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Strategy to reduce salt consumption in millennial generations using potato stick snack as a food model: a study case in Indonesia

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Abstract

High salt intake indicates high sodium consumption behavior in someone's diet then possibly increases the risk of hypertension. The strategy needed to reduce salt consumption by maintaining palatability and consumer acceptance in low-salt food. Mushroom broth, an umami substance, is used as an alternative to improve the sensory characteristics of lower salt products. In this study, a survey of salt consumption behavior to identify the correlation between salt consumption with knowledge of salt and individual characteristics (n=435) was carried out. Fifty panelists were recruited for sensory tests to determine the threshold of salt concentration using snack as a food model. The hedonic and palatability test using four samples with different levels of salt, each added with 0.5% mushroom broth was carried out to evaluate the consumer acceptance of the mushroom broth in a salt-reduced product. The results showed that there was no correlation ($p>0.05$) in age, sex, body mass index, and knowledge of salt between salt consumption using the Kendall Tau B test. Reducing salt up to a level of 25% in potato stick snacks was achievable, without the panelists detecting a difference in taste and was still preferred. Using 0.5% mushroom broth as a source of umami flavor was accepted by consumers to replace the role of salt in food so it can act as an alternative strategy to reduce salt consumption.

1. Introduction

Hypertension is a non-communicable disease, and its prevalence is increasing from year to year. The prevalence of hypertension in the population aged ≥18 years in Indonesia is 34.1% (Ministry of Health, 2018). One of the factors causing this disease is consuming excessively high-sodium foods. The food that most contributes to sodium consumption is salt. It turns out that the average Indonesian salt consumption is 6.68 grams/person/day exceeding the recommendations from the Indonesian Ministry of Health and WHO which is 2000 milligrams of sodium or 5 g of salt (Istiqomah et al., 2021). Twenty-nine out of 34 provinces in Indonesia consume salt more than the limit recommendation indicating that most provinces in Indonesia have the same urgency to reduce salt intake.

The tendency to consume foods high in salt is due to unhealthy eating behavior. Eating behavior is an individual's way of thinking and speculating about food which is expressed in the ways of eating and choosing food and will change into eating habits if the situation is repeated (Fadhilah *et al.*, 2018). Eating behavior itself is a complex thing as humans make hundreds of eating decisions every day that are influenced by multi-factors, including individual factors, physical environmental factors, social environmental factors, to macro-environmental factors (Lacaille and Patino-Fernandez, 2013; Deliens *et al.*, 2015). According to Paramitha dan Suarya (2018), individual or personal factors that influence eating behavior are physiological processes such as hunger, satiety, innate preferences, and brain mechanisms; and psychological processes such as food preferences, knowledge, motivation, attitudes, values, personality traits and self-regulation.

The sensory aspect of food affects individuals in their food habits (Forde, 2018). Sensory properties of products such as visual appearance, odor, texture, and taste are very important to build the sensory response of consumers, giving influence and decisions on the amount and type of food eaten. Taste attributes such as sweet, salty, and savory are some of the sensory aspects that affect individual preferences in food and are also important parameters that determine the acceptance of a food product. Sensory experiences when eating

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determine individual preferences for food which then forms the behavior and control of food intake (Mccrickerd and Forde, 2016).

An individual who usually consumes foods with high salt levels will need more salt to get the same sensation of satisfaction compared to individuals who are more sensitive to salt, meaning this increases the individual sensory threshold for saltiness. The hedonic perception (preference) of a food is above the sensory threshold concentration, there is a suprathreshold (intensity above the detection threshold) assessment of taste preferences in the food matrix.

Eliminating or reducing salt in food products is quite challenging because the presence of salt in food has an important role; such as giving a salty taste by affecting epithelial sodium channels (ENaCS), these channels are specific enough for sodium; salt can interact with other sensory attributes in the material foods such as suppressing bitter taste, increasing sweetness, increasing the volatility of aroma and flavor profile components by decreasing water activity, and increasing water holding capacity in high-protein products. Salt (NaCl) can also activate the somatosensory system which also contributes to the sensory perception of food flavor by giving mouthfeel by influencing the lubrication properties of saliva (Henney *et al*., 2010; Koliandris *et al.*, 2010; Liem *et al*., 2011; Hoppu *et al.*, 2017).

