The quality and mineral content of the community salt conventional in Kupang City and Kupang District East Nusa Tenggara Province

Umbu Paru Lowu Dawa¹, Dewi Setyowaty Gadi¹, Renya Rosari², Yunialdi Hapynes Teffu¹

¹Fisheries Product Technology Department-Marine Science and Fisheries Faculty, Artha Wacana Christian University
²Accounting Department of Economics Faculty, Artha Wacana Christian University

E-mail: umbupaki@yahoo.com

Abstract. The production of conventional salt produced by the community salt processing in the city of Kupang and Kupang district has quality at below the standards set. This study aims to analyze the quality of conventional salt and mineral contents. The sample is taken by random sampling method. Analysis of moisture content based on the AOAC method, NaCl content based on the method of wet dewatering and mineral content using Inductively Coupled Plasma Optical Emission Spectrophotometer (ICP OES). The quality of conventional salt is produced based on the criteria for the content of NaCl, water content and the content of Iodine is still below the Indonesian National Standard. The mineral content of magnesium, calcium and potassium is still in the range of Indonesian National Standard.

1. Introduction
An increase in population and industry has resulted in an increase in national salt demand from year to year. Industrial needs that require high-quality salt, namely with a NaCl content of more than 95%. Food and beverage industries, for example, which require an average salt per year of 509.6 thousand tons per year also desperately need government wisdom in seeing the national salvation situation that happened all this time. This is because salt is a raw material that is very essential in the production process of the food and beverage industry. Based on data from the Ministry of Maritime Affairs and Fisheries [1], national salt production in 2015 reached 2.84 million tons. A total of 2.5 million tons are produced by people's salt which is used to meet the needs of consumption salt and the remainder in the form of industrial salt produced by the salt company. The MMAF data [1] also shows that the quality of local salts produced, especially by salt farmers (community salt) is not uniform so that the sale of salt from pond farmers is also classified into several classes according to their quality. The first quality (KW1) is salt with a NaCl level of 95% -98%, the second quality (KW2) contains NaCl between 90% -95%, and the third quality (KW3) has a NaCl level of less than 90%. The production of salt in Indonesia generally through the solar evaporation method in small plot areas has resulted in the quality of the salt produced varying. The content of domestically produced salt NaCl only ranges from 81%-96%. There are many
factors that are thought to contribute to the low productivity of salt in Indonesia. First, the production techniques and equipment used are still very traditional and the production of salt is very dependent on the weather and allows the production of salt in just 4 months [2]. This production period is much shorter when compared to Australia where the climate allows to produce salt for up to 8 months so as to produce far more salt with high quality. This prompted the government through the Indonesian Salt Users Industry Association (ISUIA) to set the ENT region as a potential location for national salt production because it has a summer (dry) that is longer than 7-8 months compared to other regions in Indonesia. East Nusa Tenggara (NTT) is one of the areas in Indonesia that has the potential for salt ponds estimated at around 60,000 hectares, but has not been managed optimally following national directions and policies to support salt self-sufficiency. Some areas that have potential for salt, including the areas of Kupang City, Kupang Region, the Middle North Timor Region, Ende, Manggarai, Nagekeo, Sumba, Alor and Sabil. Kupang Regency at Bipolo Village, has a potential production area of 318 hectares and utilization of up to 12 hectares in 2017 with production reaching 3.7 tons of salt. The potential of community salt land that exists if managed properly, ENT can fulfill its own needs. While some potential areas for industrial salt, can be focused on becoming a production pillar to meet national salt needs because it is supported by good weather conditions, vast and clean coastal and marine areas. The purpose of this study is to analyze the quality and content of traditionally produced cooking iodine salt and minerals.

2. Material and Method

The main materials in the study were cooked salt and krosok salt taken from the cooking salt production sites in Kupang City and Kupang Regency. Chemicals used include: aquades, potassium chromate solution (K2CrO4) 5%, silver nitrate solution (AgNO3) 0.1 M, sodium thiosulfate with starch indicator, H2SO4 2 N, KI 10% solution, and Na2S2O3.5H2O 0.005 N. The tools used include desiccator, oven, burette, Erlenmeyer, Inductively Coupled Plasma Optical Emission Spectrophotometer (ICP OES).

