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Public attitudes towards genetically-modified food

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Abstract

Purpose – This study aimed to investigate the impact of information about traceability and new detection methods for identifying genetically-modified organisms in food, on consumer attitudes towards genetically-modified food and consumer trust in regulators in Italy, Norway and England. It further aimed to investigate public preferences for labelling of genetically-modified foods in these three countries.

Design/methodology/approach – A questionnaire was designed to investigate public attitudes toward genetically-modified food and trust in different information sources. Participants were recruited in Italy, Norway and England for this study. A between subjects design was used, where each participant was randomly allocated to either the experimental “information condition”, or the control “no information condition”.

Findings – Receiving information about new detection methods and traceability did not directly influence consumer attitudes towards genetically-modified foods or trust in regulators. However, response to the development of an effective system of traceability for genetically-modified food and ingredients throughout the food chain was positive. People's preferences for labelling of genetically-modified food were “process-based”, in that there was a desire for all food produced using genetic modification or containing genetically-modified ingredients to be labelled.

Originality/value – An open and transparent system of labelling regarding genetically-modified foods and ingredients, coupled with effective traceability mechanisms, is likely to provide the best basis for consumer choice regarding the consumption of genetically-modified foods. This information will be useful for both national and international regulators, and the various sectors of the food industry. The study provides useful information about likely public reaction to new EU labelling and traceability regulations.

Keywords Food industry, Labelling, Consumer behaviour, Norway, Italy, England

Paper type Research paper



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Introduction

Consumer attitudes will be an important determinant of the long-term role of genetic modification and its applications in society. This is particularly true in the agro-food area, where consumer negativity towards genetically-modified foods has already had an impact on commercialisation. It is therefore important to examine these attitudes and to understand the basis of consumer concerns, in order to introduce a regulatory framework which satisfies consumer needs, and facilitates the development of appropriate commercialisation strategies for products resulting from the application of genetic modification.

Research indicates that, while there is some evidence of cross-cultural differences in attitudes across different EU Member States (Gaskell *et al.*, 1998; Saba *et al.*, 1998; Scholderer *et al.*, 1999; Gaskell *et al.*, 2000), public perception of genetically-modified food across Europe tends to be negative. Genetically-modified food is associated with (unintended, particularly long term) risks for personal health and human health in general, risks to the environment, to future generations and to animal welfare. Genetic modification is seen as unnatural and unnecessary. An extra dimension not found with many other food safety issues is the presence of moral and ethical concerns influencing perception. There are concerns that the various sectors of the food industry will consider profit over and above safety. There is also some societal cynicism about the adequacy of current regulations, and a preference for accountable regulatory structures. Additionally, people want public consultation about biotechnology (Scholten *et al.*, 1991; Frewer *et al.*, 1994; Gaskell *et al.*, 1998; Gaskell *et al.*, 2000; Saba *et al.*, 2000; Eurobarometer, 2001; Grünert *et al.*, 2001; Marris *et al.*, 2001; Miles and Frewer, 2001; Miles and Frewer, 2002).

The attitudes of European consumers are not ubiquitously negative. For example, the public recognise the *potential* for benefits associated with genetically-modified food (Miles and Frewer, 2001). The acceptability of specific products is contingent on whether specific benefits are actually desired by consumers, and who is perceived to be the recipient of such benefits. For example, benefits related to consumer safety or health, the environment, animal welfare, or reduced cost are appreciated by consumers, and benefits for the food industry are not (Frewer *et al.*, 1996; Frewer *et al.*, 1997). There is evidence that information about potential benefits does improve consumer acceptance of genetically-modified food (Lusk *et al.*, 2004; see however, Rowe, 2004). Furthermore, for some people the absence of perceived benefits is enough to lead to rejection of genetically-modified food (Gaskell *et al.*, 2004).

