	moderate	strong	very

Sensory Attributes	Nugget Formulation				
	F I	F II	F III	F IV	F V*
					strong
Firmness	less firm	firm	firm	firm	firm
Chewiness	less chewy	less chewy	less chewy	less chewy	chewy

* = control

Table 3 showed the results of sensory evaluations from 32 panelists which had been analyzed by doing descriptive analysis. The researcher identified the highest percentage of answers in the questionnaire than matching it with the qualitative part. The collectivity than seen as the sensory characteristics of the nugget.

The color of the nugget was mostly brown yellow due to Maillard reaction, except for F V which most panelists seen as yellow. Researcher suspect that it was because of the different batter, affecting microstructural properties of the nuggets [25]. The chicken aroma for F I – F III were quite strong, for F IV was strong, and for F V was very strong. For the jackfruit aroma, all of formula did not have it and the general odor for each of the nuggets was fresh. The different intensity of chicken flavor was mainly because of its content, but for the F V it was related to the chicken spices as well.

The flavor of all of the formulations were dominated by chicken and spices. All of the nuggets had none of the jackfruit flavor. Chicken flavor on F I – F III were quite strong, on F IV was strong, and F V was very strong. These were closely related with jackfruit/chicken ratios and the addition of chicken spices in F V. The spice flavor in F V was very strong, both F I and F IV were strong, but on the F II and F III were moderate. On the F V, the explanation was simply because the addition of MSG and the spices, but it was different a story for another formulation. The spices in F I was highlighted because it had no chicken, which means there was only little disruption of taste. In F IV the spices became stronger, because more chicken means increased fats which will increase the savory when fried [18]. Addition of spices will increase the taste and reducing food spoilage because of its antifungal and antimicrobial properties [26]. The firmness and chewiness were related to the batter and water content of the nuggets. From table I, it could be seen that F I had highest water content which made it into less firm and less chewy. The addition of chicken on the other hand, will lead to chewier texture, which could be seen on F V

TABLE IV. NUGGET WITHOUT JACKFRUIT OR WITHOUT CHICKEN

Nugget Formulation	Panelist Answers				
	F I	F II	F III	F IV	F V*
Without Jackfruit	5	2	0	1	24
Without Chicken	12	8	6	2	4

*= control

Panelist asked to guess which nugget has no chicken and which nugget has no jackfruit. As shown in table IV, 75% panelists could guess that there was no jackfruit on the F V. On the other hand, only 37.5% could guess that there was no

chicken on the F I. This shown that 62.5 % panelist could not give the correct answer right away, this means that the sensory characteristics of the F I was really close with the other nugget.

IV. CONCLUSIONS AND SUGGESTIONS

It could be concluded from the macronutrient characteristic, that F I had lowest fat and calories content but highest carbohydrate and water content. The F I also had quite similar sensory characteristic and could not be distinguished easily from another formulations. The F IV had lower fat and similar protein content. The sensory characteristics of F IV also closest to the commercially available nugget. It was suggested that Jackfruit nugget could be healthier alternative to the chicken nugget. More research should be done, regarding the use of Jackfruit nugget on different circumstances.

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