

Profile of sodium chloride levels and proximate value in salt fortification with knife clams (*Solen* spp.) as dietary salt from Madura Waters

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Abstract. The abundance of *Solen* spp. in Madura waters contains essential macronutrients for the body, which have the potential to be used as innovative nutritious food products, for example fortified salt with knife clams. The aims of this research were to determine the best formula for adding knife clams flour to salt on the NaCl content and proximate value as dietary salt, and analyze the effect of different concentrations of salt and knife clams powder in the product formulation on the NaCl and proximate level. Focus of this research was to determine the treatment differences F1 (5:95); F2 (10:90); F3 (15:85); F4 (20:80); F5 (25:75); F6 (50:50); FC (100% Salt) to test NaCl levels and proximate values. The research results showed that the best product NaCl content was found in F6 (52.25%±0.06%) with a drying time 30 minutes and temperature 95 °C. Proximate values at F6 including water 6.61±0.04%, protein 42.11±0.38%, fat 0.98±0.01%, ash 46.60±7.85% and carbohydrates 3.7±1.8%. The results of the statistic test show that NaCl, water, protein, fat, ash, and carbohydrates have a significance value (p<0.05). The salt formulation had a real influence on the protein and ash of each treatment, but no significant influenced on the water, fat and carbohydrate.

1 Introduction

Marine organisms are one of the marine biological resources that are used as a source of healthy and nutritious food with high protein content by coastal communities. A source of animal protein from marine organisms that are easily obtained by the coastal communities of Madura is a group of shellfish, one of which is the knife clams or « lorjuk » (*Solen* spp.). Knife clams or bamboo clams are known by the local name lorjuk by the coastal communities of Madura [1]. This type of shellfish is found abundantly in 4 districts on the southern coast of Madura, namely the waters of Sumenep [2], Pamekasan [3], Sampang, and Bangkalan [4]. Knife clams contain macronutrients from primary metabolite compounds, namely protein, fat, carbohydrates, water, and ash [5], while the secondary metabolite compounds are alkaloids, steroids, and flavonoids [6].

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The large amount of essential macronutrients needed by the body gives this organism great potential to be used as an agent for innovation in healthy and nutritious food from the sea. This healthy food innovation can be used to meet the need for a variety of typical Madurese culinary delights made from knife clams, reduce the problem of malnutrition and hypertension sufferers in Madura. The highest number of toddlers experiencing malnutrition in Madura was dominated by 2 districts, including Bangkalan Regency with 113 toddlers [7], and Sampang Regency with 280 toddlers [8]. The number of hypertension sufferers in Madura was also relatively high, including 182.581 people in Sampang Regency [8]. One effort to verify potential products using the fortification of knife clams (*Solen* spp.) is the fortification with knife clams (*Solen* spp.). Coarse salt and knife clams (*Solen* spp.) are two fisheries and marine commodities that are abundant in Madura. Madura as the main national salt-producing center has four production centers, namely Sampang, Pamekasan, Sumenep, and Bangkalan Regencies [9] with a total salt production land area of 11,170.9 Ha [10]. All these salt-producing locations also found abundant knife clams (*Solen* spp.).

Salt is a mineral-rich product that is used for daily food needs. Salt has focused on raw materials, food additives (flavor enhancers), preservatives [11], and dietary salt. The function of salt as an ingredient to enhance the taste of food products plays an important role in daily life, including as a seasoning ingredient for housewives' cooking and culinary businesses for typical Madurese dishes. So far, Madurese people are accustomed to consuming coarse salt in the form of non-iodized "krosok" salt. This type of salt triggers many hypertension sufferers in Madura because it has high NaCl levels, namely 93.24% [12]. The production of low-NaCl salt needs to be done to help hypertension sufferers [13] so that they can still meet their needs for the important minerals found in this healthy salt. Research on low NaCl salt and application to food products and fortified salt has previously been carried out including low NaCl salt using *Sargassum polycystum* [14], *Ulva lactuca* [15], *Sargassum polycystum* with active carbon [16], *Ulva lactuca* with active charcoal [17], *Ulva lactuca* and *Limncharis flava* [18], *Padina minor* [16], kamaboko with fortified seaweed salt [19], crackers with brown seaweed salt [20], and powder drink with brown seaweed salt [21]. Research on fortified salts includes salt with the spice *Curcuma domestica* Val. [22], and salt with Dayak onions [23].

