Fatty acid profile of paste, sensory quality, and microstructures surface of patty added with red fruit paste (*Pandanus conoideus Lamk*)

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Abstract: This study aimed to determine the sensory quality and the microstructure surface of the patty added with red fruit paste (RFP). An experimental method was employed with a completely randomized design in this study. The addition of RFP consisted of four treatments with three replications of each treatment. Since RFP was a substitute for animal fat in the patties mixture, the paste levels in the treatment were R0 (control), R1 (5% RFP), R2 (10%), and R3 (15%). Sensory quality was checked by a hedonic test for texture, taste, color, and juiciness and the microstructure was examined by comparing the patty samples before and after the cook. However, before the red fruit paste was being applied to the patties, the fatty acid profile was analyzed using gas chromatography. The chromatogram graph showed that red fruit paste is rich in fatty acids, dominated by oleic acid, palmitic acid, and omega 9 fatty acids. Hence, the results indicated that the addition of RFP significantly (P<0.05) increased the sensory quality parameter score. Patties with 15% RFP had the highest value for texture, taste, color, and juiciness while the control treatment had the lowest value for texture, taste, color, and juiciness. The surface of the patty microstructure was described based on the shape on the patty's surface between R0 and R3. The appearance of the patty before and after the cook looked different. The results of microscopic observations on patties support the sensory value of R3, especially in texture and juiciness for the surface of the patties in the R3 treatment was flatter, not rough, and looked softer than the control treatment.

1. Introduction

Patty is a restructured meat product. The ingredient composition patty conventional uses 75% beef and the rest is fat. The presence of fat in food has a major effect on the sensory value such as improving the quality of texture, mouthfeel, and palatability but the presence of fat makes the patty prone to rancidity. [1] claims that the weaknesses of the patty as restructured meat, in general, are easily rancid due to the oxidation process, uniform color of the product, and hard and fibrous texture of the product. Additionally, the oxidation process occurs due to damage by enzymes closely related to the presence of microbes in fat. As a result of microbial growth, besides accelerating the oxidative process which affects the shelf life, it also causes damage to the sensory character responsible for reducing nutritional value [2,3]. Patty generally contains animal fat. Most animal fats contain saturated fatty acids and...
cholesterol associated with the onset of cardiovascular disease, triggering several types of cancer and obesity [4]. To reduce the negative effects of using animal fats in patty products, it is recommended that animal fats be replaced with vegetable fats that are rich in unsaturated fatty acids. Unsaturated fatty acids are considered of better nutritional value since they are more reactive and are antioxidants in the body. [5] argues that in food, the existence of fat might be replaced or reformulated called Fat Replacer. replacer based on lipid called fat substitute and based on protein and carbohydrates called fat mimetic. Several studies on fat substitution include research conducted by [6] using vegetables and soybean granules to substitute some of the fat and meat in a beef burger. Tiwari et al. [7] suggested that fat replacement of 2 to 4% inulin in ice cream result sensory properties and overall acceptability of ice cream were similar with control (10% fat). Gadekar et al. [8] used additional ingredients combined with salt and tripolyphosphate sodium in restructuring pork which might improve sensory quality (color, aroma, flavor, texture, and juiciness). Further, Wan Rosli [9] added that the oyster mushroom in chicken sausage can increase the brightness, chewiness, hardness, but cannot change the red color of the sausage.

Red fruit is an endemic plant from Papua Province which is rich in active compounds the red fruit contains a nutritional component such as carbohydrate, vitamin C, phosphorus, calcium, and total carotenoids of 976-1,592 ppm and total tocopherol of 1.256-2.016 ppm and also contained a 23.77% saturated fatty acid and 70.92% unsaturated fatty acid [10–12]. The main product of red fruit is red fruit oil which the Papuan local people process using wet rendering with 2 stages of squeezing. The first press produces waste in the form of hard seeds, while the second press produces waste in the form of red fruit paste. Red fruit paste has a soft, slightly oily, red emulsion texture. The content of fatty acids in red fruit oil may still be in the red fruit paste even though it is in small amounts and has the potential to be used as a fat substitution. There has been no research on the effect of using red fruit paste as a fat substitution in a burger patty. The use of red fruit paste as a substitute for animal fat in the patty dough in this study was expected to improve the sensory quality (organoleptic) and microstructure appearance of patty conventional.

