



Consumer Perception and Acceptance of Pasteurised Pineapple Juice With Encapsulated Probiotics

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ABSTRACT

Fresh pineapple juice is widely appreciated for its numerous health benefits derived from the nutrients in the fruit. Current busy lifestyles have caused many people to prefer ready-to-drink commercial functional juices, such as probiotic-added juice. The probiotics are encapsulated to preserve their bioavailability and survivability in the acidic juice. However, consumer acceptance of this enhanced juice remains uncertain, as the heating process and the addition of encapsulated probiotics may change the juice's sensory parameters (taste, texture, and colour). Therefore, focus group discussion (FGD) sessions ($n=18$) were conducted to assess consumer perception and acceptance of pasteurised pineapple juice with encapsulated probiotics. The FGD sessions assessed general fruit consumption, safety concerns, and health benefits of taking probiotics. The findings revealed that 100% consumers preferred the safety provided by pasteurisation and the additional health benefits associated with the addition of encapsulated probiotics to the juice. The acceptance of this experimental juice formulation indicates its potential for commercial applications.

Key words: Consumer perception and acceptance, encapsulated probiotics, focus group discussion, functional beverage, pasteurisation, pineapple juice

INTRODUCTION

Fruit juice is one of the most widely consumed drinks worldwide, and pineapple juice stands out as a favourite due to its pleasant aroma and flavour. Fruit juice also helps fulfil dietary requirements for fruit consumption, providing numerous beneficial health benefits. In today's fast-paced lifestyle, pasteurised commercial pineapple juice meets the needs of busy consumers, acting as a convenient option, as the juice eliminates the process of fruit preparation, and it is portable and available in packs or bottles (Nee *et al.*, 2024; Yusoff *et al.*, 2024; Zaini *et al.*, 2024).

Interestingly, consumers today not only want a convenient way to quench their thirst but are keen on beverages that offer additional health benefits (Podshadri *et al.*, 2024). The demand for commercial functional fruit juices has increased over the past three years and is projected to continue increasing until 2030. Functional or fortified fruit juices are marketed as healthy options for individuals of all ages, as consumers appreciate the presence of key bioactive components added to the drink, such as probiotics. *Lactobacillus casei* strains are one of the *Lactobacillus* probiotics commonly utilised in functional food production. These strains have been shown to lower cholesterol levels and inhibit the proliferation of cancer cells. Additionally, *L. casei* probiotics also exhibit significant antibacterial capabilities. Incorporating them into the diet can help with gastrointestinal problems, allergies, and lactose intolerance (Ibrahim *et al.*, 2024; Ilyanie *et al.*, 2024; Koh *et al.*, 2024; Sin *et al.*, 2024). However, probiotics designed for dairy products require modification for fruit juice delivery.

Compared to directly adding probiotics to the drink, encapsulation improves probiotic bacteria's stability, efficiency, and survival rate during processing and human digestion (Ramly *et al.*, 2024). Encapsulation is a superior technique that can help disguise undesirable flavours and odours produced by probiotics in the beverage. A product of encapsulation, known as a microbead, provides an anaerobic environment favourable for probiotic growth and protection from hostile external environments, such as acidic fruit juice and gastrointestinal conditions, thus reducing cell destruction (Yanyium *et al.*, 2024; Yu *et al.*, 2024). Tiny microbeads produced by encapsulation, resembling commercial "bubble tea," can also be a marketing gimmick (Tanganurat, 2020; Fu *et al.*, 2023).

Nevertheless, the processes involved in producing this functional pineapple juice, including pasteurisation and probiotics

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addition, may lead to changes in sensory parameters (Chandra *et al.*, 2021; Teh & Ting, 2024). Therefore, food processors must assess consumer acceptance before launching, as different beverage formulations yield varying levels of overall acceptability, and consumer perception determines the commercial acceptability of a food product (Gupta *et al.*, 2023; Yasin & Zainudin, 2023).