2.1. Research procedure

The sampling method uses random sampling, by determining the homogeneous population and then taken randomly into a representative sample. Quantitative methods are used for laboratory tests of water content, salt content (NaCl) and mineral (magnesium, potassium calcium) and iodine content. Samples are in the form of folk salt produced in Kupang City (Oesapa Village) and Kupang Regency (Oeteta Village and Pariti Village).

2.2. Water content analysis [3]

The analysis procedure is that the porcelain cup is washed and then dried in an oven at 105ºC for one night. The cup is put into a desiccator which contains a silica gel to absorb the moisture that is still attached to the cup. The porcelain saucer was weighed using an analytical scale and weighed 1 g of sample and inserted into a porcelain dish. The porcelain cup is put into an oven with a temperature of 105ºC for 5 to 6 hours or until the weight is constant. The porcelain cup was then put into the desiccator for 30 minutes then weighed the final weight. Salinity is calculated by the formula:

\[
(\%) \text{ Water Content} = \frac{B-C}{B-A} \times 100\%
\]  

Information:
A: The weight of the empty proselene cup the weight of the empty proselene cup (g)
B: Porcelain plate weight the proselene weight + initial sample weight initial sample weight (g)
C: Final porcelain cup weight Final weight of proselene cup (g)
2.3. Analysis of NaCl levels

NaCl analysis was carried out with wet fogging referring to Day and Underwood [4], namely salt weighed as much as 250 mg, washed with distilled water as much as 10 mL and transferred to Erlenmeyer 250 mL, potassium chromate solution (K₂CrO₄) 5% added 3 mL and titrated with silver nitrate solution (AgNO₃) 0.1 M. The endpoint of the titration is achieved when the first orange or orange color appears. NaCl levels can be calculated using the following formula:

\[
Salt \text{ (NaCl)}(\%) = \left(\frac{T \times M \times 58.4}{W \text{ (mg)}}\right) \times 100\%
\]  

(2)

Information:

\( T \) = Volume of the standard solution of AgNO₃ 0.1 M  
\( M \) = Molarity of silver nitrite  
\( W \) = sample weight

2.4. Mineral content analysis [5]

Analyze mineral magnesium, calcium and potassium carried out by using Inductively Coupled Plasma Optical Emission Spectrophotometer (ICP OES). The wavelength used for determining minerals is adjusted based on the wavelength of the type of mineral to be tested. The stages of testing the mineral content of magnesium, calcium and potassium are presented in Figure 1.

![Figure 1. Flow chart of metal and mineral tests with ICP OES](image)

Calculation:

Slope = Y (absorbance) / X (concentration, ppm)  
(3)

Metal and mineral concentrations, μg / mL of sample curves = absorbance / slope  
(4)

The metal and mineral content in the sample is calculated using the following formula:

\[
\text{Metal / mineral content (μg / g)} = \frac{(μg \text{ metal or mineral / mL from the calibration curve}) \times V}{m}
\]  

(5)

Information:

\( V \) is the dissolution volume (mL)  
\( M \) is the sample weight (gram)
2.5. Iodine level analysis (KIO₃)
Iodine level analysis was carried out with the principle of free iodine titration in the sample solution using sodium thiosulfate with starch indicator. The testing phase was carried out by: Samples were weighed as much as 25 g and put into Erlenmeyer 300 ml. Next, the sample was dissolved with 50 ml of distilled water. Samples were added with 2 ml H₂SO₄ 2 N, 5 ml KI 10% solution, then placed in a dark place for 10 minutes to achieve optimal results. The samples were titrated using Na₂S₂O₃ 0.005 N until the yellow color disappeared, then added 2 ml of the starch indicator and continued the titration until there was a color change from dark blue to colorless (clear). Calculation of KIO₃ content of original material, namely:

\[
\text{KIO₃ content of original material (mg/kg)} = \frac{V \times 35.67 \times N \times 1.000}{W}
\]

Information:
- \( V \) = the volume of Na₂S₂O₃ required for imaging, expressed in milliliters (ml);
- \( N \) = the normality of Na₂S₂O₃;
- \( W \) = the sample weight expressed in grams (g); 35.67 is the equivalent weight of KIO₃

Calculation of KIO₃ content of dry ingredients:

\[
\text{KIO₃ level on the basis of dry ingredients (mg/kg)} = \frac{100 \times X}{100 - \text{water content}}
\]

