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Effective Strategies to Reduce Sodium Intake among Consumers: Pork Cutlet Sauce as a Model Food System

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Abstract

This study assessed effective strategies to reduce the sodium intake among consumers using pork cutlet sauce as a model food system. Original pork cutlet sauce and sodium-reduced sauce (29% reduced by a salt substitute) were analyzed to characterize the sensory properties using descriptive analysis. The effects of sodium-reduction of the sauce, consumer type (nutrition teachers vs. general consumers), information related to the sodium content, serving method, and consumer's health, taste and sodium-related attitudes on the consumer's preference, perception, and intake of the sauce were analyzed using a consumer test. In descriptive analysis, the original and sodium-reduced sauce showed similar sensory characteristics but did not differ in saltiness. In the consumer test, there were no significant differences in the overall preference levels between the two sauces. On the other hand, there were significant differences in preference and perception between nutrition teachers and general consumer groups, which were due largely to their age as well as the health and sodium-related attitudes and nutritional knowledge differences. Sodium-reduced information decreased the perceived saltiness intensity. In addition, reducing sodium intake by serving pork cutlet sauce in a bottle can be an effective strategy because this serving method increased the acceptance and induced the smaller intake of sauce.

Key Words: Sodium-reduction, sauce intake, consumer type, serving type, information

I. Introduction

It is well known that over consumption of sodium is strongly associated with cardiovascular disease and stroke (Strazzullo et al. 2009). Koreans daily sodium intake is gradually decreasing to 4831 mg in 2010 and 3668.94 mg in 2016, but it still surpasses the WHO's recommended daily intake level (2000 mg/day).

It has been reported that school meal is the source for high sodium intake among the students (Ahn et al. 2013) and sauces were high sodium content food items among the food materials (Lee et al. 2010). Various strategies are implemented to reduce student's sodium intake nowadays in Korea, like making low sodium menu for students (Jung 2016).

To reduce sodium intake, common approaches are reducing the sodium content in food or reducing the intake of target food. Sodium is mainly applied to food as NaCl and this carries various functions providing salty taste, controlling microbial growth and water holding capacity, etc. Sodium reduction also decrease other palatable taste and flavor quality not just saltiness. So, many materials that can substitute NaCl in foods are developed and studied (Guardia et al. 2006; Mcgough et al. 2012; Grummer et al. 2013), but it is very challenging to reduce or substitute NaCl because of these reasons.

To reduce sodium intake by reducing the intake of target food, changing the environmental condition of eating can reduce people's consumption amount without consciously recognizing. Studies have shown that manipulating serving containers can significantly reduce the portion size of consumption without subjects noticing (Rolls et al. 2002; Wansink & Kim 2005; Freedman & Brochado 2010; Birch et al. 2015).

Nutrition or health related information had various effects on food depending on the food type studied (Fernqvist & Ekelund 2014). This information mostly had positive effect

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on the acceptance of foods (Annett et al. 2008; Johansen et al. 2010; Vidigal et al. 2011), but in some cases information had insignificant (Kim & Kwak 2015) or negative effects on the acceptabilities (Kim et al. 2013). This information mostly had positive effect on the acceptance of foods (Annett et al. 2008; Johansen et al. 2010; Vidigal et al. 2011), but in some cases information had insignificant (Kim & Kwak 2015) or negative effects on the acceptabilities (Kim et al. 2013).

In the present study, sensory characteristics and consumer perception of sodium reduced pork cutlet sauce, which was produced by substituting NaCl by salt substitute (Sub4salt, Jungbunzlauer SUISSE AG, Switzerland), were investigated. The sensory characteristics of sodium reduced pork cutlet sauce were analyzed and compared with its original product and other pork cutlet sauces available in market. Consumer's perception and intake of the low sodium and the original sauces were studied by tasting the pork cutlet applied with these sauces. The consumers consisted of general consumers who liked and frequently consumed pork cutlet and nutrition teachers who are responsible for managing the school meals in elementary, middle, and high schools. Additionally, the effect of non-food factors such as sodium related information, consumer's food related attitudes and serving methods of sauce on the perception and intake of sauces were explored.

II. Materials and Methods

1. Descriptive analysis

For descriptive analysis, consumers who like and consume pork cutlet with on a regular basis were recruited via on-line bulletin board to participate as panelists. Volunteered consumers were tested for their taste sensitivity and evaluation accuracy. Finally, 10 female consumers (age 25-28) were selected as the descriptive analysis panelists to evaluate various types of pork cutlet sauces. Descriptive analysis was conducted on 7 types of pork cutlet sauce. Two types of sauce samples, bulk type for institutional food service, were produced from same producer. One was a regular product already available in market and the other was a sodium-reduced version for the former product. Part of NaCl was substituted by a substitute Sub4salt (Jungbunzlauer SUISSE AG, Switzerland). Other sauce products were intended for general home use from various producers. The information of samples are shown in <Table 1>.

