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The new emerging market for Malaysian fresh jackfruit: A Case study in China

(Pasaran baharu berpotensi bagi nangka segar Malaysia: Kajian kes di China)

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Abstract

After 20 years of negotiation, Malaysia officially gained legitimate market access for fresh jackfruit to China when the Export Protocol of Phytosanitary Requirements was formally signed between the Malaysian government and the General Administration of Customs of the People's Republic of China (GACC) on April 11th, 2023. China has been identified as a new emerging market while remaining the world's largest jackfruit importer, albeit currently relying on the dominant supplier, Vietnam, which has now opened to Malaysia for exportation in fresh whole form. Subsequently, the first export trial was implemented in September 2023 involving Malaysian exporters and government representatives to evaluate the quality, shelf life and physiological aspects by applying fruit coating and to identify the market potential of the premium Malaysian fresh jackfruit variety, J33. This study delved into sensory evaluations and market observations to assess consumers' and industry players' acceptability of Malaysia's fresh jackfruit in China. Quantitative and qualitative data were obtained involving 129 local consumers, 15 market platforms and four industry players, mainly fruit wholesalers and importers. Three samples of fresh jackfruit pulps were used for the sensory tests, including J33 with chlorine treatment, J33 using fruit coating, and Vietnamese jackfruit as a controlled sample. Structured questionnaires were applied as survey instruments. The analysis of variance was used to measure mean differences between the three samples. The results revealed that mean scores of Malaysian J33 are higher and had significant differences from the Vietnamese jackfruit for each attribute, demonstrating that J33 is more acceptable and thus showing positive signals to the Malaysian jackfruit industry. The industry evaluations suggested that Malaysian jackfruit can be classified as a premium segment due to the attributes' strength and high acceptability level relative to the existing and dominant product, however, the market price remains an important indicator to competitively penetrate the jackfruit market in China.

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Introduction

The global jackfruit market size is projected to reach US$359.1 million by 2026 and is expected to continue growing at a Compound Annual Growth Rate (CAGR) of 3.3%. The Asia Pacific recorded the largest market share at 37% in 2020 and is predicted to remain dominant, followed by European countries (23%), the United States (20%) and South America (8%). The increased consumption trends of food ingredients multiplied with the innovation in jackfruit-flavoured food products offering a variety of jackfruit-based product segments in the market, urging the jackfruit market's growth (Zion Market, 2023). In Malaysia, jackfruit is classified as one of the high-value tropical fruits, which focuses on generating significant national income (NAP 2.0, 2021). Moreover, a significant increase in exports has encouraged jackfruit production domestically with the total jackfruit exports doubling in quantity from 3 mt – 7.3 mt (Department of Agriculture Malaysia, 2022) and a tremendous increase in value from US$14.6 million to US$108.8 million during the past ten years at a 644.01% (Tridge 2023). Nevertheless, the most crucial issue in the jackfruit industry is to maintain the fruit's quality due to its limited shelf-life causing significant losses and, hence limited market. Fresh jackfruits can be stored no longer than 14 days to maintain their physical and nutritional qualities, restricting not only market activities along the supply chains but also market destinations, particularly for export purposes. Subsequently, MARDI has developed a standard of procedures (SOP) to introduce technology to extend fruit shelf-life, including skin treatment, fruit coating and low-temperature storage techniques. The fruit coating is widely used as a treatment to delay fruit ripening and improve physical fruit appearance while maintaining freshness, nutritional values and quality for up to three weeks. As a result, the jackfruit market is predicted can be broadened with a longer shelf-life.

For decades, the majority of Malaysian fresh jackfruits has been shipped to Singapore, a traditional and dominant importer, with current market share exceeding 60% of the total exports in 2021, followed by Hong Kong (7%), the United Kingdom (5.2%), the United Arab Emirates (5%), and Germany (5%). In line with the new policy agenda, the Ministry of Agriculture and Food Security, Malaysia (KPKM) is now emphasising high-value tropical fruits by targeting new emerging markets globally, including China. China, a billion-population region, would be a huge market for Malaysia as the country has been identified as the largest jackfruit importer with a current import value of US$ 1.1 billion in 2023 (Tridge, 2023). With the current approval status of market access, Malaysia has become the third exporter of fresh jackfruit to China (after Thailand and Vietnam) and must be ready to strive for established and dominant suppliers and more recognised jackfruits. Currently, China has been the largest market for Vietnam's agricultural produce including jackfruit, accounting for nearly 65% of total agricultural exports in 2023, besides, both countries have created a logistic chain connecting wholesale markets. On the other hand, Thai jackfruit is well-accepted in China due to its variety and sensible prices. Thailand has strongly developed the cultivation area targeting to fulfil demand in China. To differentiate, Malaysia has positioned its jackfruit as a premium product segment for the J33 variety.

Following the authorisation of market access to China in April 2023, Malaysia conducted a pilot program in September 2023 to export the first batch of fresh jackfruits in whole form by sea shipment from Port Klang, Malaysia to Port Tianjin, China. Efforts to secure this market access began in 2004, involving numerous negotiation rounds with the General Administration of Customs of the People's Republic of China (GACC) and the engagement sessions between

KPKM, the Ministry of Health Malaysia, MARDI, FAMA, and industry stakeholders to finalise the export protocol over the years. A collaborative program involved the government and stakeholders including MARDI, Federal Agriculture and Marketing Authority (FAMA), industry players, the Malaysian Department of Agriculture and the Malaysian Agricultural Consulate in Beijing China. Currently, seven jackfruit farms and eight fruit processing facilities registered under the Department of Agriculture (DOA), Malaysia have met the standards and export requirements imposed by the GACC. For export purposes, the fruit ripeness level must be determined before harvesting. The J33 is harvested from 130 – 140 days after flowering or at the maturity stage of 90 – 95 days after the fruits are bagged (on the trees). Jackfruit at this stage reaches the maturity of physiological aspects with the surface fruit skin turned to light green or slightly greenish-to-yellow and has rather sharper thorns. After harvesting, the ripening process begins and produces a fragrant aroma and the fruits' skin becomes smoother (under ambient temperature). The Department of Standards, Malaysia has provided quality requirements and sizing standards for fresh jackfruit to facilitate industry players in sorting and grading before distributing to markets (*Table 1*). The maturity index, the freshness quality and the defect degree are the main indicators to classify grading for fresh jackfruits. The jackfruit farms that meet the prescribed

