FOOD QUALITY and CULTURE
Food Quality Culture 2(1): 37~42 (2008)

Quality Characteristics of Orange Sauce according to Sugar Contents for Recipe Standardization

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ABSTRACT This research examined the quality characteristics of orange sauce samples prepared with different sugar contents in order to create a standardized recipe.In the foodservice industry, attempts have been made to make superior sauces, often resulting in error. In this study, different sugar contents were examined for orange sauce to determine why varied results occur during its preparation as well as the best methodology for preparing orange sauce. Quality characteristics such as color differences, spreadability, and pH were analyzed, as well as sensory evaluations of taste, texture, color and overall acceptability. The pH values of the orange sauce samples ranged from 3.6 to 3.63 and after the initial simmering of ingredients, the weight reduction rates of the sauces were 88, 75, 64, 63, and 64% for sugar contents of 200, 300, 400, 500, and 600 g respectively. Hunter's color L, a, and b values of the samples changed according to the sugar contents after simmering (1st sauce). The L and b values showed similar patterns, where increasing sugar content resulted in higher values; however, in the 2nd sauce, the pattern was reversed. This indicates that the color of the sauce was affected by sugar caramelization during the reduction process; however, the final color was modified by the additions of mayonnaise and butter as well as by aeration. In the sensory evaluation the sample containing 30% sugar (500 g) had significantly higher acceptability scores ($p<0.05$) for color, mouth feel, appearance, taste, and overall acceptability. Finally, the optimal ingredient ratios of the standardized orange sauce recipe were determine as: 48% total liquid consisting of orange juice and mandarin and orange fruit; 30% sugar; 10% mayonnaise and 11% butter.

KEYWORDS: orange sauce, sugar, standard recipe, caramelization, viscosity

INTRODUCTION

In cultures throughout the world, various kinds of foods are made from many different ingredients based on social circumstances and geographical conditions. In addition, there are many kinds of foods that fulfill economic and religious purposes, and these foods can be divided into categories such as domestic foods, middle-class foods, art foods, local foods, industrial foods, gathering foods, etc.

Since its origin, sauce has evolved and been developed into diverse products within food cultures. Sauces have supposedly been used to hide food deterioration when there was no refrigeration, for improving the taste of bad quality meat. Today, however, with great improvements in sanitation and food quality, sauces are used worldwide to enhance the taste, appearance, and moisture content of foods (Choi SK 1998).

Sauces were defined as a category of food in the 17th century in France, and were divided into cold and hot sauces of various forms derived by various methods. Later, they were classified as mother sauces and derivative sauces, and then organized as brown and white sauces. Consequently, sauces have been categorized into cold, hot, and dessert categories, with a variety of names, purposes and ingredients (Choi SK 1998).

James Peterson (1991) has expressed that efficiently made sauces can complete the flavor, texture, and color of foods more than any other cooking activity.

Sauces are carefully created through many steps that have unique methods. They need to be continuously changed to harmonize flavors and colors and to make suitable concentrations.

A sauce should be designed as a complement, to perfect food, and not as a separate entity from it. While it functions as seasoning in contrast with a food, it also promotes a deeper flavor. However, most sauces lie between those two functions because they are based on the concept of adding flavor to the basic taste of a food.

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Received March 29, 2008; Accepted May 15, 2008

Despite the various kinds of sauce required in the foodservice industry, there have been relatively few studies examining them; these include studies on brown sauce (Kim YS 1997, Lee KH 2002, Lee KI 2002), demiglace sauce (Kim HD 2006, Yang YN 2006), and teriyaki sauce (Oh JS and Park WB 2003).

In cooking, the principle of choosing ingredients should be to harmonize textures, colors, and. In this respect, citrus fruits are good choices, creating pastel shades in contrast with other food materials.

According to Allen Susser (1997), citrus fruits which have been cultivated in southern areas of China and Southeast Asia for over 4000 years, are numerous in kind, including oranges, grapefruits, lemons, mandarins, limes, and citron.

Citrus fruits are generally composed of flavedo, albedo, and pulp. The flavedo is the skin providing color; it is edible, but its stinging bitter taste may not be favored, so it is often used as a ground zest for flavoring or for nutritional purposes because it is a good source of vitamin C. The albedo layer is under the flavedo. It is high vitamin C as well as pectin, so it gives viscosity and texture to jam, jellies, and sauces. The pulp, also known as the endocarp, is primarily composed of pectin, and is made up cells filled with sap.

