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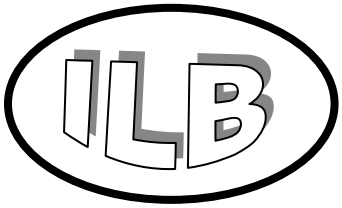

Consumer Perception of the Use of High-Pressure Processing and Pulsed Electric Field Technologies in Food Production[1]

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Introduction

New food processing technologies are developed on a continuous basis. While food scientists may applaud the progress of science, consumers have been known to take a more conservative approach and do not always readily see the benefits of new processing methods. As learned from earlier examples (such as GM and irradiation), the advantages that a new processing technology has to offer do not necessarily guarantee the success of a product in the market place. If consumers do not perceive the benefits of a new technology as relevant, its application is threatened. For example, studies of consumer attitudes towards GM foods have found that consumer acceptance depends on whether consumers perceive specific benefits associated with the product (Frewer et al. 1996; Frewer et al. 1997). Hence, a benefit that is perceived only to be in the interest of the manufacturer is not sufficient.

This paper examines consumers' attitudes towards apple juice produced by two new food processing technologies, high-pressure processing (HPP) and pulsed electric field processing (PEF) in four European countries.[2] Products produced by these technologies are soon to be introduced on the markets in Europe on a larger scale. Therefore, from a managerial point of view it is interesting to learn more about how consumers perceive food products produced by these novel processing technologies.

Theory

The study is based on "Means-end chain" theory. Means-end chain theory has recently been applied in consumer research to study the motivations underlying consumer purchasing decisions. The theory of means-end chains argues that consumer attitudes and product preferences can be explained by how consumers mentally link perceptions of product attributes to the attainment of basic life values through self-relevant consequences (Gutman, 1982; Olson, 1989). Hence, means-end chains build the link of individual consumers´ perceived connection between product attributes, the tangible positive outcomes associated to these (*functional consequences*), personal outcomes which pertain to the individual psychological realm or relationship with other people (*psychosocial consequences*) and values. This is interesting since a number of studies support the basic assumption of MEC theory that product attributes, which are associated with personal values influence product preference more than attributes which are not (e.g. Reynolds et al. 1985; Bech-Larsen et al. 1996).

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1. This study is performed as part of the EU project NovelQ
2. For a short description of HPP and PEF see appendix

So product attributes are means through which consumers achieve their values, via the positive consequences or benefits accruing from the attributes. In other words consumers do not only buy products because of the product characteristics but these have desirable consequences which can satisfy underlying needs. By analyzing the link between the consumer and the product the means-end approach attempts to reveal the often hidden motives behind consumer choices. This can aid e.g. product managers to get a better understanding of which characteristics of a product the consumer perceive to be desirable/undesirable, the consequences associated with these and how these may help consumers to achieve higher order goals. The principle of means-end-chains is illustrated below by the example of skim milk, where one can see that an important attribute of skim milk is that it is low in fat. This means fewer calories and has the consequence that it is easier to stay slim, which is important because it means social acceptance, which again leads to more self-confidence and higher self-esteem.