Table 1. Quality requirements of fresh jackfruit

Grade	Requirement	Tolerance (maximum)
Premium	- similar varietal characteristics - free from damages and defects or very slight defects are allowed provided these do not affect the general quality, appearance, keeping a good quality of the fruit and presentation in the package - uniform in size	5% by number or weight of the fruit not satisfying the requirements of this grade, but meeting those of Grade 1
1	- similar varietal characteristics - practically free from damages and defects provided these do not affect general quality, appearance, keeping good quality of the fruit and presentation in the package - slight defect of the skin and other superficial defects not exceeding 10% of the total surface area - practically uniform in size	- damage not exceeding 5%; - defect not exceeding 5%; and - 10 % by number or weight of the fruit does not satisfy the requirements of this grade, but meeting those of Grade 2
2	- similar varietal characteristics - satisfy the minimum requirements specified in Clause 4, but do not qualify for inclusion in the higher grades - slight defect of the skin and other superficial defects not exceeding 15% of the total surface area - retain the general quality appearance, keeping good quality of the fruit and presentation in the package - reasonably uniform in size	- damage not exceeding 5% - defect not exceeding 10% - 15% by number or weight of the fruit satisfying the requirements of this grade

Source: Specification for fresh jackfruit MS1055:2016

phytosanitary protocol stipulates those farms, packing houses and processing facilities must be accredited by Malaysia's good agricultural practice (GAP), including traceability systems and integrated pest management techniques (i.e. system-based approach) approved by the Department of Agriculture, Malaysia and the GACC.

The quarantine pests required by the GACC consist of seven species of insects and two types of fungi, explicitly fruit fly (*Bactrocera carambolae*, *B. dorsalis* and *B. Umbrosa*), fruit borer (*Glyphodes caesalis*), Koya (*Dysmicoccus neobrevipes* and *Planococcus minor*), barnacles (*Hemiberlesia lataniae* and *Milviscutulus mangiferae*), jackfruit rot disease (*Rhizopus artocarpi*) and seedling wilt disease (*Pythium splendens*). Every packaging, processing and delivery operations are carried out at a processing facility that has also been approved by the GACC with the supervision of the Ministry of Agriculture and Food Security, Malaysia (KPKM), or a representative agency authorised by KPKM. Before exporting, KPKM or the authorised agency is required to send a random fruit sample of 2% to China for the detection and inspection of listed diseases or pests. If fruits do not meet the requirements upon arrival, the Chinese customs authorities have the right to either exterminate the pests and return the fruit shipment to the country of origin of the exporter or destroy them. The detection of fruit pests and diseases in fruit samples might result in the rejection of the entire shipment. Therefore, MARDI proposed a standard of procedure (SOP) for fresh jackfruit export to China which was applied to the first export trial. The SOP suggested EONature fruit coating, which is a vegetable oil-based liquid, containing a safe antifungal ingredient that was applied to a partial batch for export trial to China to evaluate the shelf life associated with quality parameters. A total of 300 pieces of whole fresh jackfruit (Malaysian J33) were packed in individual corrugated boxes and transported via an equipped ventilated container at a consistent temperature of 10°C for 12 days and further were loaded and processed at the Xinfadi Wholesale Market in Beijing. Understanding market acceptance is critical, especially when introducing a product to a new international market, while market acceptance essentially gauges how well a new market will likely receive product offers, based on local preferences, needs, purchasing power and economic conditions. As sensory evaluation has been an undoubted method for measuring consumer acceptability and appearance significantly influencing purchasing decisions, this approach was applied to both consumers and industry players. Subsequently, this study evaluated the market acceptability of the Malaysian fresh jackfruit variety J33 relative to the dominant jackfruit in China to identify the market potential of Malaysian jackfruit in China.

Consumer acceptability and sensory properties

Product quality directly reflects purchasing decisions and consumer satisfaction, hence crucial to assess consumer acceptance and sensory evaluation, particularly in entering a new market. Predieri (2006) found that acidity, astringency and sweetness indicated a positive correlation with overall acceptance in sensory evaluation of peaches and nectarines from Emilia-Romagna. Sensory evaluation of plums identified that Bellamira, Haganta, President and Tuleu Timpuriu varieties have excellent attributes and quality and thus are recommended to consumers and traders (Bozhkova 2014). Bavay (2013) stressed the importance of fruit variability in apple quality using a sensory evaluation approach and observed that crunchiness, firmness, juiciness and acidity were proposed for further analysis to measure the contribution of fruit variability.

Sensory evaluation, a scientific method to evoke, measure, analyse and interpret responses to food products and is perceived by the sensory organs through the senses of sight, smell and taste, has been widely

used to identify market acceptability in food industries for new product development and improvement, hence playing a significant role in the marketing of food products (Kemp et al. 2009; IFT 2007; Stone and Sidel 1993). Chauvin et al. (2009) found sensory evaluation approach is the most effective for taste, flavour and colour attributes, while the analytical measurements were effective for firmness determinations. Sensory evaluation combined with instrumental measures, such as texture and colour, can be advantageous and help to improve the final product. By conducting sensory evaluation, companies and researchers will learn valuable information regarding product attributes and overall liking that help to provide more widely accepted and sustainable foods (Fiorentini 2020). The results of sensory evaluation could determine future market acceptability, either for a new product or a new market. The combination of the preference tests between products that are evaluated for attributes including paired preference using control sample, rank preference tests and attribute scales can be used to gain the most insight into the acceptability of a product (Brigham Young University 2024).

Sensory descriptive analysis between products should be equivalent to defining product characteristics allowing better prediction that influences consumer acceptability, which leads to more appropriate and successful product introduction (Yang & Lee 2019). The Netherlands showed that, while consumers are typically aware of the ethical and political implications of their food choices, purchase intention is ultimately driven by the product's sensory attributes (Hoek et al. 2011). Fiorentini et al. (2020) evaluated sensory attributes of meat analogues and meat extenders through hedonic testing and/or descriptive analysis to demonstrate how these analytical approaches are important for consumer acceptance. While the sensory properties of a food product play a collective role in forming positive expectations both before and during consumption, some may be more important than others. According to a 2019 survey of US adults, 86% of consumers considered taste to be the major driver of purchase intention (IFIC, 2020). In the same light, unpleasant or unexpected tastes can represent a barrier to acceptance. For instance, non-vegetarians seem to be reluctant to try meat analogues due to the belief that consuming healthy products might compromise taste (Reipurth et al. 2019). This obstacle can be overcome by developing products that meat-eaters will enjoy not only in terms of their individual sensory properties but also in the real context in which they will be consumed.

