Food Chemistry 112 (2009) 1060–1064

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Analytical Methods

South Africa: A case study for voluntary GM labelling

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ARTICLE INFO

Article history:
Received 31 March 2008
Received in revised form 4 June 2008
Accepted 22 June 2008

Keywords:
Consumer
Genetically modified (GM)
GM food
GM labelling
GM testing
South Africa
Voluntary GM labelling

ABSTRACT

South Africa is the only country in Africa growing genetically modified (GM) crops, yet, consumer knowledge of biotechnology is limited and labelling regulations regarding consumer preference is lacking. In the absence of mandatory GM labelling, voluntary GM labelling is being used as a marketing strategy to attract discerning consumers. The aim was to detect and quantify the GM content in food products in South Africa, specifically labelled to indicate an absence of genetic modification. Of the products labelled 'GMO-free', 'non-GM' and 'organic', it was found that 31% had a GM content above 1.0% and 20% a GM content above 5.0%. Product batches differed by up to 40% in terms of GM content. In the absence of specific regulations, voluntary GM labelling is not providing discerning consumers with the choice intended. Thus, unregulated GM labelling is not a viable alternative to a regulated approach in terms of consumer protection.

1. Introduction

South Africa, the only country in Africa to produce genetically modified (GM) food since 1997, is ranked eighth in terms of global biotech production (James, 2006). Current GM food crops include white and yellow maize and soybean with an estimated production of 44%, 50% and 75%, respectively (James, 2006). White maize is an important staple consumed by the majority of people in South Africa and soybean, similar to international practise, is used extensively in processed foods.

Despite significant levels of GM food crop production, the majority of South Africans are not aware of the existence of GM foods (Cole, 2003; Joubert, 2001; Mulder, 2003; Rule & Ianga, 2005). Furthermore, most South Africans are also not aware that they are consuming GM food (Rule & Ianga, 2005). Thus it is difficult to determine consumer preference for GM food in South Africa when most consumers are oblivious to genetic modification. However, it is ironic that despite a lack of awareness of genetic modification, several food products in South Africa are labelled in terms of GM content, most of these to indicate an absence thereof (Viljoen, Dajee, & Botha, 2006).

The South African Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972 (Regulation 25 of 2004) mandates the labelling of GM food if it differs from its conventional counterpart in terms of nutritional composition, storage and preparation, or if it contains an allergen or a human or animal gene (Department of Health, 2004). In addition, voluntary GM labelling is allowed for products with consumer value added traits such as improved nutrition or reduced allergenicity. However, no provision is currently being made for GM labelling in terms of consumer preference, even though some South African companies are applying voluntary GM labelling. South Africa is therefore a good case study to determine whether voluntary GM labelling is practical to meet the needs of discerning consumers.

The argument against mandatory GM food labelling for consumer preference in South Africa is that it could result in a negative perception of the technology (personal communication, Department of Science and Technology). This incorrectly suggests that ignorance and acceptance are synonymous, and implies that knowledge of genetic modification would result in rejection of GM food by consumers. It is also argued that GM labelling is not feasible for 'poor' developing countries as it would increase the cost of food unnecessarily (Bullock & Desquilbet, 2002). Ironically, it is accepted practise to label food products in terms of additives and colorants, even though these do not pose any health risk, as well as life style choice, such as Halal, Kosher or vegetarian, without any consideration of cost (Carlsson, Frykblom, & Lagerkvist, 2004; Cheftel, 2005; Klintman, 2002). Furthermore, it is argued that voluntary and not mandatory GM labelling gives discerning consumers a choice without prejudicing non-discerning consumers in terms of cost (Bullock & Desquilbet, 2002). However, a problem with the application of voluntary GM labelling throughout the world is that it is currently not being regulated and may result in consumers being misled.

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doi:10.1016/j.foodchem.2008.06.050

Currently in South Africa, 'GMO-free', 'non-GM' and 'organic' labels are being used to indicate an absence of genetic modification despite the fact that no definitions exist for these terms in a regulatory context (Viljoen et al., 2006). The absence of specific definitions for voluntary GM labelling is exacerbated by the use of these terms in a mandatory context in other countries. For example, the European Union (EU) applies a 0.9% (Regulation, 2003a, 2003b) GM threshold for 'non-GM' whilst in Japan it is 5.0% (Viljoen et al., 2006). Thus unless specifically defined, companies may apply their own definition to what constitutes 'GMO-free', 'non-GM' and 'organic'.

