

Public Willingness to Pay For Purple Corn Attributes

Norzalila Kasron^{1,a*}, Nurul Nadia Ramli^{2,b}, Rawaida Rusli^{3,a}, Nor Azlina Saari^{4,a}, Nur Fazliana Md. Noh^{5,a}

¹ norzalila@mardi.gov.my; ² nurulnadia.ramli@upm.edu.my; ³ rawaida@mardi.gov.my;

⁴ inasaari@mardi.gov.my; ⁵ fazliana@mardi.gov.my

^a Socioeconomic, Market Intelligent and Agribusiness Research Centre, Malaysian Agriculture Research & Development Institute (MARDI), Malaysia

^b Department of Agribusiness and Bioresource Economics, Faculty of Agriculture, Universiti Putra Malaysia, Malaysia

*corresponding authors

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ABSTRACT

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Sweet corn also known as sugar corn or sweet maize, is a popular multi-purpose cereal crop of the family Poaceae. The crop is the second most important crop in Asia after rice. China remains as the largest producer with a production of 260 million MT in 2019. In Malaysia, the crop area is estimated 10 thousand ha with production yield of 73 thousand MT. Purple variety that rich with anthocyanin content is classified as sweet corn that relatively new in local market. The cultivation of purple corn is not encouraging as Malaysian Department of Agriculture (DOA) recorded only eight farmers throughout Malaysia with a total area of 17.7 ha. Considering this variety is new and less accessible, this study evaluates consumers' Willingness to Pay (WTP) in Malaysia towards purple corn. Data was collected through online platforms using structured questionnaires. The total of 431 responses were received in one month. The discrete choice experiment (DCE) is used to measure consumer WTP and the results showed that anthocyanin content and sweetness of purple corn are positive and significant at the level of 1%. This indicated that the higher the anthocyanin content and corn sweetness, the higher the level of consumer utility would be. Consumers are willing to pay for higher prices than the lowest market price if the purple corn variety satisfies both value-added anthocyanin and sweetness attributes.

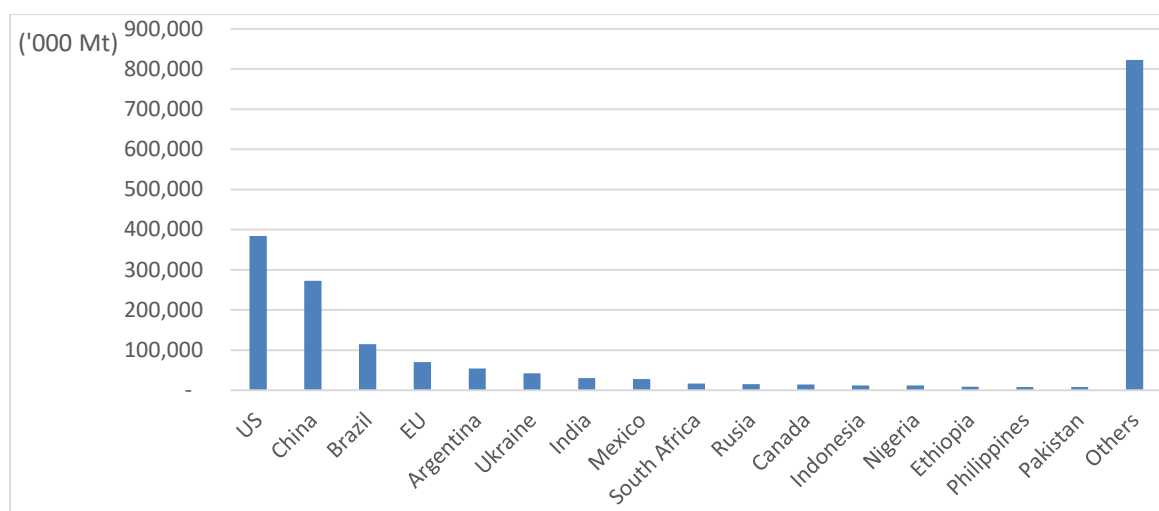
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Introduction

Corn, known by the scientific name *Zea mays*, was included in the grass's family, under coarse grains. It is the third-largest crop after wheat and rice (Transparency Market Research, 2022). The global production in 2021 was 1.2 billion MT, and the United States of America (USA) is the largest producer with a total production of 383.9 million MT. China and Brazil rounded off the top corn-producing countries with 272.5 million MT and 116 million MT, respectively (Statista, 2022) (Figure 1). Malaysia ranked the 112th producer of sweet corn in 2019 (Atlasbig, 2022).

