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Analysis of the Mineral Content of Mountain Salt in South Krayan District: Implications for Local Food Health

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ABSTRACT
This research focuses on analyzing the mineral content in mountain salt derived from saltwater sources in the mountainous area of Krayan, especially South Krayan. The main objective of this research is to identify the mineral content in mountain salt, with the hope that it can be further developed for economic, environmental, health, and scientific aspects. Potential uses include natural resource development, health and nutritional benefits, mountain salt-based industries, and sustainable mining practices. The research method involved laboratory testing using Atomic Absorption Spectrometer (SSA), X-Ray Difractometer (XRD), and Scanning Electron Microscopy (SEM). SSA results showed the content of minerals such as Na, K, Mg, Al, Cu, Zn, Fe, Ba, and Sr. XRD analysis identified the main peak of NaCl crystals with impurities of KCl, $CaCl_2$, $MgCl_2$, and $AlCl_3$. SEM observations revealed a cuboidal crystal morphology with a space group of Fm3m and a crystal lattice length of 5.620 Å. Overall, this study aims to understand the mineral composition of mountain salt and its implications for local food health.

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INTRODUCTION

Salt is one of the essential commodities in human life, not only serving as a flavor enhancer in food but also playing a vital physiological role in the human body (Damongilala, 2021). In Indonesia, the majority of salt needs are met through sea salt, which has undergone fortification with iodine to prevent various health issues caused by micronutrient deficiencies, such as thyroid dysfunction and impaired cognitive development (Batafor, 2020). However, amidst the dominance of commercial salt products, there exists a type of non-commercial local salt that is still widely used by indigenous communities—one example is mountain salt from South Krayan, Nunukan Regency, North Kalimantan.

Mountain salt is derived from naturally occurring brine found in mountainous regions. In South Krayan, this brine emerges from springs or wells that have formed through geological processes and contain distinctive mineral content as a result of thousands of years of natural formation. The local community has, for generations, utilized this brine as raw material for salt production using traditional methods—boiling the water until salt crystals precipitate. This activity is not only part of the local food system but also reflects cultural knowledge passed

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down across generations. Mountain salt from Krayan is not only used as a seasoning for various dishes, particularly vegetables and broths, but is also believed to possess traditional medicinal properties. Some members of the community believe that this salt can help treat diabetes, hypertension, skin disorders, and is even thought to prevent goiter and several other ailments.

Scientifically, salt plays a crucial role as a primary source of sodium and iodine (Safitri & Roosdiana, 2021). Sodium helps maintain fluid balance and nerve function, while iodine is essential for thyroid hormone synthesis, which affects human growth and development. Therefore, the quality and content of dietary salt must be carefully considered. The Indonesian National Standard (SNI 3556:2010) mandates that dietary salt must contain a minimum of 30 ppm iodine as part of a national strategic effort to combat iodine deficiency disorders (IDD). According to Winarno (2018), the presence of iodine in table salt is essential to ensure optimal thyroid gland function and support healthy growth.

Nevertheless, to date, there is still very limited research specifically analyzing the mineral content of non-commercial mountain salt, such as that from South Krayan. Most existing studies have focused more on fortified sea and industrial salts, while traditional salts from mountainous regions have not received sufficient scientific attention. In fact, their use is extensive in the daily lives of local communities and has become an integral part of traditional food and medicine systems. The lack of scientific information regarding its chemical composition—particularly mineral content and potential iodine levels—represents a significant knowledge gap. This issue becomes increasingly relevant in the context of promoting public health based on local potential and preserving traditional food culture.

Given this background, the present study aims to analyze the mineral content of mountain salt from South Krayan District and assess its implications for local food health. This research is expected not only to provide a scientific basis for the safe and nutritious use of mountain salt but also to contribute to the strengthening of local food security rooted in indigenous wisdom. Furthermore, the findings are expected to serve as a reference for developing policies and food innovations focused on preserving local resources and improving public health in remote areas.