2. Materials and methods
This research includes three series of tests, starting with testing the fatty acids content of the red fruit paste using GC (Gas Chromatography), the red fruit paste then applied to the burger patty dough with 4 levels of red fruit paste as a treatment and 3 repetitions, the treatment with the best value will be checked the surface texture (topography) and the elements contained in the sample through tools SEM-EDS (Scanning Electron Microscope-Energy Dispersive X-ray Spectroscopy), merk Oxford, the other tools were stainless steel steamer, food processor (Philips HR-7672), burger molds, aluminum foil, digital scales (notebook series 1105-08), gas stove (Rinnai). The ingredients in this study were red fruit paste made from new types of red fruit obtained from the Jayapura district of Papua province, ground beef, beef fat, eggs, salt, pepper, carboxymethylcellulose (CMC), cucumber, mineral water purchased at Lai-Lai supermarkets in Malang.

2.1. Research implementation
Red fruit paste is obtained from the Barugum type of red fruit and processed by wet rendering. The level of paste used was 0%, 5%, 10%, and 15%. Ground beef and other ingredients were processed using a food processor for 30 seconds. Then, the level of red fruit paste was added and grind again for 30 seconds. After the dough was smooth and well blended, it was shaped and printed using a special burger mold. The printed patty is then steamed and aerated for 3 minutes and then tested for sensory quality, including texture, aroma, color, and juiciness. the best treatment will be followed by microstructure testing. This test will compare the best treatment with control treatment before and after cooking. The patty formulation is described in the following table 1.
Table 1. Patty beef burger with different levels of Red fruit paste.

| Ingredients (%) | Red Fruit Paste Level (%) |
|-----------------|---------------------------|
|                 | R0 (0%) | R1 (5%) | R2 (10%) | R3 (15%) |
| Ground beef     | 75      | 75      | 75       | 75       |
| Fat             | 20      | 15      | 10       | 5        |
| Red fruit paste | 0       | 5       | 10       | 15       |
| CMC             | 0.7     | 0.7     | 0.7      | 0.7      |
| Onion           | 1.3     | 1.3     | 1.3      | 1.3      |
| Salt            | 1       | 1       | 1        | 1        |
| Egg             | 1       | 1       | 1        | 1        |
| Pepper          | 1       | 1       | 1        | 1        |
| Total           | 100     | 100     | 100      | 100      |

2.2. Research variable
The analysis of red fruit pastes fatty acid was conducted using the Gas Chromatography (GC) method of the Shimadzu brand [13]. The fatty acid analysis was carried out through the extraction, methylation, and identification stages by gas chromatography with the stages of fatty acid extraction using soxhlet extractor, the formulation of methyl esters (methylation), and fat or oil as much as 20-40 mg NaOH 0.5 N in methanol, 2 mL of BF₃·CH₂OH 20% and then heated for 20 minutes. After that, it was cooled and added 2 mL of saturated NaCl and 1 mL of hexane before being shaken until homogeneous. The hexane layer was transferred by pipette to a tube containing 0.1 g of anhydrous Na₂SO₄, left for 15 minutes. The liquid phase was separated and then injected into GC. The identification of fatty acid was done by injecting methyl esters into a gas chromatograph with the fatty acid standard used was the SupelcoTM 37 component FAME Mix. The gas used as the mobile phase was nitrogen with a pressure flow of 20 mL/minute. The column used was Quadrex fused silica capillary column 007 with an inner diameter of 0.25 mm. The temperature used was 125°C which then increased by 5°C per minute until the final temperature was 225°C with the injector temperature of 220°C and the detector temperature of 240°C.