For appearance, 15 g of sample was poured to a disposable plastic cup (diameter 70 mm, height 40 mm, Samboopack Co., Ltd, Icheon, Gyeonggido, Korea) and lidded. 0.5 g of each sauce sample was served on a disposable plastic spoon (width 20 mm, length 90 mm, Samboopack Co., Ltd, Icheon, Gyeonggido, Korea) to evaluate aroma, taste, and flavor. Subjects received 3 spoons filled with sauce per sample. Warm water and crackers (Carr's Table Water, Carr's Of Carlisle, Ltd., UK) were provided as palate cleanser to rinse off the residuals of the previous sample before proceeding to the next sample. And prior to the main descriptive analysis, panelists were trained on accurately and precisely evaluating basic tastes (sweet, salty, and sour) which are the key tastants present in pork cutlet sauces. For each taste quality, training solutions were formulated to elicit 4 different intensities. Then, sensory descriptors were developed and defined to characterize the sensory properties of the 7 sauce samples. Panelists determined standard reference and standard score corresponding to each descriptor.

All 7 types of pork cutlet sauce samples were evaluated based on the sensory attributes developed during the training sessions. The intensity of each attribute was rated on a 15-category scale ("0" and "14" were labeled as "not detected" and "very strong", respectively). Samples were evaluated on 27 sensory attributes consisting of 6 appearance (Darkness of brown color, redness, glossiness, Particle size, amount of particle, viscosity), 6 aroma (Sour, Sweet, Salty, Pepper, Oriental medicine, Worcester sauce), 13 taste/flavor (Overall taste intensity, Sour, Sweet, Residual sweet taste, Salty, Bitter, MSG, Ketchup, Pepper, Ginger, Sweet chili, Oriental medicine, Worcester sauce), and 2 texture terms (Thinness, Burning). Standard references were utilized to facilitate the evaluation for each sensory attributes.

Subjects evaluated the samples in individual sensory booths. Aroma, flavor, and texture attributes of samples were evaluated under red light while appearance attributes were evaluated in normal light condition. The serving order of the samples were determined by William Latin square design. Duration for single sample evaluation on aroma, flavor, and texture took approximately 6-7 minutes including break between samples. It took 2 min per sample for appearance evaluation. All 7 samples were evaluated in a single session. The samples were evaluated in 4 replicates.

General Linear Model (GLM) analysis was conducted to analyze the effect of sample on the intensities of various sensory attributes. When the sample effect was statistically significant for a specific attribute, Duncan's Multiple Range Test was performed as a post-hoc test.

<Table 1> The ingredients of 7 pork cutlet sauce samples used in descriptive analysis

Sample Code	Ingredients of Pork Cutlet Sauce sample
CCS	Yongin-si, Gyeonggi-do/pure water, tomato paste (China), Fructose, Seasoning MixPK {sugar, refined salt (Korea), modified starch, caramel pigment, xanthan gum, soybean oil (foreign-made)}, black sugar, brewing vinegar (ethanol, yeast extract), worcestershire sauce {high fructose, white sugar, refined salt (Korea), fermentated vinegar, brewed soy sauce (sea salt/Austrailia)}, pinapple 2.0%, apple concentrate, vegetable concentrate
OHS	Chungcheongbuk-do/pure water, white sugar, high fructose corn syrup, fermentated vinegar (ethanol, fermentation nutrient), tomato paste [foreign-made (USA, Chile, China etc.)], refined salt (Korea), apple concentrate (China), modified starch, dried molasses, yeast extract, spice, shiitake extract, tropical fruit puree, vegetable protein, onion extract, caramel pigment, garlic extract, xanthan gum, enzymatically modified stevia glucosyl stevia
JCS	Nonsan-si, Chungcheongnam-do/worcestershire sauce [apple fruit juice concentrate2 (China), fermentated vinegar {ethanol, fermentation nutrient (Germany)}, red grape concentrate (USA), fructose, refined salt], high fructose corn syrup, pure water, fermentated vinegar{ethanol, fermentation nutrient (Germany)}, tomato paste (USA), worcestershire sauce (black sugar, fermentated vinegar, refined salt, mixed soy sauce, white sugar), molasses (high fructose, brown syrup, brown sugar, glucose), mixed vegetable concentrate, brown sugar, apple concentrate, mixed soy sauce, mixed formulation (modified starch, maltodextrin), refined salt, jujube concentrate, natural ageing bean fermentation flavoring, red wine concentrate, mixed herb and spice, flavor enhancer
BCS	Tatebayashi Factory, 374-0072 群馬縣館林市大新田町61-5/fruit, vegetable 6.6% (tomato paste, apple puree, prune paste, carrot, onion, lemon juice), pure water, isomerized sugar, sugar, distilled vinegar (pure water, rice, ethanol), refined salt, rice starch, hydrolyzed soybean protein, spice (cinnamon, garlic extract, nutmeg, dried sweet bay leaf, ginger extract, red pepper, clove, sage, thyme, fennel), yeast extract
OOS	Anyang-si, Gyeonggi-do/pure water, white sugar, tomato paste (China), fermentated vinegar, apple puree (apple: Korea), worcestershire sauce (soybean, wheat), wheat flour, refined salt, modified starch, dried molasses, garlic, xanthan gum, caramel pigment (sulfurous acid), spice
ONS	Anyang-si, Gyeonggi-do/pure water, white sugar, tomato paste (China), fermentated vinegar, apple puree (apple: Korea), worcestershire sauce (soybean, wheat), wheat flour, Sub4salt, modified starch, dried molasses, garlic, xanthan gum, caramel pigment (sulfurous acid type), spice
CMS	Yongin-si, Gyeonggi-do/pure water, white sugar, starch syrup, brewed vinegar (ethanol, yeast extract), tomato paste (China), fructose, modified starch, refined salt (Korea), bean protein fermentation product {sauce type (defatted soybean: India)}, mixed formulation (carrageenan, corn starch, xanthan gum, guar gum, locust bean gum, maltodextrin), black pepper powder, cinnamon powder, citric acid, caramel pigment, clove powder, rich spice (milk), flavor enhancer