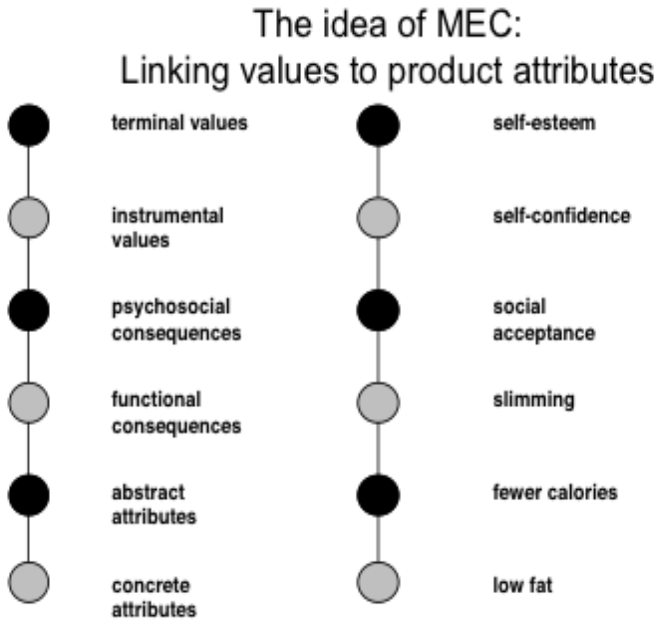

Figure 1. The idea of means-end chain

Methodology

Through laddering interviews with 30 consumers in Denmark, Norway, Hungary and Slovakia the objective is to study consumer attitudes towards a product produced by PEF and HPP. Laddering is a semi-structured qualitative interview technique (Reynold & Gutman, 1988) designed to measure means-end chains (MEC).

Respondents were presented with three juice cartons and asked to study them for as long as they liked. The three cartons were labelled with the same design and only differed in the description given about the processing method, one processed by conventional method (pasteurization), one processed by PEF and one by HPP, as well as in the nutritional values declared. The processing

method was also stated clearly on the front label (e.g. PEF treated). The respondents were then asked to rank the three products of apple juice from the product they found most appealing to the product they found to be the least appealing. Further, the respondents were asked to elaborate on the reasons for the ranking of the three products. Based on these elicited product attributes the interviewer followed up with a series of "why is this important to you" type of questions to get the respondent to build "ladders" ranging from product attributes to personal values. This resulted in one or more ladders per respondent for each of the three products. After completing the fieldwork the laddering data were categorized into attributes, consequences and values. Through meaning-based interpretation of all individual mentioned concepts the data were then coded into broader categories.
The section below will report the results from the analyses of the aggregated respondents´ ladders and present these in hierarchical value maps. Hierarchical value maps (HVM) are cognitive maps illustrating the connection between product attributes, consequences and values for a number of respondents. To aid the data analysis and produce hierarchical value maps the software "Mecanalyst" was used. Ideally, all links between categories should be portrayed in the maps. However, this would make them uninterpretable, so a trade off has to be made between richness in data and interpretability. Therefore links between categories are only portrayed in the map to the extent that they were mentioned by some minimum of respondents. This number varies from country to country and from product to product. So the hierarchical value maps are produced with different cut-off levels based on the interpretability of the maps.

Results

The results provide insight into which attributes consumers associate with a product processed by PEF and HPP and a pasteurized juice and how these product attributes are related to more abstract personal values. The results are presented first, per product for all countries, secondly, an analysis of north versus east European respondents is performed, since it is also interesting to compare results on a cross-national level.

Product preferences

When looking at which product was preferred by respondents the HPP treated juice was selected most frequently. This is an interesting result since it indicates that consumers are positive towards juice produced by a new method that they consider to offer an advantage over a traditional processing method like pasteurization.

HPP juice

As can be seen from figure 2, the most frequently mentioned attribute when asked why do you prefer this product was "high content of vitamin C". This was considered to be particularly important because it lead to the consequence of "being more healthy". Another attribute that was considered to lead to a healthier body was that the product did not contain any additives or sugar. An interesting result is that "gentle processing method" is also perceived as leading to the consequence of a healthier body. That health is a very central consequence is also seen in that it is connected to a large amount of personal values. To be healthy was considered to be important for a number of reasons; naturally it was considered important because it was desirable to live a long and healthy life. But health was also considered to be important because it influence family´s well being, improve quality of life and made one feel good about self. Some respondents also mentioned that it was important to be healthy because when you are healthier you can achieve more in life.

Figure 2. HPP juice - all countries

The high content of vitamin C was also by some respondents considered important because it meant that they could avoid taking vitamin tablets. It was also mentioned that high intake of vitamin C would influence positively the level of fitness and endurance.
A second central attribute is "preserves taste". HPP processing was mentioned as preserving taste which was perceived as influencing the naturalness and freshness of the product. Many respondents mentioned that they imagined it would be almost like eating a real apple. This was perceived to be important because it had the consequence of more enjoyment and in the end contributed to having more fun and pleasure in life.
Finally, that the processing method was perceived to be environmentally friendly was important because it is good for nature and many respondents mentioned it was important for them because they felt responsible for nature.

