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## The Application of Biotechnology in Food Production: How Does Malaysian Consumers React?

**Suhana Mohezar**

Faculty, Department of Business & Accountancy, University Malaya, Kuala Lumpur, Malaysia

**Mohd. Aidil Riduan Awang Kader**

Faculty, Department of Business Management, Universiti Teknologi MARA (UiTM) Pahang, Bandar Jengka, Pahang, Malaysia

**Mohammad Nazri**

Faculty, Department of Business & Accountancy, University Malaya, Kuala Lumpur, Malaysia

### **Abstract:**

*In recent years, the issue of the biotechnology applications in agro-food industry has received considerable attention. Consumers' attitudes towards biotechnology have been changing as more information has been provided to the public, primarily through media. This study attempted to examine the factors influencing consumers' purchasing decision of biotechnological food products in Malaysia. Data were collected in supermarkets in the area of Klang-Valley, Malaysia using mall-intercept approach. Based on the 274 responses, we found that the consumers' purchasing decision towards biotechnological food products were influenced by their social surroundings and religiosity levels.*

**Keywords:** Malaysia, Biotechnology, Genetically-Modified Organism (GMO), Food, Purchase Intention

### **1. Introduction**

The agro-food industry serves as a backbone of many Asian countries' economy including Malaysia. The sector is not only restricted to support daily human life, yet it also plays a significant role in the national economy. In 2015, the agro-food sector is expected to contribute 38.8 per cent of the total agriculture value added. While the food demands are anticipated to increase, the area of arable land for agriculture and the availability of potable water are expected to decline, posing great challenges to its agricultural systems (Teng, 2008). The traditional farming equipment and practices are reaching their limits of effectiveness in increasing agricultural productivity. Furthermore, as countries develop, people are also demanding not only for more food, but varieties and better, creating pressures to the shrinking agricultural land, rising labour costs and shortage of farm workers.

Within the Malaysian context, the export of agro-food products had also increase at an average annual growth rate of 9 per cent from RM20.5 billion in 2011 to RM25.6 billion in 2014. As part of the sustainable plan, the Malaysian government, under its Eleventh Malaysian Plan has signified that this sector will be transformed and modernized into a high-income and sustainable industry, with more focused given on food safety, wider application of modern technology, participation of a skilled workforce and productivity (Malaysian Government, 2015). Recently, biotechnology which could be referred as the process of culturing and recombining various organism has been publicized as the future of the country's agro-food industry. This technology is currently being developed in Malaysia as a means to improve post-harvest quality through increasing food crops resistance towards disease (Amin et al. 2010). Other biotechnology-derived food crops are at early stages of gene cloning and transformation. The modern biotechnology approach is adopted because of its potential to overcome constraints faced by conventional breeding techniques.

Despite the potential of this novel technology in food production, the business leaders, producers and scientist involved in this field may not foresee how controversial this issue would be for consumers, particularly for *halal* markets. In Malaysia, the used of biotechnology in food production may raise concerns as majority of Malaysian populations are Muslims. In Islam, tampering with nature and changing God's creation to create another invented creation is a sin, and people is assigned to manage and utilize the God's resources for living purposes in the best way. Therefore, while God forbids unnecessary changes of His creation, such alteration that falls under the category as essential is permissible. For instance, if the genetic engineering is performed as a measure taken to reduce reliance on pesticides and herbicides, which could be harmful to environment, such act is permissible and is consistent with the 'Shariah' guideline as it promotes welfare and prevents harmful effects to environment. In this regard, the biotechnology research is seen as '*ibadah*' (act or worship), and a means of better living which should be promoted by man, as a vicegerent and trustee of God's resources (Anas et al. 2013). The religion places a set of '*halal*' dietary laws which should be abided by the Islamic followers. Muslims are also prohibited from consuming animals that are classified as carnivores and predatory birds such as dogs, tigers, owls and hawks. Amphibians (i.e. crocodiles, frogs, and turtles), undesirable insects (i.e. worms, flies, cockroaches) and poisonous animals (i.e. rates, snakes, centipedes and scorpions) are also parts of the outlawed foods in Islam (Wan Hassan and Awang, 2009). In line

with this, the used of genetic engineering to transfer cell or genes of forbidden food such as pig's protein to 'halal' animal or plants is also forbidden.

