

## Consumers' Acceptance and Attitude towards Bioactive Enriched Foods

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### ABSTRACT

The aim of our research was to explore the consumers' attitude towards healthy diet and food consumption and measure the acceptance of these types of products on the product portfolio developed in PATHWAY-27 projects. The benefit of the experiment was to have a better understanding on HTAS based questionnaire with using real prototypes of bioactive enriched foods with potential health claims. The results showed clearly, that unusual appearance and flavour have negative effect on the opinion of the product and the positive health effect also increases the acceptance of the products.

**Keywords:** *HTAS; functional foods; sensory test; bioactive enriched foods*

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### 1 Introduction

Non-communicable diseases (NCDs) have shown high prevalence in the last decades. Four main types of non-communicable diseases are cardiovascular diseases (like heart attacks and stroke), cancers, chronic respiratory diseases (such as chronic obstructed pulmonary disease and asthma) and diabetes.

These diseases are responsible for the death of 38 million people each year. Cardiovascular diseases account for most NCD deaths, or 17.5 million people annually, followed by cancers (8.2 million), respiratory diseases (4 million), and diabetes (1.5 million) (WHO, 2015).

World Health Organization determined the main forces which drive these diseases, and unhealthy diet, lifestyle and physical inactivity is among them. Dietary recommendations and nutrition education campaigns have tried to increase the awareness toward the relationship between health and the content of diet.

Because of that changes in consumers' food choices have been detected, today food not just satisfies hunger and provides the necessary nutrients for individuals but also helps in prevention of nutrient-related diseases and contributes to the improvement of well-being.

The changes in consumer trends influences the new product development. Food and drink industry constantly tries to satisfy the consumers' demand. The most important factor in determining food choice is taste. Consumers seek appetising and delicious food products. The healthy content of each product in most cases is generally found to be second to taste (Steptoe & Pollard, 1995; Contetno, et al. 2006). Furthermore, foods touted for their healthful properties are perceived as poor tasting. Taste is enhanced by ingredients that are

over consumed by most consumers – sweeteners, salt and fat. Consumers may even have expectations that unhealthy food (i.e. food high in fat, sweeteners and salt) tastes better (Thunström & Nordström, 2012).

In the framework of PATHWAY-27 EU funded project, bioactive enriched foods (BEFs) were developed. Bioactive compounds used for the enrichments caused unusual sensorial characteristics in all developed products.

Aim of our research was to estimate the value of the sacrifice the consumers willing to make in order to consume healthy products.

## 2 Methods

### 2.1 Tested products

In PATHWAY-27, six products were developed. Bakery matrix includes biscuit and bun, the dairy products were combined dessert and milk shake and egg-based products were pancake and omelette. All products were presented in 5 variation. Three bioactive components and their combinations were used as enrichments, namely beta-glucan (BG), anthocyanin (AC) and docosahexaenoic acid (DHA) (Table 1).

Table 1: Products presented during the tasting session

Matrix type	Product	Enrichments*
Bakery products	Biscuits	5 enrichments (BG; AC; DHA; BG+DHA; AC+DHA)
	Buns	5 enrichments (BG; AC; DHA; BG+DHA; AC+DHA)
Dairy products	Combined dessert	5 enrichments (BG; AC; DHA; BG+DHA; AC+DHA)
	Milk shake	5 enrichments (BG; AC; DHA; BG+DHA; AC+DHA)
Egg-based products	Pancake	5 enrichments (BG; AC; DHA; BG+DHA; AC+DHA)
	Omelette	5 enrichments (BG; AC; DHA; BG+DHA; AC+DHA)

\*beta-glucan (BG), anthocyanin (AC) and docosahexaenoic acid (DHA)

### 2.2 Sensory assessment

For the sensory profiling, a trained sensory panel was used. Assessors were selected and recruited, trained in compliance to ISO standards. Continuous panel performance and monitoring techniques were also in place to ensure all assessors maintain a high level of competence. The samples were evaluated by using descriptive profiling. Assessors were trained to recognise different quality levels of the key attributes. 8 assessors assessed the blind coded samples in 2 replicates according to the experimental design (Williams Latin square) in randomized order to minimize the possible carry over effects. For each attribute, each assessor scored the product on a 0-9 category scale. The test was carried out in a sensory laboratory. Each assessor was required to undertake the tests in an individual booth. The panel used filtered water as palate cleansers between the samples.

### 2.3 On-line survey

The Health and Taste Attitude Scales (HTAS) based questionnaire consisted of four parts (Roininen et al., 2001). First part contained socio-demographic questions (e.g. age, sex etc.). This part is not explained in this article. Second part included questions related to attitude, behaviour of the consumers towards health and diet. Questions related to attitude towards functional foods were in the third part of the questionnaire. In the fourth part, photos were presented to the consumers to evaluate the appearance of the experimental samples developed in PATHWAY-27. A 9-point hedonic scale was used to measure the liking. 360 consumers filled the on-line survey developed by Compusens-at hand®.

### 2.4 Tasting sessions

The 3 different product matrixes (bakery, dairy, egg) were evaluated by different 120-120 participants, who were consumers of the product type and willing to try out new foods and drinks. Participants received full briefing about the test procedure and the type of the products.

The samples were presented individually, according to the experimental design (Williams Latin Squares). The same codes were used for all respondents. The milk shake and the combined dessert were served in pre-coded white coloured plastic cup, the bakery and egg products on pre-coded plastic plate. Mineral water was provided for the respondents as palate cleanser between each sample.

The questionnaire contained questions on overall attributes of appearance, aroma, flavour and texture. These questions had a 9-point hedonic scale, where top of the scale (9 point) indicates the highest liking and bottom of the scale means the disliking. Beside the main attributes, the extended list contained specific attributes as colours (e.g. yellow, purple), aromas (e.g. cereal, baked dough, vanilla), flavours (e.g. sweet, sour, egg), aftertaste or textures (e.g. thickness, softness or crispness) to score. These attributes were scored on a JAR (just about right)-scale, which is a 5-point scale where

- the middle point means 'just about right'
- the left part of the scale means that the attribute is evaluated as too low, and
- the right side of the scale indicates that the intensity of the attribute is too high.

In addition they were asked to indicate how much they liked the product in overall, even considering the healthiness of the product, and how they are likely to buy the products.

## 2.5 Methods of evaluation

### Analysis of Variance

The hedonic data were analysed by using analysis of variance (ANOVA) to determine if there were significant differences between the samples with respect to preference. A two way (respondent, sample) ANOVA was performed. Following ANOVA, a Tukey multiple comparison test was undertaken to establish which samples were different at the 5% level of significance. Samples marked with the same letters are not significantly different from each other.