2. Consumer test

Two segments of subjects were recruited. One group was general young female consumers (117 subjects) who liked and consumed pork cutlet with sauce on a regular basis. The other group consisted of nutrition teachers (170 subjects) who are responsible for managing the food service in elementary, junior high, and high schools. Nutrition teachers are an important consumer group in a sense that their selection of food materials heavily affect the student's daily diet since students eat lunch and even dinner in school.

The products of interest were original pork-cutlet sauce produced for institutional food service and sodium reduced version of the original sauce. The overall formulation of the two products were roughly the same but part (100%) of the sodium chloride in the original product was substituted by Sub4salt (Jungbunzlauer SUISSE AG, Switzerland).

In order to investigate the effect of sauce presentation on the liking, perception, and amount consumption of the sauce, sauce samples were presented in two forms, pour (bottle) type vs. dip type. For pour type, subjects were able to spread/pour the sauce to the cutlet as much as they wanted whereas for dip type, subjects had to dip the cutlet into the sauce provided.

Approximately 45-50 g of samples were poured into either plastic sauce cup (diameter 70 mm, height 40 mm, Samcheo-pack Co., Ltd., Icheon city, Gyeonggi-do) or sauce bottle (diameter 37 mm, height 155 mm, hole diameter 2 mm, Dongbang Plastic Co., Ltd, Gimpo, Gyeonggido) for dip type and pour type serving, respectively. Sample weight was exactly measured and panelist code was labeled during the preparation of sample to monitor the amount of sample consumed during sample evaluation.

Pork cutlet served as a carrier food was purchased freshly from a local diner (Jinfood Co., Ltd., Pocheon, Gyeonggido, Korea). Two sheets of pork cutlet were fried in a fryer filled with 8L of vegetable oil for 8 minutes. The fried cutlet was cooled and cut into small pieces. Each sauce sample was served with cutlet weighing approximately 30±2 g. Subjects were asked to consume all cutlet pieces, 120 g in total, provided during sauce evaluation. Cooked rice (Haetban, CJ

CheilJedang Co., Ltd., Busan, Korea) was heated in a microwave (1000 W), portioned (100-105 g) into plastic cups and was served as a palate cleanser.

All subjects, both general consumers and nutrition teachers, were randomly divided into 3 groups. First group of subjects evaluated the 2 samples labeled with two types of information (original vs. sodium-reduced) using factorial design. They were asked to dip (dip type) the pork cutlet to the sauce for sample consumption. The second group was also exposed to the same information as the first group for sample evaluation but they were asked to pour the sauce from a bottle (pour type) onto the cutlet. Lastly, the third group evaluated the two sauces under blind condition but had to apply sauce differently (dip vs. pour) using factorial design. The overall liking, appearance, odor, taste/flavor likings of the samples were evaluated using 9-point hedonic scale. Nine-point JAR (Just-about-right) scale was used to rate the sample's saltiness, sweetness & sourness intensities. The reasons of liking and disliking samples were surveyed with CATA (check-all-that-apply) method. The samples were labeled with 3 digit random numbers. The sample serving order was determined by factorial design. Warm cooked rice (Haetban, CJ CheilJedang Co., Ltd., Busan, Korea) and spring water were offered between samples as palate cleansers. It took approximately seven min to evaluate one sample.

