

## Correlation between Microbiological and Sensory Quality Indexes of Korean Seasoned Side Dishes Stored under Chilled Conditions

– Research Note –

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### Abstract

The correlation between microbiological and sensory quality indexes was investigated for Korean seasoned side dishes stored under chilled conditions, by using both published data and experimental evaluation. Aerobic bacterial counts on the perishable Korean side dishes showed high inverse correlation with sensory quality and could also be regarded as a main cause of sensory quality deterioration. Therefore, monitoring or estimating the microbial growth on these products should be an effective means for estimating and extending their shelf life.

**Key words:** shelf life, microbial count, sensory score, Korean side dish, chilled storage

### INTRODUCTION

Commercially prepared ready-to-eat traditional Korean foods are increasingly available in supermarkets in Korea. These foods include many types of prepared foods such as traditional side dishes and soups, and sales of these products has grown dramatically due to people's life style changes (1). Most Korean side dishes are blanched vegetables, meats, fishes or other foods seasoned or mixed with spices and/or sauces. They are not a food type that is normally available as pasteurized or sterilized in the packages. These characteristics of heterogeneity and nonsterility confer on them a vulnerability to biochemical and microbial spoilage. Because of their perishable nature, these products are mostly distributed and marketed under chilled conditions in the food supply chain. As with any chilled foods, shelf life control of these products is very important for assuring quality and safety. Shelf life determinations should, in principle, be based on food quality deterioration mode and kinetics which depend on food type and storage conditions (2,3). Proper selection of a quality index is the first task to be undertaken for the shelf life study (2,4). Microbial growth index is considered to be the most important quality criterion for shelf life determination of the Korean seasoned side dishes because of its relationship to food spoilage and safety. Controlling sensory quality during food distribution and storage is also very important for these products as with microbial quality. However, a sensory quality index is subjective by nature,

and thus limited in its application for objectively establishing shelf life and expiration dates for foods. Therefore, many investigators have searched for an easily measurable quality index having high correlation to sensory quality (5,6): relationship of instrumental and biochemical indexes to sensory quality has been investigated mostly. However, only a few studies have looked for a correlation between microbiological and sensory qualities (7).

This study, therefore, aims to investigate the correlation between microbiological and sensory quality indexes of Korean seasoned side dishes stored under chilled conditions.

### MATERIALS AND METHODS

Literature data were analyzed first and then product samples at different stages of deterioration were experimentally evaluated for quality attributes to develop a strategy for monitoring quality and establishing a model for effective shelf life control.

#### Analysis of literature data

The data reported by Kim et al. (8) for beef soup, seasoned soybean sprouts and fried seasoned tofu were used for correlations between different quality indexes. Their work reported sensory, physical and microbiological quality changes in seasoned dishes stored at 0, 3 and 10°C. Their data set showed complete matches of different quality indexes for the sample foods stored for different periods under the three experimental

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temperatures. However, they did not give systematic analysis among different quality attributes. Therefore, statistical calculations were conducted in this study by using S-PLUS 2000<sup>®</sup> (MathSoft Inc., Seattle, WA, USA).

#### Analysis of seasoned soybean sprouts under different storage conditions

Seasoned soybean sprouts were purchased in the summer season directly from a local preparation shop, Masan, Korea. The product was prepared by mixing 1,000 g of steamed soybean sprouts with 24 g salt, 19 g minced garlic, 18 g sesame oil and 8 g sesame salt powder. The product was then transferred to the laboratory just after preparation and stored under different combinations of storage temperatures and times, covering 35~48 hours at 0~15°C, to induce different degrees of quality deterioration. Each 100 g of seasoned soybean sprouts was placed into a 18.0×13.0×2 cm rectangular polystyrene tray.

Different samples were taken simultaneously from each tray to assure that each treatment group was evaluated fairly. For determination of microbial counts, 10 grams of each sample were aseptically transferred to a sterile Stomacher bag and diluted with 40 mL of 0.1% sterile peptone water. Samples were then homogenized in a Stomacher (Lab-Blender, TMC International, Seoul, Korea) for 2 minutes and 0.1 mL aliquots were plated out directly or as 10-fold dilutions in 0.1% peptone water on Plate Count Agar (PCA; Difco Laboratories, Detroit, USA). Microbial colonies were counted after incubation at 30°C for 48 hr and expressed as colony forming units (cfu) per gram (9). The sensory quality of the samples was measured based on appearance, aroma, texture and overall acceptability by a hedonic test with a 5 point scale: 1 for 'unacceptable', 3 for 'fair' and 5 for 'very good' (10). A sensory panel of 10 members was asked to score the sensory quality attributes of the samples.

