Modelling of Avoidance of Food Additives: A Cross Country Study

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Food additives are strictly regulated and from technological point of view are useful ingredients. However, due to negative media news seeking for sensation, and sometimes irresponsible producer behaviour, utilization of food additives generates consumer aversion, thus shopping rejection. The present study examines the factors that influence consumers' motives and attitudes towards the avoidance of food additives. On the basis of a questionnaire survey a theoretical model was developed and applied by path analysis in three European countries (Hungary, Romania and Spain), respectively. Results suggested, that even though the avoidance of food additives (action) can be modelled identically, it can be influenced by different measures based on the country's specific features. For the grounding of the shopping decisions towards the avoidance of food additives it is important to decrease the perceived risk, to improve consumers' knowledge, as well as to take into consideration the peculiarities of the concerned countries.
Keywords: additives; food; shopping decision; consumer behaviour; risk perception

Introduction

Due to our changing lifestyles (e.g. more physically active lifestyle, increasing number of single households, the need for ready-to-eat and convenience foods), domestic food production and preservation are continuously surpassed, and at the same time, the importance of foodstuffs produced by industry with extended shelf-life is marked up. Foodstuffs must fulfil multiple consumers' expectations (e.g. large scale, to be convenient, attractive, affordable, healthy and wholesome, safe, chemical free, longer shelf-life) at the same time. One of the solutions to meet these complex and often conflicting requirements would be the use of food additives, which favourably influence the attributes of foodstuffs, facilitate the processing of the raw materials, improve the technological quality of food products and prolong their shelf-life. All food additives must be authorized before they can be used in food, and – in order to simplify and harmonise the labelling substances – an identical "E-number" is given to each. On the food label the additives marked by the name of its functional class, followed by its specific name, or its' "E-number" (1169/2011/EU). As consumers became quite concerned about the "E-numbers", without fully understanding their meaning and attributes, food producers prefer to mark the functional class and

the name of the additives to avoid "too many E-numbers" on the label, and to be perceived as "less artificial" (Evans et al. 2010). Furthermore, on the food labels several allusions regarding food additives (e.g. free from preservatives) try to captivate consumers' purchasing interest (Szűcs and Bánáti 2013). Since December 2008, food additives, food enzymes and food flavourings – also known as "food improvement agents" – are regulated by the Food Improvement Agent Package (FIAP) (1331-1334/208/EC). As food safety issues have gained importance throughout Europe (Bánáti and Lakner 2005), the safety of all food additives are assessed by the Scientific Committee on Food (SCF) and/or the European Food Safety Authority (EFSA). Only those additives which were considered safe are on the EU positive list. In spite of the fact, that the safety all authorised food additives has been thoroughly assessed, the European Commission (EC) called upon the European Food Safety Authority (EFSA) (1333/2008/EC), under Commission Regulation (EU) No 257/2010, to carry out a new risk assessment of food additives authorised before 20 January, 2009. As a result of the re-evaluation, the Acceptable Daily Intake (ADI) value of some additives have has been decreased (e.g. quinolone yellow (E 104), sunset yellow (E 110), ponceau 4R (E 124)) (EFSA 2009a, 2009b, 2009c) or was even withdrawn (Red 2G (E 128)) (EFSA 2007).

In spite of the rigorous legal regulations and supervision, more and more conscious consumers worry about the widespread application and safety of food additives, and try to avoid purchasing foodstuffs containing additives and/or try to consume products containing less food additives or which supposed to be "natural" (Pai 2011). A number of studies found, that according to consumers, food additives are considered as unhealthy components (Tarnavölgyi 2003; Honkanen and Voldens 2006; McCarthy et al. 2007; Ozer et al. 2009; Marián at al. 2011; Zugravu et al. 2017), which can cause cancer (Zagravu et al. 2017; Wardle et al. 2001) and allergic reactions (Marián et al. 2011; Christensen et al. 2011) in humans. At the same time, consumers are sceptic about the utilization of food additives, because they are not aware of their advantages. Consumers believe that these components are just used the processing of products, to increase producers' profit, that they are not safe enough, as well as their utilization is excessive and unnecessary (Christensen et al.

2011; Shim et al. 2011). Furthermore, consumers' mistrust is heightened by the damning of the use of food additives by the media, which often seeks sensational headlines, and consequently, disproportionately skews their drawbacks and negative aspects.

According to the results of the available European surveys, regarding food additives both high (Raats and Shephers 1996; Food Standard Agency 2015, 2016) and low (McCarthy et al. 2007; Röhr et al. 2005; Tobin et al. 2005) aversion was found. Based on the country comparison, the lowest level of concerns about food additives was found in Ireland (Röhr et al. 2005; Tobin et al. 2005) and in Sweden (Eurobarometer 2006a, 2010). Results of the Eurobarometer (2010) survey showed that in Hungary, for example, the rate of concern about food additives was high (81%), while in Romania (74%) and even in Spain (54%) it was much lower. Furthermore, a high rate of the Hungarian (82%) and Romanian (90%) consumers thought, that the foodstuffs and drinks could contain chemicals (Eurobarometer 2013) and for these consumers the avoidance of foodstuffs containing additives is an important element of "eating healthy diet" (Eurobarometer 2006b). Less Spanish consumers thought that chemicals can be found in foods and drinks (75%) (Eurobarometer 2013) and for them the avoidance of food additives is not a basic element at all, when they are thinking about a healthy diet (Eurobarometer 2006b). Differences in perception can be partly, due to the media news and scandals as well as the spreading of cheap, poor quality and additive-rich, so-called "as if" foodstuffs, combined with consumers' information from dubious sources (e.g. in Hungary and Romania) (Zugravu et al. 2017), while in case of Spain, the appearance of food additives in the media is not typical at all. Furthermore, Spanish consumers are satisfied with their consumption habits (Guerrero et al. 2012) and – in accordance with the information provided by mass media – they consider that their Mediterranean diet is healthy enough (Carrillo et al. 2011).

