Effect of application edible coating on the quality of kopyor coconut meat during storage

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Abstract. In order to increase the shelf life of kopyor coconut meat, it is necessary to pre-process it so that its quality can be maintained. The study aimed to determine kopyor coconut meat characteristics, which can be applied in biocellulose edible coating. The research was conducted in 2019 at the Laboratory of Indonesian Palm Crops Research Institute. The treatments consisted of 1) Without edible coating, 2) Edible coating application, and 3) Edible coating application plus ascorbic acid. Kopyor coconut meat has a water content of 77.51%, protein 1.71%, fat 9.92%, carbohydrates 10.00%, ash content 0.82%, and crude fiber 0.78%. Medium-chain fatty acids 42.64% and long-chain fatty acids 44.60%. The organoleptic test showed that kopyor coconut meat during 0-3 months of storage without edible coating had color, aroma, and taste values ranging from 3.24-4.07. Furthermore, edible coatings applications have color, aroma, and taste values ranging from 3.13-3.53. In comparison, those with edible coating and ascorbic acid have color, aroma, and taste values ranging from 1.78 to 3.53. The total microbes without edible coating application were the highest, although there was a decrease during storage, while those with edible coating application were inhibited.

Keywords: kopyor coconut meat, organoleptic, total microbe

1. Introduction
Kopyor coconut is a coconut whose flesh component is different from normal coconut flesh. The fruit's flesh does not stick perfectly to the shell, so it does not look compact. The nature of the flesh is soft, and some of it floats in coconut water. The nature of kopyor, which is assumed to be the result of natural mutation, is expressed in the form of endosperm abnormalities with a crumb texture and detached from the shell [1]. In the Philippines, it is known as 'Makapuno,' in Sri Lanka it is called 'Dikiri Pol,' in India 'Thairu Thengai' in Thailand 'Maphrao Kathi' and in Vietnam 'Dua Dac Ruot' [2]. It tastes savory, delicious, tender so that it is in great demand by consumers. The supply of 3,000-5,000 pieces from Pati-Central Java and 300-500 pieces per week from Kalianda, South Lampung, has not been able to meet market demand in Jakarta, which continues to increase [3]. The need per week reaches 600 pieces and during the fasting month reaches 900 pieces/week, with a price of IDR 50,000 to IDR 60,000 [4].

In Indonesia, kopyor coconut is generally consumed in limited quantities as an ingredient for kopyor coconut ice, while in the Philippines and Thailand, there are several variants of food that have been mixed with kopyor coconut meat. One of the variants of kopyor coconut meat products that have been processed and packaged in jar bottles can be found in one of the world's well-known e-commerce sites with varying prices. Because kopyor coconut flesh is easy to change in quality, various efforts have been made, including packaging and followed by storage at a specific temperature.
Several research results show that kopyor coconuts that have been separated from their coir and stored at 5°C have a shelf life of 6 weeks, compared to three days stored at 30°C. Furthermore, the shelf life can reach 10 weeks if stored in one plastic bag (characteristic 0.3 x 0.25 m; thickness 22-23 microns) at 25°C [5]. Then kopyor coconut flesh packed in Polyamide (PA) plastic, with dimensions of length 14x20 cm and thickness of 150 m, can maintain organoleptic quality and suppress microbial growth for up to 27 days at 5°C storage [6]. Cold storage and packaging methods have been widely used to ship to long-distance markets such as Europe and the United States [7].

Another method to maintain product quality that is currently being developed is to use edible film/coating. The basic ingredients for making edible films can be classified into three groups, namely hydrocolloids (proteins, polysaccharides, and fats). Fats (fatty acids and waxes) and mixtures of hydrocolloids with fats and proteins (corn protein, soybean, wheat gluten, casein, collagen, gelatin, corn zein, milk protein, and fish protein. Polysaccharides are cellulose and its derivatives, starch, and its derivatives, pectin, extracts of marine algae (alginate, carrageenan, agar), and gums (gum arabic, gum karaya) [8].

