Effect of Flavor and Monosodium Glutamate (MSG) on Consumer Perception and Acceptance Towards Chicken Clear Soup and Chicken Cream Soup With Different Salt Level

KANTIDA APIRAKSATTAYAKUL

A special senior project submitted to Faculty of Biotechnology, Assumption University in part of fulfillment of requirement for the degree in Bachelor Degree of Science in Biotechnology

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Title	: Effect of flavor and monosodium glutamate (MSG) on consumer perception and acceptance towards clear soup and cream soup with different salt level
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Level of study	: Bachelor of Science
Department	: Food Technology
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Advisor

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EFFECT OF FLAVORS AND MONOSODIUM GLUTAMATE (MSG) ON CONSUMER PERCEPTION AND ACCEPTANCE TOWARDS CHICKEN CLEAR SOUP AND CHICKEN CREAM SOUP WITH DIFFERENT SALT LEVEL

ABSTRACT

Salt (Sodium Chloride) is the most commonly used food additive for enhancing taste and flavor as well as creating sense of pleasure after consuming. People tend to consume salt more than daily recommended intake, 5 grams per day. High salt intake can lead to a great deal of health issues especially cardiovascular disease and chronic kidney disease. Thus, World Health Organization (WHO) plans to reduce the global population's intake of salt by relative 30% by year 2025. Scientist have studied salt reduction in food by adding substitutes such as flavors, monosodium glutamate (MSG), and potassium chloride (KCl). In this research, salt reduction in food was studied based on saltiness perception among fifty panelists. Two types of soup, chicken clear soup and chicken cream soup, were used as a food model. Each type of soup was varied by MSG added including chicken clear soup without MSG, chicken clear soup with MSG, chicken cream soup without MSG and chicken cream soup with MSG. Three different flavors – bacon, lobster and smoke – were added into each kind of soup with five different level of salt – 0.05%, 0.0375%, 0.025%, 0.0125% and 0%. Salt, MSG and flavors were found to have effect on saltiness perception and overall liking. The results have shown that overall liking toward soup with bacon flavor was not significantly different at 0.025% salt comparing to 0.05% salt, then followed by clear soup with smoke flavor and lobster flavor which was not significantly different at 0.0375% salt comparing to 100% salt. Therefore, with flavor adding, salt in soup can be reduced by 0.0125% to 50% without effect on overall liking.

KEYWORDS: salt / monosodium glutamate (MSG) / flavor / salt reduction

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Introduction

Salt is as known as Sodium Chloride consists of 40% sodium and 60% chloride. Salt is the most important ingredient in food preparation. It is added to every kind of food including savory, dessert and beverage. More than 40% of salt consumption originates from bread, meat, processed poultry, and soup. One of the most interesting function of salt is enhancing flavor by smoothening sweet taste and blocking bitter taste in food. Interestingly, salt taste plays important role in food choice due to the feeling of pleasure created after consuming salt. Moreover, salt is an essential mineral that act as electrolytes in the body which help in overall body's fluid balancing. Nevertheless, high salt consumption (more than 5 gram per day) can lead to a great deal of health issues especially cardiovascular disease and chronic kidney disease.

Globally, trend of salt consumption continuously rises in overall aspect. people tend to eat saltier than before and get used to salty taste. Thus, World Health Organization (WHO) becomes more aware of the issues. WHO Member States have agreed to reduce the global population's intake of salt by relative 30% by 2025. Reducing salt intake has been identifies as one of the most cost-effective measures countries can take to improve population health outcomes[1].

Therefore, aim of this study is studying saltiness perception in different salt level and effect of flavor in saltiness perception in chicken soup and chicken cream soup in term of salt reduction in food.

Objectives

1. To formulate the standard chicken soup and chicken cream soup for the experiment.
2. To conduct sensory analysis of different amount of salt in chicken soup and saltiness perception.
3. To study the effect of Monosodium Glutamate (MSG) on saltiness perception
4. To study the effect of different flavors on saltiness perception

Literature Review

Salt is crystalline mineral presenting in vast quantities in nature. It is an ionic compound that primarily compose of sodium and chloride. The characteristic of salt is water soluble which can be dissociated into sodium ion (Na^+) and chloride ion (Cl^-) by the attraction force between salt and water molecules. Sodium ion is attracted by positive-charge molecule or hydroxide ion (OH^-) of water whereas chloride ion is attracted by negative-charge molecule or hydrogen ion (H^+) of water.

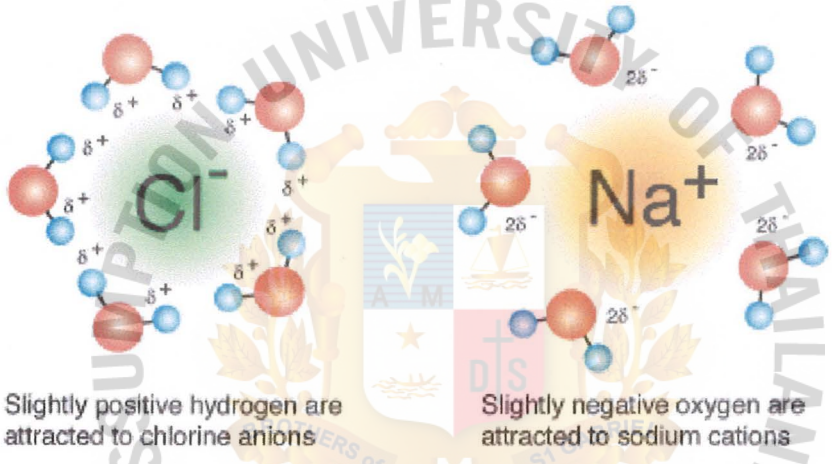

Figure 1: Salt molecule dissolve in water

(https://socratic.org/questions/52f1151702bf34733dc14e7e)

Salt, in chemistry, substance produced by the reaction of an acid with a base. A salt consists of the positive ion (cation) of an acid and the negative ion (anion) of a base. The reaction between an acid and a base is called a neutralization reaction. The term salt is also used to refer specifically to common table salt, or sodium chloride. When in solution or the molten state, most salts are completely dissociated into negatively and positively charged ions and are good electrolytes, conductors of electricity (The Editors of Encyclopaedia Britannica, 2019).

Taste Perception

Taste is the sensation produced when a substance in mouth reacts chemically with taste receptor cells located on taste buds in the oral cavity, mostly on the tongue. On the tongue there are taste bud with up to 100 taste cells. These cells form shape like onion. At the tip, there is a taste pore that work as fluid-filled funnel. This funnel contains taste hair, finger-shape, for sensory cell extensions.

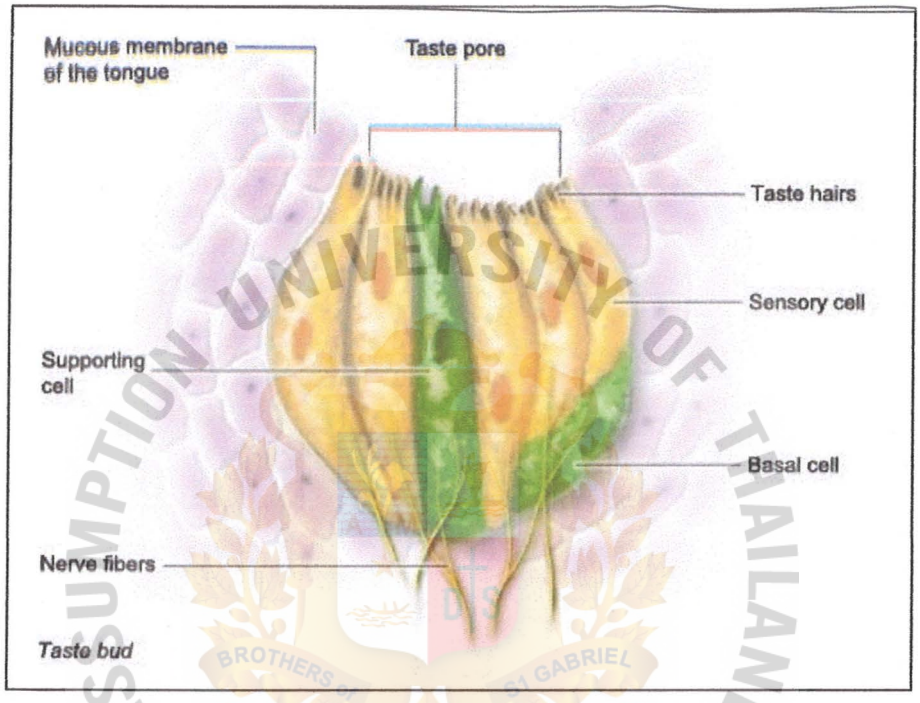

Figure 2: Taste Bud Structure
(https://www.ncbi.nlm.nih.gov/books/NBK279408/)