### Cluster analysis

In order to identify respondents, who had similar attribute utility patterns, cluster analyses were used. These were determined by performing Ward's Hierarchical cluster analysis and observing the agglomeration schedule.

### Software

XL-STAT and FIZZ statistical softwares were used for evaluation of the data.

## 3 Results

### 3.1 Results of the on-line survey

#### 3.1.1 Result of the Cluster analysis

Cluster analysis was performed on the questions included in the second part of the questionnaire. Those questions were aiming the attitude and the behaviour of the consumers towards health and diet. After examining the dendrogram, 3 clusters were considered to be adequate. Splitting the clusters did not provide new clusters with different pattern, and merging the clusters resulted loss of clusters with different behaviour pattern. Three clusters of respondents were identified with similar attitude towards health related questions (Figure 1).

Cluster 1 included 175 respondents (49%), Cluster 2 included 67 respondents (19%), and 118 respondents (33%) belong to the third cluster.

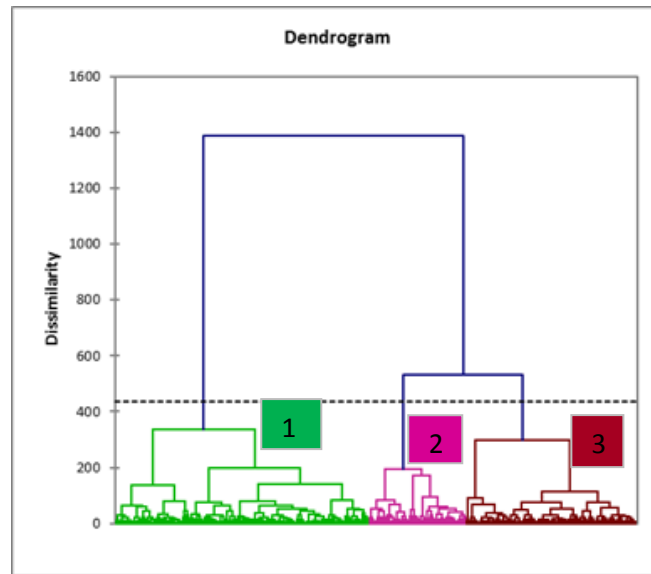


Figure 1: Dendrogram of the cluster analysis

All consumers consider themselves as health conscious, but the level of that which tell them apart.

Respondents in Cluster 1 can be described as ‘*extreme health conscious consumers*’. Their health is a centre point of their life, always examine their status and visit regularly their doctors. Notwithstanding, they do not consider very important the composition of their food: higher vitamin and mineral content, additives and artificial flavourings had slight impact on their food choices.

Cluster 2 included consumers who pay attention to their health and diet, however they strive for *delicious food consumption*. Furthermore, they are more particular about the composition of the food. They prefer meals with high vitamin, mineral content and low cholesterol/fat level and try to avoid additives in their food.

Cluster 3 is a *transition between Cluster 1 and 2*. These consumers are also health conscious, they try to follow healthy diets, and although they priority the composition of the food, the enjoyment of food also has an impact on their food choices. They prefer if their food contains high quantity of vitamins and minerals, and organically grown vegetables just as Cluster 2. They try to avoid consuming processed food and food with additives.

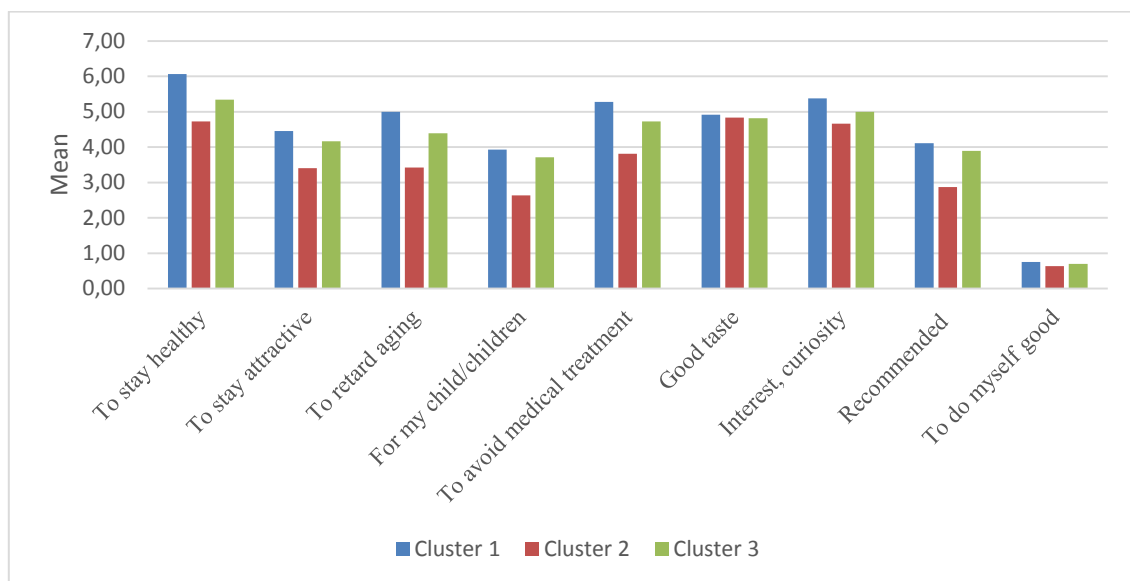


Figure 2: Reasons of purchasing foods with health benefits

Within the survey the key drivers of purchasing products with health claims were also identified such as “to stay healthy”, followed by “to avoid medical treatment” and “good taste” in all the three clusters (Figure 2).

This suggests that food with health claims has not only to be “functional”, i.e. have an effect on the health and well-being of consumers, it has also to be “food” in that consumers expect it to taste good. The main results matched the conclusions reported in several studies such as Mintel in UK, 2013; by JRC SCIENTIFIC AND TECHNICAL REPORTS, 2008. At the JRC study the reasons for not buying “functional” food were investigated and showed a very heterogeneous picture in the examined four EU countries (Spain, Germany, UK, Poland), including general concerns about novel food, bad taste, preference for organic food, focus on the present rather than on the future, absence of illness, fear of side effects, aversion towards artificial additives, distrust of effectiveness and price.

### 3.1.2 Results of the tasting sessions – Acceptance of the BEF products

The aim of the tasting session was to evaluate the consumers’ acceptance towards the developed BEFs. In order to have a clear picture about the food products developed in the project different approaches were used, such as products were shown on images, were tasted by consumers and sensory assessors, etc. The type of enrichment influenced the acceptance of the products. Using penalty analysis, we identified those attributes which had high impact on the overall liking of the tested products, but this is not part of this article.

