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# Sensory Characteristics and Consumer Acceptance of Fruit Juice Containing Probiotics Beads in Thailand

Wunwisa Krasaekoopt and Kamolnate Kitsawad

Faculty of Biotechnology, Assumption University  
Bangkok, Thailand

E-mail: <wunwisakrs@au.edu; kamolnatekts@au.edu >

## Abstract

*Although the survival of probiotics in fruit juices, which were nominated to be a good probiotic carrier, could be improved by using microencapsulation technique in alginate bead coated with chitosan, the satisfactoriness of the consumer must be considered. Consumer assessment and sensory evaluation of this product were performed by consumers in Thailand and by using descriptive analysis, respectively. Four hundred consumers from Bangkok and the suburbs of Bangkok were served with orange and grape juices containing probiotic beads together with questionnaire in order to determine the consumer demographic, buying behavior and consumer acceptance. Most consumers bought fruit juice due to its taste (9.6) and nutritional value (8.9). However, the addition of probiotic beads influenced the sensory quality of the product by increasing the swallowing difficulty and remaining particles of the products. The majority of consumers accepted orange and grape juices containing probiotic beads (82.3 and 84.3%, respectively), giving scores of texture and overall preferences as 6.6 and 6.7 for orange juice; and 6.8 and 6.9 for grape juice. Application of probiotic beads also increased turbidity of grape juice. Moreover, more than 86% of the participants were willing to try and purchase the product, reflecting existence of a potential market for fruit juice containing probiotic beads.*

**Keywords:** probiotics, fruit juice, consumer acceptance, healthy drink, microencapsulation.

## 1. Introduction

The interest in probiotic products has been increased in the last two decades due to the health awareness of consumers (Menrad 2002). Probiotics are living microbial supplements, which beneficially affect the host by controlling intestinal infection, controlling serum cholesterol levels, beneficially influencing the immune system, improving lactose utilization in lactose maldigestors, and having anticarcinogenic activity (McNaught and MacFie 2001; Saarela *et al.* 2002; Rafter 2003). Currently, industrial probiotic food products mainly belong to dairy products such as yogurt and fermented milk. Nevertheless, lactose intolerance and the cholesterol content in milk are two drawbacks related to the consumption of consumers. Fruit juice is found

as a healthy food product, and is currently consumed by a large percentage of the global consumer population (Verbeke 2005). Fruits are healthy foods because they are rich in antioxidants, vitamins, dietary fiber and minerals. In addition, fruits do not contain any dairy allergens, such as casein and lactose. (Luckow and Delahunty 2004a). Fruit juice was also suggested to serve as a good medium for probiotics (Tuorila and Cardello 2002).

Although cooperation of probiotics in fruit juices either by probiotication process, which allowed probiotic bacteria to grow in fruit juice, or direct addition provided the health benefit to consumers, the sensory quality of the product was not accepted (Krasaekoopt and Chea 2007). Luckow and Delahunty (2004a) demonstrated the sensory "off-flavors" in probiotic fruit juices.

They also reported that the off-flavors in blackcurrant juice were less intense than those found in probiotic orange juices. Consumers prefer the sensory characteristics of conventional orange juices to their functional counterparts, when tasted without product information, health claims, branding, or price structure. However, the sensory attributes associated with the functional orange juice product were completely unacceptable to the frequent orange juice consumers; they did not affect the satisfaction among light and non-users of orange juice product. On the other hand, the appearance and flavor of probiotic blackcurrant juice did not affect the consumer desire to consume or to purchase the product (Luckow and Delahunty 2004b).

The microencapsulation technique does not only improve the survival of probiotics in fruit juices (Krasaekoopt *et al.* 2008), but may also improve the off-flavor of the product. Moreover, the consumer assessment of fruit juices containing probiotic beads has not been reported anywhere else except in Kitsawad (2007). The addition of probiotics encapsulated in alginate beads coated with chitosan may affect the consumer preference and sensory attributes of the product due to the size of the beads. Therefore, the aim of this study was to investigate the assessment of orange and grape juices containing probiotic beads by consumers in Thailand. Simultaneously, the effect of probiotic beads on sensory attributes using descriptive sensory analysis was studied.

## 2. Materials and Methods

### 2.1 Preparation of Probiotics

*Lactobacillus casei* 01 (Chrs. Hansen) was inoculated into 10 mL de Man Rogosa and Sharp (MRS) broth and incubated at 37 °C for 2 days under aerobic condition. The culture was transferred to 95 mL MRS broth and incubated at the same condition. The cells were harvested by centrifuging at 1,500 × g for 15 min at 25 °C. The harvested cells were washed twice with sterile water.

