DOCTORAL (PhD) THESIS SUMMARY

KAPOSVÁR UNIVERSITY

FACULTY OF ECONOMIC SCIENCE

Department of Marketing and Trade

Head of Doctoral School

Prof. GÁBOR UDOVECZ

Doctor of the Hungarian Academy of Sciences

Supervisor:

Dr. habil. ZOLTÁN SZAKÁLY

CSc in Agricultural Sciences, Associate Professor

PROFESSIONAL AND CONSUMER ATTITUDES TOWARDS FOOD ADDITIVES

By:

GÁBOR TARNAVÖLGYI

KAPOSVÁR

2009

1. BACKGROUND AND AIM OF THE RESEARCH

Food additives are a special group of substances added to foods. They do not occur in foods accidentally or unavoidably: they are intentionally added to foods in order to improve organoleptic properties, to enhance the keeping quality or stability, to preserve the nutritional quality or to provide aids in foods processing.

Food additives are used in preparing foods since ancient times. Food preservation began by salting and smoking of meat and fish. Egyptian papyri mention colouring and spicing foods. Romans mastered food preservation techniques and discovered how to prepare natural flavours from edible fruits. Sulphur dioxide in wine making and saltpetre in curing meats are additives used for centuries, while improving flour with oxidants was already in practice in the 19th century.

Over the last centuries, there has been an enormous change in food production: the local subsistence structures have been replaced by an industrial regime exploiting economies of scale. The technological improvement was accompanied by the increased use of food additives.

The extensive use of food additives began around the turn of the 20th century, side by side with the development of the synthetic industrial chemistry. This was the time when natural ingredients proven to be harmless by experiences of centuries were replaced by cheaper, more available and often more effective synthetic compounds in order to meet the demands of mass production and retail.

The use of new synthetic compounds was not always antedated by toxicological tests which resulted in several harmful compounds were added to foods temporarily.

Recognizing this threat, the UN initiated an international cooperation to regulate the safe use of food additives. In 1956 the Joint FAO/WHO Expert Committee on Food Additives (JECFA) was formed, establishing the principles that food additive legislation is still based on in all countries.

The most important principle established by JECFA is that food additives should be used only after they are proven safe by toxicological tests and authorized by the appropriate governmental bodies (positive list), and only if there is a technological justification for their use and it has advantages of benefit to the consumer.

The rapid expansion of the number and applications of food additives was watched by consumers and consumer organizations with growing suspicion. After adopting the E numbering system for labelling food additives in the middle of the 1990's, concerns about food additives arose in Hungary as well. Consumer anxiety may be attributed to the fact that at the establishment of the system no adequate attention was paid to informing the public, therefore E numbers are still surrounded by the atmosphere of mystery and distrust.

According to the well known paradox of foods, foodstuff is a basic condition of health, but at the same time it is the most important risk factor as well. This dichotomy of foods is also reflected in the food consumer behaviour.

The food scandals of recent years (BSE, avian influenza, etc.), the chemicals used in agriculture, and the extensive use of synthetic food additives in food

manufacturing have severely undermined the consumers' confidence in foods. It can be noticed, however, that hazards perceived by consumers are higher than the actual risks, and much consumer concern about food relates to "virtual risks", based on claims about hypothetical health problems – such as those from food additives – that are based on plausible scientific theories, but lack any empirical scientific evidence.

Some of this concern may also be fuelled by sources such as the media and consumer organizations exaggerating the actual risk levels. Since consumers are underinformed when making their shopping and consumption decisions, food and nutrition misinformation can have harmful effects on the health of consumers or cause them to spend money on products with no real benefit.

Lessing the groundless consumer anxiety of food additives would be beneficial for food manufacturers, food retailers and food authorities as well. A more effective consumer information program should be based on exploring consumer attitudes to food additives.

To the author's knowledge, the current work is the first comprehensive consumer research carried out in Hungary regarding food additives.

As a preparation for the consumer research which makes up the majority of this doctoral work, a shorter questionnaire survey was conducted on a smaller regional sample in 2004. The current country-wide, representative, comprehensive survey was designed based on the experiences from that previous research.

The major objects and aims of this doctoral work are the following:

a) To review the legislation, and the technological and health implications of food additives;
b) To analyse the media presence of food additives;
c) To explore professional opinions on food additives;
d) To analyse consumer attitudes to food additives;
e) To establish a model summarizing the role of food additives in food-related consumer behaviour;
f) To draw up recommendations based on the results of the research to increase consumer knowledge, consciousness and trust, and to promote the more responsible, more modern use of food additives.

The majority of the research was made up of the exploration of consumer attitudes to food additives. The following questions were to be answered:

a) Do consumers know the definition of food additives and E numbers?
b) Do consumers consider food additives hazardous compared to other factors from the points of view of health and food safety?
c) What is consumers' opinion on the technological necessity of the use of food additives?
d) What do consumers think about the current legislation of food additives, with special regards to labelling issues?

e) Which sources of information form consumer opinions on food additives, and which channels of communication may be used most effectively in informing consumers?
f) Which factors affect the consumers' food choice, and what rule does the additive content of foods play in the consumer decisions?
g) Are there any differences by demographic variables in consumer attitudes to food additives?
h) Can consumer clusters be separated based on consumer attitudes towards food additives?

2. MATERIALS AND METHODS

2.1. Secondary Research Methods

The first part of the secondary research focused on the classification and legislation, chemical, technological and health implications of food additives. For the current survey, it was also essential to review the professional and consumer opinions, and the media presentation of food additives.

2.2. Primary Research Methods

2.2.1. Qualitative Methods

The qualitative marketing research of the current work consisted of *in-depth expert interviews*, *expert focus group surveys* and *consumer focus group surveys*.

2.2.1.1. In-Depth Expert Interviews

Besides secondary data collection on the legislation, use, health implications of and consumer opinions about food additives, the author deemed it necessary to directly explore the opinion of the renowned experts of the respective fields. To achieve this, 9 *semi-structured in-depth interviews* were carried out.

Experts from *food authorities* provided very valuable information about past and current issues and future trends of food additive legislation. *Consumer groups* helped explore consumer attitudes to food additives and their role in consumer decision. A researcher from the *Central Food Research Institute* (KÉKI) provided information about current and future trends of product development and the role of food additives in product development. An independent expert recognized among *opinion-leaders* in the topic of additives was also interviewed.

2.2.1.2. Focus Group Surveys

5 focus group interviews were conducted with consumers, food industry experts and doctors.

The purpose of the *consumer* focus group interviews was to collect instructions and ideas for designing the questionnaire of the qualitative survey.

During the interviews, attitudes towards food additives were studied. The questions were designed to explore the knowledge of additives, the opinions on the justification and health implications of additives, and the impact of the additive content on food choice decisions.

The *experts'* focus groups consisted of *food industry experts* and *doctors*. Technologists and product developers employed in the *food industry* were interviewed on technological aspects of food additives, current and future trends of product development and the role of food additives in product development while doctors provided information about health implications of food additives. Besides professional questions, participants were also asked about their personal opinion on food additives as consumers.

2.2.2. Quantitative Methods

The qualitative research consisted of a country-wide, representative *consumer questionnaire survey* and a *non-representative expert questionnaire survey*.

2.2.2.1. Consumer Survey

Sample Size

The sample consisted of 750 respondents. According to the experiences in marketing research, this sample size ensures that the subgroups formed by different background variables are sufficiently large to yield statistically reliable results.

Sample Selection

The sample was drawn using *multi-step quota sampling*. Basic population was determined as the residents of Hungary between 15 and 69 years of age; the quota was prepared using the data from the 2001 Census. The sample was finalized using multi-dimensional weighting.

The sample selection method yielded a sample representative by *gender, age, education* and *residence type* which is also a good approximation of the base population by *region*.

Data Collection

Data were collected using mixed-mode survey technique which methods are still very infrequently used in Hungary while being the norm these days in the USA and Western Europe. In this case personal interviews and online questionnaires were used.

Considering the proportion of Hungarian internet users within the different demographic segments, respondents with primary education between 25 and 54 years of age, and individuals between 55 and 69 years of age were interviewed personally only while in the rest of the sample (respondents between 15 and 24 years of age, and individuals with secondary or higher education between 25 and 54

years of age) interviewers and respondents were given a choice between personal interviews and online surveys.

Questionnaire

The questionnaire contained 11, mainly closed-ended questions.

First, general consumer behaviour was studied, and then *perceived risk of food ingredients and food industry processes* was queried. The majority of the questionnaire consisted of questions regarding *knowledge of and attitudes towards food additives*. After that, the role of different *sources of information* in consumer information about food additives was studied, lifestyle analysis was conducted, and *demographic variables* were recorded.

The online questionnaire was prepared at *www.surveymonkey.com*.

Data Processing

The collected data was analysed using *SPSS 13.0* software. Frequencies were calculated, and relations among variables with background variables and relations among variables were studied using crosstabs. *Means* and *correlations* were calculated, and *significance tests (Chi-square)* were conducted. For multivariate analyses *ANOVA*, *factor analysis* and *cluster analysis* were used. Significance level was set to $p<0.05$.

The consumption frequency of foods was expressed using the annual *consumption frequency index* originally developed by Szakály Z. (1993) modified by the author.

2.2.2.2. Professional Survey

Besides in-depth interviews and focus group surveys, a questionnaire survey was carried out with individuals from food related fields, the health sector and consumer groups, for the purpose of exploring professional opinions on food additives.

Certain questions of the expert questionnaire were copied over from the consumer survey for comparability purposes, and several professional questions were added. At the end of the questionnaire, the education and workplace of the respondent were recorded.

The questionnaire was prepared and filled out online at *www.surveymonkey.com*.

Sampling was done using *snowball method*: the link to the questionnaire was sent to the objects of the in-depth interviews, to certain participants of the focus group surveys and to other experts, who then forwarded it to their colleagues and acquaintances working in the same field. The above sampling method offers no representativeness but informative conclusions may be drawn.

Out of the 64 questionnaires completed total, 35 questionnaires filled out by respondents from the food industry, food authorities, the health sector and consumer groups were selected for analysis.

The collected data was analysed using *SPSS 13.0* software.

3. RESULTS

In this chapter, the results of the primary research are summarized. First, professional opinions on food additives are reviewed by expert in-depth interviews, focus group surveys and questionnaire survey, and then consumer attitudes to food additives are analysed by consumer focus group interviews and a country-wide consumer questionnaire survey.

3.1. Professional Attitudes towards Food Additives

3.1.1. Public Authorities

In order to learn about the opinion of food authorities regarding food additives, experts from the *Central Agricultural Office Food and Feed Safety Directorate* (MgSzHK ÉTbI) and the *Hungarian Food Safety Office* (MÉBiH) were interviewed.

According to the interviewees' concurrent opinion, toxicological evaluations performed prior to authorization ensure that food additives used currently are safe. They recognize the limits of today's toxicological tests (such as the applicability of animal test results to humans or interactions between compounds), however, they think that there are no methods being more reliable currently available. They emphasized, however, that although food additives are harmless for the average consumer, individual hypersensitivity reactions may occur, and in this case the additive concerned has to be avoided.