Information:
- \( X \) is KIO₃ origin material

3. Results and Discussion

3.1. Public salt in Kupang Regency

3.1.1. Making salt in Oeteta Village. Traditional folk salt produced in Oeteta Village, Sulamu District, Kupang Regency generally is pond salt produced traditionally by utilizing sunlight. The salt pond which is the research center belongs to Mr. Melkianus Y. Loe'iu with a total size of 10,000 m² (100 m long, 100 m wide). Visualization of the conditions of the salt ponds is presented in Figure 2. The production of pond salts takes around 30 days (4 weeks) after they can be harvested. Several stages of pond salt making are carried out, that is:

1. Extracting seawater from the mangrove forest to the first reservoir with the help of a water pump. In the first reservoir, seawater is stored for 1 week.
2. Seawater is forwarded to the second reservoir with the help of a water pump and stored for one week.
3. Seawater in the second tub, then proceed to the third reservoir and stored for one week. The time needed for hatching seawater before reaching the drying tub is for 3 weeks.
4. Seawater from the hatchery is forwarded to the drying table with the help of a water pump.
5. Seawater that has been moved to the first drying tub, then stored for 1 week and forwarded to the second drying tub and stored for one week.
6. Seawater from the second drying tub is forwarded to the third drying tub with the help of a water pump and stored for 1 minute, then continued to the fourth drying tub and stored for one week. In the fourth drying tub, the seawater has turned into old water.
7. From the fourth drying tub, old water is flowed to the fifth tub and stored for one week. In the fifth tank, seawater is ready to be channeled into the pond to be processed into people's salt.

The salt produced in Oeteta Village consists of 2 types, namely fine salt and coarse salt (krosok). Refined salt is sold at Rp 2,000 / kg, while coarse salt (krosok) is sold at Rp 500/kg. The salt production
from one tank is 26 sacks (50 kg capacity/sack) and there are 5 tanks used to produce people's salt in Oeteta Village. The size of the drying tub has an area of $150 \text{ m}^2$ (length of $30 \text{ m}^2$ and width of $5 \text{ m}^2$). Harvesting carried out once a week, so that within one month there are 4 (four) harvest times.

Figure 2. Condition of salt ponds in Oeteta Village, Sulamu District, Kupang Regency. (a) hatchery; (b) Drying tanks; (c) Drying and salt baths; (d) Pond salts

3.1.2. *Making salt in Pariti Village (A2).* Salt produced in Pariti Village is cooking salt sourced from filtered seawater from ash. The owner of the people's salt business is Ms. Lefina B. Tamoes. He worked as a salt farmer for 8 years, starting from 2000 until now. Visualization of the conditions of salt ponds is shown in Figure 3. The stages of making cooking salt from ash are as follows:

1. Taking ash. Ash is collected and in filtering containers and added with seawater as many as 12 buckets of other brands (capacity of 20 kg / bucket).
2. Filtering. Filtering seawater through ash is carried out for ± 2 hours. Filtered seawater is collected in a container measuring $185 \text{ cm}^2$ in length and $50 \text{ cm}$ wide and then cooked for ± 12 hours.
3. The cooking process uses stoves and wood fuel. Cooking temperatures range from 85 to 103°C.
4. Salt that has been cooked for 12 hours, then removed using a spoon made of plate.
5. Salt is drained for 1 hour, after draining the salt, it is ready to be sold for Rp 10,000 / kg.
Figure 3. Condition of cooking salt in Pariti Village, Sulamu District, Kupang Regency.
(a) Ash used; (b) Containers for taking ash; (c) Dissolving ash using sea water; (d) Salt water that is ready to be cooked; (e) Salt cooking stove; (f) Cooked salt produced

3.1.3. Quality of public salt. The results of mineral, iodine, water and heavy metals content in traditional salts produced by the people of Kupang Regency, namely traditional pond salt in Oeteta Village and traditional cooking salt from abu in Pariti Village are presented in Table 1. The results of mineral analysis on pond salts produced by the community in Oeteta higher content of Mg and K compared to cooked salt from ash produced in the Pariti. The presence of large amounts of magnesium minerals for salt producers can cause a decrease in the quality of the salt produced. The presence of large amounts of magnesium in the salt produced can reduce the NaCl content. This is evident from the results of the
research conducted, the presence of large amounts of magnesium minerals, causing the value of the resulting NaCl content to be low.

