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Consumer Information and Agro-Biotechnology: The Experience of Malaysia

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Abstract: The emergence of GM food has caused numerous debates where useful information consumer can access is not sufficient, therefore controversies of GM food issues also considered as consumer information issues. This paper provide an overview on the Malaysian experience on the GM food consumer information issue which covers from the research efforts to general public acceptance and further proposing willingness to pay research as essential tools to capture the consumer preference on GM food. As one of the earliest country in South East Asia who approved GM food, Malaysian researchers involved in a series of high profile researches on improving the quality of several crops, however the public is largely unfamiliar with GM food or biotechnology related issues. This paper also proposes valuation of GM as indicator of consumer preference and also suggests possible Malaysian consumer reaction towards GM food which may serve as template for developing countries.

Key words: Agro-biotechnology · Consumer information · Public attitude · Willingness to buy

INTRODUCTION

Since the introduction of GM crops in mid 1990s, the debate of using such technology never cease and the acceptance of GM foods varies among region. The ongoing propaganda-style debates between supporting and anti-biotech groups induce more confusion rather than giving useful information to the public whereby the debate surrounding biotechnology and GMO related issues often focus on normative arguments without solid evidence to support their arguments. Therefore, the controversial agricultural biotechnology issue is also considered as a consumer issue. The lack of information availability on biotechnology may cause overreacting from the public if there's irresponsible parties tries to provoke certain emotional response from the public. The lack of efforts in scoping, categorizing and explaining what is and not GM food by the experts creating more confusion among the public and make them tends to resist GM food [1, 2].

The Malaysian National Biotechnology Policy has entered the second phase (2011-2015) [3] assuming that the resource, industry and human power were created enough to produce biotechnological product or service that will transfer from the lab to the market. The potential biotechnological product or services may spring huge benefits to various stake holders or may spell disastrous the other way. However, the low familiarity of Malaysian's public toward GM food contributes uncertainties for policy makers to execute the National Biotechnology Policy that started in 2005 to improve the life quality of Malaysian by increasing national income and creating more job opportunities [4]. Therefore setting up suitable marketing decisions will ensure that the interest of stake

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holders are intact as the national policy directions are on course, ensuring the services and products brings net benefits to the public. Furthermore, the decision and the direction of Malaysia regarding GM food may influence the similar decisions and approaches for the surrounding region.

This paper was designed to get a general overview of consumer information issues and GM food and the research of agricultural biotechnology in Malaysia. Furthermore, this paper will also discuss public's general acceptance of GM food; a comparison of previous studies to similar studies in Malaysia, as well as proposing valuation research on public's willingness to pay (WTP) for GM food in Malaysia and a brief review of previous WTP studies for GM food across the world. Furthermore proposing factors that might influence the consumer preference on GM food.

Background of GM Food: Modern biotechnology or more commonly known as biotechnology refers to using technologies to manipulate organism's gene for specific uses and usually are for industrial purpose. According to UN [5], at Cartagena Protocol on Biosafety, modern biotechnology were defined as an in-vitro nucleic acid techniques that involves injection of DNA into organic cells or fusion of cells beyond presently known taxonomic family that overcome the natural physiological barriers and are not techniques used in traditional breeding or selection. In layman's understanding, it involves surgical precision technology to directly transfer specific strain of foreign DNA into another cell to create new kinds of species with desired characteristic.

Until 2009, 134 million hectares of biotech crops were planted globally, a staggering increase of a factor of 80 from 1996 to 2009 or increase 7% per year. More than 77, 49, 26 and 21 percent of soy bean, cotton, corn, canola planted globally were GM crops [6]. The USA, Brazil and Argentina from the western hemisphere were the production force of GM crops as they planted 64.0, 21.4 and 21.3 million hectares or producing nearly 79.6 percent of global GM crops in 2009.

The Controversies and Consumer Information of GM Food: Some believe the introduction of agricultural biotechnologies might provide alternatives towards stressing food demand global energy crisis by providing higher yield and introducing biofeul. Yet there are skeptics that believe there's not enough tested been conducted and have unforeseen risks that must be carefully handled Just *et al.* [2]. The sharp rise of food price during early 2008 suggests that these so called GM crops that are supposed to be green aren't so green at all. Grunwald [7] indicates that as more and more portion of the soybean/corn harvest are given to biofuel research; it contributes to price increase over foods and also leads to more and more deforestation, making global warming worse as forest are cleared for plantation of potential candidates for biofuel such as corns and soybean.

