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Effect of Hydroxypropyl methylcellulose from oil palm empty fruit bunch on oil uptake and physical properties of French fries

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Abstract

Oil palm empty fruit bunches (OPEFB) can be used as raw material for Hydroxypropyl Methylcellulose (HPMC). HPMC can be used as a French fries coating to reduce oil uptake. This research aims to study the utilization of HPMC OPEFB as a French fries coating. This research consists of two stages. The first stage is cellulose extraction and HPMC synthesis. HPMC synthesis through alkalization, methylation, propylation, and neutralization. The second stage is the use of HPMC as a French fries coating with different concentrations (0, 1, 2, and 3%). Potatoes that have been peeled and washed, cut lengthwise with a thickness of about 0.5 cm. Further dipped in HPMC solution with different concentrations for 10 seconds, then carried out a frying pan. The HPMC from OPEFB is characterized by methyl and hydroxypropyl groups found at a wavenumber of 2891.30 cm^{-1}, a ring of pyranose at 995.79 cm^{-1} and hydroxyls (OH) groups at 3371.10 cm^{-1}. The coating of French fries with 3% HPMC OPEFB can reduce oil absorption by 16.09%. The higher the concentration of HPMC, will reduce the fat content but increase the moisture and the texture of French fries become softer. The preferred type of coating was HPMC 1%.

Keywords: oil uptake, coating, french fries, HPMC, OPEFB.

Practical Application: Oil palm empty fruit bunches (OPEFB) can be used as raw material for Hydroxypropyl Methylcellulose (HPMC). HPMC can be used as a french fries coating to reduce oil uptake. The coating of french fries with 3% HPMC OPEFB can reduce oil absorption by 16.09% and potential to be applied to the industry.

1 Introduction

Indonesia is currently the country with the largest area of oil palm land in the world. In 2019, oil palm plantations amounted to 14.6 million hectares, with CPO production reaching 48.42 million tons (Badan Pusat Statistik, 2020). It causes waste produced from oil palm plantations (on-farm) and palm oil mills (off-farm) more and more.

Palm oil plantation waste derived from the plantation includes palm oil stems and fronds produced at the opening of plantation areas, rejuvenation, and harvest of oil palm. Palm oil stem waste is obtained when replanting or replacing new crops after the oil palm plant is about 25 years old (Ngatirah et al., 2013). Biomass waste from palm oil mills, including empty fruit bunch (EFB), fiber, and palm shells. EFB waste is one of the most abundant palm oil solid wastes produced in palm oil mills. Processing of 1 (one) ton of fresh fruit bunch (FFB) will have 23% EFB or about 230 kg/ton TBS. The average potential number of EFB per year could reach 6.66 million tons of EFB/year (Yanti & Lestari, 2020). The estimated amount of EFB waste in Indonesia produced in 2030, around 54 million tons of TKKS (Hambali & Rivai, 2017).

During this time, the utilization of EFB returned to plantation land as compost and organic mulch. Not many efforts have been made to utilize solid waste as a value-added product (generating value-added products). One of the value-added products that can be developed is chemical compounds made from palm oil biomass, such as cellulose and its derivates. Palm oil biomass contains cellulose, hemicellulose, and lignin (Ngadi & Lani, 2014). EFB is a potential palm waste to be developed as a raw material for cellulose and its derivatives. EFB contains 49.25% cellulose, 51.61% lignin, and 11.36% hemicellulose (Ngatirah et al., 2013).

Cellulose is composed of glucose compounds with a bond of β-1.4 glycosidic. The physical properties of cellulose are influenced by three hydroxyl groups, located on carbon atom number 6 for the primary OH group and numbers 2 and 3 for secondary OH. These OH groups have different reactivity, and each other can form hydrogen bonds (Ngadi & Lani, 2014). Cellulose extraction from EFB begins with the delignification process using an alkaline solution to eliminate the lignin and hemicellulose components. An effective alkaline solution used is NaOH (Sudiyani et al., 2010; Ngadi & Lani, 2014; Ngatirah et al., 2013). Delignification with NaOH solution of 1% can reduce lignin by 31.47% (Ngatirah et al., 2013). The alkaline treatment will make the cells bulge to be easier to enter by chemical compounds and enter the crystalline part (Ngadi & Lani, 2014).