METHOD

This research was conducted from July to October 2024. The study was carried out in two stages: interviews/questionnaires (observation) and laboratory testing. The interviews were conducted randomly among several residents of South Krayan, specifically those living in Long Layu, Pa Sing Village.The mountain salt sample testing was carried out at the Chemistry Laboratory, Faculty of Mathematics and Natural Sciences (FMIPA), Brawijaya University. The steps of the research procedure carried out were as follows:

1. Sample Collection: Mountain salt was collected from the production site in South Krayan District.
2. Laboratory Analysis: The mineral content, such as sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), iodine, and other minerals, was analyzed using Atomic

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Absorption Spectroscopy (AAS), with structural and morphological analysis conducted using X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM).

3. Literature Review: Secondary data were collected from relevant literature on the health benefits and risks of the various minerals found.
4. Public Health Survey: A survey was conducted to gather data on salt consumption and the health status of the local community.

RESULTS AND DISCCUSION

Based on the test of the mountain salt content that was conducted, the results are as follows:

Table 1. Data of Mountain Salt Measurement

No	Minerals	Levels	
		Ppm (mg/kg)	% (g/g)
1	Sodium (Na)	19342920,00	19,3498
2	Potassium (K)	0,2920	98,00
3	Calcium (Ca)	3225,00	0,3225
4	Magnesium (Mg)	1418,00	0,1418
5	Alumunium (Al)	14,98	0,0015
6	Copper (Cu)	0,99	0,0001
8	Zinc (Zn) 0	1,99	0,0002
9	Iron (Fe)	59,92	0,0060
10	Barium (Ba)	56,90	0,0060
11	Strontium (Sr)	497,00	0,0497
12	Iodine	0,0228	0,00235
13	Not identified*	798304,00	79,8304

Table 2. X-ray Diffraction Peak Interpretation of Mountain Salt Powder compared with the Standard

No.	Peak Position 20 (o)	Peak Interpretation with Standard	Standard Reference Number (PDF No.)
1	27,511	NaCl	72-1668
2	31,8417	NaCl	72-1668
3	34,9831	KCl	77-2121
4	36,2096	AlCl3	22-0010
5	38,5974	MgCl2 & CaCl2	74-0521 & 24-0223
6	44,4808	AlCl3	22-0010
7	45,5814	NaCl	72-1668
8	49,4507	KCl	77-2121
9	54,0231	NaCl	72-1668
10	56,5951	NaCl	72-1668
12	66,3783	NaCl	72-1668

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No.	Peak Position 20 (o)	Peak Interpretation with Standard	Standard Reference Number (PDF No.)
13	68,4544	NaCl	72-1668

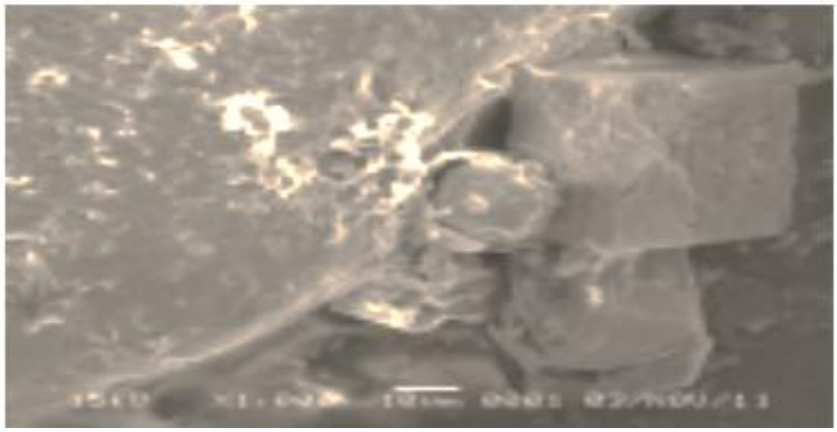

Figure 1. SEM Micrograph of Mountain Salt

Based on the test results using SSA in Table 1, it is evident that the dominant metal ion component in South Krayan Mountain Salt is the sodium ion (Na), amounting to 19.35% or 193,498 ppm. According to Makkarennu (2018), salt containing sodium ions is highly beneficial for the body, as sodium ions play a vital role in regulating fluid osmolarity, blood pH and volume, aiding nerve signal transmission, and muscle contraction. Sodium is categorized as a macromineral (required in amounts >100 mg per day). The recommended daily intake (RDI) for adults ranges between 500 - 2400 mg. The RDI serves as a guideline for the amount of nutrients the body needs each day to maintain health, prevent deficiencies, and support optimal physical activity (Rahman, 2014).