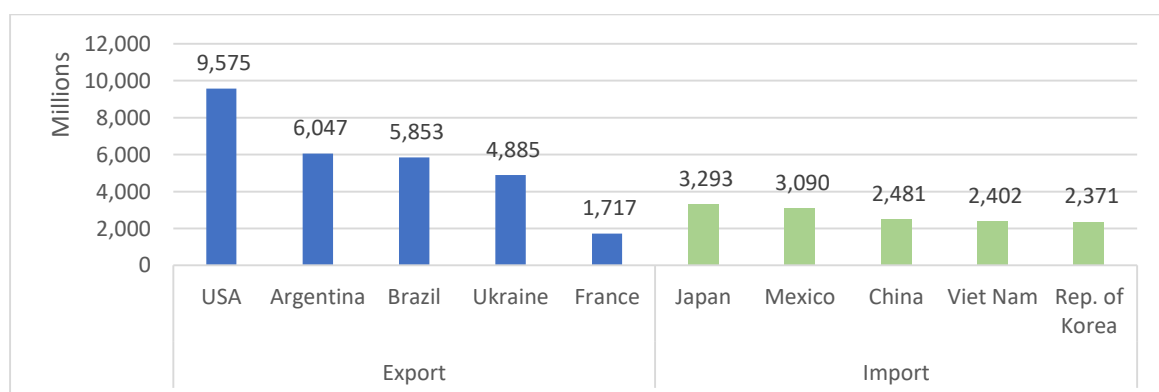
The global export value in 2020 increased by 2% from 2019 and reached USD36.7 billion. USA remained dominant in the world corn market with the highest export value (USD9.6 billion), followed by Argentina (USD 6.1 billion) and Brazil (USD 5.9 billion), which account for 60% of the world corn export market (UN Comtrade, 2021). Japan is the world's highest corn importer, with an import value of USD 3.3 billion, followed by Mexico (USD 3.1 billion) and China (USD 2.5 billion) (UN Comtrade, 2021) (Figure 2).



Source: Statista (2022)

Figure 1. Global corn production by country, 2021

Over 60% of global corn production is used in animal feed, providing a high amount of energy and oil content to the livestock and the rest for human consumption (Transparency Market Research, 2022). Average global human food consumption of corn amounts to 18.5 kg/capita/year (2014-2018), which recorded 11% of the average annual cereal human consumption of 175 kg globally. Asia recorded average human corn consumption (also known as sweet corn) as about 10.1 kg/capita/year (FAO, 2021). China is the largest producer of sweet corn in Asia, with a production of 260 million MT in 2019, followed by Indonesia (30 million MT) and India (27 million MT) (Statista, 2021).



Source: Comtrade (2021)

Figure 2. Global leading corn exporter and importer, 2020

Sweet corn production in Malaysia is 73 thousand MT in 2021, with the crop estimated at 10 thousand ha. Perak is the highest producer (23 thousand MT), followed by Johor (12 thousand MT) and Sarawak (9 thousand MT). Total exports slightly decreased from 6,919 MT (2019) to 6,882 MT (2020). Total imports also decreased from 5,013 MT in 2016 to 3,288 MT in 2020. (SUA, 2016-2020) (Table 1). Singapore is the main export market for fresh sweet corn.

Table 1. Crop Area, Production and Trade of Sweet Corn in Malaysia, 2011 - 2021

Year	2016	2017	2018	2019	2020	2021
Crop Area (Ha)	10,683	11,156	10,362	7,605	9,810	10,105
Production (MT)	64,867	72,561	68,907	60,498	68,207	73,323
Export (MT)	5,670	6,768	6,755	6,919	6,882	
Import (MT)	5,013	2,937	4,139	3,307	3,288	

Source: Malaysian Department of Agriculture (2022); Malaysian Department of Statistic (2021)

Various varieties known as yellow corn, pearl corn, milk corn and many more that penetrated local market. Purple corn also known as Peruvian Purple Corn is one of the varieties; however, it is less known by consumers in Malaysia. The variety that available in the global market originating from Peru since and has been cultivated for more than 100 years. In 2010, the export value of purple corn reached up to USD18 million (Lao, 2017). Various studies have been conducted to identify the benefit and nutritional content. The anthocyanin content found in the corn is believed to prevent various diseases such as cancer, high blood pressure and diabetes. In fact, the anthocyanin content in purple corn is higher than blueberry (Zhang et al., 2014; He and Giusti, 2010). In global market, various food products have been produced using purple corn extract such as juice, flour, and food colouring. Food coloring from purple corn has penetrated the market of food coloring products worldwide and is recognized by Japan and the European Union under the E-163 code (Lao et al., 2017).