Cellulose can be derived into carboxymethyl cellulose (CMC), methylcellulose (MC), hydroxypropyl methylcellulose (HPMC), and hydroxypropyl cellulose (HPC) compounds. These cellulose-derived compounds have properties capable of forming good films (Varela & Fiszman, 2011; Ngadi & Lani, 2014). Therefore, these compounds can be used for coating various products fried

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in a lot of oil (deep frying), one of which is french fries. French fries are one of the products that people love. Fries that are not coated can absorb oil up to 50%. Therefore it is necessary to make efforts to reduce the amount of oil absorption in french fries. One of them is using coating using cellulose derivatives. At the beginning of the frying pan, a hydrocolloid layer will be formed that acts as a protective layer due to gelation due to heat induction at temperatures above 60 °C. It will inhibit or minimize the transfer of water and oil from the frying materials and medium (Ngadi & Lani, 2014).

HPMC is one of the cellulose derivatives that have ideal characteristics as coatings of food products. HPMC is widely used in the food and medicine industry because it has no taste, is odorless, flexible, and can dissolve in digestive fluids, organic solvents, and water. HPMC also has stability against moisture, heat, light, and air (Ghosal et al., 2011). In addition to hydroxyl groups, HPMC also has hydroxypropyl and methyl function groups that are hydrophobic so that the coating process becomes better.

Given the very high number of EFB (the average potential per year reaches 6.66 million tons), its utilization is not yet maximized. It is necessary to be studied about the potential of EFB as a source of cellulose and its derivatives and the use of HPMC EFB as a French fries coating. The purpose of this study is: (1) Studying cellulose extraction and HPMC synthesis cellulose empty fruit bunches, (2) Knowing the effect of french fries coating with HPMC EFB on the decrease in the amount of oil absorbed, moisture content, texture, and organoleptic preferences of french fries.

2 Materials and methods

2.1 Materials

The main ingredient for this study is EFB. Other ingredients are cooking oil, potatoes, seasoning flour, water, NaOH, acetic acid, NaOCl, H_2O_2, aquadest, PP indicator, Propylene oxide, Cellulose dimethyl (DMS), acetic acid, and ethanol 96%.

2.2 Cellulose extraction

Oil palm empty fruit bunch washed thoroughly then dried in the oven (Memert) and reduced in size 3-5 cm. EFB as much as 12.5 g in delignification using a solution of NaOH 12% (b/v) for 3 hours at a maintained temperature of 90-95 °C. After that, cooling and filtering are performed to separate cellulose from NaOH and other components of EFB. The following process is bleaching using a solution of H_2O_2 10% (b/v) for 1.5 hours with a maintained temperature of 80-90 °C. Then cellulose is washed thoroughly with aquadest to a neutral pH and obtained cellulose. Cellulose was further analyzed FTIR (FTIR spectrophotometer 8201PC Shimadzu).

2.3 HPMC Synthesis

As much as 5 g of cellulose fibers, added 100 mL isopropanol and catalyzed with 20 mL NaOH solution 10%. The mixture is then stirred at 25 °C for 1 hour and after alkalization, followed by a methylation process. The methylation process is done by adding 4.6 g DMS followed by propylation process by adding 5 g of propylene oxide (PO) at 55 °C while stirring for 3 hours. Furthermore, neutralization with acetic acid is 96%. After the slurry is neutral, filtering and washing are done four times with 96% alcohol solution. Solids obtained from the filtering results are then dried using an oven at a temperature of 60 °C for 30 minutes. After drying, continued with the completion using a blender and sieving using a scale sieving 60 mesh. HPMC flour then performed FTIR analysis (FTIR spectrophotometer 8201PC Shimadzu).