The complexity of public reactions to the introduction of genetically-modified products is shown in the following examples. Genetically-modified soya was introduced into the European food supply in 1996 under conditions where neither traceability mechanisms nor an efficacious labelling policy regarding genetically-modified ingredients had been put into place. The soya was mixed with non-genetically-modified soya after harvesting and subsequently used as an unlabelled ingredient in various food products. The lack of traceability and segregation meant that effective labelling was not possible. As a result, consumers were unable to choose whether or not to consume genetically-modified foods. It is known that consumers prefer to make informed choices about food consumption, identifying effective labelling as a strategy to accomplish this for genetically-modified food (Gaskell *et al.*, 1998; National Consumer Council, 2001; Miles and Frewer, 2001; Consumers'

Association, 2002). The lack of choice associated with their exposure to genetically-modified soya as an ingredient, and a feeling of having genetically-modified food "imposed" on them was likely in part responsible for consumers' negative reaction to this food. People felt that they were being forced to take an involuntary risk, with no evidence of any tangible benefits (Gaskell *et al.*, 2001). In contrast, a more positive reaction was observed following the earlier introduction of the Zeneca tomato puree, sold in tins in two leading UK supermarkets, which was clearly labelled as being produced from genetically-modified tomatoes. There was no consumer opposition, and the product sold well (Gaskell *et al.*, 2001). One consequence of the introduction of genetically-modified soya into the European food supply was an increase in public debate regarding the safety, acceptability and need for genetically-modified food that is still ongoing, with issues of consumer protection, labelling, and accountability as central issues (Grabner *et al.*, 2001).

European labelling regulations for the genetically-modified food products consumers have been exposed to in the market place thus far are based on product (i.e. what is in the final product) rather than process (i.e. the fact that genetic modification has been used) characteristics. In contrast, evidence suggests that consumer perception is driven by process rather than product characteristics (Grünert *et al.*, 2001). For example, many consumers express a preference for foods containing ingredients from a genetically-modified crop where there is no genetically-modified material in the final product to be labelled, and they also want meat and other products from animals fed with genetically-modified feed to be labelled (National Consumer Council, 2001; Consumers' Association, 2002). At the time of data collection, regulations allowed 1 per cent of genetically-modified material to be present in conventional food through accidental contamination unlabelled, but most consumers believe this level is too high (National Consumer Council, 2001; Consumers' Association, 2002). It should be noted that labelling rules in the EU have now changed, and the threshold level for unintentional contamination of conventional products with genetically-modified material is now 0.9 per cent.

There is also evidence that people are more prepared to tolerate genetically-modified food if it is always clearly labelled (Hunt and Frewer, 2001). While labelling will not address the concerns of people who do not want genetic modification for ethical or environmental reason, it will allow these people to feel more in control of their exposure to genetically-modified food and to make informed food choice decisions. Labelling requires a good system of traceability; which, with respect to genetically-modified food, provides a means to trace food products containing or produced from genetically-modified organisms through the whole production and distribution chain. In addition to allowing for accurate labelling, traceability also allows for the monitoring of unintended effects (e.g. on human or animal health or the environment), and fast withdrawal of products should a risk be established. Accurate labelling of genetically-modified food also requires better detection methods for genetically-modified organisms and products derived thereof. However, it needs to be seen if consumers respond to information about traceability and detection methods with more confidence and trust in the stakeholders.

Research thus indicates that public concerns about genetically-modified foods are more complex and go beyond the concerns about risk to the environment and human health addressed by existing regulations (Lassen *et al.*, 2002). Public concerns include

issues of consumer choice, labelling and traceability. From this, one might predict that the introduction of labelling practices acceptable to the public, and mechanisms designed to improve traceability, would improve public confidence in regulatory activity and potentially acceptance of genetically-modified foods.

There were two aims to this study. The first aim was to investigate consumer preferences for labelling of genetically-modified foods in Italy, Norway and England. There was no hypothesis associated with this aim. The second aim was to investigate the impact of information about traceability and new detection methods on attitudes towards genetically-modified food and trust in regulators in these three countries. It was hypothesised that such information would:

- H1.* Increase perceptions of trust in regulators' ability to protect the public's health from any unintended risks.
- H2.* Decrease perceived risk associated with genetically-modified food.
- H3.* Increase perceived benefits associated with genetically-modified food.
- H4.* Increase perceived personal control over exposure to genetically-modified food and ingredients.

