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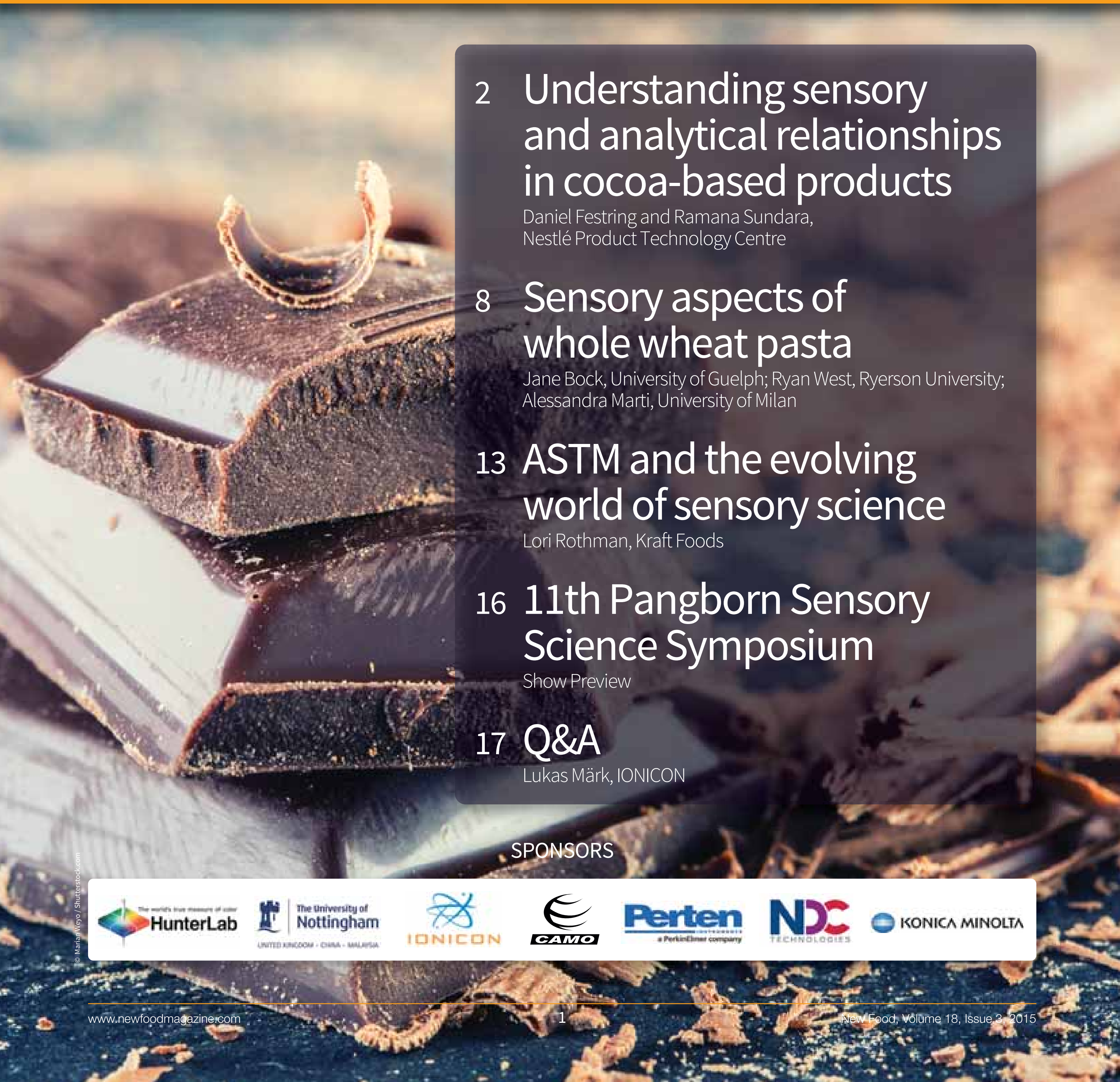

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Understanding sensory and analytical relationships in cocoa-based products

The distinctive flavour of cocoa or chocolate made from fermented and roasted cocoa beans (*Theobroma cacao* L.) is familiar to everybody in the cocoa consuming world. The industry differentiates between cocoa processing and chocolate manufacturing. Cocoa processing covers the activity of converting the beans into nib, liquor, butter, cake and powder. Chocolate manufacturing covers the blending and refining of cocoa liquor, cocoa butter and various optional ingredients, such as milk and sugar[1].

A journey towards sensomics

Since Bainbridge and Davies first successfully studied the flavour composition of cocoa back in 1912[2], scientists have so far characterised more than 600 volatile chemicals in cocoa and chocolate which include hydrocarbons, alcohols, aldehydes, ketones, esters, pyrazines, pyridines, furans, pyranones, lactones and sulphur compounds[3]. Studying the whole entity of volatile components of cocoa enables a global understanding of transformations occurring during processing as well as the identification of metabolomic pathways. However, a sensory guided approach is required to differentiate those volatiles being crucial for cocoa flavour from those having low or no impact.

A generally recognised approach to identify key odourants starts with the careful isolation of the volatile fraction from the non-volatile residue by high vacuum distillation techniques such as solvent assisted flavour evaporation (SAFE)[4]. The volatiles are separated by gas chromatography and are assessed for their sensory impact using the human nose as a detector. This approach, known as gas chromatography-olfactometry (GC-O), has proven to be a very useful tool to identify odour active regions in the volatile food fraction.

The importance of the individual odourants is most frequently assessed applying aroma extract dilution analysis (AEDA). This approach consists of the stepwise dilution of the extract followed by evaluation by means of GC-O. The factor of dilution in which an odourant is detectable is described as the flavour dilution (FD) factor. Those odourants with high FD factors are generally considered as more important for the flavour of the finished product than those with low FD factors.

