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Gelatin Jelly Candy from Mackerel Skin (*Scomberomorus commersonii*)

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Abstract.
Jelly candies are colorful, delicious, and loved by children. Mackerel skin gelatin has a good nutritional potential to increase the protein content in jelly candy. The present study tested consumer acceptance, proximate value, and quality of gelatin jelly candy fortified with eight different natural flavorings: honey, date juice, olive oil, soy milk, goat's milk, grape juice, avocado, and pumpkin.

Gelatin was extracted from mackerel (*Scomberomorus commersonii*) skin. The quality assessment involved tests on the water, ash, fat, and protein contents, as well as bacterial contamination. The sensory evaluation involved a hedonic test with 10 panelists, who found all samples acceptable in appearance, smell, flavor, and texture.

The average score for each criterium was 7.00 out of 9.00. The sample with soy milk proved to have the most optimal formulation: water (9.76 ± 0.70%), ash (0.21 ± 0.02%), protein (16.20 ± 0.37%), fat (2.32 ± 0.50%), carbohydrate (51.61 ± 0.80%), reducing sugar (0.14 ± 0.01%). All samples were free from *Salmonella* sp. and *Escherichia coli*, with a total plate count of 1×10^2 colonies per 1 g.

The jelly candy with mackerel skin gelatin was high in protein, had a favorable sensory profile, and met the Indonesia National Standard for this type of food products.

Keywords. Gelatin, halal gelatin, jelly candy, nutritional value, quality, mackerel skin, *Scomberomorus commersonii*

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Жевательный мармелад с желатином из кожи скумбрии (*Scomberomorus commersonii*)

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Аннотация.
Жевательный мармелад – это яркое и вкусное лакомство, которое пользуется спросом у детей. Желатин из кожи скумбрии (*Scomberomorus commersonii*) обладает хорошими питательными свойствами и может способствовать увеличению содержания белка в жевательном мармеладе. Описали потребительскую привлекательность, пищевую ценность и качество жевательного мармелада с желатином из кожи скумбрии и 8 натуральными ароматизаторами: мед, финиковый сок, оливковое масло, соевое молоко, козье молоко, виноградный сок, авокадо и тыква.
Желатин экстрагировали из кожи скумбрии (*S. commersonii*). Качество мармелада оценивали по содержанию влаги, золы, жира, белка и наличию бактерий. Органолептическая оценка заключалась в проведении гедонического теста: десять экспертов оценили все образцы как приемлемые по внешнему виду, запаху, вкусу и текстуре.
Средний балл по каждому критерию составил 7,0 из 9,0. Оптимальным по составу оказался образец с соевым молоком: содержание влаги составило 9,76 ± 0,70 %, золы – 0,21 ± 0,02 %, белка – 16,20 ± 0,37 %, жира – 2,32 ± 0,50 %, углеводов – 51,61 ± 0,80 %, редуцирующего сахара – 0,14 ± 0,01 %. В образцах не обнаружены *Salmonella* sp. или *Escherichia coli*; общее количество бактерий составило $1{\times}10^2$ колоний на 1 г.
Жевательный мармелад с желатином из кожи скумбрии оказался богат белком, продемонстрировал хорошие органолептические свойства и соответствовал государственному стандарту, принятому в Индонезии для данного типа пищевых продуктов.

Ключевые слова. Желатин, халяльный желатин, желейные конфеты, пищевая ценность, качество, кожа скумбрии, *Scomberomorus commersonii*

Финансирование. Исследование было поддержано Программой обязательных исследований по схеме PNBP для преподавателей Университета Ламбунг Мангкурат в 2021 финансовом году (основной кластер), договор № 010.49/UN 8.2/PL/2021.

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Introduction

Gelatin is a protein commonly extracted from cartilage, skin, and scales of cows, pigs, and fish [1]. Halal gelatin cannot contain any pig-based products. As a rule, it is extracted from fish, e.g., mackerel (*Scomberomorus commersonii*) [2]. Gelatin preparations are part of various foods and non-food products. Gelatin serves as an emulsifier, a stabilizer, a microencapsulation agent, as a component of biodegradable packaging, etc. [3]. Its most useful property is the ability to form gels with convenient viscosity and melting point. As a result, gelatin is a popular component of various candy products [1].