## RESULTS AND DISCUSSION

From the analysis of the work by Kim et al. (8), significant negative correlation was found between aerobic bacterial count and sensory hedonic scores for beef soup

**Table 1.** Correlation between aerobic bacterial count and sensory attribute for beef soup and seasoned tofu stored at 0, 3 and 10°C

Sensory attribute (hedonic score)	Product	
	Beef soup	Seasoned tofu
Aroma	-0.950**	-0.746**
Appearance	-0.930**	-0.753**

Based on the analysis of data of Kim et al. (8). \*\*p<0.01.

and seasoned tofu stored at 0, 3 and 10°C (Table 1): higher bacterial count means lower sensory quality for aroma and appearance. The two sensory quality attributes were highly correlated with each other, with correlation coefficients greater than 0.98 (0.985 for beef soup and 0.988 for seasoned tofu). It has been reported that the sensory attributes or qualities are often correlated with one or more of the other sensory parameters or variables (11-13). The degree of correlation between microbial count and sensory score was higher with beef soup than with seasoned tofu. It is noted from the data of Kim et al. (8) that beef soup had a higher degree of microbial proliferation than did seasoned tofu. Active growth of aerobic bacteria would have caused more rapid quality degradation, which would have been reflected in the sensory quality measurement by the panel. However, seasoned meat products preserved by drying, smoking or steaming showed little correlation between microbial count and sensory score during storage at 4°C (14); perishable chicken meat had the highest correlation under the same conditions (7,15). Microbiological quality is a valid index to determine sensory quality of foods which are sensitive to microbial spoilage during storage, which applies to many Korean seasoned side dishes.

When the bacterial count of seasoned soybean sprouts was correlated to their chemical and physical quality attributes from the systematic analysis of the data of Kim et al. (8), all of ascorbic acid concentration, surface color and textural force were found to have significant correlation with the former (Table 2). While there is high correlation between ascorbic acid content and surface color, two physical properties, color and texture, had lower correlation between each other although the correlation remained significant at p=0.01. There was also low degree

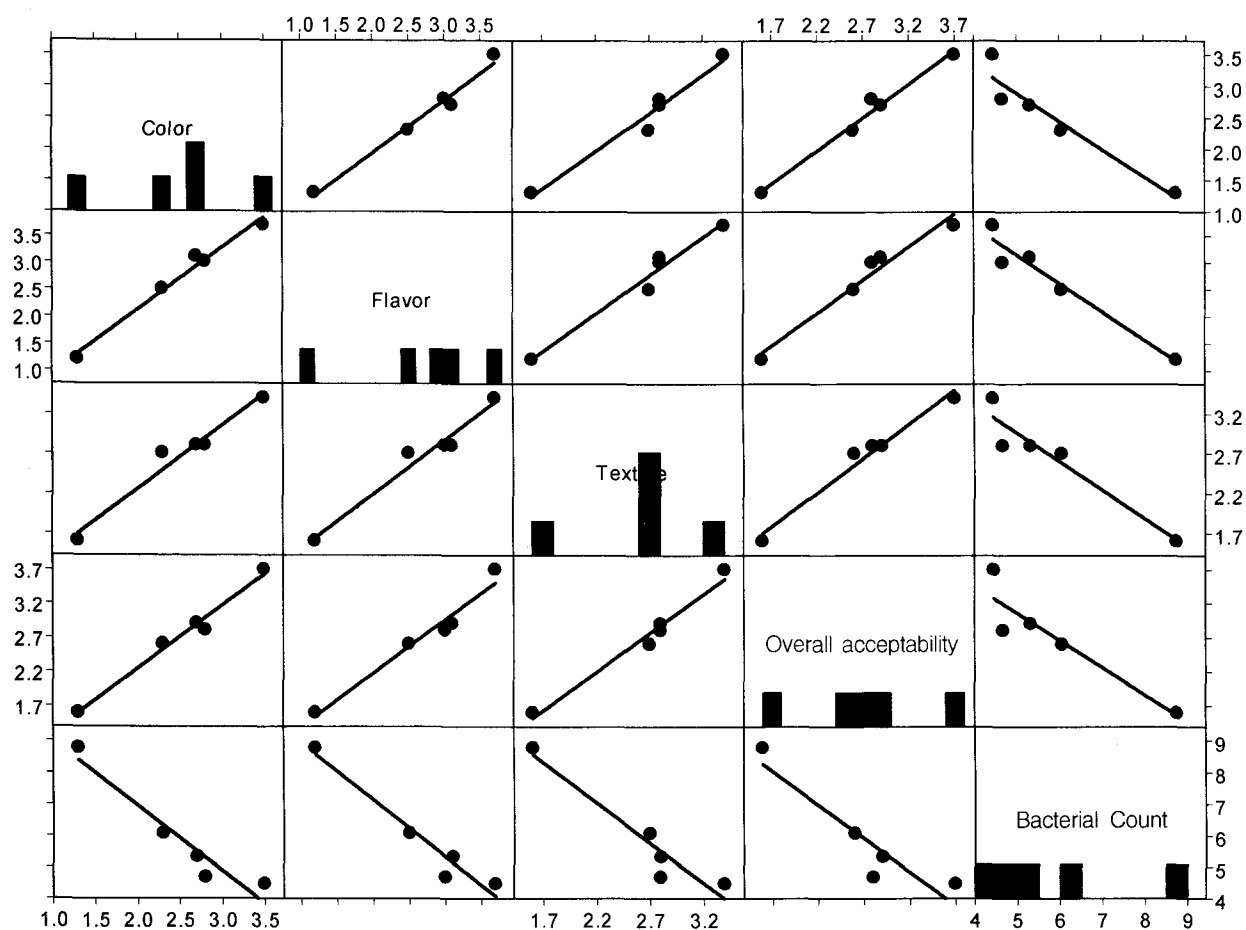
**Table 2.** Correlation between the different quality indexes for seasoned soybean sprouts stored at 0, 3 and 10°C