Elzerman et al. (2011) concluded that a successful interaction of food ingredients depends on their sensory attributes, for instance, before consumption, shape, colour, and appearance have a greater influence on consumer acceptance compared to flavour and texture. This is because visual cues define the appropriateness of the meal, which is dictated by other factors. By contrast, consumers' perception of the flavour and texture of meat analogues are minimised to a certain extent, due to other ingredients in the meal that can have either masking effects. Sensory evaluation can help to increase consumer acceptance of meat analogues by investigating the complex interaction between factors that are known to affect meal appropriateness to understand the best way to market these products based on their sensory properties. The extended applications of this approach might include the integration of sensory tests during product development to better direct product processing and formulation. Tomlins et al. (2007) suggested descriptive sensory evaluation predicts consumer acceptability can also be extended to provide useful information on affordability and market price when compared to other food samples of known market value.

Specifically, the main jackfruit attributes that should be emphasised are the pulp texture and juiciness, however, the sweetness and the aroma. Ismail & Kaur (2013) discovered that consumers generally preferred the J33 variety because of its crunchier texture, less juicy and sweeter than other varieties while colour does not significantly affect consumer preferences. Since 2011, several new jackfruit clones have been released including J32 (Mantin), J33 (Tekam Yellow) and J35 (Mastura), albeit consumer acceptance remains unknown. Most studies on jackfruit largely focused on technical research such as pest and disease management, new variety development and high-yield clones. Consumer studies are also crucial in guiding the choice of clones or varieties that meet the demands and requirements of the market (Ritthiruangdej et al. 2011). Haq (2006) suggested that high-yield food crops do not guarantee marketability, which requires consumer preference studies as jackfruit attribute varies according to their varieties. Horsburgh & Noller (2005) stressed the study of consumer acceptance of jackfruit's characteristics is very important to growers and marketers during their decision-making process and marketing strategies. Consequently, the marketing of agricultural produce channels industry players to focus on consumer and market needs, however, the success of agricultural produce depends on the demands and expectations of consumers who have higher buying power (Weinberger & Lumpkin 2006). Foxall (1984) stated that it is essential to provide information on new products before they are marketed, which also applies to fresh items such as fruits. Producers and marketers need more information before deciding on what agricultural product or produce to plant and market (Kappel et al. 1995) as the results determine the success of that agricultural product in future (Foxall 1984).

Methodology

Data and information were obtained from a consumer survey, market observations, and industry players' evaluation through in-depth interviews involving importers, processors, wholesalers, distributors and retailers, which was conducted in Beijing, China. A comparison of the price and quality of fresh jackfruit and consumer acceptance was carried out between Malaysian fresh jackfruit and the dominant fresh jackfruit in the Chinese market as a control sample. Market observation was conducted at a selected marketing platform of various scales in Beijing, China to assess the level of competitiveness of J33 Malaysian fresh jackfruit compared to the existing fresh jackfruit that dominates the market in China.

Data collection

Consumer survey

This study applied descriptive sensory evaluation to identify consumer acceptability of Malaysian fresh jackfruit in Beijing China. The evaluation is carried out to determine differences among the product samples and whether the acceptance or rejection of products is based on mean differences. The consumer surveys were conducted at three selected conducive market platforms – T11 Supermarket, Xinfadi Premium Wholesale Market and Rainbow Premium Supermarket. A purposive random approach was applied to select only local Chinese respondents while the participation was voluntary basis. The major environmental controls include the elimination of psychological distraction, irrelevant odour and light stimulation to provide a conducive environment. Preferably sensory testing must be done using specially designed facilities. However, where such facilities do not exist, researchers should create a comfortable environment as closely as possible (Chambers & Wolf 1996; Hough 2010). Before the sensory evaluation was carried out, the respondents were given a brief explanation about the procedure for implementing the sensory evaluation

to avoid mistakes when answering the questionnaire, but the information on fresh jackfruit samples, especially the country of origin, must be kept confidential. Each respondent was given a survey kit consisting of three fresh jackfruit samples and research questions. Each fresh jackfruit sample is only labelled with a 3-digit numbered code with a random order of numbers (i.e. 141, 612, 852) without any identity information of the samples. This method is important to avoid the evaluation of respondents so as not to prejudice the country of origin as well as the probability of being influenced by ordinal or nominal numbers. To diminish or eradicate such biases, panelists should pick the right protocols and experimental design (Hough 2010).

After carrying out the test, the respondent needs to make an assessment using a questionnaire based on the sample code. The purpose of the sensory evaluation is to evaluate the attribute parameters of fresh jackfruit (colour intensity, aroma, taste intensity, and texture) based on the respondent's level of inclination by using a hedonic scale of 1 to 5 (1= Strongly dislike; 2= dislike; 3= neutral; 4 = like; 5= like very much). The hedonic scale is a common way to assess acceptability through which the participants indicate how much they like or dislike the sample in terms of a specific sensory property, such as appearance, flavour, taste, texture, and overall liking/ acceptance. Hedonic assessment is the economical and ideal method to find out the influence of variations in ingredients, manufacturing, wrapping, or shelf life. The successful sensory evaluation in food industries is achieved by linking sensory properties to physical, chemical, formulation and process variables which enables the manufacturing of food products with maximum consumer acceptance. An effective sensory assessment helps meet end-user expectations and ultimately get a large market share (Sharif et al. 2017).

Market observations

Market observation is a useful approach in market research that allows researchers to understand marketing intricacies particularly market segments, product preferences, consumer behaviour, product innovation and market dynamics (Creswell and Creswell 2017; McDaniel and Gates 2013; Belk 2013; Malhotra and Barks 2007) was applied in this study. The market observations are carried out to obtain market information, especially from the aspects of product segments, product position and dominance in the market, market prices, product categories, brands, packaging and labelling of jackfruit products in the market, both fresh jackfruit and jackfruit-based products involving various categories, scales and marketing platforms in Beijing, China while consisting of public market/ fruit market, supermarket/mini market, and premium market (*Table 2*). To be representative, the selection of market platforms is according to the significant market share while having various retail chains.