The process of taste perception begins with water-soluble chemical in food, tastants, such as sugar, salt, or acid dissolved by saliva in mouth, then detected by taste bud. The stimulation of chemical in taste cells caused by the binding of these chemicals and receptors. When the chemicals pass through a specific channel, nerve signal is generated and transferred to end of nerve fiber which send impulses along cranial nerve to taste region in brain. From here, the impulses are relayed to the thalamus and on to a specific area of the cerebral cortex, which makes us conscious of the perception of taste.

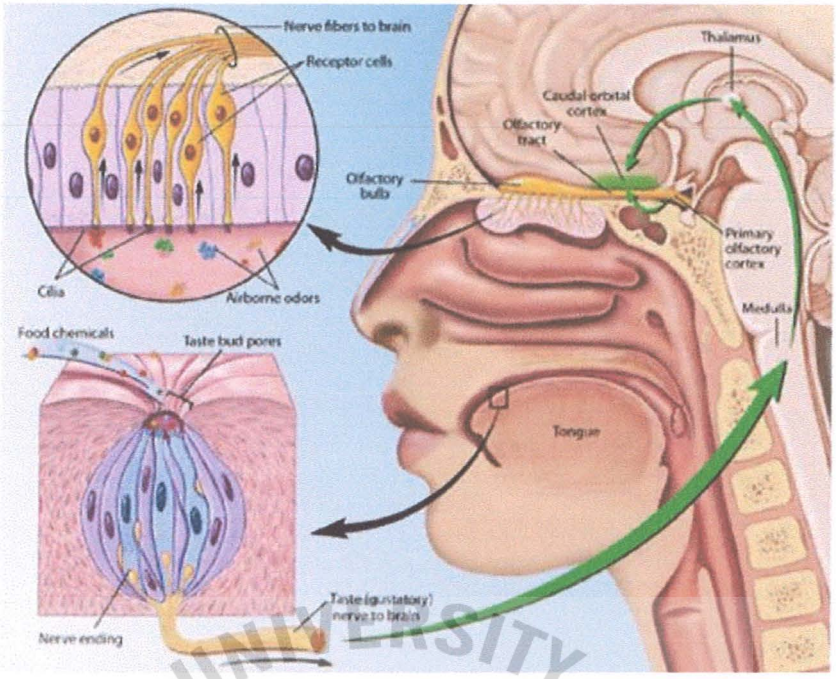

Figure 3: The process of how we perceive taste
(http://www.brainfacts.org/thinking-sensing-and-behaving/taste/2012/taste-and-smell)

About half of the sensory cells react to several of the five basic tastes. They only differ by having varying levels of sensitivity to the different basic tastes. Each cell has a specific palette of tastes with fixed rankings: this means that a particular cell might be most sensitive to sweet, followed by sour, salty and bitter, while another has its own ranking (Institute for Quality and Efficiency in Health Care, 2006). The five qualities that Lindemann refers to are salty, sour, bitter, sweet, and umami, the last being the Japanese term for a savory sensation. Salty and sour detection is needed to control salt and acid balance. Bitter detection warns of foods containing poisons-many of the poisonous compounds produced by plants for self-defence system are bitter. The quality sweet provides a guide to calorie-rich foods. And umami (the taste of the amino acid glutamate) may flag up protein-rich foods (Bradbury J, 2004).

For particular taste, there is specific channel for chemical movement to generate nerve signal. The entry of Na+ into these cells results in the depolarization of the cell membrane and the generation of a receptor potential. Sour taste is the perception of H+ concentration. Just as with sodium ions in salty flavors, these hydrogen ions enter the cell and trigger depolarization. Sour flavors are, essentially, the perception of acids in our food. Increasing hydrogen ion concentrations

in the saliva (lowering saliva pH) triggers progressively stronger graded potentials in the gustatory cells. The first two tastes (salty and sour) are triggered by the cations Na+ and H+. The other tastes result from food molecules binding to a G protein–coupled receptor. A G protein signal transduction system ultimately leads to depolarization of the gustatory cell. The sweet taste is the sensitivity of gustatory cells to the presence of glucose dissolved in the saliva. Bitter taste is similar to sweet in that food molecules bind to G-protein coupled receptors. However, there are a number of different ways in which this can happen because there are a large diversity of bitter-tasting molecules. Some bitter molecules depolarize gustatory cells, whereas others hyperpolarize gustatory cells. Likewise, some bitter molecules increase G-protein activation within the gustatory cells, whereas other bitter molecules decrease G protein activation. The specific response depends on which molecule is binding to the receptor. One major group of bitter-tasting molecules are alkaloids (lumenlearning, 2019). Umami taste, stimulated by amino acids or peptides, is a general indicator of protein in food which will bind to G-protein coupled receptors. Amino acids such as glutamate probably represent a primary taste stimulus, or umami taste may be derivative of the other taste sensations. Umami is a 'helper' quality that triggers a strong response in humans only in the context of other flavors. This may be due to the fact that free amino acids rarely appear alone in nature (Breslin, P. A., & Spector, A. C., 2008)

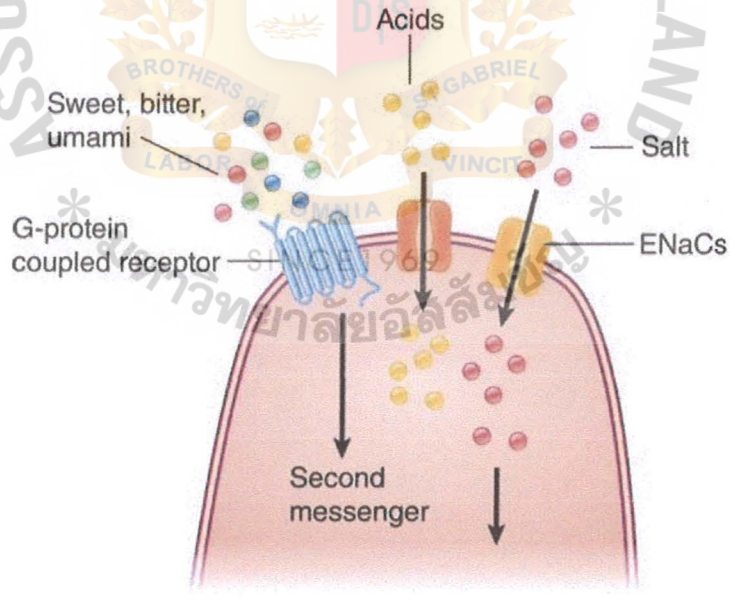

Figure 4: Specific channel for each tastant

(https://burnsbites.com/2019/01/04/chemical-senses-and-capsaicin/)

Sensory Threshold Level

Sensory Threshold is the minimum quantity of a specific stimulus or compound that is able to be detected by a person, or the boundary at which the subject crosses from 'not detecting' to detecting'. Usually, the measure or physical intensity of taste perception is concentration. Thus, the threshold for a particular taste or smell is the lowest concentration of a compound that a panelist can distinguish from water (or other solvent). At and above this concentration, the panelist will indicate that a compound is present, while below this concentration the panelist will indicate there is no compound present. Hence, detection thresholds are one way of establishing the relative potencies of different compounds, although caution must be used when making this comparison.