Salt reduction can have a bad impact on the taste of food, adding ingredients that have the potential of umami flavor is used as an alternative to control and improve the taste attributes of low-salt foods. Natural ingredients that are rich in umami flavor components are mushrooms. Oyster mushrooms (Pleurotus ostreatus) are widely cultivated in Indonesia because affordable, easy to discover, low in calories, good nutritional content and have a low sodium content, there are 3 mg sodium/100 g of fresh mushrooms. Low sodium and high potassium levels, this mushroom is recommended as an anti-hypertensive diet (Agarwal et al., 2010; Widyastuti et al., 2012; Deepalakshmi and Mirunalini, 2014).

Oyster mushrooms were added as a flavor enhancer. Umami attributed the synergistic effects of free amino acids (such as free amino acids and glutamate acid) and 5 'mononucleotides (such as 5 'guanosine monophosphate (GMP), 5' monophosphate inosine (IMP), 5 'xanthosine monophosphate (XMP), and 5' 'adenosine monophosphate (AMP)) (Yamaguchi, 1998). Oyster mushroom has an MSG-like free amino acid concentration of 11.2±0.57 mg/g DM and umami nucleotides as much as 0.52±0.02 mg/g DM. Some amino acids in food can help decrease unpalatable food (Tokuyama *et al.*, 2006).

Palatability is the intensity of the delicacy in food. Palatability is one of the sensory experiences in food and it supports the selection and intake of individual meals (Yamaguchi and Ninomiya, 2000; Mccrickerd and Forde, 2016). Palatability reflects the results of interactions between taste compounds. When two or more taste stimuli are combined, the forms of interaction that occur include enhancement or suppression (Keast dan Breslin, 2002). Keast and Breslin (2002) explained that the interaction of the umami taste of the mushroom broth and the saltiness of salt showed an enhancement in taste. Compounds in the umami taste can enhance saltiness (Yamaguchi, 1998). The interaction between taste compounds (taste-taste interaction) is related to the palatability of food and the perception of food taste, it is considered as a way to reduce salt with a sensory response approach to low-salt foods.

Although, the government executed various efforts to salt consumption and hypertension by making regulations limiting salt consumption in the Minister of Health Regulation number 30 the year 2013, campaign through the Gerakan Masyarakat Hidup Sehat (Germas) which promotes increasing fruit and vegetable consumption and encouraging a healthy balanced diet and strengthening the Integrated Post Development Services for Non-communicable Diseases. This intervention did not increase public awareness to reduce their salt intake (Lee et al., 2017). Society still has not changed the behavior of high-salt food consumption because the intervention is not effective and not directly carried out on individuals or types of food that are usually consumed.

2. Materials and methods

This research consists of two main stages: an online survey and a sensory test. The results from each stage are used as a reference for the next stage.

2.1 Survey of salt consumption behavior

Data was collected using an online questionnaire. The questionnaire consisted of questions about the demographic characteristics of the respondents i.e age, sex, height, and body weight, and questions adopted from Newson *et al*. (2013) about the intention or interest in reducing salt consumption, salt use recommendation, attitudes to reduce salt use, and knowledge of salt consumption. The question of belief in the impact of salt consumption was adopted by Mørk *et al*. (2019). Then another question developed by researchers is about food type preferences, consumption of processed foods, and knowledge of the amount of salt in food. Arrangement of the answer to processed food consumption is made based on statistical data on average food and beverages which

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are often per capita consumption in 2018 published by the Center for Agricultural Data and Information Systems.

Respondents who are required in this survey are all people from various societies who live in the province of Daerah Istimewa Yogyakarta within a minimum period of three months and are not undergoing a diet program. Determination of the number of respondents used was calculated using the Slovin formula (Ismail, 2018),

$$n = \frac{N}{1 + Ne^2}$$

where n is the sample size; N is the population size, the total population of DIY Province in 2019 were 3,842,932 people (Central Bureau of Statistics of DIY Province, 2019); e is error tolerance; and 1 is a constant number. Then the number of respondents needed is 399.33 or a minimum of 400 respondents.

2.2 Sensory test

Sensory tests were held at the Sensory Test Laboratory, Department of Food Technology and Agricultural Products, Faculty of Agricultural Technology, Gadjah Mada University. The panelists recruited for this sensory test consumed snacks more than 2 times per week, liked salty seasoning snacks, and were not sick. Panelist recruitment was conducted openly by distributing online forms and several panelists were respondents to survey salt consumption behavior.