Cross-national comparison

When comparing the HVM for north and east European respondents (appendix figure 4 and 5) taste is central in both cases. The main difference is in that in Norway and Denmark (north) respondents believed that the juice taste/smell like fresh, natural apples due to that the HPP method preserves taste. In Hungary and Slovakia (east) the respondents saw this as a result of that the juice was not made from concentrate, rather than due to the method. Also it is worth noting that the north European consumers point to that "taste/smell like fresh natural apples" has the consequence that it is perceived as making you healthier. This indicates that there is the perception that fresh and natural is not only associated with taste but also with healthiness. Healthiness is of course a very central consequence for both north and east European consumers. This is in particular due to that the product is perceived as containing a high amount of vitamin C. The difference lies in the values that are associated with healthiness. In both cases

healthiness is also seen as having the consequence of "better work performance". So it is considered important to be healthy because then one can perform better at work. Doing well at work is important for different reasons, for the east European respondents this is related to achievement. For the north European respondents it is instead associated with feeling good about yourself and stimulation, i.e. being able to have an exciting and varied life.

An interesting result is that in the two east European countries the "hearth of the technology is mentioned" with the attribute "made with pressure". Also the North European respondents mention the method directly by noting that it is an unknown method. This could imply something negative but this does not seem to be the case since "unknown method" is linked directly to the value "long healthy life". In the same manner the east European respondents point to the consequences of "being healthier" and to the value "security". This is an exciting result because it implies that although the method makes use of high pressure and is unfamiliar, respondents associate it with a positive consequence as health and values such as security and a long healthy life.

That the method is environmentally friendly is considered important for both east and north European respondents. The main difference is that in the case of the north European respondents the fact that the method is good for the environment is considered important not only because on feel responsibility for nature but also because one feel responsible for other people as well as for mankind in general (i.e. future generations).

PEF juice

A number of positive attributes were mentioned in connection with the PEF juice. As was also the case for the HPP juice the attribute that was most frequently mentioned was that the product contains a high amount of vitamin C. Again this was considered important because it had the consequence that one would be healthier. Further, it was considered important to be healthy because it meant one would live a long and healthy life, it would increase own and family´s well-being and generally improve the quality of life.
As was also the case for the HPP juice the method is seen as environmentally friendly and this is considered important because it is good for the environment and in harmony with respondent's feeling of responsibility for nature. In the same manner it is mentioned by a number of respondents that the method preserves taste, which gives more enjoyment and in the end contributes to a more fun and pleasurable life.
Where we see the biggest difference between the perception of PEF and HPP is that where the HPP juice was merely associated with positive consequences, this picture is more nuanced in the case of PEF. While respondents appreciated some product attributes of the PEF treated juice, as can be seen in figure 3 there is also skepticism expressed in the product attribute "made with electrical impulses" and "unknown method". Electrical impulses is raised as an issue of concern since respondents are unsure of what are the long term consequences for the body when consuming food products treated with electricity. It is an unknown method and there is a lack of information of what exactly this method does to the product and how it influences the product.