Table 2. Production of Purple Corn in Malaysia, 2020

State	District	No. of Farmers	Crop Area (Ha)	Production/Season (Mt)	Farm Price (RM/Cob)
Melaka	Jasin	2	9.0	106.2	1.50 - 2.00
Negeri Sembilan	Kuala Pilah	2	6.0	70.0	1.50-2.00
	Rembau	1	0.5	5.9	1.50-2.00
Kedah	Pendang	1	1.4	13.8	2.50
Perak	Kuala	1	0.4	4.5	2.00
Pahang	Cameron	1	0.4	4.7	2.00
Total		8	17.7	205.1	

Source: Malaysian Department of Agriculture (2021)

In Malaysia, the varieties that refer to purple corn are King Corn, King Purple, Morado and Purple Glutinous Corn. About eight (8) farmers grow this purple corn variety throughout Malaysia, with a total area of 17.7 ha (DOA, 2021). Data recorded only two farmers are growing

commercially in Jasin and Kuala Pilah with a planting area of nine (9) and six (6) ha, respectively (Table 2).

Several studies have conducted to determine the consumers' acceptance and willingness to pay for health enhancing product. Markosyan et al (2009) found that the presence health benefits information of antioxidants has a positive significant effect on consumers' willingness to pay for apples that contain antioxidants. This suggested that the consumers response positively to the provision of nutritional and health benefit of food product (Hellyer et al 2012). Similar finding was reported by Bruschi et al (2015) in which the consumers were putting more value for the product that provides health-enhancing characteristics information such as anthocyanin contents over the basic products. The anthocyanin content found in the corn is believed to prevent various diseases such as cancer, high blood pressure and diabetes. The production of this sweet corn is currently limited in several areas in Malaysia and they are currently grown commercially in Jasin and Kuala Pilah. The limited market has resulted in a higher selling price than the other sweet corn. Before proposing to increase the production of sweet corn including expanding the area planted, thus it is important to determine the consumers' demand for this variety of corn. Therefore, this study assessed the willingness to pay consumers for this purple corn variety according to anthocyanin content and sweetness.

Method

Primary data was collected online, and a random sampling method was used. The survey location is throughout Malaysia. Structured questionnaires were distributed through social media platforms such as Whatsapp, email, Facebook and Instagram messages for a month, and a total of 431 responses were obtained during the period. Descriptive analysis is used to look at the socio-demographics of users to provide an overview of the study sample that is representative of the user population by using the frequency of each respondent demographic variable.

Willingness-to-pay (WTP) was assessed using the discrete choice experiment (DCE). It is one of the survey-based methods adopted in evaluating the WTP for goods or services where are defined in terms of attributes with their pre-determined levels (Hanley et al., 2001). The DCE was used to assess consumers' willingness to pay for purple corn that contained anthocyanins. The price of corn is added to allow the derivation of the monetary value of the purple corn attributes considered in this study. The respondents are required to make a trade-off between the attributes and gives choose the option that gives them the highest level of utility. Using the MktEx procedure in SAS 9.4 (Inc., 2019), eight choice sets have been obtained as an efficient design. There are several options available on the choice set where the choice is between different hypothetical scenarios. Table 3 shows the attributes and levels used to develop the purple corn set choice.

This level of anthocyanin content was compared to yellow sweet corn, which has no anthocyanin content. The tastes for sweetness are subjective. Thus, the sweetness level of purple corn was assessed using two groups: sweet and less sweet. Prices are determined based on the current market, is: farm prices (through direct marketing channels) and retail prices. Price is the most important parameter to measure WTP and consumer preferences because it significant significantly influences a purchase decision.

Table 3. Attributes and levels of purple corn

Attributes	Level
Anthocyanin contains	1. Contains anthocyanins
	2. No anthocyanin content
Sweetness	1. Sweet
	2. Less sweet
Price/corn cobs	1. RM 2
	2. RM 4
	3. RM 6
	4. RM 8

The results of discrete choice experiments will be analyzed by following McFadden’s Random Utility Theory (RUT) (Domencich, 1975). The random utility model of respondent i choosing option j is represented by:

$$U_{ij} = X_{ij}\beta + \varepsilon_{ij} \tag{1}$$

Where $X_{ij}\beta$ denotes the determinant part or the observable utility part, while the stochastic utility part is represented by the error term ε_{ij} . The vector X_{ij} is the attribute of purple corn (anthocyanin content and sweetness) and β is the corresponding parameter vector. The model specifications for the alternative utility function j, for respondent i are as follows:

$$U_{ij} = \beta_{0i} + \beta_{1i}anthocyanin_j + \beta_{2i}sweetness_j + \beta_{3i}price_j + \varepsilon_{ij} \tag{2}$$

