Mie Krill: Incorporation of Indigenous Udang Saih (Sumatran Krill) Extract Containing Astaxanthin and Essential Fatty Acids into an Instant Noodle Product Made from Composite Flour

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Abstract
The Sumatran Krill (SK) commonly known as ‘Udang Saih’ (Acetes sp.) is an indigenous species of sea products. Local people in Padang, West Sumatra use the SK to make traditional condiment, such as shrimp paste. The SK can be extracted to create more valuable products since it contains various important unsaturated fatty acids, such as omega-3, omega-6, omega-7, and omega-9 and the powerful antioxidant carotenoid named astaxanthin. Astaxanthin as the main carotenoid in the SK extract offers several health benefits, i.e. anti-inflammatory properties, support immune system modulation, as well as maintaining brain, cardiovasculat, and eye health. In this study, we aim to incorporate the SK extract into an instant noodle product and to evaluate the sensory profile of instant noodle prototypes compared to its prototype without the addition of the SK extract and benchmark noodle product. We used the composite flours consisted of high-protein wheat flour (WF) and yellow sweet potato flour (YSPF) which are rich in \( \beta \)-Carotene as a vitamin A precursor, to further enhance its eye health property. The instant noodle prototype (M2) was made from a mixture of YSPF (40 g), WF (40 g), super-concentrated astaxanthin in sunflower oil (8 mL) had the highest score of sensory attributes. This instant noodle prototype was claimed to contain astaxanthin, essential fatty acids, and provitamin A carotenoid as well as low in gluten content. Therefore, this instant noodle prototype could be proposed to increase the health benefits and well accepted in society.

INTRODUCTION
Indonesia is the biggest archipelagic country in the world having more than 17,000 islands with three-quarters part of its territory being the waters [1]. Also referred to as a maritime nation [2], most people that live along the coastline earn their living as fishermen. One of the indigenous specimens that can be found in Padang, West Sumatra is a shrimp-like crustacean commonly known as ‘Udang Saih’ or we can call it as Sumatran Krill (SK). The SK (Acetes sp.) was an invertebrate living on a mangrove in Sirandah Island, Padang, West Sumatra, which mainly lives in \( Pongamia \) pinnata (Kayu laut in Bahasa) by up to 43.38% in there island [3].

The focus of krill usage on various food products for human consumption appears from its umami taste, as well as its nutritive compound composition [4]. In Indonesia, especially the local people in Sumatra use the SK as the main ingredient for making traditional condiments such as shrimp paste, shrimp crackers, and fish sauce [5]. Nevertheless, more technologically advanced industries have been producing supplements from krill oil extract in the last decades [6]. The krill oil itself is a rich source of fatty acids and bioactive compounds [7], and the main

Keywords: astaxanthin, dietary fatty acids, instant noodle, sumatran krill, yellow sweet potato

Marketable functional-instant noodle: From its sensory evaluation, the M2 prototype was highly acceptable and marketable as compared to the benchmark product (Lemonilo instant noodle) and control (prototype without SK extract added, M0). M2 prototype made from composite flour containing yellow sweet potato flour and enriched with SK extract known to have valuable carotenoid \( \beta \)-carotene as well as astaxanthin (174.53 \( \mu \)g/mL SK extract) and various essential fatty acids which are important for human health.

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interest for studies comes from the abundance of polyunsaturated fatty acids (PUFAs) and monounsaturated fatty acids (MUFA), such as omega-3, omega-6, omega-7, and omega-9.

Omega-3 fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are crucially needed to maintain cellular functions [8]. The polyunsaturated fatty acid is linoleic acid classified as the omega-6 [9]. The MUFA could be found in the forms of omega-7, i.e. palmitoleic acid, and omega-9, i.e. oleic acid [10]. The another fascinating thing about krill oil is the presence of astaxanthin. Astaxanthin is the main carotenoid compound that can be found in some marine organisms [11].

