



## The potential of seaweed salt as an alternative low sodium salt: safety and sensory test

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### Abstract

**Background:** Indonesia is one of the largest producers of red seaweed in the world, but there is very little research done on the role of red seaweed in the health sector. This study is about red seaweed type *Eucheuma cottonii* and its potential as seaweed salt that has lower sodium and rich in other minerals.

**Methods:** This research was divided into two phases and conducted from December 2016 to March 2017. The first phase is a safety analysis in terms of metal, mold and bacteria contamination of seaweed from three different places of Indonesia: Saumlaki, Maluku; Nusa Dua, Bali and Flores, Nusa Tenggara Barat. After the seaweed safety was selected, the seaweed was made into powder at Industrial Research and Development Agency (BPPT), Tangerang. The seaweed powder mixed with ordinary salt with four type of concentrations were subjected to a salty sensory test by nine panellists who have been working at the food production at Hospital for at least one year. The second phase was to do acceptance sensory test of the seaweed salt product taste against a concentration that was selected in first phase to first-degree hypertensive subjects aged 25–59 years by using soup as the meal-media. Chi-square test was used to analyse the difference.

**Results:** Seaweed from Saumlaki, Maluku was selected as the safest seaweed due to its lowest content of metal, mold and bacterial contaminations. The ratio of seaweed powder to ordinary salt powder 1:1 was selected by nine panellists in salty sensory test. Analysis of minerals from the seaweed salt product found that besides the lower sodium and iodine content, its potassium and magnesium content were much higher than ordinary salt. Salty taste test by 62 respondents with first degree hypertension with age 25-59 years showed no significant difference in saltiness between seaweed salt and ordinary salt.

**Conclusions:** In conclusion, the seaweed salt product with a 1:1 ratio to ordinary salt powder is safe and acceptable to be used as an alternative low sodium salt.

**Keywords** *Eucheuma cottonii*, seaweed salt, salty sensory test

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### Introduction

Red seaweed which is widely available in Indonesia is *Eucheuma cottonii*.<sup>1</sup> Seaweed contains minerals of more than 36% dry weight with calcium (Ca) and magnesium (Mg) and iodine (I) as its main

minerals.<sup>2,3</sup> Na levels in seaweed is generally low around 2-3%, while the K content is around 5-6%.<sup>3</sup> Na content in seaweed is around 1.87 grams per 100 grams and K content is around 5.87 grams per 100 grams. Thus, the Na/K ratio is about 0.32. Some studies suggest that low sodium may reduce blood pressure.<sup>4,5</sup> High K intake is also said to be inversely related to the incidence of hypertension.<sup>5</sup> Recommendations from WHO and European Society of Hypertension/European Society of Cardiology: *Guidelines for the Lifestyle Management to Reduce Cardiovascular Risk* for Na intake is 2 – 2.4 grams per day (equivalent to 5-6 grams of salt per day).<sup>6,7,8</sup> Recommendations from WHO for K intake of at least 3,51 grams per day.<sup>9</sup> The composition of Na and K in seaweed is thought to be beneficial as an antihypertension in mild hypertension.<sup>10</sup>

Indonesian Basic Health Research 2013 and 2018 showed hypertension prevalence in Indonesian adults increased from 25.8% to 34.1%,<sup>11,12</sup> while data from the Basic Health Research 2007 and 2013 revealed that Indonesian population aged over 10 years consume high daily salt.<sup>11,13</sup>

Seaweeds also contain peptides which have angiotensin converting enzyme inhibiting (ACE-I) activity that may play a role in overcoming hypertension.<sup>10,14</sup> Other nutrients contained in seaweed are fibres with a greater percentage of water-soluble fibres, fatty acids (eicosapentaenoic and arachidonic acids), some vitamins (B<sub>12</sub>, C, and E), and carotenoids that have antioxidant activity.<sup>2,10,15</sup> Efforts to reduce salt intake are constrained because salt substitute products with low Na content in Indonesia are very limited. Research on the nutrient contents, the role of seaweed and its benefits for health is still limited, especially in Indonesia.<sup>16</sup>

The objective of this study is to analyse the safety of seaweed salt product and to test its saltiness taste as compared to the ordinary salt, to be used as an alternative to reduce blood pressure among mild hypertension subjects.

## Methods

The research method was divided into two phases. In the first phase, *Eucheuma cottonii* seaweed from three regions: Saumlaki, Maluku; Nusa Dua Bali and Flores, West Nusa Tenggara were tested for safety

from metal contamination at the Analysis and Calibration Laboratory, Center for Agro Industry, Industry Research and Development Agency, Bogor, and safety testing from bacterial contamination at the Industrial Research and Development Agency (BPPT), Tangerang. After obtaining the ethic approval and ethic license from *Harapan Kita* Hospital and Ethics Committee of the Medical Faculty, Universitas Indonesia, *Eucheuma cottonii* seaweed powder from the region with the lowest contamination was made and produced at BPPT, Tangerang. Seaweed that had been cleaned, cut about two or three cm, pasteurized, then grind with 0.5 mm disc mill, filtered, to produce seaweed powder. Furthermore, the seaweed powder is mixed with ordinary salt with a concentration of 1:2, 2:3, 1:1 and 3:2, then salty sensory test was performed to compare those four different concentrations of seaweed salt to the ordinary salt. The test was conducted in the food production department of Hospital, at east Jakarta from December 2016 to March 2017.