The authority professionals criticized the current practice of the food industry, they do not believe that the basic criteria of the use of additives such as reasonable technological need and not mislead the consumer are always complied with. In this issue, they expect positive changes with the upcoming new food additive regulation in the EU. In order to reveal possible infringements on the use of food additives, they suggest that official controls should be more frequent and better coordinated.

The respondents consider the E numbering system for labelling additives to be very appropriate, and they do not understand consumers' dislike to E numbers.

In the professionals' opinion, groundless consumer aversions can only be alleviated by credible information, and increasing consumer knowledge and consciousness.

Although authorities consider currently used food additives to be safe, they deem it necessary to decrease their use to the lowest level necessary: efforts should be made to add as less foreign compounds to foods as possible. Being able to influence food industry practices through their preferences and product choice decisions, consumers play a crucial role in this process.

3.1.2. Food Industry

One of the *professional focus groups* consisted of technologists, product developers and quality control experts from the food industry.

According to the interviewees' opinion, the vast majority of food additives are safe in the quantities used. They suppose, however, that there may be some potentially harmful substances as well such as preservatives. They added, however, that preservatives used by the canning industry were still less detrimental than microorganisms that would grow in the absence of preservatives, and preservatives used in the food industry are still less harmful than e.g. salicylates used for household bottling.

As far as the *justification* of the use for additives are concerned, the respondents have said that certain food cannot be produced without additives added, while in other cases additives improve the sensory value of foods and allow the manufacturers to produce cheaper foods.

The food industry strives to use as less additives as possible; as a result of consumer concerns, retailers often demand products "free from E numbers" from the manufacturers. Besides that, product developers also try to use additives of natural origin rather than synthetic ones. However, this cannot be achieved in every case: the food industry is heavily pressured to produce good quality foods at low prices, and this cannot always be accomplished with natural additives only.

The food industry experts interviewed experience that the majority of consumers feel aversion to food additives and more and more people study food labels. *However, the respondents generally state that it is unnecessary to provide consumers with more information about food additives.* In their opinion, *"people working in the food industry see clearly in the matter of food additives but for common consumers it is completely useless to know."*

Based on his own experiences, one of the respondents confirmed that *the ingredients declared on product labels do not always correspond to the real composition of foods* which came up in the consumer's focus groups as well; in order to avoid such abuse, more stringent control and penalization should be implemented.

Regarding the future use of food additives, the attendees had the same opinion as the consumer focus groups (see Chapter 3.2): mass production was set against special consumer demands. Besides conventional foods, there are so-called premium products on the market even today but there are still too few consumers able to pay their higher price. Food industry is not interested in propagating these products anyway because this would worsen the image of their conventional products.

In order to learn about *current and future trends of product development* and the *role of food additives in product development* a researcher from the *Central Food Research Institute* (KÉKI) was interviewed.

According to the expert's opinion, food developers try to use natural or at least natural identical additives; however, these are usually more expensive, and their costs cannot be recovered in cheaper products.

In the researcher's experience, food industry complies with the regulations on food additives, or at least the *"fair manufacturers"* do; besides penalties, infringements revealed would considerably worsen the reputation of the company as well.

Concerning future trends of using food additives, the interviewee had similar opinion to that of the respondents of the food industry focus group: food industry will be dominated by mass production, and only a small consumer segment will be conscious about nutrition, demanding less processed more natural foods. She emphasized, however, the importance of the responsible use of food additives.

3.1.3. Health Sector

Due to their chemical, biological and health studies, the *doctors* attending the other *professional focus group* were better *informed* about the issue of additives than the members of the consumer groups. They are aware that E numbers identify food additives and the declaration of additives by chemical names or E numbers are equivalent. It has to be noted, however, that the interviewee's knowledge of food additives fell far behind the level that could have been expected from a doctor. This may be attributed to the fact that the topic of food additives is hardly addressed in the Hungarian medical education, only dietitians studying at certain colleges receive detailed education on the subject.

Regarding the *justification* of using food additives, they believe that in certain products food additives are essential to the safe manufacture (e.g. preservatives), while in other products they make foods more consumable (e.g. stabilizers).

They assume that if these additives are permitted for use by authorities then they must have been thoroughly tested, and thus are safe for consumption. According to one respondent, however, 50–60 food additives were found to be carcinogenic so far while the remaining additives are presumably carcinogenic.

This suggests that doctors, unlike food industry experts, have some *doubts* regarding the safety of food additives, however, their aversion is less expressed than that of the consumers' focus groups. Besides the carcinogenic effect already mentioned, allergy, immune dysfunctions, gastro-intestinal disorders and Alzheimer's disease were named as health problems supposedly caused by food additives. Most concerns addressed synthetic colours. According to the doctors interviewed, food additives can also cause allergy, and they increase the prevalence of certain illnesses by influencing the activity of the immune system. The respondents consider the purity of additives to be another important factor: health problems are often caused by not the additives itself but by their contaminants.

The doctors *do not think it is necessary to provide consumers with more information about additives*: according to their opinion, there are such huge amounts of information that the average person cannot handle anyway.

Regarding the *future prospects* of additives, doctors had similar views to that of the food industry experts' and customers' focus groups. Mass production will continue to demand additives, and only health conscious people and the ever increasing number of allergic individuals will study the label and maybe even prefer organic foods.

3.1.4. Consumer Organizations

Food additives are one of the favourite topics of consumer organizations. In order to learn about the views of consumer organizations on food additives, the leader of the expert committee on food at the *National Association for Consumer Protection in Hungary* (OFE) was interviewed.

According to the expert's opinion, certain additives such as preservatives and azo dyes may be detrimental to the health. She mentioned allergy and hyperactivity as illnesses caused by food additives; she also considers the interactions between additives to be a potential risk, and emphasized the importance of purity of additives. The expert deems it very important to re-evaluate the safety of food additives regularly in the light of the new scientific developments, and to monitor the intake of food additives and revise the regulations accordingly.

The interviewee strongly criticized the current practice of using food additives. In her opinion, the food industry often uses additives for the purpose of saving valuable ingredients from the foods, thus improving the profitability of the production. She acknowledges that the use of additives is induced by consumer expectations also; however, she believes that the food industry is accountable for having people accustomed to more intense colours and flavours.

The expert interviewed is the originator of the advice often appearing in the media and in the public, and being strongly contended by food authorities, saying that foods with more than 5 or 6 E numbers on the label should be avoided. As she explained, besides the risk of uncontrollable interactions between additives, the other motive of this advice is that the need to use such a large number of additives indicates the lower quality of the raw material.

The professional considers the E numbering system to be a very good initiative towards labelling additives. However, she perceives consumers' dislike to E numbers, too, for which attitude she blames the media in the first place. As she expressed: *"The problem is not the E number but the additive itself."*

In her opinion, it would be important to inform consumers at least about the potent allergenic ingredients (including additives) of foods sold without pre-packaging in some way. The consumer organization she is working for also proposes that restaurants and home-delivered food services should declare certain ingredients, or at least the allergens.

The expert deems it very important to increase consumer knowledge and to redress misbeliefs about foods in general, including additives. In her opinion, much more efforts should be made to teach knowledge of nutrition in schools, and besides that, consumer organizations and consumer forums may play an important role as well.

3.1.5. Results of the Professional Questionnaire

In order to directly compare professional opinions on food additives, besides in-depth expert interviews and professional focus group surveys, a questionnaire

surveys was also carried out among individuals from food-related fields, the health sector, and consumer organizations.

In the following, the results of the questionnaires completed by respondents from the food industry, food authorities, the health sector, and consumer organizations are presented.

The first question of the professional survey was the same as the fourth question of the consumer questionnaire, referring to the *perceived risk of food ingredients, food contaminants and food industry processes* on a 5-point interval scale. The averages of the factors, completed with the results of the consumer survey are shown in Table 1 (p. 11), in the increasing order of the average of the four professional groups. The results of the consumer survey are detailed in Chapter 3.2.2.2.

It is notable that all groups considered *mycotoxins* to be the most hazardous among the factors listed; this can most likely be attributed to the paprika scandal that occurred recently.

Additionally, *food industry* finds different chemical residues and contaminants, trans fatty acids, and food deterioration to be very dangerous, and many also recognize the importance of allergy as a risk factor. In accordance with the results of the focus group interview, preservatives were named as the most harmful among food additives, while other additives were considered only moderately risky.

Experts from *food authorities* have a similar opinion to that of the food industry, with a more expressed risk of nutritional factors other than trans fatty acids as well. Among food additives, non-caloric sweeteners were considered the most dangerous while other food additives were classified among the least risky factors. It is notable, that these experts show the lowest level of perceived risk in the average of all factors as well as in the average of food additives listed (printed in italic).

Health professionals consider similar factors to be the most hazardous as food authorities. The opinions on food additives, however, are remarkably negative: four out of the six additive-related factors were considered the most harmful in the health sector, which resulted in the highest average perceived risk of additives among the four professional groups. Preservatives are thought to be the most dangerous, and other groups of additives, except for sweeteners are judged not much more favourably, either.

In *consumer organizations*, the order of factors perceived as the most dangerous are similar to that of the authorities. Their risk perception, however, is the highest among the four professional groups: with a few exceptions, they considered all risk factors to be the most dangerous. Their opinion on food additives is rather negative: the average of the six additive-related factors is not much higher than that of the health sector. Among additives, synthetic colours are thought to be the most harmful; this can probably be attributed to a recent study on the effects of synthetic colours on the hyperactive behaviour of children which commanded a particularly wide following in the consumer groups.

Next, respondents were asked about the *labelling, health impacts and use of food additives*. The average results of some questions that were also included in the consumer survey, completed with the results of the consumer survey, are shown in

Table 1

Perceived risk of food-related factors among professional groups and consumers

Risk factor	Food industry	Public authorit	Health sector	Consum. organiz.	Con-sumers
	n=11	n=6	n=14	n=4	n=750
Mycotoxins	1.09	1.17	1.14	1.00	1.40
Pesticide residues	1.36	1.50	1.14	1.00	1.40
Food deterioration	1.55	1.50	1.21	1.25	1.38
Hormones, drug residues	1.18	1.67	1.43	1.50	1.39
Environmental contaminants in the food	1.36	1.33	1.50	1.25	1.44
Allergenic food ingredients	1.73	2.00	1.43	1.50	1.55
Trans fatty acids	1.18	2.50	2.50	1.25	2.12
High sugar content	2.36	2.17	1.93	2.00	2.32
Cholesterol	2.55	2.00	2.00	1.75	2.26
High fat content	2.64	1.83	2.21	1.50	2.40
Preservatives	*2.27*	*3.00*	*1.86*	*2.00*	*2.21*
GM ingredients	2.45	3.50	2.36	1.50	1.98
Synthetic colours	*2.73*	*3.50*	*2.36*	*1.50*	*2.58*
Microorganisms in the food	2.91	2.50	2.50	2.00	2.73
High calorie content	3.18	2.83	2.50	2.00	2.81
Non-caloric sweeteners	*3.00*	*2.67*	*2.79*	*2.25*	*3.10*
Smoking foods	3.18	2.67	2.64	2.50	3.63
Stabilizers	*3.27*	*3.33*	*2.21*	*3.00*	*2.36*
Food additives	*3.00*	*4.17*	*2.29*	*3.00*	*2.27*
E numbers	*3.09*	*3.33*	*2.57*	*3.00*	*2.06*
Animal fats	3.45	3.00	2.71	2.75	3.26
Salt	3.45	2.83	3.21	2.50	3.20
Average	2.41	2.50	2.11	1.91	2.27
Average of food additives	*2.89*	*3.33*	*2.35*	*2.46*	*2.39*

1=very dangerous, 5=completely safe

Table 2 (p. 12), in the decreasing order of the average of the four professional groups.