Sensory Quality analysis was carried out by 10 laboratory panelists ranging from 30 to 45 years old. Evaluation of sensory quality organoleptic testing used the hedonic quality scoring method for color, aroma, texture, juiciness [14]. Samples were randomly presented to 10 trained panelists by filling in the prepared questionnaires. The hedonic scale used scoring from number 1 to 5.

Microstructure observation was conducted using a scanning electron microscope (SEM-EDS). A microstructure test was performed to determine the appearance of the product surface by microscopic magnification. Before carrying out the microstructure test, the specimen was prepared in advance, in the form of a 2 cm long cut at one end of the sample for 2 cm long (a flat part preferred). The specimen was taken and put on top of the stub with double-sided carbon tape. With no sputter coating, the sample was placed at the sample location in an electron microscope with magnification of 1500 times. The occurrence of an electron shot towards the sample was recorded into the monitor and a photoshoot was taken.

2.3. Statistical analysis
This study employed a completely randomized design. All treatments were repeated 3 times. The obtained data were then analyzed statistically by Kruskal Wallis [15]. A further test was carried out using to see the location of the differences and using by Mann Whitney a test according to [16] in the case of the differences exist. Sensory data were analyzed using the Statistical Program for Social Science (SPSS) for windows while microstructure data using SEM-EDS (Scanning Electron Microscope-Energy Dispersive X-ray Spectroscopy) were analyzed descriptively.
3. Results and discussion

3.1. Red fruit paste (RFP) fatty acid profile

The fatty acid profile is determined using the principle of gas-liquid chromatography by distributing the sample between the stationary and mobile phases, where the separation occurs based on the partition coefficient (relative volatility and solubility levels in the liquid phase). The peak sequence was calculated based on the retention time. Each peak represents one compound in the mixture passing through the detector, in which the resulting chromatogram area was used as a quantitative analysis of a sample. Based on the results presented in Table 2, the fatty acid of the red fruit paste was identified into the saturated fatty acid (SFA) with dominant palmitic acid (3.70%), monounsaturated fatty acids (MUFA) with dominant oleic acid (12.08%), and polyunsaturated fatty acid (PUFA) with dominant omega 9 fatty acids (12.09%).

Table 2. Fatty acid profile of red fruit paste by qualitative Gas Chromatography (GC) test method.

| Fatty Acid                        | Percentage (%) |
|----------------------------------|----------------|
| Saturated Fatty Acid (SFA)       |                |
| C 20:0 (arachidic acid)          | 0.0227         |
| C 10:0 (caprylic acid)           | 0.0067         |
| C 18:0 (stearic acid)            | 0.2864         |
| C 12:0 (lauric acid)             | 0.0246         |
| C 24:0 (lignoceric acid)         | 0.0031         |
| C 14:0 (myristic acid)           | 0.0260         |
| C 15:0 (pentadecanoic acid)      | 0.0226         |
| C 16:0 (palmitic acid)           | 3.7081         |
| C 17:0 (heptadecanoic acid)      | 0.0164         |
| Total SFA                        | 4.1208         |

| Monounsaturated Fatty Acid (MUFA)|                |
| C 20:1 (eicosenoic acid)         | 0.0342         |
| C 16:1 (palmitoleic acid)        | 0.1207         |
| C 17:1 (heptadecenoic acid)      | 0.0261         |
| C 18:1 W9C (c-oleic acid)        | 12.0844        |
| Total MUFA                       | 12.2264        |

| Polyunsaturated Fatty Acid (PUFA)|                |
| C 18:3 W3 (linolenic acid)        | 0.1229         |
| C 20:2 (eicosadienoic acid)       | 0.0030         |
| omega 3 fatty acids               | 0.1229         |
| omega 6 fatty acids               | 1.0695         |
| omega 9 fatty acids               | 12.0854        |
| Total PUFA                        | 13.4037        |