Estimating the number of panelists was based on the research of Hough *et al.* (2006), using the following four parameters: α = 1%, β = 5%, RSML = 0.23, d = 0.2 and use minimum of 48 panelists. This approach based on many studies does not mention the reason for choosing the number of sensory test panelists for consumer tests. Fifty untrained panelists (students of Gadjah Mada University 43 women and 7 men aged 18-22 years) participated.

Panelists were asked not to smoke, eat, and drink with a strong flavor 30 mins before testing. Each panelist was served a tray containing test samples (4-5 pcs ≈ 4-5 g potato sticks) in a 4 oz disposable paper cup, tissue, scoresheet, and one glass of mineral water to neutralize the mouth after changing samples. Samples are labeled with three random digit numbers and the samples were presented in random order to avoid bias. To illustrate the natural condition of a consumer when consuming the product, panelists were asked to spend all the sample not just tasting one bite. Before testing the panelists were asked to sign informed consent.

2.2.1 Difference test

The sensory difference test performed in this study was a paired comparison test or 2-AFC (Alternative Forced Choice). The principle of paired comparison test in this study is based on Lawless and Heymann (1999). The test sample used was a potato stick snack with varying salt content, 0.9%, 0.8%, 0.7%, 0.6%, and 0.5% while the reference sample was potato stick snacks with 0.9% salt content. Table 1 shows the seasoning formulation for the difference test.

Table 1. Seasoning formulation for difference test.

Sample	Maltodextrin (%)	Sugar (%)	Salt (%)
0.9% salt	71.2	3	12.8
0.8% salt	72.93	2.67	11.4
0.7% salt	74.66	2.34	10
0.6% salt	76.39	2.01	8.6
0.5% salt	78.22	1.66	7.14

Panelists evaluated five sets of test samples at the same time, given the reference sample coded "control" and five test samples each coded three digits. Start by tasting the salty sensation of the "control" coded sample then continue to taste the three-digit numeric coded sample. Panelists were asked to evaluate the samples one by one, compare the sensations and find differences in the saltiness between the three-digit coded samples with the control samples. Then the panelists were asked to taste the sample from left to right, and then write down the results in the worksheet, with the following values given an X sign if the sensation was the same as the control and √ sign if the sensation was different from the control.

2.2.2 Hedonic and palatability test

The hedonic test and the palatability test were based on the principle of the consumer test described in Meilgaard *et al*. (2013). The sample used was potato stick snack with varying salt content of 0.675%, 0.45%, 0.225%, and 0% as well as with additional flavorings, oyster mushroom broth with 0.5% content each sample. Table 2 shows the seasoning formulation for the hedonic and palatability tests. Panelists were asked to rate (on a scale of 1-7) their preference or level of acceptance and

Table 2. Seasoning formulation for hedonic and palatability test.

Sample	Maltodextrin (%)	Sugar (%)	Salt (%)
0.675% salt + 0.5% mushroom broth	67. 96	2.26	9.64
0.45% salt + 0.5% mushroom broth	71.92	1.51	6.43
0.225% salt + 0.5% mushroom broth	75.90	0.75	3.21
0% salt + 0.5% mushroom broth	79.86	0	0

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palatability of potato stick snacks spontaneously without comparing other test samples.

2.3 Food samples and preparation

Food models used in this sensory test are snacks. Based on a survey of salt consumption behavior, which has completed the data processing, it is known that the most often consumed more than once a week by respondents are fried foods and snacks. However, each portion of snacks has a higher sodium content which is 593 mg compared to 125 mg of fried foods (The University of Maine, 2011; Bulletin and Demedia Kitchen Team, 2010).

The source of the salty taste in snacks is its seasoning because the snack base generally has a bland taste. The development of a snack seasoning formula based on Seighman (2001). The preparation of the seasoning formulation begins with the salt content as a reference and other ingredients adjust the literature. Determination of the initial concentration of salt used according to commercial snack products that are widely sold in supermarkets in the Province of DIY, Indonesia, namely Pringles "original" brand snacks with a salt content of 0.9% is a potato-based snack. In this study brick-type salt (briquette) was used, because of the highest demand for this type of salt in the Indonesian market, so it was assumed the use of salt consumption more often used brick-type salt. The use of sugar and salt is formulated with the same ratio (1:4). The use of oyster mushroom broth and spices in the spices snacks at the same level is 7.14% and garlic powder 3%, pepper 3%, dried parsley 7%. Brick salt, mushroom broth powder, and pepper were sieved using a 60-mesh sieve.