Recognition of consumers' risk perception about food additives, as well as exploration and understanding of the underlying thoughts and the hidden motivations, have an outstanding importance in the appointment of both the effective consumer communication ways and the directions of the producers' product development. Thus the main objective of this study was to

develop and apply a theoretical model in order to get detailed information about the factors affecting consumers' motives and attitudes towards the avoidance of food additives in different European countries.

Research framework and hypotheses development

Based on the models establishing the consumer food choice behaviour (e.g. Pilgrim consumer behaviour model, Shepherd food choice and intake model) (Pilgrim 1957; Shepherd 1999) and the results of studies conducted in the field of risk perception – because of the restricted results on the fields of food additives, most of them were about risk perception of new technologies –, and attitude formation, a theoretical model was developed. Avoidance of food additives' is the dependent variable and the "trust in the utilization of food additives", the "self-reported knowledge", the perceived "risk of food additives", the "risk of factors independent from food additives" and the "perceived health risk of food additives" are the intermediate variables in the model (Figure 1).

Knowledge referring to food additives

A number of studies verified, that better nutritional knowledge is associated with healthier food choice and dietary intake (Patterson et al. 1995; Wardle et al. 2000; Spronk et al. 2014). Respondents who had knowledge about wood-based food additives, evaluated those better, in contrast to those, who had wrong ideas about them (Stern et al. 2009), while Mucci et al. (2004) found higher purchase intent in case of participants, who had not or were not sure of having heard of GM (Genetically Modified) foods.

Chen and Li (2007) concluded that the knowledge had negative impact on the perceived risks of applying gene technology to produce food products. Results of Bredahl (2001) showed the weak effect of perceived own knowledge on the perceived risk, while the study of Martinez-Poveda and

co-workers (2009) indicated that more information resulted in higher level of perceived risk in case of GM foods. Based on these literature findings the following hypotheses are stated:

H1: High level of knowledge can influence consumers' intention towards the "avoidance of food additives".

H2: Increasing consumers' knowledge about food additives can decrease the level of the perceived risk.

Identification of the actual concerns of the public regarding specific food hazards showed a connection between the lack of knowledge and the perceived health risk (Miles and Frewer 2001). Based on these literature findings the following hypotheses are stated:

H3: There is presumably a positive connection between the "knowledge" and the "perceived health risk of food additives".

H4: There is presumably a connection between the level of "knowledge" and consumers' "trust in the utilization of food additives".

Trust

Several studies concluded that, trust in governmental institutions had an impact on the perceived risk, which resulted in an increased consumption intention (Chen and Li 2007; Prati et al. 2012; McCarthy and Vilie 2002). Based on these literature findings the following hypotheses are stated:

H5: The "avoidance of food additives" is influenced by the "trust in the utilization of food additives".

H6: A direct connection can be assumed between the "trust in the utilization of food additives" and the "risk of food additives".

H7: There is presumably a connection between the "trust" and the "perceived health risk of food additives".

Perceived health risk

The level of concern connected to the health status has found to have positive correlation with the perceived level of risk, thus it can be stated, that the more people are worry about their health, the higher the perceived risk is (Martinez-Poveda et al. 2009). Based on these literature findings the following hypothesis is stated:

H8: Positive correlation is expected between the worries about health and the "perceived risk".

Results of Zhang et al. (Zhang et al. 2012) demonstrated that one of the independent dimensions affecting significantly consumers' online purchasing behaviour is the perceived health risk. Consumers' purchasing intention is negatively affected by the perceived health risk. Based on these literature findings the following hypothesis is stated:

H9: "Avoidance of food additives" is directly influenced by the "perceived health risk of food additives".

Risk

The analysis of the public risk perception of food additives and food scares showed, that consumer attitude towards behaviour mediated by risk perception of additive safety, has a strong effect on the purchasing intention (Wu et al. 2013). Based on these literature findings the following hypotheses are stated:

H10: "Avoidance of food additives" is directly influenced by the perceived "risk of food additives".

H11: There is presumably a connection between the risk perception of "factors independent from food additives" (e.g. pesticides, antibiotics, genetically modified foods) and "food additives".

Attitude formation

It is important to understand, how consumer attitudes are formed. In social psychology there are two classes of theories on attitude formation: the bottom-up and the top-down approaches. These

describe two basic mechanisms, in which people form attitudes. The bottom-up formation implies, that the attitude towards an objective is formed according to the knowledge of it. The top-down formation refers to an attitude as embedded into a system of general attitudes and values (Grunert et al. 2004). These theories were used in many fields, like the analysis of consumer acceptance of genetic modification (Grunert et al. 2004; Scholderer and Frewer 2003), consumer attitudes to enzymes in food production (Søndergaard et al. 2005), and consumer perception of new technologies (Nielsen et al. 2009).