In general, monounsaturated fatty acids have a beneficial effect on cholesterol levels in the blood, especially when used as a substitute for saturated fatty acids. Thus, oleic acid is more popularly used for processed food formulation [17]. According to [18], long-chain fatty acids are commonly used as edible films for they have high melting points and are hydrophobic. Meanwhile, oleic acid from plants is found in the pulp and seeds. Rhomadhoniyah [19] found that the addition of 0.1% oleic acid can function as an enhancer (diluent) for piroxicam drug preparations difficult to dissolve in oral or parenteral administration. Palmitic acid is widely used in the cosmetic field, especially for coloring. Palmitic acid is an important source of calories but has low antioxidant power. Omega 9 fatty acids are included in non-essential fatty acids for omega 9 fatty acids that might be produced naturally by the
body unlike omega 3, and omega 6 fatty acids. Omega 9 fatty acids have the main fatty acids, namely oleic acid, and erucic acid. Omega 9 fatty acids help reduce the risk of cardiovascular disease and stroke. The total of RFP unsaturated fatty acids is 13.46% and saturated fatty acids are 4.12% while the red fruit oil according to [11] contains a total of 23.77% saturated fatty acids and 70.92% unsaturated fatty acids. This difference is reasonable because pasta is residual. the result of pressing the red fruit to obtain oil as a commercial product and most of the fatty acid content included in the red fruit oil so that the SFA and MUFA values look very different. But with a smooth emulsion paste texture, red in color and still contains fatty acids and bioactive components, it can potentially act as a fat replacer and food coloring in various restructured meat products. [11] stated that the development of the fruit during the ripening process greatly affects the chemical composition of the active components of the fruit, such as the levels of fat and active components (carotene and tocopherol) of red fruit (Pandanus conoideus Lamk) which increase with increasing ripening. The processing process also affects the nutritional value. For example, too high temperature of heating might convert saturated and unsaturated fats into trans fats and too long storage might reduce nutritional value.

3.2. Sensory quality of beef burger patty
The ability to give an impression might be distinguished based on the ability of the senses to react to receive stimuli. These abilities include the ability to detect, recognize, discriminate, compare (scaling), and express likes or dislikes (hedonic) [20]. The sensory quality of the patty with the addition of red fruit paste was assessed using the hedonic test with scores between 1 to 5. The variables observed were texture, aroma, color, and juiciness. The results of the sensory quality analysis are presented in the following table:

| RFP Level | Texture  | Aroma   | Color    | Juiciness |
|-----------|----------|---------|----------|-----------|
| 0%        | 1.53±0.52a | 1.93±0.46a | 1.00±0.00a | 1.00±0.00a |
| 5%        | 2.53±0.83b | 2.93±0.80b | 2.40±0.51b | 1.80±0.41b |
| 10%       | 3.87±0.74c | 3.53±0.83bc | 3.33±0.82c | 3.40±0.51c |
| 15%       | 4.47±0.64d | 4.07±0.96c | 4.13±0.64d | 4.13±0.52d |

Letters in the same column show significantly different (P<0.05).

Table 3 presents the average organoleptic number of the highest texture in R3 (15% RFP) was 4.47±0.64, and the lowest average organoleptic (texture) number in the R0 (Control) was 1.53±0.52. R3 was significantly different from R2, R1, and R0, and vice versa. For aroma, the highest average organoleptic number was in R3 (15% RFP) of 4.07±0.96, and the lowest was in R0 (Control) of 1.93±0.46. R3 was significantly different from R0 and R1. However, R3 was not significantly different from R2. For the highest average organoleptic number (color) in R3 (15% RFP) was 4.13±0.64. Meanwhile, the lowest average organoleptic number (color) was in R0 (Control) of 1.00±0.00. R3 was significantly different from R0, R1, and R2, and vice versa. The parameter juiciness shows that the highest average number of organoleptic (juiciness) in R3 (15% RFP) was 4.13±0.52. Meanwhile, the lowest average number of organoleptic (juiciness) in treatment R0 (Control) was 1.00±0.00. R3 was significantly different from R0, R1, and R2 while R0, as the lowest mean, was significantly different from R1, R2, and R3.