Table 1. Mineral content, iodine, moisture content, and heavy metals in people's salt in Kupang regency

| Parameters Test | Level                        | Salt Traditional Cooking | Cook Salt from ash |
|-----------------|------------------------------|--------------------------|---------------------|
| Mineral         |                              |                          |                     |
| Magnesium (Mg)  | 1015.33 mg/100 g             | 492.93 mg/100 g          |                     |
| Potassium (K)   | 206.37 mg/100 g              | 124.74 mg/100 g          |                     |
| Calcium (Ca)    | 145.82 mg/100 g              | 487.86 mg/100 g          |                     |
| Sodium Chloride (NaCl) | 71.79% |                     | 80.21%              |
| Iodine (KIO₃)  | 0.77 mg/kg                   | 1.28 mg/kg               |                     |
| Water (H₂O)     | 9.73%                        | 5.87%                    |                     |
| Heavy metal     |                              |                          |                     |
| Lead (Pb)       | Undetectable (mg/kg)         | Undetectable (mg/kg)     |                     |
| Cadmium (Cd)    | Undetectable (mg/kg)         | Undetectable (mg/kg)     |                     |

For buyers, the presence of high magnesium minerals as impurities can reduce the quality of salt. Salt needs for processing purposes, especially those related to the processing of salted fish can be a problem with the low quality of salted fish stored, if the presence of magnesium minerals is high. This is in contrast to the desired conditions in the pharmaceutical industry, which is in dire need of high amounts of magnesium minerals [6]. The calcium content in cooking salt is higher than that of pond salt. The high calcium content is very helpful in meeting the human body’s need for calcium. According to Amandia and Sulistiani [7] that calcium requirements for children and adolescents will increase according to age, with several functions including helping in the formation and maintenance of bones and teeth, preventing osteoporosis, glycogen storage, accelerating the function of muscles, brain and nervous system. Murray et al. [8] explained that minerals Ca, Na, K and Mg are the main minerals that are needed in the human body because the intake of minerals recommended for consumption every day for each individual human body must reach > 100 mg per day. The content of NaCl produced by traditional pond salt samples and samples of cooked salt from ash is still below the requirements of SNI 3556-2016 for the category of iodized salt consumption, which is a minimum NaCl content of 94%. Purbani [9] classifies salts based on the content of NaCl as the main element in 3 categories, namely "very good" containing NaCl > 95%; "Good" contains NaCl 90-95%; “Medium” contains NaCl between 80-90%. Therefore, cooked salt from ash (A2) is included in the "moderate" category because it has a content of 80.21% NaCl but does not meet the salt requirements of raw materials for iodized consumption salt [10]. Sulistyaningsih et al. [11] explained that the constituents of the largest chemical compounds in salt were NaCl, and impurities were magnesium chloride, magnesium sulfate and calcium sulfate. Low NaCl content under SNI requirements is influenced by the mineral content of magnesium present in the salt produced. Furthermore, Zainuri et al. [6] explained that magnesium content in salt granules is one of the elements that can reduce NaCl levels from salt. The National Standard Agency [12] in the SNI 3556: 2016 document requires a minimum standard content of iodine-forming compounds (KIO₃) of 30 mg/kg. This condition is far different from the iodine content produced from pond salt (A1) in Oeteta Village and cooking salt (A2) in Pariti Village. Government regulation through Presidential Decree No. 69 of 1994, stipulates that all salts circulating in the community must contain iodine enriched with potassium iodate [13]. The iodine content produced is different from people's salt produced from several regions in East Nusa Tenggara. In some districts in East Nusa Tenggara that produce people's salt, iodine content is not found. This is interesting, because geographical conditions in a region can also determine the presence of certain minerals. The people's saltwater content that meets the requirements of SNI 3556: 2016 and SNI 4435: 2017 (maximum 7%) [10,12] is found in cooked salt.
from ash with a value of 5.87% while in salt ponds it does not meet the standard because it exceeds the standard set. The salt water level of the pond that is high than the standard is thought to be influenced by the time of draining and drying carried out and the storage conditions. Moist conditions also affect the pond's salt water content because of the hygroscopic nature of the salt, which allows an increase in the salt water content of the pond. The analysis of Pb and Cd Heavy metals in folk salt produced in Oeteta Village (A1) and traditional pond salts in Pariti Village was not detected. The requirements stipulated in SNI 3556-2016 and SNI 4435: 2017 stipulate the content of heavy metal lead (Pb) in iodized salt-forming compounds to a maximum of 10 mg/kg and cadmium (Cd) to a maximum of 0.5 mg/kg.