2.4 French fries coating with HPMC

The way of research is conducted as follows: first prepared HPMC solution empty bunches of palm oil and commercial CMC with a concentration of 1, 2, 3% and control (0%) by weighing HPMC and CMC commercial as much as 1, 2, and 3 g further dissolved with warm aquadest (80-90 °C) as much as 100 mL and stirred to homogeneous and added polypropylene glycol as much as 10% of the igniting material. Polypropylene glycol serves as a plasticizer. Potatoes are peeled and washed, then cut to an elongated size with a thickness of about 0.5 cm. The potato pieces are dipped in a coating solution for 10 seconds. Frying is done with a deep fat fryer (Astro engine) that has previously been given cooking oil 3 liters, at a temperature of 150 °C for 10 minutes until the color of potatoes golden yellow. French fries are drained and analyzed, including decreased oil content, fat content, moisture content, texture, and organoleptic preferences.

2.5 Decreased levels of french fries oil

Samples of french fries were carefully mashed and weighed 25 g on watch glasses previously known to weigh. The material is wrapped in filter paper and then put on the extraction tool. Then the solvents (n-hexane) as much as 250 mL are inserted into the extraction flask. The heater is turned on, and the extraction process is carried out at 80 °C. Observe the reflux that occurs, and the extraction process is stopped after reflux occurs ten times. The resulting extraction is separated by distillation at 80 °C. The distillation process is stopped after the solvent evaporates and is isolated and separated from the extract (oil). The oil was poured into a beaker glass, then dried in the oven at about 102 °C to remove residual solvents and water. The oil is cooled in the oil desiccator obtained then weighed. The percentage decrease in fat is obtained using the Equation 1:

$$\textit{Decreased levels of french fries oil}\,(\%) = \frac{(A-B)}{A} x100\% \tag{1}$$

A is the weight of french fries oil without mouthfuls and B is the weight of french fries oil with coating.

2.6 Fat Content Analysis

The sample of french fries was carefully mashed and weighed by 2 grams, then wrapped in filter paper and inserted into a soxhlet extraction tube that had been watered with tap water as a coolant. Prepare an Erlenmeyer flask that has been known to weigh and has been filled with 30 mL of petroleum ether solvent and attached to the test tube for 6 hours. After sufficient extraction time, the fat extract is put in the oven at 105 °C for

30 minutes, cooled in a desiccator, and weighed. Fat content was calculated with Equation 2:

$$Fat\,content\left(\%bb\right)=\frac{\mathrm{B}-\mathrm{C}}{\mathrm{A}}x100\% \tag{2}$$

Where, A is the initial sample weight (grams), B is the weight of Erlenmeyer and fat (grams), and C is the weight of empty Erlenmeyer (grams).

2.7 Moisture

Weighed 2 grams of mashed fries using a porcelain cup known to consider and then put in the oven at a temperature of 105 °C for 5 hours. The sample is cooled in a desiccator for 15 minutes, after which the cooled sample is weighed using an analytical balance sheet. The treatment is repeated to a constant weight. The moisture content was calculated with Equation 3:

$$Moisture\left(\%\right)=\frac{\mathrm{C}-\mathrm{A}}{\mathrm{B}-\mathrm{A}}x100\% \tag{3}$$

Where A is the weight of the unsampled cup (g), B is the weight of the cup with the sample before in the oven (g), and C is the weight of the cup with the sample after in the oven (g).

2.8 Texture

The sample of french fries is prepared and placed on the base of the penetrometer (Humboldt) so that the pointing needle and the surface of the sample are precisely tangent and the arrow on the scale shows a zero. Press the lever of the penetrometer for 10 seconds. The stabbing was carried out on the fries as much as 5 points, then read the scale on the tool that shows the depth of the needle penetrate the sample. The hardness measurement is repeated three times. The hardness of french fries is b/a/t with mm/gr/s units.

2.9 Sensory test of French fries

Sensory test of French fries following Li et al. (2020) with modification. Sensories test using 20 panelists. The test was conducted by giving questionnaires to panelists with parameter assessments, including taste, aroma, and color. The scale used ranges from 1-7 (immensely dislike – very like).