Methodology

The study was conducted during 2001 among a sample of consumers in three European countries: Italy, Norway and England. The data was collected using a self-administered questionnaire that had been translated, and back-translated to ensure similar meanings of expressions. A self-administered questionnaire has the benefit of being easy to administer and saving resources, both in terms of time and money. Furthermore, a large number of participants can be reached, and a wide variety of topics can be covered. Disadvantages can include a lack of control over who is responding and, more importantly, who is not responding. Additionally, it is difficult to control whether the participants answer the questions truthfully. Also, the results may be skewed with respect to the topic being investigated because only participants with special interests participate. However, these, and other drawbacks are also present in other types of data collection methods to varying degrees. For the purpose of this study, where we wanted to involve a large number of participants in three different countries, questionnaire methodology was considered to be appropriate. A pilot study was conducted to ensure that there were no problems with the way the questionnaire was laid out or with the question wording. Changes suggested by the pilot study participants were incorporated into the design of the final questionnaire.

Design and conditions

To investigate the effect of information, a between subjects design was used, where each participant was randomly allocated to either the experimental "information condition", or the control "no information condition". Participants in the "information condition" were provided with information about new detection methods and improved traceability associated with genetically-modified food part way through the

questionnaire (see Appendix 1). Participants in the “no information condition” received no information.

Questionnaire

The questionnaire consisted of five sections designed to investigate public attitudes toward genetically-modified food, and trust in different information sources. Results from sections 1, 2 and 5 are reported in this paper. Data from the sections 3 and 4 are not reported here and can be found in Miles and Frewer (2002). Section 1 contained items designed to investigate attitudes toward labelling (see Appendix 2 for question wording). For participants in the experimental “information condition”, Section 1 was followed with the page of information about traceability of genetically-modified material, and new detection methods (see Appendix 1). Participants in the control “no information condition” went straight to Section 2. The aim of Section 2 was to assess participants’ perception of risk and benefit associated with genetically-modified food, as well as their perceptions of control over personal exposure to genetic modification. In addition, items were included to investigate people’s trust in scientists, national regulators and the European Commission, specifically related to protecting the public’s health (see Appendix 2 for question wording). People’s preference for measures that could be taken to increase their perceived control over exposure to genetically-modified food, and their confidence that genetically-modified products were safe were also assessed (see Appendix 2 for question wording). Demographic data were collected in Section 5.

Procedure

In England and Italy participants were recruited by a market research company to ensure quota sampling for gender, age and socio-economic class. The data were collected between July and September 2001. The participants were not paid. In Norway, participants were recruited from an existing participant panel operated by the Norwegian Food Research Institute, MATFORSK between September and November 2001. The participants were paid NOK 60 (€7.5). At the time of data collection, there were no genetically-modified whole foods on the market in any of the three countries; this was not the case for genetically-modified ingredients (such as soya), which are found in most European countries. No major food scares occurred during the study period in any of the three countries.

Participants

There were 416 participants in Italy (209 males, 207 females; mean age = 43.40 (15.22); mean number of years in full time education after age 11 = 5.77 (4.28)), 315 in Norway (152 males, 161 females; mean age = 42.32 (14.33); mean number of years in full time education after age 11 = 6.21 (4.03)) and 402 in England (200 males, 202 females; mean age = 43.03 (15.86); mean number of years in full time education after age 11 = 7.31 (3.45)). There were no differences between the three countries in terms of participants’ gender ($\chi^2(2)=0.207$, ns), with about 50 per cent male and female in each country. Nor was there a difference between the three countries in terms of age ($F(2,1125) = 0.453$, ns). Participants in England had been educated for slightly longer than those in the other two countries ($F(2,1050) = 15.376$, $p < 0.001$); but this was not thought to be a great enough difference to bias the results.

The samples were split between the two information conditions, with half in each condition. There was no difference between the participants in the two conditions (for each of the three countries separately) in terms of gender, number of years in full-time education post age 11 or age range; in addition, there was no difference in whether or not the participants had heard of genetically-modified food.

Statistical analysis

SPSS version 11 was used to analyse the data. The chi-square test was used to compare the three countries' labelling preferences, as this was categorical data. MANOVA analysis with *post hoc* analysis using Tukey HSD, was used to compare attitudes to genetically-modified food and trust in regulators in the three countries, and in the two information conditions.

Results

Labelling of genetically-modified food (data collected prior to provision of information)

One aim of the reported research was to investigate consumer preferences for labelling of genetically-modified foods. It was found that almost the entire combined sample claimed to have heard of genetic modification, or genetically-modified food, but this knowledge of genetic modification was slightly lower in Italy than in Norway or England. Purchase intentions for genetically-modified food were moderate, with 10-15 per cent of the sample claiming that they would definitely purchase and 40 per cent would possibly purchase genetically-modified food if it became widely available. There were no differences between the three countries in terms of people's stated intention to purchase genetically-modified food (Table I).