An effective method for assessing consumer acceptance of food products is by conducting a focus group discussion (FGD). It is an explorative qualitative technique used to gather primary data from targeted individuals or consumers who meet specific criteria relevant to the researcher's focus (Hüppe & Zander, 2021; Susilowati *et al.*, 2024). For example, one FGD session conducted among consumers in Ghana revealed that health and nutrition were the main motivations for juice consumption. However, factors such as taste, cost, availability, and culture were found to be barriers to consumption (Acquah *et al.*, 2023). Besides, gender and social conditions also played a role. Although women in a high-income inequality society were more likely to consume fruits and vegetables, they were less likely to meet fruit and vegetable recommendations due to various income and social-related concerns (Horino *et al.*, 2020). Therefore, a specific FGD is critical to understand local consumers' acceptance of a new food product, in this case, pasteurised pineapple juice with encapsulated probiotics.

MATERIALS AND METHODS

Materials

Sodium alginate with a high L-guluronic acid to D-mannuronic acid (G: M) ratio was purchased from Kimika Cooperation, Japan. Calcium chloride was bought from Bendosen, Malaysia. The probiotics used for encapsulation were *L. casei* Shirota probiotics, cultured from a commercial probiotic-fermented milk beverage (Yakult, Malaysia). De Man, Rogosa, and Sharpe (MRS) broth and agar powder were bought from Oxoid, United Kingdom.

Pineapple juice preparation

The ripe MD2 pineapples used in this research were sponsored by Smart KJ Agro (Asia) PLT (Smart KJ) from their plantation in Bukit Tangga, Kedah. Three pineapple juice samples, i.e., non-pasteurised (S1), pasteurised (S2), and pasteurised juice with encapsulated probiotics (S3), were prepared for the informants during FGD sessions. The pineapples were cut into small chunks, and their juice was extracted using a slow juicer (BioChef Synergy, Australia). The juice sample was poured into a clear glass bottle (250 mL) and labelled as S1. The other two juice samples underwent the pasteurisation process. Pasteurisation of these two juice samples was conducted at 90°C for 30 s using a custom-made pasteuriser, which consisted of a peristaltic pump (Easy-load Masterflex 7518-10, Cole-Parmer, USA), a 1 cm diameter plastic tube (1 m inlet to the coil, 1.5 m outlet), a wort chiller 304 stainless steel coil (pipe size of 9.52 mm & coil length of 8.8 m), and a thermostatic water bath (TW12 Julabo, Germany). The pasteurised juice was then dispensed into UV-sterilised glass bottles with twist caps and placed in an ice bath. This pasteurised juice sample was labelled as S2.

Probiotics encapsulation

Probiotics from the Yakult drink were cultured in MRS broth and were placed in a shaking incubator (110 rpm) (Sartorius, 3-18K, Germany) at 37°C for 24 hr. Then, the 10 mL broth was transferred into a 250 mL Erlenmeyer conical flask containing 90 mL sterilised MRS broth and was incubated again at 37°C for 16 hr. The cell culture was then centrifuged at 5,000 rpm (Eppendorf, USA) at 25°C for 10 min and homogeneously dispersed into a sodium alginate solution (Pourjafar *et al.*, 2020) for encapsulation.

Probiotic encapsulation was performed using a custom-made air extrusion system, with 2.0% w/v sodium alginate as the matrix and 1.5% calcium chloride solution as the gelation bath. The average diameter of the produced microbeads was 1.77 ± 0.13 mm. Finally, 10 g of the encapsulated *L. casei* Shirota was added to pasteurised pineapple juice. The final product was labelled as S3.

Focus group discussion

Consumer perception and acceptance of pineapple juice with encapsulated probiotics were evaluated using the FGD method. The FGD sessions were conducted at the Viva Room of the Faculty of Engineering & Chemical Technology, Universiti Malaysia Perlis. Each session lasted for 60 min. Six informants participated in three FGD sessions, making it 18 informants in total. The informants were working adults aged 25 to 55 years. They were consumers with stable incomes and busy lifestyles, who were presumed to be consumers who might be interested in purchasing the proposed product. To confirm their status as fruit juice consumers, the prospects were verbally asked if they used to buy fruit juices. An invitation letter was sent to the prospects, allowing them to choose a suitable time to attend from several tentative dates and times.

