

*Full Length Research Paper*

## Risks and benefits of genetically modified foods

Latifah Amin<sup>1,2\*</sup>, Fadhli Hamdan<sup>1,2</sup>, Roosfa Hashim<sup>1,2</sup>, Mus Chairil Samani<sup>1,3</sup>, Nurina Anuar<sup>1,4</sup>,  
Zinatul A. Zainol<sup>1,5</sup> and Kamaruzzaman Jusoff<sup>6</sup>

<sup>1</sup>Social Impact of Biotechnology Development in Malaysia Research Group (SIMBIO), Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.

<sup>2</sup>Centre for General Studies, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.

<sup>3</sup>Faculty of Social Sciences, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia.

<sup>4</sup>Faculty of Engineering and Architecture, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.

<sup>5</sup>Faculty of Law, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia.

<sup>6</sup>Faculty of Forestry, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia.

Accepted 29 September, 2011

There are claims that fear towards new technology has been caused by the lack of information and education on the subject to the public. Modern biotechnology and its applications have been receiving the same criticism. Thus, the objective of this study is to analyze the trends and coverage of genetically modified food (GMF) related issues available in an online database. In order to achieve this, GMF-related articles (n = 60) were retrieved from a database, Science Direct, from the year 2005 until 2010. These articles were then analyzed using the annotated bibliography and content analysis techniques. It was found that the highest number of articles was in the 'Technical/Progress' theme with 22 counts followed by the 'Attitude' theme with 13 counts. Meanwhile, the 'Social Risks and/or Benefits' theme was the lowest with only 1 paper identified. This trend shows that the focus of the majority of papers published were on the progress of GMF technology followed by attitude studies (such as perceptions and willingness to buy) and only a few were discussing the risk and benefit aspects of GMF. These findings are useful in giving us an insight of what have been discussed on GMF in the existing literature.

**Key words:** Genetically modified food (GMF), themes, risks and benefits, content analysis, biotechnology.

### INTRODUCTION

Modern technology such as biotechnology has been criticized for its application and unknown impacts on human health and environment (Dona, 2009). Many believe that if we want to improve public perception towards this technology, information sharing process must be properly made. Lack of knowledge will only hamper biotechnology development and cause misperceptions on its application (Gaskell et al., 2004). Some also argue that this information was not available and even if it is available, they are not well explained (Pusztai et al., 2003; Gewin, 2003; Peterson et al., 2000).

The term 'genetically modified food' refers to the alte-

ration of the genetic makeup of certain foods or crops by the insertion of novel genes from other sources or deletion of existing genes. The genetically altered foods or crops have now acquired traits and capabilities that they did not naturally have (Uzogara, 2000). For example, GM corn are resistant to certain herbicides and insect pests after being incorporated with a gene that is coded for *Bacillus thuringiensis* (Bt) toxin (Wu, 2006).

According to many scientists and crop producers, there are many benefits in applying biotechnology in the food industry. Its benefits include the possibilities of solving the world's hunger problem, introducing super food with added vitamins and nutrients and improving economic growth (James, 2010). However, the production of genetically modified foods (GMF) and crops has also raised ethical questions. Opposing parties question the possible harmful effects caused by the alteration of the genetic

\*Corresponding author. E-mail: [nilam@ukm.my](mailto:nilam@ukm.my). Tel: +603-89216907. Fax: +603-89252976.

makeup of natural foods and crops (König et al., 2004; Pusztai et al., 2003). Some also claim that the introduction of foreign genes could cause allergenic reactions, toxicities, and other long term effects on the environment and the whole ecosystem (Mendelsohn et al., 2003).

The application of biotechnology in the food industry has raised a lot of questions and criticisms despite the idea that this technology will help to produce better foods and even someday would solve the world's hunger problem (James, 2010). Many issues on GMF have been discussed in hundreds of articles thus it is important to analyze these documents to identify/observe any occurring trends. By understanding this issue better, governments, scientists and other responsible bodies could then decide in which direction the development of the biotechnology industry should be taken.

In this study, a research method known as 'content analysis' has been applied to analyze GMF-related literature retrieved from an online database. The method of content analysis is a very common technique used to understand the facet of communication and it is a popular method used by many researchers to identify and analyze media content such as figuring out frequencies of specific commercials or advertisements in published electronic or print media (Wimmer and Dominick, 1991). Content analysis technique is used to analyze content or communication in media in a very systematic manner and the coding protocol used to retrieve specific data from the pool of samples must also be objective and precise (Berger, 2000; Hansen, 2008; Berelson, 1971; Walizer and Wieneir, 1978). This systematic and objective nature of content analysis technique makes it a very popular method used in content-analytic research. Wingenbach and Rutherford (2006), a media researcher at Texas A and M University, USA, studied the behavior and information sources used by journalists in Texas and local journalists on the issue of agricultural biotechnology. In another example, Matthews et al. (2003) have done a content analysis of 427 news articles from four different newspapers in Canada and found out various topics covered by the media on biotechnology such as water pollution, food safety and biotechnology-related food products.