In Table 1, the chemical composition also reveals the presence of other mineral elements, including trace amounts of heavy metals such as copper. However, their levels remain below the safety threshold, making South Krayan Mountain Salt relatively safe for food consumption. Based on the X-Ray Diffraction (XRD) pattern analysis of South Krayan Mountain Salt, several main peaks are observed. These primary peaks, along with their corresponding *dhkl* values and relative intensities of the X-ray diffraction pattern, are presented in Table 2.

According to Sudirman (2015), salt quality based on the Indonesian National Standard (SNI) 01.3556.2016 must meet the following requirements: a minimum NaCl content of 94%, minimum KIO_3 content of 30 ppm, a maximum of 0.5% insoluble matter in water, a maximum moisture content of 7.0%, and maximum contaminant levels of Cd, Pb, Hg, and As (0.5; 0.1; 0.1; 0.1 mg/kg respectively). The NaCl content in South Krayan Mountain Salt does not yet meet the SNI standards, and therefore cannot be used for specific industrial salt purposes. However, according to Makkarennu (2018), traditional salt has the potential to be developed as a market product to enhance entrepreneurial capacity. South Krayan Mountain Salt has significant development potential.

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South Krayan Mountain Salt is unique due to its natural mineral content—such as magnesium, calcium, potassium, and others—and is traditionally produced from brine springs (Herman, 2012). Compared to SNI 01-3556-2016, this salt generally contains lower NaCl levels, naturally occurring iodine (not fortified), and varying moisture content. Although it does not fully meet SNI standards for table salt, it holds high value as a premium product due to its distinctive taste and added health benefits.

It can be concluded that the main composition of South Krayan Mountain Salt is NaCl, with impurities including KCl, $CaCl_2$, $MgCl_2$, and $AlCl_3$. This finding aligns with the AAS (Atomic Absorption Spectroscopy) results, which show sodium ions (Na) as the predominant component of South Krayan Mountain Salt.

Based on SEM (Scanning Electron Microscope) observation, as shown in Figure 3, the SEM morphology of South Krayan Mountain Salt exhibits cubic crystal shapes, which are characteristic of NaCl crystals. NaCl crystals have a cubic structure with space group Fm3m and a lattice constant of 5.620 Å.

The use of mountain salt in local communities has significant health implications. While the mineral content in mountain salt may offer health benefits, excessive consumption poses health risks. In the context of local food safety, salt consumption control is crucial to prevent health issues such as hypertension, stroke, and heart disease that can result from high sodium intake.

Therefore, it is essential for local communities to receive education about safe salt consumption limits. Using the right amount of salt allows the body to benefit from other minerals, such as potassium and magnesium, without the adverse effects of excessive sodium. In addition, further research is needed to determine the iodine content in mountain salt, to assess whether the local population receives adequate iodine intake or whether additional sources of iodine should be included in their diet.

CONCLUSION

Based on the research findings, the mountain salt from South Krayan has been proven to be rich in minerals such as Na, K, Mg, Al, Cu, Zn, Fe, Ba, and Sr. XRD analysis revealed that the main compound is NaCl crystal, with impurities including KCl, $CaCl_2$, $MgCl_2$, and $AlCl_3$. Meanwhile, SEM results showed a cubic crystal morphology characteristic of NaCl. Functionally, these mineral contents offer health benefits—such as sodium for fluid balance, potassium for heart health, and calcium and magnesium for bone and muscle function. However, excessive consumption, particularly of sodium, can increase the risk of hypertension and heart disease. Therefore, it is important for communities to consume mountain salt wisely to optimize its benefits for local food health.

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