Recently, the term 'sensomics' is gaining significant interest in literature[5]. After the screening by AEDA, this approach involves the quantification of the putative key aroma compounds followed by the calculation of odour activity values (OAV) being defined as the quotient of concentration and aroma threshold of the individual aroma compound. Finally, aroma recombinates are prepared to confirm that the most important odourants were characterised. If the flavour of the artificial mixture deviates from the original food material, further experiments are required to identify additional important aroma active molecules. The impact of selected compounds or compound classes on the aroma of the recombinant is evaluated in omission experiments (**Figure 1**, page 4).

Differences in the sensory characteristics of roasted and non-roasted cocoa beans have been demonstrated to relate to the concentration of specific odourants

A sensomics study performed on cocoa powder showed that it was possible to mimic the flavour of the original sample with a mixture of 24 aroma active chemicals[6]. Acidic odourants (such as acetic-, 3-methylbutanoic- and 2-phenylacetic acid), and especially Maillard reaction products (such as Strecker aldehydes, cyclic enolones and pyrazines), implied a high aroma impact[6].


Cocoa pod maturity at time of harvest and post-harvesting pod storage can both considerably affect fermentation and, ultimately, flavour

Aroma active compounds in cocoa-based products

The complex composition of the volatile fraction of cocoa comprises of those components responsible for the desirable flavour. The complexity is the outcome of several post-harvesting processes. Pod maturity at time of harvest and post-harvesting pod storage can both considerably affect the course of the fermentation stage and, ultimately, the flavour of the cocoa. Cocoa fermentation is crucial not only for the primary production of important flavour active volatiles but also for the degradation of intrinsic cocoa components such as proteins and sucrose, resulting in the release of nitrogen containing components (e.g. amino acids) and reducing sugars serving as flavour precursors. Bean drying is performed to reduce growth of moulds and to minimise levels of acidic components within the bean. Finally, cocoa roasting transforms the flavour precursors formed during fermentation into flavour-active compounds.

The aroma of cocoa mass was assessed by GC-O in combination with the AEDA approach. The flavour was successfully associated with 3-methylbutanal (malty), ethyl 2-methylbutanoate (fruity) and 2- and 3-methylbutanoic acid (sweaty), showing the highest FD factors in the investigated material[7].

Investigations on dark chocolate revealed the highest FD factors for 2-methylpropanal, 3-methylbutanal, phenylacetaldehyde, 2,3-dimethylpyrazine, tetramethylpyrazine, 3,5(or 6)-diethyl-2-methylpyrazine, identifying these as the most important contributors to the flavour of a non-conched product[8]. The key odourants in a hazelnut paste containing milk chocolate were extensively studied in 1997. The identified key odourants comprised mainly of Maillard reaction products such as Strecker aldehdydes and pyrazines as well as lipid derived compounds such as aldehydes, ketones and lactones[7]. Unfortunately no recombination experiments were performed in the mentioned studies.

Flavour generation during cocoa roasting

The crucial role of the Maillard reaction in the formation of the appealing cocoa and chocolate flavour is unquestionable and has been the subject of a variety of different studies. A study on the changes in key aroma compounds of Criollo cocoa beans during roasting linked the sensory changes with the concentration of odorants in roasted and non-roasted beans[9]. The orthonasal impression of the unroasted beans was dominated by a vinegar-like descriptor with lower sensory score for malty, roasty, caramel-like, honey-like, coconut-like, flowery, seasoning-like and earthy notes.

The roasting process significantly changed the flavour profile by reducing the vinegar note, while the malty note became dominant followed by caramel-like, earthy, honey and roasty aroma qualities. The authors linked these differences with the changes in the odour activity values (OAVs) of the key odourants in both samples. On closer inspection of the ratio of the $OAV_{roasted}/OAV_{unroasted}$, the odourants can be classified into three different groups (**Table 1**, page 5).

The first group contains those odourants already present above their threshold concentration in the unroasted sample but showing a drastic increase in OAV after roasting. In particular, the Strecker aldehydes 2-/3-methylbutanal (malty) and phenylacetaldehyde (honey) revealed higher OAVs in the roasted cocoa, increasing up to a factor of 83. Additionally several odourants were described as being absent (2-acetyl-1-pyrroline (popcorn)) or present in sub-threshold concentrations (4-hydroxy-2,5-dimethyl-3(2*H*)-furanone (caramel-like)) in unroasted cocoa, but showed OAVs>1 in the roasted products.

Those compounds showing the same OAV in roasted and unroasted products form a second group. These volatiles are already present in the raw material and remain unaltered by the roasting process (e.g. 2-methylbutanoic acid (sweaty)). The authors described only one

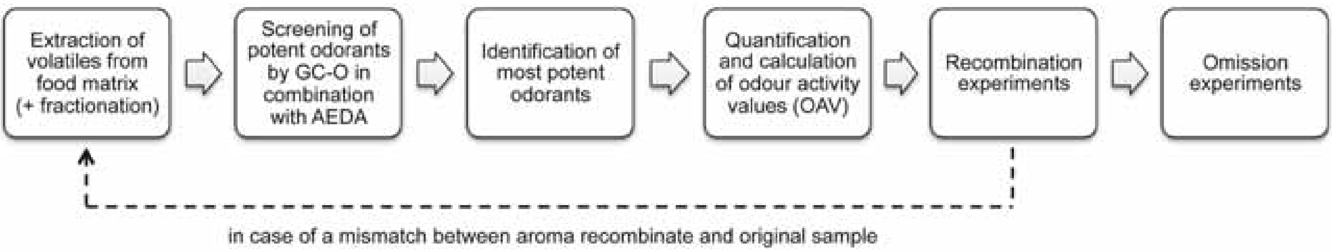


Figure 1: Schematic description of a sensory guided ('sensomics') workflow for the identification of key aroma compounds in food materials

component with a significantly reduced OAV (forming the third group), namely acetic acid, exhibiting vinegar-like characteristics. The changes in the composition of the aroma active volatiles, specifically the reduction of acetic acid and increase in Maillard products, was held responsible for the change in the aroma profile of unroasted to roasted beans.

