Consumers' Preferences towards
Nutrition-modified Milk in Urban Areas of China
with Rating-based Conjoint Analysis

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This study focuses on consumers' preferences for different types of nutrition-modified milk in urban areas of China. An online survey was conducted, which obtained 386 valid questionnaires. The results of conjoint analysis indicated that the ideal nutrition-modified milk was low-fat or skim milk. Also, consumers evaluated price least. Moreover, although the demographic effect and the influence of the level of involvement in milk had no significant effect on consumers' preference, consumers who feel very healthy and are more concerned about modified nutrition had a higher intention to purchase nutrition-modified milk.

Key words: nutrition-modified milk, Chinese consumers' preference of milk, conjoint analysis

1. Introduction

The issue of low consumption of fluid milk in China has aroused public attention. The annual per capita consumption of fluid milk in China is 17.67 kg, which is only 61% of the amount in Japan and 27% of the amount in the United States, respectively (China Industry Information, 2017). Moreover, Dietary Guidelines for Chinese Residents (Chinese Nutrition Society, 2007) suggested that adults should consume 300 grams of milk per day or a comparable amount of dairy products. However, according to the Chinese Milk Quotient Report (China Dairy Industry Association, 2018), only 22.5% of the residents had actually reached this standard.

Currently, the government is trying to expand the consumption of fluid milk (State Council, 2018). However, from the perspective of nutritional intake, the increase of fluid milk consumption also gives rise to additional fat intake. This is a dilemma that needs to be considered, because overconsumption of fat is a problem that still exists in China, especially in urban areas. The daily intake of energy from fat has exceeded the recommended amount by 30% among urban residents (National Health and Family Planning Commission of PRC, 2014).

It is known that conventional fluid milk can only provide limited trace elements; for example, there exists very little of the Fe mineral in fluid milk (Chinese Food Nutrition Table, 2002), which does not meet the demands of specific groups of consumers (Yu, 2001).

Under these circumstances, nutrition-modified milk has received widespread attention in China. Nutrition-modified milk is defined as one kind of milk product made by effective processes by adjusting the fat content or adding nutrient-enhancing ingredients (such as calcium, Vitamin D, etc.). For instance, high calcium milk and low-fat milk, which can commonly be seen in the market in urban areas (Wu, 2010). Furthermore, in order to solve the dilemma of increasing milk consumption and overconsumption of fat mentioned above, it is important to understand consumers' preference for nutrition-modified milk.

Previous studies on nutrition-modified or functional milk have been conducted to compare consumers' preferences towards one or two nutrition modified features with conventional milk. The fat content in fluid milk was considered in a large number of studies. Many researchers obtained the conclusions that low-fat milk (1% or 2% fat content) was most preferred among consumers (Harwood *et al*., 2018; Bus *et al*., 2003; McCarthy *et al*., 2017). On the other hand, fat content in fluid milk increases palatability and socio-demographic characters, affecting choices of low-fat milk (Bakke *et al*., 2016). Urala and Lähteenmäki (2004) conducted research on a sample of stated consumers' preferences for blood pressure-lowering milk drinks, and positive attitude and preference were found. However, to the

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best of our knowledge, most of the studies focused on only one or a few modified nutrition characters, and an intercomparison of consumers' preferences towards different kinds of modified nutritional characters in urban areas of China is still lacking.

Much of the current literature in China on consumers' preferences or perception of fluid milk pays particular attention to the safety concern (Cheng *et al*., 2015; Ortega *et al*., 2012), milk traceability (Bai *et al*., 2013), consumers' acceptance and willingness to pay for organic milk (Xu *et al*., 2016). Moreover, Bai *et al*. (2007) analyzed the attributes of fluid milk including low-fat or skim character. However, little research has focused on nutrition-modified milk for its differently modified nutrition characters.

Therefore, the objective of this research is to clarify consumers' preferences towards different nutrition-modified milk in China, especially for different forms of modified nutrition. Moreover, the effect of socio-demographic characters on consumers' intention to purchase nutrition-modified milk is also identified in this study.