Out of the group of questions regarding *labelling* issues, the generally most supported statement was that the E numbering system should be amended to clearly reflect the natural or artificial origin of additives, and almost as many respondents deem it necessary to introduce a “Contains natural food additives only” mark on foods. Suggestions were the most agreed in the food industry and in the health sector, while much less supported in the public authorities and consumer organizations. The opinion of the food industry probably arises from their hopes that such changes may help them communicate product advantages implied by natural additives to consumers in a more emphasized way.

Table 2

Professional and consumer opinions on labelling, health impacts and use of food additives

Statement	Food industry	Public author.	Health sector	Cons. organiz.	Con-sumers
	n=11	n=6	n=14	n=4	n=750
It would be necessary to amend the E numbering system to clearly reflect whether the food ingredient concerned is of natural or artificial origin.	4.91	3.33	4.21	3.25	4.37
It would be necessary to introduce a "Contains natural food additives only" mark on foods.	4.27	3.33	4.57	3.00	4.47
The best way would be to print both the names and E numbers of food ingredients on labels.	4.00	4.00	4.14	4.00	4.08
It would be necessary to introduce a "Contains no additives" mark on foods.	4.18	3.33	4.64	2.50	4.40
E numbers are a better option than printing the names of food ingredients on labels.	2.00	2.50	1.71	3.00	2.28
Food additives of natural origin are less dangerous to health than synthetic ones.	3.27	3.50	3.57	3.75	4.16
The current bad health state of the population can partly be attributed to the excessive use of food additives.	2.82	2.50	3.64	2.75	3.75
Certain additives are unnecessarily added to foods and may be eliminated.	4.00	3.33	4.21	3.75	4.06
Food additives help disguise quality problems.	3.64	3.17	3.64	3.75	3.67
Foods containing less or no additives are more expensive.	3.64	4.33	3.00	3.50	3.92
The use of additives if essential because they improve the quality and sensory value of foods.	3.27	3.00	1.93	2.50	2.91

1=strongly disagree, 5=strongly agree

All professional groups strongly agree that the best way would be to print both the names and E numbers of additives on food labels while much less respondents consider E numbers to be a better option than declaring additives by names. It is notable, however, that despite the fact that almost three quarters of food industry experts supported the first statement and this declaration form is not prohibited by the current legislation, foods with additives indicated both with names and E numbers can very rarely be found. This may be probably attributed to the limited space available on labels.

A surprisingly high number of respondents from the food industry and the health sector think that a "Contains no additives" mark should be introduced, and it

is just as an unexpected result that this suggestion is the least supported by consumer organizations.

The two questions regarding the propriety of claims on additives appearing more and more often on labels (‘Marks such as “Contains no additives” or “No preservatives added” violate the regulations for if a certain additive is not declared on the label it means that it was not added to the food.’ and ‘Marks such as “Contains no additives” or “No preservatives added” are adverse for they suggest to consumers that food additives are harmful.’) greatly divided the respondents of all professional groups. The total averages (3.01 and 2.71, respectively) suggest a moderate level of agreement, but this value comprised of many distinct opinions which is also reflected in the very high standard deviations (1.50–1.97). Surprisingly, the propriety of the above claims were the most questioned by consumer organizations while the most supported in the health sector.

Another remarkable result was obtained from the question stating that manufacturers always list all ingredients on food labels. Two out of three food industry experts admit that there may be deficiencies in this matter while the least scepticism was observed in the consumer organizations.

Out of the group of questions regarding the *health implications* of food additives, all professional groups agreed more than moderately with the statement saying that food additives of natural origin are less dangerous to health than synthetic ones. Consumer organizations agreed the most while the food industry the least.

The majority of the respondents do not accept the statement claiming that the current bad health state of the population can also be attributed to food additives; however, the highest proportion of the people supporting the claim is found in the health sector.

The vast majority of respondents from public authorities and the food industry believe that animal toxicological studies provide adequate information about the risks of food additives in humans. However, the most negative opinions were again observed in the health sector with only half of the respondents agreeing.

All professional groups reject the incorrect statement claiming that food additives cause allergy more frequently than other foods or food ingredients (2.23). It is remarkable, however, that nobody from the food industry and only one out of five respondents in the health sector disagreed strongly with the statement.

Out of the group of questions regarding the *use* of food additives, the statement saying that the food industry should put more emphasis on reducing the use of food additives was generally the most supported (4.29); almost as many respondents said that the food industry should put more emphasis on replacing artificial food additives with natural ones (4.20). Both statements were supported most in the food industry and in consumer organizations.

The current practice of the food industry, however, stands out in sharp contrast to these meanings. Among this series of questions, the lowest average level of agreement was observed for the statement claiming that the food industry strives to reduce the use of food additives (2.20), and not much more respondents think that the food industry strives to replace artificial food additives with natural ones, either

Table 3

Professional opinions on consumer attitudes towards food additives

Question	Food industry	Public author.	Health sector	Cons. organiz.
	n=11	n=6	n=14	n=4
How concerned are Hungarian consumers about food additives?[1]	3.18	3.00	2.93	4.00
To what extent is consumers' food choice affected by the additive content of foods?[2]	2.55	2.33	2.64	3.25

[1] *1=not at all concerned, 5=greatly concerned*

[2] *1=not affected at all, 5=greatly affected*

(2.51). Remarkably, people from the food industry also criticized their branch rather strongly: only one fifth and one half of the respondents agreed with the above statements, respectively.

The negative opinions on food additives are also reflected in the fact that, except for public authorities, all professional groups had many respondents thinking that certain additives are unnecessarily added to foods and that food additives help disguise quality problems. Even the majority of food industry experts admit that there are some infringements in the use of additives.

Much less people believe that the use of additives is essential because they improve the quality and sensory value of foods; however, not surprisingly, the statement was supported most in the food industry.

Less than half of the respondents claim that foods containing less or no additives are more expensive. The statement was the supported most in public authorities, however, in the food industry only two out of three respondents while in the health sector and in consumer organization even less people agreed. This result is rather surprising for one of the most common arguments communicated in support of the use of food additives is to reduce cost.

In the next two questions, respondents were asked about the *attitudes of Hungarian consumers towards food additives* (Table 3).

The different professional groups have rather distinct perceptions about *how concerned Hungarian consumers are about food additives*. All respondents from consumer organizations, less than every other from the food industry, and even less from authorities and the health sector perceive consumer fears, and only one respondent, a doctor thinks that Hungarians are greatly concerned about food additives.

Even lesser respondents think that *consumers' food choice is affected by the additive content of foods*, with the vast majority saying that consumers are either unsure or do not care about additives at all when choosing foods.

Next, the respondents were asked to determine *whose responsibility it is to inform consumers about food additives*.

According to the majority of the respondents from the *food industry*, informing consumers on the subject would primarily be the responsibility of the public authorities while food industry and consumer organizations were rarely named as

primary sources of information. Besides these, many would rely on the mass media and the trade sector as well.

Contrary, *public authorities* state that food manufacturers should inform consumers about additives, which indicates that the two parties concerned try to push the responsibility on each other in this matter. Experts from food authorities mentioned consumer organizations, authorities and the health sector as secondary sources of information.

Similarly to the opinion of public authorities, *health professionals* also think that it is the primary responsibility of the food industry to inform the public on the subject. They would only accept a little role for themselves in informing consumers; however, many would rely on the mass media as a secondary source of information.

Consumer organizations did not point out any preferred source of information; they do not even refer to themselves as being of great importance in this matter.

According to the author's personal opinion, each professional group has its own responsibility in informing consumers about food additives; however, their actual duties are distinct from each other (see Chapter 4.2.).

In the last questions of the survey, respondents were asked whether *they deem it necessary to increase consumers' knowledge of food and nutrition* and *to provide consumers with more detailed information about food additives*. For both questions, only positive answers were received. The result for food additives is rather unexpected since both food industry experts and doctors interviewed in the focus group surveys thought it was useless to provide consumers with more information about food additives. The difference may probably lie in the fact that the participants of the focus group surveys did not know that the interview would be about food additives, while in the questionnaire survey, the topic was indicated both in the cover letter and on the opening page; thus, the survey was primarily completed by people showing interest to food additives only.

3.2. Consumer Attitudes towards Food Additives

The majority of the current doctoral research was made up of the exploration of consumer attitudes to food additives. This chapter summarizes the most important results of the consumer focus group interviews and the consumer questionnaire survey.

3.2.1. Results of the Focus Group Surveys

Preservatives, stabilizers, harmful, illnesses, cancer, fast foods, mockery – these ideas were the first associations with the term 'food additives' in our respondents' minds.

The majority of respondents in the consumers' focus groups have basically negative feelings about the *use* of food additives. They recognize that these substances have some technological functions, but they think that food processors only add them to the products in order to make foods more marketable, thus

increasing their profit. According to some respondents, most additives may be eliminated from the foods but this cannot be completely achieved since average people have no time to prepare meals from traditional raw materials.

Preservatives and colours are the additive groups that were criticized the most for their justification.

According to the consumers' opinions, *preservatives* could be replaced by technological methods such as heat treatment, but most consumers are not willing to pay the higher prices associated. However, convenience must also be mentioned: the use of preservatives results in a longer shelf-life which is advantageous to the consumers, too. Other respondents stated that preservatives might be eliminated if settlements were self-supplying in foods, thus producing small-scale quality foods with shorter shelf-life instead of large-scale mass products with longer shelf-life. Consumer expectations encourage the use of additives, too: consumers demand foods that can be prepared easily and quickly.

The respondents questioned the justification of *food colours*, too since colours are used for aesthetic purposes only. They acknowledge, however, that the use of colours is induced by consumer demands as well; colour make foods appetizing, and consumers often judge by the appearance of products. Some participants, however, would buy colour-free foods even if their appearance would be much more unfavourable compared to conventional products.

