Outcome of Soybean Dregs and Cassava Addition towards Synthetic Chicken Meat Texture and Nutrition

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Abstract

Meat is one of the main sources of protein that society enjoys consuming, particularly chicken. However, meat may be unhealthy and cause excessive cholesterol, diabetes, and weight gain, also pathogenic such as avian influenza. Meat alternative that is healthier is synthetic meat. Synthetic meat is created from organic ingredients with protein content that resembles meat. Protein in synthetic meat is obtained from ingredients such as gluten, soybean dregs, and cassava. Aside from protein, other nutrition such as fiber, carbohydrate, fats, and minerals are also incorporated in synthetic meat. In manufacturing synthetic meat, the concentration of soybean dregs and cassava are varied in order to observe the effect from both ingredients towards nutrition and texture. Synthetic meat will be analyzed proximately, calorimetrically, its texture by texture profile analysis (TPA) and scanning electron microscopy (SEM), shelf life, and amino acids. From this research, a formulation for synthetic chicken meat is obtained based on its nutrition and texture. The best composition for synthetic chicken meat consists of 60% gluten, 5% cassava, and 20% soybean dregs.

Keywords:synthetic chicken meat, gluten, cassava, soybean dregs

Introduction

One of human's nutrition main components is protein that could be obtained from various sources, such as meat and vegetables. However, people prefer to consume meat because of its higher protein content. Though protein content in meat is higher, there are several risks in consuming it excessively, such as cholesterol; weight gain; diabetes; and heart disease. In a few researches, there has been a correlation between meat consumption and breast; prostate; and lung cancer.[8] Saturated fats; cholesterol; calories; even synthetic hormones and antibiotics that are obtained from meat may cause the risks given previously. In addition, when being cooked in high temperature, meat may produce a carcinogenic substance, which is heterocyclic amine (HCA). HCA is formed when amino acid and keratin reacts in high temperature.[9] Due to public's fear of disease that are mentioned previously, an alternative for meat is needed that doesn't contain substances that could harm the human body.

One of main materials in synthetic meat production is gluten. Gluten is one of the common materials in producing synthetic meat. However, gluten could cause allergies to some individuals. Hence, other ingredients are needed as nutrition addition to substitute gluten. Soybeans are one of protein; fiber; and vitamin source. Protein in soybeans is quite high, therefore it could be an alternative to a healthier meat substitute. Cassava is the main material for tapioca production. Nutrition in cassava which are carbohydrate; fats; protein; vitamins; calcium often makes it utilized as rice substitute. Based on these materials, synthetic chicken meat is made from gluten; soybean dregs; and cassava, is made in order to imitate chicken meat's taste and texture. In order to achieve it, nutrition and texture of synthetic chicken meat is analyzed by proximate, amino acid, fatty acid, calorimetric analysis; total plate count; texture profile analysis; and scanning electron microscopy.

Materials and Methods

Synthetic chicken meat production will go through several steps. First, the preparation of soybean dregs. Soybean dregs are byproduct from soymilk production. Next, all materials are mixed together until homogenous. Finally, synthetic chicken meat is steamed until cooked.

There are several types of meat that has variations of soybean dregs and cassava concentration. Synthetic chicken meat with cassava concentration variations will be analyzed at Balai Besar Industri Agro for proximate and calorimetric analysis, also amino acid analysis at Saraswanti Indo Genetech Laboratory in Bogor. Texture analysis will be done in Institut Pertanian Bogor, Bogor. Scanning electron microscopy will be done in Department of

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Metallurgy and Materials Universitas Indonesia, Depok. Finally, the shelf life of synthetic chicken meat will be analyzed by total plate count in Saraswanti Indo Genetech Laboratory in Bogor. The flow diagram below shows process of this study:

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┌─────────────────────────┐
│       Preparation        │
└─────────────────────────┘
             │
             ▼
┌─────────────────────────────────┐
│   Manufacture of synthetic meat  │
└─────────────────────────────────┘
             │
             ▼
┌──────────────────────────────────────────┐
│ Variation of gluten, cassava, and soybean │
│            dregs composition               │
└──────────────────────────────────────────┘
             │
             ▼
┌──────────────────────────────────┐
│  Proximate + Calorimetric Analysis │
└──────────────────────────────────┘
             │
             ▼
┌──────────────────────────┐
│    Amino Acid Analysis    │
└──────────────────────────┘
             │
             ▼
┌──────────────────────────┐
│  Texture Profile Analysis │
└──────────────────────────┘
             │
             ▼
┌──────────────────────────────┐
│  Scanning Electron Microscopy  │
└──────────────────────────────┘
             │
             ▼
┌──────────────────────────┐
│     Total Plate Count     │
└──────────────────────────┘
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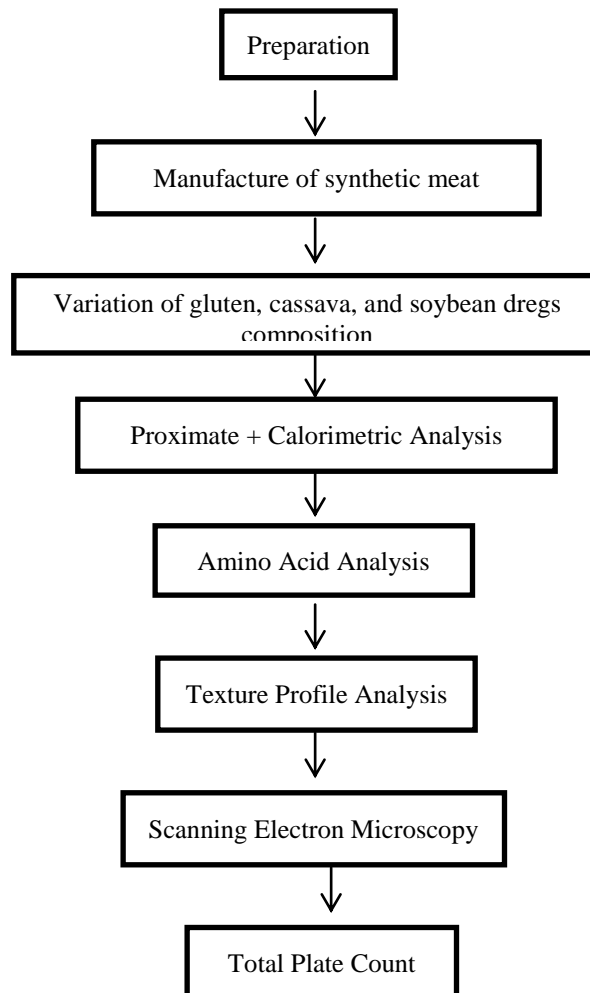
Results and Discussions

The goal of this study is to determine the best composition for synthetic chicken meat based on its protein content and texture. Table 1 below shows proximate analysis results.

Table 1. Proximate Analysis Result

Result of Proximate Analysis	Chicken Meat	Synthetic Chicken Meat Gluten:Cassava:Soybean Dregs:TVP (%)				
		60:0:20:5	60:5:20:5	60:10:20:5	60:15:20:5	70:5:20:5
Water Content (%)	66,75	53,45	54,4	55,85	57,55	54,7
Ash Content (%)	1,05	0,47	0,425	0,35	0,47	0,385
Protein Content (%)	20,45	21,7	20,35	19,1	18,1	20,8
Fat Content (%)	2,365	6,665	6,395	0,915	6,53	6,875
Carbohydrate Content (%)	9,385	17,7	18,45	23,8	17,35	17,25

Synthetic meat protein content ranged between 18-21%, which the composition that has no cassava has the highest value. Protein content decreases as cassava increases, which is caused by increased carbohydrate levels in synthetic meat due to cassava as one of the main source of carbohydrate. The fat content in synthetic is significantly

higher than chicken meat; this is caused by one of the supporting materials, which is oil that we added about 5%. Which is why, synthetic meat fat content is above 5%.

Calorimetric analysis is done to observe how much energy synthetic meat produces. Table 2 below shows how much calories are contained 100 grams of synthetic meat.

Table 2. Calorimetric Analysis Result

Type of Meat		Calories per 100 gram
Chicken Meat		140.5
Synthetic Chicken Meat (Gluten:Cassava:Soybean Dregs:TVP)	60:0:20:5	217.5
	60:5:20:5	212.5
	60:10:20:5	179.5
	60:15:20:5	200.5
	70:5:20:5	214

From the results given above, synthetic meat contains more calories than chicken meat. This may be caused by cassava, which is a carbohydrate source and added materials such as oil. In such case, synthetic meat could substitute chicken meat to meet human's daily calorie intake.