2. Analytical Framework and Data

Based on the research purpose, rating-based conjoint analysis was conducted in this study. Although choice-based conjoint analysis provides more real situation for consumers, rating-based conjoint analysis can provide more information to the respondents, also the part-worth utility of every level and importance of each attribute can be calculated. In the first step, attributes and levels that reflect the dimensions which are important for consumers were designed. Then, factorial design, i.e., the orthogonal main effect design was applied to minimize the number of the profiles which respondents have to rate in the survey. Third, the mixed ANOVA model was applied to calculate the main effects of product attributes and consumers' characteristics on intension to purchase.

1) Levels and attributes

Including a modified nutrition attribute, the conjoint survey addressed four attributes of nutrition-modified milk with three levels per attribute to give respondents the feeling of a realistic situation. The attributes and levels were selected with reference to the pre-survey (*n*=70) conducted on July 2018. In the pre-survey, consumers' characteristics and their evaluations of different attributes of milk were inquired. Respondents for the pre-survey were randomly selected by using an online survey platform and carried out in Hangzhou and Ningbo, Zhejiang Province. The result indicated that

consumers considered brand, freshness, and price as important attributes when purchasing, therefore those attributes were selected in this study. All the attributes and levels are listed in Table 1.

Each product file was presented in the questionnaire with information for the attributes and levels below: Nutrition modified (High calcium, Low-fat or skim, Trace element added level). To respond specifically to respondents concerning trace elements, we added an example of Vitamin D. Also, since comparison among different nutrition-modified milk is the main focus for this study, conventional milk character was not included in the attribute. Moreover, Brand (Famous domestic brand, Local brand, Foreign brand) was included in this study. For foreign brand, Weidendorf, so natural and Oldenburger were included. Shelf life (Relatively short (3~10 days), Medium (30~45 days), Relatively long (180 days)); Price (4RMB/250ml, 5RMB/250ml, 6RMB/250ml) were also included in the conjoint analysis.

Table 1. Attributes and levels used in conjoint survey

Product Attribute	Level
Modified nutrition	High calcium
	Low-fat or skim
	Trace element (Vitamin D etc.) added
Brand	Famous domestic brand
	Local brand
	Foreign brand
Shelf-life	Relatively short (3~10 days)
	Medium (30~45 days)
	Relatively long (180 days)
Price	4
(RMB/250ml)	5
	6

2) Orthogonal main effect design

The profile number of full factorial design is $3\times3\times3\times3=81$; it is difficult to conduct all the profiles to each respondent, as it could affect the reality of the survey result. Therefore, orthogonal main effect design was used to minimize the number of the profiles used in the survey. For D-efficient design, it could enlarge the burden of the respondent due to composing choices with same utility (Aizaki, 2005), so orthogonal main effect design was applied in this study. Since we have four attributes with three levels, symmetrical orthogonal table $L_9(4^3)$ was applied. Therefore, the number of profiles need to be rated in the questionnaire was nine.

3) Conjoint model

The mixed model focusing on the main effect of conjoint variables and consumer characteristics could be considered in the formula below:

$$Y = Nutri + Brand + Shelf + Price + Age + Gender + Edu + Inc + heal + Con + Know + C + Nutri \times C + Brand \times C + Shelf \times C + Price \times C + \varepsilon \qquad (1)$$

where Y denotes the rating score for each nutrition-modified milk from the respondents. The respondents rates 1~10 points, in which 1 point denotes extremely low willingness to buy, and 10 points denotes extremely high willingness to buy. *Nutri* is the main effect for modified nutrition factor, *Brand* represents the main effect for brand factor, *Shelf* represents the main effect for shelflife of the nutrition-modified milk, and *Price* represents the main effect for the price of the nutrition-modified milk. Variables from *Age* to *Know* represent the main effect of consumers' age, gender, education, income, self-stated health, concern of nutrition-modified milk, and knowledge of nutrition-modified milk, respectively. These are the consumer' characteristics of interest in this study. In addition, *C* is the random effect for consumers, and *Nutri*C, Brand*C, Shelf*C, Price*C* are the interaction effect between consumer effect and conjoint variables. As consumer effect is random effect, all the interaction effects are also random effect in this model. ε denotes the random effect. Besides, all the main effects are fixed effect in this model. The calculations were conducted by using package *SensMixed* in software R (Version 3.5.1).