Candy can be hard and soft. As a rule, candy contains cane sugar, corn sugar, flavorings, dyes, and gelling agents. Gelatin-based candy is called jelly candy and has a higher sugar content [4]. Jelly candy is often fortified with vitamins and minerals to improve children's diet [5]. Some sorts of jelly candy involve natural flavorings, e.g., nutmeg extract, strawberries and mangoes [6–8]. However, some confectionery industries prefer synthetic acid flavorings with unreliable safety, e.g., citric acid, tartaric acid, and lactic acid [9]. According to Yanchenko *et al.*, the food industry does not meet nutrition standards in this sphere because producers ignore consumer safety to maximize profit [10]. In addition, jelly candy is rarely rich in protein. Fish skin gelatin may solve this problem by fortifying jelly candy with protein.

Natural flavorings with vitamins and minerals offer good prospects for candy production. According to Kia *et al.*, food products with natural additives are health-beneficial [11]. In this research, we used such natural ingredients as honey, date juice, olive oil, soy milk, goat's milk, grapes, avocado, and pumpkin. These flavorings are expected to raise the consumer attractiveness of halal gelatin candy. Furthermore, jelly candy made from mackerel skin gelatin potentially provides protein intake and reduces sugar consumption. This study featured consumer acceptance, proximate value, and quality profile of jelly candy with mackerel skin gelatin fortified with eight different natural flavorings.

Study objects and methods

Extracting mackerel skin gelatin. We used the protocol described by Rahmawati & Pranoto to extract gelatin from mackerel skin [12]. After soaking dried mackerel skin in water for ± 5 h, we heated it for ± 1 min to remove the remaining impurities. Then, the sample was soaked in 0.05 M of ethanolic acid (CH_3COOH) solution for 10 h. The extraction process involved heating with H_2O at 80°C for 2 h. Finally, the gelatin extract remained three days in an oven at 55°C.

Preparing gelatin jelly candy. We designed eight different natural flavorings, i.e., honey, date juice, olive oil, soy milk, goat's milk, grape juice, avocado, and pumpkin. Each test was performed in triplicate. The formulation and technology for jelly candy with fish skin gelatin was borrowed from Eletra *et al.* with some modifications [13]. We mixed 75 g gelatin, 85 g sucrose, 5 g salt, and 85 g natural ingredients. After adding 300 mL cold water, we stirred the mix until it became homogeneous. The sample was then heated at 100°C for 2 min, molded with soft silicone bear-shape templates, and cooled.

Water content analysis. To analyze the water content, we appealed to the method published by the Association of Official Analytical Chemists [14]. The samples were weighed up to 2.00 ± 0.01 g on a porcelain dish of known weight and dried in an oven at 105°C for 3 h. After being cooled in a desiccator, the weighing was repeated.

Ash content analysis. The samples were weighed up to 2.00 ± 0.01 g on a porcelain dish of known weight, ignited on a burner flame, and burned in an electric furnace at ≤ 550°C until complete combustion. Then, they were cooled in a desiccator and weighed until constant mass [14].

Fat content analysis. We placed 2.00 ± 0.01 g of each sample into a cotton-lined paper bag. The paper sleeve was covered with cotton, dried in an oven at ≤ 80°C for ± 1 h, and put into the Soxhlet extraction apparatus connected to an oil bottle with boiling chips. After drying, we determined the weight and extracted the sample with hexane for ± 6 h. Then we filtered the hexane and dried the fat extract in an oven at 105°C, cooled it, and weighed. The cooling process continued until constant weight [14].