Analysis of Variance (ANOVA) using General Linear Model was conducted to analyze the effects of sample, subject type, information, sauce presentation on the perception of the sauces. Concerning food related attitudes, the scores of individual questionnaires within each attitude scales were summed for data analysis. Subjects were allocated into one of the three groups (High, Medium, Low) depending on the score percentile for the corresponding attitude scale. The relationships between subject type and attitude characteristics were test by Chi-square analysis.

III. Results and Discussion

1. Descriptive Analysis

27 sensory attributes were developed to characterize the sensory properties of 7 pork cutlets sauce samples. Sample effect was present in most of intensities of sensory attributes except for 'Sweet odor', 'Pepper odor', 'Pepper flavor', and 'Burning'.

<Table 2> shows the mean attribute intensities of the 7 sauce samples. OOS is a product available and sold as pork cutlet sauce for institutional food service. ONS used identical formulation to that of OOS but applied salt substitute (Sub4salt, Jungbunzlauer SUISSE AG, Switzerland) instead of NaCl to flavor the sauce to reduce the sodium content of the product. As can be expected, the two products elicited relatively similar the sensory characteristics similar to each other when compared to other five samples. Interestingly OOS and ONS did not differ in saltiness intensities between the two samples although the sodium content of ONS (469.43 mg/100 g) was approximately 29% lower than OOS (659.70 mg/100 g). KCl, which is a popularly used material for substituting NaCl, and sodium gluconate was the main ingredient in the salt substitute. Substituting salt significantly influenced the sweet-related characteristics and viscosity. Overall, the sweet-related characteristics increased while sour related characteristics decreased by replacing NaCl to Sub4salt.

2. Consumer test

1). Demographic information and health, taste, sodium related attitudes of consumers

Majorities of nutrition teachers were in their 40's (55.4%) and 50's (25.6%) and the mean age was 45.6 <Table 3>. Consumers in the general group were all in their 20's and their average age was 23. The effect of consumer type on the health, food and sodium related attitudes was investigated using Health and Taste attitudes (Roininen, et al. 1999) scale and sodium-related dietary attitude scale (Kim et al. 2015). When ANOVA was conducted, statistical significance was observed between the two consumer groups on the attitude scores. Scores on food for pleasure were not significantly different between the two groups <Table 4>.

Roininen et al. (2001) have reported that attitudes related to general health interest and natural product interest showed strong positive correlation with frequency of choosing health food items. Similar to the present study, Roininen et al. (1999) observed that older subjects scored higher than younger subjects in general health interest and natural product interest attitudes. Additionally, food for pleasure attitude did not show any significant correlation with health related attitudes. The present survey indicate that nutrition teachers were had higher health related interests and concerns than general consumers. Sodium related dietary attitudes have been shown to have positive correlation sodium related nutritional knowledge (Kim et al. 2015). The high scores of sodium related dietary attitude among nutrition teacher may be due to their in depth knowledge on

<Table 2> Significant effect on sensory attribute of 7 pork cutlet sauces and mean values

	Darkness of Brown color	Redness	Glossiness	Particle size	Amount of particle	Viscosity
p-value	0.000***[1)]	0.000***	0.000***	0.000***	0.000***	0.000***
BCS	11.4±2.1[d2)]	2.8±3.5[ab]	10.2±2.3[e]	4.3±2.6[b]	5.9±3.1[c]	5.2±2.5[b]
CCS	9.2±2.1[b]	4.4±3.7[d]	8.6±1.8[c]	3.5±2.9[a]	3.6±2.5[a]	8.1±2.3[d]
CMS	9.1±2.2[b]	3.7±3.7[cd]	7.3±2.4[a]	3.5±2.8[a]	4.4±3.2[b]	11.9±1.6[e]
JCS	10.4±2.5[c]	2.9±3.4[ab]	9.0±2.0[c]	6.3±2.7[c]	7.4±2.6[d]	4.8±2.1[b]
OHS	8.5±2.1[b]	3.2±3.3[bc]	9.6±1.8[d]	5.9±3.0[c]	5.8±2.9[c]	4.0±2.0[a]
ONS	4.44±1.6[a]	2.8±3.4[ab]	7.6±1.9[ab]	4.9±2.6[b]	4.2±2.7[ab]	7.3±2.0[c]
OOS	4.5±2.3[a]	2.1±3.1[a]	7.9±2.3[b]	3.2±2.8[a]	3.8±2.2[ab]	5.1±2.0[b]