There are four main types of threshold value in sensory evaluation; Absolute Threshold, Recognition Threshold, Just Noticeable Difference Threshold (JND), and Terminal Threshold. The actual threshold is the lowest concentration of particular stimulus that can be detected or distinguished. At and above this concentration, panelist capable of indicating the present of the compound or taste. For example, it takes 0.02M of salt as the lowest sodium concentration for majority of the normotensive consumers to detect the saltiness (Azotea, Ava Nicole., 2019). However, absolute threshold vary accordingly to sensory adaptation. The recognition threshold is the level of concentration of specific stimulus can be recognized or identified. Typically, this threshold level will be higher than actual threshold. For example, a specific level of salt concentration salt which panelist can recognize the salty taste. The just noticeable difference threshold or JND is the extent of change in stimulus necessary to produce noticeable difference. JND is focusing on the increasing of stimulation from a specific base intensity that can elicit the change in sensation. For example, baseline of salt concentration is given and the certain amount of salt must be added to baseline concentration until it can be distinguished from reference containing only baseline (Delwiche J, 2008). A terminal threshold is the level beyond which a stimulus is no longer detected. This is the point where the stimulus is too strong so the receptors no longer detect the stimulus.

However, different person will have different sensitivity toward specific stimulus or taste as well as their responses are based on their experience or personal's bias. Studying sensory threshold help scientist to learn how human process and sensory information as well as human perception toward specific stimulus. In addition, age has effect on some basic taste perception but

age effects are not equal for all compound. Older people tend to be less sensitive to some tastants related to salty, bitter and umami (Mojet, J., Christ-Hazelhof, E., & Heidema, J., 2001).

Besides, addition of flavor can decrease the threshold value which lower than the threshold for detecting either taste of odor alone. The mixture could have a lower threshold than either single component because of probability summation (Veldhuizen, M. G., Shepard, T. G., Wang, M. F., & Marks, L. E., 2009).

Monosodium Glutamate

Monosodium Glutamate or MSG is white crystalline powder mostly used as food additive or food enhancer in savory dishes. The structure of MSG consists of sodium and glutamate, one kind of amino acid. MSG, by itself, does not have a pleasant taste. It is necessary to complement this substance with other foods so that it can enhance, harmonize, and balance the flavor of certain dishes, making them more appetizing. It is the purest form of umami, which is a taste that brings out the savory deliciousness of food and adds dimension to the flavors. Glutamate activates the umami receptors on your tongue in the same way that adding sodium chloride activates saltiness receptors.

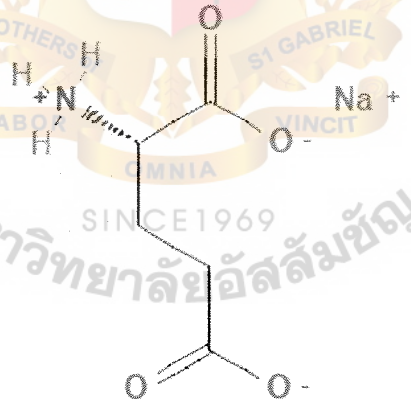

Figure 5: Monosodium Glutamate structure
(https://pubchem.ncbi.nlm.nih.gov/compound/Monosodium-L-glutamate)

Consumer Trend (Health Perception) and Trend of Salt Reduction in Food Product

According to relevant organizations and statistic research, people become more concern about health and salt daily intake. WHO Member States have agreed to reduce the global population's intake of salt by a relative 30% by 2025. Reducing salt intake has been identified as one of the most cost-effective measures countries can take to improve population health outcomes. Key salt reduction measures will generate an extra year of healthy life for a cost that falls below the average annual income or gross domestic product per person. An estimated 2.5 million deaths could be prevented each year if global salt consumption were reduced to the recommended level (World Health Organization, 2016).

Moreover, trend of reduced salt food product has been increasing continuously since 2018 and projected growing constantly in the following years. *"Vendors are trying to replace or restrict the use of salt by using more herbs and spices. They are also experimenting with salt substitutes such as potassium salt which occurs naturally in milk, fruits, vegetables, and grains. Moreover, dietary guidelines encourage the increased use of potassium salt, which is leading to its increased use as a salt substitute,"* says a senior analyst at Technavio for research on food (Technavio Research, 2018). Another salt substitute in food is monosodium glutamate (MSG) which many manufacturers believe that it can help promote saltiness perception in food and enhance umami flavor.

Related Research and Studies

Previous studies have reported that the monosodium l-glutamate (MSG) and salty smelling odors (e.g., soy sauce, bacon, sardines). It is suggested that addition of the salty-smelling improves the detectability and prolongs the perceived duration of salty taste substances in the mouth (Onuma, T., Maruyama, H., & Sakai, N., 2018). For some products, although it is necessary to consider salt interaction with sensory components when reducing the sodium content of dishes, this study indicates that sodium content can be reduced by about thirty percent, without significantly changing salt perception in those complex dishes where a main carrier is not present but where all ingredients together contribute to the taste. We propose that perceived saltiness also depends on the medium in which sodium is presented and not only on the sodium concentration (Malherbe, M., Walsh, C. M., & van der Merwe, C. A., 2003).

Methodology

Raw Materials

1. Raw Chicken Carcass (Tesco Lotus)
2. White Radish (Tesco Lotus)
3. Onion (Tesco Lotus)
4. Garlic (Tesco Lotus)
5. Coriander Root (Tesco Lotus)
6. Plain Flavored 100% Pasteurized Whole Milk (Chokchai Dairy Farm®)
7. White Peppercorn (Tesco®)
8. Ground Black Pepper (Nguansoon Hand®)
9. Rock Sugar (Wangkanai®)
10. Iodized Refined Salt (Prung Thip®)
11. Monosodium Glutamate, MSG (Ajinomoto®)
12. All Purpose Flour (Uncle Barns'®)
13. Corn Flour (Knorr®)
14. Food Flavors; Bacon Flavor, Lobster Flavor, and Smoke Flavor (Value Industrial Products, VIP®)

Apparatus

1. 3 oz. paper cup (Aro®)
2. 1.2 L. Thermal Cup
3. Thermocouple
4. 6 L. Pot
5. Electric Stove
6. 2000 ml. Beaker
7. Stirring rod
8. Dropper

Method

Formulation (Preliminary)

Chicken clear soup and chicken cream soup recipes were formulated. Soup formula as well as preparing process were adjusted base on consumer testing, 9-Point Hedonic Scale questionnaire on liking score, and laboratory constraint. The basic recipes and preparing process were retrieved from internet (Aroypoong[1], pinchofyum[2]). The chicken clear soup was used further in preparing chicken cream soup as a stock soup.

Sample Preparation

There were two types of soup the experiment, chicken clear soup and chicken cream soup. Each type of soup was divided into 2 groups with MSG added and without MSG added. A standard formula and process were used for the whole experiment with the different amount of salt added. One sample set consisted of reference, 0.05%W/V salt, and 5 samples with different %salt concentrations. Each sample contained different percentage of salt decreased accordingly to standard formula including 0.05%W/V, 0.0375%W/V, 0.025%W/V, 0.0125%W/V, and 0%W/V respectively. Furthermore, three different flavors; bacon, lobster, and smoke were added into each sample set.