Materials and Methods

Data collection and sample

An internet-based questionnaire survey was conducted (snowball sampling) with the help of a questionnaire survey (Szűcs and Bánáti 2010) with the participation of three European countries (Hungary, Romania and Spain). Respondents decided their level of agreement on a 1 to 5 Likert scale (1: I do not agree – 5: I really agree) regarding the listed statements alluded to "avoidance of food additives", "health risk of food additives" "trust against the utilization of food additives" and "shelf-reported knowledge". Furthermore, level of the perceives risk in case of statements of "risk of food additives" and "risk factors independent from food additives" variables were measured on a 1 to 5 Likert scale, too (1: not hazardous at all – 5: really hazardous). According to cross-cultural researches, inaccuracies in the translation process are common (Su and Parham 2002). In order to achieve equivalence between the source version and the target version, a back-translation and a pre-test was performed in all three countries (Bullinger et al. 1993). As a first step, a bilingual translator made an initial translation from the source version (English) into the target version (Hungarian, Romanian and Spanish) (forward-translation). Then another bilingual translator – without access to the original source version – translated this material back into the source language (back-translation). To revise the conflicting meaning the back-translated version and the source version were compared. After the two versions were identical, the final questionnaire was tested (pretest)

with a small group of consumers (10-15 members per each country) (Su and Parham 2002; Lin and Chen 2001; Maneesriwongul and Dixon 2004).

The questionnaire survey target groups were consumers who purchase foodstuffs at least on a monthly basis. Finally, a total of 1171 adult (over 18 years old) respondents were recruited in Hungary (N= 437), Romania (N= 386) and Spain (N= 348). Demographic variables and their breakdown among countries are shown in Table 1.

Data analysis

In order to test the theoretical model, to create the variables of the model, a factor analysis was done in each country; however, the chi-square "goodness-of-fit test" did not show significant fitting and the resulted factors were not applicable. So as a next step, a principal component analysis (PCA) was done. Created components that did not load with a value higher than 0.25 were removed, and the PCA was re-run. The adequacy of the variables in the sample was measured with KMO (Kaiser-Meyer-Olkin) and Bartlett's Test of Sphericity. KMO ranges from 0 to 1, and accepted index is greater than 0.5. Bartlett's Test refers to the relationship between the variables, thus must be less than 0.05 (Hinton et al. 2004). For the characterization of the shape of the distribution Skewness (less than -1 or greater than +1 the distribution is highly skewed) data was used (Blumer 1979). Reliability of the variables was measured by Cronbach alpha. According to the literature review of Tavakol and Dennick (2011) the acceptable values of alpha are between 0.70-0.95. As the last step, by means of these principal components (variables), a path analysis was done which is a causality model for the understanding of the connections between the variables (Wright 1921, 1934). In fact, this method is the series of regression models where variables are linked with arrows which show the direction of the relationship (way). The intermediate variables can have a direct and an indirect (through other variables) effect on the dependent variable. The ways' β values (standardised partial regression coefficients or path coefficients) show the strength of the connection, as well as its' sign the "direction" of the relation between the two variables. Product of the intermediate variables' β

values results the strength of the independent way. Explained variance of the models are shown by R^2 value (how much of the total variation in the dependent variable is explained by the independent variables). For the data analysis IBM SPSS Statistics 24. was used (IBM Corporation 2016).

Results and discussion

Characterization of the model variables

The model variables were created by PCA and the results are presented in Table 2 and Table 3.

Explained variance of the dependent factor (*"avoidance of food additives"*) was found to be high in Hungary (57.3%) and Spain (56.1%), and by the principal component analysis almost half of the information content of the Romanian component was managed to keep (49.6%). In the Hungarian component the statement referring to the willingness of buying foodstuffs containing less "E-numbers" (0.843) and in Romania the less "food additive" (0.799) had the highest loading. Spanish respondents try to make strong efforts to give foodstuffs containing less "E-numbers" to their children (0.794). The statement referring to the purchasing habits about directly measured foodstuffs did not fit into the Spanish factor (communality ≤ 0.25), which can be due to the fact, that these products are not so common in the Spanish food shops. Strongly negative values of the Skewness data show, that Romanian participants took higher attention to the foodstuffs' additive content during their shopping decision, than the Spanish ones.

Component of "*risk of food additives*" – developed on the basis of the list of additives – explained variance values are high in Spain (58.0%) and in Hungary (57.1%), while in Romania a bit lower (49.5%). Factor loadings show different importance in the analysed countries. In Hungary, the "preservatives" (0.834), in Spain the "food additives" (0.825) and in Romania the "other food additives" (0.800) had the highest weight in the explanation of the factor. Negative Skewness values – mainly in Romania – suggest, that elements of the model variable were judged as rather hazardous by the respondents of the countries.

As consumers deemed "*risk factors independent from food additives*" to be more hazardous than food additives and their groups, it had a high importance to create a principal component from these elements and to analyse the created variable's effect in the context of consumer actions towards the avoidance of food additives. Expect of the Romanian component (41.6%), value of the explained variance exceeded 50%. In the Hungarian (0.802) and Romanian (0.744) factor loadings, the "chemical residues (e.g. pesticides)" had the highest weight, while in the Spanish the "chemical substances from environmental pollution (e.g. heavy metals)" (0.795). Based on the Skewness data listed factors were judged as really hazardous according to the countries' participants.