2.10 Data Analysis

The randomized complete block design (RCBD) was used as an experimental design, consisting of 2 factors. The first factor is a type of coating (HPMC EFB and commercial CMC). The second factor is the concentration of coating material consists of 1, 2, 3%, and control (0%). Each treatment is duplicated. The data were analyzed using analysis of variance (ANOVA) and Duncan multiple range tests (DMRT), which showed a significant difference.

3 Results and discussions

3.1 Analysis of FTIR (Fourier Transform Infra Red) cellulose and HPMC from EFB

Analysis of FTIR EFB cellulose showed in Figure 1.

The spectra FTIR results of cellulose palm bunches have peaks at a wavenumber of 3331.33, indicating the presence of hydroxyl groups (OH)—the spectra at a wavenumber of 1637.79 cm^{-1} show H_2O. CH_2 group at wavenumber 1421.88 cm^{-1} while CH group at wavenumber 1369.73 cm^{-1}. The COH (COC) cluster is visible at wavenumbers of 894.84-1157.07 cm^{-1}, as shown in Figure 1. The function groups at the peak of the FTIR spectra indicate that the identified compound is cellulose. Spectra FTIR cellulose empty bunches of palm oil above were not found peaks at a wavenumber of 1606-1623 cm^{-1} or 1432 cm^{-1}. It shows that the results of cellulose extraction no longer contain lignin components. The C=C bond in lignin will be found at a wavenumber of 1606-1623 cm^{-1}, while the O-CH_3 detoxifying group is located at a wavenumber of 1432 cm^{-1} (Ngadi & Lani, 2014). The extraction of cellulose empty palm bunches was also not found spectra with a wavenumber of about 1730-1740 cm^{-1} which is a group of C=O in hemicellulose.

Analysis of FTIR HPMC from EFB showed in Figure 2. The spectra FTIR work in Figure 2 shows a peak at a wavenumber of 3371.10 cm^{-1}, the peak identified as an OH cluster. Peak 1639.41 cm^{-1} was detected as a C-O cluster while CH_3 cluster was at peak 1417.59 cm^{-1}, while peak 1367.65 cm-1 was C-O-C group and methoxy group. The peak of 1020.93 cm^{-1} was identified as the pyranose ring. The CH_3 cluster is found at a wavenumber of 2891.3 cm^{-1}.

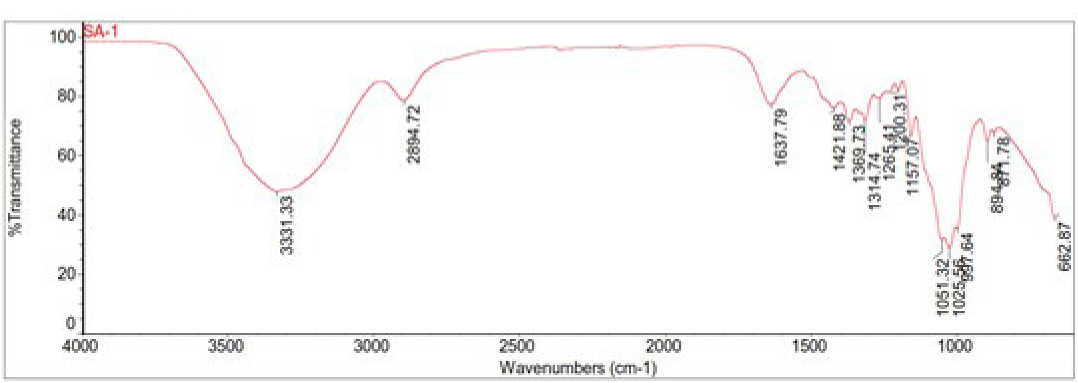

Figure 1. FTIR Cellulose extracted from empty fruit bunches.