Table1: Standard Formula of Chicken Clear Soup (0.05%W/V salt concentration)

Raw Material	Amount		Percentage
Water	4	L.	65%
Chicken Carcass	1	kg.	16%
Onion	600	g.	10%
White Radish	500	g.	8%
Garlic	25	g.	0.4%
White Peppercorn	3	g.	0.05%
Coriander Root	20	g.	0.3%
Rock Sugar	15	g.	0.2%
Salt	20	g.	0.05%*
MSG	4	g.	0.05%

*calculated by amount of water o

Table3: Treatments with different %salt concentration and flavor for chicken clear soup

Soup	MSG	Flavor	%Salt
Chicken Clear Soup	No	Bacon	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)
		Lobster	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)
		Smoke	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)
	Yes	Bacon	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)
		Lobster	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)
		Smoke	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)

Table4: Treatments with different %salt concentration and flavor for chicken cream soup

Soup	MSG	Flavor	%Salt
Chicken Cream Soup	No	Bacon	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)
		Lobster	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)
		Smoke	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)
	With MSG	Bacon	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)
		Lobster	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)
		Smoke	5 g. (0.05%W/V)
			3.75 g. (0.0375%W/V)
			2.5 g. (0.025%W/V)
			1.25 g. (0.0125%W/V)
			0 g. (0%W/V)

Result and Discussion

Chicken Clear Soup

1. Study Effects of Factors and interaction on Saltiness Perception and Overall Liking

Table 5: Effect of each factor and interaction on degree of difference (DOD)

Dependent Variable: dod

Source	DF	Type III SS	Mean Square	F Value	Pr > F
msg	1	27.625351	27.625351	41.08	<.0001
flavor	3	18.277442	6.092481	9.06	<.0001
msg*flavor	3	11.925761	3.975254	5.91	0.0005
salt	4	4735.301581	1183.825395	1760.60	<.0001
msg*salt	4	10.132627	2.533157	3.77	0.0047
flavor*salt	12	31.969695	2.664141	3.96	<.0001
msg*flavor*salt	12	22.480350	1.873362	2.79	0.0009

Table 6: Effect of each factor and interaction in overall liking

Dependent Variable: like

Source	DF	Type III SS	Mean Square	F Value	Pr > F
msg	1	37.445370	37.445370	17.02	<.0001
flavor	3	128.205174	42.735058	19.43	<.0001
msg*flavor	3	2.253485	0.751162	0.34	0.7954
salt	4	1927.978074	481.994519	219.10	<.0001
msg*salt	4	8.860324	2.215081	1.01	0.4026
flavor*salt	12	134.558976	11.213248	5.10	<.0001
msg*flavor*salt	12	45.012682	3.751057	1.71	0.0598

As shown in table 5, all individual factors (msg, flavor, and salt) and combination of factors (msg*flavor, msg*salt, flavor*salt, and msg*flavor*salt) have significant effect on saltiness perception. It can be assumed that consumers are able to detect the difference in saltiness comparing between samples. Changing in amount of salt or different flavors as well as monosodium glutamate (MSG) adding can significantly affect saltiness perception.

As shown in table 6, there are some individual factors and combination of factors, consist of msg, flavor, salt, and flavor*salt, have significant effect on overall liking. It can be assumed that changing in amount of salt or different flavors or msg adding can alter the consumers' preference as well as flavor is an individual preference. Otherwise, other combination of factors (msg*flavor, msg*salt and msg*flavor*salt) have no significant effect on overall liking. It can be assumed that, in factor combination, some factors cover another factor's characteristic or the interaction between factors can blend in the characteristic with each other which leads to the non-significant effect on liking.

Table 7: Effect of monosodium glutamate (MSG) on degree of different (DOD)

msg	**dod LSMEAN H0:LSMean1=LSMean2**	
		Pr > |t|
N	-2.51414690	<.0001
Y	-2.27327053	

Table 8: Effect of monosodium glutamate (MSG) on overall liking

msg	**like LSMEAN H0:LSMean1=LSMean2**	
		Pr > |t|
N	4.92985507	<.0001
Y	5.21029469	

According to table 7 and 8, monosodium glutamate (MSG) have significant effect on both degree of difference (DOD) in saltiness perception and overall liking. Consumers tend to be able to detect less difference in salty taste in soup with monosodium glutamate (MSG) and more prefer soup with monosodium glutamate

Table 9: Comparing effect between each flavor on degree of difference (DOD)

flavor	dod LSMEAN	LSMEAN Number
Bacon	-2.27400000	1
Lobster	-2.40652174	2
Original	-2.53800000	3
Smoke	-2.35631313	4

Least Squares Means for effect flavor Pr > |t| for H0: LSMean(i)=LSMean(j) Dependent Variable: dod				
i/j	**1**	**2**	**3**	**4**
1		0.0125	<.0001	0.1228
2	0.0125		0.0132	0.3562
3	<.0001	0.0132		0.0007
4	0.1228	0.3562	0.0007	

Note: 1 = bacon, 2 = lobster, 3 = original, 4 = smoke

Table 10: Comparing effect between each flavor on overall liking

flavor	like LSMEAN	LSMEAN Number
Bacon	5.32600000	1
Lobster	5.00652174	2
Original	4.68000000	3
Smoke	5.26777778	4

Least Squares Means for effect flavor Pr > |t| for H0: LSMean(i)=LSMean(j) Dependent Variable: like				
i/j	**1**	**2**	**3**	**4**
1		0.0009	<.0001	0.5461
2	0.0009		0.0007	0.0080
3	<.0001	0.0007		<.0001
4	0.5461	0.0080	<.0001	

Note: 1 = bacon, 2 = lobster, 3 = original, 4 = smoke

According to table 9, comparing effect between each flavor on degree of difference (DOD) in saltiness perception, there is no significant difference in saltiness perception between bacon and smoke flavor as well as between lobster and smoke flavor. It can be assumed that consumers detect not much difference in saltiness when compare between particular flavors. Since bacon and smoke flavors share similar characteristic which is slightly smoked feeling, consumers detect difference or changing in saltiness in similar trend. Similarly, between lobster and smoke flavor, trend of detecting difference in saltiness goes the same way. Moreover, consumers are able to detect least difference in saltiness in soup containing bacon flavor and followed by smoke, lobster and original flavor respectively.

As shown in table 10, the trend of detecting difference in saltiness between bacon and smoke flavor is non-significant different, thus the effect on overall liking when compare between these particular flavors is non-significantly different. In addition, the same trend is shown in overall liking as well. Consumers more prefer soup containing bacon flavor the most and follow by smoke, lobster and original flavor respectively.

Table 11: Comparing effect between different %salt on degree of difference (DOD)

salt	dod LSMEAN	LSMEAN Number
0	-4.48620773	1
25	-3.62868357	2
50	-2.47399758	3
75	-1.29141304	4
control	-0.08824166	5

Least Squares Means for effect salt
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: dod

i/j	1	2	3	4	5
1		<.0001	<.0001	<.0001	<.0001
2	<.0001		<.0001	<.0001	<.0001
3	<.0001	<.0001		<.0001	<.0001
4	<.0001	<.0001	<.0001		<.0001
5	<.0001	<.0001	<.0001	<.0001	

Note: 1 = 0%, 2 = 25%, 3 = 50%, 4 = 75%, 5 = 100% (control)

Table 12: Comparing effect between different %salt on overall liking

salt	like LSMEAN	LSMEAN Number
0	3.51001208	1
25	4.41497585	2
50	5.19566425	3
75	6.11595411	4
control	6.11376812	5

Least Squares Means for effect salt Pr > |t| for H0: LSMean(i)=LSMean(j) Dependent Variable: like					
i/j	**1**	**2**	**3**	**4**	**5**
1		<.0001	<.0001	<.0001	<.0001
2	<.0001		<.0001	<.0001	<.0001
3	<.0001	<.0001		<.0001	<.0001
4	<.0001	<.0001	<.0001		0.9838
5	<.0001	<.0001	<.0001	0.9838	

Note: 1 = 0%, 2 = 25%, 3 = 50%, 4 = 75%, 5 = 100% (control)

According to table 11 and 12, there is significant effect of each %salt on degree of difference in saltiness perception comparing between each %salt. It can be assumed that consumers can detect the difference in saltiness between each salt level. The less amount of salt, the more difference in saltiness detected. Likewise, there are significant effect of %salt on liking. Consumers tend to prefer soup with higher salt level. However, there is no significant difference in liking score between 100% and 75% salt. It can be assumed that consumers like either 100% salt or 75% salt the most and equally.