The modification of the genetic structure of agriculture raw materials and foodstuffs is a relatively new research area, where there are lot of uncertainties and worries. As food covers basic human needs, consumers have strong views on what they eat leading to a set of complex and broader requirements of quality attributes encompassing the manner in which products are produced. Hence, the public acceptance of the biotechnology product is another important factor for successful commercialization. Understanding of biotechnology is generally low among Malaysians, which may lead to low acceptance of biotechnology-derived products (Amin et al. 2010). Consumers may not be well-informed about the disadvantages and advantages of this new technology in food production causing them to develop a certain level of fear of the new and unknown technologies, particularly when they are unable to assess and judge the consequences and the level of risks involved. A better understanding of consumer attitudes and behaviours toward biotechnological food production therefore, is essential for designing marketing strategies. Moreover, with the increase in the demand for *halal* food globally, greater responsibility is also emphasized on the food manufacturers to understand the requirements for producing biotechnology food for Muslim markets.

With reference to the research problem, this study aims to investigate the level of Muslim consumers' awareness and attitudes towards biotechnology food products; and what factors play a role in determining their awareness and attitudes. In examining the factors that may affect their attitudes towards such product, this study expands prior research work by incorporating Diffusion of Innovation Theory. Innovation is defined as the generation, acceptance and implementation of new ideas, products or services in organizations, which provide improvement. Biotechnological food products are considered as an innovation in the agro-food industry, as it introduces new and different technologically enhanced foods.

## 2. Literature Review

### 2.1. Consumers' Attitudes towards Biotechnological Food Products

In recent years, the issue of biotechnology in food production has received considerable attention. Biotechnology has emerged as a powerful tool that has a big potential impact for a number of economic sectors including agro-food. Within the literature, studies have been conducted to gauge the consumers' perceptions and acceptance of biotechnological products. Yet, various levels of acceptance and rejections were reported. For instance, European consumers were found to have strong rejection towards such products (Banati 2011; Tsourgiannis et al. 2011), while majority of the U.S. consumers had relatively positive attitudes (Wolf et al. 2012). Perhaps, news media reports have contributed to the widespread fear and mistrust of biotechnological food and crops, in which they are labelled as "Frankenfoods", "disaster", "environmental risks", "risks of cancer" and "food health fears". These social amplification phenomenon has distorted the public views on the biotechnology in the Europe, despite the significant advances in food quality and security (Robaey, 2013).

Within the African countries, the results were also varied (Leahey, 2013). In Nigeria and Kenya for instance, people showed a negative interest in the biotechnological food products. In Uganda however, their perception differs across social classes. Similar research has been done among Asian consumers. Earlier studies conducted by Zhong et al. (2003) found that majority of Chinese were not aware of the existence of such technologically enhanced foods. In a more recent survey conducted by Ji-Kun and Bo-Wen (2015), a substantially larger number of consumers perceived that food produced using biotechnology are not safe for consumption. The increasing negative media reports on such food products perhaps serve as a contributing factor that may raise heightened consumers' concern on this issue. Nevertheless, they indicated that a large amount of consumers still do not have clear mind on this matter. In Japan, the increasing awareness on the biotechnology has hold negative views towards its application for agriculture sector (Yamaguchi and Suda, 2010).

On the Malaysian front, biotechnology has emerged as a powerful tool that has a great potential for a number of economic sectors including agro-food industry. The application of biotechnology in the agro-food industry is seen as crucial as the sector must prepare itself not only to produce sufficient amount of food, but also to produce high quality products that could compete with the imported produced during the globalisation era (Ismail et al. 2012). Notwithstanding this, Malaysia as a developing country is experiencing a flood of biotechnology-based food products imported from the U.S. due to the Free Trade Agreement (FTA). The country has also being urged to consider making such products labelled as "containing GM food" as mandatory (Zainol et al. 2015). The lack of GM labelling for biotechnological food products has led to low consumer awareness, exposure and experience. Without adequate information, public acceptance on such products may be lower, with the future for modern biotechnology application in developing food products for the benefits of the society will not be a success (Amin et al. 2010). Moreover, the consumers, especially Muslims, are very particular concerning food consumption. Thus, it is very important to respect the consumer's right to information and to choose their consumption, especially in respect of biotechnological food products.

