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Developing a Descriptive Analysis Procedure for Korean Pumpkin Gruel (*Hobakjuk*)

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ABSTRACT The objective of this study was to develop a reliable and reproducible descriptive analysis procedure for Korean style sweet pumpkin gruel (*Hobakjuk*). The sensory attributes of the sweet pumpkin gruel were developed and defined, the sample preparation method was standardized, and the sensory evaluation procedure for a sample was established. Seven types of sweet pumpkin gruel (five ready-to-eat type vs. two ready-to-heat type) were selected to be analyzed. Panel training and descriptive analysis were carried out with these 7 samples. A total of 12 sensory attributes (2 aroma/odor, 5 taste/flavor, 4 texture/mouthfeel, and 1 aftertaste attributes) were developed to describe the sensory characteristics of the sweet pumpkin gruel. The definition and reference standards for each sensory attribute were determined to clearly understand each attribute. In the main experiment, trained panelists evaluated the sensory characteristics of the 7 gruel samples based on a fifteen-point intensity scale using the developed attributes. The results were statistically analyzed by analysis of variance, principal component analysis, and cluster analysis. The results showed that the 7 sweet pumpkin gruel samples significantly differed in their intensities of all attributes except for sweet pumpkin aroma and viscosity. The ready-to-eat style samples were distinctly characterized by their sweet pumpkin aroma and flavor, whereas the ready-to-heat style samples were markedly characterized by their low intensity of gelatinized starch and pumpkin flavor retention.

KEYWORDS: Descriptive analysis, *Hobakjuk*, Pumpkin gruel, traditional Korean food, Sensory analysis

INTRODUCTION

Korean style gruel (*Juk*) is generally defined as a fluid-type food that is fully gelatinized by boiling grain such as rice, barley, or millet with a sufficient amount of water (5-10 times the weight of the grain) for an extensive length of time (Cho and Shin 1996). Supplementary ingredients such as beans, pine nuts, or abalone are favorably used to enhance the flavor of gruel. It is a traditional Korean food that has been present ever since grains started being harvested in this country, and currently, more than 100 kinds of gruel exist (Cho and Shin 1996; June et al 1998). Gruels are by and large preferred and consumed among Koreans because of their taste, delicacy, ease of digestion, healthiness, and convenience of eating (Chang and Lee, 1989; June et al 1998; Zhang et al 2002).

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As consumers' lifestyles are becoming more health oriented and the need for convenient food is rapidly growing, the size of the gruel product market has been expanding significantly. It is estimated that the total gruel product market is approximately 150 billion won in South Korea (Yang et al 2007). Thus, various gruel products and franchised restaurants specializing in gruel are actively being developed.

A number of studies have been conducted concerning gruel products. Most researchers have focused on the processing methods (Han and Oh 2001; Lee et al 2003; Lee et al 2005; Yang et al 2007), storage conditions (Lee et al 2000), and product development of gruel using various ingredients (Cho et al 1996; Kim et al 1996; June et al 1998; Lee et al 2002; Zhang et al 2002; Zhang et al 2003; Kim et al 2004; Lee et al 2006; Ryu et al 2007; Park et al 2009). Although most of these studies conducted sensory analyses, many employed inadequate sensory analysis procedures, such as by using vague sensory attributes, failing to define the sensory attributes evaluated, or confusing descriptive analysis with consumer acceptance testing. Thus, a standardized descriptive analysis method that can objectively evaluate the sensory characteristics of Korean style gruel is crucial in order to conduct competent research on gruel.

The gruels preferred among Koreans are shown to be red bean gruel, pumpkin gruel, chicken gruel, and plain rice gruel (June et al., 1998). Among these products, pumpkin gruel, which is usually cooked by boiling pureed pumpkin with red bean and rice powder (Cho et al., 1996), is popular due to its taste and various health functionalities. The objective of this study was to develop a reliable and reproducible descriptive analysis procedure for Korean style sweet pumpkin gruel (*Hobakjuk*).

MATERIALS AND METHODS

Samples

Seven types of sweet pumpkin gruel (RTEK, RTHA, RTEL, RTEB, RTEJ, RTEC, RTHB) were selected for the experiment. Among the samples, 2 types of sweet pumpkin gruel (RTHA and RTHB) were ready-to-heat type products produced from major processed food companies in South Korea. The other 5 samples (RTEK, RTEL, RTEB, RTEJ, and RTEC) were ready-to-eat type samples that were purchased from a nationally franchised gruel restaurant in South Korea. All the samples were purchased 4 hours in advance of the experiment.