Moreover, in order to obtain the part-worth utilities of each level, conjoint analysis utility model was applied as below:

$$U = \beta_0 + \sum_{i=1}^{M} \sum_{J=1}^{N} u_{ij} x_{ij} + \partial \qquad (2)$$

where U denotes the rate for one profile, β_0 is the intercept, M and N represents the number of attributes and levels u_{ij} denotes the j-th level utility value of attribute i; x_{ij} is the j-th level dummy variable of attribute i. If the level j appears in the profile, then $x_{ij}=1$, otherwise, $x_{ij}=0$; ∂ is the regression error.

In terms of calculation the importance of each attribute, the function can be presented as follows:

$$W_i = \frac{R_{ij}}{\sum_{i=1}^{M} R_{ij}}, R_i = \max(u_{ij}) - \min(u_{ij}) \qquad (3)$$

W_i is the importance score for attribute i, $\max(u_{ij})$ and $\min(u_{ij})$ are the maximum and minimum values of the j-th level utility value of the product attribute i. The calculations were conducted by using package *Conjoint* in software R.

4) Data

All the data used in this article were drawn from responses in China at the end of July 2018. Online survey was developed by using online questionnaire platform Wenjuanxing (Changsha Ranxing Information Technology Co., LTD) Survey participants ($n = 444$) who were 18 year of age or older from urban areas of China were able to enter the survey. Participants who reported consumption of fluid milk at least once a month were allowed to participate in the conjoint analysis exercise and subsequent survey sections.

Table 2. Personal characteristics of respondents

Personal characteristics	Total%	Personal characteristics	Total%
Gender		Education	
Male	46.98%	≧Bachelor	69.78%
Female	53.02%	High school	24.45%
Age		≦junior high school	5.77%
20-29	42.31%	Frequency of drinking milk	
30-39	32.69%	< 1 time/week	18.68%
40-49	12.36%	1 or 2 times/week	32.14%
50-59	12.36%		
≧60	0.27%	3 or 4 times/week	26.65%
Income (RMB/month)		5 or 6 times/week	12.09%
<5000	30.49%	Everyday	10.44%
5000-10000	37.64%	Concern of added nutrition	
10001-15000	18.13%	Not concern	20.88%
15001-20000	5.49%	Concern a little bit	57.42%
> 20000	8.24%	Very concern	21.70%
Knowledge of Nutrition-modified milk		Health status	
Don't know at all	15.11%	Not very healthy	6.87%
know a little	63.19%	Moderate	40.66%
know very well	21.70%	Very healthy	52.47%

Notes: 1) Health status denotes self-rated health status.

2) Knowledge of nutrition-modified milk denotes subjective knowledge about nutrition-modified milk.

384 valid samples were obtained. Nearly 70% of the respondents were from southern China (Chongqing, Shanghai, Guangdong, Fujian, Zhejiang, Sichuan, Yunnan, Hubei, Jiangsu, Anhui, Henan, Hunan, Jiangxi, Tianjin, Shanxi, Inner Mongolia, Hebei), and 30% of the respondents were from northern China (Beijing, Liaoning, Shandong, Shanxi, Jilin, Gansu). Description statistics for the respondents were reported in Table 2.

The portion of the females was slightly higher than males. Most of the respondents were young or middle-aged. Moreover, 68.03% of the respondents' income was RMB 0~10,000 per month, and 94.23% of the respondents had attended high school or above. Furthermore, considering the self-reported health status, only 6.87% of the respondents stated that they did not feel very healthy while more than 50% of the consumers claimed that they felt very healthy.