### 2.2. Theoretical Development

In this study, we adopted Diffusion of Innovation (DOI) Theory to explain the factors contributing to the consumers' purchasing decision of biotechnological food products. The theory seeks to explain how, why and at what rate new ideas are spread through cultures. It asserts that perceived innovation characteristics, social influence and individual innovativeness may influence an individual adoption of innovation (Rogers, 2005).

Forty-nine to eighty per cent of the variance in rate of new product adoption is explained by product characteristics. Prior research have associated biotechnology production with food availability, more nutritious and higher economic advantage (Simeland et al., 2016). In China for instance, the government realised that the tremendous growth of population tenders them to find more efficient agricultural production methods to continuously feed the people. Consumers in China are also willing to pay more for genetically modified rice due to the existence of additional vitamin content (Li et al. 2015). Hence, we postulate that:

- H<sub>1</sub> Product attributes will affect consumers' attitudes towards biotechnology food production

Social influence which originates from psychological studies, refer to a change of thinking or feeling of individuals reflected on their behaviour owing to the relationship with others (Pavalou and Chai, 2002; Woolthuis et al. 2005). This suggests that even though a person might not have a constructive attitude towards biotechnological food products, the incongruence between his or her attitude and family or friends' expectations may influence his or her behaviour. They may embark on positive attitude towards such food products to ensure their legitimacy, since they may look for a balance between their actions and how they are perceived by others. Based on these arguments, this study postulates that:

- H<sub>2</sub>. Social influence will affect consumers' attitudes towards biotechnology food production

Innovativeness is defined as the degree of individual willingness to adopt new ideas earlier than other members in a society (Rogers, 2005). This dimension appears to receive widespread attention from consumer and marketing studies (Tajeddini, 2010; Hirunyawipada and Paswan, 2006; Phau and Cheong 2009), since innovators are considered as important factors in new products diffusion and adoption (Bhate and Lawler, 1997). Within the biotechnology industry, consumers who are more open to new experience may habitually enjoy searching for information about potential benefits of biotechnological food products and may also influence other shoppers' product choices by sharing their knowledge (Kim et al. 2010). Given these arguments, this study postulates that:

- H<sub>3</sub>. Consumer innovativeness will affect consumers' attitudes towards biotechnology food production

Some researchers in the *halal* discipline suggest religion as pertinent factor that may influence people's attitudes, values and behaviours at both individual and societal levels (Mokhlis, 2009; Mukhtar and Butt, 2012). Religion could be defined as a set of beliefs that are imparted since childhood and will gradually impacted a person's life as the understanding towards its teaching grow. In light of this, we incorporate religiosity which could be defined as the extent to which an individual has incorporated the tenets of a particular religion into his/her attitudes, beliefs and values (King and Williamson, 2005). Highly religious society members may tend to perceive the world based on religious dimensions and values. Within the Muslim culture, the attitudes towards biotechnology food production may differ depending on the level of religiosity. Muslim consumers with higher religiosity values may also tend to be more concern on how others in the Islamic society evaluate them. Hence, an individual can devalue the product characteristics, social factors and innovativeness with respect to religion. Given these arguments, this study postulates that:

- H<sub>4</sub>. Religiosity will affect consumers' attitudes towards biotechnology food production