#### 3.1.2.1 Sensory assessment

##### *Buns*

The buns could be divided into two groups regarding their colours of crust and crumb. The samples enriched with AC had a brown and lilac in colour crust and crumb. Buns with DHA and BG had yellow in colour crust and crumb.

The samples had moderate cereal, baked dough and anise aromas. Buns enriched with DHA had slightly stronger cereal and baked dough aroma than the other buns. Sample with AC had the most intense anise aroma from all samples. Off-note, fish aroma or other aromas were not mentioned.

The samples had cereal, sweet and anise flavours with slight bitter aftertaste. Regarding anise flavour the same trend appeared than aroma: buns with AC had the most intense anise flavour. Off-flavour, fish flavour or other flavours were not mentioned. The samples with DHA had significantly crustier crust and less easy to chew and soft textures.

##### *Biscuits*

All biscuit samples were uneven sized and baked unevenly which influence the colour of the samples. The samples enriched with AC were lilac and brown in colour biscuits, while DHA and BG containing biscuits were yellow and brown in colour samples.

All sample had moderate cereal and sweet biscuit aromas, biscuits with BG had significantly stronger sweet biscuit aroma than the other samples. All DHA containing biscuit had slight fish aroma, and samples with AC had weak anise aroma. Off-note or other aromas were not mentioned.

All sample had sweet and baked dough flavours. Biscuits enriched with AC and BG had the most intense sweet and baked dough flavours. The weak anise flavour was mentioned regarding biscuits with AC mostly. Off-flavour or other flavours were not mentioned. Biscuits enriched with AC and BG were very hard to chew and crispy and had less residue in the mouth.

##### *Pancakes*

Pancakes with AC were deep lilac in colour with slight brown tone while samples enriched in DHA or BG (or their combination) were yellow in colour pancakes with slight brown tone.

The pancakes had sweet, egg aromas, from all samples BG enriched versions were the sweetest pancake samples. All three pancakes with DHA had fishy tone and pancakes enriched in AC had burnt aroma as well.

All pancakes had sweet, egg and slight salty flavours. Samples with DHA also had fishy flavours. Pancake enriched in BG had the strongest sweet flavour. Pancake with BG and DHA+BG had spongier texture than the other samples.

#### *Omelette*

As the chilled products, frozen omelettes also can be grouped by their colour: Samples with AC was blue in colour with slight brown and grey tone while the other three omelettes was yellow in colour. The most intense yellow colour was belong to the omelette enriched in DHA. All sample had slight brown tone from the preparing and they were also slight grey in colour. Omelette enriched in AC was slightly wrinkled.

All omelettes had mild egg aroma. Omelette enriched in DHA had significantly stronger egg aroma compare to the others. Some fishy note was also mentioned during tasting of samples enriched in DHA. Omelette with BG had sweet and baked egg aroma as well.

Samples had egg and salty flavours. Omelettes with AC and DHA+AC had the most intense salty flavour, while samples enriched in DHA had the strongest egg flavour. Fishy note was also perceived in case of omelette with DHA. Omelettes with AC was significantly drier and less dense compared to the others. The densest textured samples were omelettes enriched in DHA and DHA+BG.

#### *Combined desserts*

As powders AC was intense lilac in colour, and DHA had the most intense yellow colour as powder, DHA+AC together was grey in colour powder. After preparing, the samples with AC were lilac in colour, the other three sample was yellow and grey in colour combined desserts. Except from AC, all products contained lumps as powders and as ready to consume products as well. The dessert with DHA was the less homogenous sample.

All powder had the aroma which refer to the origin of the bioactive component: AC had slight grape aroma; DHA had fish aroma; BG had grain aroma. In cases of the combined powders, the fish aroma was also perceived. After preparing, the aroma of Mont Blanc dessert dominated over the powders' aroma. The samples had vanilla and caramel aromas. The very weak fish aroma of the DHA enriched samples were also perceived, while the AC enriched desserts lost their grape aromas.

All BEFs had sweet, vanilla and caramel flavours from the Mont Blanc dessert. Main difference between the samples were the floury flavour, samples with BG had the most intense floury flavour and weak vanilla and sweet flavour. Desserts enriched with DHA had weak fish flavour.

Combined desserts enriched with BG left a very sticky mouth feel, and they had the grainiest texture. Same as the appearance enriching desserts with DHA resulted products with small-sized lumps.

#### *Milkshake*

The main difference between the samples was the intensity of the colours as powders and as ready to consume products. While the milk shakes enriched with AC were lilac in colour, the samples containing DHA and BG were yellow in colour. Adding beta-glucan to the samples resulted slight greyish appearance. The milk shakes with DHA were the less homogenous samples, small sized lumps appeared in the powders and the prepared milk shakes as well.

All powder sample had vanilla aroma, however in cases of samples enriched with DHA and DHA+AC, fish aroma was also perceived. The ready to consume milk shake samples also can be described as products with vanilla aroma, but weak fish aroma was only perceived in DHA+AC enriched versions.

The samples had moderate intense vanilla and sweet flavours. Milk shake with AC and DHA had the most intense sweet and vanilla flavours from all samples while, these products had the least intense floury flavour. Adding BG to the samples resulted significantly higher intensity of floury flavour. Fish flavour was perceived in DHA enriched milk shakes. Milk shakes enriched with BG left a very sticky mouth feel, and they had the

grainiest texture. Same as the appearance the enriching milk shakes with DHA resulted products with small-sized lumps.

#### 3.1.2.2 Consumer acceptance

Adding anthocyanin to the products, resulted an unusual, extraneous lilac in colour appearance. Both bakery and egg-based products with not conventional appearance obtained significantly lower scores than the other products. In case of the dairy category, lilac appearance did not affect negatively the opinion of the consumers as they expected berry flavour from lilac products.

DHA can cause fishy aroma and flavour in foods, but it was detected minimally by the consumers. All six products with DHA kept its usual appearance which resulted that DHA enriched products received significantly higher scores than the other products.

Beta-glucan has high water absorption capacity which cause that products with beta-glucan had compact and thick texture. It caused slight grey tone in some product but it was not evaluated negatively, however, milk shakes and combined desserts with BG had very thick and floury texture which had a negative effect on the acceptance of the products.

Following the European trends, taste (with a connection to aroma and texture) influences mainly the food choice of the consumers (FoodDrinkEurope, 2015). Our results also proved that the overall liking of all products corresponded with liking of aroma, flavour or texture, but also highlighted the importance of the appearance.

The results also showed that the possible health promoting effect of the products increased the acceptance of the products (Appendix).