3.2. Profile of public salt in the City of Kupang

3.2.1. Making krosok cook salt in Oesapa Village (B1 and B2). Krosok salt obtained as a raw material is pond salt obtained from Oli'o Village. Cooked salt from Krosok salt produced in Oesapa Village, precisely at RT 002 / RW 001 is a business run by Mr. Marthen Fafoh since 2001 until now. The visualization of making cooking salt in Oesapa Village (B2) is presented in Figure 4. The salt making process is as follows:

1. Preparation of raw materials in the form of krosok salt taken from salt ponds in Oli'o Village, Kupang Regency.
2. Weighing 16 kg of krosok salt, then put into a filtering container and dissolved with as much as 100 liters of fresh bargain. The filtering process (filter) lasts for 2 hours.
3. The filtered water is put into a container (drum) cooking measuring 87 cm long, 58 cm wide, and 28 cm high. The cooking process lasts for 7-8 hours until salt crystals are formed.
4. Salt is removed from the cooking container using a spoon and placed in a drying container to melt for 1-2 hours. The amount of salt produced in one cooking is 25 kg.
3.2.2. Making salt from ash in Oesapa Village (B3). Traditional cooking salt from ash is a work done by Mr. Philip Fallo from 2000 to the present, but it is located in RT 001 / RW 001 in Oesapa Barat Village, Kupang City. The source of the raw material used for ash comes from the soil obtained from the area of salt ponds and seawater used also sourced from the waters around the West Oesapa Village. Visualization of the condition of cooked salt from ash (B3) in Oesapa Barat Village is presented in Figure 5. The stages of the process are as follows:

1. Prepare as much as 8 baskets of ash (equivalent to 112 kg) into the filtering container which has been given sand. This functions as a filter.
2. Dissolution using seawater as many as 20 buckets (equivalent to 300 liters), then let the water drip into the storage container. The filtering time is 2 hours.
3. The filtered water is put into a boiling container which is 87 cm long, 58 cm wide, and 28 cm high.
4. Cooking is done in a furnace measuring 38 to 40 cm high. Cooking lasts for 10 hours, until salt crystals are formed.
5. Salting and drying of salt is carried out for 2 hours. From one boiling can get 25 kilos of salt to cook salt.

Figure 4. Condition of cooking salt from salt krosok in Oesapa Village (B2), Kupang City. (a) Krosok salt to be used; (b) Imitation of using fresh water (c) Salt water that is ready to be cooked; (d) Salt that has crystallized; (e) Thinning of cooking salt; (f) Cooked salt is ready for sale.
Figure 5. Condition of cooking salt from ash in Oesapa Barat Village (B3), Kupang City. (a) Ash used; (b) Dissolving ash using sea water; (c) Salt water ready to be cooked on the stove; (d) cooking salt produced

3.2.3. Quality of public salt. The results of the analysis of several test parameters for traditional salts produced by the people of Kupang City, namely salt krosok from traditional salt ponds in Oli’o Village (B1); cooking salt from krosok salt (B2) in West Oesapa Village; and traditional cooking salt from ash (B3) in Oesapa Village is presented in Table 2.

| Test Parameters            | Krosok Salt     | salt krosok from cooked salt | Salt cooked From ash |
|----------------------------|-----------------|-----------------------------|----------------------|
| Mg                         | 387.16 mg/100 g | 559.05 mg/100 g             | 222.33 mg/100 g      |
| K                          | 97.91 mg/100 g  | 168.55 mg/100 g             | 60.71 mg/100 g       |
| Ca                         | 152.96 mg/100 g | 458.44 mg/100 g             | 193.74 mg/100 g      |
| NaCl                        | 80.61%          | 78.16%                      | 74.45%               |
| KIO₃                        | 4.87 mg/kg      | 1.28 mg/kg                  | 9.15 mg/kg           |
| H₂O                         | 5.33%           | 11.33%                      | 7.00%                |

| Heavy metal                | Undetectable (mg/kg) | Undetectable (mg/kg) | Undetectable (mg/kg) |
|----------------------------|----------------------|----------------------|----------------------|
| Lead (Pb)                  | Undetectable (mg/kg) | Undetectable (mg/kg) | Undetectable (mg/kg) |
| Cadmium (Cd)               | 0.25 mg/kg           |                      |                      |