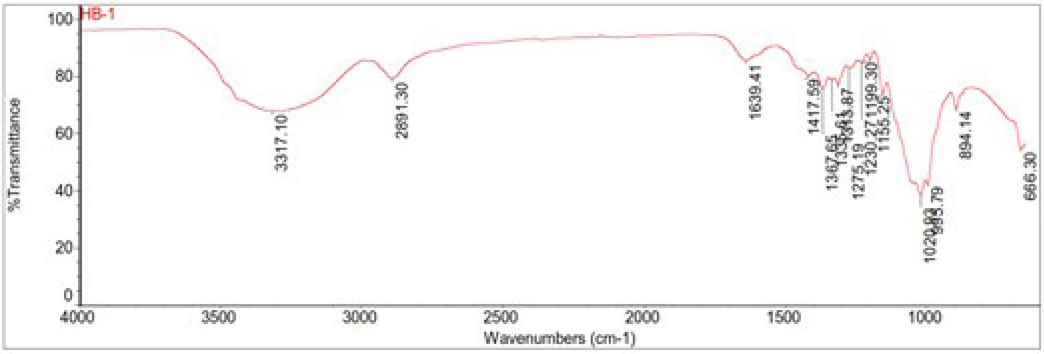

Figure 2. FTIR HPMC from empty fruit bunches.

The results are following the results of Somashekarrappa et al. (2013). The spectra for pure HPMC OH clusters are at wavenumber between 3050-3750 cm^{-1} (Somashekarrappa et al., 2013). While the C-O-C and C-O clusters are at a wavenumber of 1000 cm^{-1}, CH, CH_2, and CH_3 clusters are at 1250-1460 cm^{-1} and 2850-2980 cm^{-1}. H_2O is located at 1648 cm^{-1}, and OH is at 3500 cm^{-1}.

The spectra of HPMC EFB found no longer peaks at a wavenumber of 871.78 cm^{-1} (C-H), 1051.32 cm^{-1} (C-C) previously found in EFB cellulose spectra. The HPMC EFB spectra appear peaks at a wavenumber of 1336.61 cm^{-1}(C-O-C) and 1230.27 cm^{-1} (C-O-C). In ranges, HPMC number also occurred changes in the intensity of the broader and stronger OH (3317.10 cm^{-1}) group. The methyl and hydroxypropyl groups found at a wavenumber of about 2891.30 cm^{-1} medium at a wavenumber of 995.79 cm^{-1} were identified as pyranose rings. It is in accordance with Sahoo et al. (2011), which found that the OH group in HPMC spectra was found at a wavenumber of 3400-3500 cm^{-1}, methyl and hydroxymethyl groups at a wavenumber of 2900 cm^{-1}, C-O groups at a wavenumber of 1600-1650 cm^{-1}, C-O-C group and methoxy group at wavenumber 1350-1400 cm^{-1}, epoxide groups (C-O-C cyclic) 1250-1300 cm^{-1}, pyranose rings are at a wavenumber of 950-1000 cm^{-1}, and CH_2 clusters are at a wavenumber of 800-850 $cm^{-1.}$

3.2 Appliaction of HPMC EFB as a french fries coating

- a. Fat content of french fries

French fries can be coated with several compounds that are cellulose derivatives. The average fat content in french fries coated with HPMC EFB and commercial CMC can be seen in Table 1.

CMC is one of the cellulose derivatives considered the most effective as a mouthwash and can reduce oil absorbs by 35-40% (Kurek et al., 2017). Fried potatoes coated with HPMC EFB and commercial CMC have a fat content that tends to be lower than control (concentration 0%) or no coating French fries. There is no difference between the fat content of french fries and commercial HPMC EFB or CMC coating. That's because both HPMC and CMC are derivatives of cellulose to have almost the same properties. According to Li et al. (2013), both HPMC and CMC solutions have non-Newtonian pseudoplastic types, which are shown by the presence of polymers in the solution.

Table 1. Fat content of french fries with HPMC EFB and commercial CMC coating (%).

	Types of Coating*	
	HPMC EFB	Commercial CMC
Concentration 0%	26.70 ± 0.01^{a}	30.41 ± 0.01^{a}
Concentration 1%	24.66 ± 2.89 ^{a}	19.17 ± 0.04^{a}
Concentration 2%	17.65 ± 3.10^{ab}	17.79 ± 1.16^{ab}
Concentration 3%	12.47 ± 6.04^{b}	9.23 ± 7.96^{b}

*value is average ± SD (n=3). Average on column, followed by the same letter, indicates a not significant an insignificant difference in the Duncan Multiple Range Test (DMRT).