#### 3.1.3.3 Consumer acceptance of experimental product photos

The last part of the on-line questionnaire included photos of the experimental samples. The participants were asked to evaluate the photos of the products. When we compared the overall liking of the products with the opinion of the photos the same liking trends were shown. Products with familiar and usual appearance had higher liking scores. The overall liking scores usually higher than the scores of the photos. Especially, in case of BG enriched version of milk shake and combined dessert. The very thick appearance and the greyish tone of the product was off-putting for most participants. Same can be observed in case of pancakes and omelettes with AC. The strange lilac appearance caused that the consumers evaluated negatively the photos.

#### Bakery products

Regarding the buns, samples with more conventional appearance (yellow, light brown in colour with grey tone) had higher score than the samples enriched in AC. Bun enriched in BG got the highest score.

In case of the biscuits, sample with BG and DHA had the most desirable appearance, while biscuit with AC got the lowest scores. Consumers better accepted biscuits with slight unusual appearance: biscuits with AC+DHA had almost the same score than version enriched in BG which had a more traditional look (Figure 3).

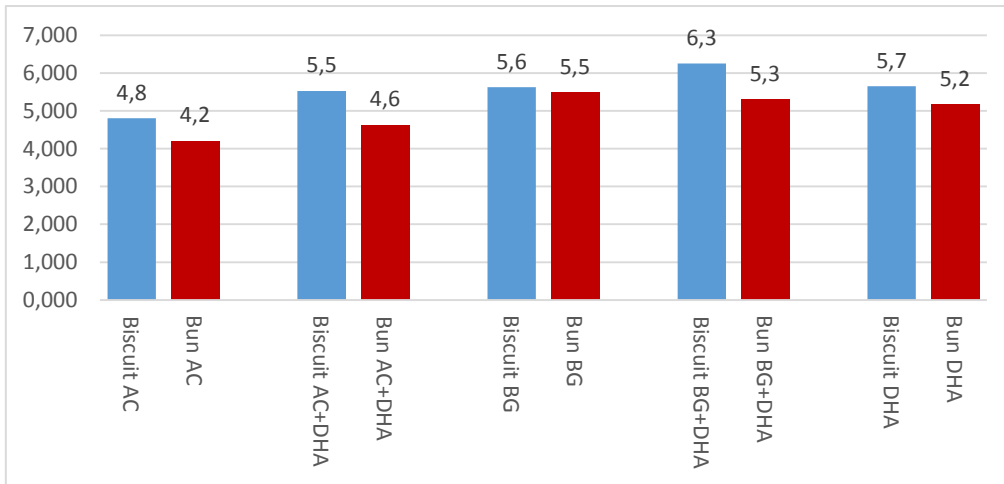


Figure 3: Acceptance of the photos presented bakery products

*Egg based products*

Difference in the evaluation of the egg products were more noticeable.

Both egg products enriched in BG and DHA, having a more appealing and conventional appearance, got significantly higher scores than those enriched with AC (Figure 4).

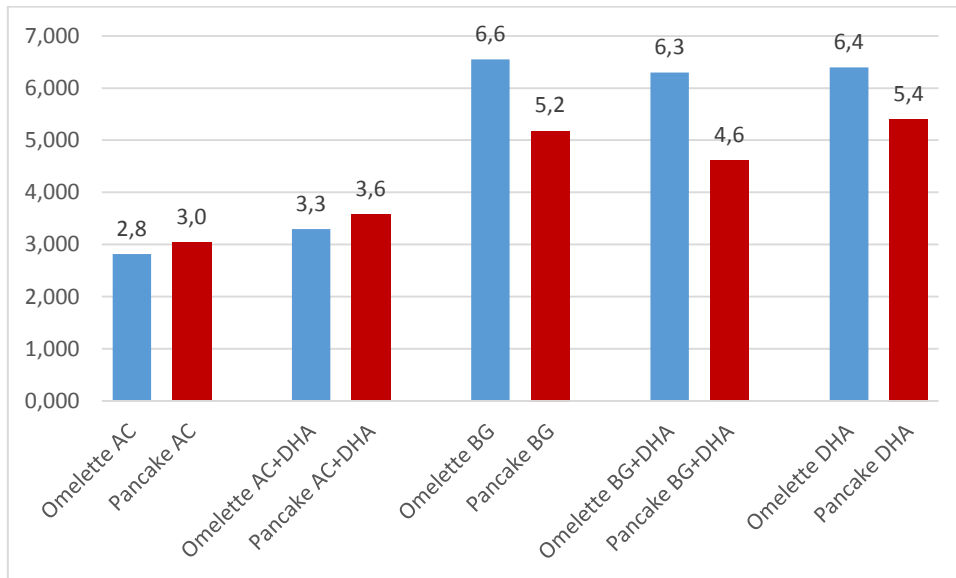


Figure 4: Acceptance of the photos presented egg products

*Dairy products*

Regarding the dairy products, version enriched in DHA had higher score than the other products, probably because these enrichments were bright yellow in colour, which match perfectly for a vanilla flavoured dessert or a milk shake (Figure 5).



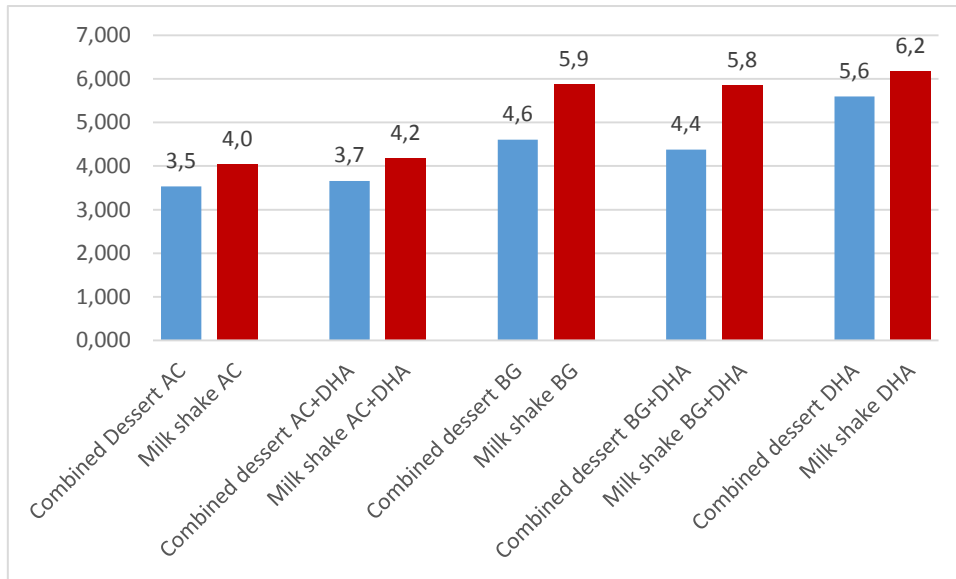


Figure 5: Acceptance of the photos presented dairy products

The possibility of the three different clusters evaluated the presented photos differently was also examined.