Astaxanthin is found to be the main carotenoid found in krill [12]. Recent studies have reported that the antioxidant activity of astaxanthin was 100 times more potent than α-tocopherol, and was still 10 times stronger compared to other carotenoids such as zeaxanthin, lutein, and β-carotene [13]. It also plays important roles in preventing cardiovascular disease, improving efficacy in the eye by increasing blood flow in retinal capillaries, anti-lipid peroxidation activity, anti-inflammatory, anti-diabetic activity, anticancer activity, and immuno-modulation [14, 15]. Furthermore, the presence of astaxanthin as a natural pigment gives a dark reddish color to the krill oil.

Nowadays, consumers appear to be easily worried about what they eat while having tendencies to look for practical and delicious foods [16]. For this kind of people, it is less bothering if they can just ingest healthy-yet-tasty foods rather than supporting their diet with dietary supplements which might have several safety issues about the dosing, side-effects, or potential interaction with active compounds [17, 18]. Also, considering the extensive, rich, and uniqueness of functional food development at the moment, we decided to try to develop an instant noodle product by incorporating the beneficial SK extract that contains astaxanthin and essential unsaturated fatty acids. Moreover, the interesting part of our instant noodle is to enhance the functionality of our instant noodle product by combining wheat flour (WF) and yellow sweet potato flour (YSPF).

As we know, yellow sweet potato (YSP) (Ipomoea batatas L.) is widely cultivated in Java Island and is commonly processed as traditional snacks [19]. As a staple food substitute, the YSP contains great numbers of nutritional values such as crude fiber, carbohydrates, minerals, and β-carotene. Therefore, the use of YSPF mixed with WF in this research hopefully can achieve a more balanced nutritional value. A recent paper had shown that YPS is indeed available to be used as the raw material for noodles products with the low-gluten claim [20]. A hydrocolloid compound called xanthan gum is also needed to increase the viscosity pseudoplastic material level since the dough has low gluten content, so it could facilitate rapid rehydration, water absorption, and rheology [21]. Besides, its contribution as a thickener and gel former agent may affect the texture of the noodles become stronger and more elastic [22].

The objectives of this study are to develop instant noodle products made from composite blends of WF and YSPF containing the SK extract and to evaluate the sensory profile of instant noodle products compared to its product without the addition of the SK extract and benchmark noodle product. Additionally, the analysis of nutrient content for fatty acid and astaxanthin were also conducted. Indigenous ingredients of the SK extract was used in this product to promote the uniqueness of Indonesia and the economic growth of local fisheries, as well as increasing health awareness with a highly marketable and acceptable product. The real challenge about creating functional food products is to develop the right formula for each ingredient to keep adequate health benefits while maintaining its flavor and texture properties of instant noodle products.

**EXPERIMENTAL**

**Materials and instrument**

Sunflower oil, YSP, white flour, and xanthan gum were purchased from local stores in Malang, East Java, Indonesia. The SK extract in pellet form obtained from the subcritical-DME extraction was kindly gifted from PT. Mitra Ayu Adi Pratama, Padang, West Sumatra, Indonesia. Meanwhile the solvents used were n-hexane (C6H14, 100%), potassium hydroxide (KOH, 60%), methanol (CH3OH, 100%), water, MTBE (C8H18O2, 100%), and ethanol (C2H5OH, 100%) with the grade of pro analysis were purchased from Merck KGaA (Darmstadt, Germany) and used without any further purification.

The instruments used in this work were noodle machine (Oxone-355 AT, Indonesia), vortex (Genius 3 Ika, USA), and centrifuge (Hermle Z 160 M, Germany). Spectrophotometer UV-Visible (UV-1700, Shimadzu, Japan), and high-performance liquid chromatography (HPLC, Shimadzu LC-20 AT, Japan) equipped with a photodiode array detector (PDA, SPD-M20A) were used for determination of carotenoid content in the SK extract. Gas chromatography-mass spectrometry (GC-MS, Shimadzu QP2010 Plus, Japan) was used for determination of fatty acids contained in the SK extract. ColorFlex EZ 0530 (HunterLab, USA) was used for determination of color properties.

**Preparation of yellow sweet potato flour (YSPF)**

YSPF was prepared according to the method of Nogueira et al. [23] and then the resulted YSPF was stored in a plastic container in the desiccator until further use.