Correlation of analytical and sensory data

Flavour chemistry and analytical methodologies represent only a part of the story. Consumer preference tests are employed to determine to what degree the target consumers like each sample and why. A sound understanding of the flavour of any cocoa product partly involves correlating the sensory perception of its flavour with its volatile chemical components. Even though a good correlation between the measured aroma volatiles and sensory attributes may not signal a cause, it implies both variables to vary in the same manner[10]. A very challenging task remains the understanding of the relationship between the odourants identified and the descriptors utilised in human-sensory experiments. In previous years, several studies have been published trying to consolidate those causal links.

The success of the analytical investigations depends on several factors such as the selection of the appropriate analytical tools and approach (targeted, non-targeted or a combination thereof). Recently, a comprehensive study was published combining instrumental analysis of cocoa liquor, milk and dark chocolate with sensory data[11]. The authors investigated the understanding of the relationship between aroma-active compounds and sensory perception by a targeted approach.

After confirmation of the key odourants in the different products by GC-O in combination with AEDA, the most important aroma active volatiles were quantified using GC-MS. The results were combined with human sensory analysis of the samples and subjected to statistical treatment. The identified links between individual sensory descriptors were in many cases highly causal. The *Strecker* aldehydes 2-methylpropanal and 3-methylbutanal for example, were found to be linked with malty aroma detected during sensory analysis, while phenylacetaldehyde and phenylethanol were linked with floral flavour. The article even described spiking experiments on different odourants, confirming the causality of the relationships obtained before.

Another study assessed the links between important odourants and sensorially perceived flavour attributes in dark chocolate, particularly focusing on the influence of processing parameters[10]. After GC-O analysis a subset of 16 important aroma compounds was selected and correlated

Table 1: Selected aroma compounds in unroasted and roasted beans with their corresponding odour qualities as well as the ratio of their odour activity values after and before roasting ($OAV_{roasted}$ / $OAV_{unroasted}$).
Adapted from Frauendorfer & Schieberle (2008)[9]

Odourant	Odour quality	$OAV_{roasted}$ / $OAV_{unroasted}$*
3-methylbutanal	Malty	21
phenylacetaldehyde	Honey-like	83
2-methylbutanal	Malty	8.0
2-methylbutanoic acid	Rancid	1.0
2-phenylacetic acid	Honey-like	1.1
Butanoic acid	Sweaty	1.0
Acetic acid	Sour	0.3

*The ratio of odour activity values determined for an odourant after roasting divided by its corresponding OAV before roasting. OAVs represent the quotient of the concentration of an odourant and its orthonasal detection threshold concentration.

with different sensory attributes. Fruity flavour was found to be highly correlated with ethyl-3-methylbutanoate; 2,5-dimethylpyrazine, dihydro-2(3H)-furanone; linalool oxide; benzaldehyde and 2/3-methylbutanal. The astringent mouthfeel was positively correlated with 5-methyl-2-phenyl-2-hexenal while negative correlations were found with ethyl-3-methylbutanoate and pentylacetate. Although it might be assumed that some of these correlations are not causal, it was possible to develop a model for these important flavour attributes in dark chocolate using volatile markers.

Opportunities for untargeted analysis of cocoa volatiles

While the targeted analysis is often laborious and time intensive, non-targeted approaches are of growing interest to gain a deeper understanding on the whole cascade of reactions happening during cocoa processing from the bean to the finished application. Chemometric approaches are frequently applied in analytical science to solve both descriptive and predictive problems. Particularly with the development of more powerful analytical tools, chemometric techniques are gaining more interest to unravel the often complex datasets.

In cocoa-based products, chemometrics has been successfully applied to determine the origin of chocolate samples[12]. The authors combined GC-FID data of 51 chocolate samples of different origins to identify key analytical markers. Identification by GC-MS revealed seven characteristic volatiles acting as tracers of the cocoa's continental origin. Another study developed a fingerprinting of cocoa liquor extracts by flow-injection electrospray mass spectrometry (FIE-MS) and illustrated the feasibility of chemical prediction of sensory qualities[13].

Besides offline technologies such as GC-MS, online mass spectrometric techniques are of growing importance in gathering real time insights into flavour generation processes. Selected ion flow tube mass spectrometry (SIFT-MS) was assessed as a possibility to monitor the kinetics of selected cocoa volatiles during roasting[14]. The measurement in real time offers the opportunity to optimise the roasting profile of different types of cocoa beans by following the formation or degradation of selected key flavour compounds. Unfortunately no link to the sensory attributes of the cocoa was presented in the study. Nevertheless, the opportunity of predicting the sensory properties of a finished product from analytical data obtained, e.g. by PTR-MS[15] or PTR-TOF-MS[16], is well documented in the literature.

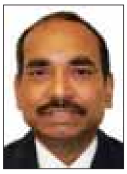
Conclusions

Sensory attributes of eating cocoa products are influenced by processing variables and inherent characteristics of the cocoa bean. Monitoring of the flavour is therefore vital, which is being partly influenced by the initial roasting conditions and partly by subsequent processing in the manufacture of the finished product. Therefore, judicious processing and selection of ingredients is necessary to deliver desirable attributes. Using offline volatile analysis in combination with human-sensory evaluation and multi-variant statistics is a frequently applied approach to use one variable to predict another.