In a study of off-the-shelf food products in South Africa, Viljoen et al. (2006) determined that genetic modification was present in 76% of products carrying a 'GMO-free', 'non-GM' or 'organic' label. They concluded that in the absence of specific guidance or regulations for voluntary labelling, companies would apply their own systems to satisfy perceived consumer demand and that although the presence of genetic modification, in a 'GMO-free', 'non-GM' or 'organic' product, is not illegal in South Africa, it may be misleading to discerning consumers. However, this study did not determine the percentage GM content in the food products tested and it could arguably have been extremely low as found in studies in other countries (Abdullah, Radu, Hassan, & Hashim, 2006; Partridge & Murphy, 2004; Ujhelyi et al., 2008). Thus the aim of this study was to detect and quantify the GM content in 'GMO-free', 'non-GM' or 'organic' labelled food products and determine the validity of GM food labels in a voluntary GM labelling environment.

2. Materials and methods

A total of 23 food products labelled 'GMO-free', 'non-GM' or 'organic' were selected from retail chain outlets including Pick 'n Pay, Shoprite Checkers, Spar and Woolworths as well as small retail outlets such as health food shops according to product availability during 2006/2007 (Table 1). Each product was re-sampled after a period of approximately between three to six months to test batch variability.

DNA was extracted in duplicate as described by Lipp et al. (2001). GMO screening was performed using the 35S CaMV promoter sequence for maize products and the EPSPS gene sequence for soybean products according to the method of Lipp et al. (2001) on an Applied Biosystems GeneAmp PCR System 9700. The limit of detection was 0.01%.

Total GM content was quantified, in GM positive samples, in duplicate according to the content of 35S CaMV promoter for maize products and EPSPS for roundup ready soybean products on the ABI 7500 Real-time PCR system, with the use of absolute quantification using a standard curve consisting of four data points in duplicate with a minimum correlation of 0.98. The limit of quantification (LOQ) was 0.05%. The GMO content of a sample was determined relative to the total content of plant DNA. Two dilutions of each sample were tested to determine sample inhibition. To minimise the risk of cross-contamination, individual steps were performed in separate work areas and the necessary negative and positive controls included with each reaction.

Products identified in the Viljoen et al. (2006) study with a 'GMO-free', 'non-GM' or 'organic' label were compared to the products tested in this study to determine whether any change in the use of GM label had occurred.

Food producers and retailers whose products were identified and tested in this study were sent the tabulated results and invited to make comments.

Table 1
Products with an 'organic', 'non-GM' or 'GMO-free' label in South Africa

Product name	Description	Label
Amazon corn flakes	Maize cereal	Organic
Baby corn	Raw maize	Organic
Envirokids organic munch	Maize cereal	Organic
Soysense	Soy milk	Organic
Soya chunks	Processed soy	Non-GMO
Soy shake	Soy milk	Non-GMO
Cape creamy	Soy milk powder	GMO-free
Swiss dream	Dairy-free milk powder	GMO-free
Chick burger	Soy protein	GMO-free
Corn thins	Puffed maize	GMO-free
Just protein	Protein	GMO-free
Soy flour	Soy flour	GMO-free
Soya milk powder	Soy milk powder	GMO-free
Vegetarian hot dogs	Soy protein	GMO-free
Vegetarian burgers	Soy protein	GMO-free
Braai flavour sausages	Soy protein	GMO-free
Chunky strips	Soy protein	GMO-free
Cutlets	Soy protein	GMO-free
Golden nuggets	Soy protein	GMO-free
Schnitzels	Soy protein	GMO-free
Spiced burger	Soy protein	GMO-free
Traditional burgers	Soy protein	GMO-free
Veggie mince	Soy mince	GMO-free

3. Results

A total of 23 off-the-shelf products were identified with a 'GMO-free', 'non-GM' or 'organic' label. Nineteen of these were soybean based and four were maize based. Of these, 17 carried a 'GMO-free', two a 'non-GM' (also labelled 'no GM ingredients' or 'non-GMO') and four an 'organic' label (Table 1).