Concerning *health risks* of food additives, the respondents showed a great doubtfulness. Most people do have much information about additives in general, thus about their health implications, either. Most respondents assume that there are food safety regulations destined to protect the public but they are doubtful of their effectiveness, arising several questions. They consider the testing period to be too short to test the possible accumulations of the compounds in the body. Additionally, they say that it is almost impossible to test the interactions between the large numbers of substances. However, the most important problem perceived by respondents is that due to lack of money, food authorities are unable to enforce the food safety regulations, and taking advantage of this, food processors break them. The results suggest that consumers are practically not aware of the rigorous authorization and monitoring system of food additives.

As a specific risk of food additives their carcinogenic effect was emphasized in the first line – while actually, carcinogenicity is a disqualifying factor at the toxicological assessment of additives. However, opinions on food additives are not unified; substances of natural origin are generally considered less harmful than the synthetic ones. According to the respondents, most food additives are synthetic. This belief is wrong: the majority of food additives used in the modern food industry are of natural origin. Food additive hypersensitivity, which is a rare but actual problem, was not mentioned in any of the focus groups.

The most critical aspect of using food additives is *labelling*. The E number declaration widely used by food processors is consonantly criticized by consumers: they think that its only purpose is to conceal something from them. The main reason for this misconception is that the list containing the substances and their respective E numbers are unavailable to the consumers, hindering them in identifying the

additives what leads to mistrust. Interviewees suggest that the list of E numbers should be more available, for example in food stores and at family doctors. By the list being more available, much less people would worry about additives. Otherwise, they would prefer indicating additives on labels by chemical names.

The mistrust in additives is also reflected in the doubt that food manufacturers indicate those ingredients on food labels that were actually used.

According to the respondents, media has the most important role in forming consumers' opinion about food additives. However, this role is judged by consumers negatively, they think that the purpose of such vast amount of advert-isements is to persuade and mislead consumers. The respondents obtain most of their negative impresses about food additives from the press, the electronic media and hand-outs. Many people believe the rumour from unverifiable sources saying *"no smoke without fire"*. The respondents state that food manufacturers are not interested in providing adequate information to the public; it should be the responsibility of the ministry of health. However, due to lack of capacity, it cannot be achieved, thus the dominance of media and personal communication will remain.

Contrary to consumer aversions, *food additives have only a slight influence on consumer decisions*. When shopping, people look at the manufacturer, price, expiry date, energy and fat content of foods in the first place; they choose what they usually buy and like. Besides these and the convenience factor already mentioned, there is another possible explanation for this paradox: consumers presume that all foods contain additives, therefore there is no way to avoid them.

This attitude is in accordance with the results of the survey conducted at the beginning of the conversation querying about consumption of certain foods. Even the respondents claiming to be afraid of additives regularly consume products with particularly high additive content e.g. margarine or ketchup. However, certain consciousness is evolving in this field, too: some respondents look for and prefer foods without additives such as canning industry products without preservatives, and they are even willing to pay a higher price for these foods.

Regarding the *future perspectives* of additives, the respondents came to the conclusion that food industry would advance in two different ways. Because of the growing population on Earth mass production will dominate, and to produce more and cheaper food more and more additives will be used. However, the consumer segment aspiring to a more natural nutrition is already present, and the back-to-nature life philosophy will gain more and more popularity in the developed countries. The demands of these consumers may be satisfied by additive-free, perhaps even organic foods.

3.2.2. Results of the Questionnaire Survey

3.2.2.1. Factors Affecting Food Choice

In the questionnaire survey, the factors affecting food choice were investigated first using an open-ended and a closed-ended question.

Table 4

Relative importance of factors affecting food choice (n=750)

Factor	Average	Factor	Average
Freshness	4.62	Country/place of origin	3.30
Good taste	4.57	Packaging	3.18
Healthfulness	4.01	Quick to prepare	2.99
Price	3.79	Low fat content	2.87
Familiarity	3.77	Brand name	2.79
Ingredients	3.64	Low calorie content	2.72
Food safety	3.59	Expert recommendations	2.61
Long shelf-life	3.45	Low cholesterol content	2.60
Additive content	3.42	Promotions	2.18
E numbers on the label	3.39	Advertisements	2.08

1=no impact at all, 5=a great impact

The unprompted answers show that, beyond price and expiry date, the majority of consumers look for the ingredients (21.9%) on foods most frequently, followed by the origin (18.1%), brand/manufacturer (12.0%) and packaging (10.2%). Ingredients include additives, too, but only 7.7% of the respondents mentioned additives as such in the first place, and even less (4.5%) people look for E numbers on the labels. One-fifth (19.1%) of the respondents check nothing else but price and expiry date on products, or not even these data, either.

Women and people with higher education levels presented higher level of consciousness, and besides that, significant differences were found by age, residence type and income, too.

Among the 20 factors listed in the closed-ended question regarding factors affecting food choice (see Table 4), freshness and good taste of foods are the primary deciding factors for the majority of consumers when shopping for food (affecting 93.7% and 93.6% of the respondents, respectively); however, many consider the healthfulness of the product (73.3%), the price (62.7%) and their familiarity (66.5%) important, too. Food ingredients, additives and E numbers are taken into consideration by 59.2%, 53.2% and 49.5% of consumers, respectively; however, in the case of the latter two, opinions were widely diverse. The origin and practical factors are important for many; nutritional values affect much less people while marketing factors are taken into consideration by only a very small proportion of consumers.

Again, women proved to be more conscious consumers: apart from two factors with no significant difference, women consider all examined factors more important than men do. The order of importance of the factors differs in the two genders; ingredients are rated much higher while food additives and E numbers are in somewhat higher positions on women's list.

The diverse value system of different consumer segments reflected in the absolute and relative importance of the factors was proven in the rest of the demographic variables as well.

No significant differences were found in the importance of food additives and E numbers in the different age groups; however, their importance related to other factors decrease with age.

Food additives and E numbers are more important for people with higher education levels; the importance of food additives related to other factors was particularly greater for people with higher education levels.

Income has a significant influence on consumers' food choice: the absolute and relative importance of food additives and E numbers are greater for respondents with an income somewhat above the average.

3.2.2.2. Perceived Risk of Food Ingredients and Food Industry Processes

Comparing the results of the question also included in the professorial questionnaire regarding the perceived risk of 22 food ingredients and processes (see Table 1, p. 11) with the actual risk levels it is favourable that consumers recognize that food deterioration implies the highest risk on food safety (with 91.3% of the respondents saying they are dangerous); however, the risk of microorganisms which are generally also related to food deterioration is greatly underestimated. Nutrition risk factors came to the second half of the list indicating that Hungarian consumers still do not recognize the hazards implied by the consumption of foods high in energy, fat, sugar and salt. It has to be underlined that less than the one fifth of consumers are aware of the risks of trans fatty acids (TFA's) and half of the respondents cannot form an opinion on this issue at all, while the severe health impairing effects of TFA's are definitely proven now. The risk of mycotoxins and chemical residues are overestimated by the consumers which may primarily be attributed to the intense media attention. Food additives are considered moderately dangerous in general with 60.6% saying they are harmful. Within additives, E numbers, preservatives and stabilizers are perceived more dangerous (with 67.8%, 65.2% and 58.5% saying they are harmful, respectively) while synthetic colours and calorie-free sweeteners are considered somewhat less dangerous (with 51.2 and 37.3% saying they are harmful, respectively). However, according to the results of objective risk assessments, food additives are among the least hazardous food safety factors indicating that consumers exaggerate the risk of additives – even that of the ones of more favourable judgment.

Women consider almost all listed factors, including food additives and E numbers more dangerous than men do; the order of the factors, however, is roughly the same in the two genders. This suggests that women's greater risk perception is more a result of the greater interest in health issues than that of deeper knowledge.

The youngest respondents worry the most while the oldest ones the least about most risk factors. The order of the factors is somewhat different in the groups; however, there is no considerable difference in the opinions on food additives.

Generally, the risk perception is the highest in people with secondary education while most factors are considered as the least dangerous by consumers with primary education. In the order of risk factors, however, food additives move forward with education: the relative risk of additives is perceived the highest in people with college or university degrees.

Table 5

Knowledge of the definition of E number and food additives, and the frequency of remarks "artificial" and "harmful to health" mentioned, % (n=750)

	Definition					Remark	
	DK/NA[1]	Incorrect	Partially incorrect	Partially correct	Correct	Artificial	Harmful to health
E numbers	18.1	11.6	4.7	26.9	38.8	12.9	13.9
Food additives	15.6	4.0	11.5	36.0	32.9	10.7	5.8

[1] *Do not know or no answer*

People living in larger settlements generally consider most listed factors including food additives more harmful. The order of the factors is greatly different in the groups; however, there is no considerable difference by settlement types in the perceived relative risk of additives.

3.2.2.3. Knowledge of and Attitudes towards Food Additives

The majority of the questionnaire consisted of questions regarding *knowledge of and attitudes towards food additives*.

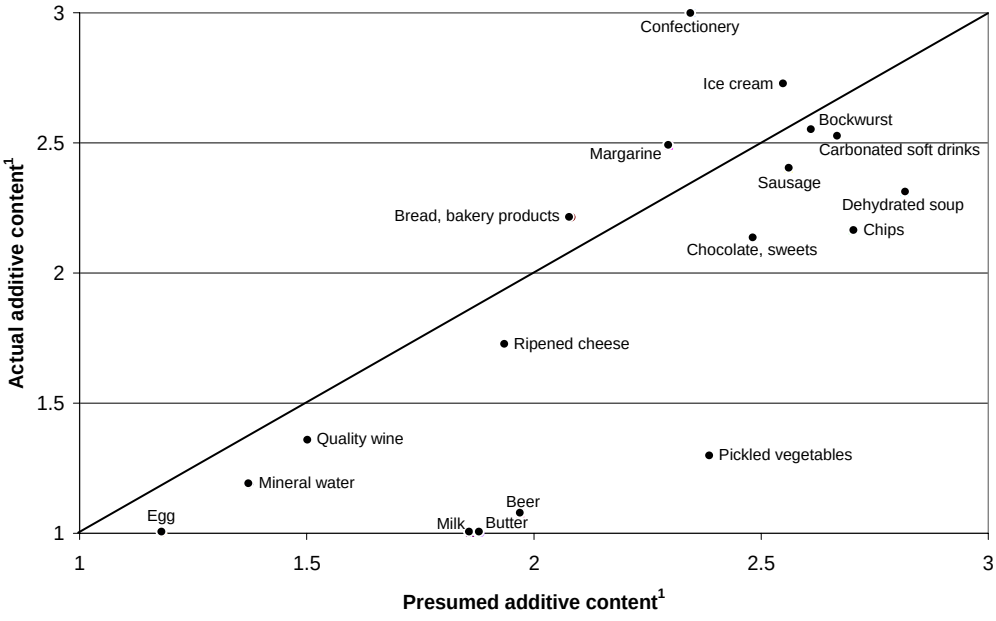
At first, the respondents were asked to define the *meaning of food additives* and *E numbers* in their own words.