"*Health risk of food additives*" components' explained variance was over 50% in the analysed countries, moreover in Romania reached the 64%. Risks of cancer had the highest communality in Hungary (0.803) and in Romania (0.813), while in the Spanish sample the statement referring to the "digestive system problem" (0.868). Negative signal of the statement shows, that respondents assumed the permitted food additives as dangerous to their health. Some of the elements communality was low in the Romanian and Spanish component, so these statements were evident for the participants, thus they did not differentiate the answers to them. Negative Skewness values refer to the high scale values, thus respondents mainly agreed with the negative health effects of food additives.

The principal component analysing of the "*trust in the utilization of food additives*" had the highest explained variance value in Hungary (52.7%); however the Romanian (49.2%) and the Spanish (45.4%) variables retained a high information content, too. Statement referring the industrial utilization of the permitted food additives influenced the Hungarian (0.831) and the Spanish (0.742) components remarkably, while the trust in the labelling information influenced the Romanian (0.787) one. Differences among the analysed countries' level of trust are revealed by the Skewness data. In Hungary, but especially in Romania, plus values denote low scale values, consequently respondents had low level of trust in the food industry and in controlling authorities, in particular

the Romanian ones. On the other hand, negative sign of the Spanish Skewness value indicates agreement with the variables' statements, so suggests a positive level of trust.

The variable analysing the "*self-reported knowledge*" referred to high information content in Hungary (59.4%) and Romania (58.3%), as well as slightly less, but still notable in Spain (49.7%). The statement referring the adequate level of knowledge about "E-numbers", was the most dominant in the Hungarian (0.849) and in the Spanish (0.802) variable, while the level of knowledge about food additives in the Romanian (0.887). According to the Skewness data, the Spanish and the Romanian respondents agreed less with the statements, while the Hungarian participants on the contrary. In other words, Hungarian participants presumed to have higher level of knowledge about food additives than the respondents of the other analysed countries.

Application of the theoretical model

For checking the theoretical model a path analysis was done by means of the developed variables (principal components). In the crated models (Figure 2-4) the continuous lines show the significant connections ($p < 0.05$), while the dashed lines the non-significant ones ($p > 0.05$). Direction of the connections is presented with the help of the arrows, and the strength of the connections (β values) is indicated in a box for each lines.

Explained variance of the *Hungarian* model was high (51.7%), and this means that 48.3% other factors influence the dependent variable ("avoidance of food additives"). According to the model it can be stated that "self-reported knowledge" ($\beta_{H1} = 0.215$), "trust in the utilization" ($\beta_{H5} = -0.328$), "perceived health risk of food additives" ($\beta_{H9} = 0.272$) and "risk of food additives" ($\beta_{H10} = 0.292$) had a direct impact on the shopping decisions towards the "avoidance of food additives". "Trust in food additives" had the strongest influence on the dependent factor ($\beta_{H5} = -0.328$), thus by increasing the level of "trust" related to producers and controlling authorities, the "avoidance of additives" can be decreased (top-down attitude formation). However, it is important to note, that the "self-reported knowledge" had positive impact on the dependent factor, too ($\beta_{H1} = 0.215$), thus

increasing the level of consumers' knowledge with the help of understandable and accurate information can also have an effect on the attitude formation (bottom-up way). The strongest indirect connection in the model was between the "trust in the utilization" and the "perceived health risk of food additives" (β_{H7} = -0.613). Hence, the high level of "trust" in the authorities and producers can decrease the "perceived health risk of food additives", thus consumer actions towards the "avoidance of food additives" (β_{H9} = 0.272). Furthermore, it should be noted, that the "self-reported knowledge" had strong positive impact on the "trust in the utilization" (β_{H4} = 0.410), so by increasing the level of knowledge, the level of trust can be enhanced. The "risk of food additives" can be decreased by increasing the level of the "shelf-reported knowledge" (β_{H2} = -0.184) and the "trust in the utilization" (β_{H6} = -0.323), as well as by lowering the perceived risk of the "factors independent from food additives" (β_{H11} = 0.211) and "health risk" (β_{H8} = 0.391). However, the model did not verify the significant connection between "self-reported knowledge" and "health risk of food additives". Thus, except of H3, all Hypothesis were supported by the Hungarian model (Figure 2). Results of the Hungarian model showed conformity with several studies (Stern et al. 2009; Mucci et al. 2004; Chen and Li 2007; Martinez-Poveda et al. 2009; Prati et al. 2012; Wu et al. 2013).

The *Romanian* model explained 30.1% of the variance in the main effects on the dependent variable. "Self-reported knowledge" (β_{H1} = 0.435), "trust in the utilization" (β_{H5} = -0.258) and "perceived health risk of food additives" (β_{H9} = 0.211) were all found to be significant contributors to consumers' actions towards the "avoidance of food additives", while the direct impact of the perceived "risk of food additives" was not confirmed. As "self-reported knowledge" (β_{H1} = 0.435) had the strongest impact on the dependent factor, the attitude formation based on authentic and plain information (buttom-up) would be favourable in Romania. Perceived "risk of food additives" is influenced only by the "perceived health risk" (β_{H8} = 0.177) and the "risk of factors independent from food additives" (β_{H11} = 0.590). Analysis of the indirect ways showed the positive impact of the

level of "shelf-reported knowledge" on the "trust" (β_{H4} = 0.192), which can decrease the "perceived health risk" (β_{H7} = -0.324) and thus influence consumers' actions towards the "avoidance of food additives" (β_{H9} = 0.211). Thus expect of H2, H3, H6, H10, other Hypothesis were supported by the Romanian model. The findings of the Romanian model were in consonance with the results of several studies (Stern et al. 2009; Martinez-Poveda et al. 2009; McCarthy and Vilie 2002; Zhang et al. 2012) (Figure 3).