	Sour odor	Sweet odor	Salty odor	Pepper odor	Oriental medicine odor	Worcester sauce odor
p-value	0.000***	0.251[NS]	0.012*	0.358[NS]	0.000***	0.000***
BCS	6.9±2.1[bc]	3.6±2.3	4.6±2.9[bc]	2.7±3.1	2.7±2.7[bc]	4.4±3.1[b]
CCS	7.5±1.8[c]	3.7±2.6	4.6±2.8[bc]	2.4±2.8	1.6±2.2[a]	4.2±2.9[b]
CMS	6.5±2.0[b]	3.5±2.3	4.3±2.9[abc]	2.3±2.6	3.0±3.1[c]	4.4±3.2[b]
JCS	6.8±1.6[bc]	4.1±2.2	4.8±2.9[c]	2.7±2.9	2.2±2.3[ab]	4.5±3.1[b]
OHS	6.9±1.7[bc]	3.8±2.2	4.7±2.9[bc]	2.5±3.0	1.9±2.4[a]	4.6±3.1[b]
ONS	5.7±2.0[a]	3.4±2.2	3.9±2.8[a]	2.4±2.7	1.4±1.6[a]	3.5±2.9[a]
OOS	5.5±2.2[a]	3.4±2.0	4.1±2.9[a]	2.2±2.3	1.8±2.5[a]	3.4±3.0[a]

	Overall taste	Sour taste	Sweet taste	Residual sweet taste	Salty taste	Bitter taste
p-value	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
BCS	9.1±1.8[c]	6.5±2.2[d]	2.7±1.8[a]	2.3±1.8[a]	7.7±2.7[c]	3.6±3.0[c]
CCS	8.4±2.0[bc]	6.3±2.0[cd]	3.7±2.4[b]	3.4±2.4[b]	7.1±2.6[b]	2.4±2.6[b]
CMS	8.3±1.7[bc]	5.8±2.2[bc]	2.8±2.3[a]	2.4±2.3[a]	6.9±2.7[b]	3.0±3.0[bc]
JCS	8.9±1.6[bc]	6.5±1.9[d]	2.8±1.9[a]	2.6±1.9[a]	7.8±2.9[c]	3.3±3.0[c]
OHS	8.1±1.8[b]	6.4±2.0[cd]	3.6±2.3[b]	2.9±2.3[ab]	7.3±2.8[bc]	2.6±2.5[b]
ONS	6.5±2.2[a]	4.6±1.4[a]	6.1±1.6[d]	5.5±2.2[d]	4.8±2.4[a]	1.3±1.9[a]
OOS	6.9±1.9[a]	5.2±2.1[ab]	5.4±1.5[c]	4.5±2.1[c]	5.1±2.9[a]	1.5±2.1[a]

	MSG taste	Ketchup flavor	Pepper flavor	Ginger flavor	Sweet chili flavor
p-value	0.000***	0.000***	0.071[NS]	0.008**	0.000***
BCS	4.4±2.9[b]	4.4±3.3[ab]	3.0±3.1	2.5±2.6[bc]	1.9±2.4[a]
CCS	4.4±2.8[b]	6.2±3.2[c]	2.7±2.6	1.9±2.2[ab]	2.6±2.9[a]
CMS	5.0±2.6[bc]	4.9±3.0[b]	3.6±3.6	2.8±2.8[c]	2.3±3.0[a]
JCS	5.4±2.6[c]	4.7±3.1[b]	3.2±3.3	2.4±2.6[abc]	2.1±2.6[a]
OHS	4.8±2.7[b]	4.9±3.3[b]	3.3±3.2	2.3±2.6[abc]	2.5±2.6[a]
ONS	3.3±2.6[a]	3.8±3.0[a]	2.8±3.0	1.8±2.4[a]	4.8±3.6[c]
OOS	3.4±2.5[a]	4.3±3.0[ab]	3.1±2.8	1.9±2.4[ab]	3.9±3.5[b]

	Oriental medicine flavor	Worcester sauce flavor	Thinness	Burning
p-value	0.000***	0.000***	0.000***	0.076[NS]
BCS	4.0±3.4[e]	5.7±3.2[de]	6.6±2.3[bc]	3.1±3.1
CCS	1.8±2.5[ab]	4.8±2.9[c]	7.3±2.7[bcd]	3.0±3.5
CMS	3.3±3.3[de]	4.4±3.2[c]	4.5±2.9[a]	3.8±3.8
JCS	2.9±2.9[cd]	6.2±3.4[e]	6.3±2.3[b]	3.2±3.4
OHS	2.2±2.5[bc]	5.4±3.0[d]	8.7±2.4[e]	3.0±2.9
ONS	1.3±2.1[a]	3.1±2.9[a]	7.5±2.7[cd]	2.5±2.8
OOS	1.9±2.7[ab]	3.8±3.1[b]	7.8±2.2[de]	3.0±3.3

[1)]***p<0.001, **p<0.01, *p≤0.05, NS: p>0.05

[2)]Duncan's multiple range test (a<b<c<d<e)

<Table 3> Age distribution and average by consumer type

Age	Nutrition teacher	General
20s	11 (6.5)	117 (100)
30s	20 (11.9)	-
40s	93 (55.4)	-
50s	43 (25.6)	-
60s	1 (0.6)	-
Mean	45.4	23.0

nutrition in general.