About one third of Hungarian consumers are aware of the *meaning of food additives* and *E numbers* (see Table 5). More people were able to define E numbers than that of food additives; this can be attributed to the fact that in the case of E numbers, mentioning food additives was accepted as a correct answer, and it was a common situation that the respondent knew that E numbers marked food additives but he/she did not know the exact meaning of additives. However, there were only very few who recognized that E numbers and food additives actually imply the same thing. Another one third of the consumers gave a partially acceptable definition while the remaining one third is aware of neither the meaning of food additives nor the fact that E numbers mark food additives.

Examining the distribution of answers by demographic variables it turns out that people with more education, those living in larger settlements and of younger age groups have the most detailed knowledge of food additives; however, there is not significant difference between genders.

The sole artificial origin of E numbers and food additives was mentioned by one in eight and one in ten respondents, respectively; this misconception was particularly widespread in women.

Presumed health impairing effects of additives were incorporated in the definition by less than 6% of the consumers; E numbers, however, were considered detrimental by twice as many people. This result definitely reflects the aversion of Hungarian consumers for the unfamiliar numerical codes. Again, women more often expressed negative opinions than men did indicating that women are more interested in issues on additives, at the same time being more susceptible for unverifiable rumours in the topic, too.



1=no additives 3=a large amount of additives

Figure 1: Presumed and actual additive content of foods (n=619–691)

In the next question, the respondents were asked to assess the *food additive content of 18 food groups* on a 3-point scale. The question served as a double purpose. First, the results compared with the actual additive content of foods reflect the respondents' knowledge of additive content of foods. The second purpose was to explore consumer behaviour. At the beginning of the questionnaire, before the respondents could have discovered that the survey was about food additives, the consumption frequency of the same food groups was queried. Comparing the presumed additive content with the consumption frequency of foods provides information on the actual importance of food additives in the decision process.

In order to assess the actual additive content of foods, 10 foods were selected from each group, and the average number of additives declared on the label was projected on the 3-point scale used in the consumer survey. The presumed and actual additive content of the foods are shown in Figure 1.

Generally, the respondents assess the additive content of about half of the food groups listed (margarine, ice cream, bakery products, bockwurst, wine, carbonated soft drinks, sausage, egg, mineral water, ripened cheese) correctly.

The additive content of confectionery, however, was greatly underestimated. This misconception may be attributed to the fact that confectioneries are typically sold without prepackaging, with the list of ingredients appearing only on the commercial documents referring to the products which is not a realistic option for inquiring consumers.

The respondents think that sweets, dehydrated soups and chips contain somewhat more additives than they actually do while the additive content of pickled vegetables, beer, milk and butter was greatly overestimated – the latter two being

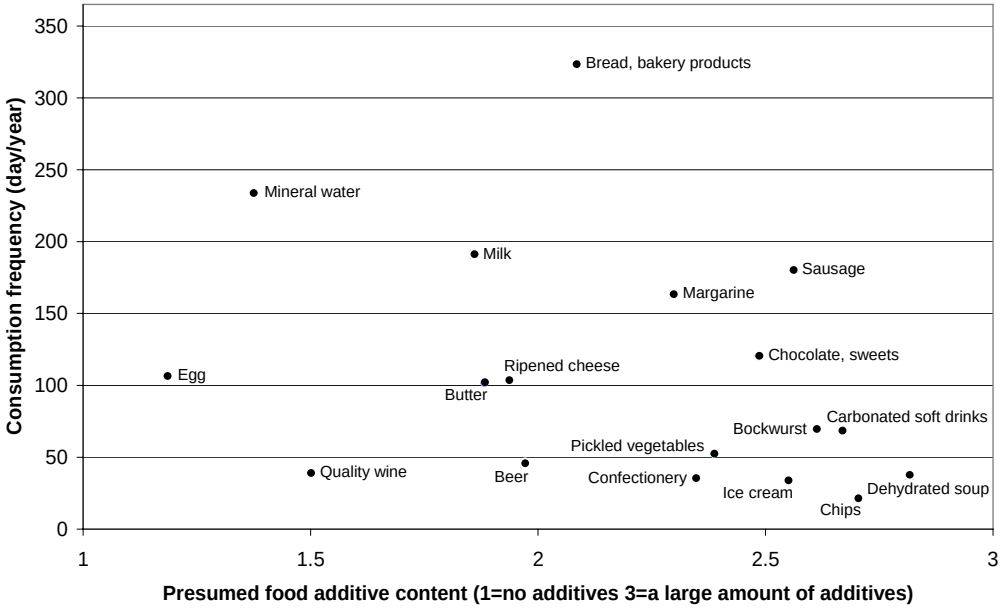


Figure 2: Presumed additive content and consumption frequency of foods (n=619–691)

particularly unfortunate since these basic dairy products cannot contain any additives at all. Considering the fact that the list of ingredients can always be found on the label of these foods (except for milk and butter), this misconception may originate from two sources. One of the possible reasons is that consumers do not actually check food labels, assessing the additive content of foods based on rumours, information from the media and their own beliefs. The lack of confidence in the credibility of food labels may also contribute to this misbelief: according to a later question in the survey, only 13.5% of the respondents believe that manufacturers always list all ingredients on food labels.

The very weak correlation ($r \leq -0.24$) between the *presumed additive content* and *consumption frequency* of foods (see Figure 2) indicates that attitudes towards additives do not considerably influence consumers' food choice, other factors play a much more important role in the decision process. Although less definitively, this statement is also true for consumers who, according to previous questions in the survey, claim to be more conscious about food additives ($r \leq -0.41$).

Consumer attitudes towards food additives were studied using 40 statements where the extent of agreement was marked on a 5-point Likert scale.

The opinions on the *health implications* of food additives (certain questions are shown in Table 2, p. 12) were controversial, but rather negative in general: most respondents (54.6%) are convinced that food additives are detrimental to the health but opinions are greatly diverse. Artificial additives and preservatives are viewed as particularly negative. Two thirds (66.5%) of the consumers have heard about food additive hypersensitivity, however, many of them (32.3%) believe that food

additives cause allergy more frequently than other foods or food ingredients which is untrue.

There is little difference in the health impacts of additives between demographical segments; people with higher levels of education, however, express somewhat deeper knowledge and less clear-cut opinions.

In contrast, consumer opinions on the *use* of additives (certain questions are shown in Table 2, p. 12) are consistently negative: only one fourth of the respondents (24.3%) mean that additives improve the quality and sensory value of foods while twice as many people (48.9%) think that additives help disguise quality problems, and even more consumers (62.8%) believe that certain additives are unnecessarily added to foods. According to most respondents (43.2%), foods of international brands do not contain less additives than those of less known brands; it is very unfortunate, however, that very many people (51.2%) think that the long shelf-life of UHT milk can be attributed to the preservatives added. Every other consumer (49.0%) agrees with the statement also confirmed by the author's own experiences, that foods containing less or no additives are more expensive.

Women and older respondents tend to question the justification of the use of additives the most while men and middle aged consumers expressed less clear-cut opinions. People with higher levels of education presented somewhat deeper knowledge in the topic of additives.

The results of the questions regarding the *labelling* of food additives (certain questions are shown in Table 2, p. 12) definitely reflect the aversions from additives, particularly artificial additives: vast majority of consumers would support the introduction of "Contains no additives" (81.7%) and "Contains natural food additives only" (84.7%) marks on foods and the amendment of the E numbering system to clearly reflect the natural or artificial origin of additives (77.1%). Only one out of four respondents is aware that all food additives have E numbers not only artificial ones. Consumer opinions on E numbers are definitely negative: only a minority (30.0%) thinks that E numbers serve the purpose of providing consumers with appropriate information, and many people (38.3%) believe that the sole purpose of using E numbers is to conceal the actual composition of foods from consumers. Only every seventh respondent (15.5%) prefers E number declaration to printing chemical names while according to the vast majority of consumers (69.0%) both the names and E numbers of additives should be listed on labels. Consumers' negative attitudes towards E numbers are particularly remarkable due to the fact that the purpose of establishing the E numbering system was the simple and definite identification of food additives by avoiding mistranslations of complicated and sometimes very long chemical names in the multilingual European community. Font size is a very critical point of labelling additives: the majority of respondents (61.1%) find it difficult to read the list of ingredients labelled with a small font size. According to one third of the consumers (38.9%), restaurant menus should contain the list of additives used in dishes. The lack of trust in the food industry is reflected in the fact that only every seventh consumer (13.5%) believes that manufacturers always list all ingredients on food labels.

Women generally support the above suggestions on additive labelling more than men do. In the different age groups, various opinions are met regarding the labelling issues of food additives. In general, the current labelling practice is the most criticized by the elderly while the most positive opinions were presented by the youngest respondents. There were significant differences by level of education only for a few questions, with people possessing higher levels of education presenting deeper knowledge and greater consciousness in most of these cases.

Negative consumer attitudes are reflected in the results of the questions regarding the *legislation* of food additives as well. Two thirds of the respondents (67.8%) would reduce the use of food additives by more stringent regulations; even more people (72.5%) would reduce the use of artificial additives while every third respondent (32.7%) would ban food additives completely. Consumers showed mistrust not only in food industry but in food authorities as well, with a majority of them believing that authorities are unable to enforce the regulations on food additives.

Restricting or banning the use of additives was much more supported by women and the oldest respondents than by men or youngsters. Restricting food additives was the most supported by respondents with secondary education while the complete ban was most agreed by respondents with primary education; consumers with college or university degrees generally have more moderate opinions.

The vast majority of consumers (75.4%) would like to get more detailed *information* on food additives, and every other consumer (51.6%) would worry less about additives if they had the list containing the names, E numbers and functions of additives to help identify the certain compounds. Only every ninth respondent (11.2%) say that authorities inform consumers properly about food additives, however, the majority (57.3%) is sceptical about the negative information appearing in the media, too.

Women, older people and consumers with higher education showed the greatest demand for information about additives. Media activities were the most strongly criticized by men while middle aged consumers and those with higher education were the least satisfied with the communication work of public authorities.

The last group of attitude questions were designed to explore the role of food additives in the *consumer decision process*. Three fourths of the respondents (76.3%) claim to prefer buying products containing fewer additives among foods of same quality and price, however, there are much less people (56.3%) who are willing to pay more for foods containing fewer or no additives at all. It is remarkable, however, that only every other consumer (52.9%) is willing to change their common preferences in order to decrease the intake of additives even in the case of colours used for sole aesthetic purposes: they are the ones who would buy foods free from artificial colours despite their unusual colour provided that they taste the same as their common counterparts. Nearly half of the respondents (47.4%) claim that there was an instance when they did buy a food product just because it contained a lot of additives, and there are not much less people (42.2%) who would even avoid their favourite food if it turned out that it contains a lot of additives. Consumers are greatly divided in the questions whether food additives

are more of a problem in Hungarian than imported foods and whether the long shelf-life of foods or the absence of preservatives are more important factors.

Women, people with more education, and those living in larger settlements showed greater consciousness in almost all questions. The trend is less clean-cut for age groups; however, youngest respondents turned out to be the least interested for food additives again.