### 2.2 Microencapsulation of probiotics

The washed cells were suspended in 5 mL sterile water. It was mixed with 20 mL of sterile sodium alginate solution (2% w/v). The suspension was placed into a sterile syringe and injected through 0.11 mm needle into sterile 0.05 M CaCl<sub>2</sub> solution containing Tween 80. After 30 minutes of gelification, the beads were rinsed twice with sterile water.

### 2.3 Coating with Chitosan

Low-molecular-weight chitosan (Fulka) was dissolved in 90 mL distilled water and acidified with 0.4 mL glacial acetic acid. The pH was adjusted to between 5.7-6.0 with 1 M NaOH. The mixture was filter through Whatman No. 4. The volume was adjusted to 100 mL and sterilized at 121 °C for 15 min. After that, 15 g of washed beads were suspended into chitosan solution and shaken at 100 rpm for 40 min. The coated beads were washed twice with sterile water and kept in sterile water at 4 °C.

### 2.4 Application of Microencapsulated Probiotic Beads in Fruit Juice

The microencapsulated probiotic beads were aseptically added into 200 mL fruit juice at 10% of the weight of fruit juice. This was done with both orange and grape juices.

### 2.5 Sensory Evaluation

**2.5.1 Descriptive Analysis:** Eight panelists were recruited from Faculty of Biotechnology, Assumption University, Bangkok, Thailand. They were assisted in developing a consensus vocabulary for aroma, appearance, texture and flavor attributes for orange and grape juices with and without probiotic beads. This procedure for attribute development was parallel to that used in some other recent sensory studies (Vara-Ubol *et al.* 2004; Matta *et al.* 2005; Chambers *et al.* 2006). The consensus terms used for orange and grape juices are shown in Table 1.

Table 1. Product attributes. Definitions and corresponding reference standards used in the trained panel evaluation.

Term		Definition	Character References (Highest intensity)
Orange juice	Grape juice		
Yellow color		Degree to which the sample is visually dark yellow	Ripened mango
	Purple color	Degree to which the sample is visually dark purple	Mangosteen peel
Turbidity	Turbidity	Degree of clarity of the sample	Milk
Orange odor		Like the aroma of fresh orange	Fresh oranges
	Grape odor	Like the aroma of fresh grape	Fresh grapes
Swallow ability	Swallow ability	Degree of easiness to swallow the sample	Chinese sweetmeat
Sourness	Sourness	Fundamental taste	Lime
Sweetness	Sweetness	Fundamental taste	Sugar
Particle remaining in the mouth	Particle remaining in the mouth	Containing juice particles or bits	Juice with small pieces of pulp

After the vocabulary was established, the panelists were trained for 8-10 sessions by rating the intensity of each attribute in 15-cm unstructured line scale that was anchored on both ends with extremes of each descriptive term until the standard deviation of each attribute was less than 1.5. Then the panelist rated the intensity of the products. Orange and grape juices were served in clear glasses (40 mL in a 120 mL glass), topped with transparent and vented lids, respectively. They were maintained and served at 4°C. Fruit juices were evaluated triplicately.

**2.5.2 Consumer Acceptance Test:** Consumer testing was performed at public places in Bangkok (four places) and the suburb of Bangkok (four places). Based on the formula developed by Cochran (1963), four hundred fruit juice consumers (170 males, 230 females, age range from 14 to 55 years), participated in this study. The participation of the consumers was voluntary and no monetary compensation was given. The consumers answered demographic questions (gender, age, education, occupation and income); buying behavior (frequency and amount of buying, quality of fruit juice); and their attitudes of consumers for fruit juices containing probiotics.

The consumers were then served with the orange and grape juices, respectively, both with and without probiotic beads, in clear glass (40 mL glass) topped with transparent, vented lids, at 4 °C. The consumers were given the

instruction not to chew the beads in fruit juices because the protection of entrapped cells from the gastric and intestinal juices decreased. They were asked to rate their liking by using 9-point hedonic scale for texture and overall acceptance of fruit juices.

## 2.6 Data Analysis

ANOVA and least significant differences (LSD) ( $p < 0.05$ ) were executed with SPSS software (version 11.5) on descriptive analysis of fruit juices containing probiotic beads, while the hedonic ratings of the fruit juice quality were used for evaluating the consumer preference on texture, overall characteristics and purchasing decision.

## 3. Results and Discussion

### 3.1 Consumer Acceptance Test

Four hundred fruit juice consumers, 170 males and 230 females, participated in this study, where the majority was in the age range from 16 to 30 years (83.3%), indicating that most of the fruit juice drinkers were teenagers and young adults. The educational background of most consumers was bachelor degree (78.5%), of which 56.3% were students. The group of adults and elders made up approximately 15% of the fruit juice consumers. In addition, the income of fruit

juice consumers was in the range of 5,001-10,000 Baht (32.3%). Almost half of the consumers consumed fruit juices 3-4 times per week (47.2%). From the preliminary survey, even though there is a large variety of fruit juices already available in the market, most of the juice consumers preferred grape and orange juices (16.5 and 16.3%, respectively), which is the reason as to why the said fruit juices were used in this study (the result was not shown).