The difference between edible film and edible coating is that edible film is a packaging material that has been formed in the form of a thin layer (film) before being used for packaging food products. In comparison, the edible coating is a packaging material formed directly on food products and ingredients [9]. Edible films and coatings are used in medicinal products, confectionery, fresh fruits, vegetables, and some meat products [10].

Edible film/coating can be processed from biocellulose/nata de coco as the base material. Rindengan et al. [11], has carried out biocellulose processing using coconut water that has been left for 0-6 days and incubated for 1-3 weeks. Characteristics of biocellulose suitable for edible films, characterized by high levels of cellulose and percent elongation obtained at 4 days delay of coconut water and 2 weeks of incubation.

Antioxidants need to be added to protect the coated product to avoid oxidative rancidity, degradation, and color loss [12]. Furthermore, Gonzales-Aquilar et al. [13] stated that adding antioxidants to edible coatings can extend the product's shelf life.

This study aims to determine the shelf life and characteristics of kopyor coconut meat, which is applied to an edible coating made from nata de coco biocellulose as raw material.

2. Methodology
The research was conducted at the Product Processing Laboratory and the Physiology Laboratory of the Indonesian Palm Crops Research Institute, Agricultural Product Technology Laboratory- UGM, Yogyakarta, and the Integrated Laboratory of IPB-Bogor, from January to December 2019.

In this experiment, 10-month old Kopyor Green Dwarf (GHK) variety was obtained from IPCRI's experimental garden. For the nata de coco production, *Acetobacter xylinum* starter was obtained from IPCRI's collection while commercial sugar, analytical grade Sodium Hydroxide, technical acetic acid, commercial ascorbic acid, glycerol, and Carboxyl Methyl Cellulose (CMC) were obtained from local suppliers. The tools used are water bath, measuring cup, Erlenmeyer, pipette, digital scale, fermentation container (plastic), digital pH meter, filter cloth, blender, vacuum sealer, refrigerator, freezer, and other tools.

In nata de coco production, mature coconut water was used as a media solution for the growth of the bacteria. First, the coconut water was allowed to stand for 4 days to decrease its pH level. Then, the water was added 5% sucrose and boiled to dissolve all ingredients and sterilize all microorganisms. After the boiled water was cooled down to room temperature, 15% starter was added, and the fermentation process took 14 days to produce biocellulose [11].

The second stage is the manufacture of edible coatings. Biocellulose is purified by boiling in 1% NaOH solution to remove non-cellulose components, washed with water until neutral, then processed into slurry by blending, then let stand for 24 hours. Then 0.1% carboxymethyl cellulose (CMC) was dissolved in distilled water little by a little while stirring on a hot plate at 80°C, 0.15% glycerol was
added and stirred until homogeneous, then 9.75% slurry was added and kept stirring over the heater until homogeneous. Then add distilled water until the total volume becomes 300 ml.

The next stage is the application of the edible coating on kopyor coconut meat. The procedure is as follows, separate the kopyor coconut meat from the shell, then coat it with a biocellulose slurry solution to coat all surfaces, then dry it at a temperature of 40°C, for 40-45 minutes [14] so that the edible coating adheres perfectly. Then packed in a vacuum and stored in the freezer at -16°C.

For the characteristic of the coconut meat, proximate analysis, fatty acid profile, total microbes, and sensory analysis were used. The proximate analysis was done using some protocols as follows: oven drying method for the water content, protein by Kjeldahl method, fat content using solvent extraction method, ash content, crude fiber, and carbohydrates by difference. AOAC 969.33 [15] method was used for fatty acid profile analysis and total microbes was calculated using total plate count.

The study was conducted using a descriptive method, with treatments consisting of a1) without application (control), a2) edible coating application, a3) edible coating application + ascorbic acid. Observations were made for 0 months, 1 month, 2 months, and 3 months. The repetition was done 2 times. Observations consisted of the characteristics of raw materials, organoleptic and total microbes during storage. The assessment is given with a score of 1 = very dislike, 2 = dislike, 3 = normal, 4 = like and 5 = very like [16].