	Bacterial count [log (cfu/g)]	Ascorbic acid content (mg/100 g)	Color (b value)	Texture (cutting force, g <sub>f</sub> )
Bacterial count [log (cfu/g)]	1.000			
Ascorbic acid content (mg/100 g)	-0.861**	1.000	1.000	1.000
Color (b value)	-0.762**	0.852**	0.592**	
Texture (cutting force, g <sub>f</sub> )	-0.728**	0.598**		

Based on the analysis of data of Kim et al. (8). \*\*p<0.01.

of relationship, even with significance at  $p=0.01$ , between ascorbic acid content and texture. According to Kim et al. (8), physical textural change during storage of seasoned soybean sprouts was only slight and showed very low temperature dependence, which may explain the low degree of correlation with other quality indexes. Mechanical textural change may not be appropriate to indicate or express the overall quality change during storage. In this context, it cannot be used as a quality index for shelf life determination.

The high correlation between microbial count and other quality indexes in Table 1 may indicate a great effect of the former on the sensory quality because sensory quality is expected to be under the influence of chemical and physical quality attributes. Because Kim et al. (8) did not measure the sensory quality of the seasoned soybean sprouts, samples of different microbial loads were subjected to sensory test in order to see the correlation between microbial load and sensory quality. Microbial counts were highly correlated with sensory quality attrib-



**Fig. 1.** Scatter plot matrix among quality attributes on seasoned soybean sprouts. Sensory qualities of color, flavor, texture and overall acceptability are five point hedonic scale while bacterial count is in log (cfu/g). In diagonal elements, histograms for each attribute are given as frequency per its interval.

**Table 3.** Correlation between microbiological and sensory quality indexes for seasoned soybean sprouts

	Bacterial count [log (cfu/g)]	Appearance (hedonic score)	Flavor (hedonic score)	Texture (hedonic score)	Overall acceptability (hedonic score)
Bacterial count [log (cfu/g)]	1.000				
Appearance (hedonic score)	-0.958**	1.000			
Flavor (hedonic score)	-0.972**	0.991**	1.000		
Texture (hedonic score)	-0.954**	0.982**	0.983**	1.000	
Overall acceptability (hedonic score)	-0.923**	0.990**	0.981**	0.987**	1.000

\*\* $p<0.01$ .

utes as expected (Fig. 1 & Table 3): increased bacterial count means lower organoleptic quality in all the attributes of color, flavor, texture and overall acceptability, which results from longer storage. There were high correlations among the sensory quality attributes tested. As for seasoned soybean sprouts, microbial quality measured as aerobic bacterial count may be seen as a main cause and indicator of degradation of physical, chemical and sensory qualities. This emphasizes the importance of controlling microbial growth during storage and distribution.

As observed above, microbial growth on the perishable Korean side dishes may be regarded as a main cause of sensory quality deterioration, which can also be related to physical and chemical degradation. Therefore, monitoring or estimating the microbial growth on these products may serve as a tool to determine and control their shelf life. Because there is limitation in speed and easiness for the microbiological quality testing of foods (11), some biochemical markers or indicators directly related to microbial growth have been searched for this purpose: contents of volatile basic nitrogen and biogenic amines have been suggested as indicators of microbial spoilage (7,16). On the other hand, microbial growth can be estimated or predicted as a function of environmental factors for the shelf life determination. In this case, growth kinetics and affordable limits of specific spoilage organisms should be established (17), which would require further study for Korean seasoned foods. Already this kind of approach has been started and is expected to facilitate shelf life control of many perishable foods such as fish and fresh produce (18-20). We suggest that a similar approach should be applicable to the perishable Korean side dishes stored and supplied under chilled conditions.

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