The use of real time mass spectrometric tools offers interesting opportunities for day to day quality control of cocoa-based products, enabling a deeper understanding of the relationship of process parameters and sensory properties which is essential to ensure products with more desirable and preferred sensory attributes.

About the Authors

Daniel Festring studied food chemistry at the University of Münster (2001-2006) followed by a dissertation at the Technical University in Munich under the supervision of Prof T Hofmann (2007-2010). His studies focused on the identification of umami tastant and taste modulators in yeast extracts, and the Maillard reaction of guanosine 5'-monophosphate. In 2010, he joined the Nestlé Product Technology Centre in Orbe (Switzerland) focusing on the flavour of cereal-based products. Since 2013, he has worked at the Nestlé Product Technology Centre, York, UK as a research scientist working on flavour active components in confectionary products.



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Sensory aspects of whole wheat pasta

Given the proliferation of studies expounding the health benefits of whole grain consumption, consumers have increasingly demanded whole grain versions of many cereal-based products. Pasta has been a common food targeted by product developers for conversion to whole grain formats, especially whole wheat pasta, because of its simple formula and popularity with consumers. However, there are several sensory issues that become problematic with whole wheat pasta, and these issues have required further study to improve consumer acceptance and adoption.

Although Italy is generally considered the home of pasta, the popularity of this product is increasing worldwide thanks to its convenience, palatability, long and easy shelf life, and its nutritional properties. Pasta is a good source of slowly digestible polysaccharides (assuring a low glycemic index) and a moderate source of protein and some vitamins. Even if the nutrient balance in dried pasta is suboptimal in distribution, the use of sauces (tomatoes and cheese) with high nutritional value can compensate for nutritional deficiencies.

As already mentioned, pasta is considered one of the simplest cereal-based products in terms of ingredients (only two: semolina/flour and water) and processing (a sequence of hydration, mixing, forming and drying steps). Both raw material characteristics and processing conditions play a key role in determining the final quality of pasta products.

Durum wheat semolina is the raw material of choice for pasta production due to its yellow-amber colour and strong gluten proteins. However, almost any type of wheat may be used for producing pasta products. It is common to enrich pasta with other cereals (barley, rye, corn, rice, sorghum, etc.), pseudo-cereals (buckwheat, amaranth, quinoa), pulses (pea, chickpea, etc.), or whole wheat flours. The main reasons for such replacements are the lack of availability of durum wheat semolina in some parts of the world, the production of new types of pasta, the elimination of gluten for special diet products, and the enhancement of nutritional benefits (sources of fibre, minerals, antioxidants, and polyphenols).

Whole wheat pasta products are viewed by consumers as a good source of fibre. The presence of the bran and germ, however, create both technological and sensory issues, such as darker colour in whole wheat pasta (**Figure 1**, page 10), Partial or total substitution of durum wheat semolina (or wheat flour) with whole wheat flour has, for example, adverse effects on the texture, flavour and colour of the final product.

"Whole wheat pasta products are viewed by consumers as a good source of fibre"

Gluten structure in whole wheat pasta

The gluten network is key to pasta quality. It is formed by adding water and mechanical energy to the gluten storage proteins present in all wheat: gliadins and glutenins. **Figure 2a** (page 10) is a conceptualised illustration of gliadins and glutenins. Gliadins are monomeric globular proteins with intramolecular disulphide bonds. The α/β- and γ-gliadin subfractions are considered sulphur rich whereas the ω-gliadin subfraction is sulphur poor. Their amino acid sequences predispose them to aperiodic secondary structures punctuated by short runs of α-helices[1]. The glutenins are polymeric proteins that form large complexes via intermolecular disulphide bonds. The high molecular weight glutenin subunits are sulphur poor while the low molecular weight glutenin subunits are sulphur rich. Glutenins form a unique β-spiral central repetitive region due to a series of repeating β-turns[2]. The terminal ends are predominately aperiodic and α-helical. When these proteins are hydrated and mechanically manipulated within the context of pasta processing, they form a gluten matrix to entrap starch granules (**Figure 2b**, page 10) and adopt secondary structures that influence the quality and texture of the product. A high protein content and a 'strong' gluten (in terms of its visco-elasticity) are required to process semolina into a suitable final pasta product with optimal cooking performance[3,4].

When incorporating whole wheat flour into pasta, the presence of bran alters the evolution of gluten secondary structure and interactions through the pasta making process to such an extent that the gluten network favours different interaction mechanisms and exhibits different viscoelastic behaviour[5]. These structures and interactions are summarised in **Figure 3** (page 10). This can be observed immediately in the first stage of processing – the hydration and mixing of pasta 'dough' prior to extrusion. Gluten proteins strongly adopt β-sheets in refined pasta dough, indicating tighter protein–protein interactions. The physical presence of bran along with its ability to compete for