The buying behavior of fruit juice consumers was also investigated. It was recognized that the consumer buying behavior was mainly influenced by the quality of the product, in which the most important attribute was product's taste (9.6), followed by nutritional value (8.9), odor (8.2) and price (8.0) (Fig. 1). This implied that most consumers buy fruit juice due to its taste rather than other qualities.

The participants' attitude on fruit juice containing probiotic beads is shown in Fig. 2. It was recognized that although a large percentage of consumers (91.8%) wanted an increase in the nutritional value of fruit juice, only 7.8% of the participants knew about probiotics and their benefits. This implied that most of the Thai consumers had less knowledge about these beneficial bacteria. However, most of the participants were willing to try (88.8%) and buy (86.5%) the fruit juice containing probiotic beads after tasting the products, entailing an existing potential market of this product in the Thai market.

In addition, more than 80% of the consumers accepted fruit juices containing probiotic beads, both orange and grape juices, with the overall scores of 6.7 and 6.9 for orange and grape juices, respectively, thus reflecting the acceptance of this innovation (Table 2). Even though the size of the beads was quite big, 0.1-0.2 mm, less than 20% of the consumers did not like the probiotic beads, which sometimes remained in the mouth and/or stuck in the throat.

In comparison with the previous study in plain and strawberry yogurts (Krasaekoopt and Tandhanskul 2008), the acceptability of plain yogurt, orange and grape juices was similar; however, a high percentage of consumer acceptance of strawberry yogurt was obtained

(94.9%). This might be due to the observation that the consumers were familiar with yogurt containing probiotics, which was available in the market, rather than with the fruit juice.

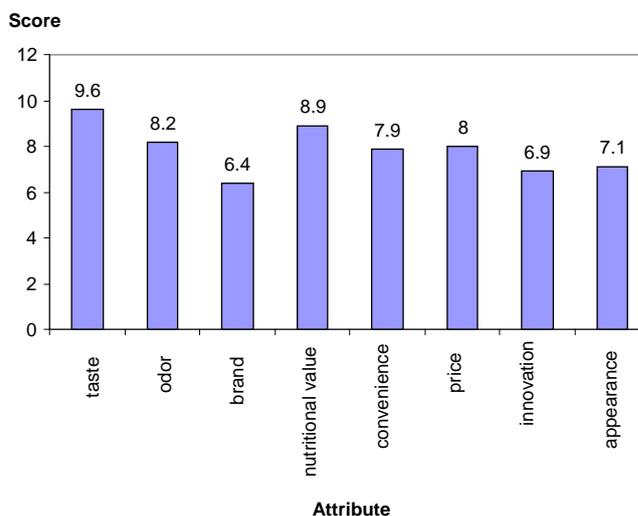


Fig. 1. Means of the consumers' hedonic rating on qualities of fruit juice used for purchasing the product (n = 400).

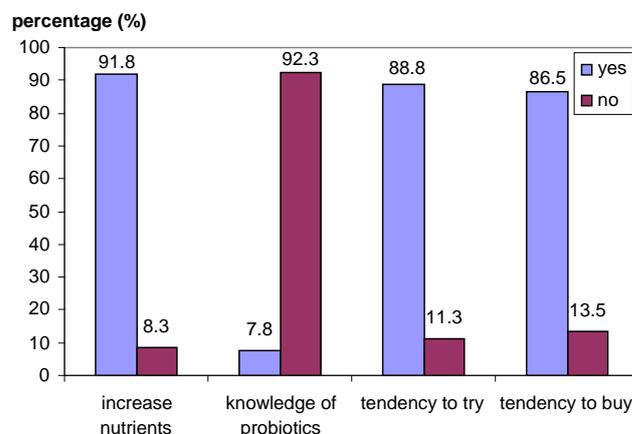


Fig. 2. Percentages of consumer opinion on yogurt containing probiotic beads (n = 400).

Table 2: Mean (± SD) of texture, overall scores and consumer acceptance for yogurts with probiotic beads by consumer test (n = 400).

Product	Texture score	Overall score	Acceptance (%)
Orange juice	6.6 <sup>a</sup>	6.7 <sup>a</sup>	82.3 <sup>a</sup>
Grape juice	6.8 <sup>a</sup>	6.9 <sup>a</sup>	84.3 <sup>a</sup>

\* The same letter means no significant difference at 95% confidential level.