The higher the concentration of hydrocolloids, the higher the viscosity. The formation of gel layers on the material's surface is thicker, and its ability to withstand the migration of water and oil is more increased. The higher the concentration of mouthpieces used, will lower the fat content in the fries. That is following Angor's research (2016) which showed that fat levels decreased markedly from 25.2 to 22.25% in potato pellet chips coated with CMC with a concentration of 2 to 14%. The lowest fat content is found in french fries covered with HPMC EFB and commercial CMC with a concentration of 3%. Due to the higher coating concentration, it will be a strong bond between the coating polymer and the material's surface so that the material coating will cover the pores on the surface of french fries. The oil can not fill the pores so that the oil content in the material will be lower than without the igniter. According to Kurek et al. (2017), in deep fat fried products, the primary function of the edible coating is to withstand oil absorption and water migration from and into the material. During frying, it will be changed in the surface microstructure of the material. Due to the migration of water out of the fabric to form pores/holes in the material's surface. If there is no igniter, then the pores of the material will be filled with oil. The presence of edible coating will form a protective layer on the material's surface to withstand water migration.

The oil content of french fries can be reduced by the HPMC EFB and CMC commercial coating. Figure 3 showed the average reduction in oil content.

The decrease in oil content in commercial CMC-coated fries is slightly higher than that of HPMC EFB, although not significant. That is according to Angor (2016), which found that

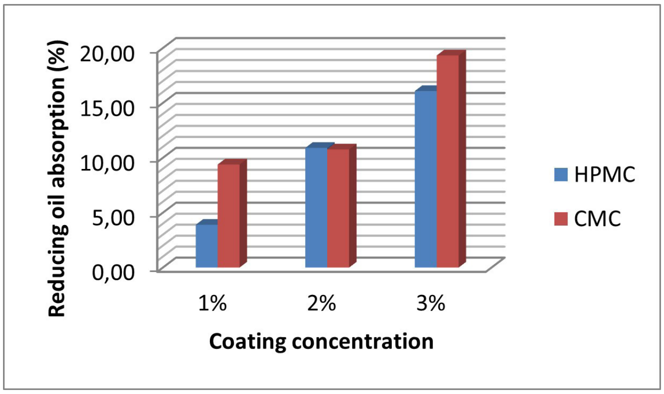

Figure 3. Reducing oil absorption of french fries oil coated with HPMC EFB and commercial CMC with a concentration of 1-3%.

coating using CMC by 1% can lower oil content by up to 21.2% without affecting sensory properties. According to Varela & Fiszman (2011), cellulose derivates such as CMC, MC, HPMC, and HPC have properties that can form a good film. CMC can reduce oil absorption in french fries, while coating chicken balls with HPMC can decrease fat absorption by up to 17.9%. According to Kurek et al. (2017), the main factors that affect the ignition are the type of coating and its concentration. Coat material with high viscosity but used with low engagement will be easier to use as a coating than material with low thickness but used with high concentration.

The higher the concentration of oil content reduction in french fries is also significantly higher, as shown in Figure 3. The higher the coating concentration in the material, the more barriers that coat the material so that it will hinder the taking of oil by the fabric. According to Kurek et al. (2017), an edible coating can form a barrier against moisture, oxygen, ultraviolet light, and solute entry in the material. Fried products with the deep fat fried method, the primary function of the edible coating is to withstand oil absorption and water migration from and into the material. The mechanism of oil retrieval relates to heat transfer and migration of oil droplets during the evaporation process of Kurek et al. water (2017). The scheme of oil reduction mechanism in deep fat fried food is as follows: fried ingredients will absorb oil to the components and evaporation of water due to heat. In the coated material, a layer will be formed that covers the pores of the fabric so that it will inhibit the entry of oil into the material and lower the capillary pressure so that the coefficient of heat transfer is reduced as a result of low water loss. While in materials that are not coated, the material's surface becomes permeable so that capillary pressure becomes high due to oil absorption and water loss becomes high (Kurek et al., 2017).

