The application of different heat processing technique on eel (Monopterus albus) galantine

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Abstract. Eel (Monopterus albus) is one of the fisheries commodities commonly used as food material in Indonesia. An innovation to attract more people to consume this high nutrient commodity is by diversifying eel into a galantine. This study investigated the effect of different eel composition and heat processing techniques on the sensory, nutrient, and microbiology quality of the eel galantine. Four different eel galantine formulas were examined, viz. steaming + 5% eel (A), steaming + 10% eel (B), grilling + 5% eel (C), and grilling + 10% eel (D). The sensory, nutrient, and microbiology quality of the samples were analyzed. The study indicated that the panelists preferred sample C's appearance and aroma. The protein, moisture, ash, and fat content in all samples met the Indonesian National Standard (SNI) requirement. Sample B had higher vitamin A compared to sample D. The Total Plate Count parameter did not meet the requirement.

1. Introduction
Swamp eel (Monopterus albus) is one of Indonesian freshwater fisheries commodities with high economic value [1,2]. The production of swamp eel aquaculture reached 464 tonnes in 2017 [3], with local market value of 2.8-4.5 USD/kg (1 USD = Rp 14,500) [1]. Indonesian swamp eel commodities are also exported to many countries, such as Japan, Malaysia, China, South Korea, Taiwan, and Singapore [4]. The swamp eel also contains high nutrition value, especially protein and vitamin A [1,5]. According to Redaksi Agromedia [5], eel comprises 14.0% (w/w) of protein, 1,600 SI of vitamin A, 303 kcal of calorie, 27% (w/w) of fat, and 58% (w/w) of water.

In some areas of Indonesia, such as Java and Sumatera, eel has been commonly processed as a food source. Some examples of processed eel products in Indonesia are eel chips, shredded eel, and eel chili sauce. However, eel's popularity as a food source in Indonesia is still low because they are not as diversified and less attractive than other processed fish products [5,6]. Therefore, the authors proposed eel galantine as an eel product diversification.

Galantine is a variation of minced meat that utilizes the gel strength of the meat, commonly processed from chicken, beef, and fish meat [7,8]. Galantine can be more preserved in cold storage compared to raw meat since galantine production has gone through the heating process. Therefore, the presence of microbes in the meat is reduced [7]. Galantine is a mixture of local and western styles of food and already well known by the people [9]. Hence, eel galantine is expected to be more attractive to consumers. Galantine is also known as high protein food, which can reach up to 16% (w/w) [9]. From an economic perspective, the local market value of galantine can reach 6.9 USD/kg [10].
In the previous report, galantine is processed through heat treatment. Heat treatment is commonly applied to fisheries products to increase the attractiveness of the products and more importantly, to extend the product’s shelf life [11]. A couple of heat treatments that can be applied for eel galantine production is steaming and grilling [7,11]. Steaming applies steam-mediated heat to the surface of materials, whereas grilling applies dry heat [12,13]. Different heat transfer media will have a different effect on the quality of the end product. Additionally, the quality of galantine is affected by the composition of the materials [8]. Therefore, this study aims to investigate the quality of eel galantine, namely sensory, nutrient, and microbiology, by applying different heat treatment and eel concentration. Hopefully, this study can support the acceptance of eel galantine by the national standard and market.

2. Material and Methods

2.1. Time of the study
This study was carried out in March-May 2020.

2.2. Sample collection
Swamp eel (M. albus) was bought from the local market, which was caught from rice fields and swamps in Karawang and Bekasi Regency, West Java, Indonesia.

2.3. Eel galantine processing
The eel galantine processing began with the receiving of swamp eel (M. albus). The eel was rinsed with flowing water and submerged in salted water (salt:water mass ratio of 1:2) for 1 hour. Lime juice was added to the water to clean the skin's mucus. The eel was cut from the posterior, ventral, to the anterior end, and then eviscerated. The eel's head, tail, and skin of eel were removed, and then the bone was cut to the length. The meat was retrieved by using a knife and a spoon, ground with a food processor, and then mixed with other eel galantine materials according to the formulation (Table 1). The formulation was based on the total weight of 1,000 g (1 kg) of materials. Formulation I and formulation II consisted of 5% (w/w) and 10% (w/w) of eel meat, respectively [14,15].