Some scientists believe necessary risk is needed in order make breakthrough or advancement on technology ti improving human's welfare. However, they did concede that there will be some stochastic effects for any new technology and the occurrence of such effects are probabilistic and accumulative. This view not well accept by some part of the public, therefore there's always concern about the potential long term environmental and health effects of GM food even though risk assessment underwent found no immediate or very low risk toward human health and the environment.

Generally the basis for the opposing the use of biotechnology in agricultural production are base on two concerns as follow:

- The concern on the production technology itself
- The concern on the business intention of using such technology.

Moral Concern on Production Technology: The main concern was on the type of genes involved, especially transferring genes across species. While the insertion of Bt gene (*Bacillus thuringiensis*) from soil bacterium to pest resistance Bt crops does not make the crops more bacteria-like, but it's still condemned as an unnatural way to fuse two distinct species to create a new crops with desired traits. The genetic engineering also seen as human assuming God's role manipulating other species' genes, has been used as religion ground to oppose the production of GM crops.

The injection of recombinant bovine growth hormone (rBST) to milk cow so that the cows can produce more yield of milk was the first modern biotechnology product prior to the blooming Bt and herbicide tolerance (HT) crops. Back in 1993, the FDA had concluded that milk and even the meat from rBST treated cows are safe to be consumed by humans and other animals FDA [8] and since then rBST milk were on the shelf of markets. European Commission (EC) insists the milk cows injected with BST (whether it is naturally produced or synthesized) underwent health deterioration. Some consumers has expressed serious concerns and caused long term

resistance due to animal rights issues while the European Commission has permanently banned the selling of rBST milk in member countries [9, 10].

Concerns also arise with the environmental and social sequences of planting GM crops whereby concern about impact of large scale GM crops plantation towards the environment such as impacts on non-target organisms and altering biodiversity of the ecosphere. Researches on the environmental impact of planting GM crops also found inconsistent results. While GM crops has been modified to have reduced amount of pesticide in production cycle, other environmental benefits such as carbon capturer, water savings and soil erosion resistance remain unknown [11].

Concern of Business Nature of Agricultural Biotechnology: The controversy of GM crops was also partly originated from the business intention of such technology. Some consumers are unhappy with the profit maximization nature of the firms producing GMO. Skeptics believe such technology only has sole purpose to make profit through GM food. The excuses of reducing pesticide usage, reducing food price and alternative to solve global famine issue merely fabrication of the intention of monopoly and make huge profits. The first generation of GM crops was modified in favor of the producer although theoretically decrease in production cost may lead to decrease in end product's price, however the global food price still ironically raising each year. A survey did by Gaskell *et al.* [12] also suggest that if there is no concrete evidence or new crops that really brings end-user benefits to the consumers, the market resistance of GM food will be continue to pass on.

There was also other concern such as patent of seeds and the technology of GM seeds may force small farmers more reliant to the multinational corporate. Worth note that the patent of HT crops such as Roundup Ready seeds will expire in 2014, usage of the seeds post patent expiry is allowed for the farmers [13]. Some people might even think that since genes occurred naturally and belongs to everyone, it is unwise to patent genetic findings and ethically untenable [14, 15].

Skeptics believe the argument of GM crops open up window to solve world famine problems as GM crops can be modified to have bigger yield, producing more nutritious foods are flawed as they believe the key solution for world hunger is distribution of foods but not production [15]. They also fear that combination of patenting seeds and increasing dependent of poor countries to these developed countries may incite further poverty problems among the poor.

However, the main root cause for the concerns is due to the uncertainties agro-biotechnology possess, as indicated by Kolodinsky [1], the scientist seems reluctant to make further explanation or lack of effort in reassuring the public causing overreactions from the public. For some people, they believe the agro-biotechnology is like "something is going to happen in the future, however we do not know what and how it will happen".