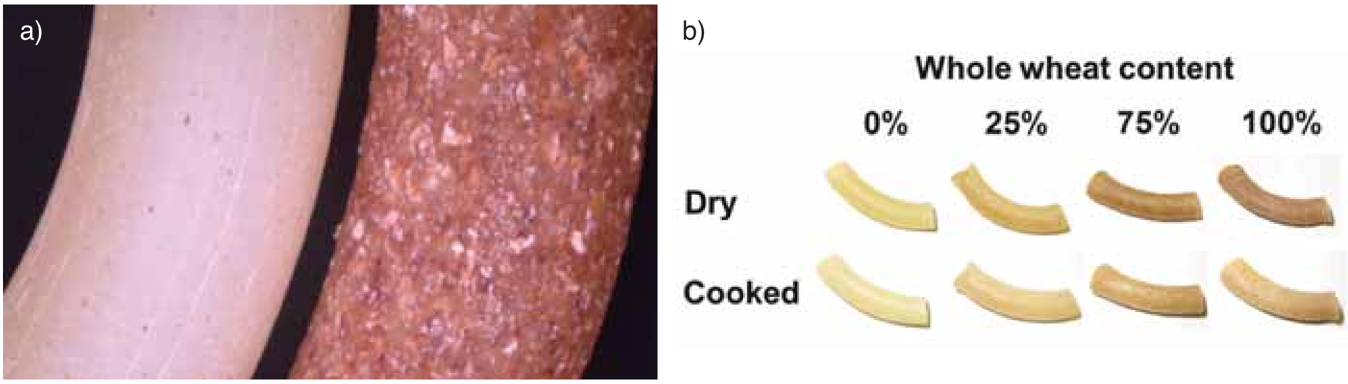


Figure 1: Examples of dry refined and whole wheat macaroni showing darker colour and surface roughness due to bran (a) and the effect of increasing whole wheat content on colour in dry and cooked pasta (b)

water inhibits such a build-up of β-sheets in whole wheat pasta dough, and this has implications that carry through to the final cooked pasta.

The secondary structural differences between refined and whole wheat pasta are minimised in dry pasta due to the removal of water, but differences in disulphide bonding and hydrophobic interaction patterns become apparent. A close look at these patterns reveals a compact gluten network in refined pasta dominated by hydrophobic interactions whereas a looser network with greater dependency on disulphide linkages prevails in whole wheat pasta[5]. Microscopic observations of dried refined pasta have revealed that the gluten network is more or less uniformly and regularly arranged around starch granules, which are still in the form of whole native granules, as in semolina[6]. The presence of bran introduces discontinuities in the gluten network structure observable in scanning electron micrographs[7], confirming a looser network structure in dry whole wheat pasta.

Whole wheat pasta texture

When taken through to cooking, observed differences in secondary structure and interaction patterns persist – greater β-sheet content and compactness in refined pasta vs fewer β-sheets and loosely associated aggregates in whole wheat pasta – and contribute to differences in pasta texture. During cooking, starch granules rapidly swell, tend to disperse and become partly soluble. At the same time, proteins become completely insoluble and coagulate, creating a strengthened network, which traps starch material[6].

Starch gelatinisation and protein coagulation are both competitive phenomena and occur at the same temperature: the faster the formation of a continuous protein network, the more limited the starch swelling, thus ensuring firm consistency and the absence of stickiness in pasta. On the other hand, if the protein network lacks elasticity or its formation is delayed, starch granules will easily swell, and part of the starchy material will pass into the cooking water, resulting in a product characterised by stickiness and poor consistency[6]. The interference of bran with the formation of a compact gluten network during processing is exacerbated during cooking as denatured proteins are hindered from interacting with the larger continuous protein network. This is observed as a loss of β-sheets, higher cooking loss and a less firm texture[5,8].

These minute changes in protein structure and interactions are significant enough to be apparent to consumers. A descriptive panel found pasta with increasing whole wheat fractions to become rougher, less firm and less adhesive on the palate due to the weakening of the gluten network. These results corresponded with concurrent instrumental analysis of firmness and adhesion via bulk sampling[8].

The loss of texture that occurs with whole wheat addition can be modulated somewhat by applying different drying treatments. Drying not only reduces moisture content in order to inhibit microbial growth and extend shelf life but also generates the precursors for texture and flavour development. Whole wheat pasta benefits from a low temperature drying regimen (50-60°C) that promotes heat setting of the protein without forming excessively rigid structures. This allows greater resilience and ability to withstand the strain of enmeshing swollen starch granules and/or bran particles. This drying treatment enhances

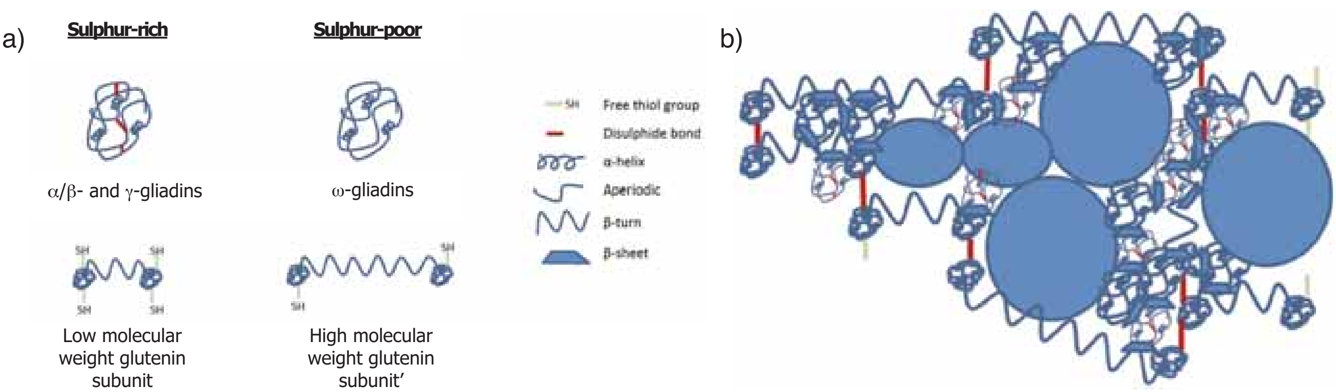


Figure 2: Conceptual illustration of gliadins and glutenins (a) and their interactions as a protein network to enmesh starch granules (b). Note that areas of high β-sheet concentration are also areas where hydrophobic interactions are more likely, especially protein junction zones.