Figure 6 shows that consumers in cluster 2 had a slight different opinion on the photos. They gave lower acceptance scores than other cluster members and in some cases it caused significant differences (e.g. Bun-AC; milk shake AC; milk shake AC+DHA; combined dessert AC+DHA; milk shake BG+DHA and omelette DHA).

Comments of the consumers highlighted that the samples enriched in AC had extraneous colour which not match to a vanilla flavoured product. Related to milk shake enriched in BG and DHA, we can state that the main reason of the lower scores was the thick appearance. Regarding the omelette with DHA, the sample was slight paler than the consumers in cluster 2 expected and it had a more pancake-like appearance.

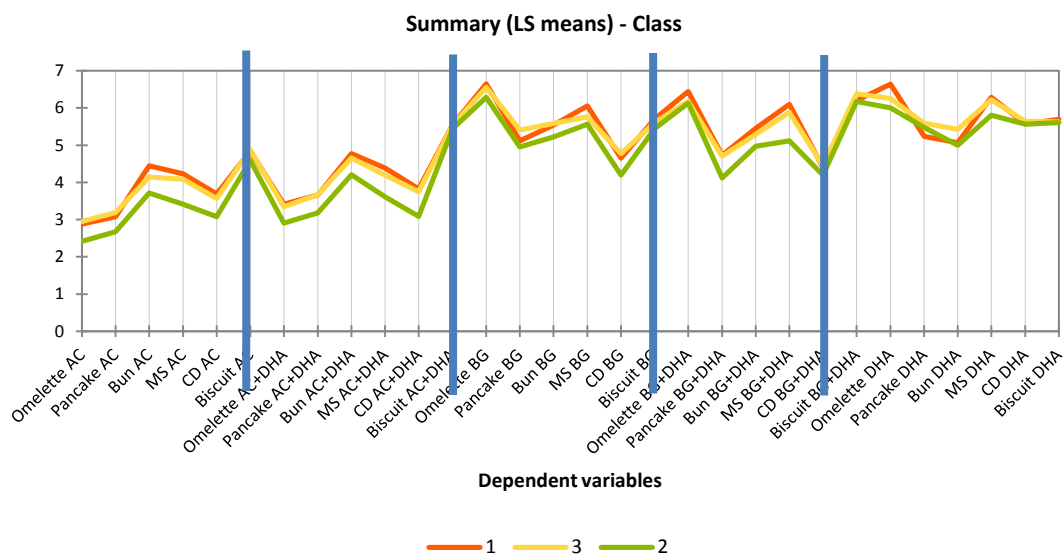


Figure 6: Compare the opinion of the clusters on the presented photos

3.1.3.4. Further analysis

Some additional analyses were done in order to find any possible correlation or relationship at least between the results of on-line survey and the consumer tasting session.

3.1.2.3 Consumers' clusters vs. overall acceptance of products

Possible influence of consumers' clusters on overall acceptance of the products was evaluated, based on

- the cluster analysis performed on the responses to general health related questions of on-line survey, where three clusters of respondents were identified
- the scores given for overall liking of each products.

In the analysis it was considered that the 3 product matrixes (bakery, dairy, egg) were evaluated by different 120-120 consumers, resulting a different distributions among the clusters (Table 2).

Table 2 Distribution of the consumers in the different clusters

Bakery			Dairy			Egg		
Clusters	Frequencies	%	Clusters	Frequencies	%	Clusters	Frequencies	%
1	58	48.3	1	63	52.5	1	54	45.0
2	25	20.8	2	18	15.0	2	24	20.0
3	37	30.8	3	39	32.5	3	42	35.0

Results show that overall acceptance of the products cannot be explained by the consumers’ clusters in most product cases.

Solely, data of pancakes show some correlation, where consumers in cluster 1 (described as ‘*extreme health conscious consumers*’) gave a bit higher scores for overall acceptance of products (Table 2).

3.1.2.4 Acceptance of product photos vs APPEARANCE liking scores

The comparison of the acceptance of the photos and the appearance liking scores were also conducted. This part of the report might be important because the packaging and the photos of the products always influence the purchasing decision. Using photos in the online survey might reproduce this situation; if the packaging shows an appealing picture of the product and it do not match with the reality, the consumer probably will not buy that product again.

In case of the buns, significant differences appeared in the DHA and DHA+BG enriched versions. In both cases the consumers gave higher scores when they evaluated the product during the tasting session, probably because in the photo both samples had more intense greyish tone (Table 3).

Table 3: Comparison of the appearance liking scores of the consumer tests, tasting session and online questionnaire-bun

Bun	Consumer, tasting	On-line	p-value
AC	4,33	4,32	0,95186
BG	6,18	5,53	0,00786
DHA	6,66 A	5,46 B	<0,0001
DHA+AC	4,61	4,84	0,40901
DHA+BG	6,14 A	5,40 B	0,00283

The biscuits got higher scores for the photos. In the photos, the samples were even coloured biscuit, and the slight porous texture did not affect the evaluation of the samples (Table 4).

Table 4: Comparison of the appearance liking scores of the consumer tests and online questionnaire-biscuit

Biscuit	Consumer, tasting	On-line	p-value
AC	4,03 B	4,82 A	0,00388
BG	4,97 B	5,64 A	0,00398
DHA	3,97 B	5,77 A	<0,0001
DHA+AC	5,68	5,59	0,71066

<b>DHA+BG</b>	5,28 B	6,34 A	<0,0001
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Both dairy product enriched in BG got significantly higher scores for their appearance based on their photos. In these cases, the thick texture of the samples might influence the consumers during the tasting session. On the contrary, the AC enriched versions got lower points on the online session (Table 5).

Table 5: Comparison of the appearance liking scores of the consumer tests and online questionnaire- dairy products

<b>Milk shake</b>	<i>Consumer, tasting</i>	<i>On-line</i>	<i>p-value</i>
<b>AC</b>	4,54	4,05	0,08711
<b>BG</b>	4,33 B	6,12 A	<0,0001
<b>DHA</b>	6,52	6,36	0,49497
<b>DHA+AC</b>	4,24	4,08	0,61017
<b>DHA+BG</b>	4,72 B	5,90 A	<0,0001

<b>Combined dessert</b>	<i>Consumer, tasting</i>	<i>On-line</i>	<i>p-value</i>
<b>AC</b>	4,32 A	3,40 B	0,00165
<b>BG</b>	3,66 B	4,84 A	<0,0001
<b>DHA</b>	5,84	5,80	0,86000
<b>DHA+AC</b>	4,07	3,54	0,06936
<b>DHA+BG</b>	3,56 B	4,76 A	<0,0001

Pancake enriched in DHA and DHA+BG got significantly higher scores during the tasting session that might be explained by the interaction among different attributes that might have influenced the liking scores of the appearance (Table 6).