The Case of Malaysia: Biotechnology was identified as one of five core technologies that can accelerate Malaysia's transformation into a highly industrialize country by 2020 [16]. Malaysia was also the first Southeast Asian country to approve a plant biotechnology product for import, Roundup Ready soybeans in 1997 [17]. According to Consumer Association Penang CAP [18] and NRE [19] there are already five approved transgenic crops available in Malaysia in the absence of biosafety law. There are: Roundup Ready soybean, MON 810 maize, MON 863 maize and NK 603 maize for food, feeding and processing purpose, as well as ice structuring protein derived from a GM yeast, for ice-cream production. However, Biosafety Act 2007 has been regulated and entered into force in 1st December 2009. Table 1 shows approved transgenetic products in Malaysia.

Genetic modification of plants in Malaysia has been underwent since early 1990's with encouragement from international bodies such as the Australian Centre for International Agriculture Research (ACIAR), International Service for the Acquisition of Agri-biotech Applications (ISAAA) and the Rockefeller Institute. Earlier research were focus on disease resistance ability and post harvest quality of local crops however recent studies has shifted towards nutritional improvements. Latest efforts including indentifying a set of molecular markers to differentiate the weedy and cultivated rice, hence reducing the loss of production due to harmfulness of weedy rice [20]. Some of the products in table 2 were patented as well [19].

Efforts in Detection of GM Material in Commercialized Product in Malaysia: In order to effectively implement the GM labeling system, a suitable yet cost effective method must be used to precisely determine the GMO content of a food product are within or above the mandated threshold level [29]. An analytic technique called real-time polymerase chain reaction (PCR) which first amplifies specific DNA sequence of food sample and then entails the specific transgenetic DNA sequence at the amplified sequence were introduced to determined the strain and the quantity of GMO present in an food sample [30].

Table 1: Approved transgenetic goods and products in Malaysia

Event	Producer	Purpose	Description
Roundup Ready Soybean	Monsanto	Food, feed and processing (FFP)	An herbicide (Glyphosate) tolerant soybean variety of soybean created by transferring modified genes from soil bacterium.
NK603 Maize	Monsanto	FFP	Maize tolerant to the herbicide glyphosate produced through the introduction of modified genes from bacterium.
MON 810 Maize	Monsanto	FFP	Maize designed to resistance attack by the corn borer (insects) by inserting modified bacterium genes.
MON 863 Maize	Monsanto	FFP	Maize resistant to corn root worm produced by transferring bacterium genes.
Ice-Structuring Protein (ISP) produced in Food	Unilever Malaysia	Ice structuring protein	ISP produced by manipulating yeast cell (Recombinant Baker's Yeast) used as a processing aid in frozen products to control ice crystal size, shape and growth in the preparation of ice-cream.

(Source: modified from NRE [19])

Table 2: Selected transgenetic research in Malaysia

Plant	Trait/Process	Summary
Banana cv Berangan *Musa acuminat*	Fusarium resistance	An effort to test the level of tolerance of fusarium wilts (a common and very destructive disease resistance transgenetic banana towards by developing a suitable bioassay method [21].
Oil palm *Elaeis guineensis Jacq.*	BT gene	Creating BT oil palm using particle bombardment method and also developed a rapid detection system that can evaluate transgene expression among putative transformed tissues [22].
Oil palm *Elaeis guineensis Jacq.*	Transformation protocols	Using Green Fluorescence Protein (GFP) as genetic marker to locate and identify the transformation, transient expression of GFP genesin embryogenic calli and immature embryos of in oil palm [23].
Oil palm *Elaeis guineensis Jacq.*	Polyhydroxyalkanoates (PHA)	An effort to create environmentally friendly polymer Polyhydroxyalkanoates (PHA) through transgenic plants that involves R. eutropha (bacterium) and E. coli (bacterium) as production vector. A cheaper way to produce such polymer so that the cost for producing biodegradable plastic would decrease significantly. It also serves as an alternative of traditionally accepted expensive bacterial fermentation method by using a polymer-accumulating bacterium [24].
Pineapple *Ananas comosus*	Resistance to Blackheart disease	A joint effort by Australia and Malaysia to create pineapple that is resistance towards Blackheart disease, a post harvest defect and discolouration of pineapple when exposed to cold condition using gene-silencing technique. Gene-silencing technique switches off the particular gene in pineapples that are responsible for 'blackheart' disease [25].
Rubber *Hevea sp.*	Biopharming	Proposing the potential of using transgenetic rubber tree as bioreactor. The enormous amount of latex produced by a rubber tree can serve as non-destructive platform for harvesting recombinant proteins that are synthesized in the latex [26].
Senduduk *Melastomataceae sp.*	Optimization of agrobacterium-mediated transformation parameters	Establishing an optimized Agrobacterium-mediated transformation system by using GFP as reporter of successful recombination of DNA of senduduk with foreign genes. Therefore, useful genes such as more flower colour gene can be inserted to senduduk to improve their quality and increse their economical value [27].
Teak *Tectonis grandis*	Biolistic Process /UidA gene	First report on genetically transform teak by biolistic-mediated gene transfer (particle bombardment) technique injecting *uidA* and *hpt*. This paper also indicates by biolistic gene transfer technique, It's possible to introduce useful gene with useful traits into teak [28].