Salt low in NaCl can be used as an agent to stabilize blood pressure and is rich in minerals compared to existing salt consumption [24]. The production of mineral-rich salt fortified with knife clams (*Solen* spp.) is an effort to increase the function and selling value of salt so as to produce products that are ready to be consumed for the dietary salt needs of hypertension sufferers and innovations in flavoring ingredients, especially culinary camphor lorjuk, rengginang lorjuk, and kacang lorjuk. This product has a dual function as an agent for healthy salt and food salt as a complementary ingredient to typical Madurese food. The innovation of fortified salt with knife clams as a candidate for food salt requires identifying the nutritional content levels such as protein, water, fat, and ash content [25] in the product to ensure the best formulation of this fortified salt as a candidate for healthy salt. Salt products fortified with knife clams (*Solen* spp.) are classified as substitute food ingredients for the diet salt category, and Savory Salt must meet BPOM Regulatory Standards number 34 of 2019 [26]. The aims of this research were to 1) determine the best formula for adding knife clams flour to salt based on the NaCl content and proximate value as dietary salt, 2) analyze the effect of different concentrations of salt and knife clams powder in the product formulation on the NaCl content and proximate value of salt fortified with knife clams. It is hoped that this research can provide initial information and reference regarding bioprospecting innovations in processing salt and knife clams (*Solen* spp.) as commercially valuable products to increase the selling value of salt in Madura.

2 Method

2.1 Materials

The tools used in this research include a cabinet drying, stainless steel frying pan, spatula, stove, stainless steel tray, 80 mesh strainer, frying pan thermometer, stainless steel spoon, hot plate, 1000 mL and 100 mL measuring flask, 250 mL and 100 mL Erlenmeyer, burette and support, volume pipette and pump, fume cupboard, aluminum foil standing pouch, airtight glass jar, soxhiet condenser and extractor, lemang cartridge, desiccator, oven (105 °C), filter paper, beaker, analytical calculation with 0.1 mg accuracy. The materials used are knife clams (*Solen* spp), diethyl ether, distilled water, potassium oxalate, phenolphthalein indicator, 0.1 N NaOH, 40% formaldehyde, silver nitrate solution (AgNO_3 0.1N), potassium chromate indicator (K_2CrO_4 5%), solution sulfuric acid (H_2SO_4 1N), sodium hydroxide solution (NaOH 4N) and phenolphthalein indicator solution.

Research on the formulation and proximate testing of fortified mineral-rich salts for knife clams was carried out at the Marine Biotechnology Laboratory, Trunojoyo University, Madura. Testing for sodium chloride (NaCl) levels was carried out at the Salt Laboratory at Trunojoyo Madura University. The research was carried out for 3 months from August to October 2023, with details of formulation making being carried out for 1 month and testing of NaCl and proximate levels being carried out for 2 months.

2.2 Sample collection

Samples of knife clams (*Solen* spp.) were taken from around the waters of Lembung Village, Galis District, Pamekasan District using the purposive sampling method [26]. The knife clams (*Solen* spp.) used for the samples were collected from the catches of fishermen and women who work as knife shellfish hunters at that location. Samples were taken from around the beach in the village by scraping the beach sediment using a scoop, modified shovel, and hoe. The visible shells were then taken one by one and then collected in a plastic tube (Figure 1). The shells that have been collected were cleaned using seawater to remove sediment and dirt that was still attached during the collection process in the field. Samples that have been cleaned from dirt were subjected to a measurement process.