Orange sauce is a derivative sauce which are syrup based. It is used in a variety of ways for appetizers, main dishes, and desserts. When used with salted salmon, it provides a sweet scent and orange taste and offers appetizers a splendid appearance with its bright color. In main dishes made from poultry such as chicken, duck, and pigeon, its citrus flavor harmonizes other ingredients. In addition, it can be topped on chocolate mousse or sponge cake and added to ice cream sweet souffls, or dessert fondue with fruits (Tom Bridge 1995).

Orange sauce is a representative dessert sauce made of orange, orange juice, milk, sugar, and cream. Its consistency is manipulated with starch or butter as thickener; it is shiny and served as a hot or cold sauce (Choi SK 1988, Grace Shugart and Molt Mary 1993, Beworth Christine 2000, Park HJ 2003).

One problem that occurs with orange sauce preparation is inconsistent sensory characteristics, such as different colors and textures due to relative changes in sugar content for the adjustment of taste, color and texture. As a result of to its color instability from the sugar, standardized recipe is required to obtain a consistent sauce.

However, most research on citrus fruits, including oranges has examined usage of the peel (Jang HN 1977), flavor substances (Lee HY 1986), the physicochemical properties of pectic substances (Rhee HJ and Rhee HS 1990), dietary fiber and flavonoids (Eun JB 1996) or the antimicrobial activity of extracts from citrus seeds (Oh HS 2003).

Therefore, this study was performed to examine the various characteristics of orange sauce according to sugar content which can influence the homogenization and stability of color, taste, and texture during preparation. Finally, standardized recipe is also suggested.

MATERIALS AND METHODS

Orange Sauce Ingredients for the Experiment

The oranges (California, 130 g) for the sauce were purchased at Garak market. The brewed vinegar (Cheongjeongwon, 2007), butter (Haitai, cream 100%, 2007), canned mandarins (Jinyang, 2006), mayonnaise (Ottogi, 2007), salt (Haepyo, 2007), sugar (Cheiljedang, 2007), orange juice (Del Monte, 2007), and bay leaves (Spain, imported, 2006) were acquired at a wholesale mart.

Orange Sauce Preparation

Orange Sauce Formula: The ingredient mixture ratios of the sample groups were varied according to a basic restaurant recipe as indicated in Table 1.

Orange Sauce Preparation by Varied Sugar Content: The preparation method was modified from the currently used orange sauce method through many preliminary cooking steps.

First, the mandarins were prepared and their pulp was ground. The oranges were washed and cut in half. Next, the ground mandarins, orange juice, oranges, sugar, and bay leaves were boiled in a pot for 20 minutes and then the oranges and bay leaves were removed. After simmering for one hour at 87~90°C, the mixture was strained through a sieve and cooled to 40~50°C (1st sauce). Finally, the mayonnaise, butter, vinegar, and salt were added to the first sauce, which was then mixed and allowed to cool (2nd

Table 1. Formula for orange sauce preparation

	Orange (g/ea)	Orange Juice (g)	Mandarin (g)	Sugar (g)	Bay leaf (ea)	Mayonnaise (g)	Butter (g)	Vinegar (g)	Salt (g)
I	130	300	450	200	1	600	180	20	10
II	130	300	450	300	1	600	180	20	10
III	130	300	450	400	1	600	180	20	10
IV	130	300	450	500	1	600	180	20	10
V	130	300	450	600	1	600	180	20	10