Besides being used popularly in media research, content analysis technique has also been used to analyze articles available in scientific journals. D' Agostino et al. (2011) used content analysis to assess the current state of research in energy studies and hypothesized that the rise of certain issues such as climate change and energy security are correlated with the frequency of reflective themes in relevant papers over time. Another study that uses content analysis approach is a content analysis of international careers articles published in four major U.S vocational/career journals over a 34 year time period which was done by Nilsson et al. (2007). Content analysis has been used to study journal articles based on various topics and issues but there has been no studies covering modern biotechnology. In this study, this technique will be

used to analyze the trends and coverage of GMF-related issues available in the online database.

## METHODOLOGY

The research began with an attempt to identify as many GMF-related articles as possible that are available from 2005 until 2010 in online database commonly used by researchers. Keywords search were done and only English-language research papers were retrieved from the selected databases. The following steps taken in selecting appropriate samples for further analysis are thus discussed.

### Selection of databases and keywords

First, suggestions from other experienced researchers and librarians were taken into account when selecting the most appropriate databases for the research. The databases initially selected were: ISI Web of Knowledge, SCOPUS, EBSCOHOST, and ScienceDirect. When searching and identifying the journals for further content analysis, the 'article type' in the search options was set to 'journals only' while excluding sources from books and other non-full text articles. 'Genetically Modified Food' was the first keyword used in the early search strategy and it yielded more than 5,000 GM food/crop-related articles (period of 2005 until 2010) from the selected databases.

Several factors demanded that the search strategy be modified. First, the sample size was really huge and second, it was difficult to analyze 5,000 articles with the limited time constraint. Thus, for a start, one database was chosen for this study. It was decided that a content analysis of articles available and downloadable from the database, ScienceDirect, were used for this study. ScienceDirect was chosen due to its wide coverage. It covers over 2,500 journals and is one of the largest online collections of published scientific research in the world. Its content reaches nearly 10 million articles from e-books, journals and reference works on fields such as physical sciences and engineering, life sciences, health sciences, social sciences and humanities. Moreover, since most of the journals on the database were already subscribed by the university, the articles were easily and readily downloadable and appropriate amount of GM-food related articles were available for an effective analysis. A content analysis of the samples from this selected database could establish a basis for GM food knowledge and interest for further research.

### Selection of themes

The first step of the coding process was the collection of basic information of each article such as the year it was published, type of research, country, and number of pages. In the next section, 'themes' are used in understanding the main idea of an article.

Six themes were selected: Progress/technical; risks and/or benefits; attitude; ethical; legal/policy; and others. However, the 'risks and/or benefits' theme was further separated into several sub themes which are: Environment; health; economic and social. Table 1 shows the definition of each theme selected for this study.

### Selection of articles

When doing the keyword search in ScienceDirect, the articles were sorted based on relevancy and only the top 10 articles from each year, from 2005 until 2010 (total = 60 articles) were extracted. These articles were then analyzed and categorized into the selected themes.

**Table 1.** Operational definitions of themes.

Theme	Definition	Example of Keyword
Progress/Technical	New development or breakthrough; discussion or proposal of new techniques in GMF technology application.	PCR technique, GMF detection
Environmental	Focuses on the possible effects of GM crop technology application in agricultural activities on the environment and the environment itself as part of the biological system.	Gene flow, 'superweed', cross-pollination, sustainable agricultural practices
Health	Focuses on short or long term effects of GMF on human or animal health.	Toxicity, allergenicity, disease, super-viruses, antibiotic resistance, birth defects
Economic	Focuses on the economical impact of GMF on farmers, biotechnology companies and consumers.	Increased dependency, loss of markets, liability, cost to consumers, profitability, prices, supply and demand
Social	Focuses on the social impacts of GM crop adaptation and production.	Threat to food security, threat to livelihood, debt trap, socio-political tension
Attitude/ Awareness	Focuses on public perception towards GM food/crop technology application or products.	Public perception, acceptance, opinion, uncertainty, moral, trust, consumer's preference, consumers concern, acceptance, willingness to pay
Ethical	Call for ethical principles; thresholds; boundaries; distinctions between acceptable/unacceptable risks in discussions on known risks; dilemmas.	Animal stress, Violation of natural organisms' intrinsic and extrinsic values
Legal/Policies	Discussions on GM food policies and the regulatory structures underlying its application and production.	Labeling, Ownership, IP protection, antitrust, tort, warranties, law, merchant, tariff, warranty, contract, purchases, agreement, protection acts
Others	Other issues on GM food such as the effects of media coverage, religions, and politics.	Media, spiritual, beliefs, politics, history