- b. French fries moisture

Table 2 showed the moisture content of french fries. Coating with HPMC provides a higher range of french fries water than the mouthing with CMC, although it is not significant. That's because the HPMC compound is a cellulose derivative that has hydroxypropyl and methyl groups that are hydrophobic and able to form gels at high temperatures (thermal gelation) around 65-90 °C. The methyl group of HPMC molecules will interact through intermolecular bonds with adjacent HPMC molecules forming a firmer layer of gel. The gel layer formed will withstand the migration of water from the product to the frying medium.

Table 2. Moisture of French fries (%).

	Type of coating*	
	HPMC EFB	Commercial CMC
Concentration 0%	0.93 ± 0.01^{a}	0.98 ± 0.01^{a}
Concentration 1%	2.45 ± 0.35^{b}	2.58 ± 0.23^{b}
Concentration 2%	2.68 ± 0.49^{b}	2.13 ± 0.06^{b}
Concentration 3%	3.51 ± 0.4^{c}	3.07 ± 0.04^{c}

*value is average ± SD (n=3). Average on column, followed by the same letter, indicates a not significant an insignificant difference in the Duncan Multiple Range Test (DMRT).

Table 3. Texture of French fries (mm/g/menit).

Concentration	Type of coating*	
	HPMC EFB	Commercial CMC
0%	2.39 ± 0.01^{c}	1.39 ± 0.01^{c}
1%	3.37 ± 0.75b^{c}	3.26 ± 0.75^{bc}
2%	3.55 ± 0.44^{ab}	4.37 ± 1.02^{ab}
3%	5.48 ± 0.61^{a}	5.53 ± 1.69^{a}

*value is average ± SD (n=3). Average on column, followed by the same letter, indicates a not significant an insignificant difference in the Duncan Multiple Range Test (DMRT).

The higher the concentration of the coating, the higher the moisture content of the fries and the real difference with the controls as seen in Table 2, but the result is not significant between the concentration of 1% and 2%. The concentration of 3% mouthpiece will produce a higher content of french fries than 1% and 2%. It is suspected that because the higher the concentration of the coating, it will form a barrier layer that is more evenly distributed so that it will withstand the migration of water out of the material. In contrast, the material that is not coated will have high capillary pressure so that the water will quickly come out of the material. As a result, after frying, the moisture content will be lower. The results following Angor's research (2016) showed that the moisture content of potato pellet chips coated with CMC with a 2-14% concentration increased markedly from 1.25% to 1.94%. According to Kurek et al. (2017), an edible coating can form a barrier against moisture, oxygen, ultraviolet light, and solute entry in the material. In deep fat fried products, the primary function of the edible coating is to withstand oil absorption and water migration from and into the ingredients.

- c. French fries texture

The texture of french fries was analyzed using a penetrometer (Humboldt). The higher the value shows, the softer texture. Table 3 showed the texture of french fries. The pairing of french fries with HPMC EFB and commercial CMC provides no different texture value. That is because HPMC EFB and CMC are both derivatives of cellulose with similar properties, so the texture or hardness of the resulting fries is no different. At a concentration of 1%, CMC-coated fries have a slightly harder texture value, although not significant. That's because CMC can react with calcium which is a component of potato cell walls.

Table 4. Preference of color, flavor, and taste of french fries

Concentration	Preference of color *		Preference of flavor*		Preference of taste*	
	HPMC EFB	Commercial CMC	HPMC EFB	Commercial CMC	HPMC EFB	Commercial CMC
0%	5.73 ± 0.02^{a}	5.73 ± 0.02^{a}	5.73 ± 0.02^{a}	5.73 ± 0.02^{a}	5.73 ± 0.02^{a}	5.73 ± 0.02^{a}
1%	5.70 ± 0.00^{a}	5.58 ± 0.02^{a}	5.63 ± 0.08^{a}	5.68 ± 0.08^{a}	4.68 ± 0.02^{b}	4.65 ± 0.00^{b}
2%	5.60 ± 0.00^{a}	5.55 ± 0.00^{a}	5.63 ± 0.03^{a}	5.13 ± 0.57^{a}	4.48 ± 0.02^{cd}	4.55 ± 0.05^{cd}
3%	5.10 ± 0.60^{b}	5.03 ± 0.63^{b}	4.45 ± 0.05^{b}	4.50 ± 0.05^{b}	4.35 ± 0.05^{d}	4.53 ± 0.02^{d}

*value is average ± SD (n=3). Average on column, followed by the same letter, indicates a not significant an insignificant difference in the Duncan Multiple Range Test (DMRT).