Fig. 1. Sample of knife clams (*Solen* spp.) collected from the research location: a) Knife clams samples that have been cleaned, b) Morphological measurements of knife clams

2.3 Production knife clams powder (*Solen* spp.)

The initial stage of making knife clams powder (*Solen* spp.) was carried out by separating the shells and clams meat [6] modified. The meat of knife clams (*Solen* spp.) that has been separated was weighed using an analytical balance and then placed neatly on a baking sheet to speed up the drying process. The prepared samples were dried in a drying cabinet at a temperature of 40 °C for 120 minutes. The dried shellfish meat was mashed

using a blender. The powder of knife clams (*Solen* spp.) was sieved using a 30-mesh sieve to produce fine, homogenous granules.

2.4 Production of fine salt and control formula

The coarse salt used in this research was salt produced by the Salt House of Trunojoyo Madura University using the multistage precipitation method. The increased concentration of seawater level was controlled regularly. The salt flower was separated at concentrations of 25 °C in seawater to reduce sodium chloride level in the product without sacrificing flavor. Making mineral-rich salt begins with preparing the ingredients, namely coarse salt and distilled water. The method used to make this salt is the recrystallization method [28] and the evaporate method modified. Dissolve 250 gr of coarse salt in 500 mL of distilled water until completely dissolved. The salt solution is then evaporate over a fire using a temperature of 95 °C for 30 minutes (Figure 2). During the recrystallization and evaporate process, the solution is stirred evenly using a wooden spatula to facilitate the evaporation of the distilled water inside. This process lasts for 60 minutes. The physical characteristics of the salt product produced using this method visually look whiter dan finer grained.



Fig. 2. Salt Samples: a) Recrystallization the salt, b) Weighing the salt before it is formulated with knife clams (*Solen* spp.), c) Salt resulting from evaporation

2.5 Production of fortified mineral-rich salt with knife clams (*Solen* spp.)

Production of mineral-rich salts fortified with knife clams (*Solen* spp.) using a fortification method with a modified 6 formula plan [29]. The fortification stage begins by weighing samples of fine salt and powdered knife clams (*Solen* spp.) according to the draft formula that has been conceptualized. The two ingredients are mixed until homogeneous manually when mixing in a pan and stirring using a hand mixer. Samples that have been homogenized are stored in airtight glass jars containing silica gel to avoid contamination and stored at room temperature. The fortification process in this study used a formulation between knife shellfish powder (*Solen* spp.) and fine salt for 6 treatments and 1 control, namely The Control Formula (FK) is 100% (100 g salt), Formula 1 (F1) is 5% (5 g knife clams with 95 g salt), Formula 2 (F2) is 10% (10 g knife clams with 90 g salt), Formula 3 (F3) is 15% (15 g knife clams with 85 g salt), Formula 4 (F4) is 20% (20 g knife clams with 80 g salt), Formula 5 (F5) is 25% (25 g knife clams with 75 g salt), and Formula 6 (F6) is 50% (50 g knife clams with 50 g salt).

2.6 Analysis sodium chloride (NaCl) levels

Tests for product sodium chloride (NaCl) levels refer to SNI 3556:2016 [30]. The sodium chloride (NaCl) content test begins by weighing ± 50 g of product samples from each formula and adding 200 mL of distilled water. Homogenize the two ingredients then filter and collect in a 500 mL flask. Rinse with distilled water and adjust to the line mark (solution a). Pipette 2 mL of solution into a 250 mL Erlenmeyer flask then acidify using a few drops of 1 N HSO₄ until the solution reacts to the phenolphthalein indicator. Next, neutralize the solution with 4 N NaOH and dilute it distilled water to 100 mL. In the final stage, add 1 mL of 5% K₂CrO₄ solution to the neutral solution and titrate the solution with 0.1 N AgNO₃ until the solution is brick red. The following is the formula for calculating NaCl levels in products:

$$\text{Sodium Chloride (NaCl) Levels (\%)} = \frac{V \times N \times fp \times 58.5}{W} \times 100 \quad (1)$$

Where: V = the volume of AgNO₃ required for the drug in mL, N = the normality of AgNO₃, fp is the dilution factor, 58.5 = the molecular weight of NaCl, and W = the sample weight in mg.