Table 2. Selected platforms for jackfruit market observations in Beijing, China

Category	Selected markets
Fresh markets	1) Sanyuanli market 2) Guoyimei market 3) Jiayuan Chunbianming market
Supermarkets	4) Beijing Chengxiang warehouse supermarket 5) Jingkelong supermarket 6) Guoranmei, Sheingxian market 7) Quansheng fruit and vegetable market 8) Wuxing market
Premium supermarkets	9) Rainbow premium supermarket 10) T11 fresh food supermarket 11) BHG market place 12) Xinfadi premium market 13) Xiushui supermarket

Source: Fieldwork (2023)

Industry evaluation

Primary and qualitative data were obtained through in-depth interviews with importers who are leading in the global trade market in Beijing, China, consisting of four (4) major companies (Seahorse Biotech Tianjin Co., Ltd, the Malaysian Chamber of Commerce and Industry in China, T11 Food Market and Rainbow Department Stores Company) which aimed to identify the demand, consumption, market preferences and opportunities for fresh jackfruit in China. Specifically, it seeks to determine the level and competitiveness of Malaysia's J33 fresh jackfruit in terms of product attributes, price, market size, market segments, and product differentiation over existing and dominant products in current markets. The collection of information through in-depth interviews with industry players aims to identify the potential of the fresh jackfruit market in China, especially from the aspects of supply, demand, and supply chains. The information is expected to be able to determine the level of competitiveness of J33 Malaysian fresh jackfruit from the aspects of product attributes, price, market needs and product differentiation relative to dominant and existing products in the current market.

Data analysis

Both quantitative and qualitative analysis methods were used in this study. The main method used is quantitative analysis, consisting of descriptive and inferential analysis involving data from user acceptance and sensory evaluation. Qualitative methods are used to analyse information from interviews with industry players and market surveys using thematic and content analysis. The one-way ANOVA (One-Way Analysis Variance) quantitative analysis method was used to evaluate the comparison of the mean score of each product attribute for studies using more than two samples. This study involved three samples of fresh jackfruit (clove form), namely J33 fresh jackfruit with EONature coating, J33 fresh jackfruit with chlorine treatment and Vietnamese fresh jackfruit as a control sample. The hypothesis of the one-way ANOVA test is as follows:

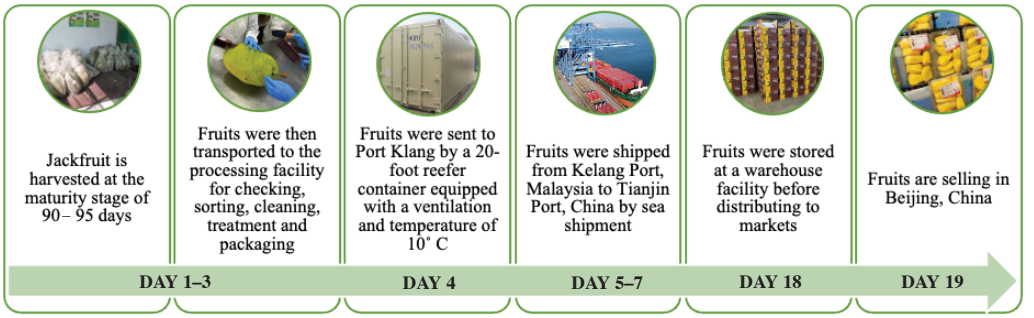
Null hypothesis (H_0): There is no statistically significant differences between group means of jackfruit samples.

Alternative hypothesis (H_1): There is a statistically significant differences in group means of jackfruit samples.

Results and discussion

Following the standard of procedures prepared by MARDI, the first delivery of fresh jackfruit from Malaysia to Beijing, China took 19 days. The procedures for exporting whole fresh jackfruit to China began with harvesting fruits from registered and accredited farms in Rawang, Selangor at the fruit maturity stage of 90 – 95 days. The fruits were then transported to the processing facility for checking, sorting, cleaning, treatment and packaging which had been carried out at the exporter's processing centre in Bentong, Pahang. On the 4th day, fruits were sent to Kelang Port by a 20-foot reefer container equipped with a ventilation and temperature of 10˚ C. On the following day, fruits were shipped from Port Klang, Malaysia to Tianjin Port, China by sea shipment, taking 12 days (*Figure 1*). Upon arrival, the fruits were stored at a nearby warehouse facility before being distributed to market platforms.

After fruits were distributed to particular markets and ready to purchase, the same fruit batches were used for consumer surveys, which were conducted to identify consumer acceptability through sensory evaluations according to fruit attributes of pulp sweetness, texture, colour, juiciness and aroma. The sensory evaluations were conducted for three series in different locations, considering market categories (i.e. standard and premium markets) at T11 Premium Supermarket, Xinfadi Premium Wholesale Supermarket and Rainbow Premium Supermarket. The control sample for Malaysian J33 was selected from the close, comparable to the Malaysian jackfruit with a dominant market in China, the Vietnamese jackfruit. Therefore, the evaluation series involved three samples including J33 Malaysian fresh jackfruit with EONature treatment and coating, chlorine treatment, and fresh Vietnamese jackfruit (i.e. control sample). A total of 129 Chinese consumer respondents voluntarily participated in the market acceptability study, however, a random and purposive sampling approach was applied to choose local Chinese consumers. The characteristics and attributes of the fruit samples are displayed in *Table 3*.



Source: Field study (2023)

Figure 1. The supply chain of jackfruit export from Malaysia to China

Table 3. The characteristics and attributes of the fruit samples

Parameter	Malaysia J33 (chlorine treatment)	Malaysia J33 (chlorine + EONature coating)	Vietnamese jackfruit
Fruit skin color	Brownish green	Green	Green with brown spots
Fruit thorn	Sharp	Sharp	Blunt
Pulp color	Yellow	Yellow	Pale yellow
Aroma	Strong	Strong	Slightly strong
Brix sweetness (%)	27.6	29.1	22.66
Acidity (%)	1.70	1.63	1.86

Source: Field study (2023)

Each fruit sample was blind identity, coding with unidentified labels to avoid biases (141= Malaysian Jackfruit J33 with EONature fruit coating treatment, 612= Malaysian Jackfruit J33 fruit chlorine treatment, and 852 = Vietnamese jackfruit). Control samples for Vietnamese jackfruit were selected as close as the Malaysian samples to ensure both are comparable based on technical parameters and fruit attributes, especially from the aspect of maturity index, pulp colour and sweetness brix. Each respondent was given a kit of survey instruments consisting of fruit samples and a questionnaire. A 5-scale hedonic (1 = dislike very much to 5 = like very much) is used for the sensory evaluation.