The snacks are made of potato sticks (93%) and seasoning mix (7% including maltodextrin, sugar, mushroom broth powder, salt, onion powder, pepper, and dried parsley). The hedonic and palatability test sample preparation uses the same procedure as the difference test, but the formulations used are different. The following table shows the percentage of the use of ingredients for making snacks in this study.

2.4 Data analysis

From the survey study of salt consumption behavior, an analysis was conducted to test the correlation between knowledge scores, and demographic characteristics of respondents to the level of salt consumption using a non-parametric analysis Kendall's Tau B correlation test. Salt content variation test on hedonic score and palatability using non-parametric statistical test types, namely Kruskal Wallis test and Mann Whitney U test and analysis testing the correlation between hedonic and palatability using Kendall's Tau correlation test b. Data was processed using IBM SPSS Statistics Version 23.0 software. Before determining the type of statistical test that will be used an assumption test is the Kolmogorov-Smirnov normality test, if p-value>0.05 then the data is normally distributed and Levene variance (homogeneity) test, if p-value >0.05 then homogeneous data.

Difference test data processing used Microsoft Excel 2013 software, by calculating the percent positive response and then plotting data in a graph of the relationship between stimulus intensity that is Δ salt concentration (difference in salt concentration) as abscissa and the percent positive response as ordinate. The difference threshold value was obtained by making a horizontal line from the Y-axis at the point of 50% (parallel to the X-axis) until crosses the graph. From the cross point, the vertical line was dragged to the X-axis to get the difference threshold value.

3. Results and discussion

3.1 Salt consumption behavior survey

3.1.1 Respondent characteristic demographic

A total of 435 respondents completed the online questionnaire with the proportions of sex, age, and body mass index listed in Table 3.

Table 3 shows the highest frequency of respondents in this study was female, with 324 respondents. This is because the number of women in the Province of DIY is more than 38,235 compared to men (Central Bureau of Statistics of DIY Province, 2019). Age grouping based on the Ministry of Health (2009), the group of late teens aged 17-25 years had the most frequency, with 387 respondents. The respondent's body mass index after being measured and classified based on the body mass index threshold (BMI) for Indonesia (2019) was 288

Table 3. Characteristic demographic profile of respondents (n = 435).

	Frequency (%)
Sex	
Male	111 (25.5)
Female	324 (74.5)
Age (year)	
Early teens (12-16)	7 (1.6)
Late teens (17-25)	387 (89)
Early adulthood (26-35)	18 (4.1)
Late adulthood (36-45)	11 (2.5)
Early elderly (46-55)	9 (2.1)
Late elderly (56-65)	3 (0.7)
BMI (Body Mass Index) (kg/m^2)	
Underweight (<18.5 kg/m^2)	85 (19.5)
Normal (≥ 18.5 - < 24.9 kg/m^2)	288 (66.2)
Overweight (≥ 25 - < 27 kg/m^2)	35 (8)
Obese (≥ 27 kg/m^2)	27 (6.2)

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respondents with normal status.

3.1.2 Overview of salt consumption practices

In Table 4, more than 1/3 of the total respondents (167 respondents) liked salty food. Many studies revealed that the habit of eating salty foods affects their preferences. More than half of the total respondents (272 respondents) did not add salt to their food before tasting. According to Newson *et al.* (2013), the discretionary of using salt in adding salt to food contributes to salt intake. The survey results showed fried foods (36.1% of respondents) and snacks (29.4% of respondents) became the most frequent food consumed. Table 5 shows the salt and sodium content of food products in the survey salt consumption behaviour.

Table 4. Distribution salt consumption practices.

The practices of salt consumption	Frequency (%)
Kind of food preference	
Salt	167 (38.4)
Sweet	119 (27.3)
Spicy	149 (34.3)
Food that most often consumed (≥ 1 times/week)	
Fried food	157 (36.1)
Snack not traditional snack	128 (29.4)
Indonesian chicken noodle	23 (5.3)
Meatball	15 (3.4)
Gado-gado – ketoprak – pecel	35 (8)
Lontong sayur	0 (0)
Fried rice	41 (9.4)
Soto-gule-soup	36 (8.3)
Adding salt to food before tasting	
Always	41 (9.4)
Sometimes	122 (28)
Rarely or never	272 (62.5)

Table 5. Salt and sodium content of food products in the survey salt consumption behaviour.