(Source: modified from NRE 2009 [19])

A study by Abdullah *et al.* [30] has showed that GM end product has infiltrated the market without any labeling or announcement from neither the authority nor producer. Of their 85 samples collected from various stores (traditional market and supermarket) 18 samples (21 %) including 9 processed food such as tofu, fucuk (traditional Chinese food) and tempe (traditional Malay food) were found positive for present of GM content. They also concede that all their samples of processed food samples were all locally processed and the origin of their raw material was come from unclear source.

Similar technique were used and expended by Kaur *et al.* [29] to detect GM maize present in processed feeds commercialized in Malaysia. Out of 103 processed feed samples, 27 of it were tested positive of GM material while for 20 maize samples, 13 were tested positive for GM material. In terms of quantification of GM levels in the samples, processed feed samples has lower levels compared to raw maize because processing possibly contributed to fragmentation of some DNA sequence. Concentrations of MON810, NK603 and GA21 were found in both feeds and maize in this study.

Table 3: Selected detected food and feed products in Malaysia

Products	Purpose	No. of samples	Positive result (GM)	Ratio (%)	Detected GM material	Levels (%)
Soybean	Food	20	9	45.00	EPSPS, RR	N/A
Soy flour	Food	5	0	0.00	-	N/A
Tofu	Food	37	8	21.62	EPSPS, RR	N/A
Fucuk	Food	10	0	0.00	-	N/A
Tempe	Food	8	1	12.50	EPSPS, RR	N/A
Soy sauce	Food	5	0	0.00	-	N/A
Maize	Feeds	103	27	26.21	MON810, NK603, GA21	4.7-69.8
Feeds	Feeds	20	13	65.00	MON810, NK603, GA21, MON863	0.3-48.2

(Source: adapted from Kaur *et al.* [29] and Abdullah *et al.* [30].

Table 4: The benefits of biotechnology outweigh risks perceived by selected countries

Country	Yes (%)	No (%)	Unsure (%)
Indonesia	81	16	3
China	72	17	11
India	69	18	13
United States	66	27	7
Brazil	53	32	13
Australia	44	42	14
Republic of Korea	43	47	10
United Kingdom	42	47	11
Japan	33	39	28
France	22	54	24

(Source: adapted from FAO [31])

The concentration of MON810 in raw maize and feeds were 34.8-69.8% and 0.3-48.2%. Concentrations of NK603 in maize and feeds recorded in the range of 5.4-31.2% and 2.7-20.9%. While 4.7-17.2% and 7.5-8.7% of GA21 were detected in both maize and feeds samples. Only one feed sample had MON863 content of 16.1%. if Malaysia was to emulate the EU, Japan and Korea Republic to label GM products, all the detected 27 feed samples and 13 maize samples bought from local animal feed outlets must be labeled as the labeling threshold for EU, Japan and Korea Republic were 0.9, 5 and 3 % respectively [29].

If extrapolate the result from the studies to the real market situation in Malaysia, there's nearly 10 percent to 45 percent of local soy and corn based food were possibly containing GM material without any notice, labeling or any relevant consumer information attached. Summary of the GM detection research were presented in table 3.

General Public Acceptance Toward Gm Food: The public attitude towards biotech products are regional and differ across regions. The US farmers are readily willing to plant GM crops as they consist of "input traits" which benefits them. An "input traits" can be explained as seeds that can reduce production cost (pest resistant, more yields and less ripen time) for the farmers, but the benefits for consumers are unclear or may inhibit risk cost [10].