The salty sensory test panel consist of healthy nine panelists aged 18 to 59 years, who have worked for at least one year in the food production department at a hospital. The panelists were asked to taste the soup (200 ml) mixed with the 3 gram of seaweed salt and did the salty sensory test that was mostly similar to soup (200 ml) mixed with 3 grams of ordinary salt. The subjects were asked to drink plain water, every time after they tasted the soup. The subjects were asked to taste and compare both soups and did the salty sensory test, from most similar to soup with ordinary salt. Values from not similar (1) to more than ordinary salt (5). Sensory test results were used to determine the concentration that would be used in phase two. Mineral contents of both seaweed salt product and ordinary salt were analysed at Sucofindo Laboratory. The second phase was the savoury test of the chosen seaweed salt product taste against ordinary salt by using soup as the meal-media to 62 first-degree hypertensive or mild hypertension subjects aged 25–59 years. Subjects aged 25-59 years are recruited due to subjects age 25 and above are independent and can plan their own diet while the oldest age of 59 years to reduce the possibility of deterioration of taste and organ function with increasing age.

## Results

*Eucheuma cottonii* seaweed from three regions: Saumlaki, Maluku; Nusa Dua Bali and Flores, West Nusa Tenggara went through safety testing from metal contamination at the Analysis and Calibration Laboratory, Center for Agro Industry, Industry Research and Development Agency, Bogor and safety testing from bacterial contamination at BPPT, Tangerang. The analysis test results of metal and bacterial contamination in **Table 1** showed that seaweed originating from Saumlaki Island, Maluku, is the best one in meeting safety requirements. Seaweed powder was made at BPPT, Tangerang. The process of pasteurization was chosen to reduce the number of bacteria, to maintain the nutritional value of seaweed and decrease water content of seaweed to 10–12 %.

### Mixing seaweed powder and ordinary salt ®

First step, the quantity of seaweed powder in gram mixed with quantity of ordinary salt in gram was calculated based on literature study. The conversion values of sodium chloride and salt was as follows: 40% Na and 60% Cl. Whereas 1 gram of Na with 2.6 grams of salt and 1 mmol Na is equal to 23 mg of Na and according to literature studies, Na content in seaweed is around 2–3% dry weight.<sup>3</sup>

Four different ratios of seaweed powder and ordinary salt that have sodium content below 2 gram as WHO recommendation<sup>6</sup>, were tested for sensory salty test. The ratio were 1:2 (A), 2:3 (B), 1:1 (C) and 3:2.(D) which contained sodium of: 1.58 grams, 1.44 grams, 1.23 grams and 1.04 grams consecutively.

The results of the salty sensory test from a nine-member panelist, the soup with type C product was the most closely palatable and nice compared to soup with ordinary salt. Therefore, in the second phase of the research formula type C was used: 3 grams of seaweed powder and 3 grams of ordinary salt.

Samples of seaweed salt and ordinary salt used in the study were examined for their Sodium, Potassium, Magnesium and Iodine content at Sucofindo Laboratory (**Table 2**). Sodium and iodine levels in seaweed salt are lower and potassium and magnesium levels are higher than ordinary salt.

The second phase was the sensory salty and acceptance test of the seaweed salt product against ordinary salt by using soup as the meal-media to 62 first-degree hypertensive or mild hypertension subjects aged 25–59 years old.

The same amount of seaweed salt and ordinary salt were sprinkled on two bowls clear chicken soup. The result is shown in **Table 3**, which indicates there is no significant differences found in the salty taste tests of seaweed salted soup and ordinary salted soup (Chi-square test,  $p = 0.332$ ).

## Discussion

Seaweed *Eucheuma cottonii* harvested from Saumlaki, Maluku was selected, due to it's lowest metal, mold and bacterial contamination compared to those from Nusa Dua, Bali and Flores, NTB. The purpose of this research is to study the potential of seaweed powder as an alternative salt function, so the safety criteria refer to guideline of iodized salt for consumption from the National Standardization Agency (BSN) in 2016<sup>17</sup>. The criteria are as follows: metal contamination in miligram/kilogram dry weight: lead (Pb) less than 10, cadmium (Cd) less than 0.5, mercury (Hg) less than 0.1, arsenic (As) less than 0.1, In the safety guidelines for iodized salt products, there is no standardization for contamination of tin (Sn), mold and bacteria. Safety criteria for contamination of tin (Sn), mold and bacteria refer to the guidelines commonly used in France.<sup>2,15</sup> France quality criteria for edible seaweed for tin (Sn) less than 5 mg/kg dry matter, and for mold and bacterial contamination in colony unit/gram: coliform less than 10, anaerobic less than 100. Seaweed from Saumlaki contained cadmium (Cd) less than 0.5 and has smallest mold contamination. This due to Saumlaki's location is in the Maluku islands, where the beach is still very quiet, the population is sparse, and the sea coast is clean and relatively low in pollution compared to the coast of Nusa Dua, Bali and Flores, NTB.