Consumer demographic profile

From a total of 129 respondents in Beijing, the gender distribution for males and females indicated 63.8% and 36.2%, respectively, slightly higher former group. Most respondents fall in the age group of 40 years and below (60.5%) while the remaining are over 40 years old (39.6%) with the majority of graduates (74%) and paid employment income sources (79%) (*Table 4*).

Consumption and preferences

The result indicated that almost 80% of the respondents in China regularly consume fresh jackfruits giving a positive signal for Malaysia to penetrate the new jackfruit market in the country, with the major consumption of fresh product forms (97.4), while little composition prefers salads (2.6%). The minimally processed segment, either fresh or chilled recorded the highest percentage of preference at 80% compared to whole form, 20%, which clearly showed that the largest preferred product tendency is ready-to-eat. The most frequent buying pattern is more than once in 6 months (44.7%), followed by at least once in a year and at least once in six months, 35% and 19.4%, respectively. Currently, Thailand and Vietnam dominate the fresh jackfruit market in China, sharing the market at 93%, while India has a marginal market share of 8%. Another source of jackfruits is locally produced from Hainan China, but the market share is insignificant relative to imported sources. Thai and Vietnamese jackfruits are well received by Chinese consumers in terms of acceptable attributes and market prices. The quality attributes of fresh jackfruit including taste, texture and nutritional values are the main driving factors for 61.5% of consumers to repeat purchasing fresh jackfruits, while others included media, advertisements, family and friends (34%) and rest of were the new buyers (4.4%).

Table 4. Demographic profile of respondent

Indicator	Descriptions	% (n = 129)
Gender	Male	63.8
	Female	36.2
Age group	19 – 29 years old	32.1
	30 – 39 years old	28.4
	40 – 49 years old	18.7
	50 years old and above	20.9
Highest level of education	Masters or PhD	25.0
	Bachelor's degree, diploma or equivalent	49.0
	High school and lower	26.0
Main source of income	Paid employment	79.0
	Own business	12.0
	Transferred income	6.0
	Fixed asset	3.0

Source: Field study (2023)

Table 5 displays the sensory evaluation tests of three samples comprising fresh jackfruit J33 (Malaysia) with EONature coating skin treatment, fresh jackfruit J33 (Malaysia) with chlorine skin treatment and Vietnamese fresh jackfruit (i.e. control sample). The results indicated that the first sample gained the highest mean score in attribute parameters with the highest acceptance score (μ = 4.38), followed by the sample under chlorine skin treatment (μ = 4.30), while Vietnamese jackfruit recorded the lowest score(μ = 3.31). These results confirmed that the consumer acceptability of Malaysian Jackfruit J33 was 86.5%, much higher than the control sample, Vietnamese Jackfruit which indicated 13.4%. The mean score of fruit attributes including pulp colour, aromatic, texture, sweetness and the overall acceptance of Malaysia's J33 revealed a significant difference between the control sample, implying the Malaysian J33 could beat the dominant and existing jackfruit in the Beijing market. Specifically, Malaysia's J33 with EONature coating treatment recorded higher mean scores of each attribute and overall acceptance level at 45.5% relative to chlorine treatment (41%). This result is associated with a longer shelf-life under the former treatment, showing better freshness and quality performance. This finding confirms the new strategy and directions to penetrate the jackfruit market in China.

Further descriptive analysis was conducted to determine whether the mean values were statistically and significantly different between samples. Since the analysis involved more than two samples, the analysis of variance (ANOVA) was applied using F-test to determine whether the variability between group means was larger than the variability of the observations within the groups. The results confirmed that the mean values of attribute parameters between the three samples were different, significantly at 1% (p <0.01) (*Table 6*).

Further, the extended analysis of the Post–Hoc Tukey HSD test was conducted to identify significant differences in the mean values between every two samples for the three samples (i.e. Fresh jackfruit Malaysia J33 treatment EONature vs. Chlorine treatment; Fresh jackfruit Malaysia J33 treatment EONature vs. Fresh jackfruit Vietnam; Chlorine-treated fresh jackfruit

vs. Vietnamese fresh jackfruit). The results proved that the mean value is different at a 1% significant level (p <0.01) between the fresh jackfruit samples of Malaysia J33 (either EONature or chlorine treatment) and Vietnamese fresh jackfruit, while there was no significant difference for all attribute parameters between the samples of J33 Malaysian under EONature and chlorine treatments (*Table 7*).

Table 5. Descriptive analysis of sensory evaluations on fresh jackfruit samples (n = 134)

Attribute parameter	Samples	Mean *(μ)*	Std. Dev. *(σ)*
Pulp (flesh) colour	Malaysia J33 (EONature treatment)	4.46	.864
	Malaysia J33 (chlorine treatment)	4.40	.766
	Vietnamese jackfruit	3.05	1.258
Aromatic	Malaysia J33 (EONature treatment)	4.48	.811
	Malaysia J33 (chlorine treatment)	4.33	.882
	Vietnamese jackfruit	3.09	1.318
Texture	Malaysia J33 (EONature treatment)	4.22	.945
	Malaysia J33 (chlorine treatment)	3.96	.995
	Vietnamese jackfruit	3.44	1.385
Sweetness	Malaysia J33 (EONature treatment)	4.43	.870
	Malaysia J33 (chlorine treatment)	4.39	.831
	Vietnamese jackfruit	3.07	1.313
Overall acceptance	Malaysia J33 (EONature treatment)	4.38	.857
	Malaysia J33 (chlorine treatment)	4.30	.850
	Vietnamese jackfruit	3.31	1.368

Note: mean scores refer to 5-scale hedonic: 1= strongly dislike to 5=, strongly like
Source: Authors' estimation

Table 6. ANOVA of sensory evaluations on fresh jackfruit samples (n = 129)

Attribute		Sum of squares	df	Mean square	F
Pulp (flesh) colour	Between groups	169.657	2	84.828	87.237***
	Within groups	387.985	399	.972	
	Total	557.642	401		
Aromatic	Between groups	155.602	2	77.801	73.576***
	Within groups	421.910	399	1.057	
	Total	577.512	401		
Texture	Between groups	41.796	2	20.898	16.496***
	Within groups	505.478	399	1.267	
	Total	547.274	401		
Sweetness	Between groups	158.612	2	79.306	75.014***
	Within groups	421.828	399	1.057	
	Total	580.440	401		
Overall acceptance	Between groups	94.512	2	47.256	42.612***
	Within groups	442.485	399	1.109	
	Total	536.998	401		

Source: Authors' estimation (2023); *** 1% level of sig.