In general, people with higher income are more skeptics towards GM products and vice versa to those who have lower income. Europeans generally express more concern about the potential risk than the Americans, Asians and Oceanian. However, on the acceptance of types of biotechnological applications, people are generally more acceptance toward medical applications than agricultural ones. Furthermore, people are generally more willing to accept argro-biotechnologies that may give benefits toward consumers and the environment rather than innovations towards increasing yield or productivity [31]. Table 4 shows the perception of biotechnology by selected countries while Table 5 shows the public acceptance level of biotechnology applications.

For Malaysian situation, a multi-dimensional attitude study conducted by Latifah *et al.* [4] and Latifah *et al.* [16] indicates that Malaysian generally have low to moderate familiarity with GM product while encouragement of biotechnology is driven by the benefits and risk acceptance level of the public. Familiarity contributes positive relations towards publics' perceived benefits and risk acceptance of GM product. The perceived risk and moral concern toward biotechnology have negative relations towards benefits and risk acceptance of the public.

Table 5: Support level toward some biotechnology applications

Applications	Support (%)	Oppose (%)
Develop new medicines	85	13
Grow pest resistant crops (fewer chemicals)	71	27
Grow more nutritious crops	68	30
Clone animals to produce medicine for human	42	54
Increase farm animal productivity	35	62

(Source: adapted from FAO [31])

Table 6: Consumer valuation of GM product from selected studies

Products	Country	Types of benefits	Study type	Value (WTP)
*Golden rice	USA	Enhanced vitamin A (DCB)	SP	12 cent / lb
*Corn Chips	USA	Enhanced shelf life (DCB)	SP	1 cent / 14.5 oz.
*GM Wheat-Bread	Norway	Herbicide tolerance (DPB)	SP	-49.5 %
*GM Wheat-Noodle	Japan	Herbicide tolerance (DPB)	SP	-60.0 %
*Bt corn-Chips	USA	Reduced pesticide (DPB)	SP	-32 cent / 14.5 oz.
Rice (De Steur *et al.* [33])	China	Enhanced folate content (DCB)	SP	+ 34.0 %

* Cited in Huffman and Rousu [10]

Note: DCB-direct consumer benefits; DPB-direct producer benefits; SP-stated preference; WTP-willingness to pay

Source: Adapted from Huffman and Rousu [10]; De Steur [33]

The Economic Valuation of GM Product: The process for valuation of GM food whether by CVM or CM usually is survey method involving carefully constructing a scenario or background of consuming GM food (hypothetical or real market situation); identifying the attributes and the levels of the GM food (ie. benefits, technology used, price et. al) and then let the respondents to choose the most preferred set of choice sets or state their preference (usually in monetary value) toward the GM foods. After that by using statistical analysis, the WTP of the respondents toward particular GM foods with various attributes can be obtained. The stated preference valuation technique was originated from quantifying the marketed and non marketed values of environmental good and services [32]. However, there is relatively few number of environmental valuation research were conducted in Malaysia including the valuation of WTP towards GM food.

Consumer Behavior in GM Product: A review by Huffman and Rousu [10] concludes that consumers are generally willing to pay more for GM product if the product delivers enhanced consumer traits such as enriched vitamins or minerals and longer shelf life. However, if the GM product only has input traits that are favorable to the producers (lowering production cost only), consumers are generally willing to pay discounts for those products. The methodologies used by those studies were market scanner data, stated preference technique and experimental auctions. Table 6 shows that consumer evaluation of GM product from selected cases.

The hostile reaction from the European public causing EU enforcing mandatory labeling of any product containing more than 0.9 percent of GMO in 2004. However, further studies also showed that the consumers albeit opposing GMO in general, they will still buy GM food [34, 35]. Generally, there has been presence of four main different consumer groups when presented with the choice of buying GM food. The first group was "non buyers" where refused to buy GM food at any price or benefit incentives. Followed by "indifference group" that does not see GM food as different as normal food. The third group of consumer was "price-sensitive" buyers where if given a price incentives, they might purchase first generation GM food. There is other group of consumer where they are "benefit-sensitive" where unless the GM product shows end user benefits, they will not consume GM product. Despite O'Connor *et al.* [26] did suggest the present of "second-generation rejecter" where the driven factors was not the concern of GM technology itself but the nutrition content of the food such as fat content. However, there was present of these four major consumer groups in most previous studies [34, 36-38]. Table 7 shows types of consumer groups when presented GM product.