The model in equation 2 is used to measure the benefit of improvement for each attribute from one level to another. Marginal WTP or marginal replacement rate indicates respondents’ WTP according to their preferences (Siebert et al., 2006) and measures the benefits of attribute improvement from one level to another (Latinopoulos, 2014). The marginal value associated with the price is measured in Ringgit Malaysia (RM).

$$Marginal\ WTP = \frac{Attribute\ coefficients\ non -\ monetary}{Coefficient\ monetary} \tag{3}$$

Marginal WTP (MWTP) is calculated using the formula for non-monetary attribute coefficients versus monetary attribute coefficients (prices).

Results and Discussion

Table 4 below presents the demographic profile of the respondents. The demographic profile of the respondents showed that 67% were aged 40 years and below. 81% of respondents had higher education, while the rest had a secondary school or below education. Household income groups are classified according to the definition used in Malaysia with the division into three income range groups, namely B40, M40 and T20. Income less than RM4,850 belongs to the B40 group with a total of 46% of respondents, while the M40 group with an income range of less than RM10,970 is 41%. The rest are respondents from the T20 group, with an income range above RM10,971.

Table 4. Demographic profile of consumer survey (n=431)

Variables	Category	Percentage (%)
Age	<=20	3
	21-40	67
	41-60	28
	>60	2
Education Level	Primary School	1
	Secondary School	18
	IPT	81
	Informal Education	1
Household Income	B40	46
	M40	41
	T20	13

Source: primary data processed

The study found that 43% of respondents were unaware of the existence of purple corn, and only 13% had ever eaten this corn. Figure 3 shows the locations with easy access to purple corn. 40% of respondents suggest that purple corn can be easily found in a tourist area such as Cameron Highland (40%), while 15% of respondents agreed to buy online. 25% of other locations refer to purchases through agents, friends, or intermediaries.

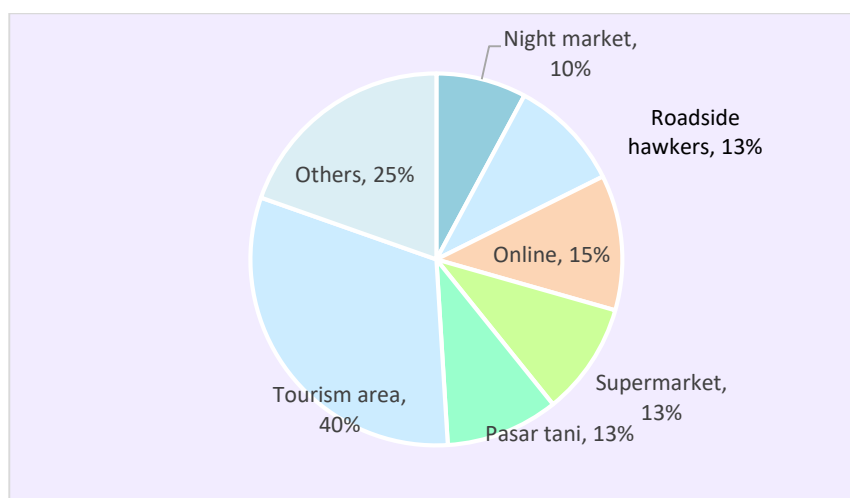


Figure 5. Length of time to be Fishermen and Fishermen's origin

Respondents who experienced buying the corn identified that the price is between RM1.00 and determined RM8.00 per cob. However, in average market price is RM1.10 per cob. Based on the consumer acceptance findings, purple corn has a low market potential compared to the existing sweet corn in the market. The limited production and market access had caused higher market prices. Figure 4 indicated that 40 out of 431 respondents had purchased purple corn, and 65% out of them liked the taste while 35% were vice versa. 42% out of 26 respondents that had purchased purple corn made repeated purchases within a month (2 respondents), once every six months (3 respondents), once a year (3 respondents) and erratic purchases (3 respondents).