Table 6: Comparison of the appearance liking scores of the consumer tests and online questionnaire- pancake

<b>Pancake</b>	<i>Consumer, tasting</i>	<i>On-line</i>	<i>p-value</i>
<b>AC</b>	3,25	3,20	0,84894
<b>BG</b>	5,48	5,13	0,21759
<b>DHA</b>	6,50 A	5,42 B	<0,0001
<b>DHA+AC</b>	3,18	3,70	0,05550
<b>DHA+BG</b>	5,96 A	4,53 B	<0,0001

In case of the omelettes, in the photos the greyish tone did not appear, all omelettes enriched in DHA, BG or their combination were very vivid yellow in colour, which match perfectly for an omelette (Table 7).

Table 7: Comparison of the appearance liking scores of the consumer tests and online questionnaire- omelette

<b>Omelette</b>	<i>Consumer, tasting</i>	<i>On-line</i>	<i>p-value</i>
<b>AC</b>	2,91	3,08	0,52130
<b>BG</b>	5,56 B	6,58 A	<0,0001
<b>DHA</b>	6,90	6,67	0,22183
<b>DHA+AC</b>	2,93 B	3,53 A	0,02819
<b>DHA+BG</b>	5,57 B	6,41 A	0,00029



## 4 Conclusion

Consumer acceptance test was organized with an involvement of 360 Hungarian consumer in order to determine their opinion on health diet and functional foods. Furthermore, to test the acceptance of food prototypes developed in PATHWAY-27.

HTAS based questionnaire was used to evaluate the attitude towards health. All participants evaluated themselves as health conscious. By a cluster analysis we were able to separate the respondents in three clusters by their level of attention towards healthy diet and lifestyle.

- cluster 1 consumers try very hard to follow a healthy lifestyle and diet, they are able to sacrifice the good taste of the food for that goal. However, the composition of food is not that important for them.
- cluster 2 members also examine their health and try to follow balanced diet, but they also think that food should be a pleasure.
- cluster 3 consumers had some common opinion with both clusters. For them the content of the meal and the enjoyment of food had also a great impact on their purchasing decision.

The evaluation of the presented photos and the results of the tasting session also resulted that consumer prefer products with familiar, usual appearance. In general it can be stated that the products received moderate liking scores and differences between caused by the different enrichments. DHA enriched products were the most popular as the sensorial attributes of the product were similar to products which are purchased every day. While lilac in colour pancakes, omelettes and buns were evaluated negatively by their unusual appearance.

It also appears that the overall linking of products corresponding the acceptance of aroma and taste attributes. This explains that AC and AC+DHA enriched dairy products got slightly higher liking scores. However, these products were lilac in colour, they had sweet vanilla aroma and flavour with a liquid texture. Consumers reported that they expected berry flavour because of the colour of the products so it was not off-putting for them.

Many products with health claim is some kind of fortified products, which means that some of their sensory attributes might differ significantly from the usual products. That makes necessary to determine the acceptance border of the consumers as they are willing to make sacrifices to eat healthier meals and the possible health promoting effect of a food is influence their acceptance positively, but taste is still one of the most important factor which influence their food choice.

The benefit of the experiment was to have a better understanding on HTAS based questionnaire with using real prototypes food matrix with potential health claims in laboratory condition. As the next tasks of PATHWAY-27, the products are involved in human intervention studies when the consumers can test the product in real-use conditions as they consume the test products at their home. The experience from consumer survey and further tests give practical input to the guideline for the industry developed in the project.

## 5 Acknowledgements

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6 References

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7 Appendix

Table 8: ANOVA summary table- Biscuits

	Attribute	Biscuit DHA BG	Biscuit DHA	Biscuit AC	Biscuit DHA AC	Biscuit BG	Probe
<b>Appearance</b>	appearance <sup>1</sup>	5.28 AB	5.67 A	4.03 C	3.98 C	4.97 B	<0.0001 ***
	purple colour <sup>2</sup>	1.88 C	1.94 C	3.52 A	2.88 B	1.93 C	<0.0001 ***
	yellow <sup>2</sup>	2.59 A	2.61 A	2.02 B	2.01 B	2.60 A	<0.0001 ***
	brown <sup>2</sup>	2.34 AB	2.20 AB	2.14 B	2.46 A	2.34 AB	0.0107 *
<b>Aroma</b>	aroma <sup>1</sup>	4.78 A	5.00 A	5.08 A	4.11 B	5.30 A	<0.0001 ***
	cereal <sup>2</sup>	2.64	2.79	2.68	2.74	2.63	0,4071
	sweet <sup>2</sup>	2.32 BC	2.58 A	2.56 AB	2.23 C	2.42 ABC	0.0008 ***
<b>Flavour</b>	flavour <sup>1</sup>	4.53 BC	5.42 A	5.08 AB	4.77 BC	4.43 C	<0.0001 ***
	sweet <sup>2</sup>	2.18 C	2.76 A	2.58 AB	2.50 B	2.12 C	<0.0001 ***
	cereal <sup>2</sup>	2.60 AB	2.78 A	2.76 A	2.71 AB	2.45 B	0.0077 **
	bitter aftertaste <sup>2</sup>	3.10 A	3.17 A	2.99 A	3.19 A	2.94 A	0.0456 *
<b>Texture</b>	texture <sup>1</sup>	4.48 C	5.91 A	4.49 C	5.20 B	4.02 C	<0.0001 ***
	crispness <sup>2</sup>	3.67 B	2.78 C	4.22 A	3.03 C	4.16 A	<0.0001 ***
<b>Overall</b>	overall <sup>1</sup>	4.72 B	5.77 A	4.75 B	4.89 B	4.46 B	<0.0001 ***
	health <sup>1</sup>	5.54 B	6.48 A	5.58 B	5.62 B	5.37 B	<0.0001 ***
	consume <sup>3</sup>	2.84 BC	3.46 A	2.91 BC	2.97 B	2.63 C	<0.0001 ***

\* significant at 5 %

** significant at 1 %
*** significant at 0,1 %

<sup>1</sup> 1-9 point-scale  
<sup>2</sup> 1-5 point JAR scale  
<sup>3</sup> 1-5 point buying intent scale