Figure 4 shows the model applied to the *Spanish* data, which explained 50.3% of the variance in the main effects on consumers' actions towards the "avoidance of food additives". The direct effects indicate that "shelf-reported knowledge" (β_{H1} = 0.309), "perceived health risk" (β_{H9} = 0.429) and "risk of food additives" (β_{H11} = 0.388) were all positive contributors to the "avoidance of food additives". But the "trust in the utilization of food additives" did not have significant direct impact on the avoidance. This means, that Spanish consumers shopping decisions related to food additives cannot be influenced by raising the level of "trust in the utilization of food additives" (top-down attitude formation). However, the knowledge based bottom-up attitude formation found to be effective influencing of consumers' actions towards the "avoidance of food additives". Analysis of the indirect paths showed, that "trust in the utilization" was positively impacted by the "self-reported knowledge" (β_{H4} = 0.206), which decreased the perception of "health risk" (β_{H7} = -0.255) and "risk of food additives" (β_{H3} = -0.243) and thus influenced the "avoidance of food additives" (β_{H9} = 0.429). Furthermore, rising the "self-reported knowledge" has a favourable effect on the "perceived health risk" (β_{H3} = -0.270), which though the "risk of food additives" (β_{H8} = 0.365) influence the "avoidance of food additives" (β_{H10} = 0.388). The model demonstrated that "risk of factors independent from food additives" had an impact on the "risk of food additives" (β_{H11} = 0.306), which means, that "risk of independent factors" reduce the perceived "risk of food additives", and thus influenced the "avoidance of food additives". Except H2 and H5, all Hypothesis were supported by the Spanish model.

Pathways of the Spanish model were in line with several literature findings (Stern et al. 2009; Mucci et al. 2004; Chen and Li 2007; Martinez-Poveda et al. 2009; Miles and Frewer 2001; Prati et al. 2012; McCarthy and Vilie 2002; Zhang et al. 2012; Wu et al. 2013).

As food additives often generate consumer revulsion, which manifests in their shopping decisions, the analysis of the provoking motivations is reasonable.

Modelling of consumer motives showed country specific features. The loadings of the dependent factors show, that the avoidance of food additives had more important role in the Hungarian and Romanian consumers' shopping decisions, while less in the Spanish ones. It can be due to the fact, that food additives and their possible risk is a common topic of the Hungarian and Romanian media, while in Spain it is not typical at all. Furthermore, Spanish consumers are satisfied with the quality of their diet (Guerrero et al. 2012; Carrillo et al. 2011) and do not assume that it can contain harmful substances (Eurobarometer 2013).

Hungarian participants high levels of distrust against the food producers and the controlling authorities were traceable in the model, as for them, trust had the strongest impact on their shopping decisions (top-down formation of attitude). Furthermore, the level of trust is an important influencing factor in the Hungarian participants' perception of health risk and risk of food additives. As the positive impact of the Hungarian participants' knowledge about food additives was not identified in the model, it can be concluded, that their subjective knowledge is quite doubtful and questionable. According to the principal component analysis, Romanian respondents thought to have low level of knowledge about food additives; however its' high importance was identified in their shopping decisions regarding food additives (bottom-up formation of attitude).

Consumers gain information about food additives not only in the media (e.g. internet, tabloids), but also from food labels, due to the labelling regulation (1169/2011/EU). Furthermore, the topic of food additives awakens the interest of a narrow consumer segment, thus integration of the topic into broader issues (e.g. healthy nutrition recommendations and healthy meal preparation) and

comprehensive information distribution (e.g. via teachers, doctors, dieticians, health visitors) can be a useful tool. In sum, supporting consumers on how to avoid information overload and cognitive stress has a high relevance.

As a common result it was found, that by supporting consumers' knowledge, the trust in producers and controlling authorities can be moderate, which would decrease the "perceived health risk", thus the risk perception of food additives (Martinez-Poveda et al. 2009), as well as it would favourably impact consumers' shopping actions towards the avoidance of food additives (Zhang et al. 2012). In addition, there is a strong connection between the risk perception of food additives and other risk factors related to foodstuffs – mainly in Romania. It can be stated, that consumers' distrust is complex, it goes beyond the food industry (e.g. utilization of food additives) it covers farmers (e.g. pesticides, pathogenic mould and myctoxins) and animal husbandry (e.g. antibiotic residues), too. This result denotes again that communication about food should focus on the whole matrix, not just on one component. Last, but not least, the created models pointed out the importance of the level of knowledge, which has an impact on the shopping motives of the analysed countries' consumers (Stern et al. 2009).

Conclusion

The models developed – based on the literature overview – for the analysis of the factors affecting the avoidance of food additives were checked – by path analysis – with the help of a questionnaire survey conducted in three European countries. Based on the data, it was concluded, that the avoidance of food additives (action) can be modelled identically; however, it can be influenced by different measures based on the country specific features related to the examined question. Even though the survey pointed out several common and country specific conclusions, further analysis of the topic would be relevant. In spite of the fact, that the explanatory power of the developed models was moderately high, identification of the effects outside of the model (e.g. environmental aspects), as well as the analysis of the model effects in case of sensitive consumer groups (e.g. young

mothers) can hide further valuable information. The present study aimed to test the theoretical model with the help of regular food purchasers.