Table 7: Consumer groups when presented GM product

Groups	Description
Non-buyer	This group of consumer is not willing to buy any food containing GMO even the GM food providing health benefits and the price are lower than conventional food.
Indifference-group	This group of consumer sees GM food as no difference with conventional food.
Benefits-sensitive group	This group of consumer willing to accept or even pay a premium for GM food that giving direct consumer benefits, but remain skeptic with GM food that favours the producers.
Price-sensitive group	This group of consumer willing accepts first generation GM food if the price is low.

(Source: adapted from Noussair *et al.* [34]; O'Connor *et al.* [36]; Burton and Pearse [37]; Font [38])

The motives that driven consumer in consuming GM food varies were several studies suggested different factors that might influence the decision or willingness to buy of consumers towards GM food. This has suggested that the factors influencing consumer willing to buy GM might be a lot more complex than solely concern of GM food issues only.

O'Connor [36] indicates that sensory flavor and nutrient level, has been the most important factor influencing consumer in buying GM yogurt. Surprisingly, contradict to other studies, brand name and price seems has little effect in driving consumer to consume GM food as the respondents believe *"premium brands could not counterbalance the negative attitudes that consumers held towards the use of GM technology in food production"* and also *"cheap yogurt can't taste good"*. However, it seems that seal of approval from highly reputational international body such as European standards agency may have a say in installing confidence in consumers as well. According to EC [35], driving factors for purchasing food products were quality and freshness, followed by value of money, familiarity with the product and also health and environmental values. Label seems matters little to their purchasing decision as the European consumers seldom read the content of the label, however a label of indicating the present of GMO material in a product (label such as "GM-free" or "contains no GMO") have more influence than label indicating the level GMO in a product. The consumers also opt for brand recognition, low price and attractive packaging. However, consumers' economic and socio-demographic attributes seems less significant in shaping their decision in consuming GM food, at least in developed countries [14, 39]. However, some studies stated otherwise [38].

Background of Selected WTP Studies on GM Food and Attributes Been Used: Consumer's choices to purchase particular goods can be analyse in terms of the attributes of the goods [40]. As mentioned earlier in this article, stated preference method requires creating a real or hypothetical scenario and carefully defines the attributes of the goods. The identification of GMO's attribute and it's level are heavily dependent on literature review and focus group discussion (FGD). The GM food products that wish to be study must be a readily available in stores, was familiar to majority of consumers and is partly contains GM ingredients [39]. Due to considering cognitive burden of the respondents, previous studies that were using CM or CA were mainly focus on 2-4 attributes with 2-4 levels and the most common attributes were price, technology or types of gene transfer, types of benefits which mixing environmental impacts and health benefits and labeling. As for studies using CVM, researchers usually defines one attribute of the goods, in this case mainly focus on the benefits of the GM food whether it's direct producer benefits or direct consumer benefits. The level for attributes such as benefits usually was positively labeled. Negative labeling of levels for some attributes such as environmental impacts and health effect uncertainty might necessary to provide more neutral information towards the respondents. A brief summary of attributes used by previous studies were presented in table 8.

Burton and Pearce [37] performed a study to understand the public attitude of west Australia towards GM beer. The first attributes was in the form of barley that was either conventional or GM barley to reduce production cost (typical direct producer benefits). The second attribute was yeast in either conventional form, GM yeast to reduce brewing cost, or increased antioxidant level. The third attribute was price of beer ranging from A$2.00-4.00. The study concludes that there are three groups of consumers regarding presence of GM substance in beer. One of the groups will not accept GM beer at any price. The second group will demand a discount for GM beer that direct benefits the producers while the rest actually pay a premium on GM beer with health benefits. As for WTP, younger respondents