**Preparation of the SK extract**

Preparation of the SK extract in vegetable oil was done by homogenizing as much as 8 g of the pellet of SK extract in 1 mL sunflower oil, and then centrifuged at 6000 rpm for 10 min to separate the supernatant from its residue. The dark red-oily solution containing the astaxanthin esters had an equal concentration of free astaxanthin about 174.53 μg/mL and was used as the super-concentrated astaxanthin.

**Formulation of composite flour blend**

The instant noodle formulations were prepared using the YSPF (40 g) and WF (40 g) as the main dry ingredients, xanthan gums (1.6 g), and salt (0.64 g). The wet ingredient used is the super-concentrated astaxanthin in sunflower oil. The dry ingredients were added in a fixed amount, while the SK extract was varied. There were three instant noodle prototypes (M1, M2, and M3) based on the set ratio of the SK extract in sunflower oil added, 0.8, 2.4, and 4.0 mL, respectively. The varying ratio of the SK extract added in the formula was then diluted with sunflower oil until it reached 8 mL of the total volume.

**Preparation of the dried noodle and cooked noodle**

All of the dry ingredients were mixed in a large bowl. Then, the wet ingredient was added and mixed manually for 15 min. After the mixture was properly blended, the mixture was then
cut into a noodle form using a noodle machine. The noodle product was then placed into a pan (24 × 18 × 22 cm) and put into the oven at 100 °C for 10 min. The cooked noodle was prepared from the dried instant noodles by soaking in boiling water for 2 minutes.

**Determination of carotenoid content in the SK extract and the dried instant noodle prototypes**

For determination of carotenoid content in the SK extract, approximately 1 mL of n-hexane was added into 0.5 g of the SK extract. The mixture was homogenized for 1 min, while soaking in an ice-bath for 1 min. The supernatant was separated from the residue by centrifugation at 6000 rpm for 5 min. This extraction procedure was repeated three times. The combined supernatants were dried using N₂ gas. After that, the extract was saponified using 2985 μL of methanol, and 15 μL of KOH 60% refers to Koomyart et al. [24]. The mixture then added with several organic solvents, i.e. n-hexane, water, MTBE, and methanol to extract the astaxanthin in organic phase and then the organic phase was dried using a N₂ gas. The dried carotenoid extract was dissolved in acetone and at least 20 μL extract was injected to the HPLC according to the method of Kurniawan et al. [25] with a slight modification. The total percentage peak area of free-astaxanthin peaks in the SK extract were determined from the HPLC chromatogram detected at 475 nm. In addition, total carotenoid of the SK extract was expressed as the equivalent of astaxanthin content according to the Lambert-Beer equation. The 0.05 g of the SK extract was diluted with 1 mL of n-hexane and then absorbance value at the maximum absorption wavelength (λmax) of this solution was measured using a UV-Vis spectrophotometer. The approximate content of free astaxanthin in the SK extract was calculated by combining the total carotenoid determined by UV-Vis spectrophotometer and the percentage peak area resulted from HPLC analysis.

The carotenoid analysis of the dried instant noodle prototypes (M0 and M2) was performed by measuring the absorption spectrum of carotenoid extract. The dried instant noodle prototype was grounded using mortar and pestle, then the water content of powders was measured using a moisture balance. To approximately 0.2 g powders in eppendorf tube, 600 μL of water, 400 μL of ethanol, and 400 μL of n-hexane were added. This mixture was homogenized by vortexing and then the upper layer containing carotenoids was collected. The extraction process was repeated three times. The combined carotenoid extracts were dried using N₂ gas and afterward, the dried extract was dissolved with 1 mL of n-hexane. The absorption spectrum was measured using a UV-Vis spectrophotometer in the range of 350-600 nm.