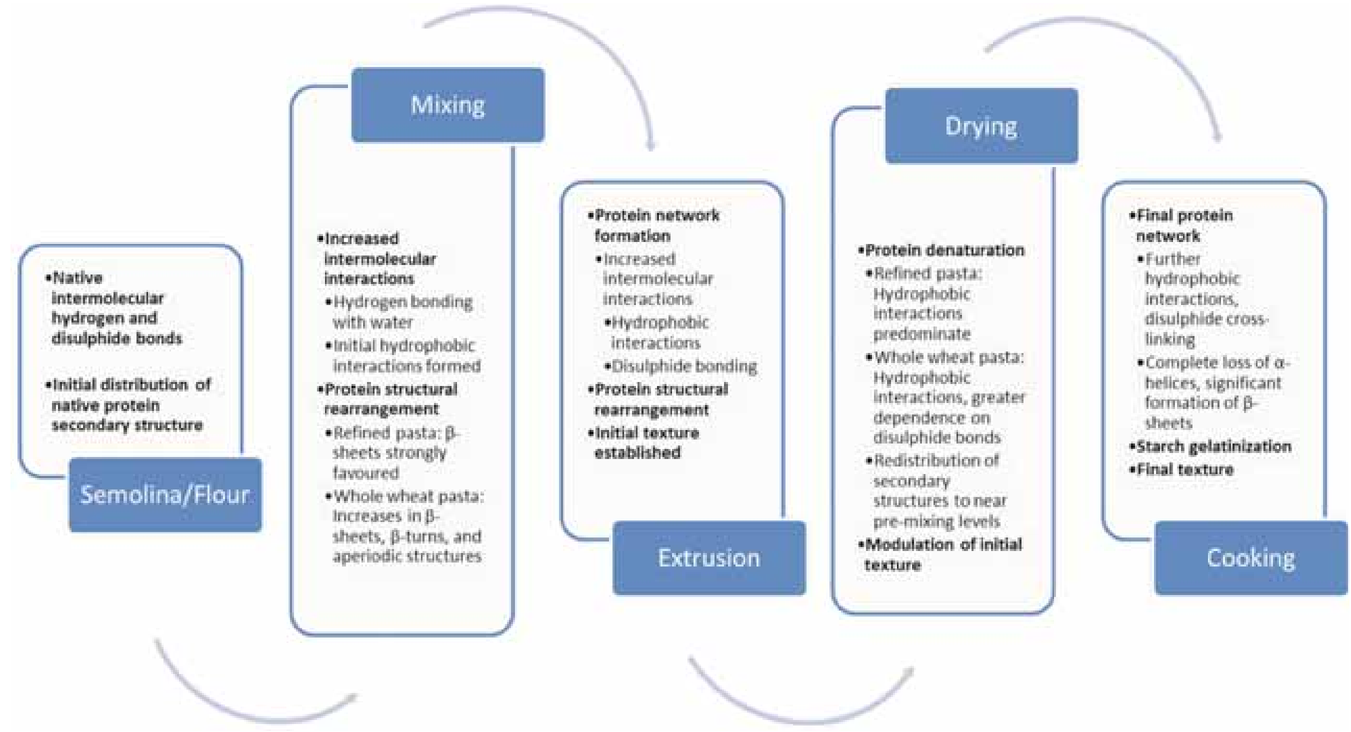


Figure 3: Outline summarising the evolution of gluten structure and interactions during the pasta making process

generation of β-sheets during cooking, which in turn leads to an improved ability to constrain swollen starch granules and firmer texture in cooked whole wheat pasta.

Whole wheat pasta flavour and colour

Pasta is composed of many molecules that undergo degradation and thermal-assisted reactions during its drying stage to generate processed tastes and flavours. For instance, the starch in pasta decomposes to its glucose monomers, imparting sweetness, while the polyphenolic species in its bran particles oxidise and decarboxylate to produce many distinct volatiles. Interestingly, these products can form adducts with Maillard intermediates to inhibit flavour formation[9].

Perhaps no other flavour generating pathway has been more exhaustively studied than the Maillard reaction and this is no exception for pasta (**Figure 4**, page 12). Optimal dough conditions for this chemistry take place during drying due to heating combined with a reduction in moisture content[10]. As illustrated in **Figure 4** (page 12), the initial stages of the Maillard reaction see the condensation of reducing sugars with peptidic amines followed by structural rearrangement into Amadori intermediates that are the precursors to many aroma and flavour compounds. Dehydration, deamination, and Strecker degradation are just some of the reactions that these intermediates undergo to liberate the volatiles responsible for aroma and flavour[11].

Processed flavours can also form from the thermal degradation of phenolic acids contributed by bran. While the ideal pasta is al dente and should possess 'nutty' and 'cooked wheat' flavours, whole wheat pasta tends to have undesirable off-flavours. Bran particles, the main distinction between refined and whole wheat pasta, are at risk of lipid oxidation, which contributes to these flavours. Subjugation to thermal treatment destroys the enzymes responsible for this oxidation, but extreme care must be taken to avoid overexposure that can damage the protein network and generate undesirable dark colours in whole wheat pasta.

Durum pasta colour is a combination of a desirable amber hue caused by carotenoids and unwanted brown and red hues caused by tyrosinase-derived melanin and Maillard products, respectively. If not controlled, these undesirable hues can mask the amber colour of whole wheat durum pasta, resulting in unacceptable colour development. Wheat breeding efforts have led to variants with reduced browning potential to aid in this area[12]. Additional processing strategies can also be employed to mitigate undesirable colour in whole wheat pasta – while high temperature/short drying time conditions lead to non-enzymatic browning, this has not been observed under low temperature/short drying time conditions.