The three juice samples prepared were brought together and presented to the informants during the FGD sessions, and the informants were allowed to observe the colour and condition of the samples. All sessions were conducted in Bahasa Malaysia and began with a brief explanation of the ground rules. In the beginning, the informants were instructed not to unscrew the caps of the sample bottles or taste the samples. Open discussion within the group was allowed, and later, the moderator asked the informants to fill out the consent form and started the discussion with a brief introduction of the informants' details. The informants were asked to introduce themselves by telling their names, hobbies, and favourite foods. These aspects were chosen to relate to the informants' interests and their responses, as a person's perception is influenced by their experience and life background (Zacharia *et al.*, 2021).

The focus groups followed a semi-structured discussion guide that had been prepared in advance, featuring three subthemes and corresponding lead questions. These questions assessed consumers' values, attitudes, and intentions to buy the proposed juice (Kowalska *et al.*, 2024). The moderator occasionally addressed related samples during the discussions. These sessions were video-recorded for transcription purposes (Lee *et al.*, 2023). Following the sessions, the informants' responses were transcribed and qualitatively analysed. The names of the informants were kept anonymous and were referred to as Informant 1

through Informant 18. The transcripts were analysed for themes, and thematic saturation was reached after the three sessions (Estradé *et al.*, 2024).

RESULTS AND DISCUSSION

The total number of informants in the three FGD sessions was 18 (17% male & 83% female; 89% Malay & 11% Chinese). These informants possessed educational qualifications ranging from a minimum degree to a PhD. Their ages ranged from 30 to 55 years (average of 42 years) at the time of the FGD. Sociodemographic details and self-introduction were also used to justify their responses to the questions asked. The details of the informants are presented in Table 1.

Table 1. Sociodemographic characteristics of respondents

Informant	Gender	Age	Race	Monthly income (RM)	Number of households	Education background
1	Male	37	Malay	5,800	5	Masters
2	Female	37	Malay	5,800	5	Degree
3	Female	44	Malay	7,200	3	Masters
4	Female	42	Malay	8,000	6	Degree
5	Female	43	Malay	6,500	6	Degree
6	Female	42	Malay	6,500	6	Degree
7	Male	55	Malay	8,000	1	Masters
8	Female	55	Malay	10,000	7	Degree
9	Female	42	Malay	9,000	5	Degree
10	Female	40	Malay	6,500	7	Masters
11	Female	42	Malay	10,000	6	Masters
12	Female	42	Malay	10,000	7	Degree
13	Female	33	Malay	4,000	3	Masters
14	Female	30	Malay	4,000	1	Masters
15	Female	41	Chinese	8,000	6	PhD
16	Male	53	Malay	8,000	4	Masters
17	Female	39	Malay	6,000	7	Degree
18	Female	36	Chinese	5,800	3	Masters

General fruit juice consumption

In this first discussion subtheme, the informants were asked about their general consumption and preference for fruit juice. This section was used to determine the informants' preference level for fruit juice to draw a baseline that can be related to their response to the questions asked later. Although the informants had different varieties of favourite food, most (94%) said that they enjoy drinking fruit juice. Only Informant 3 expressed a preference for creamy dairy products. Thus, the informants' likeness to fruit juice made their opinion on fruit juice reliable. The fruit juices favoured by the informants vary, including apple, orange, watermelon, carrot, pineapple, strawberry, pomegranate, and mango. On average, these informants consume fruit juice about two to three times a week. This consumption frequency indicates a moderate level of fruit juice intake, which can be a positive sign for the potential market.

The main reason that the informants prefer to drink fruit juice is that they enjoy drinks with the benefits of consuming fruits, such as fibre and nutrients like vitamin C. Also, they enjoy the fresh and delicious taste of fruit juice, which serves as an alternative to eating raw fruit or vegetables. Although they recognised the importance of fruits and vegetables as sources of vitamins and fibre, they sometimes struggle to incorporate them into their meals and thus feel like the nutrient gap can be filled by consuming fruit juice. According to the informants, fruit juice also helps boost the immune system, combat sinusitis, aid digestion, and enhance skin health. The informants also voiced their concern about the lack of nutrients in their children's diets and prefer fruit juice over carbonated drinks.