The results support that the new consumer group preferring conscious consumption and health (Lifestyle of Health and Sustainability, LOHAS) has already emerged in Hungary as well. A significant proportion of Hungarian consumers value healthy foods made from natural raw materials with no additives or natural additives only. This preference, however, is fundamentally not reflected in their consumer decisions. Product characteristics other than food additives such as sensory value, familiarity and not least the price are the major factors of food choice which suggests that consumers' actual actions do not follow principle preferences.

3.2.2.4. Sources of Information, Consumer Information

The series of questions regarding the *sources of information* and *consumer information* about food additives may provide important ideas for a more effective information strategy.

As far as the *perceived credibility* of sources of information is concerned, Hungarian consumers consider consumer organizations (4.05 on a 5-point scale), doctors (4.02) and public authorities (3.77) the most reliable. Among means of mass communication, the internet has the highest perceived credibility (4.41) while conventional media is less trusted. The crisis of confidence in foods is reflected in the fact that, besides hand-outs and chain letters, shops (2.56) and food manufacturers (2.78) have the lowest reliability in the respondents' views.

Men and those with a higher level of education are more sceptical towards most sources of information while the perceived credibility of most sources is rather diverse in different age groups.

The results of the question regarding the *importance of different sources in consumers' acquisition of information on additives* indicate that people obtain their knowledge from a large number of sources of medium individual importance. Currently, newspapers, magazines and books (69.8% mentioned), the internet (60.8%) and doctors (56.0%) are the most important sources, and besides these, food additives are discussed during private conversations also (55.9%/57.4%). Television and consumer organizations were mentioned by half of respondents while the rest of the information channels were marked by even less.

Women mentioned the majority of sources more often than men did; however, public authorities and food manufacturers were more important for men. Several differences in the role of information sources in consumers' orientation were found by age groups and level of education.

Most respondents *expect information* on food additives from doctors (79.8%) and consumer organizations (75.9%); the printed press (72.2%), the internet (67.8%) and public authorities (67.0%) were also often mentioned as preferred

sources of information. Generally, consumers prefer sources with higher perceived credibility.

Women and those with more education mentioned the majority of sources more often which indicates their greater interest in the topic of food additives. The preference of obtaining information was greatly diverse in the different age groups.

The *comparison of the percentages of current and preferred sources mentioned* indicates that consumers would like to receive more information than they currently get from nearly all sources. According to the respondents' opinion, public authorities, school education, food industry, consumer organizations and doctors should pay much more attention to providing people with information about food additives.

3.2.2.5. Consumer Segmentation Based upon Attitudes towards Food Additives Using Factor and Cluster Analysis

For a deeper understanding of consumer attitudes towards food additives, besides the conventional, demographical segmentation, a segmentation based upon consumer behaviour was also needed.

The segmentation based upon *consumers' knowledge and opinion on food additives* was carried out using the 40 attitude questions. In the first step, major trends of consumer behaviour were drawn using factor analysis; then using the 12 principal components obtained, cluster analysis was carried out. As a result, 5 consumer clusters were identified.

The smallest of all segments (9.7% of the sample) is the *Uninterested consumers*. These people are typically in their active wage-earners' age, most of them completed primary education only, and two thirds of them are males. The group was named after their fundamental disinterest in food additives, nutrition and shopping in general. The members of the cluster generally have poor knowledge of additives, and do not really desire more information, either. They are neither health nor quality conscious when choosing foods: sensory value, price, convenience and familiarity are more important for them. Accordingly, the majority of the group states that food additives have no impact on their food choice decisions.

Price sensitive consumers (22.2%) have typically primary education, with a very high proportion of the age group of pensioners. Their income is the lowest among all segments. They are interested in the topic of food additives but their food choice decisions are hardly influenced by additives: sensory value, price, familiarity, convenience and appearance are more important factors in their product choice. The respondents in this segment would like to get more information about food additives; they particularly emphasized the importance of doctors and consumer organization in informing consumers.

Health conscious consumers constitute the largest group (29.7%). Their demographical distribution is close to that of the base population with the proportion of women being somewhat higher. Their perceived income level is relatively low. They are interested and generally well informed in the topic of food additives. The respondents in this cluster prefer buying healthier (or considered healthier) foods, often over convenience factors and price, however, their financial

situation restricts their options. They show the greatest consciousness of food additives among all clusters: their aversions arise from presumed health impairing effects and unjustified use of additives. People in this segment definitely want to get more information about food additives; they named consumer organizations, doctors and public authorities as key players in informing consumers.

The demographical distribution of *Average consumers* (23.2%) is close to that of the base population in all variables with the proportion of people below 25 years of age being somewhat higher. They do not show any clearly differentiated opinion on food additives; the group's attitudes reflect the sample averages. Their decision factors generally reflect the average of the sample population with a greater importance of food safety. Food additives are claimed to have little impact on their food choice decisions. Despite this, they would like to get more information about the topic of additives; they would count on the printed media, the internet, doctors, consumer organizations and public authorities in the first place.

Quality conscious consumers (15.2%) are typically in their middle ages, are well educated (with twice as many people with college or university degrees than in the base population) with relatively high income. These respondents presented the deepest knowledge of food additives. The members of this segment pay attention to their shopping and nutrition habits: they strive to choose healthier products, and besides that, this group presents the decision strategy of searching for quality in the most emphasized way. Their food choice is claimed to be significantly influenced by additives, however, this preference is not due to health concerns but the better image of quality associated to more natural foods. People in this cluster definitely want to get more information about food additives; they would primarily rely on doctors, consumer organizations, the printed media, the internet and public authorities in informing consumers.

After reviewing the results from the cluster analysis it can be concluded that distinct groups were created using the attitude questions regarding food additives. Besides knowledge of and attitudes towards food additives, segments differed significantly in demographical characteristics, general consumer behaviour and food choice preferences, too.

However, the correlation analysis of the presumed additive content and consumption frequency of foods reveals that actual food choice decisions do not follow principle preferences even in the two groups claiming to be the most conscious: attitudes towards additives have only a slight impact on food choice in these segments, too. Results suggest that food additives are rather of symbolic importance for certain consumer segments. Exploring and utilizing target group attitudes towards additives may help differentiate marketing activity on the food market.

Additionally, it must be noted that knowledge of food additives showed great deficiencies even in the most informed groups. The numerous popular misconceptions on food additives propose the actuality and necessity of increasing knowledge and at the same time forming attitudes of consumers. Considering the segments' diverse preferences in obtaining information may be the foundation of a more effective information strategy in the future.

3.2.3. The Impact of Food Additives on Food-Related Consumer Behaviour

A number of models seeking to delineate the factors underlying general food-related consumer behaviour have been put forward in the literature.

The present model (Figure 3) summarizing the results from this research on professional and consumer attitudes towards additives describes the *impact of additives on the food-related consumer behaviour*.

The model basically suggests that although food additive only have a slight *direct* impact on consumers' food choice, their *indirect* influence (see dashed line) on consumer decisions exerted through other factors may be significant.

Food additives greatly influence *product characteristics*: composition, nutritional value, sensory appeal, practical properties, and shelf-life of foods, they have an impact on food safety and last but not least on the prices as well.

Product characteristics influenced by additives are connected to the *economical factors* of consumer decisions: the importance of the price in the product choice is greatly determined by the available income while the shelf-life of foods significantly affects their availability.

With the growing consumer consciousness, food additives take a more and more important place among *marketing factors* as well. Besides their role in the product image (number of additives used, natural vs. artificial additives), the labelling of additives (declaring E numbers vs. additive names, additive statements on the labels) is a very important issue as well; even some advertisements based upon the additive-free nature of the product concerned were presented recently.

Food additives are also strongly related to *health and physiological factors*. People showing hypersensitivity reactions to certain additives have to avoid the consumption of the additives concerned, and non-sugar sweeteners allow the reduction of the sugar intake, while certain additives (natural colours and natural antioxidants) have direct health protecting effects. Food additives may also help fulfil dietary goals: so-called light products manufactured using intense sweeteners and certain stabilizers allow the reduction of the daily calorie intake.

Consumer behaviour is greatly influenced by *psychological and social factors*, too. Lifestyle, values, taste, preferences, habits and experiences also determine the consumers' attitudes towards food additives at the same time.

Opinions on additives, however, react upon general consumer attitudes, thus influencing product choice decisions.

On the other side, consumer attitudes towards food additives are formed by *knowledge of additives* from different sources of information. Since the knowledge of Hungarian consumers about additives is rather deficient and there are several misbeliefs widespread in the public, informing consumers in a credible and simple way may be the key element in an effort to change current negative consumer attitudes towards food additives.

It must be noted, that the model described above based on the results of this research cannot be considered a validated model; it needs to be tested in the practice.

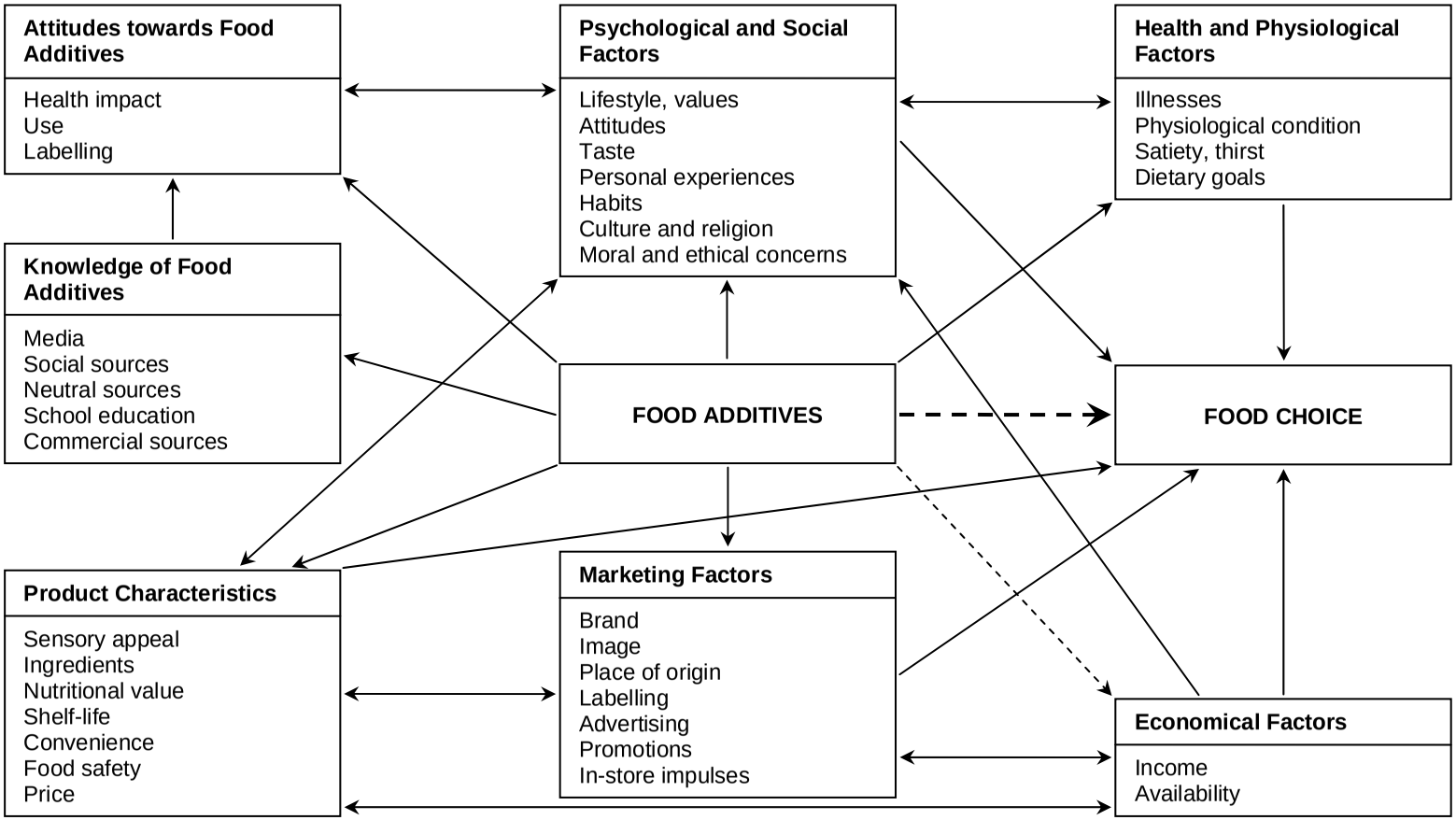


Figure 3: The impact of food additives on food- related consumer behaviour

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Consumer Attitudes towards Food Additives