## RESULTS AND DISCUSSION

In total, 60 articles published from 2005 until 2010 were selected for this preliminary study. Each article was assigned with relevant themes which were constructed prior to the study. These set of themes will give us some insights on which areas have been studied and discussed in the literature on GMF issues in the selected period of time. Based on the data shown in Table 2, the highest number of articles was found in the 'Progress/Technical' theme with 22 articles followed by the 'Attitude' theme with 13 articles while the lowest number of articles was found in the 'social risk and/or benefits' sub theme with only 1 article. However, we have to note that there are four sub themes (environment; health; economy; and social) under the bigger theme of 'Risks and/or Benefits'. Thus, the total number of articles from the 'Risks and/or Benefits' theme was actually 17 articles.

From the data, we could assume that there were a few aspects on GMF issues that were overlooked or not regularly discussed in the literature. Social issues (1 article), ethical issues (4 articles), and economic issues (4 articles) regarding GMF application were a few examples of issues that were not regularly discussed in the literature based on the low number of articles found from the sample. On the other hand, the highest number of articles were assigned in 'Technical/Progress' and 'Attitude' themes with 22 and 13 articles, respectively. Based on this data, we could further assume that there were many papers which focused on the development of new techniques in GMF technology such as proposing new methods in detecting GM content in crops and foods. There were also many articles that discussed about public attitude towards GMF technology such as measuring the willingness of consumers to pay or accept GMF in the market using survey methods.

**Table 2.** Article counts according to themes.

Year	Progress/ Technical	Risk and/or benefit				Attitude	Ethical	Legal/Policy	Other
		Environment	Health	Economic	Social				
2010	3	3	1	0	1	3	1	1	0
2009	4	1	1	4	0	0	0	0	0
2008	1	0	5	0	0	0	2	1	0
2007	5	0	0	0	0	4	0	2	1
2006	6	1	0	0	0	2	0	0	1
2005	3	1	0	0	0	4	0	1	1
Total	22	5	7	4	1	13	2	3	3

Based on preliminary findings, it is not surprising to find out that most GMF research focus are on the development of newer techniques and other improvement of the technology itself. A positive progress and development of GMF technology will encourage and increase the production of newer and better GMF products which may lead to commercialization and massive production of GM crops and foods in the market. Besides claims on GMF benefits such as reducing pesticide usage, bringing less harm to the environment, and solving world hunger, the commercialization of these GMF products will definitely bring profit in billions of dollars which has been claimed in many reports on world GMF production by both the supporting and opposing parties of GMF technology (Uzogara, 2000; James, 2010; Benbrook, 2009; Monsanto, 2003). For example, the global market value of the biotech seed market alone was valued at USD 10.5 billion in 2009 with commercial biotech maize, soybean grain and cotton valued at USD 130 billion in 2008. Considering the huge amount of profit the GMF market can bring in, it is not hard to predict that most GMF research are more focused on the development and progress of the technology itself. This is also supported by James (2010) who claims that political will, financial and scientific supports are needed for the development, approval and adoption of biotech crops. He also predicts that the adoption of GMF products would double between 2006 and 2015 (from 20 to 40 countries, 10 to 20 million farmers and 100 to 200 million hectares).

GM crops and foods adoption and production has been in the market for years in developing and poor countries. Has the adoption of GMF technology caused more harm than good to us? What are the implications in the long run? Do we really understand the promises and risks underlying GMF adoption and application? These are the questions that remind us about the importance of biotechnology education in improving the public understanding of the technology. Lack of knowledge will only lead to misperceptions and in the long run, it will only hamper its development (Gaskell et al., 2004; Burke, 2004). In order to ensure that relevant and important information from reliable sources are available, a study on existing literatures related to the technology is much

needed. A deep look at these literatures using content analysis will definitely help us in understanding the technology better while avoiding unnecessary accusations and misperceptions on the technology's advancement. This study is a preliminary effort to identify the coverage of existing literatures from one database. By having this information on the advances made in GMF studies, other researchers, government policy makers and regulators related to biotechnology or food safety will be able to benefit by the richness of the research and be able to understand which methods and topics in GMF research are underexplored and need to be investigated.

## Conclusion

It can be concluded that more GMF-related papers are reporting on the technical process of GMF technology than any other themes. The analysis of GMF-related articles will provide a better perspective on how the issues on GMF have been discussed for a certain period of time through academic writings. More research is needed to assess a lot more literatures for a longer period of time and to cover other databases as well as to cover other areas of biotechnology in order to get a more accurate picture of the trend and focus of writings in existing academic literatures.