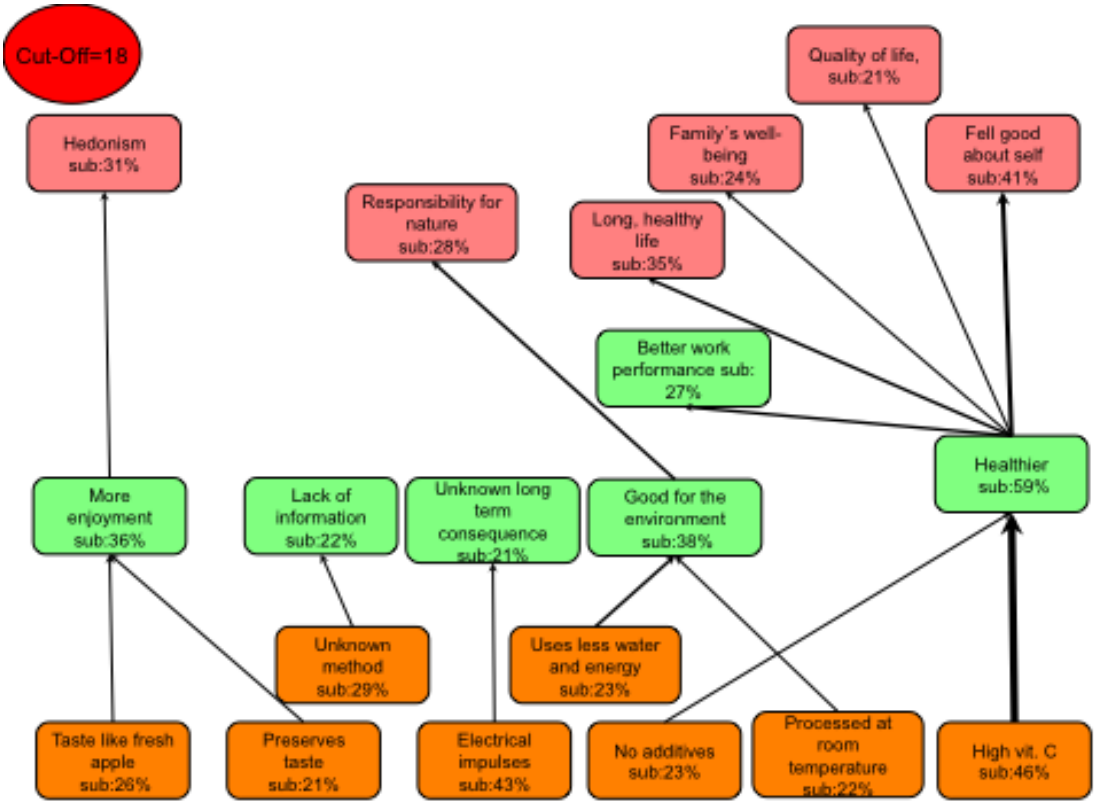

Figure 3. PEF – all countries

Cross-national comparison

When we compare the two HVM (figure 6 and 7 in appendix) for Norway/Denmark and Hungary/Slovakia we see that the skepticism towards PEF stands out even stronger. The east European respondents mention that the fact that the product is produced by electrical impulses makes you less healthy and that they feel unsure about what are the long-term consequences of consuming the product. There are also a number of respondents who feel that they are unfamiliar with a method that uses electrical impulses and therefore they have less trust in the product. Also the north European respondents react to the fact that the product is produced by electrical impulses which gives rise to fear that this may leave something in the product. So although both groups of respondents are skeptical towards that the method works by electrical impulses, it seems that the east European respondents are more concern about this. When looking at figure 7 we see that the attribute "electrical impulses" is mentioned by 60% of subject (where only 25% of north European respondents have mentioned this) and there are also a higher number of consequences linked to this in the HVM for Hungary and Slovakia.

Pasteurized juice

As was also the case for the PEF juice the pasteurized juice is evaluated as offering a mix of benefits and disadvantages. On the positive side is that it is a well-known method and consequently the product is trusted and considered to be a safer product to consume. Health is again a central theme and here the product is evaluated both as contributing to better health but also as resulting in a less healthy body. It is considered to lead to a healthier body because of two things, the product is produced by a well-known method and because it does not contain any additives (natural product, no sugar or additives is added). A healthy body is important because

respondents would like to have a long and healthy life and because they would like to feel good about themselves. The negative impact on health is caused by the attribute from concentrate. As the only one of the three products the pasteurized juice was made from concentrate. This was evaluated as influencing both taste, quality and the nutritional quality of the product. It was considered by some respondents as a lower quality product than the two other products which were not made from concentrate. Also the taste (although respondents did not taste the product) was evaluated as artificial and less natural. That the product had lower content of vitamin C was also noticed by a number of respondents (content of vitamin C was stated on the nutritional label) which was negative since the perceived consequence of this was that it would lead to a less healthy body.
As the only product, shelf life shows up as an important attribute. The pasteurized juice has a longer shelf life than the HPP and the PEF treated juice. This is perceived to be positive since it has the consequence that one does not have to go shopping very often which leaves more time for other things, such as spending time with family and engaging in sport and other hobbies.