2.7 Analysis proximate

Proximate analysis was carried out on all designed fortified salt formulations (F1-F6). Proximate testing consists of water content using the SNI 2354.2:2015 method [31], ash content using SNI 2354.1:2010 [32], fat content using SNI 01-2354.3:2006 [33], protein content using the formol titration method [34], Ash content was tested using the SNI 2354.1:2010 method [35], and carbohydrate content using the AOAC 2005 method [36].

2.8 Data analysis

This research is an experimental study that uses a completely randomized design with factorial and uses 6 different treatments with repetition 3x. The ratio of coarse salt and knife clams flour used is F1 (5:95), F2 (10:90), F3 (15:85), F4 (20:80), F5 (25:75), and F6 (50:50). Data analysis determined the best formula for adding knife clams flour to salt based on sodium chloride content and proximate values using ANOVA analysis. Data from the NaCl level and proximate test results, namely air, protein, ash, and fat content, were analyzed using the Kruskal Wallis test ($p < 0.05$) to determine the effect of differences in salt and shellfish powder concentrations in the product formulation on the NaCl and proximate value of fortified salt with knife clams. If the analysis results show a significant effect ($p < 0.05$), then a Man Whitney test is carried out to determine the real difference between the treatment of salt concentration and knife clams flour on the resulting NaCl level and proximate value. Data processing was carried out using SPSS 21 (IBM, Armonk, NY, USA) and Microsoft Excel (Microsoft Corp, Albuquerque, NM, USA) statistical software (IBM). The data is narrated based on the results which are complemented by related and supporting literature.

3 Results and Discussion

3.1 Knife clams (*Solen* spp.) morphology

The knife clams (*Solen* spp.) used as the main material in this research have morphological characteristics, namely a bilaterally symmetrical shell shape with a long shell and a small, elongated body (Figure 3). One end of the shell is sharp like a knife. The shell is yellowish-green and easily brittle. Morphometric measurements of knife clams were

carried out on 30 samples. This measurement consists of the length, width, thickness, and complete weight of the knife shell. The measurement results show that the average knife clams from Pamekasan waters is 3.13 ± 0.39 cm long, 0.45 ± 0.08 cm wide, 0.83 ± 0.15 g weight is intact. The results of this measurement are the same as previous research which stated that the overall length of knife shells was 2-5 cm with a weight of 0.8-3 g, while the width and thickness were around 0.6-0.9 cm [37]. This organism lives around the coast and tolerates salinity levels in sea waters.

Total wet knife clams meat used was 1160.9 g. The weight of the wet knife clams meat then decreased to 182.7 g of dry knife clams meat. Part of the knife shell used for the knife clam powder is the knife clams meat without the shell (Figure 3b). The visual appearance of knife clams meat that has been dried in the oven was brownish in colour. Naturally, marine organisms are susceptible to colour changes during the oven drying process. The brown colour that appears on knife shell meat after drying is a chemical reaction of amino carbonyls which causes the breakdown of glycogen clams meat [38]. An increasingly dark and excessive brown color indicates a reduction in umami taste due to the loss of amino acids in clams meat [39].

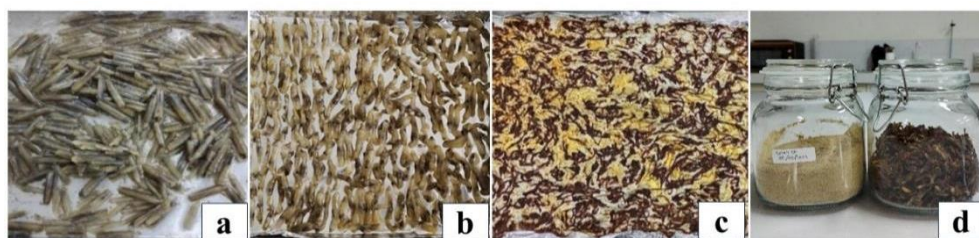


Fig. 3. Samples of knife Clams (*Solen* spp.): (a) Wet knife clam samples with shell, (b) Knife clams meat without shell (c) Dry knife clam samples without shell, (c) Knife clam powder