Virtually all of the participants believed that labels on food packaging should state if the food or any of its ingredients have been genetically-modified, and that genetically-modified and non-genetically-modified crops should be kept separate so that food can be accurately labelled. There were no differences between the three countries in these beliefs. In contrast, between 78-88 per cent of the sample believed that processed food ingredients from a genetically-modified crop should be labelled even if there is no genetically-modified material in the final product, but slightly fewer Norwegian participants held this belief in comparison to the other two countries (Table I).

Between 60-81 per cent the participants believed that the current regulations (that ingredients in food that contain less than 1 per cent genetically-modified material through accidental contamination do not need to be labelled) were not strict enough, and that ingredients should be labelled if they contained any genetically-modified material at all. Significantly fewer people in Norway believed this to be the case, with more people stating that these regulations were adequate (Table II).

Over 95 per cent of the sample claimed to currently check food labels for information about genetic modification (either all the time, or sometimes) in Italy and Norway, in contrast to only 62 per cent in England. However, 67 per cent of the English sample was aware that most UK supermarkets had removed genetically-modified ingredients from their own brand products and 66 per cent claimed that they would check food labels more frequently if this were not the case (Table I).

Table I.
Knowledge, labelling
preferences and purchase
intention for
genetically-modified food

	Italy						Norway						England						χ^2 (df)
	Yes n	%	No n	%	Possibly /some- times n	%	Yes n	%	No n	%	Possibly /some- times n	%	Yes n	%	No n	%	Possibly /some- times n	%	
Heard of genetically-modified foods	365	88	51	12			309	99	3	1			390	97	11	3			52.356 (2) *
Purchase intentions for GM foods	43	10	191	46	182	44	41	13	137	44	135	43	61	15	180	45	160	40	4.793 (4), ns
Labels should state if food or ingredients have been genetically-modified	397	92	19	5			307	98	7	2			385	96	16	4			2.868 (2), ns
Check food labels for genetic modification	263	63	19	5	134	32	142	45	13	4	159	51	70	18	154	39	176	44	300.772 (4) *
Labels should state if ingredients are from a GM crop, even if no GM material	367	88	49	12			243	78	70	22			354	88	47	12			20.343 (2) *
GM and non-GM crops should be kept separate	382	92	34	8			282	90	31	10			362	90	39	10			0.843 (2), ns
Heard UK supermarkets have removed GM ingredients from own brand products													270	67	132	33			
Check labels more frequently if GM ingredients had not been removed													264	66	136	34			
Note: * $p < 0.001$																			

The effect of information provision (data collected after provision of information)

The other aim of this study was to investigate the impact of information about detection methods and improved traceability of genetically-modified material on attitudes towards genetically-modified food and trust in regulators. It was hypothesised that information would increase perceptions of trust in regulators, decrease perceptions of risk associated with genetically-modified food, and increase perceptions of benefits and personal control over exposure to this food. However, the data did not support these hypotheses. There was only one effect of the information condition on these attitudes, which, as detailed below, was that the English participants who received the information paragraph were more likely to believe that there would be benefits to consumers in the future than English participants who received no information. However, it was found that receiving the information did effect the actions people preferred to increase their feeling of control over exposure to genetically-modified food and ingredients, and their confidence that the genetically-modified food products in the shops are safe.

Attitudes towards genetically-modified food and trust in regulators. MANOVA analysis was conducted to investigate the effect of both information condition and country on the attitude variables designed to measure benefits, harmful health effects, perceived control and trust. This indicated that while there were cross-cultural differences in attitudes to genetically-modified food ($F(16,1950) = 23.538, p < 0.001$), there was no impact of receiving the information about traceability and detection methods on attitudes ($F(8,974) = 1.863, ns$). However, a country $\times$ condition interaction indicated that this varied according to country ($F(16,1950) = 2.217, p < 0.01$). Examination of this interaction revealed that English participants who received the information paragraph were more likely to believe that there would be benefits to consumers in the future than English participants who received no information. There were no differences in attitude between participants in the two information conditions in Italy or Norway.