Genetic modification was detected in 56% (25 out of the total 45 sample batches) of sampled food products labelled to indicate an absence of genetic modification (Tables 2 and 3). Of the total product batches tested, 31% had a GM content above one percent and 20% a GM content above five percent (Tables 2 and 3). Genetic modification was detected in one of eight product batches with an 'organic' label but was below the limit of quantification (0.05%) (Tables 2 and 3). Of the 'GMO-free' labelled product batches, 64% tested positive for genetic modification of which two product batches tested below the limit of quantification, eight contained genetic modification below one percent, 13 contained more than one percent genetic modification and nine had a GM content above 5% (Tables 2 and 3). Of the four product batches with a 'non-GM' label, 75% contained genetic modification, of which two product batches had a GM content below 1% and one a GM content above 1% (Tables 2 and 3).

Of the products tested by Viljoen et al. (2006), 10 were found to have retained the same GM related label and five were not available or their GM labels had been removed (Table 4). Of the seven food producers and four retail outlets whose products were tested in this study, only three responded (Table 5).

4. Discussion

Voluntary labelling, as applied in South Africa, does not appear to be providing discerning consumers with a choice between GM and non-GM products when 56% of product batches that are labelled 'GMO-free', 'non-GM' or 'organic' contain genetic modification (Tables 2 and 3). Furthermore, 31% of product batches contained above 1.0% genetic modification whilst 20% contained above 5.0% genetic modification. These results are in contrast to other studies, in other countries with low GM production, where low level GM contamination was detected in food products (Partridge & Murphy, 2004; Ujhelyi et al., 2008). Possible explanations for the high levels of genetic modification in 'GMO-free',

Table 2
GM detection and quantification in food product batches

Product name	Description	Label	% GM	
			Batch 1	Batch 2
Amazon corn flakes	Maize cereal	Organic	Nd	Nd
Baby corn	Raw corn	Organic	Nd	Nd
Envirokids organic gorilla munch	Cereal	Organic	Nd	Nd
Soysense	Soy milk	Organic	Nd	0.03
Soya chunks	Processed soy	Non-GMO	0.18	0.15
Soy shake	Soy milk	Non-GMO	2.47	Nd
Cape creamy	Soy milk powder	GMO-free	>5.0	>5.0
Swiss dream	Dairy-free milk powder	GMO-free	Nd	Nd
Chick burger	Soy protein	GMO-free	3.23	Nd
Corn thins	Puffed corn	GMO-free	Nd	Nd
Just protein	Protein	GMO-free	Nd	Nd
Soy flour	Soy flour	GMO-free	1.20	0.03
Soya milk powder	Soy milk powder	GMO-free	>5.0	0.55
Braai flavour sausages	Soy protein	GMO-free	1.03	0.11
Spiced burger	Soy protein	GMO-free	4.23	0.05
Chunky strips	Soy protein	GMO-free	Nd	Nd
Cutlets	Soy protein	GMO-free	0.34	0.32
Golden nuggets	Soy protein	GMO-free	>5.0	Nd
Schnitzels	Soy protein	GMO-free	>5.0	Nd
Traditional burgers	Soy protein	GMO-free	0.24	0.03
Vegetarian burgers	Soy protein	GMO-free	>5.0	>5.0
Vegetarian hot dogs	Soy protein	GMO-free	>5.0	>5.0
Veggie mince	Soy mince	GMO-free	Nd	Nd

Nd, genetic modification not detected.

Table 3
Summary of GM detection and quantification results according to label type ('organic', 'non-GM' or 'GMO-free')

Label	Number of samples			% GM content[b]			
	Total product batches	GM detected	% GM detected	<0.05[a]	0.05–1.00	>1.00–5.00	>5.00
Organic	8	1	13	1 (13%)	0 (0%)	0 (0%)	0 (0%)
GMO-free	33	21	64	2 (6%)	8 (24%)	13 (39%)	9 (27%)
Non-GMO	4	3	75	0 (0%)	2 (50%)	1 (25%)	0 (0%)
Total	45	25	56	3 (7%)	10 (22%)	14 (31%)	9 (20%)

[a] The limit of quantification is 0.05%.
[b] The percentage in brackets refers to the percentage number of samples that fall within the interval group as indicated.