The eel galantine materials that were already mixed then molded with a pan. Afterwards, the eel galantine mixture was heated with two different heat processing techniques simultaneously, steaming and grilling. The steaming process was carried out for 1 hour with a temperature range of 50-90°C by using a manual steam pan. The grilling process was carried out for 30 minutes with a temperature range of 120-160°C by using an electric oven (Kirin, Indonesia). After the heating process, the eel galantine underwent a draining process for 1 hour at room temperature. Finally, the eel galantine was packed in a vacuum nylon-based plastic packaging and stored in a freezer. The resulting eel galantine variants were sample A: steamed eel galantine with 5% (w/w) eel composition, sample B: steamed eel galantine with 10% (w/w) eel composition, sample C: grilled eel galantine with 5% (w/w) eel composition, and sample D: grilled eel galantine with 10% (w/w) eel composition [14,15].

2.4. Sensory analysis
The sensory analysis was based on the Indonesian National Standard SNI 2729-2013 Fresh Fish and SNI 2346-2015 Guidelines of Sensory Test for Fisheries Products documents [16,17]. The sensory analysis was divided into an organoleptic test for the fresh eel raw material and a hedonic test for the eel galantine. Six panelists did the organoleptic test with one replication for six parameters, which are eyes, gills, skin mucus, meat, aroma, and texture. Thirty panelists performed the hedonic test with three replications for four parameters, which are appearance, aroma, texture, and taste. The result of the organoleptic and hedonic test was scored within the scale of 1-9. The scale indicator and test score calculation referred to SNI 2729-2013 and SNI 2346-2015 document [16,17].
Table 1. The formulation of eel galantine's materials.

| Materials       | Formulation I (% w/w) | Formulation II (% w/w) |
|-----------------|-----------------------|-------------------------|
| Eel meat        | 5                     | 10                      |
| Bread flour     | 10                    | 15                      |
| Egg             | 60                    | 50                      |
| Onion           | 5                     | 5                       |
| Garlic          | 5                     | 5                       |
| Candlenut       | 2                     | 1.8                     |
| White sugar     | 4                     | 4                       |
| Brown sugar     | 4                     | 4                       |
| Pepper          | 0.4                   | 0.4                     |
| Nutmeg          | 0.1                   | 0.1                     |
| Milk            | 1.8                   | 2                       |
| Salt            | 1.7                   | 1.7                     |
| Water           | 1                     | 1                       |
| Total           | 100                   | 100                     |

2.5. Chemical analysis
The chemical analysis comprised of ash, moisture, fat, protein, carbohydrate, and vitamin A content. The ash, moisture, fat, and protein content were analyzed according to the SNI 01-2354.1-2006 Chemical Analysis Method - Part 1: Determination of Ash Content in Fisheries Products, SNI 01-2354.2-2006 Chemical Analysis Method - Part 2: Determination of Moisture Content in Fisheries Products, SNI 01-2354.3-2006 Chemical Analysis Method - Part 3: Determination of Total Fat Content in Fisheries Products, and SNI 01-2354.4-2006 Chemical Analysis Method - Part 4: Determination of Protein Content with Total Nitrogen Method in Fisheries Products document [18-21]. The ash, moisture, fat, and protein content analysis were carried out in Karawang Business Service Center for Aquaculture Production (BLUPPB), Karawang, Indonesia.

The carbohydrate content was calculated based on by difference method according to the Official Method of Analysis of The Association of Official Analytical of Chemist [22]. Meanwhile, the vitamin A content was analyzed based on Krismaputri et al. [23]. The vitamin A content analysis was performed in Sucofindo test laboratory, Bekasi, Indonesia.

2.6. Microbiology analysis
The microbiology quality of eel galantine was assessed based on the Total Plate Count (TPC). The TPC was performed according to the SNI 2332.3:2015 Microbiology Analysis Method - Part 3: Determination of Total Plate Count in Fisheries Products document [24] in Karawang Business Service Center for Aquaculture Production (BLUPPB), Karawang, Indonesia.

3. Results and Discussion

3.1. Sensory quality of eel galantine
An organoleptic test was carried out to confirm the quality of the fresh eel (Figure 1). The score for eyes, gills, skin mucus, meat, aroma, and texture of the fresh eel were 7-8 (Figure 2). According to SNI 2729-2013 Fresh Fish [16], the minimum requirement of organoleptic score for fresh fisheries materials is 7. Therefore, the fresh eel used in this study passed the organoleptic parameter requirement. Eels produce mucus on their skin to support their respiration. However, the mucus causes a fishier aroma [25]. In this study, lime juice was used to support cleaning the mucus during the washing step.
A hedonic test was carried out to examine the product’s acceptance by the consumers. The hedonic test scores a product between 1-9, where 1 is very much disliked and 9 is very much liked [17]. The result of the hedonic test for each eel galantine variant was shown in Table 2, for appearance, aroma, taste, and texture parameter, correspondingly.