**I: sugar 200 g II: sugar 300 g III: sugar 400 g IV: sugar 500 g V: sugar 600 g

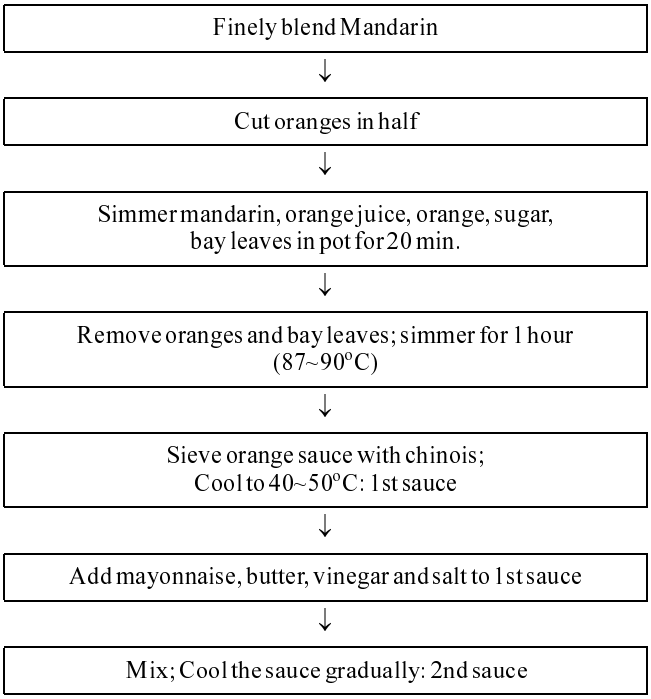

Fig. 1. Preparation procedure for Orange Sauce.

sauce). Figure 1 provides a flowchart of the preparation process.

Orange Sauce Quality Characteristics

pH Measurement and Weight Reduction Ratios: After mixing the ingredients, the pH of samples was measured at room temperature (23°C) using a pH meter (Model, 420A, Orion, USA) and is the average of three measurements.

To measure the weight reduction ratios, the pulp of the canned oranges, orange juice and mandarins were prepared in equal quantities, but the amounts of sugar in the sample groups were varied. Then, changes in the ingredients, first sauce, and second sauce weights were determined during preparation.

Color Value Measurements: Color values for lightness (L), redness (a), and yellowness (b) were measured in samples (10 ml) of the first and second sauces using a color reader (CR-200, Minolta, Japan). Average values were obtained from 10 measurements.

Spreadability Measurement: Spreadability was measured with relative apparent viscosity using a line spread chart. The second sauce samples of varied sugar concentrations were poured into a plastic cylinder (diameter 50 mm, height 25 mm) and left to sit for 30 seconds. Then, the cylinder was lifted and spreadability was measured from the flow to four directions for 30 seconds. Average values were obtained from five measurements.

Sensory Evaluations: Sensory evaluations were performed with 37 students, majoring in the culinary arts, after having received explanations regarding the color, taste, texture and overall acceptability of orange sauce.

Their evaluation scores were based on a 7 point Likert scale as follows: 1=extremely bad, 4=neither good nor bad, 7=extremely good.

Statistical Analysis: Statistical analyse of the results were carried out using SPSS 12.0, and the differences between averages were determined by t-tests and ANOVA. Significance ($p<0.05$) was determined by using Duncan's multiple range test.

RESULTS AND DISCUSSION

Weight Reduction Ratios and pH of Orange Sauce

The pH values of the sauce samples ranged from 3.6 to 3.63, show only slight differences among the sample groups (Table 2).

The reduction ratios of the first and second prepared sauces were as follows.

The reduction rates of the 1st sauce samples of varied sugar content (200-600 g) were 88, 75, 64, 63, and 64% respectively.

Sample groups I and II which had relatively high water contents as compared to the other groups, showed higher reduction rates, whereas groups III, IV and V containing 400, 500, and 600 g of sugar, respectively showed relatively lower reduction rates of approximately 63% to 64%. The

Table 2. pH and weight reduction ratios of orange sauce

	pH	Initial Weight (g)	Weight of 1st Sauce (g)	Reduction Ratio (%)	Weight of 2nd Sauce (g)
	After Mixing				
I	3.6	950	105	88	905
II	3.61	1050	253	75	1053
III	3.63	1150	413	64	1213
IV	3.61	1250	460	63	1260
V	3.62	1350	480	64	1280