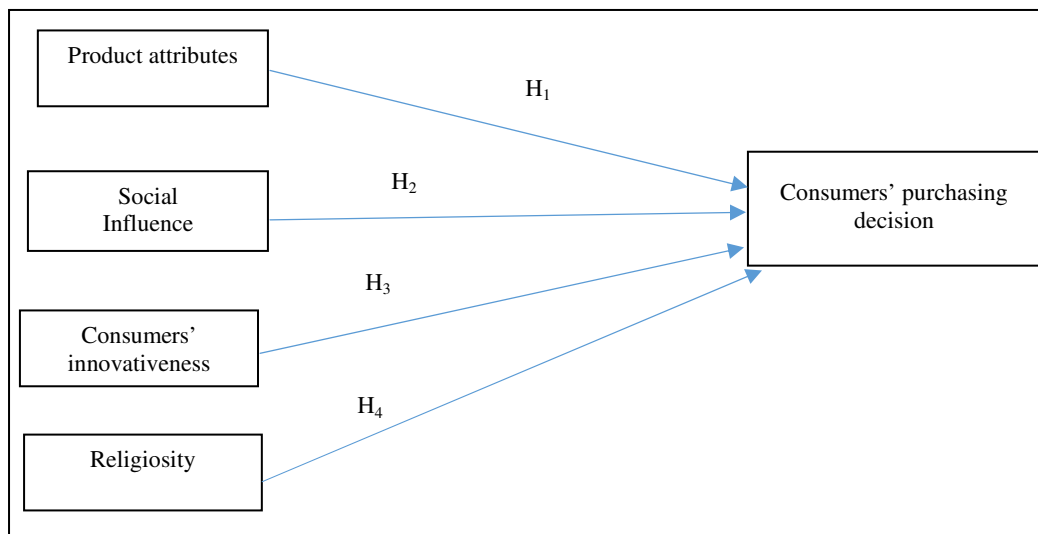


Figure 1: Research Framework

### 3. Methodology

The constructs used in this study are measures from the literature which were adapted to the context of this study. Product characteristics was measured using four items, which evaluate how consumers perceived the benefits of biotechnological food products as compared to the conventional. Social influence was measured using three items, which evaluate the extent of biotechnological food product consumption among peers and family. Innovativeness was evaluated using three items that measure the degree of respondents' willingness to try new products. These items were adapted from Rogers (2005) and modified accordingly so that the focus was on biotechnological food products. Purchasing decisions were measured using four items adapted from Lada *et al.* (2009) and Mukhtar and Butt (2012). Six items measuring the religious commitment of respondents were adapted from Mohklis (2009). These items evaluated how well the consumers have integrated the Islamic values in their daily life. All the questions used a 5-point Likert scale ranging from 1 "strongly disagree" to 5 "strongly agree".

This study employed a survey method, using a questionnaire to test the conceptual model and hypotheses developed. The survey was conducted in Kuala Lumpur in March 2016 in a number of supermarkets. In the process of collecting data, mall-intercept technique was used. The prospective respondents were politely approached by researchers while they were shopping. The researchers described the study and sought their approval to be considered as part of the participants. Researchers also emphasized that the data collected would be exclusively used for research purposes and their participation was anonymous and voluntary. Respondents completed the questionnaire and handed to the researcher. A total of 500 questionnaires were distributed with 274 returned, expressing a response rate of 58.4 per cent. As indicated in Table 1, majority of them possess tertiary education (82.5 per cent), with more than half (82 per cent) earn above RM 3,000. Most of the samples in this study are between 31-35 years old.

Demographic		Frequency	Percentage (%)
Gender	Male	139	50.7
	Female	135	49.3
Age (years)	<20	15	5.5
	20-25	39	14.2
	26-30	60	21.9
	31-35	82	29.9
	36-40	46	16.8
	>40	32	11.7
Income level	<2000	17	6.2
	2000-3000	31	11.3
	3000-4000	44	16.1
	4000-5000	79	28.8
	>5000	103	37.6
Education	Secondary school	48	17.5
	Diploma	168	61.3
	Bachelor Degree	58	21.2

Table 1: Sample characteristics

#### 4. Analysis of Findings

Results from analysing the survey showed that half of the respondents (53.3%) knew or had heard of biotechnology food products, while 21.5 per cent do not know and aware of their existence. In spite of being aware of these products, their level of knowledge however, was quite low. Only 8 per cent declared that they had a high knowledge about such products. In order to find out further on consumers' opinion about the biotechnological products, a series of questions were asked, in which they had to show their level of agreement or disagreement on a scale of 1 (strongly disagree) to 5 (strongly agree). Results are shown in Table 2. Respondents were also asked to indicate whether they are willing to buy the biotechnological food products in the future. It can be seen that the respondents are more concerned with the impact of biotechnological food products on public health. Their willingness to consume may be influenced by the health risks they perceived. As expected, only 49.3 per cent are willing to buy such products in the future.