Gantikan air bergas tu dengan fruit jus lah. Anak selalu minta air gas, tapi kita prefer jus la, better. (Informant 15)

The issues of picky eating and poor food choices have long been a concern for parents, and fruit juice is considered a good option for their children (Hansson & Schmidt, 2024). In addition, juice can be consumed in various ways, such as combining different types of fruits. This indicates that the informants are well aware of the importance of incorporating natural fruits into their diets for health reasons.

Most informants (89%) preferred freshly prepared juice, preferably self-made with no added sugar. They agreed that self-prepared fruit juice is better than processed juice in terms of purity (not only flavoured), lower sugar content, and the absence of preservatives. However, due to busy lifestyles and the perishable nature of juice, informants faced a trade-off between healthier self-made (non-processed, with no added sugar or additives) and convenience. For example, Informant 16 (a male) preferred to buy fruit juice to avoid the extra, messy task of preparing juice. Consequently, some informants admitted that they opted to buy processed juice from the store rather than prepare it themselves.

Saya rasa lebih baik buat sendiri, tapi disebabkan kekangan masa, kami beli ja, dan rasa lebih sedap kot.

Kalau buat sendiri kita boleh control kandungan gula. Tapi kalau beli sedap lagi saya rasa sebab gula kan. (Informant 17)

Biasa tu, kalau travel tu, Tropicana Twister ja la. (Informant 10)

Kalau makan kat restoran, saya cuma order jus buah. (Informant 5)

If purchasing cannot be avoided, processed fruit juice is preferable compared to fruit concentrate, carbonated, or fruit-flavoured drinks. When purchasing, informants prioritised those with the highest vitamin content, especially vitamin C. The drink must have low sugar content, and they prefer halal established brands, in addition to good packaging and reasonable pricing. Female informants expressed particular concern about the high levels of added sugar used to preserve the juice, while male informants tended to focus more on delicious taste and convenience. Despite the pros and cons, the informants acknowledged the benefits of commercial fruit juice, such as time savings, convenience, and ease of consumption, especially while travelling. These are good signs of consumer acceptance of this new proposed fruit juice formulation. Additionally, this proposed juice does not contain any added sugar.

Safety concerns and pasteurisation

Although the informants agreed that commercial fruit juice should have a longer shelf life, 89% of the informants disliked additives and sugar in the juice, even though they extend its shelf life. Therefore, this subtheme aimed to investigate the informants' approval of the S2 (pasteurised) sample. From the discussion, it was noted that some informants were aware that pasteurisation extends a product's shelf life and is important for long-term storage and commercial products. However, their awareness of pasteurisation is limited to milk, except Informant 7, who knew that pasteurisation could also be used on fruit juice, but was uncertain of how pasteurisation could be applied to the juice.

Some of the informants (four in total, 1–2 from each session) expressed concerns about the potential side effects of pasteurisation, specifically whether it affects the taste or compromises the nutrients of the juice. However, they were reassured to learn that the taste of the juice would remain unaffected if the appropriate time and temperature were used (Gonçalves *et al.*, 2020). In addition, since 83% of the informants have a background in biology, they are particularly aware and emphasise that pasteurisation can enhance consumer safety by eliminating spoilage bacteria, extending the shelf life of food products. Encouraged by the informants who understand the importance of pasteurisation, the remaining informants also agreed that safety is of utmost importance. Consequently, all informants agreed that they would buy pasteurised fruit juice from the store rather than the non-pasteurised fruit juice.

Probiotics and their health benefits

From the third subtheme, the moderator explored the informants' understanding of the health benefits of probiotics for humans and their approval of the sample containing encapsulated probiotics. Despite varying levels of knowledge, all informants knew that probiotics are good bacteria. Moreover, 89% possessed additional knowledge, primarily regarding the role of probiotics in enhancing human digestion. Some informants knew *Lactobacillus* as an example, noting its inclusion in food products such as yoghurt. This notion is supported by a descriptive statement by Informant 12, a biology lecturer, who explained the importance of probiotics to human health:

Sebab system penghadaman kita ni memang sangat memerlukan bakteria. Bacteria yang bagus dalam usus kita ni dia membantu dalam kita punya immune system jugak. Dia sangat berkait rapat dengan immune system sebenarnya. Sangat penting la untuk menjaga keseimbangan bakteria baik dalam usus kita.