Amino acid analysis is done to determine which ones are contained in synthetic meat. Table 3 below shows the amino acid content for synthetic meat.

Table 3. Amino Acid Analysis Result

No.	Type of Amino Acids	Chicken Meat	Synthetic Chiecken Meat Gluten:Cassava:Soybean Dregs:TVP					
			60:10:20:5		60:15:20:5		70:5:20:5	
		Concentration (ppm)	Concentration (ppm)	% from chicken meat	Concentration (ppm)	% from chicken meat	Concentration (ppm)	% from chicken meat
1	Histidine*	9276.235	4373.65	47%	4834.86	52%	4086.12	44%
2	Isoleucine*	11160.34	8383.975	75%	8160.625	73%	8017.305	72%
3	Leucine*	17244.9	14647.475	85%	14312.2	83%	13628.075	790%
4	Lysine*	25048.4	5335.87	21%	5010.385	20%	3819.715	15%
5	Alanine	11865.76	5304.365	45%	5229.05	44%	6357.055	54%
6	Phenilalanine*	9029.86	10169.255	113%	10864.345	120%	10161.41	113%
7	Threonin*	10702.89	6085.805	57%	6065.655	57%	4041.685	38%
8	Valin*	11239.285	8672.2	77%	8474.735	75%	8085.965	72%
9	Serin	7919.235	9998.01	126%	9972.105	126%	4819.75	61%
10	Glysin	9281.66	7095.185	76%	6928.595	75%	4993.725	54%
11	Glutamate	33401.12	69737.67	209%	74138.385	222%	60448.065	181%
12	Proline	6628.015	21816.86	329%	21682.835	327%	23575.585	356%
13	Tirosine	6017.01	4582.035	76%	4813.48	80%	5882.625	98%
14	Aspartate	19029.545	6881.245	36%	7183.675	38%	6448.525	34%
15	Arginine	13367.265	7267.46	54%	7600.48	57%	7065.285	53%

Protein is formed by amino acid, therefore, its quality is determined by amino acids type and concentration. Each amino acid has its function and characteristics. As seen in the table above, amino acids contained in chicken meat are also found in synthetic meat. Essential amino acids included in synthetic meat are histidine, isoleucine, leucine, lysine, phenylalanine, threonine, and valin.

Texture profile analysis is done to compare synthetic meat's texture to chicken meat's. The parameters that are analyzed namely hardness, cohesiveness, and springiness. Table 4 below shows the result of texture profile analysis with synthetic meat composition variation and Table 5 shows the result of fermentation time variation.

Table 4. Texture Profile Analysis Result with Composition Variation

Parameter	Chicken Meat	Synthetic Chicken Meat Gluten:Cassava:Soybean Dregs:TVP					
		60:0:20:5	60:5:20:5	60:15:20:5	60:15:5:5	60:15:0:5	60:15:20:0
Hardness (gf)	8538	3859.3	4002	4919	5502.9	8228.9	4106.2
Cohesiveness	0.428	0.567	0.545	0.544	0.521	0.557	0.539
Springiness	45.8	90	89.7	86.8	89.1	89.7	90.7

Table 5. Texture Profile Analysis Result with Fermentation Time Variation

Parameter	Synthetic Chicken Meat Gluten:Cassava:Soybean Dregs:TVP			
	0 hours	3 hours	6 hours	9 hours
Hardness (gf)	4919	5349.6	4344.1	3430.6
Cohesiveness	0.544	0.511	0.486	0.555
Springiness	86.8	88.8	89.1	89

Hardness is force needed to change a material's form[5]. The result of synthetic meat's hardness increases with cassava addition. Cohesiveness is a parameter that determines material's endurance to second deformation after the first. Cohesiveness has a linear relation with protein content, which is shown by the decreased cohesiveness and protein content with cassava addition. Springiness is the ability of material to come back to its origin state after deformation. As shown in the table above, synthetic meat's springiness is almost twice as chicken meat's. The main material of synthetic meat causes this, which is gluten that has an elastic character. Fermentation also has an impact to synthetic meat production, which affects its texture. From the result of analysis, it may be concluded that fermentation caused synthetic meat to be softer because of the formation of cavities. Cavities in synthetic meat could be seen in microstructure analysis by Scanning Electron Microscopy (SEM).