Table 8: Selected WTP studies with the product attributes and level

Product	Study type	Attributes	Levels
Beer (Burton and Pearce [37])	CM	Barley	Conventional
			GM barley to reduce production cost
		Yeast	Conventional
			GM yeast to reduce production cost
			GM yeast to increase antioxidant in beer
		Price	Australian $2.00-$4.00
Banana, tofu and pork (Onyago and Govindasamy [41])	CM	Technology	Gene transfer-Bacterium
			Gene transfer-own gene
			Gene transfer-other plants
			Gene transfer-animal
		Benefits	Less chemicals and pesticides
			Using fewer Antibiotics
			Added antioxidants
			Added health beneficial compounds
		Price	Varies with %
Cornflakes and tomatoes (Font [38])	CM	Production technology	Conventional
			Organic
			GM health benefits
			GM environmental benefits
		Product functionality (cornflakes)	Regular
			Less carbohydrate
		Origin (tomatoes)	Imported
			Locally produced
		Price (per kg)	0.50-3.50 Euro
Cornflakes (Onyago *et al.* [39])	CM	Labelling	No label
			Contains no GM corn
			May contain GM corn
			Contains GM corn
			GM corn to reduce pesticide residue
			USDA approved GM corn
		Price	US$1.70-2.10
Yogurt (O'Connor *et al.* [36])	CA	Fat content	Standard
			Low
			Non
		Brand	Normal
			Dairy fresh
		GM technology	Health benefits
			Environmental benefits
			No GM
		Seal of approval	National body (DOH)
			International body (EFSA)
			Company standard
Breakfast cookie and eggs lay by hens fed with GM corn (Canavari and Nayga Jr [40])	DC	Benefits (cookie)	Less pesticide
			Nutritionally enhanced
		Technology (cookie)	Plant based GM
		Benefits (egg)	Feed for hens uses less pesticide
		Technology (egg)	Plant based GM for feed
			Animal based GM for hens

Note: DC-discrete choice; CM-choice modeling; CA-conjoint analysis

(20 years old) would require a discount of A$0.72 before considering consuming GM beer while a lower discount rate of A$0.40 were required for older respondents (> 40 years old) to buy GM beer. However, the respondents were prepared to pay a premium of A$0.83 to purchase beer with increase antioxidant level. There was also no significant difference in terms of respondent's preference towards using plant or microorganisms in brewing beer.

A previous study performed by Onyago and Govindasamy [41] examines South Korean consumers' valuation towards different types of GM food (processed food, raw food and animal) attributes relates to observed consumer characteristics. In this study, banana, tofu and pork were used as the product for this study. The attributes used were technology of producing such food product such as bacterium gene, plant gene, animal gene and own gene (only for banana and swine) transferred into the host. The second attribute were benefits from the GM food towards the consumer such as added antioxidant, added health beneficial compounds, less chemicals and pesticides (for banana and tofu only) and using less antibiotics (for swine only). As for price attribute, percentage was used rather than monetary value. The respondents were willing to pay between 8.1 % and 11.6 % more than the normal local banana price to obtain benefits of using less pesticide, added antioxidant and added health beneficial compound. However, the respondents require a discount of 8.6-12.6 % if there's bacterium and animal genes transferred to the GM food. For tofu, the respondents willing to pay 10.3-16.3 % more to obtain the same benefits while require 10.6-18.3 % of discount if involve any foreign gene transferred to the host. As for pork, 10.9-24.4 % of premium were willing to pay by the respondent to get the same benefits while demand a staggering 113.4 % of discount if involved transferring bacterium gene into swine.

Font [38] explores valuation and preference of GM food and organic food in Spain. Processed (cornflakes) and raw food (tomatoes) was used to elicit the WTP of Spanish consumers towards GM and organic food. Attributes used were production technology with levels such as conventional, organic, GM health benefits and GM environmental benefits. Other attributes such as product functionality for cornflakes (regular and less carbohydrate as level) and origins for tomatoes (imported and locally grown as level) were also used. Price ranges between 0.50-3.50 Euros per kilogram. The Spanish consumers are willing to pay a premium of 1.21 Euros per kilogram higher than average market price for organic cornflakes and 0.13 Euros for cornflakes with GM benefits. However require a discount of 4.16 Euros per kilogram of cornflakes with GM environmental benefits. As for tomatoes, the Spanish consumers willing to pay a premium of 0.86 Euros per kilogram for organic tomatoes and 0.20 Euros for cornflakes with GM benefits. However require a discount of 1.25 Euros per kilogram of cornflakes with GM environmental benefits.