Protein content analysis. The analysis of protein content relied on the method recommended by the Association of Official Analytical Chemists [14]. During the digestion, we put 1.00 ± 0.01 g of each sample into a 100 mL Kjehdahl flask with 10 mL of concentrated sulfuric acid. A catalyst was added to speed up the digestion. After the distillation, the digestion results were diluted with distilled water up to 100 mL. After homogenization and cooling, we pipetted 5 mL into a distillation flask. A total of 10 mL of 30% sodium hydroxide solution penetrated through the walls of the still flask until a layer formed under the acid solution. The container was filled with 10 mL of 0.1 N hydrochloric acid solution and drained with a methyl red indicator. The titration was accommodated in an Erlenmeyer flask with 0.1 N hydrochloric acids and five drops of methyl red indicator. The mix was titrated directly using a 0.1 N sodium hydroxide solution. The titration resulted in a pink-to-yellow color. This treatment was repeated three times for each sample.

Total plate count. The total plate count method belonged to Salanggon *et al.* [15]. A total of 25 g of each sample was weighed aseptically. After adding 225 mL Butterfield's phosphate buffer, we homogenized the mix for 2 min and diluted it. The homogenate was put with a sterile pipette into a vial containing 9 mL of Butterfield's phosphate buffer solution to obtain a sample with a dilution of 10^{-2}. Each dilutant was stirred at least 25 times to obtain further dilutants (10^{-3}, 10^{-4}, 10^{-5}, etc.). The volume of each diluent was 1 mL, and the procedure was repeated in a sterile petri dish with a sterile pipette. In each petri dish, 12–15 mL of medium was cooled to 5°C for the plate count agar method. After the agar hardened, it was incubated at 35°C for 8 h to count the number of bacterial colonies in the petri dish.

Screening of *Escherichia coli*. We homogenized 25 g of each sample with 225 mL peptone buffer and then fortified it at 37°C for 18 h. Next, 1 mL of the sample was inoculated directly into 9 mL of MacConkey broth (CM5a; Oxoid) and then incubated at 37°C for 18 h [16]. After that, we sprayed the fortified broth preparations directly onto eosin methylene blue agar and incubated them at 37°C for 18–24 h. The isolates were confirmed biochemically using an *E. coli* antiserum express diagnostic kit. *E. coli* O antiserum consisted of polyclonal antibodies used for zero-classification of *E. coli* O antigens.

Screening *Salmonella* sp. At the pre-fortification stage, the collected samples were serially diluted (10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, etc.) using peptone water [17]. At the fortification stage, we planted them on sterile selenite cystine broth selective media and incubated at

37°C for 24 h. After the fortification stage in each dilution, 1 mL was planted on xylose lysine deoxycholate. We analyzed bacteria growth by counting the colonies and observing their morphology. Purification involvedthe quadrant streaking method, with presupposed xylose lysine deoxycholate media and incubation at 37°C for 48 h. The purification process targeted colonies with different colony morphology that belonged to gram-negative bacteria.

After that, we selected two types of colonies. Each colony was duplicated so that eventually 40 colonies were obtained. The purification results were grown on slanted nutrient agar, incubated at 37°C for 24 h, and stored at –20°C as stock culture. The storage condition of pure bacterial isolates involved 60% glycerol in a ratio of 1:1 at –80°C.

Sensory analysis. Each sample was placed on a white plastic plate together with a glass of water, coded, and served to panelists randomly in a well-lit environment. The panel consisted of 10 trained panelists from the laboratory of testing and quality control of fishery products, Banjarbaru, South Kalimantan. The criteria included appearance, smell, texture, and flavor. The panelists rated the acceptance using a nine-point hedonic scale: 1 – dislike extremely, 2 – dislike very much, 3 – dislike moderately, 4 – dislike slightly, 5 – neither like nor dislike, 6 – like slightly, 7 – like moderately; 8 – like very much, 9 – like extremely.

Data analysis. All data that passed the homogeneity and normality tests were further analyzed using SPSS 20.0 for Windows and ANOVA Analysis of Variance ($p < 0.05$) followed by the Duncan's Test.