Table 9: ANOVA summary table-Buns

	Attribute	Bun DHA BG	Bun DHA	Bun AC	Bun DHA AC	Bun BG	Probe
<b>Appearance</b>	appearance <sup>1</sup>	6.14 A	6.66 A	4.33 B	4.64 B	6.18 A	<0.0001 ***
	crust purple <sup>2</sup>	2.04 B	2.08 B	2.99 A	2.81 A	2.15 B	<0.0001 ***
	crust yellow <sup>2</sup>	2.91 A	2.94 A	1.83 C	2.11 B	2.83 A	<0.0001 ***
	crust brown <sup>2</sup>	2.44 AB	2.68 A	2.25 B	2.68 A	2.70 A	<0.0001 ***
	crumb purple <sup>2</sup>	2.00 B	1.96 B	3.31 A	3.42 A	1.99 B	<0.0001 ***
	crumb yellow <sup>2</sup>	2.97 A	2.85 A	2.04 B	2.08 B	2.87 A	<0.0001 ***
	crumb brown <sup>2</sup>	2.47 A	2.52 A	2.16 B	2.16 B	2.60 A	<0.0001 ***
<b>Aroma</b>	aroma <sup>1</sup>	4.95 AB	5.29 A	4.63 B	5.13 AB	5.17 A	0,0096 **
	cereal <sup>2</sup>	2.98	3.0	2.81	2.97	2.98	0,2268
	baked dough <sup>2</sup>	2.76	2.78	2.66	2.71	2.72	0,6939
	sour <sup>2</sup>	3.30	3.49	3.42	3.40	3.31	0,1768
<b>Flavour</b>	flavour <sup>1</sup>	4.93	5.33	4.80	5.22	5.28	0,0555
	cereal <sup>2</sup>	2.87	2.87	2.88	2.91	2.84	0,9816
	sweet <sup>2</sup>	2.68	2.75	2.57	2.65	2.53	0,155
	bitter aftertaste <sup>2</sup>	3.15	3.25	3.17	3.27	3.19	0,7873
<b>Texture</b>	texture <sup>1</sup>	5.38 B	6.17 A	5.53 B	5.67 AB	5.58 B	0.0003 ***
	softness	2.88 B	2.89 B	2.98 AB	3.02 AB	3.12 A	0.0231 *
<b>Overall</b>	overall <sup>1</sup>	5.09 B	5.74 A	4.90 B	5.17 B	5.29 AB	0.0002 ***
	health <sup>1</sup>	6.07 AB	6.53 A	5.86 B	6.16 AB	6.22 AB	0.0098 **
	consume <sup>3</sup>	3.11 AB	3.38 A	3.06 B	3.17 AB	3.22 AB	0.0247 *
* significant at 5 %							
** significant at 1 %							
*** significant at 0,1 %							

<sup>1</sup> 1-9 point-scale

<sup>2</sup> 1-5 point JAR scale

<sup>3</sup> 1-5 point buying intent scale



Table 9: ANOVA summary table-Combined dessert (CD)

	Attribute	CD DHA	CD BG	CD DHA AC	CD AC	CD DHA BG	Probe
<b>Appearance</b>	appearance	5.84 A	3.66 C	4.07 BC	4.32 B	3.56 C	<0.0001
	purple <sup>2</sup>	1.88 B	1.91 B	3.31 A	3.51 A	1.82 B	<0.0001
	yellow <sup>2</sup>	2.98 A	2.84 A	1.87 B	1.86 B	2.79 A	<0.0001
	grey <sup>2</sup>	1.89	1.89	1.94	1.98	1.88	0.4902
<b>Aroma</b>	aroma <sup>1</sup>	4.81 A	4.38 AB	3.99 BC	4.71 A	3.76 C	<0.0001
	vanilla <sup>2</sup>	2.45	2.48	2.34	2.51	2.29	0.2079
<b>Flavour</b>	flavour <sup>1</sup>	4.91 A	3.41 BC	3.89 B	5.32 A	2.98 C	<0.0001
	vanilla <sup>2</sup>	2.48 A	1.99 B	2.16 B	2.56 A	1.93 B	<0.0001
	sweet <sup>2</sup>	2.83 A	2.32 BC	2.47 B	2.81 A	2.16 C	<0.0001
	floury <sup>2</sup>	3.08 B	4.41 A	3.21 B	2.60 C	4.43 A	<0.0001
<b>Texture</b>	texture <sup>1</sup>	5.63 A	3.27 C	4.78 B	5.25 AB	2.94 C	<0.0001
	thickness <sup>2</sup>	2.68 B	4.55 A	2.68 B	2.27 C	4.43 A	<0.0001
<b>Overall</b>	overall <sup>1</sup>	5.06 A	3.33 C	4.20 B	5.30 A	2.98 C	<0.0001
	health <sup>1</sup>	5.73 A	4.28 C	4.90 B	5.85 A	3.86 C	<0.0001
	consume <sup>3</sup>	2.98 A	2.21 C	2.57 B	2.98 A	1.98 C	<0.0001

\* significant at 5 %

\*\* significant at 1 %

\*\*\* significant at 0,1 %

<sup>1</sup> 1-9 point-scale

<sup>2</sup> 1-5 point JAR scale

<sup>3</sup> 1-5 point buying intent scale

Table 10: ANOVA summary table- milk shake (MS)

	Attribute	MS DHA BG	MS DHA	MS AC	MS DHA AC	MS BG	Probe
<b>Appearance</b>	appearance <sup>1</sup>	4.72 B	6.52 A	4.54 B	4.24 B	4.33 B	<0.0001 ***
	purple <sup>2</sup>	1.81 B	1.88 B	3.52 A	3.49 A	1.87 B	<0.0001 ***
	yellow <sup>2</sup>	3.01 AB	3.29 A	1.85 C	1.90 C	2.88 B	<0.0001 ***
	grey <sup>2</sup>	1.96	1.92	1.98	2.00	1.97	0.8547
<b>Aroma</b>	aroma <sup>1</sup>	5.15 BC	5.83 A	5.76 AB	4.63 C	5.15 BC	<0.0001 ***
	vanilla <sup>2</sup>	2.59 AB	2.74 A	2.74 A	2.34 B	2.76 A	0.0003 ***
<b>Flavour</b>	flavour <sup>1</sup>	3.26 C	4.38 B	5.47 A	3.59 C	3.67 C	<0.0001 ***
	vanilla <sup>2</sup>	1.90 C	2.26 B	2.63 A	2.10 BC	1.98 BC	<0.0001 ***
	sweet <sup>2</sup>	2.12 C	2.58 B	2.84 A	2.46 B	2.13 C	<0.0001 ***
	floury <sup>2</sup>	4.36 A	3.27 B	2.93 C	3.30 B	4.30 A	<0.0001 ***
<b>Texture</b>	texture <sup>1</sup>	3.52 C	5.18 A	5.62 A	4.30 B	3.46 C	<0.0001 ***
	thickness	4.42 A	3.45 B	2.98 C	3.57 B	4.42 A	<0.0001 ***
<b>Overall</b>	overall <sup>1</sup>	3.42 C	4.72 B	5.36 A	3.78 C	3.67 C	<0.0001 ***
	health <sup>1</sup>	4.51 C	5.65 B	6.30 A	4.74 C	4.76 C	<0.0001 ***
	consume <sup>3</sup>	2.27 B	2.93 A	3.23 A	2.46 B	2.41 B	<0.0001 ***