2. Randomized Complete Block Design (RCBD)

Table 13: RCBD for degree of difference (DOD)

dependent variable: dod

Source	DF	Type III SS	Mean Square	F Value	Pr > F
trt	39	4867.618170	124.810722	190.22	<.0001
con	49	62.571172	1.276963	1.95	0.0001

Table 14: RCBD for overall liking

dependent variable: like

Source	DF	Type III SS	Mean Square	F Value	Pr > F
trt	39	2258.207054	57.902745	32.43	<.0001
con	49	861.529146	17.582227	9.85	<.0001

According to table 13 and 14, there are significant effect of each treatment and consumer on both degree of difference in saltiness perception and overall liking.

Table 15: Duncan test for chicken clear soup in degree of difference (DOD)

%salt	Flavors							
	Original		Bacon		Lobster		Smoke	
	No MSG	MSG	No MSG	MSG	No MSG	MSG	No MSG	MSG
100	-0.4 ± 1.1 ^{CD}	0.0 ± 0.8 ^{B}	-0.1 ± 1.1 ^{BC}	0.5 ± 1.1 ^{A}	0.2 ± 0.8 ^{B}	-0.2 ± 0.9 ^{BC}	-0.3 ± 0.7 ^{BC}	-0.1 ± 0.8 ^{BC}
75	-1.9 ± 1.0 ^{HI}	-1.3 ± 1.0 ^{FG}	-1.4 ± 1.1 ^{G}	-1.0 ± 0.8 ^{EF}	-1.1 ± 0.8 ^{FG}	-1.3 ± 0.9 ^{FG}	-1.7 ± 0.8 ^{H}	-0.7 ± 0.6 ^{ED}
50	-3.1 ± 0.8 ^{L}	-2.6 ± 0.7 ^{K}	-2.3 ± 0.7 ^{JK}	-2.4 ± 0.8 ^{JK}	-2.5 ± 0.7 ^{JK}	-2.3 ± 0.7 ^{JK}	-2.4 ± 0.6 ^{JK}	-2.1 ± 0.6 ^{IJ}
25	-3.6 ± 0.8 ^{MN}	-3.5 ± 0.7 ^{MN}	-3.6 ± 0.7 ^{MN}	-3.5 ± 0.8 ^{MN}	-4.0 ± 0.7 ^{OP}	-3.7 ± 0.7 ^{MN}	-3.8 ± 1.4 ^{NO}	-3.3 ± 0.7 ^{LM}
0	-4.5 ± 0.7 ^{Q}	-4.4 ± 0.6 ^{Q}	-4.3 ± 1.3 ^{PQ}	-4.5 ± 0.7 ^{Q}	-4.6 ± 0.6 ^{Q}	-4.5 ± 0.5 ^{Q}	-4.5 ± 0.5 ^{Q}	-4.4 ± 0.6 ^{Q}

Table 16: Duncan test for chicken clear soup in overall liking

%salt	Flavors							
	Original		Bacon		Lobster		Smoke	
	No MSG	MSG	No MSG	MSG	No MSG	MSG	No MSG	MSG
100	5.8 ± 1.6 ^{CDEFGH}	6.0 ± 1.6 ^{ABCDEF}	5.6 ± 1.7 ^{EFGHI}	6.0 ± 1.5 ^{ABCDEF}	6.3 ± 1.7 ^{ABCDE}	6.3 ± 1.4 ^{ABCD}	6.5 ± 1.3 ^{A}	6.5 ± 1.2 ^{AB}
75	5.5 ± 1.7 ^{FGHI}	6.1 ± 1.3 ^{ABCDEF}	6.1 ± 1.3 ^{ABCDEF}	5.8 ± 1.3 ^{BCDEFG}	6.1 ± 1.8 ^{ABCDEF}	6.4 ± 1.1 ^{ABC}	6.3 ± 1.3 ^{ABCD}	6.6 ± 1.1 ^{A}
50	4.3 ± 1.6 ^{LMNO}	5.1 ± 1.3 ^{IJK}	5.3 ± 1.7 ^{GHIJ}	5.8 ± 1.1 ^{CDEFG}	5.1 ± 1.3 ^{IJK}	5.2 ± 1.2 ^{HIJK}	5.1 ± 1.2 ^{HIJK}	5.7 ± 0.9 ^{DEFGHI}
25	4.3 ± 1.7 ^{LMNO}	3.9 ± 1.4 ^{NOP}	4.8 ± 1.9 ^{JKL}	5.7 ± 1.3 ^{DEFGHI}	3.7 ± 1.6 ^{NOPQ}	4.4 ± 1.0 ^{LMN}	3.9 ± 1.6 ^{NOP}	4.6 ± 1.4 ^{KLM}
0	2.6 ± 1.6 ^{S}	3.1 ± 1.4 ^{RS}	4.0 ± 2.2 ^{MNOP}	4.1 ± 2.2 ^{MNO}	3.4 ± 1.7 ^{PQR}	3.3 ± 1.5 ^{QR}	3.7 ± 1.6 ^{OPQR}	3.8 ± 1.3 ^{NOPQ}

According to table 15 and 16, consumers perceive saltiness in a pattern. It is found that consumers detect the least different in saltiness comparing to reference and detect more difference when less salt is contained in soup. Moreover, the trend of overall liking decreases along with the less %salt concentration in soup.

3. Multiple Comparison

Table 17: Dunnett's test for chicken clear soup without MSG in degree of difference (DOD)

%salt	Flavors			
	Original	**Bacon**	**Lobster**	**Smoke**
100	Control	Control	Control	Control
75	-1.4 ***	-1.3 ***	-1.2 ***	-1.4 ***
50	-2.7 ***	-2.2 ***	-2.5 ***	-2.1 ***
25	-3.1 ***	-3.5 ***	-4.0 ***	-3.5 ***
0	-4.1 ***	-4.2 ***	-4.5 ***	-4.3 ***

Note: Comparisons significant at the 0.05 level are indicated by ***.
Compare within same column

According to table 17, there is a significant difference in saltiness perception comparing between sample and control in every flavor. It can be assumed that consumers can perceive the difference in saltiness between control and sample. The more salt is reduced, the more difference can be detected. This pattern is shown in every flavors; original, bacon, lobster and smoke.

Table 18: Duncan test for chicken clear soup without MSG in overall liking

%salt	Flavors			
	Original	**Bacon**	**Lobster**	**Smoke**
100	5.8 ^{A}	5.6 ^{AB}	6.3 ^{A}	6.5 ^{A}
75	5.5 ^{A}	6.1 ^{A}	6.1 ^{A}	6.3 ^{A}
50	4.3 ^{B}	5.3 ^{BC}	5.1 ^{B}	5.2 ^{B}
25	4.3 ^{B}	4.8 ^{C}	3.7 ^{B}	3.9 ^{C}
0	2.6 ^{C}	4.0 ^{D}	3.4 ^{C}	3.7 ^{C}

Note: Different subscript letter indicates significant difference at alpha = 0.05
Compare within same column

According to table 18, significant difference in overall liking is compared between sample, with different %salt, and control. There is no significant difference in overall liking when salt is reduced by 25% in every flavor. The significant difference in overall liking begins to appear when salt is reduced to 50% in original flavor, lobster and smoke flavor whereas there no significant difference in overall liking in soup with 50% salt with bacon flavor. Soup with less than 25% salt shows the significant difference in overall liking. It can be assumed that salt can be reduced by 25% in every flavor without effect on preference and can be reduced up to 50% when adding bacon flavor.