In order to reduce consumers' aversion regarding food additives and increase their overall trust, the food chain members' endeavour is indispensable. Safety re-evaluation of food additives is a promising step by the relevant authorities. The food industry has an undoubted importance in the qualitative food supply of consumers. Thus, review of the rate of the application of food additives in the supply chain is reasonable. For the reduction of the amount of food additives used, revision of the recipes from the point of view of a reasonable shelf-life and commercial needs (e.g. storage time) is necessary. Supporting consumers' healthy food choice and understanding their needs, so determining the influencing factors can have a key importance. For the avoidance of the one-sided communication and the information overload of consumers, integration of this topic into broader issues (e.g. healthy nutrition recommendations or healthy meal preparation) and comprehensive information distribution would be useful. Last but not least, consumers' open-mindedness and willingness is also important in changing their diet and present consumption habits.

The present study does not contain the possible impact of the different socio-demographic profiles on the tested models. Analysis of these requires further research.

Disclosure statement

The authors report no conflicts of interest.

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Table 1. Demographic profile of respondents by country in percentages (N= 1171)

		Hungary	Romania	Spain
Gender	Female	69.3	75.6	59.5
	Male	30.7	24.4	40.5
Age	18-24 years	30.4	47.7	7.2
	25-44 years	52.9	40.9	48.3
	over 45 years	16.7	11.4	44.5
Place of residence	Big city	71.4	75.9	74.1
	Small city	13.3	13.2	10.3
	Village, other	15.3	10.9	15.5
Type of household	Single	16.2	11.1	11.8
	Living with spouse/relatives	43.4	49.7	67.5
	Multigenerational family	23.8	21.2	15.8
	Other (e.g. dormitory)	10.5	17.9	4.9
Highest level of education	School leaving examination	14.2	15.3	46.0
	Higher educated	85.8	84.7	54.0
Level of income	Below average	21.5	10.9	9.5
	Average	55.6	59.3	76.4
	Better than average	22.9	29.8	14.1

Table 2. Factor loadings of the elements of the principal components (N= 1171)

Hungary	Romania	Spain
Avoidance of food additives		
I rather buy foodstuffs containing less "E-numbers".		
0.843	0.789	0.749
I rather buy foodstuffs containing less food additives.		
0.837	0.799	0.759
I am willing to pay more money for a foodstuff which contains less "E-numbers".		
0.829	0.738	0.770
If there are more than 5 'E-numbers' on the list of ingredients, I do not buy the foodstuff.		
0.822	0.788	0.787
I am willing to pay more money for a food additive free foodstuff.		
0.822	0.726	0.767
If there are more than five food additives on the list of ingredients, I do not buy the foodstuff.		
0.822	0.796	0.782
I prefer products which state that no additives are included.		
0.814	0.611	0.684
For my child I try to give foodstuffs containing less "E-numbers".		
0.735	0.646	0.794
Whenever I can I always consume organic foodstuffs.		
0.661	0.548	0.702
There are some food additives which I consciously avoid.		
0.642	0.646	0.726
I try to avoid the directly measured (loose) foodstuffs, because in that case I cannot check my food additive intake.		
0.596	0.652	n/a

There are some “E-numbers” which I consciously avoid.		
0.587	0.658	0.710
Risk of food additives		
Preservatives		
0.834	0.681	0.769
Sweeteners		
0.806	0.678	0.720
Other food additives (e.g. gelling agents)		
0.781	0.800	0.778
Flavourings		
0.770	0.757	0.719
“E-numbers”		
0.762	0.622	0.748
Gases of the modified atmosphere in food packaging		
0.743	0.575	0.738
Artificial preservatives		
0.736	0.742	0.804
Food additives		
0.687	0.754	0.825
Artificial sweeteners		
0.670	0.679	0.747
Risk factors independent from food additives		
Chemical residues (e.g. pesticides)		
0.802	0.744	0.755
Antibiotics and hormones in meat and milk		
0.798	0.595	0.741

Substances migrating from the packaging materials into the product		
0.783	0.643	0.739
Pathogenic mould and myctoxins in food above the permitted level		
0.696	0.655	0.747
Pathogenic microorganisms in food		
0.686	0.618	0.725
Chemical substances from environmental pollution (e.g. heavy metals)		
0.682	0.727	0.795
GMOs in foodstuffs		
n/a	0.505	0.505
Perceived health risk of food additives		
Excessive food additive consumption can cause cancer.		
0.803	0.813	0.755
One reason for the more frequently occurring allergies may be the foodstuffs' additive content.		
0.759	0.813	0.730
Those who suffer from digestive system problems have to consume less food additives.		
0.751	0.799	0.868
Children have to consume less food additives, so more attention have to be paid to them.		
0.693	n/a	0.840
Food additives can be harmful for health.		
0.627	n/a	0.617
Permitted food additives in general do not pose danger to our health.		
-0.611	n/a	n/a
Trust in the utilization of food additives		
Food industry only uses permitted additives.		
0.831	0.762	0.742