Results and discussion

Mackerel skin gelatin characterization. The water content in fish skin gelatin was 6.45%, which was lower than in the raw material (Table 1). In this research, the water content exceeded that reported by Viji *et al.* as 4.81 ± 0.41% [18]. However, it was lower than the data published by Ismail & Abdullah as 6.93% [19]. Yet, the water content met the Indonesian National Standard No. 01-3735-1995 Gelatin quality and test method. The Joint FAO/WHO Expert Committee on Food Additives defines the maximum of 18%, and the Gelatin Manufacturers Institute of America mentions 10.5 ± 1.5% [20, 21].

According to Esfahani *et al.*, water content determines the stability of dry products [22]. High water content causes particle agglomeration and accelerates microbial growth and oxidation. Ash content was essential for evaluating gelatin quality, especially in terms of mineral content and purity. The ash content of fish skin gelatin (Table 1) meets the standards specified by the Indonesian National Standard (3.25%), the Joint FAO/WHO Expert Committee on Food Additives (max. 2.00%), and the Gelatin Manufacturers Institute of America 0.5 ± 0.4–1.5 ± 0.5% (Indonesian National Standard No. 01-3735-1995) [20]. Specifics of aquatic environment, habitat, and species affect the ash content of fish skin gelatin. Its ash content also depends on the extraction process [23].

In this research, the protein content of gelatin depended on the time and concentration of chemicals used. This concentration broke more amino acid bonds, so that more protein broke down during extraction. The resulting protein content in gelatin was 91.52%, which exceeded the initial data for dry fish skin (69.76%) and wet fish skin (35.63%). The protein content in gelatin met the Indonesian National Standard (87.25%). However, our results exceeded those obtained by Zarubin *et al.* by 73.2 ± 0.9% [23]. The difference in the protein content resulted from the differences in the concentration of acid and base used during extraction. Acid and base concentration and immersion time combined were reported to produce high protein content [24].

Fat content is known to affect the quality of raw materials during storage. The fat content of skin gelatin equaled 0.73%, which was lower than the initial data for dry skin (4.85%) and wet skin (2.24%). This result was similar to that reported by Gunawan *et al.* as 0.71 ± 0.07% [24]. High-fat content shortens the shelf-life of gelatin and affects the quality of gelatin in the application process [23]. In our research, the value of carbohydrates in gelatin was 6.45%, which was much less than the initial data for dry fish skin (20.18%) and wet fish skin (60.74%). Carbohydrates are not considered as an essential parameter in gelatin production: the essential parameters include protein, water, and ash.

Sensory profile of gelatin jelly candy. Sensation is a psycho-physiological process in which sensory recognition of object characteristics is carried out through stimuli received by the senses [25]. In our research, the sensory evaluation results for the appearance ranged from "liked moderately" to "like very much". Figure 1 shows that the liquid honey-flavored sample received a bigger score than date juice, olive oil, and grape juice. The natural color of honey, clear brown when added, turned light brown. Adding olive oil and date juice made the jelly candy blackish-brown while adding grape juice made it yellowish [26, 27]. The appearance score of the soy milk and goat's milk samples was very similar; both were yellow-brown but not like the honey sample. The milk powder had a color similar to that of the jelly candy formulation. According to Charoenphun, milk powder

Table 1. Mackerel skin gelatin proximate

Таблица 1. Предварительный анализ состава кожи скумбрии

Proximate, %	Mackerel raw skin	Mackerel dry skin	Mackerel gelatin
Water	60.74	20.18	6.45
Ash	5.23	2.36	0.86
Protein	35.63	69.76	91.52
Fat	4.85	2.24	0.73
Carbohydrate	60.74	20.18	6.45