2) Effect of sodium reduction in pork cutlet sauce

Samples L-Na and ORG did not significantly differ in the scores of overall liking. Subjects rated ORG as having stronger saltiness intensity (p=0.000) than L-Na <Table 5>. When the sodium content of the two samples were measured, L-Na and ORG were contained 469.43 and 659.70 mg/100 g of sodium, respectively, showing 28.84% reduction in sodium content. These discrepancies in saltiness intensity perception between the results of descriptive analysis and consumer taste test may be due to the simplified attribute list used in consumer test when compared to descriptive analysis.

Although consumers perceived that the two samples were different in salty and this difference did not affect the overall acceptance levels of the two samples. Other studies have also shown that partly reducing sodium did not affect the acceptance for the sodium reduced products. Reducing the sodium content of hash brown from 170 mg Na/100 g to 120 mg Na/100 g (Lucas et al. 2011) or 33% of sodium in crumbed porridge and beef stew (Van der Merwe 2003) did not significantly influence the liking for the products although the saltiness intensities were significantly reduced. Similarly, it has been reported that sodium content of salad dressing can be decreased to 50% by substituting NaCl to soy sauce without affecting the liking for the dressing (Kremer et al. 2009). Based on the results of the present study, approximately 30% reduction of sodium can be acceptable in pork cutlet sauces from consumer's perspective.

<Table 5> Mean ratings of overall liking, saltiness intensity and intake for the L-Na and ORG samples

	Overall Liking	Saltiness Intensity	Intake (g)
p-value	0.056	0.000***[1)]	0.035*
L-Na	5.9±1.6	5.2±1.4	9.1±5.1
ORG	5.7±1.6	5.5±1.6	8.8±4.8

1)***p<0.001, **p<0.01, *p≤0.05

<Table 6> Mean ratings of overall liking, saltiness intensity, and intake for the L-Na and ORG samples evaluated under different consumer type

		Overall Liking	Saltiness Intensity	Intake (g)
p-value		0.009**[1)]	0.694	0.086
Nutrition teacher	L-Na	5.7±1.6	5.5±1.3	8.6±4.8
	ORG	5.3±1.5	5.8±1.5	8.0±4.3
General	L-Na	6.2±1.5	4.9±1.5	9.8±5.4
	ORG	6.2±1.5	5.1±1.6	9.7±5.2
p-value		0.000***	0.000***	0.003**
Nutrition teacher		5.5±1.6	5.7±1.4	8.3±4.6
General		6.2±1.5	5.0±1.5	9.8±5.3

1)***p<0.001, **p<0.01, *p≤0.05

3) Effect of consumer type

Consumer type had significant effect on overall liking, saltiness intensity and intake <Table 6>. General consumers gave higher score than nutrition teachers for overall liking. This result implies that nutrition teachers show lower acceptability for pork cutlet sauce as well as pork cutlet itself than general consumers since the sauce was evaluated together with pork cutlet as carrier food. The differences in the liking ratings between the two groups are largely due to the differences in age and consumer characteristics. As shown in the consumer attitudes toward health, nutrition teachers were significantly more concerned with health than general consumers. Pork cutlet is perceived as one of the most typical food items in fried food category in Korea and thus regarded as less healthy. On the contrary, general consumer subjects participated in the study were consumers who consumed pork cutlet on a regular basis. Nutrition

<Table 4> Mean value of attitudes by consumer type and significant difference between two consumer groups

	General Health	Natural product	Pleasure	Sodium
p-value	0.000***[1)]	0.000***	0.058	0.000***
Nutrition teacher	41.9±6.2	31.1±5.2	29.7±6	58.7±8.1
General	29±8	24.4±6	31.1±5.6	45±9.3

1)***p<0.001, **p<0.01, *p≤0.05

teachers showed smaller amount of sauce intake than general consumers which reflects the liking ratings for the sauce. A study by Wardle et al. (2000) are in line with the present result. They have shown that consumers with more nutritional knowledge consumed more of healthy foods such as fruits and vegetables but of less fatty foods. It also has to be pointed out that age was another factor differentiating the two consumer groups. Approximately 80% of nutrition teachers were age ranging in their 40's-50's while age of general consumers were all in their 20's. Consumers in different age tend to prefer different food items attitudes toward foods. Specifically, younger consumers display higher the preferences for fried foods (Lee & Kim 2014). Older consumers also show stronger interest in health while younger consumers show more interest in the taste of foods (Roininen et al. 1999). The difference acceptance level of pork cutlet sauce observed among nutrition teachers and general consumers can be mainly attributed to the discrepancies of nutrition knowledge, food attitudes, and age between the two groups.