Note: B1 is the sample code for krosok salt; B2 is the sample code for cooking salt from krosok; B3 is cooking salt from ash. Description: B1 is the code for the krosok salt sample; B2 is a code for samples of cooking salt from krosok; B3 is cooking salt from ash.

The results of mineral analysis on the salt of krosok from salt ponds in Oli’o Village, Kupang Regency (B1) have lower mineral content of Mg, K and Ca compared to cooking salt produced in Oesapa Village (B2) with values tending to increase. The presence of large amounts of magnesium minerals in B2 has implications for decreasing the NaCl content and consequently decreases the quality of the salt produced. Unlike the case with the mineral content of Mg and K produced by ash cooking salt (B3), it tends to be lower compared to B1 and B2, while for Ca minerals (193.74 mg / 100 g) it is higher than B1 (152.96 mg / 100 g). According to Amandia and Sulistiani [7] that calcium requirements for children
and adolescents will increase according to age, with several functions including helping in the formation and maintenance of bones and teeth, preventing osteoporosis, glycogen storage, accelerating muscle, brain and nervous system functions. Murray et al. [8] stated that minerals Ca, Na, K and Mg are the main minerals that are very necessary in the human body because the intake of the recommended amount of minerals to be consumed every day for each individual human body must reach >100 mg per day. The content of NaCl produced by sample B1 is higher than that of samples B2 and B3, but it is still below the requirements of SNI 3556-2016 for the category of iodized salt consumption, which is a minimum NaCl content of 94%. The content of NaCl in B1 salt (80.61%) is categorized as "moderate" according to Purbani [9] because it contains NaCl between 80-90%. Sulistyaningsih et al. [11] explained that the constituents of the largest chemical compounds in salt were NaCl, and impurities were magnesium chloride, magnesium sulfate and calcium sulfate. Low NaCl content under SNI requirements is influenced by the mineral content of magnesium present in the salt produced. Furthermore, Zainuri et al. [6] explained that magnesium content in salt granules is one of the elements that can reduce NaCl levels from salt. Iodine content (KIO₃) required by SNI 3556: 2016 [12] that the content of iodine salt-forming compounds, which is 30 mg / kg minimum. The iodine content in B1 salt is higher than B2 salt which is the result of cooking salt. This shows that iodine decreases due to the dissolution process with fresh water and cooking that occurs. It is different from the iodine content in B3 salt (9.15 mg / kg) higher than that of salt B1 and B2. The iodine content produced is quite high compared to people's salt produced from several other regions in East Nusa Tenggara. In parts of Kupang City that produce people's salt, iodine content is not found. This is interesting because geographical conditions in a region can also determine the presence of certain minerals. Government regulation through Presidential Decree No. 69 of 1994, stipulates that all salts circulating in the community must contain iodine enriched with potassium iodate [13]. Public salt water content (H₂O) that meets the requirements of SNI 3556: 2016 and SNI 4435: 2017 (maximum 7%) [10,12] is found in B1 salt (5.33%) and in B3 salt (7.00%), whereas in B2 salt it is not meet the standards. Salt water levels are thought to be influenced by the time of draining and drying carried out and storage in humid conditions due to the hygroscopic nature of the salt which allows for an increase in the amount of water content. The results of analysis of Pb and Cd metal contamination in salts B1, B2 and B3 were not detected, but the Cd metal in B3 salt was detected 0.25 mg / kg certainly did not exceed the required quality standards SNI 3556-2016 and SNI 4435: 2017, namely metal contamination cadmium (Cd) a maximum of 0.5 mg / kg.

4. Conclusion
The quality of cooking salt produced based on the Indonesian National Standard for kitchen salt, cooking salt produced based on NaCl addiction criteria is below the standard 94.6% and water content above 5%. Mineral content including iodine is within the range of the standard set.

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