Table 7. Results of Tukey HSD: Sensory evaluation on fresh jackfruit in Beijing China (n=129)

Dependent Variables	I	J	Mean Diff (I-J)	S.E	Sig.	Interval	
						Lower bound	Upper bound
Pulp (flesh colour)	J33 Malaysia (EONature treatment)	Malaysia J33 Klorin	.067	.120	.843	-.22	.35
		Vietnam	1.410*	.120	.000	1.13	1.69
	J33 Malaysia (chlorine treatment)	Malaysia J33 EONature	-.067	.120	.843	-.35	.22
		Vietnam	1.343*	.120	.000	1.06	1.63
	Vietnamese jackfruit	Malaysia J33 EONature	-1.410*	.120	.000	-1.69	-1.13
		Malaysia J33 Klorin	-1.343*	.120	.000	-1.63	-1.06
Aromatic	J33 Malaysia (EONature treatment)	Malaysia J33 Klorin	.149	.126	.461	-.15	.44
		Vietnam	1.388*	.126	.000	1.09	1.68
	J33 Malaysia (chlorine treatment)	Malaysia J33 EONature	-.149	.126	.461	-.44	.15
		Vietnam	1.239*	.126	.000	.94	1.53
	Vietnamese jackfruit	Malaysia J33 EONature	-1.388*	.126	.000	-1.68	-1.09
		Malaysia J33 Klorin	-1.239*	.126	.000	-1.53	-.94
Texture	J33 Malaysia (EONature treatment)	Malaysia J33 Klorin	.261	.138	.140	-.06	.58
		Vietnam	.776*	.138	.000	.45	1.10
	J33 Malaysia (chlorine treatment)	Malaysia J33 EONature	-.261	.138	.140	-.58	.06
		Vietnam	.515*	.138	.001	.19	.84
	Vietnamese jackfruit	Malaysia J33 EONature	-.776*	.138	.000	-1.10	-.45
		Malaysia J33 Klorin	-.515*	.138	.001	-.84	-.19
Sweetness	J33 Malaysia (EONature treatment)	Malaysia J33 Klorin	.037	.126	.953	-.26	.33
		Vietnam	1.351*	.126	.000	1.06	1.65
	J33 Malaysia (chlorine treatment)	Malaysia J33 EONature	-.037	.126	.953	-.33	.26
		Vietnam	1.313*	.126	.000	1.02	1.61
	Vietnamese jackfruit	Malaysia J33 EONature	-1.351*	.126	.000	-1.65	-1.06
		Malaysia J33 Klorin	-1.313*	.126	.000	-1.61	-1.02
Overall acceptance	J33 Malaysia (EONature treatment)	Malaysia J33 Klorin	.082	.129	.799	-.22	.38
		Vietnam	1.067*	.129	.000	.76	1.37
	J33 Malaysia (chlorine treatment)	Malaysia J33 EONature	-.082	.129	.799	-.38	.22
		Vietnam	.985*	.129	.000	.68	1.29
	Vietnamese jackfruit	Malaysia J33 EONature	-1.067*	.129	.000	-1.37	-.76
		Malaysia J33 Klorin	-.985*	.129	.000	-1.29	-.68

Source: Authors' estimation (2023)

Market observations

Market observations were conducted in various categories including fresh fruit markets, supermarkets, and premium markets involving 13 selected platforms in Beijing, China (see the methodology section). Fresh jackfruit in MP forms was extensive in most markets while other forms (whole and processed products) were very limited market. During the observation period, the existing Vietnamese jackfruit dominated the majority of market platforms in Beijing, while others were from Thailand and a few unusual supplies of locally grown, in Hainan. The market price of Vietnamese jackfruit varies according to the platforms, starting from RM16.30/500 g to RM29.00/500 g with the highest selling

price at the fresh market. Instead, the price is much lower at the premiums. Chinese local has a very limited market, selling at RM22.79/500 g. Hence, the market category in China does not determine the market prices for jackfruits, yet depending on supply capacity, stemming from demand and supply which reflects the current selling prices. Many platforms have their processing facilities to provide the freshest jackfruit in MP forms and thus encourage consumers to purchase with their guaranteed freshness marketing strategy. Vietnam offered the lowest market price, ranging from RM19.42/500 g to RM27.50/g, while Thailand's was a bit higher at RM29.20/g. The price of J33 Malaysian fresh jackfruit which is classified as a premium segment is estimated to be RM32.30/500 g which will be the highest market price in China (*Table 8*).

Table 8. Market observations of fresh jackfruit in Beijing, China

	Country of origin	Malaysia
	Variety	J33
	Price	RM32.30 (500 g)
	Attribute	Golden yellow, bulb shape
	Country of origin	Vietnam
	Variety	Yellow
	Price	RM19.42 - RM27.50 (500 g)
	Attribute	Pale yellow, cylinder shape
	Country of origin	Thailand
	Variety	Thongprasert
	Price	RM29.20 (500 g)
	Attribute	Golden yellow, bulb shape
	Country of Origin	China (Hainan)
	Variety	unknown
	Price	RM22.79 (500 g)
	Attribute	Soft yellow, bulb shape

Source: Field study (2023)

Industry evaluation

Table 9 summarises the findings of focus group discussions and in-depth interviews with four industry players engaging the importers, wholesalers and processors in Beijing, China. The results of industry reviews confirmed that Vietnamese jackfruit dominated the Chinese market for many years with well accepted by consumers, mainly as a result of consistent supplies, and reasonable prices due to logistics and proximity factors with acceptable quality. However, J33 Malaysian jackfruit is expected to be positioned as a premium product segment with higher quality and better attributes and thus deserves higher market prices. J33 is expected to complement the fresh jackfruit market in China in different segments. As price remains the most sensitive factor for jackfruit, the price difference between the premium and standard segments should be in a competitive gap. In addition, consistent quality and supply are crucial for Malaysia to position and dominate the premium product segment with the strongest attribute parameters in the future.