**Determination of fatty acids contained in the SK extract**

The analysis of fatty acid was carried out according to the method of Wang et al. [26]. Approximately 0.08 g the SK extract was mixed with 0.7 mL of KOH solution (10 M) and 5.3 mL of methanol. The mixture was incubated at 55 °C for 1.5 h by stirring for 5 s every 20 min. After that, the mixture was cooling down until it reaches room temperature, then 0.58 mL of concentrated sulfuric acid was added and incubated again with the same method as described previously. Three mL of n-hexane was added into the mixture and then centrifuged at 6000 rpm for 5 min. The upper layer was taken into a vial and dried using N₂ gas. Then, the dried layer mixed with 1 mL of n-hexane, and as much as 0.2 μL of fatty acid methyl ester solution was injected into gas chromatography-mass spectrometry (GC-MS) using the adaptability method of Wang et al. [26].

**Determination of visual appearance**

The color properties of the dried and cooked instant noodle prototypes as well as the M0 prototype without the SK extract added and benchmark noodle products were measured by using ColorFlex to obtain the value of \(L^*, a^*, b^*\). The instrument was first standardized with a white tile \(L^* = 92.93, a^* = -0.92, b^* = -1.48\). Each value obtained was used to determine the instant noodle color visually in addition to the photos taken by a phone camera.

**Sensory evaluation**

The instant noodle prototypes of M1, M2, and M3, as well as the benchmark product and M0, were presented for hedonic testing before evaluating the sensory characteristics (color, texture, aroma, taste, and overall preference) to the 35 panelists at Universitas Ma Chung (mainly belong to students, academics, and employees) and some of the panelist dwelling. The panelists consist of 54.3% of females and 45.7% of males and came from a different age: 17–20 years old (y.o.) (23%), 21–30 y.o. (46%), 31–40 y.o. (17%), and > 41 y.o. (14%). Each panelist was served with approximately 2 g of each sample (without any seasoning added) placed in a clear plastic cup labeled with a random three-digit number. The panelists were requested to fill out the questionnaire and rated all of the instant noodle formulations using 9-points of hedonic scale (1 = dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neutral; 6 = like slightly; 7 = like moderately; 8 = like very much; and 9 = like extremely). Moreover, the panelists were also asked about the individual preference, the understanding of raw material we used, how frequent, and the reason for consuming instant noodle products.

**RESULTS AND DISCUSSION**

**Carotenoid analysis of the SK extract**

Astaxanthin is well known as the main carotenoid found in the krill and other marine animals as well as algae [27]. Astaxanthin in the krill oil was reported in the form of astaxanthin esters. The results of HPLC analysis for the unsaponified and saponified carotenoids from the SK extract in this work are shown in Figure 1.

![Figure 1. HPLC chromatograms detected at 475 nm of the unsaponified (black) and saponified (red) carotenoids from the SK extract.](image-url)
The carotenoid identification in the SK extract was carried out by comparing its $\lambda_{\text{max}}$ and its elution order to the results of Holtin et al. [28] with a similar HPLC system used. The carotenoid composition of unsaponified SK extract (Figure 1, black) showed a relatively equal amount of the free astaxanthin peaks eluted at retention time ($t_n$) below than 15 min (37.83%) and the peaks of astaxanthin esters eluted at $t_n$ above 15 min (62.17%). On the other hand, another study of Lambertsen and Braekkan [29] reported that the relative percentage of free astaxanthin in krill oil was only 6%, while the astaxanthin esters reached 94%. This difference in the percentage of free astaxanthin is due to the dried krill used for astaxanthin extraction in this study. Yang et al. [30] revealed that astaxanthin esters undergo hydroxylation caused by thermal processing, which converts astaxanthin esters into free astaxanthin and fatty acids.

Astaxanthin esters can be converted into free astaxanthin by alkaline hydrolysis. Figure 1 (red) showed the elution profile of saponified carotenoids from the SK extract. The percentage peak area of astaxanthin esters (26.6%) was reduced compared to the unsaponified sample, while the percentage area of free astaxanthin peaks increased to 73.4%. The yield of astaxanthin extraction from the cells of Haematococcus pluvialis by using sunflower oil was up to 87.42% [31]. The present result indicates that the extraction process of astaxanthin from the SK extract by using sunflower oil can be remarkably used to obtain the super-concentrated astaxanthin without any co-solvent or organic solvent involved.