Sample preparation

Initially, for samples that consisted of solid sub-ingredients such as beans, these ingredients were removed from the samples in order to sensitively evaluate the flavor of the pumpkin gruel itself. Then, approximately 300 g of each sample was heated for 90 seconds in a microwave oven. Forty grams of sample was poured into an odorless plastic serving cup which was then immediately closed. The samples were served to the panelists when the temperature reached 55±1°C. The panelists evaluated the samples at approximately 45~50°C.

Panelists

Six trained panelists (female, age 22~24) who had previous experience as panelists for descriptive analysis participated in the study.

Descriptive analysis

A generic descriptive analysis was conducted to analyze the sensory characteristics of the sweet pumpkin gruel. The descriptive analysis consisted of a training session and a main experiment session. In the training session, the sensory attributes that would sufficiently characterize the 7 pumpkin gruel samples were developed. To clearly understand each attribute, a corresponding definition and reference standard were established using a consensus method among the panelists. The 12 sensory attributes, definition, and reference standard developed for the sweet pumpkin gruel are fully described in Table 1. The panelists were then trained to evaluate the intensity of each attribute in a sample using a 15-point intensity scale. The training continued until a panelist's evaluation performance showed a discriminating ability among the samples and reproducibility within a sample.

In the main experiment, the sensory characteristics of the sweet pumpkin gruel samples were evaluated according to the sensory attributes developed in the training session. The intensity of each attribute was evaluated on a 15-point intensity scale that was anchored with "not detectable" and "very strong" at the left and right ends, respectively. The serving orders of the 7 samples were determined by randomized complete block design. The seven samples were divided into 2 sets (3 samples in set 1 and 4 samples in set 2), and the 2 sets were evaluated in separate sessions to prevent sensory adaptation. The samples were served in a sequential monadic order to keep the sample temperature constant. The panelists were asked to rest for 5 minutes between the samples. Spring water and spit cups were given to rinse the palate between evaluations. The sample evaluation was replicated 3 times for each panelist.

Statistical analysis

Two way-analysis of variance (ANOVA) was conducted to evaluate the effects of the products on the sensory attribute intensities. When the product effects showed significant differences ($p<0.05$), Duncan's multiple comparison test was conducted. Principal component analysis (PCA) was executed to visually summarize the sensory characteristics of the 7 types of pumpkin gruel. Finally, cluster analysis using Ward's method was performed to group the sensory attributes with strong positive correlations.

RESULTS AND DISCUSSION

In order to analyze the sensory characteristics of the 7 kinds of sweet pumpkin gruel, 12 sensory attributes were developed in the training session (Table 1). These sensory attributes were sweet pumpkin aroma, sour odor, sweet taste, sour taste, salty taste, sweet pumpkin flavor, gelatinized starch, pumpkin chunks, smooth texture, viscosity, astringent mouth feel, and pumpkin flavor retention. Many previous gruel studies used sensory descriptors such as overall taste, overall flavor, nutty, pumpkin flavor, flavors other than pumpkin, off odor, viscosity, gritty texture, etc. (June et al 1998; Kim et al 1996; Cho et al 1996; Lee et al 2002; Ryu et al 2007; Zhang et al 2003; Park et al 2009; Han and Oh 2001; Lee et al 2003; Lee et al 2005; Yang et al 2007). While some of these studies conducted consumer taste tests and thus used limited numbers of sensory attributes to evaluate the acceptance level of a product, in other studies, it was frequently found that: 1. insufficient numbers of sensory attributes were used to evaluate the samples, 2. the definitions of sensory attributes were unclear, 3. the acceptability of a sample was measured with trained

Table 1. Definitions and reference standards of the descriptive attributes used in the descriptive analysis of sweet pumpkin gruel

Category	Attributes (abbreviation)	Definition	Reference standard
Aroma/ Odor	Sweet pumpkin (pmkO)	Typical aroma of steamed sweet pumpkin	Steamed sweet pumpkin
	Sour (sourO)	Typical odor of acidic solution	pickle (Heinz Korea, Seoul, South Korea)
Taste/ Flavor	Sweet (sweet)	Typical sweetness of 2% sucrose solution	2% sucrose solution
	Sour (sour)	Typical sourness of yogurt	Yogurt (Yoplait, Binggrae, Kyunggido, South Korea)
	Salty (salty)	Typical saltiness of 1% NaCl solution	1% NaCl solution
	Sweet pumpkin (sweetpmk)	Typical pumpkin flavor of steamed pumpkin	Steamed sweet pumpkin
	Gelatinized starch (gelatstrch)	Typical flavor of gelatinized starch	Rice gruel (Hetbahn, CJ Cheiljedang, Seoul, South Korea)
Texture/ Mouthfeel	Pumpkin chunk (pmkchunk)	Typical texture of steamed pumpkin	Puree of steamed sweet pumpkin
	Smooth (smooth)	Typical smooth texture of a cream	Heavy Cream (Seoul Milk, Seoul, South Korea)
	Viscosity (viscosity)	Degree of resistance of a flow	Fat free vs. full fat milk (Seoul Milk, Seoul, South Korea)
	Astringen (astringent)	Typical astringent mouthfeel sensation when raw sweet potato is chewed and swallowed	Raw sweet potato
Aftertaste	Pumpkin flavor retention (pmkflavretnt)	Flavor retention of pumpkin flavor	-