I believe that labelling information reflects the truth.		
0.781	0.787	0.702
Food additives have an important role in foodstuffs, they cannot be missed out.		
0.721	0.666	0.652
The amount of food additives used by the food industry is safe.		
0.703	n/a	0.607
Utilization of food additives is reasonable, otherwise producers would not add these to make foodstuffs more expensive.		
0.657	0.537	0.638
Official control is rigorous enough to control the utilization of food additives.		
0.648	0.725	0.693
Self-reported knowledge		
I have adequate knowledge about "E-numbers".		
0.849	0.865	0.802
I have adequate knowledge about food additives.		
0.833	0.887	0.703
I know 'E-number' that is not harmful.		
0.792	0.576	0.774
I know food additive that is not harmful.		
0.776	n/a	0.689
I know food additive which can cause allergy.		
0.570	0.684	0.525

n/a not applicable data (communality ≤ 0.25)

Table 3. Criteria of the developed principal components (N= 1171)

	Explained variance	**Skewness**	**Cronbach's alpha**	**KMO**
Avoidance of food additives				
Hungary	57.3%	-0.177	0.929	0.854
Romania	49.6%	-0.663	0.903	0.792
Spain	56.1%	-0.040	0.921	0.850
Risk of food additives				
Hungary	57.1%	-0.162	0.904	0.881
Romania	49.5%	-0,634	0.868	0.867
Spain	58.0%	-0.340	0.908	0.902
Risk factors independent from food additives				
Hungary	55.2%	-1.706	0.829	0.837
Romania	41.6%	-2.239	0.747	0.815
Spain	51.9%	-2.314	0.818	0.854
Perceived health risk of food additives				
Hungary	51.5%	-1.185	0.789	0.796
Romania	64.6%	-1.880	0.724	0.682
Spain	58.8%	-0.859	0.821	0.774
Trust in the utilization of food additives				
Hungary	52.7%	0.024	0.818	0.804
Romania	49.2%	1.400	0.731	0.739
Spain	45.4%	-0,111	0.757	0.725
Self-reported knowledge				
Hungary	59.4%	-0.537	0.808	0.676
Romania	58.3%	0.108	0.719	0.671