The two groups also differed in the perception of saltiness. Nutrition teachers gave significantly higher intensity rating. General consumers rated the saltiness intensitiy closer to 5 point which was anchored as just about right while nutrition teachers perceived these intensities to be much stronger. The fact that nutrition teachers rated the saltiness of samples farther away from just about right reflects their lower acceptance of the samples compared to general consumers.

The consumer type*sample interaction effect was significantly present in overall liking <Table 6>. Nutrition teachers gave higher acceptance score for L-Na than ORG while general consumers gave similar ratings between the two samples. Other studies often report a significant decrease in acceptance level for sodium reduced sample or insignificant difference in liking from original sample at best (Guàrdia et al. 2006; Gomes et al. 2011; Noort et al. 2012). In the present study, nutrition teachers perceived the saltiness and sourness intensities of L-Na sample to be closer to just-about-right than ORG and this result may have positively influenced the liking for L-Na. From sensory quality perspective, L-Na may be suitable to replace ORG to be sold for institutional food service since general consumers did not show differences in the acceptability between ORG and L-Na and nutrition teachers, who are responsible for purchasing food ingredients in school meals, expressed higher acceptance for L-Na than ORG.

<Table 7> Mean ratings of liking, perceived intensities, and intake for the different type of information

	Overall Liking	Saltiness Intensity	Intake (g)
p-value	0.038*[1)]	0.000***	0.587
Sodium reduced	6±1.5	5±1.6	8.9±5.1
Non	5.6±1.6	5.5±1.5	8.8±4.3
Original	5.7±1.6	5.7±1.4	9.2±5.3

[1)]***p<0.001, **p<0.01, *p≤0.05

4) Effect of sodium reduced information

Information significantly affected the ratings of overall liking (p=0.036), and saltiness intensity (p=0.000) <Table 7>. Samples labeled with sodium reduced received higher ratings on overall than samples labeled with original or samples with no label. These results are concurrent with study by Kim et al. (2012) who have shown that 'sodium reduced' information influenced purchase intent positively. Levis and Chambers (1997) also reported an increase in liking when 'Unsalted' information was provided. Saltiness intensity perception was significantly affected by the types of information on the sauce samples. Samples with 'Sodium-reduced' label was perceived to be less salty than samples with no label or sampled labeled with original. Similar result was observed in a soup study and soup labeled with 'reduced salt' was significantly rated low in saltiness intensity (Liem et al. 2012). In the present study, sodium reduced information increased overall liking but decreased the perceived saltiness intensity of the labeled sample.

Information*consumer type effect was significantly influential on the overall liking (p=0.013). In the Health and Taste attitude and Sodium-related attitude survey, nutrition teacher showed more interests and concerns for Health attitude and sodium-related attitude. These high concerns among nutrition teachers may have affected them to be more sensitive to information type during sample evaluation, leading to higher liking for 'low sodium' labeled samples than other label conditions. For saltiness intensity perception, the two consumer groups were similarly affected by information and rated samples to have lower saltiness intensities when they were labeled 'sodium reduced' regardless of sample types.

5) Effect of serving methods

The serving method of the sauce significantly influenced overall liking, saltiness intensity and the amount intake of

sauce samples <Table 8>. Subjects gave significantly higher overall liking score when they tasted the samples using pour method than dip method. Subjects generally perceived stronger saltiness intensity of samples when they dipped as opposed to pour the sauces to the cutlet and tasted. This is partly due to the fact that subjects consumed more sauces using dipping method than pouring method. Subjects perceived saltiness intensity of the sauces to be more closer to just-about-right range when they used pouring method than dipping. This result indicates that subjects were more satisfied with the amount of sauce applied to the cutlet using pouring method while excessive amount was applied to the cutlet using dipping method leading to different outcomes in the acceptance score of the samples on the whole. Subjects had more control over the amount of sauces to be applied the cutlet in pouring than dipping method. Sauce container used in the study had relatively small opening (2 mm diameter), thus easier for the subjects to control the amount of sauce poured to the cutlet. In the case of dipping method, the surface of the cutlet being rough and the sauce being viscous causing large amount of sauce coating the cutlet which was less controllable by subjects. One of the frequently reported strategies to cut down the intake of food is to reduce the portion size of food to the level not noticeable by the consuming subjects (Rolls et al. 2002; Wansink & Kim 2005; Freedman & Brochado 2010; Birch et al. 2015). When reducing the size of a bowl or serving container, subjects can unconsciously reduce the amount of food consumed without noticing that they had eaten less. The present study is also showing that serving condition can have a prevailing effect more than consumer's intention in sauce intake.