## ACKNOWLEDGEMENT

The authors would like to thank Universiti Kebangsaan Malaysia for supporting this research under the UKM-AP-CMNB-21-2009/1 grant.

## REFERENCES

- Benbrook C (2009). Impacts of Genetically Engineered Crops on Pesticide Use in the United States: The First Thirteen Years at [http://www.organic-center.org/reportfiles/13Years20091126\\_ExSumFrontMatter.pdf](http://www.organic-center.org/reportfiles/13Years20091126_ExSumFrontMatter.pdf).
- Berelson BR (1971). Content Analysis in Communication Research. New York: Hafner Publishing Co.
- Berger AA (2000). Media and communication research method: An

- introduction to qualitative and quantitative approaches. Thousand Oaks: Sage Publications, Inc.
- Burke D (2004). GM foods and crops: What went wrong in the UK? *Eur. Mol. Biol. Organ.* doi:10.1038/sj.embor.7400160.
- D'Agostino AL, Sovacool BK, Trott K, Ramos CR, Saleem S, Ong Y (2011). What's the state of energy studies research?: A content analysis of three leading journals from 1999 to 2008. *Energy*, 36(2011): 508-519.
- Dona (2009). Health risks of genetically modified foods. *Crit. Rev. Food. Sci. Nutr.* doi:10.1080/10408390701855993.
- Peterson G, Cunningham S, Deutsch L, Erickson J, Quinlan A, Raez-Luna A, Tinch R, Troell M, Woodbury P, Zens S (2000). The Risks and Benefits of Genetically Modified Crops: A Multidisciplinary Perspective. *Ecol. Soc.* 4(1): 13.
- Gaskell G, Allum N, Wagner W, Kronberger N, Torgersen H, Hampel J, Bardes J (2004). GM Foods and the Misperception of Risk Perception. *Risk. Anal.* doi: 10.1111/j.0272-4332.2004.00421.x
- Gewin V (2003). Genetically Modified Corn: Environmental Benefits and Risks. *PLoS Biol.* doi/10.1371/journal.pbio.0000008.
- Hansen A (2008). Mass communication research methods. London: Sage Publications, Inc. Vol. II.
- James C (2010). Global Status of Commercialized Biotech/GM Crops: 2009. The first fourteen years, 1996 to 2009 at <http://www.isaaa.org/resources/publications/briefs/41/executivesummary/default.asp> [20.11.2010]
- Matthews J, Sheeskha J, Finlay K (2003). Effective risk communication? A content analysis of four Canadian newspapers. *Can. J. Dietetic Pract. Res.* 64(2): 93.
- Mendelsohn M, Kough J, Vaituzis Z, Matthews K (2003). Are Bt crops safe? *Nat. Biotechnol.* doi:10.1038/nbt0903-1003. 21(9): 1003-1009.
- Nilsson JE, Flores LY, Berkel LV, Schale CL, Linnemeyer RM, Summer I (2007). International career articles: A content analysis of four journals across 34 years. *J. Vocational Behav.* 70(2007): 602-613.
- König A, Cockburn A, Crevel RWR, Debruyne E, Grafstroem R, Hammerling U, Kimber I, Knudsen I, Kuiper HA, Peijnenburg AACM, Penninks AH, Poulsen M, Schauzu M, Wal JM (2004). Assessment of the safety of foods derived from genetically modified (GM) crops. *Food. Chem. Toxicol.* doi:10.1016/j.fct.2004.02.01.
- Monsanto (2003). Safety assessment of YieldGard Rootworm corn at [http://www.monsanto.com/products/Documents/safety-summaries/yeildgard\\_rw\\_pss.pdf](http://www.monsanto.com/products/Documents/safety-summaries/yeildgard_rw_pss.pdf) [5.3.2011]
- Pusztai A, Bardocz S, Ewen SWB (2003). Genetically Modified Foods: Potential Human Health Effects at <http://pelennor.leopold.iastate.edu/news/pastevents/pusztai/0851996078Ch16.pdf>
- Uzogara SG (2000). The impact of genetic modification of human foods in the 21st century: A review. *Biotechnol. Adv.* 18: 179-206
- Walizer M, Wiener P (1978). *Research Methods and Analysis: Searching for Relationships*. New York: Harper and Row.
- Wimmer RD, Dominick JR (1991). *Mass media research and Introduction*. Belmont: Wardsworth, Inc.
- Wingenbach GJ, Rutherford TA (2006). National agricultural and Texas journalists' attitudes toward and information source of biotechnology issues. *J. Agrobiotechnol. Manage. Economic*, 9(1): 42-50.
- Wu F (2006). An analysis of Bt corn's benefits and risks for national and regional policymakers considering Bt corn adoption. *Int. J. Technol. Globalisation* 2(1-2): 115-136.