Table 4
Products in the current study that have kept the same GM label compared to Viljoen et al. (2006)

Product name	Description	Label	Viljoen et al. (2006) GM result[a]	Current study GM result[a]
Amazon corn flakes	Cereal	Organic	Detected	Nd
Baby corn	Raw corn	Organic	Nd	Nd
Soysense	Soy milk	Organic	Detected	Nd
Cape creamy	Soy milk powder	GMO-free	Detected	Detected
Braai flavour sausages	Soy protein	GMO-free	Detected	Detected
Chick burger	Soy protein	GMO-free	Detected	Detected
Corn thins	Puffed corn	GMO-free	Nd	Nd
Soy flour	Soy flour	GMO-free	Nd	Detected
Soya milk powder	Soy milk powder	GMO-free	Detected	Detected
Spiced burger	Soy protein	GMO-free	Detected	Detected

Nd, genetic modification not detected.
Detected, genetic modification detected.
[a] The limit of detection is 0.01%.

'non-GM' or 'organic' food products in South Africa is that there is no segregation of GM and non-GM grain, there are no regulations that control GM labelling for consumer preference and voluntary GM labelling is applied without any requirement for third party validation.

There appears to be a lack of consistency between batches with a 40% difference in results (including GM negative or positive as well as changes between below LOQ, below 1.0%, above 1.0%, below 5.0% or above 5.0%). This suggests that the internal systems companies use to validate the GM content of these products is not sufficient, validation is not being performed or not performed on each batch of product or that the correct sampling strategy is not being applied. Be that as it may, consumers are not guaranteed that the GM content of food labelled 'GMO-free', 'non-GM' or 'organic' will consistently be below a specific threshold of GM content.

Table 5
Response to the results of this study from producers and retailers, whose products were tested

Company	Company policy on GM labelling	System to validate GM labels	Comments
Producer of health food products		No response	
Producer of health food products		No response	
Producer of health food products	No specific policy	No system	Seed supplier should provide GM certificate that must accompany produce from point of origin to retail supplier
Producer of soy food products		No response	
Producer of soy food products		No response	
Producer of soy food products		No response	
Producer of soy milk products	Conform to EC regulation 1829/2003 that provides a threshold of 0.9% for GM presence	Rely on supplier for verification and "non-GM" certification	Recommend a threshold level of 5.0% for presence of GM in "non-GM" food or feed in SA labelling legislation
Retailer		No response	
Retailer		Requested that comments not be included	
Retailer		Requested that comments not be included	
Retailer	To "remove , replace or label" ingredients from GM crops in foods	Supplier has procedures in place: (1) raw material tested with a threshold level of 1.0% GM and (2) identity preservation process to ensure traceability	Products are labelled for customers to be accurately and sufficiently informed about products, in order to make informed buying choices

From producer and retailer comments (Table 5) it is clear that in an absence of regulations, different systems will be applied to GM labelling – possibly based on the perceived requirement of the specific niche market being serviced. The label 'GMO-free' was used in 75% of products to indicate an absence of genetic modification despite the guideline to not use this term by the Department of Health (2004). Although South African companies may not be aware of the existence of the Department of Health guideline, the use of 'GMO-free' in terms of the guideline is not illegal. However, this does suggest that the use of guidelines instead of regulations in voluntary GM labelling will result in incoherent labelling practise by companies.

Although there are no definitions for GM labelling in a South African context, the common interpretation for 'organic' and 'GMO-free' imply zero genetic modification (Viljoen et al., 2006). The problem is that in the absence of specific regulations, companies may apply existing systems taken from other countries (Table 5). For example, from 2009, 'organic' in the EU may contain up to 0.9% adventitious genetic modification (currently 0.0%) whereas in the United States (US) it may contain up to 5.0% genetic modification. However, discerning consumers in South Africa may have a different expectation of the GM content of the products they are buying, especially since 'organic', 'non-GM' or 'GMO-free' labels are not being qualified on the label. Although there are exceptions, with 56% of 'organic', 'non-GM' or 'GMO-free' product batches containing above 1.0% genetic modification, voluntary GM labelling has failed in South Africa.

Compared to the study of Viljoen et al. (2006), of the 17 products previously tested which were labelled to indicate an absence of genetic modification, 10 were still available and the GM related label had been removed for three products, white maize meal, soya chunks and soya beans. In addition, 13 new products were found with an 'organic', 'non-GM' or 'GMO-free' label. This suggests that the demand for GM labelling is increasing in South Africa. Furthermore, it does not appear that the results of the previous study, sent to all the producers and retailers involved, has made any significant change to the validity of the GM labels being used (Viljoen et al., 2006). Thus without mandatory regulations, there is currently no external incentive or obligation for companies to ensure the validity of their products in terms of the GM label.