Based on the results observed, it can be a practical strategy to serve pork cutlet sauce in a sauce bottle for consumers to pour because this increases the acceptance for the sauce by applying smaller amount of sauce to the cutlet and induces smaller intake of the sauce which have an effect on cutting down the intake of sodium in the sauce.

6) Effect of consumer's food related attitudes

The ANOVA results of consumer's food related attitudes on the overall liking, saltiness intensity and intake of pork cutlet sauce is shown in <Table 9>. A strikingly similar results were observed between the effects of GHI, NPI and SDA on the perception and intake of the sauce samples.

<Table 8> Significant difference and ratio for different consumer type by food related attitudes level

H, M, L	Consumer type	General Health	Natural product	Pleasure	Sodium related
Chi-Squared		0.000***[1)]	0.000***	0.134	0.000***
High	Nutrition teacher	68 (85%)	57 (77%)	31 (40.8%)	63 (85.1%)
	General	12 (15%)	17 (23%)	45 (59.2%)	11 (14.9%)
	Total	80	74	76	74
Middle	Nutrition teacher	45 (56.3%)	42 (56%)	41 (53.9%)	44 (53%)
	General	35 (43.8%)	33 (44%)	35 (46.1%)	39 (47%)
	Total	80	75	76	83
Low	Nutrition teacher	5 (6.7%)	19 (22%)	46 (55.4%)	11 (14.1%)
	General	70 (93.3%)	67 (78%)	37 (44.6%)	67 (85.9%)
	Total	75	86	83	78
Total		235 (Nutrition teacher: 118, General: 117)			

[1)]***p<0.001, **p<0.01, *p≤0.05

<Table 9> Mean ratings of liking, perceived intensities, and intake by food related attitudes level

	General Health Interest			Natural product Interest			Sodium related dietary		
	Overall Liking	Saltiness Intensity	Intake	Overall Liking	Saltiness Intensity	Intake	Overall Liking	Saltiness Intensity	Intake
p-value	0.007**[1)]	0.002**	0.054	0.011*	0.251	0.009**	0.000***	0.029*	0.013*
H	5.6±1.7[a]	5.6±1.5[b]	8.7±4.1[a]	5.6±1.6[a]	5.5±1.6[b]	8.6±4.6[a]	5.5±1.7[a]	5.5±1.7[c]	7.8±3.8[a]
M	5.9±1.4[b]	5.2±1.4[a]	8.9±5.2[a]	5.9±1.5[n]	5.3±1.5[ab]	8.8±4.6[a]	5.9±1.5[b]	5.3±1.5[b]	10.2±5.1[c]
L	6.1±1.6[b]	5.1±1.6[a]	10±5.5[b]	6.1±1.6[c]	5.1±1.6[a]	10.1±5.5[b]	6.3±1.5[c]	5.1±1.5[a]	9.5±5.5[b]

[1)]***p<0.001, **p<0.01, *p≤0.05

Attitude related to food as pleasure did not show significant effect on the perception and intake of the sauce. The distribution of consumer types in each of the attitudes with high, medium, and low scoring consumers are organized in <Table 8> along with results from chi-squared test. High proportion of nutrition teachers scored high on GHI, NPI, and SDA while high proportion of general consumers scored low on these attitudinal scales.

The effects of the significant attitudes are specifically discussed on the attributes overall liking, saltiness intensity, and sauce intake <Table 9>. Consumers characterized as having high interests in general health, natural food, and high concerns on sodium intake significantly rated low on the acceptance for the pork-cutlet sauce. Consumers with high general health interest and concerns of sodium intake rated the perceived saltiness intensity stronger than other consumers. Consumers who were highly interested in natural product and concerns of sodium intake ate less amount of sauce than other consumers.

These results resemble the different perception of sauce observed between nutrition teachers and general consumers. Additionally, these concurrent results between attitudinal effect and consumer type effect is largely due to the fact that large rate of nutrition teachers showed high interests in general health, natural products, and dietary sodium intake while significant number of general consumers expressed relatively low interests concerning these attitudes.

IV. Summary and Conclusion

The present study showed that the sensory characteristics of original and sodium reduced pork cutlet sauce were similar to each other and there were no significant difference in liking between the two sauces. Nutrition teachers showed lower acceptance and intake of pork cutlet sauces, and preferred the sodium reduced information than general consumers. These differences were due to the difference of age, health and sodium related attitudes and nutrition knowledge between two consumer groups. Sodium reduced information decreased the perceived saltiness intensity. Additionaly, it can be a practical strategy to serve pork cutlet sauce in a sauce bottle for consumers to pour because this increases the acceptance and induced smaller intake of the sauce which have an effect on reducing the intake of sodium in the sauce.

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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