Table 19: Dunnett's test for chicken clear soup with MSG in degree of difference (DOD)

%salt	Flavors			
	Original	**Bacon**	**Lobster**	**Smoke**
100	Control	Control	Control	Control
75	-1.3 ***	-1.5 ***	-1.1 ***	-0.6 ***
50	-2.6 ***	-2.9 ***	-2.1 ***	-2.0 ***
25	-3.5 ***	-3.9 ***	-3.5 ***	-3.2 ***
0	-4.4 ***	-5.0 ***	-4.4 ***	-4.3 ***

Note: Comparisons significant at the 0.05 level are indicated by ***.
Compare within same column

According to table 19, there is a significant difference in saltiness perception comparing between sample and control in every flavor. It can be assumed that consumers can perceive the difference in saltiness between control and sample. The more salt is reduced, the more difference can be detected. All kind of soup shows the same pattern.

Table 20: Duncan test for chicken clear soup with MSG in overall liking

%salt	Flavors			
	Original	**Bacon**	**Lobster**	**Smoke**
100	6.0 ^{A}	6.0 ^{A}	6.3 ^{A}	6.5 ^{A}
75	6.1 ^{A}	5.8 ^{A}	6.4 ^{A}	6.6 ^{A}
50	5.2 ^{B}	5.8 ^{A}	5.2 ^{B}	5.7 ^{B}
25	3.9 ^{C}	5.7 ^{A}	4.4 ^{C}	4.6 ^{C}
0	3.1 ^{D}	4.1 ^{B}	3.3 ^{D}	3.8 ^{D}

Note: Different subscript letter indicates significant difference at alpha = 0.05
Compare within same column

According to table 20, significant difference in overall liking is compared between sample, with different %salt, and control. There is no significant difference in overall liking when salt is reduced by 25% in every flavor. The significant difference in overall liking begins to appear when salt is reduced to 50% in original flavor, lobster and smoke flavor whereas there no significant difference in overall liking in soup with 50% salt and 25% salt with bacon flavor. Soup with less than 25% salt and 0% salt shows the significant difference in overall liking. It can be assumed that salt can be reduced by 25% in every flavor without effect on preference and can be reduced up to 75% when adding bacon flavor.

In addition, monosodium glutamate (MSG) tend to have effect on the degree of difference in saltiness perception and overall liking. Comparing the degree of difference (DOD) and overall liking between soup with- and without monosodium glutamate (MSG), the is a slightly difference. Soup without monosodium glutamate (MSG) has larger gap in degree of difference (DOD) and overall liking. Thus, it can be assumed that monosodium glutamate (MSG) has effect on salty taste and liking score due to the Na+ in its structure and glutamate that promote umami flavor. Moreover, as shown in previous result, consumers tend to prefer salty soup. Thus, the overall liking score of soup with higher %salt or with monosodium glutamate (MSG) is a little higher.

Chicken Cream Soup

1. Study Effects of Factors and interaction on Saltiness Perception and Overall Liking

Table 21: Effect of each factor and interaction on degree of difference (DOD)

Dependent Variable: dod

Source	DF	Type III SS	Mean Square	F Value	Pr > F
msg	1	6.309673	6.309673	12.13	0.0005
flavor	3	8.213527	2.737842	5.26	0.0013
msg*flavor	3	4.006167	1.335389	2.57	0.0530
salt	4	4918.064282	1229.516071	2362.85	<.0001
msg*salt	4	2.005837	0.501459	0.96	0.4263
flavor*salt	12	20.000707	1.666726	3.20	0.0001
msg*flavor*salt	12	5.435959	0.452997	0.87	0.5769

Table 22: Effect of each factor and interaction in overall liking

Dependent Variable: like

Source	DF	Type III SS	Mean Square	F Value	Pr > F
msg	1	27.221908	27.221908	9.64	0.0019
flavor	3	7.753728	2.584576	0.92	0.4327
msg*flavor	3	16.399871	5.466624	1.94	0.1217
salt	4	1695.982352	423.995588	150.15	<.0001
msg*salt	4	39.794240	9.948560	3.52	0.0071
flavor*salt	12	152.052293	12.671024	4.49	<.0001
msg*flavor*salt	12	64.038463	5.336539	1.89	0.0313

As shown in table 21, all individual factors (msg, flavor, and salt) and some combination of factors (flavor*salt) have significant effect on saltiness perception. It can be assumed that consumers are able to detect the difference in saltiness comparing between samples. Changing in

amount of salt or different flavors as well as monosodium glutamate (MSG) adding can significantly affect saltiness perception. Also, an interaction of flavor and salt can affect salty taste perceived by consumers. While some interaction between factors (msg*flavor, msg*salt and msg*flavor*salt) have non-significant effect on saltiness perception. It can be assumed that milky taste or mouthfeel and fat molecule in milk mask the effect of these interactions. Therefore, it is more difficult to perceive the difference.

As shown in table 22, there are some individual factors and combination of factors (msg, salt, flavor*salt and msg*flavor*salt) have significant effect on overall liking. It can be assumed that changing in amount of salt or different flavors or msg adding can alter the consumers' preference as well as different flavor is an individual preference. Otherwise, other factors and combination of factors (flavor and msg*flavor) have no significant effect on overall liking. It can be assumed that, in factor combination, some factors cover another's factor characteristic or the interaction between factors blend the characteristic of each other which leads to the non-significant effect on liking.

Table 23: Effect of monosodium glutamate (MSG) on degree of different (DOD)

msg	dod LSMEAN	H0:LSMean1=LSMean2
		Pr > |t|
N	-2.34804167	0.0005
Y	-2.23454167	

Table 24: Effect of monosodium glutamate (MSG) on overall liking

msg	like LSMEAN	H0:LSMean1=LSMean2
		Pr > |t|
N	5.32020833	0.0019
Y	5.55595833	

According to table 23 and 24, monosodium glutamate (MSG) have significant effect on both degree of difference (DOD) in saltiness perception and overall liking. Consumers tend to be able to detect less difference in salty taste in soup with monosodium glutamate (MSG) and more preference in soup with monosodium glutamate (MSG).

Table 25: Comparing effect between each flavor on degree of difference (DOD)

flavor	dod LSMEAN	LSMEAN Number
Bacon	-2.24600000	1
Lobster	-2.23125000	2
Original	-2.29000000	3
Smoke	-2.39791667	4

Least Squares Means for effect flavor Pr > |t| for H0: LSMean(i)=LSMean(j) Dependent Variable: dod				
i/j	**1**	**2**	**3**	**4**
1		0.7490	0.3349	0.0010
2	0.7490		0.2026	0.0004
3	0.3349	0.2026		0.0193
4	0.0010	0.0004	0.0193	

Table 26: Comparing effect between each flavor on overall liking

flavor	like LSMEAN	LSMEAN Number
Bacon	5.40200000	1
Lobster	5.42916667	2
Original	5.54200000	3
Smoke	5.37916667	4

Least Squares Means for effect flavor Pr > |t| for H0: LSMean(i)=LSMean(j) Dependent Variable: like				
i/j	**1**	**2**	**3**	**4**
1		0.8003	0.1879	0.8316
2	0.8003		0.2935	0.6449
3	0.1879	0.2935		0.1296
4	0.8316	0.6449	0.1296	

According to table 25, comparing effect between each flavor on degree of difference (DOD) in saltiness perception, there is significant difference in saltiness perception between smoke and other flavors; bacon, lobster and original. It can be assumed that consumers detect much difference in saltiness when soup containing smoke flavor. Since cream soup contain milk, smoke flavor may be enhanced when milk is boiled or make. This can cause the effect of smoke flavor on perception.