Items	Mean	SD
I am concerned about the effect of biotechnology food products on human health	4.03	1.05
The consumption on biotechnology food products can be harmful to health	3.91	1.02
Biotechnology food products can produce allergies	4.32	0.98
Biotechnology food products can include properties that will improve my health or that of my family	3.01	0.63
Biotechnology food products are not very natural products	3.23	1.11
Businesses have other interests in genetic engineering besides social welfare	3.62	1.02
Biotechnological food products are regulated by regulations	2.01	1.21
Biotechnological food products can signify economic advantages for producers	3.38	0.79

Table 2: Mean scores of opinions on biotechnological food products

A factor analysis using Principal Axis Factoring with Varimax Rotation was further performed to determine the underlying factors. The suitability of the data for this analysis was assessed based on the Kaiser-Meyer-Olkin (KMO) and the Bartlett's test of sphericity result. The KMO exhibited as score of .853, indicating the sample adequacy for EFA (Kaiser 1974). The Bartlett's test of sphericity had an associated significant p value ( $p < 0.001$ ), further indicating that there was relationship between variables tested (Bartlett, 1950). As represented in Table 3, the EFA on these items produced a four factor solutions, with all the items had a factor loading of above .50. Factors are identified as Factor 1- religiosity, Factor 2- product attributes, Factor 3- social influence, Factor 4- consumers' innovativeness All the factors have a Cronbach's alpha value of above .70, indicating an acceptable reliability for the overall scale (Nunnally, 1978).

Items	Factors			
	1	2	3	4
I regularly pray five times a day	.971			
I fast regularly during Ramadan	.968			
I pay zakat fitrah every year if I meet the prescribed criteria	.968			
I regularly recite the Holy Quran	.948			
I try to follow Islamic conjunctions in all matters of my life	.936			
Biotechnological food products can be kept longer		.758		
Some biotechnological food products may have better flavour and aroma than conventional food		.651		
Biotechnological food production will allow the eradication of harmful pests in crops		.522		
Biotechnological food can include properties that will improve human health		.515		
Most people around me use biotechnological food products			.725	
People who I listen to could influence me to consume biotechnological food products			.619	
I choose biotechnological food products based on recommendations from friends and relatives			.593	
I spend little time exploring biotechnological food products in the market				
Among peers, I am usually the first to try new food products				
Eigen values	4.646	3.271	1.66	1.18
Cumulative %	30.97	52.77	58.28	62.14

Table 3: Factor Analysis

Multiple regression analysis was performed to test the hypotheses. Measures of religiosity, social influence, product's attributes and consumers' innovativeness were entered as predictor variables for consumers' purchasing decision. In summary, these four factors accounted for .52 per cent of the variance in the consumers' purchasing decision ( $R^2 = .52$ ;  $R^2_{adj} = .47$ ,  $F=16.89$ ,  $p<0.001$ ), suggesting that the group of variables (i.e. religiosity, social influence, product's attributes and consumers' innovativeness) can be used to reliably predict the consumers' purchasing decision. Religiosity ( $\beta=0.344$ ,  $p<0.001$ ) and social influence ( $\beta=0.224$ ,  $p<0.05$ ) were found to have a significant impact on consumers' purchasing decision. In contrast, consumer innovativeness ( $\beta=0.044$ , n.s.) and product attributes ( $\beta=0.074$ , n.s.) were found to be insignificant. Hence,  $H_2$  and  $H_4$  are supported, while  $H_1$  and  $H_3$  are rejected.