Post hoc analysis, using Tukey HSD, was used to elucidate the cross-cultural differences in attitudes to genetically-modified food. It was found that the Norwegians were most trusting of both scientists and their own regulators, and English participants were least trusting. The Italian sample was most trusting of the European Commission, and the English participants were the least trusting. However, the Norwegians perceived that they had less control over their exposure to

	Italy		Norway		England		χ^2 (df)
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
Current regulations are not strict enough	336	81	187	60	297	76	47.739 (6) *
Current regulations are fine	55	13	95	31	80	21	
Current regulations are too strict – label if ingredients contain more than 1 per cent GM	21	5	23	7	9	2	
Current regulations are too strict – no need to label GM ingredients	4	1	6	2	5	1	

Note: * $p < 0.001$

Table II.
Satisfaction with regulations stating that ingredients in food that contain less than 1 per cent genetically-modified material (through accidental contamination) do not need to be labelled

genetically-modified food than the Italians or the English. The Italian sample was more likely to believe that both they and other people would experience harmful health effects from consuming genetically-modified foods than the Norwegians or the English. The Italians believed that any harmful health effects were more serious than participants in the other two countries. The Italians also believed that it was less likely that there would be future benefits to consumers from genetically-modified food than the Norwegians (Table III).

Measures to increase perceived control and confidence in food safety. Participants were asked what, of 11 actions, would make them feel more in control of their exposure to genetically-modified food and ingredients, and help them feel more confident that the genetically-modified food products in the shops are safe. Preferences selected were similar in the three countries, with the three most popular options being: "clearer labelling of genetically-modified foods on food packaging", "more information about how food and ingredients are genetically-modified" and "more information about any associated risks". More participants in England expressed a preference for the development of an effective system of traceability throughout the food chain compared to the other two countries (Table IV).

Chi-square analysis was used to compare the actions selected by participants in the two information conditions. It was found that in Italy ($\chi^2(1) = 8.847, p < 0.01$) and Norway ($\chi^2(1) = 4.686, p < 0.05$) people who had received the information about detection methods and traceability were more likely to express the view that an effective system of traceability throughout the food chain would increase confidence regarding perceived safety when compared to those who had not received information. Additionally, in Norway receiving information was associated with claiming that traceability would also increase perceptions of control ($\chi^2(1) = 4.315, p < 0.05$). In Norway ($\chi^2(1) = 8.274, p < 0.01$) and England ($\chi^2(1) = 4.468, p < 0.05$) participants who had received the information were less likely to want to know about the activities of the national risk regulators to increase their perception of control than those who had not. In Norway this was also the case for increasing confidence about perceived safety ($\chi^2(1) = 11.197, p < 0.001$). In Italy confidence in the safety of genetically-modified foods was increased with labelling of all genetically-modified foods, even if they were similar to those produced by conventional means, if information was received ($\chi^2(1) = 7.432, p < 0.01$). Norwegian participants who had received information were more likely to select clear labelling of genetically-modified foods on food packaging as a means to increase perceived control over exposure to genetically-modified food than those who had not (Table IV) ($\chi^2(1) = 3.887, p < 0.05$) (the raw data for these chi-square tests is not reported here, and is available from the authors).

Discussion

The hypotheses that providing information about traceability and improved scientific detection methods would improve consumer confidence in genetically-modified foods by increasing trust in regulators, decreasing perceived risk and increasing perceived benefits and control over exposure to genetically-modified food were not supported. The only effect of information provision on these attitudes was that English participants receiving the information were more likely to believe that there would be benefits to consumers in the future than those who did not. The lack of an effect could