However, as shown in table 26, there is no significant difference in overall liking between each flavor. It can be assumed that there is no significant in preference among each flavor.

Table 27: Comparing effect between each %salt on degree of difference (DOD)

salt	dod LSMEAN	LSMEAN Number
0	-4.34770833	1
25	-3.62218750	2
50	-2.38864583	3
75	-1.03385417	4
Control	-0.06406250	5

Least Squares Means for effect salt Pr > |t| for H0: LSMean(i)=LSMean(j) Dependent Variable: dod					
i/j	**1**	**2**	**3**	**4**	**5**
1		<.0001	<.0001	<.0001	<.0001
2	<.0001		<.0001	<.0001	<.0001
3	<.0001	<.0001		<.0001	<.0001
4	<.0001	<.0001	<.0001		<.0001
5	<.0001	<.0001	<.0001	<.0001	

Table 28: Comparing effect between each %salt on overall liking

salt	like LSMEAN	LSMEAN Number
0	4.10739583	1
25	4.73187500	2
50	5.46156250	3
75	6.31958333	4
Control	6.57000000	5

Least Squares Means for effect salt
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: like

i/j	1	2	3	4	5
1		<.0001	<.0001	<.0001	<.0001
2	<.0001		<.0001	<.0001	<.0001
3	<.0001	<.0001		<.0001	<.0001
4	<.0001	<.0001	<.0001		0.0371
5	<.0001	<.0001	<.0001	0.0371	

According to table 27 and 28, there significant effect of each %salt on degree of difference in saltiness perception comparing between each %salt. It can be assumed that consumers can detect the difference in saltiness between each salt level. The less amount of salt, the more difference in saltiness detected. Likewise, there are significant effect of %salt on liking. Consumers tend to prefer soup with higher salt level. However, there is no significant difference in liking score between 100% and 75% salt. It can be assumed that consumer like either 100% salt or 75% salt the most.

2. Randomized Complete Block Design (RCBD)

Table 29: RCBD for degree of difference (DOD)

Source	DF	Type III SS	Mean Square	F Value	Pr > F
trt	39	4959.056521	127.155295	249.88	<.0001
con	49	47.009854	0.959385	1.89	0.0002

Table 30: RCBD for overall liking

Source	DF	Type III SS	Mean Square	F Value	Pr > F
trt	39	1996.344750	51.188327	19.40	<.0001
con	49	483.901417	9.875539	3.74	<.0001

According to table 26 and 27, there are significant effect of each treatment and consumer on both degree of difference in saltiness perception and overall liking

Table 31: Duncan test cream soup, degree of difference (DOD)

%salt	Flavors							
	Original		Bacon		Lobster		Smoke	
	No MSG	MSG	No MSG	MSG	No MSG	MSG	No MSG	MSG
100	-0.4 ± 0.9 ^{B}	-0.2 ± 0.8 ^{AB}	-0.1 ± 0.8 ^{AB}	-0.1 ± 0.8 ^{AB}	0.2 ± 0.7 ^{A}	0.0 ± 0.6 ^{A}	-0.1 ± 0.6 ^{AB}	0.2 ± 0.7 ^{A}
75	-1.2 ± 1.0 ^{E}	-1.0 ± 1.0 ^{CDE}	-1.1 ± 0.8 ^{CDE}	-0.8 ± 0.9 ^{C}	-0.9 ± 0.6 ^{CDE}	-0.8 ± 0.8 ^{CD}	-1.5 ± 0.7 ^{F}	-1.1 ± 0.6^{DE}
50	-2.4 ± 0.9 ^{GH}	-2.2 ± 0.8 ^{G}	-2.5 ± 0.8 ^{GH}	-2.4 ± 0.6 ^{GH}	-2.3 ± 0.7 ^{GH}	-2.4 ± 0.6 ^{GH}	-2.6 ± 0.6 ^{H}	-2.4 ± 0.7 ^{GH}
25	-3.6 ± 0.8 ^{IJK}	-3.3 ± 0.9 ^{I}	-3.5 ± 0.8 ^{IJ}	-3.5 ± 0.7 ^{IJ}	-3.7 ± 0.7 ^{JK}	-3.7 ± 0.6 ^{JK}	-3.7 ± 0.6 ^{JK}	-3.9 ± 0.7 ^{K}
0	-4.4 ± 0.6 ^{L}	-4.3 ± 0.7 ^{L}	-4.3 ± 0.6 ^{L}	-4.3 ± 0.7 ^{L}	-4.4 ± 0.6 ^{L}	-4.3 ± 0.6 ^{L}	-4.6 ± 0.5 ^{L}	-4.3 ± 0.7 ^{L}

Table 32: Duncan grouping cream soup without MSG (liking)

%salt	Flavors							
	Original		Bacon		Lobster		Smoke	
	No MSG	MSG	No MSG	MSG	No MSG	MSG	No MSG	MSG
100	6.4 ±1.2 ABC	6.7 ± 1.1 AB	6.2 ± 1.3 ABCDEFG	6.2 ± 1.3 ABCDEFG	6.8 ± 1.1 AB	6.8 ± 0.9 AB	6.8 ± 1.3 AB	6.7 ± 1.2 AB
75	6.3 ± 1.3 ABCDEF	6.8 ± 1.1 A	6.0 ± 1.1 BCDEFG	6.1 ± 1.1 ABCDEFG	6.0 ± 1.0 ABCDEFG	6.5 ± 1.3 ABC	6.5 ± 1.2 ABC	6.3 ± 1.3 ABCD
50	5.5 ± 1.6 GHIJ	5.8 ± 1.3 CDEFGH	5.1 ± 1.2 HIJK	5.5 ± 1.4 FGHIJ	5.5 ± 1.0 EFGHI	5.6 ± 1.0 EDFGH	5.0 ± 1.3 HIJK	5.6 ± 1.2 EDFGH
25	4.6 ± 1.5 KLM	4.8 ± 1.3 IJKL	5.3 ± 1.0 GHIJ	4.7 ± 1.3 KLM	4.4 ± 1.4 KLMNO	4.8 ± 1.3 JKLM	3.9 ± 1.4 NOPQ	4.3 ± 1.5 LMNOPQ
0	3.8 ± 1.4 OPQ	4.7 ± 1.0 KLM	3.5 ± 1.5 Q	4.3 ± 1.5 KLMNOP	3.6 ± 1.5 PQ	4.3 ± 1.5 LMNOPQ	4.0 ± 1.3 MNOPQ	4.6 ± 1.2 KLMNO

According to table 31 and 32, consumers perceive saltiness in a pattern. It is found that consumers detect the least different in saltiness comparing to reference and detect more difference when less salt containing in soup. Moreover, the trend of overall liking decreases along with the less %salt concentration in soup.

Table 33: Dunnett's test for cream soup without MSG in degree of difference (DOD)

%salt	Flavors			
	Original	**Bacon**	**Lobster**	**Smoke**
100	Control	Control	Control	Control
75	-0.8 ***	-0.9 ***	-1.0 ***	-1.4 ***
50	-2.0 ***	-2.3 ***	-2.5 ***	-2.5 ***
25	-3.3 ***	-3.4 ***	-3.8 ***	-3.6 ***
0	-4.1 ***	-4.1 ***	-4.5 ***	-4.5 ***

Note: Comparisons significant at the 0.05 level are indicated by ***.
Compare within same column

According to table 33, there is a significant difference in saltiness perception comparing between sample and control in every flavor. It can be assumed that consumers can perceive the difference in saltiness between control and sample. The more salt is reduced, the more difference can be detected. The pattern is shown in every flavor.