The appearance of sample C was more preferred by the panelist, with a score of 7 (Table 2). Sample C was grilled and had a brownish color that possibly was more attractive for the panelists [26]. The panelists more preferred sample C’s aroma with a score of 6.5 (Table 2). It was expected that sample C released more aromatic volatile compounds due to the grilling process. Sample C also had lesser eel composition compared to sample D. Therefore, the fishy smell from the eel was probably covered by
the other ingredients [26,27]. Sample B-D's taste were scored 6.5, which is between slightly liked and liked (Table 2). The taste of food materials is usually affected by their ingredients, the temperature, and other cooking method variables [26]. Sample B and C's texture were scored 6.5, which is between slightly liked and liked (Table 2). The texture was perceived as a cookedness level by the panelists and was mostly affected by the moisture content [28].

### Table 2. The hedonic score of eel galantine variants.

| Hedonic parameters | Sample  | Sample  | Sample  | Sample  |
|--------------------|---------|---------|---------|---------|
|                    | A       | B       | C       | D       |
| Appearance         | 6       | 6.5     | 7       | 6       |
| Aroma              | 6       | 6       | 6.5     | 6       |
| Taste              | 6       | 6.5     | 6.5     | 6.5     |
| Texture            | 6       | 6.5     | 6.5     | 6       |

#### 3.2. Nutrient content of eel galantine

The nutrient content of eel galantine will be discussed according to the trend based on different eel composition and heat treatment, and then compared with the quality requirement from the Indonesian National Standard document. Since there is no standard document for galantine products, the SNI 3820:2015 Meat Sausage document [29] was used as the reference. Sausages are processed meat that use tapioca flour, while galantines are processed meat that use bread flour and egg as the additive.

The ash content of eel galantine (Table 3) did not have a trend based on both different eel composition and heat treatment. The ash content of all eel galantine variants met the Indonesian National Standard requirement [29]. The ash content represents the mineral content in food products [30].

The eel galantine with higher eel composition (sample B and D) had less moisture content (Table 3). It was probably due to the substitution of the watery material, such as egg, with eel meat. Egg contains 74% (w/w) moisture. On the other hand, the steamed eel galantine variants (sample A and B) had higher moisture content (Table 3). It was possibly due to the steaming process itself. The steaming process involves water vapor that carries the heat, while the grilling process involves direct heat [31]. The moisture content in all eel galantine variants passed the Indonesian National Standard requirement [29]. The moisture content is an important nutrient parameter in food materials, since the moisture or water affects the appearance, texture, and preservation of the food [27].

### Table 3. The nutrient content in eel galantine variants.

| Nutrient components | Sample  | Sample  | Sample  | Sample  |
|---------------------|---------|---------|---------|---------|
|                     | A       | B       | C       | D       | Quality requirement [29] |
| Ash (% w/w)         | 2.39    | 2.70    | 2.76    | 2.57    | < 3 |
| Moisture (% w/w)    | 60.76   | 57.29   | 57.20   | 56.87   | < 67.0 |
| Fat (% w/w)         | 2.46    | 2.70    | 3.33    | 2.17    | < 20 |
| Protein (% w/w)     | 10.18   | 10.49   | 11.85   | 10.81   | > 8 |
| Carbohydrate (% w/w)| 24.21   | 26.82   | 24.86   | 27.58   | - |
| Vitamin A (mg/kg)   | -       | 0.38    | -       | 0.17    | - |

The fat content of eel galantine (Table 3) did not have a trend. Nevertheless, the fat content of all eel galantine variants was lower than the maximum limit according to SNI 3820:2015 [29]. The fat content in eel galantine can be affected by the eel meat composition and other additives such as egg and milk [32]. The temperature and duration of the heat treatment must also be considered to make sure that the fat content is not decomposed [33].