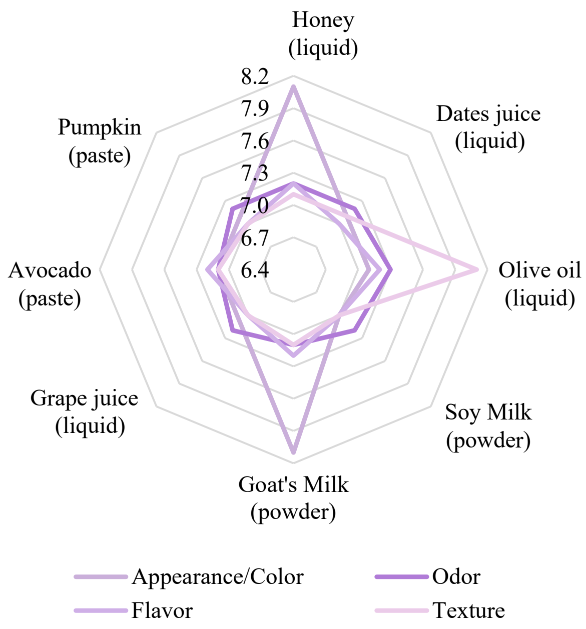

Figure 1. Sensory analysis of gelatin jelly candy

Рисунок 1. Органолептический анализ жевательного мармелада с желатином из кожи скумбрии

makes jelly candy light yellow or pale white [28]. Avocado and pumpkin turned the gelatin black. The problem is that avocado naturally produces ethylene gas, which is associated with ripening. It converts methionine to S-adenosylmethionine, which causes blackness when added to food [29].

The smell category received "like moderately" from all panelists. The samples with goat's milk powder had the highest score for smell (7.6), followed by olive oil (7.3) and honey, grape juice, date juice, soy milk, avocado, and pumpkin (7.1–7.2). The aroma of goat's milk turned out to be stronger than that of the other flavorings. Even unprocessed, goat's milk has a strong smell and taste caused by caproic acid [30]. The specific aroma can be removed by adding rare sugar (D-psychose, D-tagatose, D-sorbose): it would neutralize caproic acid with a glycation reaction. Znamirowska *et al.* stated that fresh goat's milk contains protein (2.69 ± 0.22%), fat (2.98 ± 0.53%), and general acidity (6.20 ± 1.20%) [31].

The flavor category also received "like moderately" from most panelists, the score ranging from 7.0 to 7.4. The avocado paste sample had the highest score of 7.4. Avocado has a naturally sweet taste, soft and savory. The savory flavor comes from the fat vegetable content of 0.71–2.15% and the total fatty acid content of 37–85% [32].

The texture evaluation ranged from "like moderately" to "like very much". The sample fortified with olive oil demonstrated a significant difference from other samples in this respect. Olive oil has a characteristic yellowish-gold color, sometimes greenish, and its relatively thick texture is rather oily. According to Bermúdez-Oria *et al.*, gelatin serves as a stabilizer, as well as an adhesive and gelling agent in jelly candy while olive oil gives it an oily and shiny chewy texture [33].

Gelatin jelly candy proximate analysis. Table 2 shows the proximate analysis of gelatin jelly candy with various natural ingredients. Water content had no significant effect ($p > 0.05$): each natural ingredient brought about different water content. The samples with soy milk and goat's milk powder produced the best water content between 9.76 ± 0.70 and 9.92 ± 0.68%. Initially, soy milk powder contains 3.31 ± 0.27% water, and goat's milk powder has 5.48 ± 0.23% water [34, 35]. Honey, dates, olive oil, and grapes added in liquid form resulted in very high water content compared to pasta ingredients (avocado and pumpkin). The correlation with the initial water content in the natural raw materials is very strong: honey contains 5.20 ± 0.33% of water while grapes contain 21.17 ± 0.76%, avocado contains 34.28 ± 0.95%, and pumpkin contains 14.18 ± 0.22% [36–39].