Country	Condition	Benefits in the future		Seriousness		Harmful effects – others		Harmful effects – you		Control		Trust – scientists		Trust – national regulators		Trust – European Commission	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Italy	Information	4.85	1.39	3.30	1.25	3.56	1.27	3.96	1.37	4.07	1.32	4.32	1.13	4.63	1.08	4.38	1.22
	No information	4.72	1.25	3.49	1.41	3.68	1.23	4.00	1.27	4.19	1.31	4.51	1.16	4.88	1.14	4.76	1.14
	Total	4.78	1.32 ^a	3.40	1.34 ^{a,b}	3.62	1.25 ^{a,b}	3.98	1.32 ^{a,b}	4.13	1.31 ^a	4.42	1.15 ^a	4.76	1.12 ^a	4.57	1.19 ^a
Norway	Information	4.55	1.51	3.68	1.54	4.29	1.38	4.39	1.41	4.62	1.48	3.92	1.54	4.13	1.51	4.98	1.62
	No information	4.27	1.61	4.08	1.61	4.46	1.47	4.57	1.51	4.68	1.48	4.28	1.68	4.35	1.62	5.17	1.50
	Total	4.41	1.56 ^a	3.88	1.59 ^a	4.38	1.43 ^a	4.48	1.46 ^a	4.65	1.48 ^{a,b}	4.10	1.62 ^b	4.24	1.57 ^b	5.07	1.56 ^b
England	Information	4.31	1.96	4.11	1.80	4.22	1.63	4.73	1.72	4.36	1.58	5.12	1.58	5.23	1.45	5.35	1.39
	No information	4.91	1.94	4.01	1.91	4.28	1.80	4.64	1.84	4.17	1.74	5.06	1.67	5.17	1.58	5.37	1.43
	Total	4.62	1.97	4.06	1.86 ^b	4.25	1.72 ^b	4.68	1.78 ^b	4.26	1.66 ^a	5.09	1.62 ^c	5.20	1.51 ^c	5.36	1.41 ^c
Total	Information	4.60	1.63	3.66	1.56	3.98	1.46	4.32	1.53	4.32	1.46	4.46	1.48	4.67	1.40	4.85	1.46
	No information	4.66	1.61	3.82	1.66	4.09	1.53	4.37	1.56	4.32	1.52	4.62	1.52	4.82	1.47	5.07	1.37
	Total	4.63	1.62	3.74	1.61	4.04	1.50	4.35	1.55	4.32	1.49	4.54	1.50	4.75	1.43	4.97	1.41

Note: Means with the same letter by them are significantly different at the $p < 0.05$ level (Tukey) for that dependent variable

Table III.
Mean (and standard deviation) ratings of perceived benefits, risks, control and trust

Table IV.
Options preferred by
participants to increase
perceived control and
confidence in food safety

Statement options	Preferred options re: control over exposure to GM foods and ingredients				Preferred options re: confidence that GM food products in shops are safe			
	Italy n	%	Norway n	%	Italy n	%	Norway n	%
More information about how food/ingredients are genetically-modified	264	64	162	52	278	67	156	50
An effective system of traceability throughout the food chain	122	29	115	37	128	31	112	36
More information about the benefits to consumers from genetic modification of food	156	38	103	33	168	40	97	31
Clearer labelling of genetically-modified foods on food packaging	244	59	230	73	201	48	230	74
Better methods to detect whether food products contain genetically-modified ingredients	138	33	103	33	104	25	110	35
More information about any risks associated with genetic modification of food	235	57	174	55	242	58	164	52
Labelling of all food products containing ingredients produced using genetically-modified technology, even if no genetically-modified material in final product	166	40	92	29	157	38	80	26
Labelling of all genetically-modified foods, even if they are similar to those produced by conventional means	136	33	136	43	117	28	112	36
More information about what national risk regulators are doing to make sure your food is safe	147	35	132	42	178	43	146	47
Clearer labelling of genetically-modified foods in restaurants on menus	89	21	87	28	61	15	65	21
More information about how the European Commission is ensuring your food is safe	151	36	102	33	165	40	93	30

Note: Percentages do not add to 100 per cent because participants were allowed to select more than one option

be due to the fact that the participants were aware that these systems were not yet in place.

However, while there was no impact of receiving the information on ratings of personal control over exposure to genetically-modified food; receiving information did affect the desirability of actions to increase perceived control over exposure to genetically-modified food and confidence that genetically-modified products in the supermarkets were safe. For example, participants receiving information about traceability and detection methods recognised the benefits of these mechanisms and expressed a desire for the implementation of an effective system of traceability to increase control and confidence. Furthermore, in England and Norway information provision made consumers less likely to want information about what national risk regulators were doing to ensure genetically-modified food was safe. This may have been because of a belief that personal control would increase with traceability and labelling, resulting in less reliance on regulators for consumer protection. Taken together, the results suggest that dissemination of information about traceability of genetically-modified foods and ingredients is likely to be regarded as a positive development by consumers with respect to increasing personal control and confidence.