The protein content of eel galantine (Table 3) did not have a trend based on the eel composition. However, the steamed eel galantines (sample A and B) had lower protein content than the grilled...
samples (sample C and D). Usually, higher temperature process (viz. grilling, $T = 120-160^\circ C$; compared to steaming, $T = 50-90^\circ C$) could potentially denature more protein and therefore decrease the protein content of the food materials. Possibly, the lower moisture content in the grilled eel galantine variants had a role in this result [30,31]. The protein content of all eel galantine variants also met the requirement according to SNI 3820:2015 [29]. Besides the eel composition, the protein content of eel galantine could also be affected by other additives, such as egg and milk composition [32].

The eel galantine with higher eel composition (sample B and D) had more carbohydrate content (Table 3) than the samples with lower eel composition (sample A and C). Also, the grilled eel galantines (sample C and D) had higher carbohydrate content than the steamed galantines (sample A and B). The carbohydrate content in eel galantine was mostly affected by the bread flour composition. Sample B and D had higher bread flour composition (15% w/w) compared to sample A and C (10% w/w) and therefore had higher carbohydrate content. Whereas the grilled eel galantine variants had higher carbohydrate content, possibly due to the less moisture content that they had [34]. The carbohydrate content has a role in food characteristics, such as taste, texture, and color [26].

The vitamin A content in food materials is very affected by the temperature of the heat treatment [35]. Therefore, the vitamin A content in eel galantine was only observed based on the heat treatment. Sample B and D represented steamed eel galantine and grilled eel galantine, respectively (Table 3). Sample B had higher vitamin A content compared to sample D. This result confirmed the information from the literature that vitamin A is not resistant to high temperature [35]. A higher cooking temperature could degrade most of the vitamin A and therefore lower the vitamin A content in the food material. In this case, the steaming process applied a temperature of 50-90°C, while the grilling process applied a temperature of 120-160°C.

3.3. Microbiology quality of eel galantine

The result of the Total Plate Count (TPC) of eel galantine variants is presented in Table 4. The TPC of eel galantine had an increasing trend from sample A to sample D. However, the TPC of all eel galantine variants did not meet the quality requirement from the Indonesian National Standard [29]. This result possibly occurred due to the characteristic of the eel galantine that was moist. The moist condition could support the rapid growth of bacteria in the eel galantine [36].

| Microbiology quality parameter | Sample | Quality requirement [29] |
|-------------------------------|--------|-------------------------|
| Total Plate Count (CFU/mL)    | A      | B                       | C        | D        | < 1 x 10^5 |
|                               | $4.3 \times 10^8$ | $6.6 \times 10^8$ | $8.9 \times 10^8$ | $9.5 \times 10^8$ |