Table 34: Duncan test for cream soup without MSG in overall liking

%salt	Flavors			
	Original	**Bacon**	**Lobster**	**Smoke**
100	6.4 ^{A}	6.2 ^{A}	6.8 ^{A}	6.8 ^{A}
75	6.3 ^{A}	6.0 ^{A}	6.0 ^{B}	6.5 ^{A}
50	5.5 ^{B}	5.3 ^{B}	5.5 ^{C}	5.0 ^{B}
25	4.6 ^{C}	5.1 ^{B}	4.4 ^{D}	4.0 ^{C}
0	3.8 ^{D}	3.5 ^{C}	3.6 ^{E}	3.9 ^{C}

Note: Different subscript letter indicates significant difference at alpha = 0.05
Compare within same column

According to table 34, significant difference in overall liking is compared between sample, with different %salt, and control. There is no significant difference in overall liking when salt is reduced by 25% in every flavor except lobster. The significant difference in overall liking begins to appear when salt is reduced to 50% in every flavor. It can be assumed that salt can be reduced by 25% in every flavor without effect on preference either with or without flavor added.

Table 35: Dunnett's test for cream soup with MSG in degree of difference (DOD)

%salt	Flavors			
	Original	**Bacon**	**Lobster**	**Smoke**
100	Control	Control	Control	Control
75	-0.9 ***	-0.7 ***	-0.8 ***	-1.3 ***
50	-2.0 ***	-2.3 ***	-2.4 ***	-2.6 ***
25	-3.2 ***	-3.5 ***	-3.7 ***	-4.0 ***
0	-4.1 ***	-4.2 ***	-4.3 ***	-4.4 ***

Note: Comparisons significant at the 0.05 level are indicated by ***.
Compare within same column

According to table 35, there is a significant difference in saltiness perception comparing between sample and control in every flavor. It can be assumed that consumers can perceive the difference in saltiness between control and sample. The more salt is reduced, the more difference can be detected. All kind of soup shows the same pattern.

Table 36: Duncan test for cream soup with MSG in overall liking

%salt	Flavors			
	Original	**Bacon**	**Lobster**	**Smoke**
100	6.7 ^{A}	6.2 ^{A}	6.8 ^{A}	6.7 ^{A}
75	6.8 ^{A}	6.1 ^{A}	6.5 ^{A}	6.4 ^{A}
50	5.8 ^{B}	5.5 ^{B}	5.6 ^{B}	5.6 ^{B}
25	4.8 ^{C}	4.7 ^{C}	4.8 ^{C}	4.6 ^{C}
0	4.7 ^{C}	4.3 ^{C}	4.3 ^{D}	4.3 ^{C}

Note: Different subscript letter indicates significant difference at alpha = 0.05
Compare within same column

According to table 36, significant difference in overall liking is compared between sample, with different %salt, and control. There is no significant difference in overall liking when salt is reduced by 25% in every flavor. The significant difference in overall liking begins to appear when salt is reduced to 50% in every flavor. Soup with less than 50% salt shows the significant difference in overall liking. It can be assumed that salt can be reduced by 25% in every flavor without effect on preference either with or without flavor added. Moreover, consumers still accept soup with 50% salt based on 5 score in 9-Point hedonic scale.

In addition, monosodium glutamate (MSG) tend to have less or effect on the degree of difference in saltiness perception but still have slightly effect on overall liking. Fat molecule in milk can mask the effect of monosodium glutamate (MSG) in saltiness as well as milk create mouthfeel which reduce salty cover salty taste. Moreover, as shown in previous result, consumers tend to prefer salty soup. Thus, the overall liking score of soup with higher %salt or with monosodium glutamate (MSG) is a little higher.

CONCLUSION

In conclusion, it is found out that with- and without flavor added making a significant difference in saltiness perception and overall liking. It is clearly shown that with flavor replacement salt can be reduced by 25% and can be reduced up to 50% from standard formula in chicken clear soup with bacon flavor. Furthermore, monosodium glutamate (MSG) has a significant effect on both saltiness perception and overall liking. Thus, adding monosodium glutamate (MSG) helps in reducing salt added and improving overall liking toward the soup.

SUGGESTION

1. Panelists should be explained or trained in order to conduct right procedure during sensory evaluation.
2. Other characteristics should be used for further study, for instance:
    a. Study effect of color on saltiness perception
    b. Study effect of viscosity on saltiness perception

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APPENDIX

Data Analysis

SAS code for Factorial Design

```
data soup;
input con msg$ flavor$ salt$ dod like;
cards;
1    N    Original    control -2    3
2    N    Original    control 1     3
.
.
.
;
proc glm data=soup;
class con msg flavor salt dod like;
model dod like = msg|flavor|salt;
lsmeans msg/pdiff cl;
lsmeans flavor/pdiff cl;
lsmeans salt/pdiff cl;
run;
```

SAS Code for Randomized Block Design (RCBD)

```
data soup;
input con trt$ dod like;
cards;
1       A1      -2      3
2       A1      1       3
.
.
.
;
proc glm data = soup;
class trt con dod like;
model dod like = trt con;
means trt/duncan;
run;
```

SAS Code for Multiple Comparison (Dunnett's and Duncan Test)

```
data cm;
input panel trt$ dod like;
cards;
1       control 0       8
2       control 1       2
.
.
.
;
proc glm data = cm;
class trt panel;
model dod like = trt panel;
means trt/ dunnett ('control');
means trt/duncan;
run;
```

Please test the product carefully and rinse your mouth with water between the sample. Then rate the Degree of Different (DOD) (mark x)

กรุณาชิมตัวอย่างและล้างปากด้วยน้ำเปล่าระหว่างตัวอย่าง จากนั้นให้คะแนนค่าความแตกต่างโดยกากบาทในช่อง

-5 = extremely less salty (เค็มน้อยกว่าที่สุด)

-4 = much less salty (เค็มน้อยกว่ามาก)

-3 = moderately less salty (เค็มน้อยกว่าปานกลาง)

-2 = slightly less salty (เค็มน้อยกว่า)

-1 = very slightly less salty (เค็มน้อยกว่าเล็กน้อย)

0 = none (ไม่แตกต่าง)

1 = extremely more salty (เค็มมากกว่าเล็กน้อย)

2 = slightly more salty (เค็มมากกว่า)

3 = moderately more salty (เค็มมากกว่าปานกลาง)

4 = much more salty (เค็มมากกว่ามาก)

5 = extremely more salty (เค็มมากกว่าที่สุด)

Please rate overall liking score in 9-Point Hedonic Scale

กรุณาให้คะแนนความชอบโดยรวมจาก 1-9 คะแนน

1 = Dislike extremely (ไม่ชอบมากที่สุด)

2 = Dislike very much (ไม่ชอบมาก)

3 = Dislike moderately (ไม่ชอบปานกลาง)

4 = Dislike slightly (ไม่ชอบนิดหน่อย)

5 = Neither like nor dislike (เฉยๆ)

6 = Like slightly (ชอบนิดหน่อย)

7 = Like moderately (ชอบปานกลาง)

8 = Like very much (ชอบมาก)

9 = Like extremely (ชอบมากที่สุด)

Sample : ________________ Overall liking : ________________

less salty (เค็มน้อยกว่า)	-5	-4	-3	-2	-1	0	1	2	3	4	5	more salty (เค็มมากกว่า)

Sample : ________________ Overall liking : ________________

less salty (เค็มน้อยกว่า)	-5	-4	-3	-2	-1	0	1	2	3	4	5	more salty (เค็มมากกว่า)

Sample : ________________ Overall liking : ________________

less salty (เค็มน้อยกว่า)	-5	-4	-3	-2	-1	0	1	2	3	4	5	more salty (เค็มมากกว่า)

Sample : ________________ Overall liking : ________________

less salty (เค็มน้อยกว่า)	-5	-4	-3	-2	-1	0	1	2	3	4	5	more salty (เค็มมากกว่า)

Sample : ________________ Overall liking : ________________

less salty (เค็มน้อยกว่า)	-5	-4	-3	-2	-1	0	1	2	3	4	5	more salty (เค็มมากกว่า)