Moreover, strawberry yogurt usually contains fruit pieces, which could have no texture difference if it contained probiotic beads. A regular fruit juice, conversely, usually does not contain any particles. Thus, fruit juice containing probiotic beads may give a slight difference in texture in the mouth compared to the conventional ones. The difference in viscosity of these two products also played a major role in determining the difference in the acceptability level. Yogurt is a viscous product, thus it can hold the probiotic beads. Contrastingly, fruit juice is a watery type product and the beads tend to sink down. In addition, the spherical beads also gave a sensation of foreign particles in the fruit juice.

### 3.2 Descriptive Sensory Analysis

Eight trained panelists were inquired to evaluate fruit juice with and without probiotic beads. Spider web diagrams were developed for both orange and grape juices (Fig. 3). It was realized that addition of probiotic beads had a remarkable influence on the texture profile of the product. The presence of the beads created the swallowing difficulty and the beads sometimes remained in the mouth. The scores of swallowability of fruit juices with probiotic beads were 2.1 and 2.0; and without probiotic beads were 6.9 and 6.8 for orange and grape juices, respectively.

Moreover, the addition of probiotic beads significantly ( $p < 0.05$ ) affected the turbidity of grape juices. The intensity of turbidity increased from 6.5 to 7.2 in the presence of probiotic beads. This might be caused by the white color of the beads contrasting with the deep purple color of grape juice, resulting in an increase of the turbidity of the product. Furthermore, some probiotic beads might not be completely encapsulated, therefore, some microorganisms and entrapped material might be released from the beads, consequently contributing to an increase in turbidity of grape juice. On the other hand, addition of probiotic beads did not affect the turbidity of orange juice due to the presence of pulp and the color of the juice.

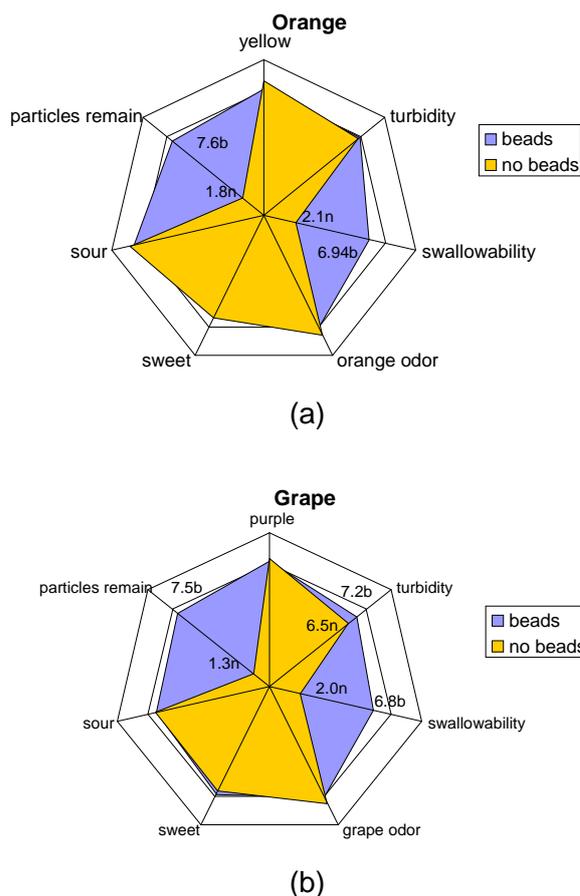


Fig. 3. Typical spider plot for intensity of attributes in fruit juices containing microencapsulated probiotics: (a) Orange juice; and (b) Strawberry yogurt.

Likewise, the presence of the probiotic beads in fruit juices gave aftertaste attribute to the panelists with some remaining particles. The intensity of remaining particles was reduced from 7.6 to 1.8 and 7.5 to 1.3 for orange and grape juices, respectively. This was probably due to the watery characteristics of fruit juices. Conversely, the difference in this attribute was not detected in yogurt (Krasaekoopt and Tandhanskul 2008) because of the higher viscosity or thicker texture of the product compared to fruit juice.

Fruit juice containing probiotic beads is an innovative product; therefore, the price of the product may be higher than the traditional product due to the fortification of the probiotic beads. However, the beneficial health effects obtained from this product are invaluable; so the consumers may be willing to pay more for a better quality of the products.

## 4. Conclusion

Although an alternative product as fruit juice containing probiotic beads is a new product to the consumers, a potential niche market for this product appears to strongly exist in the Thai market. Consumers bought fruit juice due to its taste and nutrients. Simultaneously, they also wanted higher health benefits from fruit juices as well. Even if fortification of probiotic beads had an effect on the texture characteristics of the products by increasing the swallowing difficulty, remaining particles and turbidity, a good number of consumers accepted orange and grape juices containing probiotic beads.

## 5. Acknowledgement

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