3.2 Characteristics of salt with knife clams (*Solen* spp.) powder

The basic ingredients for the coarse salt used in this research came from production at the salt house at Trunojoyo University, Madura. This coarse salt then recrystallized again to obtain fine salt that is free of impurities so that a salt quality that meets the standards expected for product formulation is obtained. The product description that has been made consists of 6 formulations with 1 control (Figure 4). The physical characteristics of the raw material (control) salt that has been recrystallized was clean white, has the form of fine grains like commercial table salt, and with NaCl content was $93.44 \pm 0.12\%$.

The colour difference was visible in contrast between control and Formula 1 to Formula 6. Visually, the colour of each formulation varied depending on the percentage of knife clams extract (*Solen* spp.) given in the formulation. The higher percentage of extract from knife clams (*Solen* spp.), the browner colour of the salt produced. The observation results show that a dark brown colour was found in Formula 6, while a light brown color was found in Formula 1. The shape and colour of the salt fortification with knife shells was different from Himalayan salt which is known as a mineral-rich salt. Himalayan salt has a granular structure in the form of broken, homogeneous, larger crystals dominating the surface [40]. Other commercial salt products also have varying crystal structure densities, including table salt 2.17 g/cm^3 , Bekalalan salt $2.08 \pm 0.04 \text{ g/cm}^3$, Himalaya salt $2.20 \pm 0.04 \text{ g/cm}^3$, Bamboo salt $2.06 \pm 0.04 \text{ g/cm}^3$ [41].

Differences in the percentage of knife clams powder also affect the taste and aroma of the product in each formulation. Formula 6 has a savory taste and strong knife clams aroma

because it had the highest percentage of knife clams powder at 50%. The aroma of salt products is an important indicator that consumers like the product. The results of this research are also same as the results of research on healthy food salt made from seaweed, that has been carried out by other researchers. Low sodium salts from seaweed show that salts from *S. polycystum* and *P. minor* have the highest favorability scores by panelists on the criteria that the seaweed aroma is not strong or decreases with an extract concentration of 1.25-1.50% [16]. Using substitute ingredients and fortification ingredients indirectly influences the dominant taste of salt products. *S. polycystum* salt predominantly has a salty, eggy/sulfur, and bitter taste, while *U. lactuta* salt predominantly has umami, eggy/sulfur, and bitter taste [14].

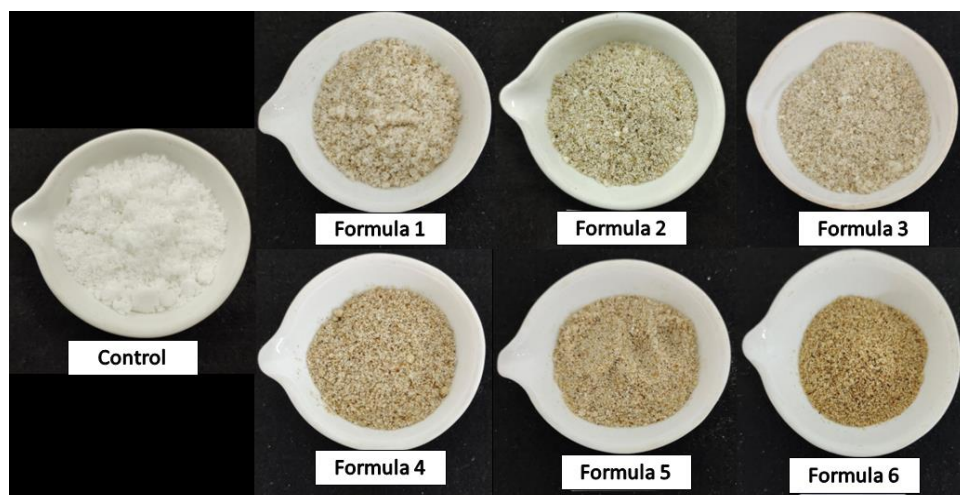


Fig. 4. Differences in color of the knife clam fortified mineral salt product Formulation 1-6 and control