\* significant at 5 %

\*\* significant at 1 %

\*\*\* significant at 0.1 %

<sup>1</sup> 1-9 point-scale

<sup>2</sup> 1-5 point JAR scale

<sup>3</sup> 1-5 point buying intent scale

Table 11: ANOVA summary table- Omelette

	Attribute	Omelette AC	Omelette DHA	Omelette BG	Omelette DHA AC	Omelette DHA BG	Probe
<b>Appearance</b>	appearance <sup>1</sup>	2.91 C	6.90 A	5.56 B	2.92 C	5.57 B	<0.0001 ***
	blue <sup>2</sup>	3.33 A	1.89 B	1.85 B	3.49 A	1.90 B	<0.0001 ***
	yellow <sup>2</sup>	1.92 C	3.09 A	2.71 B	1.80 C	2.67 B	<0.0001 ***
	grey <sup>2</sup>	2.42 A	1.84 B	1.88 B	2.27 A	1.90 B	<0.0001 ***
	brown <sup>2</sup>	2.11	1.99	2.22	1.94	2.10	0.1716
<b>Aroma</b>	aroma <sup>1</sup>	4.86 BC	5.97 A	5.27 B	4.60 C	4.97 BC	<0.0001 ***
	egg <sup>2</sup>	2.33 B	2.92 A	2.56 B	2.37 B	2.53 B	<0.0001 ***
<b>Flavour</b>	flavour <sup>1</sup>	4.58 B	5.72 A	4.47 B	4.17 B	4.21 B	<0.0001 ***
	egg <sup>2</sup>	2.42 B	2.92 A	2.38 B	2.36 B	2.38 B	<0.0001 ***
	salty <sup>2</sup>	3.08 A	3.06 A	2.51 B	3.21 A	2.47 B	<0.0001 ***
<b>Texture</b>	texture <sup>1</sup>	4.40 B	5.91 A	4.79 B	4.54 B	4.61 B	<0.0001 ***
	airy <sup>2</sup>	2.42 C	2.81 A	2.56 BC	2.69 AB	2.73 AB	<0.0001 ***
<b>Overall</b>	overall <sup>1</sup>	4.13 CD	6.11 A	4.88 B	3.95 D	4.62 BC	<0.0001 ***
	health <sup>1</sup>	5.18 BC	6.68 A	5.63 B	5.03 C	5.46 BC	<0.0001 ***
	consume <sup>3</sup>	2.68 C	3.63 A	3.08 B	2.59 C	2.89 BC	<0.0001 ***

\* significant at 5 %

\*\* significant at 1 %

\*\*\* significant at 0.1 %

<sup>1</sup> 1-9 point-scale

<sup>2</sup> 1-5 point JAR scale

<sup>3</sup> 1-5 point buying intent scale

Table 12: ANOVA summary table- Pancake

	Attribute	Pancake AC	Pancake DHA	Pancake BG	Pancake DHA AC	Pancake DHA BG	Probe
<b>Appearance</b>	appearance <sup>1</sup>	3.25 C	6.50 A	5.47 B	3.18 C	5.96 AB	<0.0001 ***
	purple <sup>2</sup>	3.73 A	1.88 B	1.82 B	3.65 A	1.77 B	<0.0001 ***
	yellow <sup>2</sup>	1.76 C	2.90 A	2.55 B	1.77 C	2.67 AB	<0.0001 ***
	grey <sup>2</sup>	1.99 A	1.78 B	1.82 AB	1.93 AB	1.77 B	0.0083 **
	brown <sup>2</sup>	1.88 B	2.01 AB	2.15 A	1.91 B	2.21 A	0.0001 ***
<b>Aroma</b>	aroma <sup>1</sup>	3.84 B	4.78 A	4.75 A	3.61 B	4.45 A	<0.0001 ***
	sweet pan <sup>2</sup>	2.03 B	2.23 AB	2.47 A	2.08 B	2.24 AB	0.0001 ***
	egg <sup>2</sup>	2.08 B	2.56 A	2.55 A	2.13 B	2.46 A	<0.0001 ***
<b>Flavour</b>	flavour <sup>1</sup>	3.78 CD	4.53 AB	4.93 A	3.34 D	4.28 BC	<0.0001 ***
	sweet <sup>2</sup>	1.77 CD	1.93 BC	2.70 A	1.63 D	2.08 B	<0.0001 ***
	egg <sup>2</sup>	2.14 D	2.69 A	2.59 AB	2.19 CD	2.40 BC	<0.0001 ***
	salty <sup>2</sup>	2.31 B	2.67 A	2.46 AB	2.28 B	2.30 B	<0.0001 ***
<b>Texture</b>	texture <sup>1</sup>	4.33 CD	5.21 A	5.12 AB	3.96 D	4.58 BC	<0.0001 ***
	airy <sup>2</sup>	2.84	2.78	2.98	2.83	2.98	0.1926
<b>Overall</b>	overall <sup>1</sup>	3.92 B	4.97 A	5.17 A	3.58 B	4.65 A	<0.0001 ***
	health <sup>1</sup>	4.68 C	5.72 AB	5.96 A	4.20 C	5.37 B	<0.0001 ***
	consume <sup>3</sup>	2.52 B	3.07 A	3.19 A	2.27 B	2.92 A	<0.0001 ***

\* significant at 5 %

\*\* significant at 1 %

\*\*\* significant at 0.1 %

<sup>1</sup> 1-9 point-scale

<sup>2</sup> 1-5 point JAR scale

<sup>3</sup> 1-5 point buying intent scale

## 8 Short vitae of the authors

**dr. Adrienn Hegyi** graduated as food engineer. Manager of sensory and consumer department and the marketing activities of the Campden BRI Hungary. She participates in the work of the European Sensory Network. She graduated on the Postgraduate Sensory Science Course at the University of Nottingham. She obtained a PhD in marketing at the Szt. István University Gödöllő, Hungary.

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