**I: sugar 200 g II: sugar 300 g III: sugar 400 g IV: sugar 500 g V: sugar 600 g

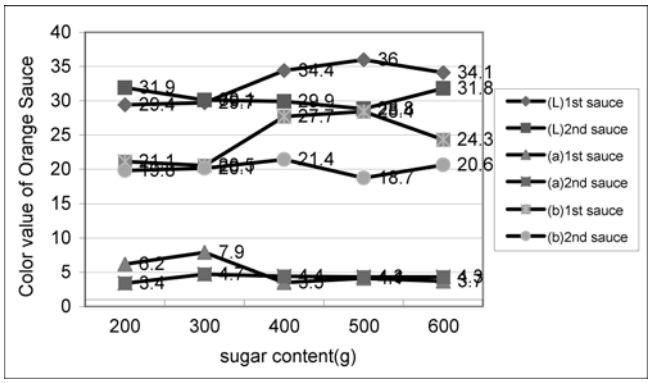

Fig. 2. L, a and b values of orange sauce by sugar content.

higher reduction rates in the lower sugar groups were attributed to increasing water evaporation as the sugar was dissolved at high temperature; however, the lower reduction rates in the higher sugar groups were the result of sugar combining with water which hindered its evaporation.

Color Values of Orange Sauce

Figure 2 presents the color differences among the orange sauce samples according to sugar content.

When the liquefied sugar was heated, it dissolved and the majority of water continued to evaporate. Accordingly, the sugar solution was gradually concentrated and its boiling point increased. When continuously heated, no water remained, leaving melted sugar, or liquified sugar.

When the liquified sugar was heated to 170°C which is a slightly higher temperature than its melting point, the sugar became caramelized, and its color changed from yellow, yellowish brown to brown. That is, the sugar was decomposed into glucose and fructose, and fructose was dehydrated to become hydroxymethyl furfural, which produced a colored material.

Changes in the orange sauce color occurred through this coloration process and color difference were shown based on the sugar contents of the samples.

For the 1st sauce, samples with low sugar content (200 g and 300 g) as compared to a high liquid content from the orange juice, mandarin, and orange had lower L values and higher a values, indicating an increased rate of water evaporation and a more rapid coloration process due to a greater amount of water than sugar. In contrast, the 2nd sauce, the results were reversed, as shown in Table 2.

In particular, the samples containing 400~600 g of sugar had significantly different L and b values. And groups I and II (200 g and 300 g of sugar, respectively) of the 1st and 2nd sauces had significantly differently a values. These results are consistent with those of Kim (Kim MH 2003) where the b value was highest for orange dressing.

Furthermore, the process of adding additional ingredients to the 1st sauce to make the 2nd sauce caused aeration, which could be a factor for increasing lightness.

The caramelization reaction refers to producing a combined, polymerized brown material from an oxidized and dehydrated material, such as when sugars alone are heated at 180~200°C without amino compounds or organic acids, which doesn't occur naturally. Therefore, a browning reaction often arises from caramelization when foods with high sugar contents are heated. Optimum pH values of the caramelizing reaction were determined as 6.5-8.2, which were different according to acid and alkaline conditions. (Han MG 2000, Shin CH 2005)

In this experiment, under the pH 3.6 condition, the browning of the orange sauce could be seen as a coloration process in part, and not entirely as caramelization from the sugar.

Spreadability of Orange Sauce

The spreadability of a sauce is important when it is added to food; therefore, the relative spreadability of samples was measured by the apparent viscosity and the results are shown in Table 3. For the orange sauce, the degree of spreadability increased as the apparent viscosity decreased with increasing sugar content.

In the samples containing 200 g and 300 g of sugar, relative apparent viscosity was low showing low degrees of spreadability. In contrast, the samples containing 400, 500, and 600 g of sugar had high spreadability. Overall, the sauces had significantly different spreadabilities according to the various sugar contents ($p<0.05$).

The water holding capacity of sugar is considered the factor affecting spreadability; the sauces containing 200 g or 300 g of sugar had low sugar contents, while the sauces containing 400 g to 600 g had high sugar contents. Therefore, even though the amounts of mayonnaise, vinegar and butter were the same for each sauce their final water holding capacities were different.

Table 3. Spreadability of orange sauce by sugar content

Content spreadability	Sugar content					F	p
	200	300	400	500	600		
$Vis._{app}$	16.62±0.32[a]	18.03±0.21[a]	21.08±0.10[a]	21.62±0.40[ab]	21.94±0.40[b]	284.502	0.000

Values are Mean±S.D.
Means with the same letters are not significantly different at $p<0.05$ by Duncan's Multiple range test.