A self-reported question allowed respondents to report how much they knew about nutrition-modified milk. Results indicated that 78.30% claimed to know a little or nothing about nutrition-modified milk. The frequency of drinking milk differed among consumers. Consumers who drank milk 1-2 times per week made up the largest proportion. Moreover, more than 50% of the consumers were a little concerned about modified nutrition in milk.

3. Result and Discussion

1) Main effect for conjoint variables

The result calculated by model shown in Tables 3 and 4.

Table 3. *P*-values for the fixed effects in the model

Category	Sources	*P*-value
Product attribute	Nutrition-modified character	<0.001
	Brand	<0.001
	Shelflife	<0.001
	Price	<0.001
Socio-demo-graphic characters	Age	0.461
	Gender	0.738
	Income	0.084
	Education	0.062
	Self-reported health status	<0.001
	Concern of modified nutrition	0.025
	Knowledge of nutrition-modified milk	0.076

All the product attributes had significant effects on consumers' willingness to buy. Moreover, consumers' self-

reported health status and concern of modified nutrition also had a significant effect. For milk with a nutrition-modified character, Table 4 demonstrated the result that low-fat or skim milk received the highest intention to purchase among consumers, while milk with added trace elements was least preferred among the modified nutrition attributes.

This result could be interpreted as indicating that currently, fluid milk consumers pay attention to the fat content in milk; as the Chinese Milk Quotient Report (2018) notes, 24.3% of the consumers worried about the weight problems, which was one of the reasons that they do not drink milk. Therefore, low-fat or skim character was the most preferred.

Table 4. Nutrition-modified factors for willingness to buy

Sources	LSMEANS	*P*-value	*S.D*
High calcium	5.8932	<0.001	0.1655
Low-fat	5.9930	<0.001	0.1655
Trace-element added	5.3914	<0.001	0.1655

Note: LSMEANS calculated from model represents the respondents' mean willingness to buy of the level.

Similar results were obtained in other research on the fat-modified attribute of fluid milk in China where fat free milk was the most preferred level, followed by milk with 1.5% fat content, and milk with a 3.8% fat level (Bai *et al*., 2007). Bai's results showed consumers' preferences towards different fat levels compared to conventional milk; however, our results demonstrated the intercomparison of different types of modified nutrition, comparing skim or low-fat level with high calcium level and an added trace element level. Still, the result showed that low-fat or skim milk was most preferred.

For the same comparison objective, nutrition-modified milk, Wu *et al*. (2010) conducted descriptive analysis and obtained the conclusion that milk with high fat was least preferred, and high calcium milk was most liked in Beijing. The reasons for different result in this study are that trade-off of nutrition-modified milk features (such as brand, price, etc.) was not considered and the data was collected in the capital of China in relatively early period.

Based on the part-worth utility estimations from conjoint model, foreign brand was most preferred following by famous domestic brand and local brand. As for the shelf-life attribute, a preference towards relatively long shelf-life was observed in overall population. Median price (5RMB/250ml) had the highest utility score within price attribute (Figure 1).

The preference for foreign brand could be interpreted that due to the early melamine incident, many consumers worried

about the safety of the dairy product in China, therefore, they tend to purchase foreign brand. Moreover, Zhang (2010) drew the conclusion that Chinese consumers tend to use brand as an indicator to determine the safety of the milk.