Food Name	Salt amount/ portion	Sodium (mg)/ portion
Fried food	sufficiently	125
Snack		593 (100 g)
Indonesian chicken noodle	¼ tsp	500
Meatball	½ tsp	1000
Gado-gado – Ketoprak - Pecel	¼ tsp	500
Lontong Sayur	¼ tsp	500
Fried rice	½ tsp	1000
Soto – Gule - Soup	¼ tsp	500

Sodium content based on Health Ministry, Indonesia and WHO where 2000 mg Na = 1 tsp salt = 5 g salt

Based on The University of Maine (2011) Bulletin and Demedia Kitchen Team (2010) summarize the levels of salt and sodium in foods used in this survey.

The level of salt consumption in this study was categorized into three categories.

High: salty food preferences, always add salt, food consumed ≥ 1 time/week containing sodium> 500mg - 1000 mg.

Medium: salty food preferences, always or sometimes add salt, food consumed ≥ 1 time/week containing sodium> 125 mg - ≤500 mg.

Low: sweet or spicy food preferences, do not add salt, food consumed ≥ 1 time/week contains sodium ≤125 mg.

Figure 1 shows the levels of salt consumption. The survey results showed 154 respondents had high salt consumption, 162 respondents had moderate salt consumption in their diet, and 119 respondents had low-salt consumption in their diet.

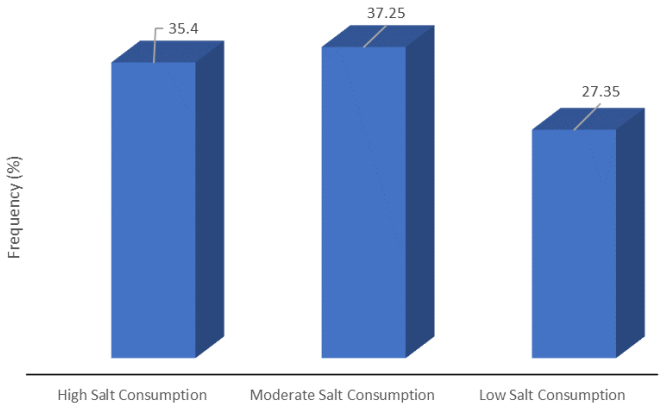

Figure 1. Histogram showing levels of salt consumption.

3.2 Overview surrounding reducing salt consumption.

The description of salt consumption is in the form of individual knowledge, attitudes, and intentions towards salt. The level of knowledge of respondents about salt in their diets is shown in Table 6. About 39.5% of respondents did not know the recommendations for salt consumption and 89% of respondents answered incorrectly about the amount of salt in food. This shows that respondents' knowledge about salt needs to be improved. Poor knowledge of salt can have an impact on the behavior of consuming foods that are high in sodium. Eating behavior based on proper knowledge or understanding will encourage the expected behavior (Notoatmodjo, 1993).

Table 6 shows the attitude to reduce salt, in terms of the readiness of respondents to reduce salt consumption. The results show the respondent considers reducing salt is not important with an average scale of 3.07. This is because the effects of excessive salt consumption do not appear directly to harm health. Whereas regarding respondents' belief in the impact of salt consumption the results showed the majority of respondents believed in

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the potential effects of salt increasing blood pressure (scale mean of 4.87), increasing thirst (5.05), and helping with iodine intake (5.27). Changes in salt consumption behavior can occur if individuals believe the effects of salt on health (Newson *et al.*, 2013). If someone does not believe that changing their behavior is beneficial, it is unlikely that a change in behavior will occur.

Table 6. Characteristics surrounding salt reduction.

Knowledge about salt	Frequency (%)
Recommended salt consumption	
Did not know	172 (39.5)
Incorrectly	111 (25.5)
Correct (answer 0-5 gram per day)	152 (34.9)
The highest salt content in food	
Incorrectly	387 (89)
Correct (answer meatball or fried rice)	48 (11)
Attitudes about salt intake reduction	
Beliefs on the effects of salt (salt in my food) *	
Increases blood pressure	4.87±1.61
Increases thirst	5.,05±1.63
Helps my iodine intake	5.27±1.52
Improves food shelf life	5.17±1.54
Readiness to reduce salt (reducing salt is…)	
Not important (1) → very important (7)	3.07±1.32
Intention to reduce salt intake	
Already reduced over six months	26 (6)
Have started in last six months	26 (6)
Interested to change in the next month	108 (24.8)
Interested to change in the next six month	129 (29.7)
Not interested in salt reduction	146 (33.6)

*Response scale to items was 1 = strongly disagree to 7 = strongly agree

Table 7 shows the correlation of salt consumption level with the characteristics and knowledge of respondents. Respondents were given 5 statements describing their interest in reducing salt at the time. Based on the survey results, 33.6% of respondents had no intention or interest in reducing salt consumption. This shows that awareness to reduce salt is still very low. Therefore, efforts need to be forced unconsciously so that people can reduce salt consumption in their diets, one of which is by reducing salt levels and replacing them with other ingredients that have the potential of umami such as the mushroom broth that is used in this study.