3.3 Sodium Chloride (NaCl) level and proximat value in knife clams (*Solen spp.*) fortified mineral salt

Data from testing results for NaCl levels in products is quite varied and ranges from $52.52 \pm 0.06\%$ to $93.44 \pm 0.12\%$ (Table 2). The highest NaCl content of salt products was found in the control formula at $93.44 \pm 0.12\%$, while the lowest NaCl content was found in formula 6 at $52.52\% \pm 0.06\%$. NaCl is the main element found in salt with sodium (40%) and chloride (60%). Chemical elements such as magnesium, calcium, sulfur, bromine, water, and soil impurities are also called salt, while the salt used daily is Sodium Chloride [42]. NaCl content is one of the parameters that can determine the quality of salt which can be used for consumption, industrial or pharmaceutical salt. The high and low levels of NaCl in salt are influenced by the presence of impurities such as Mg and Ca which also crystallize in the salt [43]. Apart from that, low NaCl levels are greatly influenced by water content. The water content of salt can affect the NaCl content value, where the higher the water content value, the concentration of the NaCl compound will decrease. Identified that the water content of the treated salt product F5 ($6.81 \pm 0.15\%$) was higher than F6 ($6.61 \pm 0.04\%$), but the NaCl content in F6 ($52.52 \pm 0.06\%$) was lower than F5 ($75.94 \pm 0.15\%$). It is thought that this occurred because the percentage of knife clams powder added was higher in F6 (50%) compared to F5 (25%), which caused the water content in the F6 treatment to be high. Another factor that causes the high water content in the F6 treatment was the storage and draining of the salt samples after the recrystallization.

The high NaCl content of 93.44% in the control formula shows that the control salt has salt characteristics for industrial salt, especially in leather tanning and water treatment industries. This salt category contains a minimum of 85% NaCl [44]. In contrast to the control, the NaCl salt content in F6 was $52.52\pm 0.06\%$, indicating that F6 had dietary salt criteria with a maximum NaCl content of 60% [44]. This type of salt is very suitable for hypertension sufferers. This shows that Formula 6 is a candidate food salt product that can be developed into a salt-reducing candidate for hypertension patients in the future.

Table 1. Results of real difference analysis using Kruskal Wallis of salt fortified knife clams

Information	Parameters					
	NaCl	Water	Protein	Fat	Ash	Carbohidrat
Chi-square	14.693	15.830	16.596	16.409	16.111	5.047
df	5	5	5	5	5	5
Asymp. Sig	0.12*	0.007*	0.005*	0.006*	0.007*	0.410*

Note: Sig 0.05* = significantly different

Based on Table 1, the analysis using Kruskal Wallis results show that the parameters NaCl, water content, protein, fat, ash, and carbohydrates have a significance value of ($p < 0.05$), so it can be concluded that all these parameters are significantly different. The difference in the percentage ratio of knife clams (*Solen spp.*) powder formulation and salt had an effect or significant difference on the parameters NaCl, water content, protein, fat, ash, and carbohydrates. The results of the proximate content analysis include water, protein, fat, ash, and carbohydrate content in the fortified salt of knife clams (*Solen spp.*) presented in Table 2. Differences in each parameter between formula treatments were evaluated using the Mann Whitney test (Table 2). The results of the Mann Whitney test showed that the salt formulation with knife clams (*Solen spp.*) had a significant effect on each treatment's protein content and ash content. The formulation of salt and knife clams (*Solen spp.*) had no significant effect on water content, fat content and carbohydrate content.