The introduction of GM food has established a new niche market for 'organic', 'non-GM' or 'GMO-free' products throughout the world. Irrespective of whether voluntary or mandatory GM labelling is applied, the definition of the GM label being used should be clear to consumers. The problem is that the application of voluntary labelling is not being regulated, not in South Africa or the rest of the world compared to mandatory labelling that inherently requires regulation. In the absence of regulations under voluntary GM labelling, there is also no requirement for product validation and hence no form of consumer protection. Furthermore, the lack of consistency between product batches suggests that some companies are not applying sufficient internal control to ensure that the product complies with the GM label. Thus in the absence of specific regulations, there appears to be an inconsistent application of the definition for 'organic', 'non-GM' or 'GMO-free' and this may result in consumer expectations, regarding the GM content of food, not being met and is not only applicable in South Africa. Voluntary GM labelling, without regulation and validation, will not provide discerning consumers with the choice they require. Finally, in terms of ensuring consumer protection, unregulated GM labelling is not a viable alternative to using a regulated approach, either voluntary or mandatory.

Acknowledgement

We would like to acknowledge the technical assistance of Ms. N.C. Meintjies during this study.

References

Abdullah, T., Radu, S., Hassan, Z., & Hashim, J. K. (2006). Detection of genetically modified soy in processed foods sold commercially in Malaysia by PCR-based method. *Food Chemistry, 98*, 575–579.

Bullock, D. S., & Desquilbet, M. (2002). The economics of non-GMO segregation and identity preservation. *Food Policy, 27*, 81–99.

Carlsson, F., Frykblom, P., & Lagerkvist, C.J. (2004). Consumer benefits of labels on genetically modified food – An empirical analysis using choice experiments. Working papers in economics 129. Available from www.handels.gu.se/epc/archive/00003449/01/gunwpe0129.pdf (accessed 25.04.07).

Cheftel, J. C. (2005). Food and nutrition labelling in the European Union. *Food Chemistry, 93*, 531–550.

Cole, B. (2003). A report on the survey of consumer opinions and knowledge of genetically modified foods. The National Consumer Forum (NCF). Available from www.pub.ac.za/resources/docs/survey_ncf2003.pdf (accessed 25.03.06).

Department of health (2004). Explaining GMO food labelling. Available from www.doh.gov.za/search/index.html (accessed 15.03.07).

James, C. (2006). Global status of commercialized biotech/GM crops: 2006. ISAAA briefs no. 35. Ithaca, NY: ISAAA.

Joubert, M. (2001). Foundation for education, science and technology survey. Available from www.fest.org.za (accessed 13.02.07).

Klintman, M. (2002). The genetically modified (GM) food labelling controversy: Ideological and epistemic crossovers. *Social Studies of Science, 32*(1), 71–91.

Lipp, M., Bluth, A., Eyquem, F., Kruse, L., Schimmel, H., Van Den Eede, G., et al. (2001). Validation of a method based on polymerase chain reaction for the detection of genetically modified organisms in various processed foodstuffs. *European Food Research and Technology, 212*, 497–504.

Mulder, M. (2003). eGoli Bio National Biotech survey. Available from www.oecd.org/dataoecd/7/37/36036991.pdf (accessed 10.03.07).

Partridge, M., & Murphy, D. J. (2004). Detection of genetically modified soya in a range of organic and health food products. *British Food Journal, 106*, 166–180.

Regulation (2003a) (EC) No. 1829/2003 of 22 September on genetically modified food and feed. *Official Journal of European Union, L268, 1–23.*

Regulation (2003b). (EC) No. 1830/2003 of 22 September concerning the traceability and labelling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending directive 2001/18/EC. *Official Journal, L268, 24–28.*

Rule, S., & Ianga, Z. (2005). Public understanding of biotechnology in South Africa. HSRC client survey 2004. Report to public understanding of biotechnology. Available from www.pub.ac.za/resources/research.html (accessed 13.02.07).

Ujhelyi, G., Vajda, B., Béki, E., Neszlényi, K., Jakab, J., & Jánosi, A. (2008). Surveying the RR soy content of commercially available food products in Hungary. *Food Control, 19*, 967–973.

Viljoen, C. D., Dajee, B. K., & Botha, G. M. (2006). Detection of GMO in food products in South Africa: Implications of GMO labelling. *African Journal of Biotechnology, 5*(2), 073–082.