4. Conclusion

In conclusion, this study showed that the grilled eel galantine with 5% (w/w) of eel composition variant (sample C) was more preferred by the panelists based on the sensory evaluation. This study also showed that the trend between different eel composition and different heat treatment with eel galantine nutrient content was shown in moisture, protein, carbohydrate, and vitamin A content. The ash, moisture, fat, and protein content of all eel galantine variants met the quality requirement of the Indonesia National Standard. However, the TPC of all eel galantine variants did not meet the quality requirement of the Indonesian National Standard. The heat treatment using a moderate temperature is more preferred, mainly to preserve the protein and vitamin A content. More variations of eel galantine composition and heat treatment should be studied further with a focus to improve the sensory and microbiology quality by producing less moisture product, and to provide more data set to see the trend of the quality of eel galantine.
References
[1] Scabra A R, Azhar F and Lestari D P 2019 Prosiding PEPADU 1 333–40
[2] Mashuri M, Sumarjan S and Abidin Z 2012 Jurnal Perikanan Unram 1 1–7
[3] The Center for Data, Statistics and Information 2018 Marine and fisheries in figures 2018 (The Center for Data, Statistics and Information, Ministry of Marine Affairs and Fisheries)
[4] Hermawan I and Setiawan W 2013 Budi daya belut (AgroMedia Pustaka)
[5] Redaksi Agromedia 2008 Budi daya belut di pekarangan rumah (AgroMedia Pustaka)
[6] Junariyata M F 2012 Panen belut: 3 bulan di media air bening tanpa lumpur (Penebar Swadaya)
[7] Atmaja F A K 2019 Pembuatan galantine (gatebe) with soy sauce dengan substitusi tempe benguk (Universitas Negeri Yogyakarta)
[8] Swastawati F, Wijayanti I, Suminto S and Prasetyo D Y B 2018 Jurnal Pengolahan Hasil Perikanan Indonesia 21 433–42
[9] Susanti A 2013 Avatara 1 450–60
[10] Amdar A A, Anas P and Yuniarti T 2012 Jurnal Penyuluhan Perikanan dan Kelautan 13 225–42
[11] Abraha B, Admassu H, Mahmud A, Tsige H, Shui X W and Fang Y 2018 MOJ Food Processing & Technology 6 376–82
[12] Mora B, Curti E, Vittadini E and Barbanti D 2011 Meat science 88 489–97
[13] Huang X H, Fu B S, Qi L B, Zhang Y Y, Du M, Dong X P, Zhu B W and Qin L 2019 Food & function 10 6473–83
[14] Darmawan D, Sulmartiwi L and Abdillah A A 2019 Energy & Environmental Science 236 012116
[15] Saputri A E 2019 Substitusi tepung sorgum dalam pembuatan selat solo galantine (Universitas Negeri Yogyakarta)
[16] Badan Standarisasi Nasional 2013 SNI 2729:2013 Ikan segar (Badan Standarisasi Nasional)
[17] Badan Standarisasi Nasional 2015 SNI 2346:2015 Pedoman pengujian sensori pada produk perikanan (Badan Standarisasi Nasional)
[18] Badan Standarisasi Nasional 2006 SNI 01-2354.1-2006 Cara uji kimia - Bagian 1: Penentuan kadar abu pada produk perikanan (Badan Standarisasi Nasional)
[19] Badan Standarisasi Nasional 2006 SNI 01-2354.2-2006 Cara uji kimia - Bagian 2: Penentuan kadar air pada produk perikanan (Badan Standarisasi Nasional)
[20] Badan Standarisasi Nasional 2006 SNI 01-2354.3-2006 Cara uji kimia - Bagian 3: penentuan kadar lemak total pada produk perikanan (Badan Standarisasi Nasional)
[21] Badan Standarisasi Nasional 2006 SNI 01-2354.4-2006 Cara uji kimia - Bagian 4: penentuan kadar protein dengan metode total nitrogen pada produk perikanan (Badan Standarisasi Nasional)
[22] Association of Official Analytical Chemist 2005 Official method of analysis of the association of official analytical of chemist (Arlington, Virginia, USA: Association of Official Analytical Chemist, Inc)
[23] Krismaputri M E, Hintono A and Pramono Y B 2013 Animal Agriculture Journal 2 288–94
[24] Badan Standarisasi Nasional 2015 SNI 2332.3:2015 Cara uji mikrobiologi - Bagian 3: Penentuan Angka Lempeng Total (ALT) pada produk perikanan (Badan Standarisasi Nasional)
[25] Taufik A and Saparinto C 2008 Usaha pembesaran belut di kolam tembok, terpal, dan drum/tong (Penebar Swadaya)
[26] Asare S N, Ijong F G I, Rieuwpassa F J and Setiawat N P 2018 Jurnal Ilmiah Tindalung 4 10–8
[27] Majid A, Agustini T W and Rianingsih L 2014 Jurnal Pengolahan dan Bioteknologi Hasil Perikanan 3 17–24
[28] Widjanarko S B, Zubaidah E and Kusuma A M 2012 Jurnal Teknologi Pertanian 4 193–202
[29] Badan Standarisasi Nasional 2015 SNI 3820:2015 Sosis daging (Badan Standarisasi Nasional)
[30] Sitoresmi M A K 2012 Pengaruh lama pemanggangan dan ukuran tebal tempe terhadap komposisi proksimat tempe kedelai (Universitas Muhammadiyah Surakarta)
[31] Miratis S T, Sulistiyati T D and Suprayitno H E 2013 Jurnal Mahasiswa Teknologi Hasil
Perikanan 1 33–45
[32] Fadmi A, Herawati N and Restuhadi F 2014 *Jurnal online mahasiswa Fakultas Pertanian Universitas Riau* 1 1–13
[33] Sundari D, Almasyhuri and Lamid A 2015 *Media Penelitian dan Pengembangan Kesehatan* 25 235–42.
[34] Riansyah A, Supriadi A and Nopianti R 2013 *Jurnal Fishtech* 2 53–68
[35] Hok K T, Setyo W, Irawaty W and Soetaredjo F E 2017 *Jurnal Ilmiah Widya Teknik* 6 111–20
[36] Shewfelt R L 2014 *Pengantar ilmu pangan* (Buku Kedokteran)