Table 4. Sensory evaluation of orange sauce by sugar content

Content sensory characteristics	Sugar	Sugar content					F	p
		200	300	400	500	600		
Color		2.13±10.1	4.02v0.94	4.84±1.02	5.84±1.05	5.02±1.55	60.254	0.103
Texture	appearance	2.55±1.05^{a}	3.94±0.80^{a}	5.10±0.98^{ab}	5.42±1.15^{b}	4.78±1.18^{a}	46.032	0.018
	mouth feel	2.73±1.20	3.97±0.99	4.39±1.10	4.94±1.06	5.26±0.97	32.218	0.525
Taste		2.36±1.21^{a}	3.89±1.06^{a}	4.60±1.15^{a}	5.36±0.85^{ab}	5.10±1.42^{ab}	40.927	0.047
Overall Acceptability		2.31±1.18^{a}	3.81±0.80^{a}	4.55±0.92^{a}	5.73±1.00^{ab}	5.21±1.04^{ab}	67.692	0.009

Values are Mean±S.D.
Means with the same letters are not significantly different at $p<0.05$ by Duncan's Multiple range test.

Table 5. Standard recipe for orange sauce

one portion: 60 mL

Orange Sauce 100 portions

Ingredients	Amounts	Unit	%	Method
Orange Juice	1.8		21	1. Blend mandarins.
Mandarin, w/o juice	2.25	kg	27	2. Wash oranges and cut half size.
Orange	5	ea.	-	3. Combine orange juice, mandarins, oranges, laurel leaves and sugar in large sauce pan.
Laurel Leaves	5	ea.	-	4. Simmer for 1hr in medium heat.
Sugar	2.5	kg	30	5. Take out orange and bay leaves, and reduce for 1 hr.
				6. Sieve the sauce (1st sauce).
Mayonnaise	600	g	10	7. Cool the 1st sauce to 40-50°C
Butter	900	g	11	8. Mix mayonnaise, butter, salt and vinegar
Salt	50	g	0.3	9. Blend with whisk finely
Vinegar	100	mL	0.7	10. Let in cool area (2nd sauce)

Orange Sauce Sensory Evaluation

Table 4 presents the sensory evaluation results of the orange sauce samples according to sugar content.

The assessed sensory qualities were categorizing into color, appearance, mouth feel, taste, and overall acceptability. Scores for color improved as sugar content increased, with group IV (500 g of sugar) being the most preferred; however, it was not significantly different. The preference scores for appearance increased as sugar content increased, in which group IV was significantly more preferred among the groups. For mouth feel, group V (600 g of sugar) received the highest scores, but it was not significantly different.

Group IV had the highest scores for taste and overall acceptability, which were significantly different. In the foodservice industry, orange sauce is generally made using 300~400 g of sugar; however, based on this study, the samples containing 500 g of sugar were more preferred in terms of color, texture, and overall preference

Standardized Orange Sauce Recipe

As a result of this experiment, a standardized orange sauce recipe was attained (Table 5).

The majority within the hospitality industry including restaurants, hotels and institutional facilities create their own sauce recipes, in which many have originated from books (1, 11-13) or are chef recipes. However, the ingredients and amounts in these recipes vary from person to person and facility to facility. Thus in this experiment, an orange sauce recipe was standardized on a % ratio basis for each ingredient which is the most effective means for orange sauce.

After analyzing the sauce characteristics and carrying out sensory evaluations according to various sugar contents, the optimal ingredient ratios were determined as: 48% total liquid, consisting of orange juice and mandarin and orange fruit; 30% sugar; 10% mayonnaise; and 11% butter.

CONCLUSION

The success of a recipe depends on the cooking environment as well as the cooks involved. They may use different ingredients, diverse manufacturing companies, as well as fruits with variable individual sugar contents.

In this experiment, the orange sauce had such variables; therefore, it was important to determine a standardized recipe that could provide optimal color and preference.

1. The average pH values of the orange sauce samples ranged from 3.6 to 3.63, and the reduction rates of the 1st sauce samples (groups I to V) were 88, 75, 64, 63, and 64%

respectively.

2. In the 1st sauce, samples containing 200 g and 300 g of sugar had lower L values and higher a values. However, in the 2nd sauce, the results were reversed. In the groups containing 200 g and 300 g of sugar, there were only slight differences in L and b values between the 1st and 2nd sauces; however, in the samples containing 400~600g of sugar, there were significant differences.