Onyago *et al.* [39] examined American's WTP for GM food under different labeling regime. Result shows that the USA consumers requires a discount of 13.11 and 2.00 cent for "Contains GM corn" and "May contain GM corn" label. A premium of 20.3, 9.13 and 7.32 cent given by the US consumers if there's a label of "Contains GM corn", "USDA approved GM corn" and "GM corn to reduce pesticide residue".

An intriguing study by O'Connor *et al.* [36] using conjoint analysis show that there were 4 types of consumers when there's an option of second generation GM yogurt product present in the Irish market. First type were strong opposing party where they rejecting any kinds of GM food. Second type of consumers were rejecting second generation GM yogurt but their main reason behind it were not hatred towards GM but rather fat content levels present in yogurt. Third type of consumers where conditional acceptors for GM food where they will consume GM yogurt but had a greater preference towards natural product. While the fourth group of consumers will accept second generation yogurt without any special conditions. The study also revealed a very surprising outcome that price does not play an important role in influencing consumer's decisions of buying yogurt as there's a general perception that cheap yogurt do not taste good. Attributes and levels being used in the study were fat content (standard, low and non), brand (normal, daily fresh), GM technology (GM health benefits, no GM ingredient, GM environmental benefits) and also seal of approval (Department of Health and Children (DOH), company standard, European Food and Safety Authority (EFSA)).

Four discrete choice were presented towards Italian in a research in obtain the willingness to pay of Italians toward GM foods [40]. Attributes for first discrete choice were breakfast cookies made by plant-based GM wheat that resulting less pesticide being used. Second choice was breakfast cookie made by plant-based GM that enhanced with antioxidant which benefits human health. Third choice was eggs lay from hens fed with plant-based GM corn resulting less pesticide being used and finally low cholesterol eggs lay from hens fed with animal-based gene transferred GM corn. The respondents refuse to consume GM food (62.12 percent of total respondents for GM cookies and 70.6 percent of total respondents for GM eggs) if the price is same with ordinary food. However, with nearly 2.70 percent and 1.17 percent of total respondents would require a discount of 10 percent before considering consuming nutritionally enhanced GM

Table 9: Possible consumer reactions to GM in Malaysia

Religious view	GM food price	Health and Environmental Impact	Consumer preference
Clearly forbidden	Attractive	Clearly adverse	No
Clearly forbidden	Attractive	Clearly positive	No
Not clear	Attractive	Unclear	Yes
Not clear	Indifference	Unclear	No
Not clear	Attractive	Unclear	Depend on income
Not clear	Attractive	Clearly adverse	Depend on income

(Source: Latifah *et al.* [42])

breakfast cookies and eggs. However for those who accept GM food (32-39 percent of total respondents for GM cookie and 29 percent for GM eggs), 92.96 percent and 96.23 percent of them willing to pay a premium of 10 percent more than normal food price in consuming nutritionally enhanced GM breakfast cookies and eggs. However the proportion drops to 61.42 and 79.41 percent when the price of nutritionally enhanced GM cookies and eggs are 20 percent higher than normal price.

Possible Malaysian Consumer Preference on GM Food: Majority of Malaysian consumers are Muslims that strongly associate their eating behavior and lifestyle with the Islamic teachings. Assuming Islamic scholars clearly defined and declared that GM food is *haram* among Muslims, majority of Muslim consumers are believed will reject GM food indefinitely even if the price are attractive and the GM food possess health benefits and greener. It is also assumed that non-muslims in the country with follow the lead of their respective religions regarding eating habits as well. If the price gap of normal food and GM food are big enough, there will be a price threshold that makes local consumer switches from normal food to GM food without any clear guidance from religion scholars. It is assumed that the price and religious stands might have more influence for Malaysian consumers that strongly tie their eating habits with religions if the abundance of normal food is high enough. However, it may also depend on the income of the consumer in the preference of GM food. Table 9 shows that possible Malaysian consumer reactions for GM food.

The consumer preference can affected by the product attributes, socio-economic demography and also sources they trust most. In the case of Muslims, they may have relied more on clear definition and declaration of religious scholars. Furthermore, the income and price constrain may have greater effect on Malaysian consumer than in western region. More research is needed to understand the true Malaysian consumer preference towards GM food as the previous studies at the western realm may seem unable to accurately predict the consumer preference for GM food in developing countries such as Malaysia. The decision and the direction of Malaysia regarding GM food may influence the similar decisions and approaches for the surrounding region.

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