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Improving the sensory quality of flavored liquid milk by engaging sensory analysis and consumer preference

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ABSTRACT

Developing innovative products that satisfy various groups of consumers helps a company maintain a leading market share. The hedonic scale and just-about-right (JAR) scale are 2 popular methods for hedonic assessment and product diagnostics. In this paper, we chose to study flavored liquid milk because it is one of the most necessary nutrient sources in China. The hedonic scale and JAR scale methods were combined to provide directional information for flavored liquid milk optimization. Two methods of analysis (penalty analysis and partial least squares regression on dummy variables) were used and the results were compared. This paper had 2 aims: (1) to investigate consumer preferences of basic flavor attributes of milk from various cities in China; and (2) to determine the improvement direction for specific products and the ideal overall liking for consumers in various cities. The results showed that consumers in China have local-specific requirements for characteristics of flavored liquid milk. Furthermore, we provide a consumer-oriented product design method to improve sensory quality according to the preference of particular consumers.

Key words: partial least squares regression, penalty analysis, just-about-right scale, local consumer preference difference

INTRODUCTION

New product introductions are critical to the growth and continuing success of a company. Developing innovative products that satisfy various groups of consumers helps maintain a company's market share. Consumer judgments are needed to exploit new markets based on preference understanding (Ruan and Zeng, 2004). Designing products that satisfy consumers' flavor prefer-

ences is the core consideration in product development. Sensory quality is one of the most important factors affecting the final choices of consumers. Qualitative and quantitative studies help to identify the factors that drive consumers' liking, providing the understanding needed to optimize new products and enhance the profitability of existing products (Raz et al., 2008).

In market research, the hedonic scale and the just-about-right (**JAR**) scale are 2 popular methods for hedonic assessment and product diagnostics. The hedonic scale is a balanced bipolar scale centered around neutral, with categories labeled with phrases representing various degrees of liking (Villanueva and Da Silva, 2009; Lim and Fujimaru, 2010; Lim, 2011). The JAR method is a direct way to solicit feedback from a consumer, asking whether a product is just right or has too much or too little of a certain characteristic (Popper and Kroll, 2005; Rothman, 2007; Plaehn and Horne, 2008). Usually, the hedonic and JAR scales are combined to provide directional information for product reformulation. Penalty analysis (**PA**) is one of the most commonly used analysis methods for the JAR scale, and it has been extensively used in the food industry (Meullenet et al., 2007; Paczkowski, 2009; Xiong and Meullenet, 2009). Penalty analysis could identify potential directions for product improvement. It assists in identifying attributes that cause an increase or decrease in hedonic scale associated with sensory attributes not at optimal levels in a product, allowing the product developer to decide what sensory properties should be improved or adjusted (Paczkowski, 2009). Regression-based method is well applied for analyzing JAR scale and hedonic scale of overall liking score (Xiong and Meullenet, 2004; Plaehn and Horne, 2008). Partial least squares (**PLS**) regression on dummy variables (Xiong and Meullenet, 2006; Worch et al., 2010) can be used to analyze JAR data, which have better prediction properties for overall liking than original variables. Both penalty analysis and regression-based methods could estimate the potential improvement margin when the attributes are not at the just-about-right level.

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With development of a national economy and the improvement of living standards in China, flavored liquid milk has become an essential daily nutrition source of Chinese residents. Today, competition in the food industry is intense, and flavored liquid milk is expected to develop toward the diverse requirements of consumers, to adapt to the different consumption levels, preferences, and nutritional requirements of consumers.

In this study, we analyzed local preference characteristics for flavored liquid milk for residents in various areas of China. An acceptance test was adopted to investigate overall liking (hedonic scale), and the perceptible intensity of attributes (JAR scale) of formulated milk product. Two methods of analysis—PA and PLS regression on dummy variables—were used to identify the improvement margin with the attributes that are not at the JAR level. We focused on the following 2 aims: (1) to investigate the consumers' preferences of milk products and their flavor attributes in various cities in China; and (2) to determine the improvement direction for specific products and the ideal overall liking for various cities. Furthermore, we provide a consumer-oriented product design method to improve sensory quality according to the preference of particular consumers.

MATERIALS AND METHODS

Sample Preparation

Flavored liquid milks were designed with different flavors referring to Chinese National Standards (2007, 2008). The main components include milk, sugar, lactic acid and citric acid, and thickener (carboxymethylcellulose, **CMC**). Milk was used as the raw material, protein content was not less than 1.0%, and sugar and acid (lactic acid and citric acid) were added to make the liquid milk have a certain flavor. Thickener was added for stability and smooth mouthfeel. An orthogonal test design was made with these 4 factors with 4 levels each (see Table 1 for details).

Table 1. Orthogonal test table for flavored liquid milk

Level	Component			
	Milk (% protein)	Sugar (g)	Acid (g)	CMC ¹ (g)
1	1.0	7.0	0.40	0.30
2	1.1	8.0	0.50	0.35
3	1.2	9.0	0.60	0.40
4	1.3	10.0	0.70	0.45

¹CMC = carboxymethylcellulose (thickener).

Sixteen types of liquid milk were formulated based on the orthogonal test design. According to the ISO standard (ISO, 1993), assessors were selected and trained to meet the sensitivity requirement, and the sensory panel consisted of 20 assessors who were recruited from the sensory panel trained and tested regularly by the sensory analysis laboratory, and 12 of which were male. Most of them were familiar with flavored milk and had an average age of 35 yr, ranging from 28 to 39 yr.

The conditions of the sensory evaluation environment met the international standard (ISO, 2007). The room temperature was air-conditioned to maintain a temperature of 18°C. All 16 samples were presented monadically in random order with samples identified by 3-digit random code on the cup. To prevent sensory and mental fatigue resulting from tasting all samples, the 16 samples were divided into 4 groups and provided to assessors as 4 samples per session. During the sensory evaluation procedure, plain bread and water were provided to panelists to cleanse the palate. Assessors were asked to rest for 3 min between sessions. The 16 samples were individually assessed for sensory attributes of appearance, texture, aroma, and flavor. Descriptors were identified and selected for establishing the sensory profile.

A vocabulary of appearance, texture, aroma, and flavor was developed following the ISO standard (ISO, 1994). Finally, 12 sensory descriptors were selected by using a multidimensional approach, and the intensities of the selected attributes were evaluated.

The 12 sensory attributes (including appearance, texture, aroma, and flavor) were scored on a 15-cm line scale that had numerical anchors (0 and 15) at both ends. The numerical anchor 0 = none, 15 = extremely strong, and 0 to 15 means the trend of low intensity to high intensity. The average results of the sensory assessors were calculated for further processing.

Investigation of Consumer Perception

Three areas of China (north, east, and southwest) were chosen to represent typical flavor preferences, and Beijing, Shanghai, and Chengdu were selected in these 3 areas, respectively. Six hundred fifty-six adult consumers (16 to 45 yr of age) participated in this study (218 in Beijing, 218 in Chengdu, and 220 in Shanghai). The ratio between male and female was almost 1:1, and the distribution of age was 5:3:2 for 16 to 25 yr, 26 to 35 yr, and 36 to 45 yr. Respondents were recruited to a central location to participate in this study. Local flavor preferences for consumers from various cities are very helpful to improve the sensory quality of flavored milk. In particular, local citizens who live in a city for a

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