At the time of data collection, the consumers included in this study were divided about whether they would buy genetically-modified products or not. However, the results suggest that failure to develop an effective labelling strategy in line with consumer preferences may eliminate consumer choice and result in more consumer negativity associated with genetic technology applied to food production. In line with research described previously, consumers expressed a preference for such a labelling strategy to address genetic modification as a process, not to just focus on genetically-modified foods and ingredients where genetically-modified material is detected in the final product. The overwhelming majority of consumers wanted food and ingredients produced using genetic modification to be labelled irrespective of whether there was any genetically-modified material contained in the final food product. They also wanted genetically-modified and non-genetically-modified crops to be segregated so that accurate labelling could occur. Furthermore, the vast majority of consumers thought that regulations allowing 1 per cent of accidental contamination without labelling were not strict enough. There were few differences between the three European countries in this respect. This implies that labelling policy can be instigated at a European level, rather than differentially developed at the level of different European Member States, and, furthermore, the results imply that it would be appropriate to harmonise Norwegian policy with that of the European Community. This is consistent with the findings of Marris *et al.* (2001) who also found similarities in public perceptions of genetic modification across the five countries they investigated.

Recently adopted European legislation (European Commission, 2003a) requires labelling of all food produced from genetically-modified organisms, regardless of whether there is any detectable genetically-modified DNA or protein in the final food product. It also requires the labelling of all genetically-modified feed. One of the key aims of this new legislation is to provide a basis for allowing consumers to make their own choice about whether to consume genetically-modified food products through comprehensive labelling (Wallström, 2002). The new EU legislation also sets up a system to trace genetically-modified organisms through the food chain. This will be achieved through obliging businesses to transmit and retain information about

products that contain or are produced from genetically-modified organisms throughout the agri-food commercial chain (European Commission, 2003b). The results of the study reported here suggest that these new European traceability and labelling regulations are likely to be welcomed by most consumers.

Conclusions

Consumer response to the development of an effective system of traceability for genetically-modified food and ingredients throughout the food chain was generally positive, although receiving information about new detection methods and traceability did not directly influence consumer attitudes towards genetically-modified foods. An open and transparent system of labelling regarding genetically-modified foods and ingredients, coupled with effective traceability mechanisms, is likely to provide the best basis for consumer choice regarding the consumption of genetically-modified foods. Failure to implement such a strategy may have a negative long-term impact on consumer confidence in food security, particularly in the current climate of consumer distrust in food safety, science and risk regulation.

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Appendix 1. Information provided to participants in the "information condition"

Consumers have the right to choose what food they purchase and consume. One of the aims of food labelling is to provide consumers with the relevant information to allow them to make these choices. With regard to genetically-modified (GM) foods, labelling should allow those who wish to avoid GM food or ingredients to do so.

This is where traceability of GM material comes in. Traceability provides information about the identity, history and source of a food product as it moves through the whole food chain, from the farm to your plate.

The benefits of traceability are as follows:

- It will be easier for products to be withdrawn if a risk to human health, animal health or the environment is found;
- It will be easier to identify and monitor any unintended and long term effects on human health, animal health and the environment; and
- It will make the labelling of food products easier.

To allow for a successful traceability system, analytical detection methods are needed to determine the GM content of a food product.

New detection methods are currently being developed to detect and identify ingredients derived from various genetically-modified organisms (GMOs) in food:

- These new methods will be able to *tell the difference between different GMOs*, which is very important as it will allow us to see if food ingredients from approved or non approved GMOs have been used.
- They will also allow us to *identify which GMO has been used in food production*, which would allow consumers to choose between products that contain GMOs they do not want to eat, products that contain GMOs they view positively, and non-GM products.

These new methods also aim to speed up the process of identifying GMOs, and reduce the analysis costs.