The total carotenoid from the super-concentrated saponified SK extract was determined by the Lambert-Beer equation using the absorbance value at 469 nm and the molar extinction coefficient of astaxanthin in $n$-hexane [32]. The absorption spectrum of the saponified carotenoids from the SK extract in $n$-hexane was shown in Figure 2. The total carotenoid equivalent to astaxanthin content from the super-concentrated astaxanthin extract was 237.69 µg/mL. The approximate content of free-astaxanthin in 1 mL SK extract was up to 174.53 µg.

**Figure 2.** UV-Vis absorption spectrum of super-concentrated astaxanthin extract in $n$-hexane.

Fatty acid analysis of the SK extract

It is widely known that krill oil is rich in highly unsaturated fatty acids (UFAs). These UFAs derived from dietary lipids, mainly EPA and DHA, have attracted much attention for health benefits [27]. The fatty acid groups and their relative content from the super-concentrated astaxanthin extract were presented in Table 1. The fatty acid analysis by GC-MS showed that super-concentrated astaxanthin extract was composed of 5 types of saturated fatty acids (SFAs) and 10 types of UFAs which the relative content of UFAs (62.28%) was higher than that of SFAs (37.72%). Therefore, the krill extract is well known to be a potential source of UFAs in agreement with the result of Araujo et al. [33].

Among SFAs, palmitic acid was present in the highest relative content (20.02%) followed by myristic acid (11.08%), stearic acid (4.42%), margaric acid (1.15%), and pentadecanoic acid (1.05%) which were confirmed from the SFAs composition of krill oil by Ivanova et al. [34]. Furthermore, PUFAs comprised of omega-3 (25.41%) and omega-6 (12.70%) was the main component of UFAs compared to MUFAs. The long-chain eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (21.88%) as the omega-3 PUFAs were the most abundant fatty acid group in super-concentrated astaxanthin of the SK extract which were similar results to other fatty acid studies on Euphausia superba [10] and Acetes vulgaris [35].

**Table 1.** The fatty acid groups and their relative content as percentage (%) peak area in the SK extract.

| Fatty acid group | Relative content (%) |
|------------------|----------------------|
| SFAs             | 37.72                |
| UFAs             | 62.28                |
| Omega-9 MUFAs   | 6.48                 |
| Omega-7 MUFAs   | 17.69                |
| Omega-6 PUFAs   | 12.70                |
| Omega-3 PUFAs   | 25.41                |

Visual appearance and carotenoid analysis of instant noodle

The visual appearance of three instant noodle prototypes (M1, M2, and M3) was compared to the M0 and the benchmark product according to their photos shown in Figure 3. Visually, the color of the dried-instant noodles products spreads from a yellow-tint (Benchmark orange) to light orange (M3).

**Figure 3.** The visual appearance of the dried- and cooked-instant noodle products for the prototypes compared to the M0 and benchmark noodle product.
The instant noodle prototypes (M1, M2, M3) have the color coordinates as follow: $L^*$ values ranged from 49.51 (M2) to 51.74 (M3), $a^*$ values ranged from -0.86 (M1) to 9.42 (M3), and $b^*$ values ranged from 24.24 (M1) to 26.05 (M3). On the other hand, the instant noodle product made from YSPF:WF without the addition of the SK extract (M0) showed a pale-yellow color ($L^* = 55.68$, $a^* = 5.13$, $b^* = 24.63$) because of YSPF was used in the formula. After the incorporation of the SK extract, the color of the instant noodle prototypes became more orange as the SK extract added increase, and the color of each prototype showed a different result. The data of color analysis is shown in Figure 4. The orange color of instant noodles prototypes is assumed to be affected by the color of astaxanthin which is originally orange to red.