The greater the concentration of the coating, the softer the texture value and significantly different from the control (without the coating). That is because the more coating material used will reduce the capillary pressure of the fabric so that the evaporation of water is lower and the water left on the material is higher so that the texture value is softer. In addition, HPMC and CMC coating are mouthpieces that have more increased water-holding capabilities. Kim et al. (2015) stated that the addition of HPMC to soy doughnuts would significantly decrease the hardness of donuts. This decrease in hardness of HPMC can bind water higher, resulting in higher product moisture content (Sabanitz and Tzia, 2011).

- d. Preferences of color, flavor, and taste of french fries

Preference of color, flavor, and taste of french fries coated with HPMC EFB and CMC commercially conducted with hedonic test with a scale ranging from 1 (very disliked) to 7 (very like). The favor value is also compared to the control (no coating). Table 4 showed the preferences of color, flavor, and taste of french fries. The preference value of the color of french fries coated with HPMC EFB is no different from commercial CMC with a rather like category.

The higher the concentration of the taster, the value of preference to the color of french fries is decreasing but still in the rather likes (for concentration 1%) until like (for concentrations of 2-3%). It may be due to the higher concentration of the coating, the less bright the color so that the panelists do not like it. Due to the film layer that forms on the surface of the product becomes thicker, thus reducing the brightness of the color. Kim et al. (2015) obtained that the color brightness value (L value) of soy doughnuts whose dough is coated with HPMC is lower than without HPMC due to the Maillard reaction between amino acid lysine and sugar reduction doughnut dough.

Table 4 showed that the preference value of the flavor of french fries coated with HPMC EFB is no different from commercial CMC (category rather like). The higher the concentration of the coating, the preference value of the flavor of french fries decreases with the criteria of likes to a concentration of 2% and somewhat likes at a concentration of 3%.

Table 4 showed the preference of french fries taste. The value of preference taste of french fries coated with HPMC EFB at a concentration of 1-3% is significantly different from commercial CMC. However, both are still in the category of rather likes. At the same time, the higher concentration of coating up to 3% produces a preference value of the taste of french fries that decreases from the category rather like to neutral. That's because the higher concentration of coating will cause the coating layer to get thicker, so it will reduce the taste of french fries. It follows Pahade & Sakhale (2012) results, which found that the fries coated with HPMC 1% have better sensory quality.

4 Conclusion

Based on the function groups at the peak of the FTIR spectra, the compounds extracted from EFB are cellulose. A peek at wavenumber 3331.33 cm^{-1} indicates hydroxyl groups (OH), and ranges at a wavenumber of 1637.79 cm^{-1} show H_2O, CH_2 group at wavenumber 1421.88 cm^{-1} CH group wavenumber 1369.73 cm^{-1}. The COH (COC) cluster is visible at a wavenumber of 894.84-1157.07 cm^{-1}. The cellulose derivation of empty palm bunches resulting in HPMC is characterized by methyl and hydroxypropyl groups at a wavenumber of approximately 2891.30 cm^{-1}, pyranose rings at a wavenumber of 995.79 cm^{-1}, and hydroxyl groups (OH) at a wavenumber of 3371.10 cm^{-1}. HPMC EFB and CMC coat types commercially affect the taste of french fries but do not affect fat content, oil reduction, moisture content, texture, organoleptic preferences of color, and aroma. While the coating concentration affects the decrease in fat content, removal of oil, increased moisture content, and softening of texture and organoleptic preferences (texture, taste, and flavor). The ignition of french fries with HPMC EFB 3% reduced the absorption of oil by 16.09%. Based on overall organoleptic preference, the preferred type of coating is HPMC EFB and a mouthing concentration of 1%.

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