The description of salt consumption practices and the representation around reducing salt consumption is important to know the level of salt consumption and understand the intentions, knowledge, and attitudes of individuals to change their dietary habits so that the government or the public that seeks to reduce salt consumption can get information on the most promising changes in salt consumption behavior, recognizing the potential for change (Newson *et al.*, 2013), and developing appropriate interventions (Mørk *et al*., 2019).

The results of the analysis using the Kendall Tau B test showed that there was no correlation between age, sex, and body mass index to the level of salt consumption. However, in the research of Mojet (2001) and Hayes *et al*. (2010), age and sex were reported to influence perceptions and preferences for salt. Body mass index is also related to salt consumption which is associated with calorie intake (Yi dan Kansagra, 2014). The difference between the results of the research with the reference is because, today, people have a lot of variability in responding to their food. In addition, knowledge about salt, in the study of Pirouznia (2001) reported that there was an influence between nutritional knowledge on food selection. This contrariety caused even though the individual has good knowledge about salt and health, the individual does not use the information about salt to choose low-salt food options (Grimes et al, 2009).

3.3 Determination of preference threshold

The results of the survey on salt consumption behavior showed that respondents' preferences are salty foods and are predicted to be the reason for the lack of interest in reducing salt consumption. Reducing or eliminating salt in food can have a negative impact on food taste. Determination of the preference threshold is done to estimate how much salt content in a food matrix can be reduced without detecting differences in salty taste and is still preferred by consumers. Information about the limit of salt reduction in food that is still preferred by consumers can be one step to controlling salt consumption and flavor attributes in low-salt foods. An individual's sensitivity to a basic taste may not necessarily provide the same sensitivity to his preference for that basic taste in a food product, it is called suprathreshold. The preference threshold is more relevant in assessing taste sensations which is an individual having a threshold of starting to like a food product at a certain concentration (Hasanah *et al*., 2014).

Table 7. Correlation of salt consumption level with characteristics and knowledge of respondents.

		Age	Sex	BMI	Knowledge
Salt	Coef. correlation	-0.110	0.060	0.042	0.019
Consumption	P-value	0.768	0.167	0.302	0.644

There is a correlation if p-value <0.05.

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According to Galindo-Cuspinera *et al.* (2009), one of the parameters commonly used to determine individual suprathreshold sensitivity is the differential threshold or just noticeable difference (JND). Determination of the threshold of preference, the threshold for the concentration of salty taste in the snack that has begun to be preferred, uses the difference threshold test conducted by the paired comparison test method. The paired comparison test is one of the differentiation tests which include attribute difference tests. The reason for choosing this method is that in this study the food model used was snacks, salt reduction only affects the taste attribute, panelists were asked to focus on specific attributes, specifically salty taste. It is different if the food model used such as bread, sausage, or cheese, the salt reduction can have an impact on other sensory aspects such as texture and color. For complex food products, prefer to use an overall difference test.

Consumers as panelist participated in this study. According to Xia *et al.* (2015), the use of panelists in sensory testing can depend on the purpose of the testing. In this study, the aim is to look at which samples when the composition is modified, that most closely with common products which consumers still like and do not detect any change in composition. While using trained panelists is concerned that the results will be irrelevant and unrepresentative because the sensitivity of individual taste depends on the experience of sensation and eating habits. The results of the threshold difference test in snacks for the saltiness attribute were summarized in Table 8.

Table 8. Difference threshold test results for salty taste in potato stick snacks.

Salt content series (%) (g/100 g snack)	Δ Salt content (%) (g/100 g snack)	% Positive response
0.9	0	18
0.8	0.1	30
0.7	0.2	44
0.6	0.3	68
0.5	0.4	86

Salt content of the reference sample 0.9% (g/100 g snack).
Δ Salt content is the difference of salt concentration between reference sample with test sample.