Given that appearance is probably the first property a consumer factors into the purchase of a product, there are industrial efforts to minimise the visual differences between refined and whole wheat pasta. White whole wheat is preferred over whole durum because its bran is lighter[13]. These bran particles cast dark, irregular specks against an otherwise monochromatic canvas and humans tend to exaggerate their size and darkness in their perceptions.

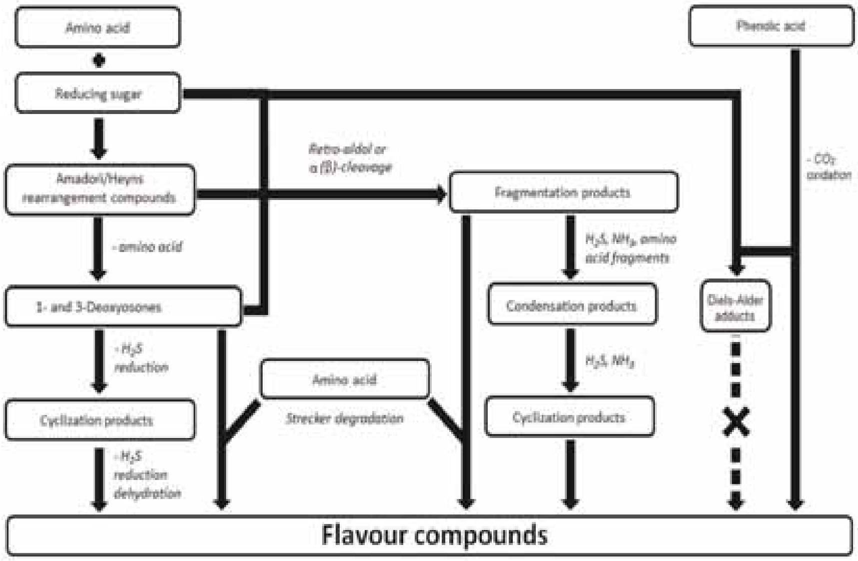


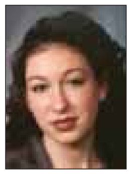
Figure 4: Schematic of different reaction pathways contributing to the generation of flavour compounds in pasta. Adapted from Kerler *et al.* (2010)[11]

Conclusion

More work is necessary to fully understand the relationship between protein structure and texture in whole wheat pasta, but it will lead to new avenues of exploration in terms of processing technology. Those avenues could include milling strategies to minimise bran particle size, adapted mixing protocols to minimise damage to the nascent gluten network, and/or new drying methods. Further work on whole wheat pasta flavour and colour could be parlayed into wheat breeding strategies focused on reducing compounds responsible for off-flavours and undesirable colour, similar to work done to reduce the browning enzyme polyphenol oxidase (PPO) in wheat varieties for noodle making. Exploration of processing aids (e.g. enzymes) to mitigate undesirable flavour and colour development or modify the gluten network could be a boon if they additionally serve to maintain clean labels.

As consumers continue to demand whole grain versions of traditional refined products like pasta, food scientists must continue to explore the fundamental aspects of structure, flavour and colour along with the processing strategies necessary to mitigate the associated sensory defects. The encouraging news is that we continue to get closer to the mark with each new piece of information.

About the Authors



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ASTM and the evolving world of sensory science

Across six conference rooms throughout the morning and afternoon, discussions are taking place. In some, the volume is quiet, with participants hunched over computer screens or paper documents, silently reading and editing. In others, the volume is more spirited with the meaning of 'discussion' stretched. While there is no shouting, different points of view are clearly in evidence, as participants attempt to convince each other of the soundness of their approach. As each discussion ends, the volume returns to normal; nothing is taken personally. The participants hurry away to their next discussion. This goes on for three days. It's another ASTM International Committee E-18 meeting.

Founded in 1898, with about 30,000 current members hailing from 140 countries, members of ASTM International (with its motto: 'Helping our world work better') publish about 12,000 international standards every year. The standards comprise a diverse group and include such disparate topics as aircraft, children's toys, chemicals, construction, highways and many more. These are consensus standards, open to all parties with a stake in their development or use and are used in contracts, laboratories, offices and by regulatory bodies. While these standards are developed and used voluntarily, government agencies are required to use privately developed standards wherever possible. Standards become mandatory when they are adopted by agencies as requirements.

The ASTM Committee E18 on Sensory Evaluation was formed in 1960, around the same time as the field of sensory evaluation was itself emerging. The committee meets twice yearly in spring and autumn, and has jurisdiction over 31 standards, published annually in the Book of ASTM Standards, Volume 15.08. Committee E18 has 10 technical subcommittees that maintain jurisdiction over these standards. They include some that are quite technical in nature, such as Fundamentals in Sensory Evaluation, Sensory Theory and Statistics, and Sensory Applications; and others that deal with the future of the Committee such as Strategic Planning, and Communication and Training. The ISO subcommittee links with the International Standards Organization.

The current standards are as varied as the field itself and include topics at the core of sensory evaluation such as 'E1885-04(2011): Standard Test Method for Sensory Analysis – Triangle Testing,' and 'E2263-12: Standard Test Method for Paired Preference Test', as well as more specialised topics such as 'E1083-00(2011): Standard Test Method for Sensory Evaluation of Red Pepper Heat', 'E1697-05(2012): Standard Test Method for Unipolar Magnitude Estimation of Sensory Attributes', and 'E1870-11: Standard Test Method for Odor and Taste Transfer from Polymeric Packaging Film'. A particularly popular standard and one which is a source of much spirited discourse is 'E1958-12: Standard Guide for Sensory Claim Substantiation'. This standard lays out the process by which one company can claim 'superiority' or 'unsurpassed', among others for a consumer product. For example, claims such as: 'Our product tastes better than any other', or 'No other product lasts longer'.