Figure 4. Pasteurized juice – all countries

Cross-national comparison

That the product has a long shelf life is only mentioned by the east European respondents (figure 8). Also it stands out that the consequence of a longer shelf life is not only that you save time but you also save money, because there is less waste and it is possible to buy the product on sale and store it for later consumption. As can be seen in figure 9 the north European respondents on the other hand also find it important to save time in shopping but see this as a consequence of that a well-known product is fast to choose at the supermarket. A well-known product does not require that you spend a lot of time studying the product label and trying to understand a new processing technology.

As was mentioned above many respondents mentioned that the attribute "made from concentrate" had the consequence that the product was of a lower quality. In the case of the east European respondents this is seen as having the consequence that it can no longer replace 1 serving of fruit and vegetables. For the north European respondents, "made from concentrate" has the consequence that it is perceived as a more artificial tasting product. The interesting effect to notice here is that it is not only the fact that the product contains less vitamin C that is perceived to lead to a less healthy body but also the artificial taste is considered to have an effect on health.

If one study the HVM constructed on the basis of the Danish and the Norwegian data one will see that it is somewhat confusing that there is an approximately equal share of respondents mentioning that the pasteurized juice contains less vitamin C and that it has a high content of vitamin C. This can be explained by the fact that in the design of the study it was decided that the pasteurized juice presented to the respondents should be comparable to the standard on the local market. In Hungary, Slovakia and Denmark this was considered to be a good quality juice made from concentrate, in Norway it was considered to be a juice that was not made from concentrate. In Norway this had the effect that there was no big difference in the vitamin C content of the pasteurized product compared to the two products produced by the new processing methods. This Norwegian effect is also seen with regard to the taste that is also described by some respondents as well preserved most likely because the product is not from concentrate.

Conclusion

Based on the results of this study it seems that consumers do recognize and appreciate the benefits that food products produced with HPP and PEF has to offer. The respondents in all four countries that participated in our study associated positive consequences with product attributes related to the nutritional value and the taste of the products produced with these novel technologies. Also the environmental benefits from processing foods by applying these technologies were seen as highly positive characteristics of the technologies. Having said this there was also in all four countries skepticism towards the PEF treated juice, since it was an unfamiliar method.

Hence, providing consumers with more information about the technologies seems to be a key to achieve consumer acceptance of products manufactured by means of these new technologies. This appears to be especially important in the case of introducing PEF products, since many consumers associated the name of the technology with electricity, and were sceptical about what the side effects of using electricity in food production might be. This consumer scepticism towards pulsed electric field processing (PEF) is also supported by a previous study on consumer attitudes towards HPP and PEF technologies (Nielsen et al. 2009). Hence, it is the responsibility of food producers and food scientists to provide the evidence that will convince consumers that this technology is safe to use in connection with food processing. Such information provision should occur in the early phases of introduction of these new technologies, as research on GMO acceptance has shown that information may have the opposite of the intended effect once attitudes have become more stable (Scholderer & Frewer, 2003).

In conclusion, there seems to be good reason for doing further work on the development of PEF and HPP, as consumers see potential in these products. What is still missing in research on PEF and HPP technologies is to examine consumers' trade-off between various product attributes, e.g. price, taste, shelf life and nutritional value. When actual PEF and HPP products will become available in Europe it will also be interesting to examine consumer attitudes and behaviour towards PEF and HPP products in real-life situations and also to do sensory evaluations.

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Appendix

Description of HPP and PEF

High Pressure Processing is a method for processing food products without using heat. The product is subjected to pressure that inactivates most micro-organism, by damaging cell components such as cell membranes. Pulsed Electric Fields is a food processing method that, like HPP, works without the use of heat. Electric impulses are sent through the object damaging cell components and deactivating/inactivating most of the micro-organisms.

Both HPP and PEF retain food quality and natural freshness, they produce nutritious and safe-to-eat foods and extend microbiological shelf life without using chemical additives. Products produced with HPP or PEF are expected to result in products that are 10-20 % more expensive than the products that are on the market today.

Figures

Figure 4. HPP juice – North European respondents

Figure 5. HPP juice – East European respondents

Figure 6. PEF juice - North European respondents

Figure 7. PEF juice – East European respondents

Figure 8. Pasteurized juice – North European respondents

Figure 9. Pasteurized juice – East European respondents