Previously, Nanthachai et al. [36] had made functional instant noodles containing pumpkin powder and the color of the product was varying from orange to red color. The darker color of the instant noodles product as the amount of pumpkin powder added was increased. Besides that, Hossain et al. [37] had also studied the incorporated of astaxanthin in a cookie’s product. They made functional cookies from oat flour and added with various concentrations of astaxanthin powder from Haematococcus sp. The product was claimed that the adding of 15% astaxanthin powder (w/w) in their formula make the red cookies can have a high level of antioxidant at 1.44 mg gallic acid equivalent per g sample. This showed that the astaxanthin from the SK extract can also be utilized as a potential natural food colorant with several benefits for human health.

The benchmark noodle product made from the combined WF and turmeric powder (0.77%, w/w) showed a yellow bright color and was assumed because of the turmeric addition in the formula [38]. The color properties, i.e. $L^*$, $a^*$, and $b^*$ values, of the benchmark noodle product were 60.59, -0.17, and 45.36 in the dried-instant noodle and 52.43, 0.71, and 40.28 in the cooked-instant noodle, respectively. The benchmark noodle product showed an increased level of the hue value at 88.99° to 90.20° after the boiling. According to Reyes and Cisneros-Zevallos [39], the hue angle of yellow color was described at the range between 72° and 90°. The color of turmeric itself was reported to become more intense after being heated, especially for $L^*$ and $a^*$ values [40]. Therefore, the color of the benchmark noodle product is not affected by the boiling treatment. On the other hand, the hue angle of the cooked-instant noodle prototypes was shown to be decreased from 74.79° to 70.13°. This may be assumed that the water from boiling treatment was trapped on the noodles that make the color of cooked prototypes became paler, or the heat treatment involved may decrease the astaxanthin content since it has a heat-labile property like other carotenoids [41]. The determination of astaxanthin content in these instant noodle prototypes for every single process may need to be done in the future.

According to the results of visual appearance and color properties, the dried-instant noodle prototypes had a significant color difference from light orange (M0) to orange (M2). The difference of color from both instant noodle prototypes can be analyzed using a UV-Vis spectrophotometer. The absorption spectra of the carotenoids extracted from these instant noodle prototypes are shown in Figure 5. The absorption spectrum of M0 had $\lambda_{max}$ at 445 nm due to the presence of $\beta$-Carotene come from the YSPF [42]. The spectrum shape and $\lambda_{max}$ of M2 were similar to the M0, while the increasing absorbance values at $\lambda_{max}$ and the shoulder around 470 nm were influenced by the addition of super-concentrated astaxanthin extract into the instant noodle prototype, M2.

![Figure 4](image-url)  
**Figure 4.** The values of color properties for $L^*$, $a^*$, $b^*$, and hue angle intensity generated from ColorFlex form the dried- and cooked-instant noodle products.

![Figure 5](image-url)  
**Figure 5.** Absorption spectra of carotenoid extracts from the dried-instant noodle prototypes, M2 and M0 in 1 mL n-hexane
Hedonic sensory evaluation

The sensory evaluation was conducted to provide the customer’s preference for the critical parameter provided, such as color, texture, taste, aroma, and overall preference towards the three instant noodle prototypes. We want to know about how the SK extract added in this research affects the acceptability of the instant noodle. Besides, because the product was not made from 100% wheat flour, we want to evaluate whether the product can be accepted by the market or not. It is known that the addition of shrimp-like ingredients in food products will affect the taste and aroma of the final product, and not so many people like this addition. Thereby, the panelists also are given a placebo-controlled test for the instant noodle, which is the instant noodle without the SK extract added and benchmark product (enriched with curcumin extract) as the benchmark product found in the market. Therefore, each sensory evaluation profile needs to be well studied before the instant noodle prototypes can be scaled up.

Figure 6a shows the mean scores of the hedonic test for each instant noodle prototype (M1, M2, and M3). All of the sensory parameters (especially the taste) of the M2 prototype was well-received by the panelists (except for the aroma), followed by M1 and M3 prototypes. We found that there was no significant difference in the texture parameter of the three instant noodle prototypes (6.54–6.80). This indicated that the increase of the SK extract added in the instant noodle formula would not give any effect on the product’s texture. The panelists also scored a similar value for the color and overall preference for the M1 and M2 (6.60 and 6.10 respectively), while the M3 prototype was very low (tend to dislike the product). From the result, we found that the higher the SK extract added in the instant noodle formula, the lower score of aroma we obtained (6.31, 5.96, 4.83 for M1, M2, M3, respectively).