Table 2. Results of statistical analysis of NaCl and proximat of salt fortified knife clams

Parameter (%)	Analysis of NaCl and proximat of salt fortified knife clams (<i>Solen spp.</i>)					
	F1	F2	F3	F4	F5	F6
NaCl	87.54 ± 0.10^a	87.60 ± 0.10^a	87.60 ± 0.05^a	75.86 ± 0.11^b	75.94 ± 0.15^b	52.52 ± 0.06^c
Water	5.98 ± 0.01^a	5.42 ± 0.07^a	5.74 ± 0.08^a	6.47 ± 0.35^a	6.81 ± 0.15^a	6.61 ± 0.04^a
Protein	11.28 ± 0.33^a	22.33 ± 0.32^b	31.93 ± 0.47^c	37.58 ± 0.59^d	41.02 ± 0.98^e	42.11 ± 0.38^f
Fat	0.13 ± 0.03^a	0.18 ± 0.03^a	0.42 ± 0.02^a	1.27 ± 0.01^a	1.06 ± 0.03^a	0.98 ± 0.01^a
Ash	82.25 ± 0.72^a	71.68 ± 0.87^b	61.33 ± 0.20^c	53.74 ± 0.61^d	48.07 ± 1.88^e	46.60 ± 7.85^e
Carbohidrat	0.35 ± 0.92^a	0.37 ± 1.02^a	0.56 ± 0.37^a	0.92 ± 1.37^a	3.03 ± 2.74^a	3.7 ± 1.8^a

Note: Differences in letter notation indicate there is a significant effect of $p < 0.05$

Water content has an important role in the durability of food products [45]. Water content is a quality parameter for salt products that can affect the shelf life of the product. The water contained in food products can affect the texture, appearance, and taste of the food [46]. The results of water content tests on products vary for each formula created. The highest water content in the product was found in Formula 5 at $6.82 \pm 0.13\%$. The lowest water content was found in the control at $4.57\pm 0.12\%$. The water content contained in formulas 1-6 was most likely come from flour of knife clam samples. (*Solen spp.*) which has been included in each formula. The average value of the water content contained in the product provides information that the formula that has a longer shelf life is F2. The longer draining time after the coarse salt recrystallization process is thought to be the cause of the low water content in F2. This estimation requires further testing in the form of a product shelf-life test. Overall,

the water content in F1 to F6 salt products meets the requirements for consumption of salt because the average product water content is <7%. This is in accordance with the provisions of SNI 3556:2016 which states that the maximum water content contained in consumed salt is 7% [30].

Other proximate parameters that were also observed in this salt product included protein, fat, ash, and carbohydrate levels. Knife clams (*Solen* spp.) as the main ingredient for fortification are one of the marine biota that is rich in protein [47]. This type of protein that comes from animal sources is a complete and high-quality type of protein because it contains many complete essential amino acids [37] and fatty acids, namely saturated fatty acids and unsaturated fatty acids [48]. Based on Table 2, it shows that the average protein content in the product varies between $11.28 \pm 0.28\%$ to $49.77 \pm 0.26\%$. The highest protein content in the product was identified in F6 ($42.11 \pm 0.38\%$), while the lowest protein content was found in F1 (11.28 ± 0.33). These results show a tendency, that the greater the amount of knife clams flour, the higher the protein content in the product. Several literature studies state that knife clams are also rich in minerals [49] including 14.48% protein, 3.68% carbohydrates, 1.72% fat, 1.53% ash content, and water content 78.59% [44]. The crude flour of knife clams also contains alkaloids, steroids, and flavonoids [6] which are needed by the body. The fat, ash, and carbohydrate content of fortified salt products for knife clams also varies (Table 2). Fat content ranges from $0.13 \pm 0.03\%$ to $1.27 \pm 0.01\%$. The fat content in knife clams has several fatty acid processes including saturated fatty acids, monounsaturated fatty acids, and compound unsaturated fatty acids [37]. Ash content ranges from $46.60 \pm 7.85\%$ to $82.25 \pm 0.72\%$, while carbohydrate content ranges from $0.35 \pm 0.92\%$ to $3.7 \pm 1.8\%$. The ash content contained in knife clams is influenced by the habitat/environment these organisms live in because the aquatic environment provides different mineral intake for the organisms [49]. The analysis results show that the lowest proximate levels in this salt product are fat content and carbohydrate content. Carbohydrate levels ranged from $0.35 \pm 0.92\%$ to $3.7 \pm 1.8\%$. According to the theory carbohydrates in marine organisms and fishery products are identified as glycogen [49]. The glycogen concentration in fishery products generally accumulates slightly compared to other compounds including 1-8% in shellfish [50].