3. Spreadability was lower in the sample groups containing 200 g and 300 g of sugar as compared to those with 400, 500, and 600 g of sugar, which had high spreadability. Overall, the sauces had significantly different ($p<0.05$) spreadabilities based on their various sugar contents.

4. Color preference scores improved as sugar content increased, and the sample containing 500 g of sugar was most preferred; however, it was not significantly different. This sample group (500 g of sugar) also received the highest appearance scores, which were significantly different. For mouth feel, group V (600 g of sugar) received the highest scores, but it was not significantly different. Overall, group IV (500 g of sugar) had significantly higher preference scores for taste and overall acceptability.

5. An optimal standardized orange sauce recipe was determined as: 48% total liquid, consisting of orange juice and mandarin and orange fruit; 30% sugar; 10% mayonnaise; and 11% butter.

REFERENCES

Allen Susser. 1997. The Great Citrus, Ten Speed Press. Berkeley, CA. USA. pp. 11.

Boworth Christine. 2000. Dinner with Ambassadors, Hollym, Seoul, Korea. pp. 183.

Choi SK. 1998. Theory and Practice of Sauce. Hyungsul Publisher. Seoul, Korea. pp. 233.

Eun JB, Jung YM, Woo GJ. 1996. Identification and determination of dietary fibers and flavonoids and peel of Korean tangerine (citrus aurantium var) Korean J Food Sci Tech. 28: 371-377.

Han MG. 2000. Food Chemistry, Hyungsul Publisher. Seoul, Korea.

James Peterson. 1991. Sauces, Classical and Contemporary Sauce Making. Van Nostrand Reinhold. New York, NJ. USA.

Jang HN, Nam KE, Hur JH. 1977. Research on effective usage of the Korean citrus fruits' peel(2). J Korean Food Sci. 9: 252-254.

Jung DH, SHin DH, Lee HY, Hur WD. 1987. Analysis of the aroma constituents of Korean mandarine (*Citrus reticula*) and orange juices by capillary GC and GC/MS. Korean J Food Sci. 19: 346-354.

Kim HD. 2006. A study on quality characteristics of medicinal demi-glace sauce with added omija. Korean J Culinary Res. 12: 119-124

Kim MH, Lee YJ, Kim DS, Lim DH. 2003. Quality characteristics of fruits dressing. J Korean Food Cookery Sci. 19: 165-173.

Kim YS. 1997. Physicochemical and sensory characteristics of brown stock and brown sauce made with pork bone. Master thesis. Dankook University, Korea.

Lee KH, Lee KI, Lee YN, Park HH. 2002. Sensory and mechanical characteristics of brown sauce by different ratio of ingredients. J Korean Food Cookery Sci. 18: 637-643.

Lee KI, Lee KH, Lee YS, Shin MJ. 2002. Changes in quality characteristics of different combination of brown sauce during storage. J Korean Food Cookery Sci. 18: 142-147

Oh HS, Park WB, An YS, Oh MC, Oh CK, Kim SH. 2003. Antimicrobial activity of extracts from citrus seeds. Korean J Culinary Res. 9: 69-80.

Oh JS, Park WB. 2003. Studies on the making of teriyaki sauce using Korean soy sauce. Korean J Culinary Res. 9: 102-113.

Park HJ. 2003. The finest Mediterranean cooking, Hyunhaksa. Seoul, Korea. pp. 245.

Rhee HJ, Rhee HS. 1990. Physicochemical properties of pectic substances from citrus fruits. J Korean Food Sci. 6: 9-12.

Shin CH, Kwon KS , Kim YH, Moon SH, Oh SC, Kook SW, Park HK. 2005. Food Science, Hyoil Publisher. Seoul, Korea. pp. 258-267.

Shugart Grace, Molt Mary. 1993. Food for Fifty. 9th ed. Prentice Hall, Englewood Cliffs, NJ, USA. pp. 608.

Tom Bridge. 1995. 200 Classic Sauces, John Wiley & Sons. New York, NJ. USA. pp. 103.

Yang YN, Park GY, Seo YK. 2006. A Study on the effect on sauce selection and preference of demi-glace sauce by material - focused on the restaurants in Kwangju and south Jeolla province. Korean J Culinary Res. 12: 151-156.