Hypothesis	Relationship	$\beta$	Decision
$H_1$	Product attributes-- $\rightarrow$ consumers' purchasing decision	0.044	Not Supported
$H_2$	Social influence-- $\rightarrow$ consumers' purchasing decision	0.224**	Supported
$H_3$	Consumers' innovativeness-- $\rightarrow$ consumers' purchasing decision	0.074	Not Supported
$H_4$	Religiosity-- $\rightarrow$ consumers' purchasing decision	0.344***	Supported

Table 4: Multiple Regression Analysis

Note: \*\* $p<0.05$ ; \*\*\* $p<0.001$

## 5. Discussion and Conclusion

This study incorporates religiosity and diffusion of innovation (DOI) theory to form an integrative framework for investigating some of the key issues related to consumers' purchasing decision of biotechnological food products among Muslim consumers in Malaysia. The impetus for the conception of this study is provided by the lack of academic inquiry into the biotechnological food adoption from the perspective of innovation research such as DOI theory. Extending prior works on biotechnological food consumption, this study views such product as innovation since it is considered as technological breakthrough in the agro-food industry. Within the DOI theory, only two variables explored in this study—religiosity and social influence are found to be congruent with existing studies.

In this study, we found that consumers' adoption of biotechnological food products is shaped by social pressure and the opinion of their reference group such as family and friends. Perceived opinion or belief from the closer and important people to the respondents may help them build confidence and gain knowledge on such products' attributes. This is not surprising considering that Malaysia is characterized as having a collectivism culture, in which social pressures play a pertinent role in influencing people's behaviour (Hofstede and Bond, 1988). As discussed in the theory development section, consumers' adoption of new products are driven by the need to attain social approval and recognition (Pavalou and Chai, 2002). Our findings support this assertion and suggest that the need to improve social standing will drive the consumers toward being constantly aware about biotechnological food products. Studies concerning the *halal* products have considered religiosity as factor that may influence the consumer preferences (Mokhlis, 2009; Muhktar, 2012). Similarly, our findings reported religiosity as a significant factor. We found that respondents who are more devoted to religion may incorporate these beliefs and values into their daily life, when deciding to consume biotechnological food products. Religious consumers may have relatively high levels of product category knowledge and be able to evaluate brands on fairly objective level based on the product attributes.

Prior studies have found product attributes as a key determinant in innovation adoption. Yet, in this research our results highlight this factor as insignificant, concluding that people may still buy the biotechnological products regardless of whether they have potential

benefits or not. This finding is not surprising since biotechnological food products are still new in Malaysia. Consumers may not be aware of the benefits and risks of consuming such food. This lack of awareness and information among respondents was observed from consumers' characteristics, since they stated that information is scarce and unclear. On a similar vein, this study also found that consumers' innovativeness was insignificantly associated with consumers' purchasing decision. While past literature (Rogers, 2005; Tajeddini, 2010; Hirunyawipada and Paswan, 2006) indicates that innovative consumers would be accessible to information and react positively towards new product innovation, this may not be in the case of biotechnological food products. Consumers may receive similar negative as well as positive information which may influence how they perceived the risks and benefits of consuming such food (Martinez-Poveda et al. 2009).

The application of biotechnology for producing food has generated some alarm among consumers owing to the potential effects on health and environment. In spite of the rapid growth in the adoption of biotechnological food products in the country, not many consumers really know its meaning or implications, possibly due to the lack of knowledge, suggesting that the interests in widening their knowledge on this kind of products is great. Knowledge on biotechnological food products as well as action taken by the government either to inform or to create awareness has not reach the satisfactory levels in encouraging the consumption of such food. Therefore, knowing how consumers perceived the biotechnological products by understanding the underlying factors of buying would probably facilitate the marketers to send appropriate message to the public.

Despite that this study expand prior research on biotechnological food industry, the present research has some limitations. Our data only confined to the voices of those consumers from the area of Klang Valley. A more heterogeneous sample of different individuals from different regions might be a better predictor. Hence, the findings may not be generalised as representative in Malaysia. Nevertheless, this work represents a first approximation to better understand Muslim consumers' values of biotechnological food products based on the innovation adoption research and religiosity perspective. It is hoped that this paper has succeeded in providing empirical evidence of biotechnological food products' purchasing decision in Malaysia. Insights gleaned from this study could facilitate industry practitioners in improving cultural competence and providing products to this culturally sensitive market segments, leading to growing market size.

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