Compared to the M0 prototype and the benchmark product (Figure 6b), the score of all sensory parameters in the M2 prototype was slightly lower except for the color. The color of the benchmark product (mean score at 7.10) was higher than M2 and M0 (6.63 and 6.43, respectively), and this is assumed that people were likely to choose the instant noodle product that has a yellow-tint color than the orange one. Interestingly, in this study, we found that the increasing amount of the SK extract added into instant noodle formula would give a higher score for the color of the product, but unfortunately lower the score of the taste parameter. We assume the addition of the SK extract that contains natural astaxanthin plays an important role as the coloring agent in this product, even though this SK extract may interfere with the aroma and taste of the product. However, the taste is one of the pivotal sensory parameters that need to be concerned. We consider that the M2 prototype may obtain high preference in the community, based on its high overall preference (6.26) and taste (6.10) score, and can the first instant noodle product that is low gluten and rich in natural astaxanthin also β-Carotene. The M2 prototype (418.8 μg in 1 mL of super-concentrated astaxanthin extract) fulfills 7% of daily value [14].

CONCLUSIONS

The M2 instant noodle prototype which consisted of YSPF (40 g), WF (40 g), 30% super-concentrated astaxanthin in sunflower oil (8 mL) was chosen as the most preferred instant noodle prototype with the highest score in each sensory attribute compared with M1 and M3. In addition, the use of YSPF in this research can lower the gluten content and increase the nutrition value because of its carbohydrate and provitamin A carotenoids content. The incorporation of indigenous SK extract in our instant noodles that contain MUFA and PUFA, and astaxanthin (7% daily value) is also believed to increase the health benefits compared to others. We believe that Mie Krill can be well-accepted in society since instant noodles are one of the most popular foods in Asia, and can be the product that may increase and promote the uniqueness and richness of Indonesia in Asia.

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Abstrak
Indonesia merupakan negara kepulauan yang sebagian besar wilayahnya berupa lautan. Salah satu spesies laut asli Indonesia yang dapat ditemukan adalah Krill Sumatera (SK), yang biasa dikenal dengan sebutan ‘Udang Saih’ dan dapat ditemukan di Padang, Sumatera Barat. Selain digunakan oleh penduduk lokal sebagai bahan untuk bumbu tradisional seperti terasi udang, krill sendiri dapat diekstrak untuk menghasilkan produk yang lebih bernilai karena kandungan asam lemak tak jenuhnya yang beragam seperti omega-3, omega-6, omega-7, dan omega-9, serta memiliki karotenoid sifat antioksidan yang kuat bernama astaksantin. Astaksantin sebagai karotenoid utama dalam ekstrak SK menawarkan beberapa manfaat kesehatan seperti anti-inflamasi, mendukung sistem kekebalan tubuh, sekaligus memelihara otak, kardiovaskular, dan kesehatan mata. Pada studi ini, kami memiliki tujuan untuk menggabungkan ekstrak SK ke dalam produk mi instan dan mengevaluasi profil sensori dari prototipe mi instan dibandingkan dengan prototipe mi instan tanpa penambahan ekstrak SK dan produk mi acuan. Kami menggunakan tepung campuran yang mengandung tepung gandum kaya protein (WF) dan tepung ubi cilembu (YSPF) yang kaya akan β-karoten sebagai prekursor vitamin A yang dapat meningkatkan kesehatan mata. Prototipe mi instan (M2) yang terbuat dari campuran YSPF (40 g), WF (40 g), dan astaksantin terkonsentrasi dalam minyak bunga matahari (8 mL) meraih skor tertinggi untuk evaluasi sensorinya. Prototipe mi instan ini dipercaya dapat meningkatkan manfaat kesehatan dan dapat diterima dengan baik oleh masyarakat.

Kata kunci: asam lemak, astaksantin, krill sumatra, mi instan, ubi cilembu