Table 9. Content analysis of industry reviews on jackfruit market in China

Parameter	Quote
Market opportunity	"… Vietnamese jackfruit is popular and well known in southern regions while the northern still not widely market" [*P1*] "… now Vietnam supplies about 10 containers/ week, 140-210 tons/ week to meet market demand" [*P1*] "…jackfruit market in China is expanding but not too big but the fresh market is much larger than processed" [*P2*] "jackfruits are special in China, have owned demand even regular users" *[P3]* "Many retailers have facilities and provide service for MP" [*P3*] *"*We ready to receive Malaysian jackfruits in future" [*P3*] "Malaysia has potential exporter jackfruit in fresh or frozen similar to frozen durian" [P4] "Malaysia jackfruit is expected to meet consumers' taste in China because of crunchy and sweet, and can beat Vietnam" [*P4*]
Price competitiveness	"The pricing factor for minimum processed (MP) jackfruit from Vietnam is the cheaper price at RMB39.90 per 500g while Malaysia's more expensive, a higher price of RMB49.90 per 500g" [*P1*] "Malaysia jackfruit has high quality and exclusive and deserves a premium price. [*P1*] "purchasing power in China still low, consumers very sensitive to price changing, so Malaysia should readily compete with lower price exporters from Thailand and Vietnam" [*P2*] "Price gaps should not be too big with Vietnam, now price Malaysia the highest, although premium but too expensive, the consumer won't buy" [*P4*]

Source: Field study (2023)

Conclusion

Despite having an extremely limited supply from locals, China continues relying on imported fresh jackfruit with Vietnam and Thailand, the major suppliers, which have dominated the market for many years. The increasing trends in the jackfruit market have urged the government of China to extend the market access when the General Administration of Customs of the People's Republic of China (GACC) ultimately approved Malaysia to export fresh jackfruit in whole forms after 20 years of trade negotiation. Further, a trial program was implemented in September 2023 to export the J33 premium Malaysian jackfruit variety. The main purpose of the trial shipment is to evaluate and thus confirm the fruit quality and shelf-life using the standard operating procedure (SOP) developed by MARDI using fruit coating and chlorine treatments. Subsequently, this study assesses the market potential of Malaysian fresh jackfruit in China using multiple approaches to obtain primary data including sensory evaluation, market observation and in-depth interviews with industry players, mainly importers. The sensory evaluation was conducted in Beijing using three different samples (J33 Malaysian with fruit coating treatment, chlorine treatment and Vietnamese jackfruit as a controlled sample). The results confirmed that consumer acceptability of Malaysian J33 was much higher than the control sample, Vietnamese Jackfruit. The mean scores of each fruit attribute were also higher and significantly different from the control, implying that the Malaysian J33 was more preferred by Chinese consumers with the samples of fruit coating indicating the highest tendency. Market observations in various platforms indicate that the minimally processed (MP) form has a more extensive market than the whole and processed products and even many retail chains have processing facilities to provide such services and serve the MP. The market category does not signify jackfruit market prices as the prices depend on the quantity of supplies, albeit the Malaysian jackfruits recorded the highest prices than Vietnamese, Thailand and the locals. Reviews from industry players expected J33 Malaysian jackfruit to be positioned as a premium product segment with higher quality attributes strength, and thus deserve higher market prices. Instead of competing, J33 is a complement to the fresh jackfruit market in China in different segments. This study proposed comprehensive market research findings to both industry and policymakers. Further, the results on consumer acceptance, market preferences (product attributes and product segment), existing products and market prices are pertinent to producers and exporters to position Malaysian J33 in China, thus targeting and expanding the market, globally, while providing useful information for the government in planning, strategising and strengthening future policy agendas and directions to penetrate the new emerging fresh jackfruit market in China.

References

Bavay, C., Symoneaux, R., Maitre, I., Kuznetsova, A., Brockhoff, P. B. & Mehinagic, E. (2013). Importance of Fruit Variability in The Assessment of Apple Quality by Sensory Evaluation. Postharvest Biology and Technology. Vol. 77, 67-74

Belk, R. (2013). Qualitative Consumer and Marketing Research. SAGE Publication Ltd. ISBN: 9781446290392

Brigham Young University. (2024). Consumer Acceptance Testing. Provo, Utah, USA

Bozhkova, V. (2014). Chemical Composition and Sensory Evaluation of Plum Fruits. Journal of Natural Science. Volume: 15 Issue: 1, 31 - 35, 01.08.2015

Creswell, J.W. & Creswell, J. D. (2017). Research De sign: Qualitative, Quantitative, and Mixed Methods Approaches (5th ed.). SAGE Publication Inc. ISBN: 978-1-5063-8670-6

Chambers, E. & Wolf, M. B. (1996). Sensory Testing Methods, 2nd ed. ASTM International West Conshohocken, PA, USA

Chauvin, M. A., Whiting, M. & Ross, C. F. (2009). The Influence of Harvest Time on Sensory Properties and Consumer Acceptance of Sweet Cherries. Page(s): 748–754, Volume/ Issue: Volume 19: Issue 4. DOI: https://doi.org/10.21273/HORTTECH.19.4.748

Department of Standard Malaysia. (2016). Malaysian Standard: MS Fresh jackfruit (Artocarpus heterophyllus Lam.) – Specification (Second revision)

Elzerman, J. E., Hoek, A. C., Van Boekel, M. A., Luning, P. A. (2011). Consumer Acceptance and Appropriateness of Meat Substitutes in A Meal Context. Food Qual. Prefer, 22, 233–240

Fiorentini, M., Kinchla, J. & Nolden, A. A. (2020). Role of Sensory Evaluation in Consumer Acceptance of Plant-Based Meat Analogs and Meat Extenders: A Scoping Review. Foods 2020, 9(9), 1334; https://doi.org/10.3390/foods9091334

Foxall, G. (1984). Predicting consumer choice in new product development: Attitudes, intentions and behaviour revisited. Marketing Intelligence & Planning, 2(1), 37-52

Haq, N. (2006). Jackfruit: Artocarpus heterophyllus. Southampton Centre for Underutilised Crops, University of Southampton, Southampton: U.K.