The table shows that 18 panelists sense a distinction in the difference salt concentration of 0%, in other words, there should be no difference between the test sample and the reference sample (that's a blind sample), this error in consumer perception can occur because the seasonings in snacks are not spread evenly so it feels different from the sample reference or the biased sensitivity from untrained panelists. Then, plotting difference threshold test data in the graph to see the value of JND is presented in Figure 2.

Based on the graph in Figure 2, the percent positive response curve or the percentage of correct response increases when the difference in salt concentration (Δ salt concentration) increases. It means panelists can sense decreasing the salty taste between the reference potato stick snack and the potato stick snack test sample. JND value is obtained when the positive response is 50% (Meilgaard *et al*., 2013). The stimulus concentration for JND at 50% correct responses was 0.225 g/100-gram snack. This shows that panelists can determine the saltiness of the potato stick snack if the difference or concentration difference is greater than or equal to 0.225 g/100 g of snack. From this JND value, the preference threshold value is the minimum concentration of salt that is still preferred and there is no difference in the taste of saltiness in snacks by 0.675 g/100 g of snacks. This means that commercial snacks that have a 0.9% salt content can be reduced by up to 0.675%.

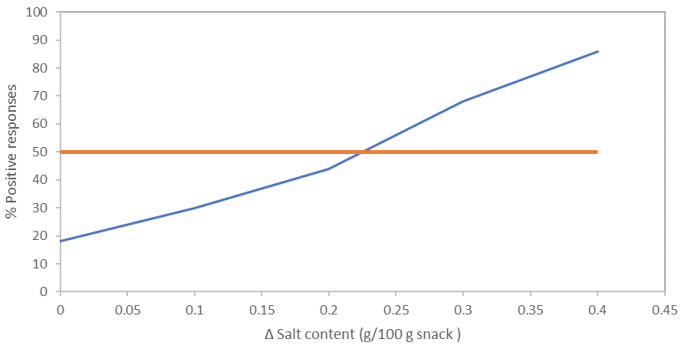

Figure 2. The difference threshold test for salty taste in potato stick snacks.

The preference threshold will show varying values from experiment to experiment, rather than an exact quantity, it's dependent on the food matrix used (product dependent), therefore choosing the food model is important. Moreover, salt has many roles, and its role is different for each food ingredient so each food ingredient has different potential limits on salt reduction.

3.4 Hedonic and palatability

Low-salt products that decrease the palatability intensity need to know their preferences or level of likes/ dislikes using hedonic tests. In this study, the salt concentration series used based on the threshold of preferences that were previously known, that the lowest levels of salt in snacks that are still preferred, and panelists do not notice the difference between the saltiness in snacks that panelists usually consume is 0.675%.

Mushroom broth with 0.5% levels used in this study based on Maluly *et al*. (2017) to reduce levels of NaCl in snacks recommended the use of MSG (by technological aspects) is 0.5 g/100 g. MSG (monosodium glutamate) is the most commonly used flavor enhancer, so this study

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decided to use the literature approach. For further research, should estimate the levels of umami material for product reformulation like this because the potential of umami for each ingredient is different. The equivalent umami concentration value (EUC) illustrates the umami potential of an ingredient upon MSG which is calculated based on the levels of all the compounds in the mushroom broth that cause the umami taste (Purwayantie, 2014). The oyster mushroom EUC value is 48.6±0.1% (Poojary *et al.*, 2017) which means that 1 g of oyster mushroom broth powder is equivalent to 0.48 g MSG.

Table 9 shows the results of hedonic tests, samples with a salt content of 0.675% and mushroom broth of 0.5% are the most preferred samples with an average score of 5.26. Whereas snacks that were not given salt at all with only 0.5% mushroom broth got the lowest average score of 4.50 (intensity near to neutral or neither like nor dislike). Kruskal-Wallis test shows that there were differences statistically significant in hedonic between the four samples, indicated by the value 0.019 (p-value <0.05). Then Mann Whitney U further tests to determine the place of the difference showed that snacks with a salt content of 0.675% were significantly different from snacks containing 0.45%, 0.225% and 0% salt.

Table 9. Hedonic and palatability tests of seasoned snacks with various salt content.

Sample		Hedonic	Palatability
Salt content	Mushroom		
0.68%	0.50%	5.26±1.26[a]	5.26±1.29[a]
0.45%		4.74±1.10[b]	4.78±1.27[b]
0.225%		4.62±1.43[b]	4.72±1.13[b]
0%		4.50±1.37[b]	4.52±1.17[b]

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different (p-value < 0.05) with the Kruskal Wallis and Mann Whitney tests.