Recent outbreaks of food safety scandals, coupled with the extensive use of artificial chemicals in agriculture and food manufacturing have severely undermined consumer confidence in foods. In the developed countries, the safety of food manufacturing and the healthiness of foods came to the forefront of consumer attention, with the use of food additives being one of the most important issues.

According to the results of the current research, most consumers have aversions to food additives; their use is often deemed as superfluous and detrimental to the health.

In some cases, consumer criticism about the technological justification of food additives is in fact grounded. Although food additives are difficult to spare in the modern food manufacture, some of the basic criteria of the use of additives (such as to be used for the benefit of the consumer and cannot mislead the consumer) are not always completely complied within the current practice. It has to be noted, however, that the use of food additives is also induced by consumer expectations regarding product characteristics and price.

Aversions to food additives reflect a broader fear of the increasing "artificiality" of the modern food supply, with consumers concerned about their lack of control over and knowledge of the ingredients in foods that they buy but no longer understand.

However, consumer fears of health impairing effects of additives are generally unfounded. Food scandals and food catastrophes leading to undermine consumer trust in foods were usually not related to the use or abuse of food additives. Food additives are appropriately tested, and as far as can be judged on the scientific evidence available, they present no hazard to the health of the average consumer at the level and conditions of proposed use.

Nevertheless, several additives can cause even severe hypersensitivity reactions in a very low number of sensitive individuals compared to the prevalence of other food allergies. Declaring additives on food labels allow sensitive individuals to avoid the additives concerned.

The most negative attitudes were experienced towards E numbers used for labelling additives. This finding deserves special attention since the purpose of establishing the E numbering system was the simple and definite identification of food additives in the multilingual European community.

Based on consumers' attitudes towards food additives, 5 distinct *clusters* were identified. Besides knowledge of and attitudes towards food additives, segments differ significantly in demographical characteristics, general consumer behaviour and food choice preferences as well. Utilizing target group attitudes towards additives may help differentiate marketing activity on the food market.

A significant proportion of Hungarian consumers value healthy foods made from natural raw materials with no additives or natural additives only. Consumers' actual decisions, however, generally do not follow principle preferences even in the segments claiming to be the most conscious about this issue. Food additives are

rather of symbolic importance for certain consumer segments, with other product characteristics and price being much more important factors in food choice.

4.2. Opportunities to Regain Consumer Trust

Regaining consumer trust in foods cannot be achieved without lessening groundless consumer fears of food additives which would be beneficial for food manufacturers, food retailers and food authorities as well. *This initiative, however, can only succeed with co-operation of all members of the food chain, using a multisectoral, harmonized, long-term strategy.*

Legislation

The *legislation* of food additives can only be effective if harmonized on a worldwide basis. JECFA and Codex Alimentarius play a crucial role in harmonizing legal decisions. At the authorization of food additives, technological justification should be considered more carefully, and the prohibition of misleading the consumer should be emphasized more than it is done currently. In this issue, some promising initiatives can be experienced in the upcoming new food additive regulation in the EU.

The results of the current research indicate that one of the most critical aspects of consumer opinions on additives is labelling, especially the E numbering system. Being unable to identify the certain additives, consumers feel that food manufacturers try to hide the actual composition of foods. According to current regulations, food additives can be designated by the functional category, followed by their specific name or E number. Most consumers, however, would prefer declaration of both the names and E numbers. The solution may be the mandatory declaration of E numbers while allowing manufacturers to add the chemical names as well.

Naturally occurring additives are definitely judged more favourably by consumers while the current legislation, including labelling regulations, does not differentiate by the origin of additives. Most consumers demand the introduction of a “Contains natural food additives only” food mark. In the opinion of the author and several experts interviewed, however, a better solution would be to reform the E numbering system to clearly reflect the origin of the additive concerned, e.g. by adding the mark of origin (N=natural, A=artificial) after the E number. Although the origin of an additive has no impact on its toxicological characteristics, introducing such a mark would encourage food industry to use natural additives which is considered a product benefit by consumers. However, it is questionable how the credibility of the marks of origin can be verified.

Another actual and important labelling issue of additive is the claims on labels regarding additives (e.g. no preservatives added) which seem to be more and more widespread with the growing consumer aversions to food additives. Such claims, suggesting that food additives are harmful contribute to consumer mistrust in additives and the food industry in general; and besides that, certain claims violate

the food labelling regulations as well. The solution would be a labelling regulation or recommendation developed in cooperation with industrial organizations, to include font size which is another aspect of labelling often criticized by consumers.

In order to inform consumers properly, it should be considered modifying the regulations on labelling foods sold without prepackaging and foods being packaged on the sales premises at the consumer's request (e.g. bread and bakery products of daily consumption or confectioneries primarily consumed by young children) in a way that the list of ingredients may be declared not only on the referring commercial documents but also on boards placed next to the foods or on the sales receipt as well. A great number of consumers and experts also propose that additives should be listed on restaurant menus as well, as seen in several other EU member states.

Public Authorities

Government authorities are responsible for controlling the compliance with the regulations on additives. There is a need to increase the frequency and stringency of official controls; its financial sources and laboratory conditions have to be developed. Public authorities should not only verify whether the additive used had been authorized; it should also be checked whether the use in certain foods or the level used was technologically justified. Additionally, more attention should be paid to control the labelling of additives as well, including the claims mentioned above.

Another important responsibility of public authorities is to provide consumers with information. According to the results of this survey, consumers greatly trust in public authorities, and they think that authorities should pay much more attention to informing the public about food additives.

Food Industry

Food industry has to play a key role in changing negative consumer attitudes towards food additives. The results of the current survey indicate that consumers are very critical regarding the current practice of food manufacturers. The use of additives often appearing to be too extensive and needless leads to consumer dislike for obvious reasons; consumers do not perceive that additives are used for their benefit. It is the consumers' natural expectation that the use of food additives be limited to the levels of technological necessity. According to recent experiences, however, the authorized levels are often exceeded accidentally (as a result of technological misconduct) or intentionally (to take advantage of their benefits) by food manufacturers. Food industry needs to pay much more attention to complying with the regulations by using only the necessary additives at the necessary levels. The responsible use of additives also means that food manufacturers do not try to gain market advantages by producing foods appearing more valuable through the use of additives.

The altered and often contesting demands of consumers, the food industry and the trade necessitate the modification of old technologies and the implementation of new ones. The ever increasing number of conscious consumers should make the food industry use minimal processing technologies conserving the original

nutritional value of foods, minimize the use of foreign ingredients through using natural additives rather than synthetic ones, and if possible, replace additives with technological methods (such as sparing preservatives by alternative preservations techniques) even if these foods are somewhat more expensive than their counterparts produced using conventional technologies.

Regarding the additive content of certain foods, most people showed greater awareness than expected; however, some extremely incorrect views were also discovered. Producers of more natural foods of lower additive content should place more emphasis on making consumers recognize the naturalness of their products, thus gaining market advantages over their competitors and the manufacturers of substitute products. However, during the communication of product benefits to consumers, attention must be paid to comply with the regulations, with special regard on claims about additives on food labels (see section *Legislation*).

Currently, the perceived credibility of the food industry is very low. Regaining consumer trust will be a great challenge to food manufacturers which can be best achieved by taking consumer concerns seriously and informing consumers truthfully. According to the results of the consumer survey, people would expect more information about additives from the food industry as well; however, the professional surveys have found that even if food manufacturers recognize the importance of informing consumers, they primarily consider it to be the responsibility of public authorities. Therefore, the first step should be to make food industry interested to inform consumers which may be greatly promoted by industrial organizations. The most effective way to reach consumers with messages regarding food additives would be through community marketing activities, in coordination with public authorities. There have been some promising initiatives in this matter recently.

With the growing consumer consciousness, food additives take a more and more important place in product development and product positioning as well. Exploring and utilizing target group attitudes towards additives may help differentiate marketing activity on the food market. The results obtained from the cluster analysis of the current research may help food manufacturers better fulfil consumer demands.

Trade

The current approach of the food industry cannot be changed without the cooperation of the *food trade sector*. Even against their own short-term interests, trade sector has to accommodate the more natural, less processed foods. Through their generally higher prices, these products would improve the long-term profitability of trade.

Additionally, food retailers may participate in consumer information programs as well; first, by making the list of E numbers available in the stores, and second, by declaring the list of ingredients of foods sold without prepackaging and foods being packaged on the sales premises on boards placed next to the foods or on the sales receipt, even if there is no legal obligation to do so.

Health Sector

According to the results of this research, the *health sector* would be the consumers' most preferred source of information about food additives; doctors have an outstanding credibility in the eyes of the people. However, the professional surveys have found that the health sector generally considers informing consumers about additives to be their own responsibility to even a less extent than food industry does. Ways need to be found to make the health sector interested in informing the public.

It must be noted, that the topic of food additives is hardly addressed in the Hungarian medical education. Thus, health professionals cannot be expected to provide consumers with credible information until they obtain appropriate knowledge of the subject.

Additionally, cooperation should be strengthened between doctors and dietitians; with the two groups of health professionals playing complementary roles and coordinating their efforts, they could benefit from each other and provide better service to consumers as well.

School Education

Passing basic knowledge of healthy nutrition and food safety to young generations should begin in the *school education*. Attracting the children's attention, increasing their knowledge and forming the right attitudes would ensure that this knowledge and practice being essential to our health become the part of everyday habits.