3. Results and discussion
3.1. Characteristics of kopyor coconut meat raw materials
The results of proximate analysis of Kopyor Green Dwarf (GHK) coconut meat show 77.51% water content, 1.71% protein, 9.92% fat, 10.00% carbohydrates, 0.82% ash content, and 0.78% crude fiber. Furthermore, the profile and fatty acid percentage of Kopyor Green Dwarf (GHK) coconut meat can be seen in Table 1.

| Kinds of fatty acids   | %     |
|-----------------------|-------|
| Caproic, C6           | 0.14  |
| Caprilic, C8          | 2.72  |
| Capric, C10           | 2.74  |
| Undecanoic, C11       | 0.02  |
| Lauric, C12           | 37.00 |
| **Total MCFA**        | **42.64** |
| Tridecanoic, C13      | 0.04  |
| Myristic, C14         | 17.80 |
| Palmitic, C16         | 10.40 |
| Palmitoleic, C16:1    | 0.02  |
| Heptadecanoic, C17    | 0.01  |
| Stearic, C18:0        | 2.84  |
| **Saturated Fat**     | **71.00** |
| Oleic, C18:1n9c       | 10.21 |
| Linoleic, C18:2n6c    | 2.75  |
| Arachidic, C20        | 0.11  |
| Cis-11 Eicosenoic, C20:1 | 0.07  |
| Cis-11,14 Eicosadienoic, C20:2 | 0.04 |
| Behenic acid, C22     | 0.03  |
| Lynoceric, C24        | 0.08  |
| **Unsaturated Fat**   | **13.06** |
| **LCFA**              | **44.40** |
Based on Table 1, lauric acid (C12) which is dominant in coconut oil is only 37%, so the total medium-chain fatty acids/ALRM, namely the C6-C12 chain [17] is only 42.64%. This value is lower than the results of Tenda et.al [18] research, namely C12 of 43.26% and total ALRM of 51.08%. This is probably caused by differences in the level of fruit maturity and also the environmental conditions of coconut plant growth. The results of research by Leorna [19], on kopyor coconut variety VMAC5, showed that C12 in coconuts aged 8 months was 43.41%, 9 months 46.91%, and 10 months 45.85%. Lauric acid (C12) can significantly reduce fasting blood sugar. When a fresh coconut is consumed, it will help reduce blood glucose levels and body weight in normal healthy people [20] and has the greatest antimicrobial effect [6]. MCFA are not packaged in the form of lipoproteins but enter easily into the circulatory system directly to the liver and are immediately converted into energy such as carbohydrates [21]. Also, MCFA has benefits in skincare, haircare, immunomodulatory effects, and preventing Alzheimer's disease [22] as well as lowering the risk of atherosclerosis and heart disease [23].

Furthermore, the total long-chain fatty acid (LCFA) is 44.40%, which contains essential fatty acids linoleic/omega-6 fatty acids (C18:2) 2.75%. Linoleic fatty acid (omega-6) is one type of essential fatty acid that must be obtained from food because it cannot be metabolized in the body. In the body, omega-6 will be metabolized into arachidonic acid (AA). AA and linoleic rank second and third of the four types of fatty acids that support brain intelligence [24].

### 3.2. Kopyor coconut meat organoleptic application with edible coating

The results of organoleptic observations of kopyor coconut meat for 0-3 months of storage can be seen in Figure 1. Based on Figure 1, control kopyor coconut meat (not applied with edible coating) during 0-3 months of storage has organoleptic values, the color ranges from 3.26-3.86, aroma 3.24-3.60, and taste 3.40-4.07. Furthermore, the application of edible coating has a color value of 3.50-3.53, aroma 3.27-3.47, and taste 3.05-3.13. Meanwhile, the application of edible coating + ascorbic acid has a value of color 3.47-3.53, aroma 2.67-3.47, and taste 1.78-2.02. According to Soewarno [16], the criteria for the value of 1 = very dislike, 2 = dislike, 3 = normal, 4 = like and 5 = very like. The criterion value was compared with the value from the panelists, showing that edible coating added with ascorbic acid, in the assessment of aroma only up to 1 month of storage is still normal/normal, while 2 to 3 months of storage is not preferred. While on the taste assessment, the panelists did not like it from 0-3 months of storage. The condition shows that ascorbic acid is not suitable to be added to edible coating if it is used to coat kopyor coconut meat, even though the overall color assessment of the panelists still stated normal/normal.
Figure 1. Organoleptic characteristics of kopyor coconut meat with an edible coating applied for 0-3 months of storage at a temperature of -16°C.