Table 2. Proximate analysis of gelatin jelly candy

Таблица 2. Предварительный анализ состава жевательного мармелада с желатином из кожи скумбрии

Natural ingredients, form	Proximate, %					
	Water	Ash	Protein	Fat	Carbohydrate	Sugar reduction
Honey (liquid)	10.25 ± 0.42[a]	0.13 ± 0.01[a]	15.67 ± 0.52[a]	2.20 ± 0.23[a]	63.93 ± 1.28[a]	0.18 ± 0.07[a]
Date juice (liquid)	14.09 ± 0.84[b]	0.32 ± 0.01[b]	15.82 ± 0.53 [a]	2.35 ± 0.26[a]	64.03 ± 1.14[b]	0.26 ± 0.03[a]
Olive oil (liquid)	10.71 ± 0.60[a]	0.18 ± 0.01[c]	15.77 ± 0.67[a]	2.09 ± 0.22[a]	58.26 ± 1.60[c]	0.13 ± 0.05[a]
Soy milk (powder)	9.76 ± 0.70[a]	0.21 ± 0.02[d]	16.20 ± 0.37[a]	2.32 ± 0.50[a]	51.61 ± 0.80[c]	0.14 ± 0.01[a]
Goat's milk (powder)	9.92 ± 0.68[a]	0.20 ± 0.03[cde]	13.97 ± 0.36[b]	1.99 ± 0.28[a]	57.57 ± 0.79[ad]	0.17 ± 0.09[a]
Grape juice (liquid)	10.82 ± 0.78[a]	0.15 ± 0.01[a]	13.62 ± 0.37[b]	2.31 ± 0.33[a]	62.55 ± 0.59[ade]	0.18 ± 0.05[a]
Avocado (paste)	10.23 ± 0.46[a]	0.18 ± 0.01[cef]	14.19 ± 0.45[b]	1.67 ± 0.30[a]	63.94 ± 1.46[adef]	0.12 ± 0.05[a]
Pumpkin (paste)	10.48 ± 0.56[a]	0.14 ± 0.02[a]	14.39 ± 0.64[b]	2.29 ± 0.35[a]	61.81 ± 1.20[aeg]	0.22 ± 0.05[a]
Indonesian National Standard for jelly candy	20.00	3.00	–	–	–	25.00

Note: Means in the rows with different superscripts are significantly ($p \leq 0.05$) different.

Примечание: Средние значения с разными верхними индексами существенно различаются ($p \leq 0,05$).

Water content greatly affects the quality and durability of gelatin jelly candy [40]. In our study, the overall water content of gelatin jelly candy fell within the standards set by Indonesian National Standard No. 3547-2-2008 Jelly candy with its maximum of 20.00%. The variance analysis showed that adding natural ingredients affected the water content significantly ($p < 0.05$). The highest ash content of 0.21 ± 0.02% belonged to the sample fortified with soy milk powder. However, the value of ash content in this study met the standards required by the Indonesian National Standard (max. 3.00%). The high ash content in the samples with soy milk and goat's milk powder was due to the initial mineral content in the raw materials. The ash content of soy milk powder is 0.40 ± 0.05%, and that of goat's milk is 0.07 ± 0.00% [34, 41].

During processing, the total minerals in the raw materials did not change significantly. The ash content and that of gelling agents were higher in the final product. The ash content tended to be lower in the samples with liquid honey, olive oil, date juice, and grapes, as well as in avocado and pumpkin pastes. Obviously, the fruit extraction process reduced the mineral content in the fruit juice. The components are easily decomposed or evaporated during fruit ashing [42].

Table 2 showed that the value of protein content ranged from 13.62 ± 0.37 to 16.20 ± 0.37%. According to the variance analysis, the natural ingredients produced a significant effect on the protein content ($p < 0.05$). The highest protein content of 16.20 ± 0.37% belonged to the sample fortified with soy milk powder. Fresh soy milk contains 23.08 ± 0.16% protein while powdered soy milk has a protein content of 5.09 ± 0.29% [34, 43]. Interestingly, the protein content of gelatin produced a very high protein content of 91.52%.

Protein intake is needed to build muscle mass, especially in toddlers. Jelly candy can deliver bioactive compounds required by the toddler's body. The protein content in the samples fortified with natural ingredients in liquid form (honey, olive oil, dates, and grapes) and paste form (avocado and pumpkin) also had a relatively high protein content [44]. Kia *et al.* reported that jelly candy with gelatin had a higher protein content [11].