Table 2. Mean attribute intensity values of 7 sweet pumpkin gruel samples

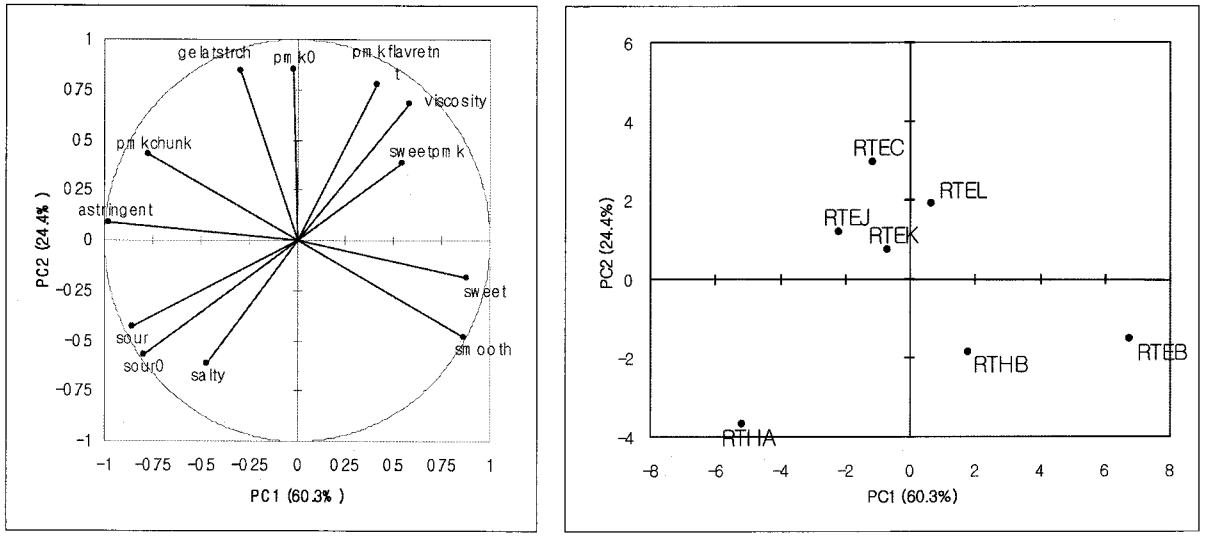
	pmkO	sourO	sweet	sour	salty	sweetpmk
RTEK	$8.7^{a1)}$	7.7^{ab}	9.4^{b}	8.3^{cd}	8.1^{bcd}	9.6^{b}
RTHA	8.2^{a}	10.7^{c}	6.8^{a}	11.7^{e}	8.9^{d}	7.8^{a}
RTEL	9.5^{a}	7.4^{ab}	10.6^{bc}	7.7^{bc}	6.7^{ab}	9.4^{ab}
RTEB	8.9^{a}	6.0^{a}	12.2^{d}	5.6^{a}	7.4^{abc}	10.0^{b}
RTEJ	10.0^{a}	8.2^{b}	8.0^{a}	9.4^{d}	8.5^{cd}	10.0^{b}
RTEC	9.9^{a}	6.5^{ab}	6.8^{a}	6.6^{ab}	6.2^{a}	8.4^{ab}
RTHB	8.4^{a}	7.9^{ab}	11.2^{cd}	7.7^{bc}	7.3^{abc}	8.5^{ab}
	gelatstrch	pmkchunk	smooth	viscosity	astringent	pmkflavretnt
RTEK	9.3^{b}	7.3^{b}	8.2^{ab}	8.9^{a}	8.7^{b}	9.4^{c}
RTHA	7.3^{a}	6.3^{b}	7.7^{a}	7.9^{a}	9.4^{b}	7.0^{a}
RTEL	10.1^{b}	6.6^{b}	7.7^{a}	9.6^{a}	7.8^{b}	9.5^{c}
RTEB	7.1^{a}	2.8^{a}	11.9^{c}	9.5^{a}	5.6^{a}	9.2^{bc}
RTEJ	9.8^{b}	6.5^{b}	7.3^{a}	9.6^{a}	8.6^{b}	9.7^{c}
RTEC	9.0^{b}	6.9^{b}	7.0^{a}	9.2^{a}	8.5^{b}	9.0^{bc}
RTHB	6.9^{a}	6.1^{b}	9.6^{b}	8.8^{a}	7.6^{b}	8.1^{b}

[1)]Mean values within the same cell with the same letter superscripts do not differ significantly ($p>0.05$)

panelists (but not with general consumers), and 4. whether a measurement was made for sample acceptance or intensity was unclearly presented. Thus, developing, defining, and standardizing the sensory lexicons are critical in order to accurately and thoroughly understand the sensory properties of gruel.