Food texture is a physical character felt through touch. The texture is also used to determine the quality of a food product. Winarno [21] argued that visually the color factor comes first and sometimes is very decisive material that has nutritional value, tastes good, and has a very good texture might not be eaten if it has unsightly color. Acceptance of the color of a material varies depending on several factors such as natural, geographic, and social aspects of the receiving community. Patty with a paste level of 15% received the highest aroma value from the panelists because of the specific pandan aroma in the red fruit paste that smells when the patty is chewed. This is in line with [22] that the normal fruit paste aroma is not distorted by the aroma of pandanus as a specific aroma of red fruit. In
the food industry, aroma or odor, in general, can be defined as the “perception of smell” or as the organoleptic attribute that the olfactory organs can discern when sniffing out certain volatile substances [23]. The perception of smell in humans is influenced by psychological interpretations that produce the impression of a particular smell due to a strong memory for that object. This aroma or odor arises for the odor is volatile, slightly soluble in water, and fat. Juiciness is the ability of meat or products to release water-soluble juices/extracts during mastication. Based on table 3, the panelists gave the highest value for all parameters in the patty in treatment R3. This means that the addition of red fruit paste into the patty dough might increase its organoleptic value. The physical character of the soft and oily red fruit paste made the patty softer, did not dry out, and left a watery impression when chewed. Additionally, the fat content in red fruit paste made the taste and aroma of patties more delicious and distinctive for the function of fat as a solvent for vitamins A, D, E, and K. Fat provides a specific taste and aroma to food that cannot be replaced by other food components. Vural [24] suggested that fat has an important meaning in processed meat products since it affects tenderness and juiciness. Likewise, the patty color of the panelists gave the highest point for the R3 because the patty appearance was more attractive and colorful influenced by the red fruit paste content which is rich in carotene. The cooking process might affect the quality of the meat since the heat can evaporate water, degrade protein, decompose amino acids, and cause connective tissue to develop which might add tenderness and the impression of meat juice. Nielsen [25] states that color, taste, and texture are three important aspects of food acceptance. Color is the most important factor in terms of acceptance since the first element the eye sees visually of a product is color. The eye might influence the perception of taste and other factors psychologically. If the product looks unattractive, consumers might refuse and no longer be interested in other factors.

3.3. The microstructure of patty
Patty samples included in the SEM-EDS (Scanning Electron Microscopic–Energy Dispersive X-ray Spectroscopy) test was sampled from treatment R0 and R3. Treatment R0 was chosen for it was a sample without the addition of red fruit paste and R3 was chosen for it was a sample that had the highest organoleptic value. The two samples of the treatment were compared before and after cook.

![Figure 1](image.png)

**Figure 1.** The surface condition of the patty is based on the SEM tool; code A1 = patty (R0) before steaming, code A2 = patty (R0) after steaming, code B1 = patty (R3) before steaming, code B2 = patty (R3) after steaming.
The results of the SE recordings on the patty microstructure became supporting data for sensory quality, especially on the texture and juiciness variables since the SEM-EDS results can provide an overview of how the surface topography and texture are related to the hardness and reflectivity of the patties. SEM-EDS results also can present the analysis of the constituent components of the patty surface quantitatively. In the form of a percentage of each atomic element through a graph of certain peaks on the recorded spot. Based on the images recorded by SEM of the microstructure of patty without red fruit paste (non-RFP) and with the addition of red fruit paste (RFP).