The natural ingredients produced no significant effect on fat content ($p < 0.05$). In the sample with soy milk powder, the fat content was 2.32 ± 0.50%. The high and low-fat content of jelly candy depended on the differences in the raw materials used. According to Nemo & Bacha, the fat content in honey is 0.27 ± 0.20% [36]. Other studies reported the following fat contents for different raw materials: soy milk powder – 11.36 ± 0.44%, goat's milk powder – 1.02 ± 0.09%, grapes – 0.64 ± 1.17%, avocado – 6.66 ± 0.10, pumpkin – 4.50 ± 0.21% [34, 37–39, 41].

The total value of carbohydrates in this study ranged from 51.61 ± 0.80 to 64.03 ± 1.14%. The variance analysis showed that adding natural ingredients to gelatin jelly candy had a significant impact on total carbohydrates ($p < 0.05$). The highest total carbohydrate value belonged to the sample fortified with date juice and equaled 64.03 ± 1.14%, probably because the calculation of carbohydrates was carried out using the by-difference method. The high value of carbohydrates in each treatment managed to meet the requirements for energy intake.

Liu *et al.* explained that carbohydrates give food a sweet taste, especially monosaccharides and disaccharides that provide energy for the body [44]. The value of carbohydrates in our study depended on the raw materials. The level of carbohydrates was quite high in grapes (49.17 ± 2.31%), avocado (54.23 ± 0.02%), and pumpkin (61.71 ± 0.10%) [37–39].

Sugar residue is a substance left after a specific chemical process; this residue could be likened to salt. In our research, the mean value ranged from 0.12 ± 0.05 to 0.26 ± 0.05%. The results followed the Indonesian National Standard for jelly candy with its maximum of 25.00%. The statistical analysis of the sugar reduction between the samples revealed no significant effect ($p > 0.05$). It was because the sugar residue came from the sucrose produced by jelly candy. Garusti *et al.* stated that palm sugar contains 87.10% sucrose with 6.06% reducing sugar [45]. The content of reducing sugars depends on the inversion of sucrose into reducing sugars. The low level of reducing sugar in the study was due to the natural ingredients used. Reducing sugar in natural ingredients tends to be lower and can be easily synthesized by the body [46].

Microbiological analysis. The total plate count value was ≤ 1×10^2 colonies per 1 g, which met the Indonesian National Standard for jelly candy, i.e., 3×10^3 colonies per 1 g (Indonesian National Standard No. 3547-2-2008). The low total plate count could be explained by the fact that sucrose has antibacterial properties. In Balakrishnan *et al.*, sucrose was oxidized to form acetals in the heating process [47]. The acetal group can release cation-charged ions that interact with the anionic charge of the microbial cell membrane through electrostatic bonds, thus increasing cell permeability, and cell leakage leads to cell death.

All samples of gelatin jelly candy exhibited negative results for *E. coli* and *Salmonella* sp. The results also met the Indonesian National Standard. The absence of *E. coli* and *Salmonella* sp. could be traced to the natural antibacterial activity of the ingredients added. According to Handayani *et al.*, some natural ingredients in liquid form have antibacterial properties against *Staphylococcus aureus* and *E. coli* at a maximum concentration of 0.04 g/mL [48].

Conclusion

The mackerel skin gelatin jelly candy fortified by different natural flavorings was well received by panelists, with evaluations ranging from "like moderately" to "like very much". The nutritional quality of the gelatin jelly candy met the Indonesian National Standard. The best results belonged to the samples fortified with soy milk: it had the highest protein and the lowest carbohydrate contents. Further research will feature the amino acids in each flavor sample of gelatin jelly candy.

Contribution

The authors were equally involved in writing the manuscript and are equally responsible for plagiarism.

Conflict of interest

The authors declare no conflict of interests regarding the publication of this article.

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