The sensory salty test results selected ratio of 1: 1, that was 3 grams of seaweed powder and 3 grams of ordinary salt, the most closely palatable and nice compared to soup using ordinary salt. Ratio of seaweed powder to ordinary salt 1:2 and 2:3 was less salty and ratio 3:2 was too salty. Six gram of selected seaweed salt ratio contained Na: 1,23 mg compare

to ordinary salt contains Na: 2.28 gr. Na of seaweed salt is lower than ordinary salt and is safer in preventing hypertension.

The salt powder was then analysed for Na, K, Mg and Iodine minerals in the Sucofindo Laboratory. The content of sodium in seaweed salt is around 24.15% and ordinary salt is around 37.6%. Six gram of seaweed salt contained Na:1.45 gr. Sodium levels appear to be higher than the initial count of about 17%, this is because the water content is very different. In the literature study, the data used were dry seaweed materials with water content around 20-30%, while seaweed powder around 10-12%, due to pasteurization process. Potassium and Magnesium levels in seaweed salt are much higher than ordinary salt. Potassium content of seaweed salt was 4 %, while ordinary salt was only 0,03 %. Magnesium content of seaweed salt was 0,16 % and ordinary salt was only 0,002%. Iodine content of seaweed salt in the form of KIO<sub>3</sub> is lower than ordinary salt, because ordinary salt products that are used and are on the market was fortified with iodine. Since the standard of Iodine requirement is 30 mg per kg<sup>17</sup>, then this salt is not recommended for people with iodine deficiency.

The second phase, sensory salty taste test was done to compare and to evaluate the acceptance of seaweed salt with ordinary salt using clear chicken soup as media to 62 first-degree hypertensive or mild hypertension subjects aged 25–59 years old. There were 8 respondents who said that the saltiness of seaweed salted soup was sufficient and tasty compared to 13 respondents who said that the salty taste of ordinary salted soup was sufficient and tasty. After being tested statistically with the Chi-square test it was found there was no significant differences ( $p=0.332$ ). Eight subjects who chose seaweed salted soup as tasty, comment that soup taste more savory than ordinary salted soup. Taste of seaweed powder was revealed as ocean-like: minerally and salty, fishy taste and has umami flavors.<sup>18,19</sup> Seaweed powder mix with ordinary salt would have salty taste and umami flavor, that was acceptable and nice by the subjects.

In conclusion, the seaweed salt product with a 1:1 ratio to ordinary salt powder is safe and acceptable to be used as an alternative low Na salt

**Table 1.** Analysis of seaweed metal and bacterial contamination from Saumlaki, Nusa Dua and Flores

Metal * Contamination	Unit	Saumlaki, Maluku	Nusa Dua, Bali	Flores NTB
<i>Lead (Pb)</i>	mg/kg	< 0.040	< 0.040	< 0.040
<i>Cadmium (Cd)</i>	mg/kg	0.02	0.69	0.92
<i>Tin (Sn)</i>	mg/kg	<0.8	<0.8	<0.8
<i>Mercury (Hg)</i>	mg/kg	<0.005	<0.005	<0.005
<i>Arsenic (As)</i>	mg/kg	<0.003	<0.003	<0.003
<b>Bacteria **</b>				
<i>Yeast mold count</i>	cfu/gr	10***	70****	
<i>Coliform</i>	APM/25gr	Negative	Negative	
<i>Escheria Coli (anaerobes)</i>	APM/25gr	Negative	Negative	

\* ) Analysis and Calibration Laboratory, Center for Agro Industry, Industrial Research and Development Agency, Bogor

\*\* ) Institute for Biotechnology Studies Technology Assessment and Application Agency (BPPT), Tangerang

\*\*\* ) Disk without colony at lowest dilution 10

\*\*\*\* ) Disk outside the number of colonies between 10-300 at the lowest dilution of 10

**Table 2.** Mineral analysis of seaweed salt and ordinary salt powder SUCOFINDO

Mineral	Unit	Seaweed Salt	Ordinary Salt®	Methods
Sodium (Na)	%	24.15	37.60	SNI 01-3556-2010
Potassium (K)	mg/kg	42,091.56	305.48	AAS-Flame
Magnesium (Mg)	mg/kg	1,622.87	18.02	AAS-Flame
Iodine (KIO <sub>3</sub> )	mg/kg	5.05	51.09	SNI 01-3556-2000

**Table 3.** Salty sensory tests of seaweed salt and ordinary salt

Variable	1 Not salty	2 Slightly salty	3 Less salty	4 Same/enough salty	5 Too salty
Seaweed salt		16	31	8	7
Ordinary salt®		8	4	13	37

Chi-square test, p = 0.332

## Conflict of Interest

Authors declared no conflict of interest regarding this article.

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