The image from the SEM tool above shows that there was a clear difference in the appearance of the patty surface, especially on the patty after cooking in R0 (control). The surface texture in R0 (control) was more coarse and was filled with small lumps in large quantities that look hard and solid. The cooking process carried out turns to contract the structure of the meat, especially the protein components. Thus, the patty lost quite a lot of moisture and became dry. The structural changes of a food material caused by heat might affect the texture and other parameters related to the quality of the meat. Moreover, processing using high temperatures can also cause changes in the protein structure of myofibrils. These changes can also be closely related to changes in water content [26,27]. The microstructure appearance on patty R3 looks smoother and softer without any solid lumps. This indicates that the addition of red fruit paste to the dough can improve the flexibility of the patty and retain moisture by keeping steam and liquid out during the cooking process. The content of fatty acids in the red fruit paste might act as a barrier for liquid out of the patty dough because red fruit paste, which is a hydrophobic emulsion when mixed in the dough, protects other components by forming a barrier layer to prevent the discharge of liquid. The scanning results of the patty surface appearance support the results of the sensory test where the panelists preferred the texture and juiciness of the patty in the R3. The results of the SEM-EDS are presented in figure 1. The graph also shows the difference in the values at the highest peak of the atomic elements from the R0 and R3 on the selected spots.

Based on the graphic records, the dominant atomic elements are the constituent elements of fat, consisting of a carbon atom (C) and an oxygen atom (O). The two elements scored higher in the patty with the addition of red fruit paste than the patty without the addition of paste. Patty at R3 had an atomic value of C=77.17% and O=22.13% while patty at R0 had an atomic value of C=66.01% and O=19.22%. Animal fat contains more saturated fat while the fat in red fruit paste contains more

![Figure 2. Graph of atomic percentages in patties R0 and R3.](image-url)
unsaturated fats, based on its nature, saturated fat is more soluble in water, so it is possible that due to the cooking process of fat in the control treatment some of it dissolves in water and evaporates during the heating process.

4. Conclusions
Red fruit paste is dominated by fatty acids such as oleic acid, palmitic acid, and omega 9 fatty acids. The addition of red fruit paste to a level of 15% based on the panelists’ assessment of sensory quality, namely texture, aroma, color, and juiciness, showed the highest and lowest values obtained on patties without the addition of red fruit paste (control). The results of microscopic observations on patties support the sensory value of R3 especially for texture and juiciness for the surface of the patties in the treatment looked flat, not rough, and looked softer than the control treatment.