The low credibility of schools explored in this research presumably correlates strongly to the standard of education. Teachers should first master the knowledge they are supposed to pass on to the children, which suggests that a successful school education program on the subject implies work to do for the graduate and postgraduate education of teachers as well.

Consumer Organizations

Consumer organizations were found to have the highest perceived credibility; besides the food sector, most people would expect information on food additives from consumer groups. Food additives are one of the favourite topics of consumer organizations; they issued several publications dealing with the technological and health implications of additives. Some of these are scientifically supported, accurate works; however, probably due to the lack of relevant knowledge, some other publications are less appropriate to provide consumers with unbiased credible information on the subject. Consumer organizations should pay much more attention to the professional foundation of their opinion.

Media

Negative consumer attitudes towards food additives are also greatly fuelled by the activity of the *mass media*. In the fight for popularity, most media participants are forced to constant sensationalism, with food additives being a very suitable subject for attracting consumers' attention. Lessening groundless consumer fears of food

additives would be greatly facilitated by the credible, unsensational presentation of the topic in the media. Another important obstacle in the way of changing media attitudes is the lack of relevant professional knowledge of media participants; therefore it would be essential to improve communication and cooperation between journalists, scientific experts and public authorities.

4.3. Information Strategy

Consumer trust or mistrust primarily depends on the familiarity of consumers with the subject concerned.

As clearly indicated in this research, consumer fears arise from the lack of knowledge and reliable information, with the majority of consumers themselves deeming it necessary to receive more detailed information about food additives. In order to increase consumer consciousness, people need to be informed about the stringent authorization system of food additives, the purpose of their use and the meaning of E numbers. Besides emphasizing the proven safety of additives, however, the risk of food additive hypersensitivity must be addressed as well. Additionally, a message needs to be conveyed that the proper choice and handling of foods are much more important priorities in food safety and consumers' health protection than avoiding food additives that are authorized and safe.

Since the knowledge of consumers is of public interest, informing people on food additives should be a task coordinated by the government, with the active participation of and coordination between the food industry, food retailers, health sector, school education, consumer organizations and mass media, as a part of the information program on healthy nutrition and food safety. An effective information activity lies in the prior education of the participants.

Considering the distinct preferences for information of different consumer segments discovered by cluster analysis in this research would also improve the effectiveness of the information program.

Additionally, credible experts should respond much more frequently to lay or unprofessional views that often appear in the media, and have a significant influence on consumer attitudes towards food additives.

Internet should play a key role among channels of information, also counteracting the unverifiable rumours that are particularly widespread on the internet.

Regaining consumer trust would also be promoted by making the list of E numbers more available for the consumers, preferably in printed form, thus allowing the identification of food additives.

The author hopes that the results of this research will provide help in developing a more effective consumer information strategy.

4.4. The Consumer's Responsibility

Last but not least, *consumers* also have their own significant role to play. Consumers have to know what characteristics they can expect from the foods; they should realize that e.g. the colour of soft drinks and jams that is brighter than that of fresh fruit do not indicate higher fruit content but more colouring additives, the flavour and scent being more intense than that of raw material means more flavourings, the extreme long shelf-life often implies preservatives, and the manufacture of highly processed foods cannot go without using additives. If consumers set more realistic expectations, if they do not choose food with the most intense scent, colour and taste, and sometimes they are even willing to give up some convenience factors as well, through eating minimally processed more natural foods they will not only reduce the intake of additives but will also obtain foods that are healthier from all aspects. Consumers are strongly advised to study food labels in order to learn not only about food additives but about other ingredients and nutritional values as well, and utilize this knowledge in their food choice decisions.

The use of additives is strongly influenced by the effective demand for foods as well. Thus, it is a key-question that consumers (or at least certain consumer segments) must be able and willing to pay the often higher prices for foods containing less additives or natural additives instead of artificial ones, commonly requiring the use of more expensive raw materials, and costlier processing and packaging technologies.

With the convenient, tasty, and nutritious foods demanded by consumers and the increasing overall demand for foods as populations increase, food additives will continue to play an important and essential role in future food production. However, by announcing their opinion on different forums, and particularly through their food choice, consumers can make food manufacturers change today's trend of trying to gain market advantages by producing foods that appear more attractive and more valuable through the unjustified use of food additives.

5. NEW SCIENTIFIC AND METHODOLOGICAL RESULTS

5.1. New Scientific Results

1. Professional attitudes towards food additives were explored in the food industry, food authorities, the health sector and consumer organizations using in-depth interviews, focus group interviews and a questionnaire survey.

2. Consumer attitudes towards food additives were analysed using focus group interviews and a country-wide representative questionnaire survey of 750 respondents. The comprehensive research carried out in Hungary for the first time embraced consumer knowledge of additives, attitudes towards health impacts, use, labelling and legislation of additives, the importance of different sources of information in forming consumer opinions and the evaluation of

current consumer information about additives, and the influence of additives in consumer decisions.

3. Professional and consumer opinions on the perceived risk of food related factors, and the labelling, health impacts and use of food additives were compared.

4. Five consumer clusters were identified based upon knowledge of and attitudes towards food additives. Besides opinions on additives, the segments differed significantly in demographical characteristics, general consumer behaviour and food choice preferences as well.

5. A model summarizing the role of food additives in food-related consumer behaviour was established.

5.2. Novel Methodological Results

1. The theoretical background and practical implications of mixed-mode survey technique were analysed and the survey method was adapted to the Hungarian conditions.

2. A modified version of the index measuring annual food consumption frequency based on a 6-point scale was developed.

6. PUBLISHED PAPERS FROM THIS THESIS

Scientific Papers

Journal Articles in Hungarian

1. Tarnavölgyi G. (2010): Az édesítőanyagok technológiai és humánegészségügyi vonatkozásai. *Ásványvíz, üdítőital, gyümölcslé*, 11(1) (on-going)
2. Tarnavölgyi G. (2009): A tartósítószerek technológiai és humánegészségügyi vonatkozásai. *Ásványvíz, üdítőital, gyümölcslé*, 10(4) (on-going)
3. Tarnavölgyi G. (2009): Az élelmiszer-színezékek technológiai és humánegészségügyi vonatkozásai. *Ásványvíz, üdítőital, gyümölcslé*, 10(2) 19–26.
4. Tarnavölgyi G. (2009): Az édesítőanyagok technológiai és humánegészségügyi vonatkozásai – 2. rész. *Élelmezési ipar*, 63(8) 230–235.
5. Tarnavölgyi G. (2009): Az édesítőanyagok technológiai és humánegészségügyi vonatkozásai – 1. rész. *Élelmezési ipar*, 63(7) 217–222.
6. Tarnavölgyi G. (2009): Az élelmiszer-színezékek technológiai és humánegészségügyi vonatkozásai – 3. rész. *Élelmezési ipar*, 63(6) 164–167.

7. Tarnavölgyi G. (2009): Az élelmiszer-színezékek technológiai és humánegészségügyi vonatkozásai – 2. rész. *Élelmezési ipar*, 63(5) 133–136.
8. Tarnavölgyi G. (2009): Az élelmiszer-színezékek technológiai és humánegészségügyi vonatkozásai – 1. rész. *Élelmezési ipar*, 63(4) 97–100.
9. Tarnavölgyi G. (2004): Fogyasztói vélemények és dilemmák az élelmiszer adalékanyagokkal kapcsolatban. *Élelmiszer, táplálkozás és marketing*, 1(1-2) 107–113.

Journal Articles in Foreign Languages

1. Tarnavölgyi G., Molnár E. (2004): Food additives – consumer concerns and dilemmas. *Buletinul USAMV-CN*, 61, 274–279.
2. Tarnavölgyi G., Molnár E. (2004): Attitudes toward food additives in Hungarian consumers – preliminary results. *Acta agriculturae slovenica*, Suppl 1, 113–120.
3. Tarnavölgyi G., Berke Sz., Szente V. (2004): Consumer evaluation of food additives in Hungary – Az élelmiszer adalékanyagok fogyasztói megítélése Magyarországon. *Tejgazdaság*, 64(1) 48.
4. Tarnavölgyi G. (2003): Analysis of consumers' attitudes towards food additives using focus group survey. *Agriculturae Conspectus Scientificus*, 68(3) 193–196.

Full Text Conference Papers

1. Tarnavölgyi G., Polereczki Zs., Székely O. (2005): Az élelmiszeriparban használt fontosabb tartósítószerek humánegészségügyi vonatkozásai. "Real Competition – Competition in Sharp" Europe Day Conference, University of West-Hungary, Faculty of Agricultural and Food Sciences, Mosonmagyaróvár, Hungary, 5–6 May 2005. CD edition.
2. Tarnavölgyi G., Klenovics P., Molnár E. (2004): Az- élelmiszer adalékanyagok fogyasztói megítélésének vizsgálata a dél-dunántúli régióban. XXX. Science Days in Óvár, University of West-Hungary, Faculty of Agricultural and Food Sciences, Mosonmagyaróvár, Hungary, 7 October 2004. CD edition.
3. Tarnavölgyi G., Molnár E. (2004): Az E-számos adalékanyagok megítélése élelmiszeripari szakemberek, orvosok és fogyasztók körében, valamint a médiában. 6th International Conference on Food Science, University of Szeged, College Faculty of Food Engineering, Szeged, Hungary, 20–21 May 2004. CD edition.

4. Tarnavölgyi G., Bartos Sz., Molnár E. (2004): Az élelmiszer adalékanyagok E-számos rendszerének kialakulása, felépítése és működése, valamint fogyasztói megítélése. 6th International Conference on Food Science, University of Szeged, College Faculty of Food Engineering, Szeged, Hungary, 20–21 May 2004. CD edition.
5. Tarnavölgyi G., Molnár E. (2004): Consumer's opinions of food additives. Within the European Union – International Conference, University of West-Hungary, Faculty of Agricultural and Food Sciences, Mosonmagyaróvár, Hungary, 2004. május 6–7. CD edition.
6. Tarnavölgyi G. (2003): Judgement of food additives by food industry experts, doctors, consumers, and the media. 4th International Conference of PhD Students, University of Miskolc, Hungary, 11–17 August 2003. Vol. Agriculture, pp. 163–168.
7. Tarnavölgyi G. (2003): Az élelmiszeripari adalékanyagok E-számos rendszere, és gyakorlati érvényesülése néhány kiemelt élelmiszer példáján. IX. Ifjúsági Tudományos Fórum, University of Veszprém, Georgikon Faculty of Agriculture, Keszthely, Hungary, 20 March 2003. CD edition.

Conference Abstracts

1. Tarnavölgyi G. (2003): Az élelmiszer adalékanyagok fogyasztói megítélésének vizsgálata fókuszcsoportos felméréssel – Evaluation of consumers' judgement of food additives using focus group method. Lippay János – Ormos Imre – Vas Károly Scientific Conference, Budapest University of Economic Sciences und Public Administration, Faculty of Food Science, Budapest, Hungary, 6–7 November 2003. Abstracts – Faculty of Food Science, pp. 128–129.