Chicken Meat	0 hours	3 hours	6 hours
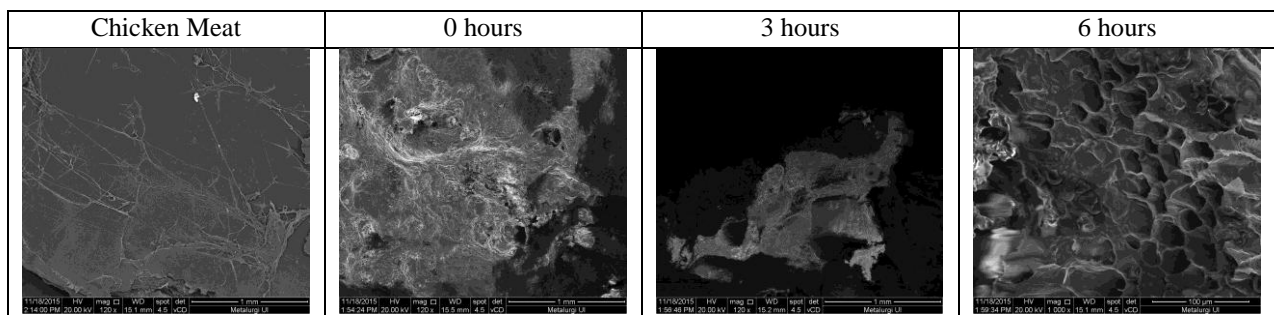
As seen in the figures above, chicken meat's structure is more fibrous, meanwhile synthetic meat is hollowed. Formation of cavities is shown by the 6 hours fermentation figure, where the cavities are clear.

Total plate count (TPC) analysis is done to measure the shelf life of synthetic meat. Analysis is done by using synthetic meat with consists of 60% gluten, 15% cassava, and 20% soybean dregs with a control of incubation temperature at 30°C for 72 hours. This composition is chosen because it has the highest water content, hence making it more susceptible towards microorganism contamination. The table below shows the result of TPC analysis.

Table 6. Total Plate Count Analysis Result

No.	Meat Type	Colonies
1	Raw Chicken Meat	$4,5 \times 10^6$
2	Steamed Chicken Meat	<10
3	Synthetic Chicken Meat	<10
	Gluten:Cassava:Soybean Dregs:TVP (60:15:20:5)	20

Total plate count analysis shows that colonies form on synthetic chicken meat is lesser than chicken meat. Synthetic chicken meat is steamed after all ingredients are mixed, which is why; a control of steamed chicken meat is also analyzed. The results yielded the same amount of colonies. From this analysis, it may be concluded that synthetic meat could be stored longer than raw chicken meat, making it healthier and safer to consume.

Conclusion

Best synthetic chicken meat formulation that is achieved from this study consists of 60% gluten, 5% cassava, and 20% soybean dregs. Proximate analysis of this type of synthetic chicken meat consists of 54,4% water; 0,425% ash; 20,35% protein; 18,45% carbohydrate; and 6,395% fat. Synthetic chicken meat has longer shelf life than chicken meat, therefore it is safer to consume.

Acknowledgments

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Lembar Tanya Jawab
Moderator :Zainal Arifin (Politeknik Negeri Samarinda)
Notulen : Renung R. (UPN "Veteran" Yogyakarta)

1.   Penanya   :   Inggrid (UNPAR)

       Pertanyaan   :   Bagaimana mengatasi bau dari asam sintesis tersebut?
                                            Bagaimana mengatasi alergi dari gluten? Padahal komposisi masih 60%
       Jawaban   :   Bau langu diatasi dengan daun salam, ketika pengukusan. Alergi bisa diatasi dengan mencari alternatif alin, misal jamur dan kacang merah.

2.   Penanya   :   Dewi Tristantini (UI)

       Pertanyaan   :   Tambahan dari pembimbing : Memang gluten sebagian orang akan alergi. Pernah dicoba dengan nangka muda. Banyak kandidat pengganti, namun daging sintesis non gluten?
       Jawaban   :   Belum ada. Asam amino esensial selain daging masih banyak.