References
[1] Wu Y-C 2017 Development of Sectioned and Formed Meat Products Using Deboned Meats (Taiwan: Tunghai University)
[2] Djaafar T F and Rahayu S 2007 Cemaran mikroba pada produk pertanian, penyakit yang ditimbulkan dan pencegahannya J. Litbang Pertan. 26 67-75
[3] Abdulla G, Abdel-Samie M A, Zaki D 2016 Evaluation of the antioxidant and antimicrobial effects of Ziziphus leaves extract in sausage during cold storage Pak. J. Food Sci 26 10–20
[4] Kassem M A G, Emara M M T 2010 Quality and acceptability of value-added beef burger World J. Dairy Food Sci. 5 14–20
[5] Guven M, Yasar K, Karaca O B and Hayaloglu A A 2005 The effect of inulin as a fat replacer on the quality of set-type low-fat yogurt manufacture Int. J. Dairy Technol. 58 180–4
[6] Martinez B, Miranda J M, Vázquez B I, Fente C A, Franco C M, Rodriguez J L and Cepeda A 2012 Development of a hamburger patty with healthier lipid formulation and study of its nutritional, sensory, and stability properties Food Bioprocess Technol. 5 200–8
[7] Tiwari A, Sharma H K, Kumar N and Kaur M 2015 The effect of inulin as a fat replacer on the quality of low-fat ice cream Int. J. dairy Technol. 68 374–80
[8] Gadekar Y P, Sharma B D, Shinde A K and Mendiratta S K 2015 Restructured meat-products production, processing and marketing: a review Indian J Sial J Rumin. 21 1–12
[9] Wan Rosli W I, Solihah M A, Aishah M, Nik Fakurudin N A and Mohsin S S J 2011 Colour, textural properties, cooking characteristics and fiber content of chicken patty added with oyster mushroom (Pleurotus sajor-caju). Int. food Res. J. 18 621-7
[10] Budi M 2003 Potensi Kandungan Gizi Buah Merah (Pandanus conoideus Lamk) sebagai Sumber Pangan Alternatif untuk Mendukung Ketahanan Pangan Masyarakat Papua Dinas Tanam. Pangan Jayawijaya
[11] Sarungallo Z L, Santoso B, Roreng M K, Latumahina R M M 2016 Nutrient content of three clones of red fruit (Pandanus conoideus) during the maturity development Int. Food Res. J. 23 1217-225
[12] Murtiningrum M and Cepeda G N 2011 Penggunaan Bahan Pengisi dalam Perbaikan Sifat Fisikokimia dan Organoleptik Dodol Buah Merah (Pandanus conoideus L) Sebagai Sumber β-Karoten agrITECH 31 14-20
[13] Association Official Analytical Chemistry [AOAC] 2005 Official Method of Analysis (Maryland (US): AOAC International)
[14] Soekarto S T 1985 Penilaian Organoleptik: untuk Industri Pangan dan Hasil Pertanian (Bhratara Karya Aksara, Jakarta)
[15] Suradi K 2007 Tingkat kesukaan bakso dari berbagai jenis daging melalui beberapa pendekatan statistik J. Ilmu Ternak Univ. Padjadjaran 7 52-7
[16] Lawless H T and Heymann H 2010 Sensory Evaluation of Food (New York: Springer-Verlag New York)
[17] Sartika R A D 2008 Pengaruh asam lemak jenuh, tidak jenuh dan asam lemak trans terhadap
[18] Hagenmaier R D and Shaw P E 1990 Moisture permeability of edible films made with fatty acid and hydroxypropyl methylcellulose J. Agric. Food Chem. 38 1799–803

[19] Rhomadhonyiah A 2007 Pengaruh Asam Oleat Terhadap Karakteristik Fisika Kimia Sediaan dan Penetrasi Piroksikam dalam Basis Gel Hydroxypropyl Cellulose (Surabaya: Universitas Airlangga)

[20] Negara J K, Sio A K, Rifkhan R, Arifin M, Oktaviana A Y, Wihansah R R S and Yusuf M 2016 Aspek mikrobiologis, serta Sensori (Rasa, Warna, Tekstur, Aroma) Pada Dua Bentuk Penyajian Keju yang Berbeda J. Ilmu Produksi dan Teknol. Has. Peternak. 4 286–90

[21] Winarno F G 1997 Kimia Pangan dan Gizi (Jakarta:PT. Gramedia Pustaka Utama)

[22] Silamba I 2010 Pemanfaatan Pasta Buah Merah (Pandanus conoideus L) sebagai Bahan Substitusi Tepung Ketan dalam Pembuatan Dodol J. Agroteknologi 4 1–7

[23] Nicolay X 2006 Odors in the food industry (United State: Springer)

[24] Vural H I 2003 Effect of replacing beef fat and tail fat with interesterified plant oil on quality characteristics of Turkish semi-dry fermented sausages Eur. Food Res. Technol. 217 100–3

[25] Nielsen S S 2003 Food Analysis (New York: Kluwer Academic/Plenum)

[26] Hurling R, Rodell J B and Hunt H D 1996 Fiber diameter and fish texture J. Texture Stud. 27 679–85

[27] Bastias J M, Balladares P, Acuna S, Quevedo R and Munoz O 2017 Determining the effect of different cooking methods on the nutritional composition of salmon (Salmo salar) and chilean jack mackerel (Trachurus murphyi) fillets Plos One 12 1-10