Table 9 shows the results of the palatability test of low-salt snacks from the four samples, in which the sample with a salt content of 0.675% and a mushroom broth of 0.5% got the highest average palatability intensity with an average score of 5.26. Whereas snacks that were not salted at all with only 0.5% mushroom broth got the lowest average score of 4.52 (intensity near to neutral or neither like nor dislike). Kruskal-Wallis test shows that there were differences statistically significant in palatability between the four samples, indicated by the value 0.015 (p-value < 0.05). Then Mann Whitney U further tests to determine the place of the difference showed that snacks with a salt content of 0.675% were significantly different from snacks containing 0.45%, 0.225% and 0 salt%.

This study reported that snacks whose salt content is reduced by 25% and added with 0.5% mushroom broth can still be accepted by consumers and still taste delicious, indicating the addition of mushroom broth can cover a 25% reduction in salt. This is consistent with the literature on interactions between flavor compounds that the interaction of umami flavor compounds with salt can increase the salty taste. Although the lower the salt content the lower the consumer acceptance score.

Kruskal-Wallis test results also showed a sample of 0.675% salt content and the addition of 0.5% mushroom broth was significantly different from other samples, this confirmed that the salt reduction limit was indeed a maximum of 0.225 g/100 g of snacks. The addition of mushroom broth does not increase the saltiness threshold in snacks but is effective at maintaining consumer acceptance. An increase in the salty taste threshold might be seen if the salt content is lowered in the range of 25% to 50%, bearing in mind that when the salt level is 0.45%, there is a significant difference with the level of 0.675%.

The hedonic response can be influenced by the umami component added as well as other sensory active compounds in food (Jinap and Hajeb, 2010). According to Kurihara *et al*. (1993), the taste characteristics of appetizing foods product are produced from a mixture of various amino acids, umami compounds, and salts at the appropriate ratio.

One g salt contains about 40% sodium (1 g salt = 0.4 g sodium) (FSAI, 2005), while oyster mushrooms (Pleurotus ostreatus) contain 3 mg sodium/100 g dried mushrooms (Deepalakshmi and Mirunalini, 2014). This means that seasoning snacks with 0.9% salt content have a sodium content of 360 mg/100 g snacks, while seasoning snacks with salt content of 0.675% and 0.5% mushroom broth have sodium levels of around 270 mg/100 g snacks. Sodium levels in mushroom broth can be ignored, as a small amount of mushroom broth does not affect sodium levels. This study has the potential to be developed because the use of salt is reduced so that the intake of sodium from salt can be suppressed.

The use of mushroom broth can help to increase consumer acceptance and the delicious intensity of products with low or no salt. According to Jinap and Hajeb (2010), the taste of umami combined with low-salt products is a solution for foods that decrease palatability aka less tasty. In the research of Yamaguchi dan Takahashi (1984) using a soup food model soup palatability can be maintained with reduced salt content and the addition of glutamate compounds. Similar results

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in the study of Jinap *et al.* (2016) reported that salts in the spicy soup were reduced by 32.5% with the addition of 0.7% glutamate levels without affecting palatability. In addition, Leong *et al.* (2016) reported that salt in mee soto broth can be reduced by 40% by adding 0.4% MSG.

4. Conclusion

The habit of consuming foods rich in salt and the preference or high preference for consuming salty foods refers to poor nutritional status for health that can increase the prevalence of hypertension. This research has focused on low-sodium diet strategies to reduce salt consumption through the salt taste perception using potato stick snacks as a food model. First, we found that there is no correlation between salt consumption with knowledge about salt and individual characteristics. Secondly, salt can be reduced up to 25% (from 0.9% to 0.675) and by adding 0.5% mushroom broth to potato stick snacks with a level that is still preferred by consumers, it is expected that people can reduce salt intake in their diets by as much as 25% each time-consuming snacks while still maintaining palatability. Thirdly, using 0.5% mushroom broth as a source of umami flavor can be accepted by consumers to replace the role of salt in food so it can act as an alternative strategy to reduce salt consumption. Understanding the maximum limit of salt reduction in food and using mushroom broth can maintain sensory properties in low-salt food. The relevant authorities can consider this way by encouraging the domestic food industry to reduce salt use in its products, so people reduce their salt consumption without them perceiving it. This study also gives insight that accepting a food product is not enough to encourage consumption of the product, it is necessary to understand the habits and behavior of individual consumption of food.

Conflict of interest

The authors declare no conflict of interest.

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