The explanation given by the informants with knowledge about probiotics prompted all informants to understand that probiotics not only help maintain intestinal health but also provide additional benefits, such as boosting the immune system. Those who initially lacked knowledge about probiotics expressed an interest in exploring other sources of probiotics in food. None of the informants had previously heard of or tried probiotics in pineapple or fruit juice. However, recognising the importance of incorporating probiotics, all informants chose pineapple juice containing probiotics over those without them. This preference can be related to 'healthy' favourite foods and hobbies. The informants who favoured fruit juice over dairy products stated that their preference was due to the lighter taste of fruit and its ease of digestion. Consequently, they believed that probiotics in fruit juice are an alternative for people who prefer juice or are lactose intolerant. Another reason is that fruit juice contains fibre, which is absent in milk and dairy products, thereby expanding its market potential.

Due to common economic pressure, some informants expressed concerns about the probability of increased prices of probiotic-added juice. In response, other informants indicated that they would still consume it occasionally, if not regularly. However, when the discussion revisited the previous argument regarding the importance of probiotics and fruit juice instead of dairy products, all informants chose to purchase pineapple juice with probiotics. Given the extra benefits, the informants stated their willingness to pay for pineapple juice incorporated with encapsulated probiotics if the drink was reasonably priced and comparable to dairy products with probiotics.

General acceptance of pineapple juice with encapsulated probiotics

This final part of the FGD aimed to determine the informants' most preferred sample among the three options presented. Before the FGD, the informants were largely unfamiliar with encapsulation, except Informant 18, who had previously read

about encapsulated bacteria and understood how the process can protect the bacteria to ensure that they reach the intestine to function. This knowledge influences the informant to gain a positive impression of the encapsulation concept. In terms of size, all of the informants, except Informant 8, preferred small-sized microbeads. Younger informants preferred to swallow the microbeads directly without chewing, which can be attributed to the fast-paced lifestyle of the younger generation. Informant 2, although still relatively young, preferred small but chewable microbeads.

In terms of the juice and microbeads ratio, most of the informants (94%) preferred a small amount of microbeads compared to the whole volume of pineapple juice (around 1 microbead: 9 juice). The highest ratio was 1/5 microbeads over the juice, as preferred by Informant 18. Therefore, the manufacturer should consider producing juice containing a relatively small amount of microbeads while ensuring it is scaled to provide an adequate level of probiotics.

We wanted (a) more juice taste rather than chewing the microbeads. A smaller number of microbeads is better. (Informant 18)

Some informants also expressed concerns about the costs associated with pasteurisation and encapsulation of probiotics in juice production. The session revealed that different perceptions and willingness to purchase were influenced by income levels and household sizes. Nevertheless, the discussion concluded that the product would be deemed acceptable if the cost was reasonable. Occasional consumption was also highlighted as described by Informant 1, who regarded the purchase of relatively costly fruit juice, which was perceived as healthier, as a form of self-reward.

Although consumers generally prioritise taste and texture when choosing a food product, a positive perception of enhanced food products may increase their willingness to buy (Embling *et al.*, 2024). These informed consumers conveyed that the most important factor is that the drink formulation is safe and beneficial for human health. Safety and health are the major determinants of consumers' choice of commercial drinks (Mollaei *et al.*, 2023). Regarding the acceptance of pineapple juice, despite the various types of fruit juices the informants enjoy, they are still interested in pineapple juice. The informants also approved the texture and colour of the proposed juice after observing the samples presented. The discussion revealed that pasteurised pineapple juice, added with encapsulated probiotics, was well received by the informants, who represented consumers.

CONCLUSION

This study assessed consumer acceptance and preference for the proposed functional beverage (i.e., pasteurised pineapple juice with encapsulated probiotics). The FGD sessions revealed that consumers like to drink fruit juice due to its fibre and vitamin content, which improves their health. The findings showed that this proposed sample was preferred over other samples and was perceived as safer, offering more health benefits to humans. Therefore, pasteurised pineapple juice with encapsulated probiotics is expected to be well received by other consumers as well.

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ETHICAL STATEMENT

This study was approved by the Ethics Committee of Universiti Malaysia Perlis (UniMAP/PTNC(P&)/JKETIKA(24).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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