The results obtained showed that in the control, there was a tendency for organoleptic values to decrease with longer storage. In parts that were applied with edible coating, organoleptic values tended to persist. Furthermore, the application of edible coating + ascorbic acid was only the color that persisted, while the aroma and taste of the organoleptic value decreased or were not favored by the panelists. Although ascorbic acid is classified as an antioxidant, it turns out to produce a taste that is not in accordance with the wishes of the panelists.

3.3. The total microbes of kopyor coconut meat are applied with an edible coating

The results of microbiological observations showed that kopyor coconut meat without heat and coating treatment has high total microbes compared to the oven-coating treatment samples (Figure 2). Since microorganisms are sensitive to heat, the pre-heating process before the coating application contributes in inhibiting microbial growth. Therefore, the control sample resulted in a higher total microbe than the other treatments. When the edible coating was applied, both without addition and with ascorbic acid, microbial growth was inhibited during storage at a temperature of -16°C. The same thing was reported by Rindengan et al. [14], young coconut meat, which was applied with edible coating and then stored in the freezer at -16°C for 3 months, had the lowest total microbes compared to that stored in the Refrigerator at 10°C. The results of Antu et al. [6] research showed that kopyor coconut meat stored at a temperature of 10°C, packaged in PA (Polyamide) plastic packaging had a total microbe of 7.46 log CFU gr⁻¹. One of the functions of adding CMC plasticizer in coating formulations is to inhibit the growth of mold in cheese and sausages [25]. It was reported by Rindengan et al. [14], that young coconut meat that was applied with edible coating and then stored at a temperature of -16°C for up to 3 months had the lowest total microbe compared to that stored at 10°C.

Until now, there is no commercialized frozen kopyor coconut meat product, so the minimum standard for total microbial is not yet available. Therefore, as a comparison, the total microbes of frozen chicken meat (carcass and boneless and minced chicken) are 1 x 10⁶ colonies/gr [26]. Thus, the total microbes in coated kopyor coconut meat are lower compared to frozen chicken meat.
Figure 2. Total microbes of kopyor coconut meat were applied with edible coating for storage 0-3 months at -16°C (Control: no oven and coating treatment; EdCo: oven treatment + Edible Coating; EdCo+AA = Oven treatment + Edible Coating+Ascorbic acid).

4. Conclusion
Fresh kopyor coconut meat has 77.51% water content, 1.71% protein, 9.92% fat, 10.00% carbohydrate, 0.82% ash content, and 0.78% crude fiber. Contains lauric acid (C12) 37% with a total medium-chain fatty acid (LCFA) 42.64%, and long-chain fatty acid 44.40%, it contains omega-9 fatty acids (oleic acid, C18:1) 10, 21% and omega-6 fatty acids (linoleic essential fatty acid, C18:2) by 2.75%.

The organoleptic test showed that the control kopyor coconut meat (not applied with edible coating) during 0-3 months of storage had a color value ranging from 3.26-3.86, aroma 3.24-3.60, and taste 3.40-4.07. Furthermore, those applied to edible coatings have a color value of 3.50-3.53, aroma 3.27-3.47, and taste 3.05-3.13. While those that are applied to edible coating + ascorbic acid have a color value of 3.47-3.53, aroma 2.67-3.47, and taste 1.78-2.02.

Kopyor coconut meat with control treatment had high total microbes, although there was a decrease during storage. While the edible coating was applied, both without addition and with ascorbic acid, microbial growth was inhibited during storage. Based on the results obtained to extend the shelf life of kopyor coconut flesh to 3 months of storage in frozen conditions, it can be applied with the edible coating made from biocellulose nata de coco.

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