3.4 Comparison of the best fortified salt with knife clam formulations with other salts

Based on the results of statistical analysis in Table 2, it shows that the best formulation of knife clam (*Solen* spp.) fortified salt to be used as dietary salt is F6. The NaCl salt content in F6 of $52.52 \pm 0.06\%$ met the criteria and basic characteristics of dietary salt which has a maximum NaCl content of 60% based on BPOM 2019 [26]. This study and analysis by looking at the comparison of fortified salt products for knife clams (*Solen* spp.) needs to be carried out with the results of previous salt research to obtain considerations and comparisons regarding the suitability of the product. These results are listed in Table 3.

Based on Table 3, shows that the NaCl content of knife clams fortified salt (*Solen* spp.) has the highest NaCl content of 52.52 ± 0.06 compared to seaweed salt that has been studied previously, using *Sargassum* sp, namely $35.38 \pm 3.75\%$ [52], *Limnocharis* sp, was $24.04 \pm 1.09\%$ [51], *S. polycystum* $49.05 \pm 0.07\%$ [53], *P. minor* 28.34% [16], and *Ulva* sp $23.90 \pm 0.08\%$ [15]. The high concentration of knife clams fortification salt is thought to be because the basic salt material used comes from production directly from seawater, while the seaweed salt material is mostly obtained by extracting the salt minerals contained in these sea plants. The protein content and ash content of fortified salt products with knife clams is higher than those with seaweed salt. On the other hand, the water, fat, and carbohydrate content of salt products fortified with knife clams is lower than that of

seaweed salt. Overall, fortified salt with knife clams and seaweed salt meets the requirements to be used as dietary salt

Table 3. Comparison of the best fortified salt with knife clam formulations with other salts

Parameter (%)	Salt with knife clam [25]	Seaweed salt				
		<i>Sargassum sp.</i> [50]	<i>Limnocharis sp.</i> [53]	<i>S. Polycystum</i> [53]	<i>P. minor</i> [16]	<i>Ulva sp</i> [18]
NaCl	52.52±0.06	35.38±3.75	24.04±1.09	49.05±0,07	28.34	23.90±0.08
Water	6.61±0.04	6.71± 0.58	9.88 ± 0.58	11.53±0.056	*	*
Protein	42.11±0.38	6.82 ± 0.13	15.25 ± 0.01	7.03 ± 0.37	*	*
Fat	0.98±0.01	*	*	0.58 ± 0.07	*	*
Ash	46.60±7.85	36.81±0.48	20.38 ± 0.41	27.49 ± 0.23	*	*
Carbohydrat	3.7±1.8	41.04±0.54	34.32 ± 0.04	*	*	*

*is not observed.

4 Conclusion

The conclusion of this research is F6 was the best formula with an average NaCl content of $52.52 \pm 0.06\%$ and proximate values including water content of $6.61 \pm 0.04\%$, protein of $42.11 \pm 0.38\%$, fat of $0.98 \pm 0.01\%$, ash of $46.60 \pm 7.85\%$ and carbohydrates $3.7 \pm 1.8\%$. This NaCl level in F6 is included in the criteria for dietary salt which has a maximum NaCl content of 60% based on the 2019 BPOM provisions. The parameters NaCl, water content, protein, fat, ash, and carbohydrates have a significance value ($p < 0.05$), meaning that the difference in the percentage ratio of knife shellfish (*Solen spp.*) powder formulation and salt has a significant effect or difference on the parameters of NaCl, water content, protein, fat, ash, and carbohydrates. The results of the Mann-Whitney test showed that the salt formulation with knife clams (*Solen spp.*) significantly affected the protein content and ash content of each treatment. The formulation of salt and knife shells (*Solen spp.*) did not have a significant effect on water, fat and carbohydrate contents.

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