The results showed that the 7 sweet pumpkin gruel samples significantly differed ($p<0.05$) in their intensities of all attributes except for sweet pumpkin aroma and viscosity (Table 2). The RTEB sample, which was a product from one of the largest franchised gruel restaurants in Korea, was characterized as having the most sweetness, sweet pumpkin flavor, and smoothness but the least sourness and pumpkin chunks among the samples. On the contrary, the RTHA sample, which was a ready-to-heat product produced from a food company, was evaluated as having the most sourness, saltiness, and astringency but the least sweet pumpkin flavor among the samples.

PCA was conducted to visually summarize the sensory properties of the 7 gruel samples (Fig. 1). The first PC explained 60.3% of the total variance. PC 1 was defined by sweetness and smoothness on the positive direction and by astringency and sourness on the negative direction. As shown in the mean intensity values, the RTEB sample



(A) (B)

Fig. 1. Principal component loadings of descriptive attributes (A) and corresponding principal component scores of the 7 sweet pumpkin gruel samples.

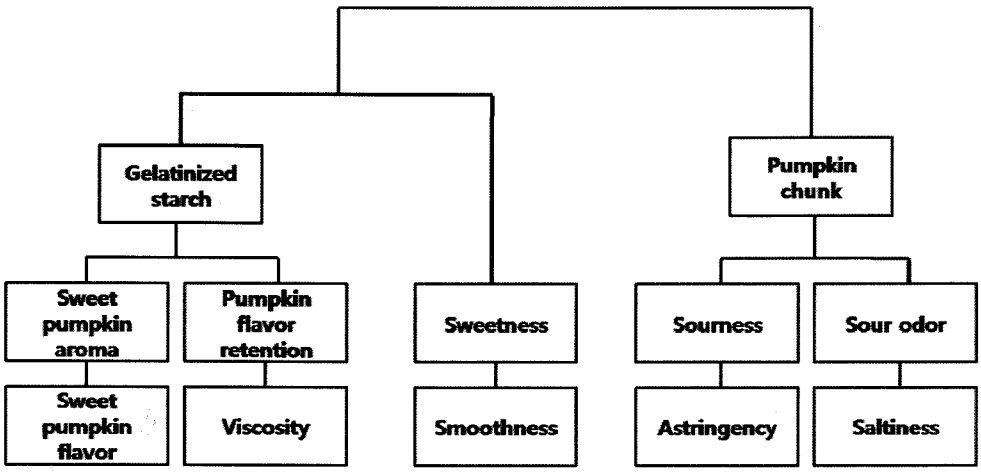


Fig. 2. Dendrogram of sensory attributes grouped by Ward's method of cluster analysis.

showed strong positive correlations with sweetness and smoothness and RTHA showed strong positive correlations with astringency and sourness. PC 2, which explained 24.4% of the total variance, was defined by sweet pumpkin aroma, gelatinized flavor, and pumpkin flavor retention. The ready-to-eat sample such as RTEC, RTEL, RTEJ, and RTEK showed strong intensities for these flavors and were located positively on the PC 2 axis, whereas the ready-to-heat samples such as RTHA and RTHB were located negatively.

In order to group the sensory attributes with strong positive correlations to each other, cluster analysis using Ward's method was performed (Fig. 2). Gelatinized starch flavor, sweet pumpkin aroma and flavor, pumpkin flavor retention, and viscosity showed strong correlations to each other. Sweetness and smoothness showed a high positive correlation to each other and were merged to the gelatinized starch group in the next level. The attributes of pumpkin chunks, sour odor and taste, saltiness, and astringency were grouped together but showed weak relationships with the previous 2 groups.

SUMMARY AND CONCLUSIONS

A reliable and reproducible descriptive analysis procedure for Korean style sweet pumpkin gruel was established. Twelve sensory attributes were developed, defined, and standardized to evaluate the sweet pumpkin gruel samples. Sweetness and sourness were the major sensory characteristics that differentiated the samples. Additionally,

the ready-to-eat style samples were distinctly characterized by their high intensities of sweet pumpkin aroma and flavor, whereas the ready-to-heat style samples were markedly characterized by their low intensities of gelatinized starch and pumpkin flavor retention. Finally, further research needs to be carried out to identify the sensory properties that drive consumer liking of Korean style pumpkin gruel.

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