Hoek, A. C., Luning, P. A., Weijzen, P., Engels, W., Kok, F. J. & De Graaf, K. (2011). Replacement of Meat by Meat Substitutes. A Survey on Person—And Product-Related Factors in Consumer Acceptance. Appetite, 56, 662–673

Hough, G. (2010). Sensory Shelf-Life Estimation of Food Products. CRC Press, Taylor & Francis Group, Boca Raton, FL, USA

Horsburgh, C. & Noller, J. (2005). Exotic tropical fruits and vegetables, category marketing opportunities. Rural Industries Research and Development Corporation: Australia

Industry Arc. (2023). Jackfruit Market Overview (Preview version)

Ismail, N. & Kaur, B. (2013). Consumer Preference for Jackfruit Varieties in Malaysia. Journal of Agribusiness Marketing: Vol. 6 (2013):37- 51

Jabatan Pertanian Malaysia. (2024). Phytosanitary Requirements for Exportation of Horticulture Produce from Malaysia

Jabatan Pertanian Malaysia. (2023). Senarai Fasiliti Nangka Berdaftar Untuk Eksport

Jabatan Pertanian Malaysia. (2021). Perangkaan Tanaman Buah-buahan

Kappel, F., Fisher-Fleming, R. & Hogue, E.J. (1995). Ideal Pear Sensory Attributes and Fruit Characteristics. HortScience, 30(5), 988-993

Kemp, S. E., Hollowood, T. & Hort, J. (2009). Sensory Evaluation a Practical Handbook. John Wiley & Sons Ltd, Chichester, West Sussex, U.K.

Malhotra, N. K. & Birks, D. F. (2007). Marketing Research: An Applied Approach (3rd ed.). Prentice Hall Inc. ISBN: 978-1-292-10315-0 (PDF)

McDaniel, C. & Gates, R. (2013). Marketing Research Essentials (9th ed.). John Wiley & Sons Inc. ISBN: 978-1-119-23945-1

Ministry of Agriculture and Food Industry. (2021). Dasar Agromakanan Negara 2.0. (2021 – 2030)

Predieri, S., Ragazzini, P. & Rondelli, R. (2006). Sensory Evaluation and Peach Fruit Quality. ISHS Acta Horticulturae 713:VI International Peach Symposium. DOI:10.17660/ Acta Hortic. 2006.713.63

Reipurth, M., Horby, L., Gregersen, C. G., Bonke, A. & Perez-Cueto, F. (2019). Barriers and Facilitators Towards Adopting A More Plant-Based Diet in A Sample of Danish Consumers. Food Qual. Prefer, 73, 288–292

Ritthiruangdej, P., Srikamnoy, W. & Amatayakul, T. (2011). Optimization of Jackfruit Sauce Formulation Using Response Surface Methodology. Kasetsart Journal (Nat.Sci.) 45, 325-334.

Sharif, M. K., Butt, Sharif, H. R. & Nasir, M. (2017). Handbook of Food Science and Technology (pp.362-386); Chapter: Sensory Evaluation and Consumer Acceptability. University of Agriculture, Faisalabad, Pakistan

Stone, H. & Sidel, J. L. (1993). Sensory Evaluation Practices, 2nd ed. Academic Press Inc., San Diego, CA.

The International Food Information Council. (2019). Food and Health Survey. IFIC Foundation: Washington, DC, USA, 2019; Available online: https://foodinsight.org/2019-food-and-health-survey/ (accessed on 14 August 2020)

Tomlins, K., Manful, J., Gayin, J., Kudjawu, B. & Tamakloe, I. (2007). Study of Sensory Evaluation, Consumer Acceptability, Affordability and Market Price of Rice. Journal of the Science of Food and Agriculture, 87:1564–1575

Tridge. (2023). Overview of the Global Jackfruit Market

Weinberger, K. & Lumpkin, T. A. (2006). High-Value Agricultural Products in Asia and The Pacific For Small-Holder Farmers: Trends, Opportunities and Research Priorities. Workshop on "How Can the Poor Benefit from The Growing Markets for High-Value Agricultural Products", October 3-5 2005, CIAT, Cali, Colombia

Yang, J. & Lee, J. (2019). Application of Sensory Descriptive Analysis and Consumer Studies to Investigate Traditional and Authentic Foods: A Review. Foods. 2019 Feb; 8(2): 54. doi: 10.3390/foods8020054

Zion Market Research. (2023). Global Jackfruit Market Size (Preview version)

Abstrak

Selepas 20 tahun rundingan perdagangan, Malaysia secara rasminya mendapat akses pasaran yang sah untuk pengeksportan nangka segar ke China setelah menandatangani dokumen Protokol Eksport Keperluan Fitosanitasi Nangka di antara Kerajaan Malaysia dan General Administration of Customs of the People's Republic of China (GACC) pada 11April 2023. China dikenalpasti sebagai pasaran baharu yang berpotensi serta pengimport nangka terbesar dunia, manakala Vietnam adalah pengeksport dominan di negara tersebut dan akses pasaran nangka segar import kini dibuka kepada Malaysia. Justeru, program percubaan eksport telah dilaksanakan pada September 2023 melibatkan pengeksport dan delegasi kerajaan Malaysia bertujuan untuk menilai kualiti, jangka hayat dan aspek fisiologi menggunakan salutan buah-buahan serta mengenalpasti potensi pasaran nangka segar premium Malaysia, varieti J33. Objektif kajian ini adalah untuk menilai penerimaan pengguna melalui penilaian sensori, tinjauan pasaran dan penerimaan pemain industri terhadap nangka segar Malaysia di China. Data kuantitatif dan kualitatif dikumpul melibatkan 129 pengguna tempatan, 15 platform pasaran, dan lima pemain industri terdiri daripada pengimport buah-buahan. Tiga sampel kajian nangka segar digunakan untuk penilaian ujirasa iaitu nangka segar J33 dengan rawatan klorin, nangka segar J33 menggunakan salutan buah, dan nangka Vietnam sebagai sampel kawalan. Soal selidik berstruktur digunakan sebagai instrumen survei pengguna dan analisis varians digunakan untuk mengukur perbezaan skor min di antara sampel. Dapatan penilaian sensori menunjukkan bahawa J33 Malaysia mencatat skor min tertinggi dan mempunyai perbezaan yang signifikan daripada sampel nangka Vietnam bagi setiap atribut. Ini membuktikan bahawa nangka Malaysia J33 mendapat penerimaan lebih tinggi dan sekaligus memberi signal positif kepada industri nangka di Malaysia. Pemerhatian pasaran dan tinjauan industri merumuskan bahawa nangka Malaysia diklasifikasikan sebagai segmen pasaran premium berdasarkan faktor atribut dan tahap penerimaan pengguna di China berbanding pasaran nangka sedia ada. Namun, harga pasaran merupakan indikator daya saing penting untuk meneroka pasaran nangka segar secara kompetitif di China.