Another result showed that contrast to most of the developed countries, relatively long shelf-life was given high utility score. One of the reasons could be considered that more than 60% of the fluid milk in Chinese market is UHT milk with long shelf-life (Mordor intelligence, 2017). Also considering the convenience of storage, long shelf-life was preferred by Chinese consumers.
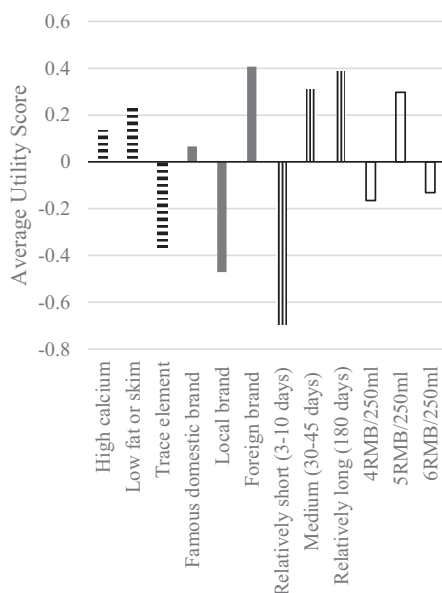

Figure 1. Average utility score of levels (All samples)

However, Bai (2007) obtained different result that the proportion of consumers choosing pasteurized milk (with short shelf life) was higher than UHT milk (with long shelf-life). This is probably for the consumers' different cognition between UHT milk and long shelf life milk.

In terms of price, the middle price (5 RMB/250ml) received the highest utility score. It could be interpreted by surrogate indicator, which denotes that consumers often use other attributes such as price, as indicators of product quality (Hawkins *et al.*, 2013), therefore, the lowest price was not preferred by consumers. Also, it is reasonable that consumers react to high price negatively.

In terms of the importance score of each attribute, modified nutrition (25.69%), brand (25.62%) and shelf life (26.91%) have no significant difference (*p*>0.05), while price

(21.78%) was the least important attribute (*p*<0.05).

(2) Main effect for consumer characteristics

As Table 5 showed that self-stated health status had significant main effect on intention to purchase nutrition-modified milk, to be specific, consumers who feel very healthy had a higher intention to purchase nutrition-modified milk (Table 5). This could be explained that consumers who feel themselves in a good health status tend to consume nutrition-modified milk to protect their good health status (Cranfield *et al.*, 2011).

Table 5. Self-reported healthy status factors for willingness to buy

Sources	LSMEANS	Standard error
Very healthy	6.2144	0.1583
Moderate	5.6505	0.1670
Not very healthy	5.4128	0.2883

Note: LSMEANS calculated from model represents the respondents' mean willingness to buy of the level.

Moreover, from Table 5, the result could be seen that consumers who were concerned about modified nutrition had a higher intention to purchase nutrition-modified milk.

Table 6. Concern of modified nutrition factors for willingness to buy

Sources	LSMEANS	Standard error
Not concern	5.4847	0.2141
Concern a little bit	5.7198	0.1595
Very concern	6.0731	0.2008

Note: LSMEANS calculated from model represents the respondents' mean willingness to buy of the level.

To summarize the conjoint analysis result, low-fat or skim milk was the most preferred while trace-element-added milk was least preferred among consumers. Also, consumers evaluate price as least important character when purchasing nutrition-modified milk. Moreover, consumers who feel very healthy and more concerned about the modified nutrition had a higher intention to purchase nutrition-modified milk. Consumers in urban areas of China who concern about the modified nutrition and feel very healthy could be the target in the market.

4. Conclusion

This study analyzed consumers' different preferences for nutrition-modified milk. Conjoint analysis results indicated that the most preferred modified-nutrition milk is low-fat or skim milk and the least preferred modified nutrition in milk

is added trace elements. Moreover, when purchasing nutrition-modified milk, consumers value foreign brand, long shelf life, and medium price the most. Also, consumers put less importance on price. Furthermore, consumers who feel very healthy and those who are more concerned about modified nutrition have a higher intention to purchase nutrition- modified milk.

This study improves the understanding of Chinese consumers' preferences for different types of nutrition-modified milk. However, this study has limitations in evaluating the preference of milk of Chinese consumers, and it's necessary to expand the sample size and target areas. In the future studies, it is important to understand the interaction effect among different levels of modified nutrition attributes and minimize the internet survey bias.

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