Spain	49.7%	0.108	0.719	0.671

Bartlet's Test of Sphericity ≤ 0.001

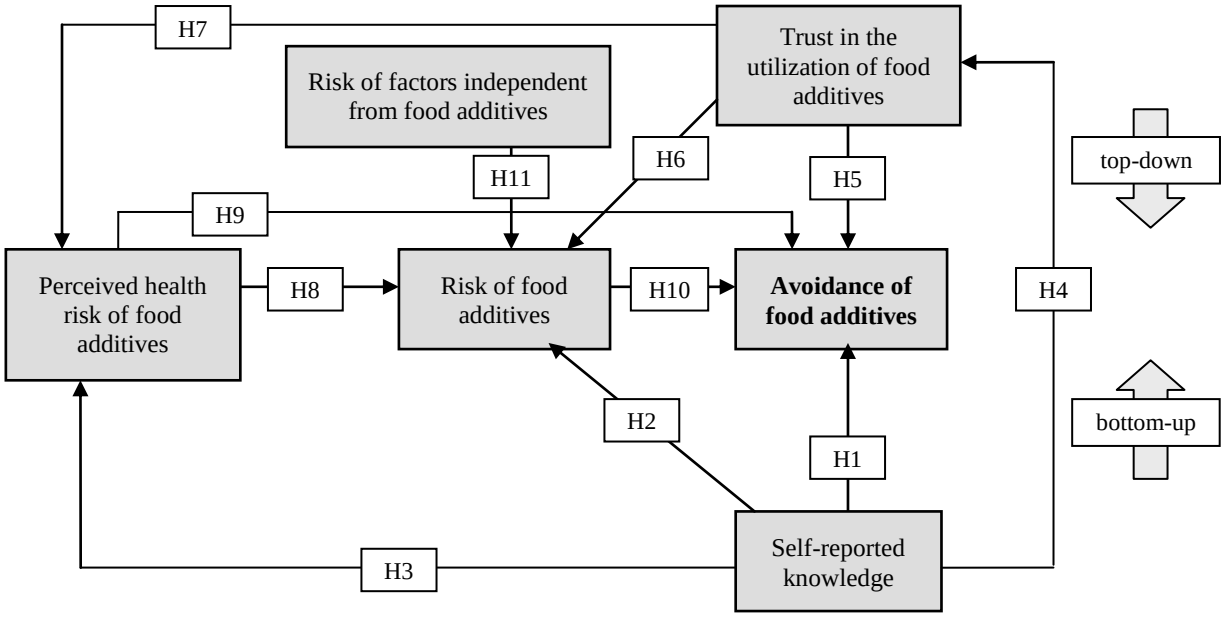

Figure 1. The theoretical model of the avoidance of food additives

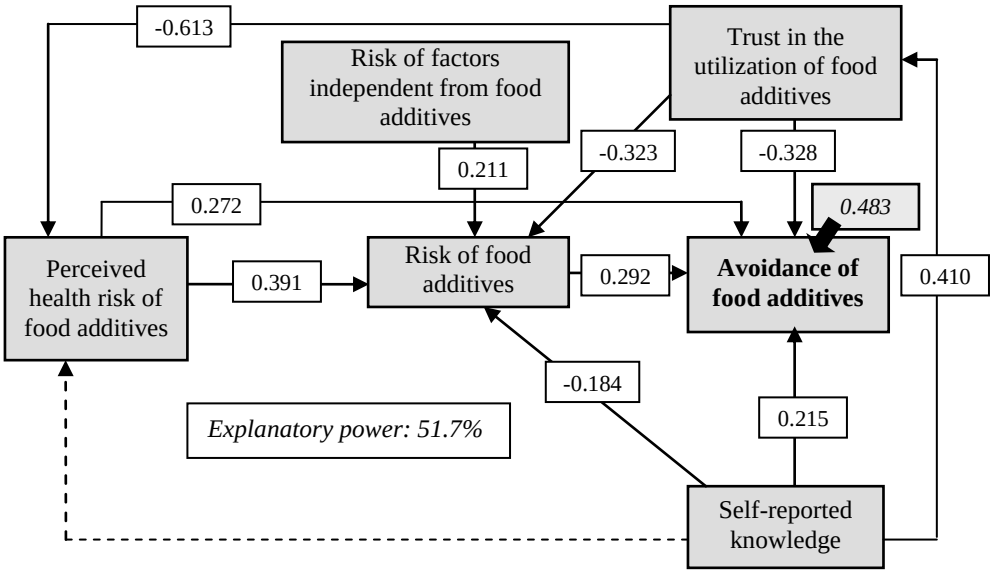

Figure 2. Pathway model of the factors affecting the avoidance of food additives in Hungary

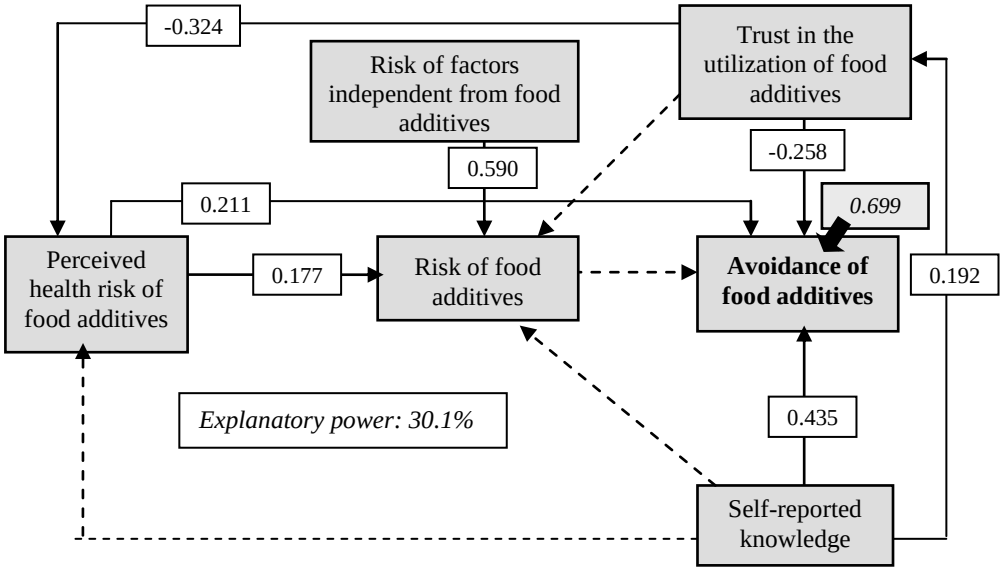

Figure 3. Pathway model of the factors affecting the avoidance of food additives in Romania

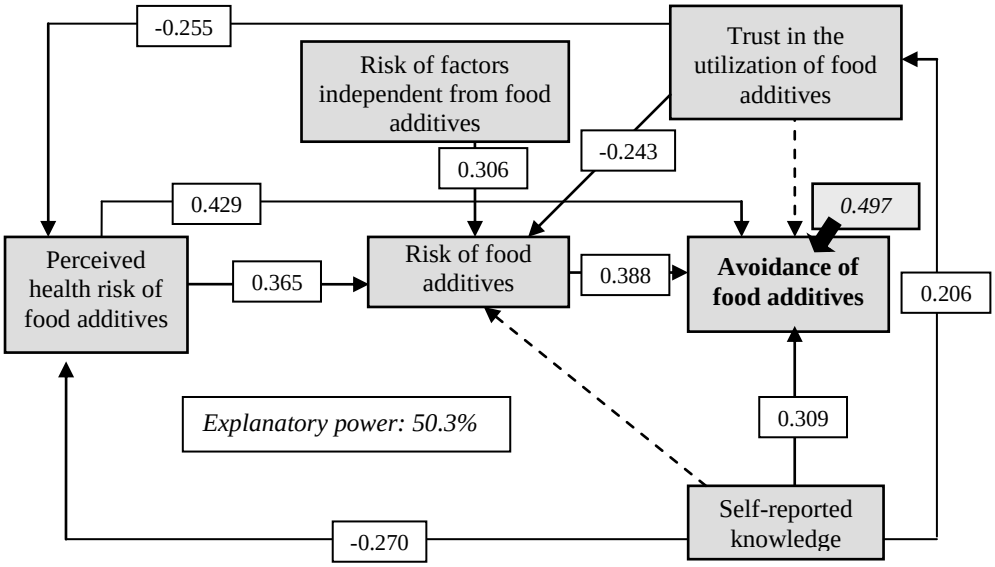

Fig. 4. Pathway model of the factors affecting the avoidance of food additives in Spain