Appendix 2. Question wording for items in Sections 1 and 2

Section 1: Questionnaire items measuring knowledge, labelling preferences and purchase intention

- (1) Have you heard of genetic modification, or genetically-modified (GM) foods? *(yes/no)*
- (2) With your current state of knowledge, would you purchase genetically-modified food if it became widely available in the supermarkets? *(yes/possibly/no)*
- (3) Do you think that labels on food packaging should state if the food or any of its ingredients have been genetically-modified? *(yes/no)*
- (4) Do you currently check food labels to see if a food product or any of its ingredients have been genetically-modified? *(yes, all the time/yes, sometimes/no)*
- (5) If a food ingredient from a GM crop has been processed there may not be any GM material in the final product. According to current regulations such food ingredients do not need to be labelled. Do you think such ingredients should be labelled? *(yes/no)*
- (6) Do you think that GM and non-GM crops should be kept separate at all stages so that food labels can accurately state whether they contain ingredients from GM or non-GM crops? *(yes/no)*
- (7) Have you heard that most UK supermarkets have removed GM ingredients from their own brand products? *(yes/no)* *Item only asked in England.*

- (8) If this were not the case, would you check food labels more frequently to see if the food or any of its ingredients had been genetically modified? *(yes/no) Item only asked in England.*
- (9) According to current regulations, ingredients in food that contain less than 1 per cent GM material (through accidental contamination) do not need to be labelled.

Which of the following options best represents your opinion about the current regulations?
(Please tick only one)

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- (1) The current regulations are not strict enough. Ingredients in food should be labelled if they contain any GM material at all.
- (2) The current regulations (which state that ingredients in food should be labelled if they contain less than 1 per cent GM material) are fine.
- (3) The current regulations are too strict. Ingredients in food only need to be labelled if they contain more than 1 per cent GM material.
- (4) The current regulations are too strict. Ingredients in food do not need to be labelled at all if they contain any GM material.

Section 2: Questionnaire items measuring perceive benefits, risks, control and trust

- (1) In your opinion, how likely is it that there will be benefits to consumers from genetic modification of food in the future? *(rated on a seven-point scale, 1 = extremely likely, 4 = moderately likely, 7 = not at all likely).*
- (2) If you believe there are harmful health effects for humans from consuming genetically-modified food, how serious are these harmful effects? *(rated on a seven-point scale, 1 = extremely serious, 4 = moderately serious, 7 = not at all serious).*
- (3) How likely is it that other people of your gender and age will experience any harmful health effects from consuming genetically-modified food? *(rated on a seven-point scale, 1 = extremely likely, 4 = moderately likely, 7 = not at all likely).*
- (4) How likely is it that you will experience any harmful health effects from consuming genetically-modified food? *(rated on a seven-point scale, 1 = extremely likely, 4 = moderately likely, 7 = not at all likely).*
- (5) How much do you trust scientists to ensure that the public's health is protected from any potential risks associated with genetic modification? *(rated on a seven-point scale, 1 = completely trust, 4 = moderately trust, 7 = do not trust at all).*
- (6) How much do you trust the UK regulators of GM food to ensure that the public's health is protected from any potential risks associated with genetic modification? *(rated on a seven-point scale, 1 = completely trust, 4 = moderately trust, 7 = do not trust at all).*
- (7) How much do you trust the European Commission to ensure that the public's health is protected from any potential risks associated with genetic modification? *(rated on a seven-point scale, 1 = completely trust, 4 = moderately trust, 7 = do not trust at all).*
- (8) To what extent is your personal exposure to food that has been genetically-modified in your diet controllable by you? *(rated on a seven-point scale, 1 = extremely controllable, 4 = moderately controllable, 7 = not at all controllable).*
- (9) Which of the following would help to make you *feel in control of your exposure* to genetically-modified food and ingredients?
- (10) Which of the following would help to make you *feel more confident* that the GM food products in the shops are safe?

Response options for both the above items:

Please tick the *five most important* to you (you may select less than five).

Please tick up to five and ensure that you read all of the statements before making your choices.

- More information about how food/ingredients are genetically-modified.
- An effective system of traceability throughout the food chain.
- More information about the benefits to consumers from genetic modification of food.
- Clearer labelling of genetically-modified foods on food packaging.
- Better methods to detect whether food products contain genetically-modified ingredients.
- More information about any risks associated with genetic modification of food.
- Labelling of all food products containing ingredients produced using genetically-modified technology, even if no genetically-modified material in final product.
- Labelling of all genetically-modified foods, even if they are similar to those produced by conventional means.
- More information about what national risk regulators are doing to make sure your food is safe.
- Clearer labelling of genetically-modified foods in restaurants on menus.
- More information about how the European Commission is ensuring your food is safe.