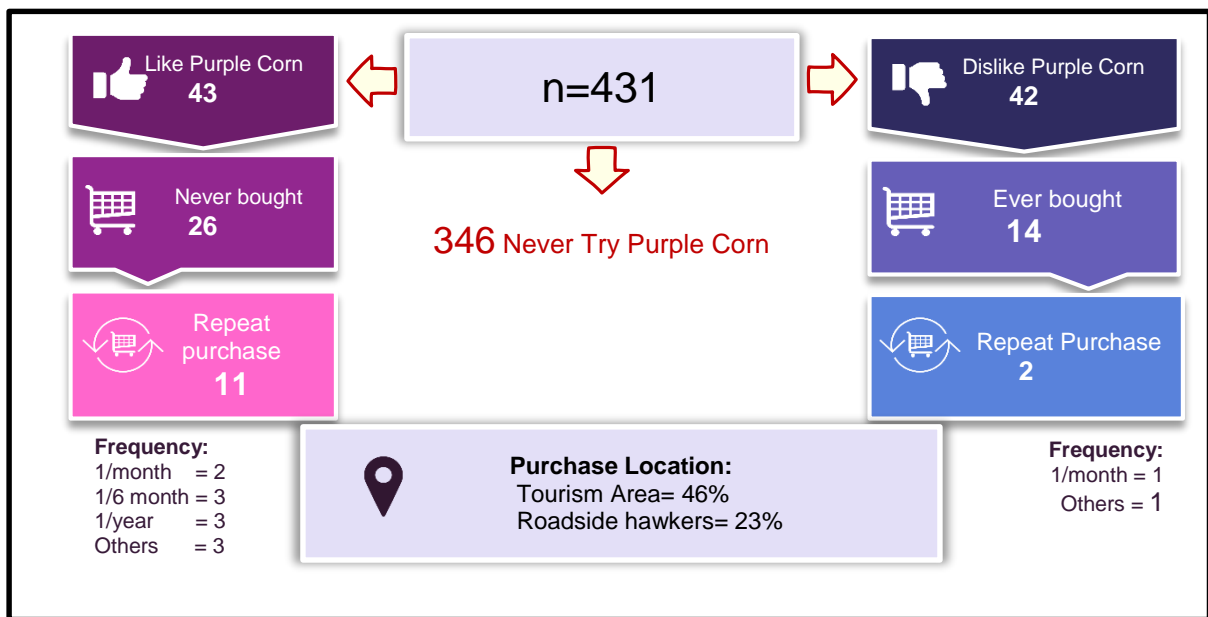


Figure 4. Market potential of purple corn in Malaysia

The anthocyanins content in purple corn and sweetness were used as variables to assess consumer willingness to pay (Table 5). Both variables are significant at 1%. Anthocyanin levels show a positive coefficient sign indicating the higher the anthocyanin content, the higher the consumer utility level. The sweet taste variable shared the same indicator, which explains the higher the sweetness of the corn, the higher the consumer utility level. The coefficient of anthocyanin content is higher than the sweet taste coefficient, explaining that consumers prefer the anthocyanin content found in corn over the sweet taste. The price shows significance at 1% with a negative coefficient level which explains that the lower the price of corn, the higher the consumer utility level.

Table 5. Findings of CLM analysis of purple maize in Malaysia

Parameter	B	S.E	Significant
Constant	-0.5104	0.08	<.0001
Anthocyanin Content	1.302	0.0544	<.0001
Sweet Taste	0.9644	0.0523	<.0001
Price	-0.1869	0.0117	<.0001

Source: primary data processed

The MWTP method was calculated to assess consumer willingness to pay for purple corn. Table 6 shows the value that consumers are willing to pay to obtain the attributes of the corn. The minimum corn price of RM2/cob (according to the minimum price that consumers had paid before) is used as an indicator to obtain the price change for each attribute. Consumers are willing to pay more RM7/cob to get the anthocyanin as compared to corn without anthocyanin content. The sweet taste attribute shows that consumers are willing to pay with the addition of RM5.20/cob to have sweet corn compared to the less sweet corn. Thus, it indicates that the consumers are willing to pay premium prices for sweet corn and the corn with the anthocyanin content.

Table 6. Marginal Willingness to Pay (WTP) for Purple Corn

Attribute	Marginal WTP (RM/cob)	Actual Price (RM/cob)	Total Price (RM/cob)
Anthocyanin Content	7.00	2.00	9.00
Sweet Taste	5.20		7.20

Source: primary data processed

Conclusion

The study is to identify the market potential of purple corn with value-added (anthocyanins content). The corn is still new in the local market. Less exposure to the advantage resulted in low consumer acceptance compared to foreign countries such as Spain, Europe, and the US. The evaluation of consumers' willingness to pay for purple corn was also conducted by using anthocyanin content and sweetness as parameters of analysis. Consumers are willing to pay a higher price for purple corn attributes (sweet taste and contains anthocyanin). However, the lack of education about the benefits and nutrients of corn makes it less known in the local market. Government intervention is needed to encourage the cultivation of purple corn throughout Malaysia. Extensive exposure to the nutrients found in corn is necessary to promote the intake of nutritious and healthy food among the Malaysian population.

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