Once standards get approved, they are reviewed and updated every five years, so it makes sense for stakeholders to participate in their creation process. Every standard is balloted by the relevant subcommittee and the entire E18 voting body, and must be approved by

90% of the voting body. The standard will not be approved unless all negative votes are resolved, either by revising the proposed standard and reballotting, having the negative voter withdraw the negative vote or by deeming the negative 'non-persuasive'. This last action is used as a last resort, done after much debate and at the closing meeting or by ballot of the voting membership.


The ASTM Committee E18 on Sensory Evaluation meets twice yearly to discuss, establish and maintain standards

Task groups

Besides the discussions mentioned above, which are called 'task group' discussions, an ASTM E18 meeting has several other activities of interest. The broader ASTM organisation conducts workshops to help ASTM leaders of task groups, subcommittees and technical committees learn the roles and responsibilities of these positions of leadership. There are also Strategic Planning, and Communication and Training meetings where participants can not only hear about but can craft the future of committee E18 by suggesting strategies for long-term growth, training of members and communicating the benefits of committee membership.

There are dinner discussion groups, where interested persons can informally discuss topics of interest and new member meetings, and where new members can get oriented and prepared for spirited discussions. Every meeting includes an educational seminar, presented by a member or an external speaker, as well an evening reception where various committee awards are presented to those who have given their efforts to standards publication, training or committee leadership. A look at the E18 meeting schedule this past April shows over 25 discussion groups having taken place over three days.

As the field of sensory evaluation has evolved, so has ASTM Committee E18. The early years of the committee were spent articulating the rationale for and identifying the best practices of sensory evaluation with standards such as 'E1871-10: Standard Guide for Serving Protocol for Sensory Evaluation of Foods and Beverages' and 'E253-15: Standard Terminology Relating to Sensory Evaluation of Materials and Products.' As the practice of sensory evaluation became more widespread, with an increasing number of methods practiced, the need for additional standards became clear. Standards such as 'E1909-13: Standard Guide for Time Intensity of Sensory Attributes', 'E2299-13: Standard Guide for Sensory Evaluation by Children and Minors' and 'E1879-00(2010): Standard Guide for Sensory Evaluation of Beverages Containing Alcohol' were published, among many others.

A glance at the ASTM E18 website shows that additional standards such as 'Standard Guide for Measuring and Tracking Sensory Descriptive Panel and Assessor Performance', 'Standard Guide for Selecting and Using Scales for Sensory Evaluation', ' Guide for Best Practices for Small Group Product Evaluations', and 'Guide for Sensory Evaluation of Oral Care Products' are in the process of being developed. The new standards will serve to align and codify current and evolving sensory evaluation methods by those who practice them for those who would like to adopt them. Thus, the standards also serve as a tool for educating others in the field or adjacent fields.

Other sensory evaluation materials

Aside from Standards (or Standard Guides, as they are typically referred to), ASTM committee E18 publishes other types of documents to help the sensory evaluation professional. Manuals are collaboratively written (though not balloted for publication) with in-depth guides for methods or other topics of interest, typically with several case studies. While quite technical, they also offer hands on guidance for implementation. These include such topics as Just About Right (JAR) Scales: Design, Usage, Benefits, and Risks, International Consumer Product Testing Across Cultures and Countries, and Physical Requirement Guidelines for Sensory Evaluation Laboratories.

There are peer reviewed Special Technical Publications such as: Guidelines for the Selection and Training of Sensory Panel Members, Product Development and Research Guidance Testing with Special Consumer Groups, and Correlation of Subjective-Objective Methods in the Study of Odors and Taste. These offer a deep dive into a specific topic. Finally, there are Data Series, which cover specific applications, contain compiled data, and usually include explanatory text. These include the Lexicon for Sensory Evaluation: Aroma, Flavor, Texture and Appearance, and and Atlas of Odor Character Profiles.

While a majority of E18 members are in the food industry, it is interesting to note that many ASTM publications address sensory evaluation practices that cover categories outside of food, such as personal care (shampoo, deodorants, creams/lotions, etc) and cleaning. When writing documents, examples from food and non-food are solicited for inclusion.

All committee members are welcome to participate in any capacity at any time. This includes developing a scope of work, an outline, case study examples or references, as well as writing document text or editing text that others have written. While committee E18 has over 200 members, 75 members typically participate in the twice yearly meetings, and one can participate without being physically present. ASTM has an excellent online collaboration network whereby task group owners can upload documents for review and editing. Members can also sign up for email alerts for news on new or revised standards. There are also online guides for standards development and the balloting process.

ASTM standards in the food industry

So, as a sensory evaluation professional in a large food company, what do the ASTM standards mean to me? Several of the E18 standard guides serve as the framework for methods that are used in the Kraft Foods Sensory Evaluation Center each and every day. If we are debating how to implement a method someone will invariably say: 'what does ASTM say?' and we check the relevant standard or manual. When constructing a new sensory facility for the Glenview, Illinois Technical Center, opened last year, the Guidelines for Laboratories document proved to be invaluable. We are pleased to see new task groups being formed to address questions or issues we have internally, particularly the 'Small Group Product Evaluation' task group (of which I am the task group chair) that will help us standardise how we conduct internal team product evaluations across categories and businesses.

Through attendance at the meetings, I have the opportunity to interact and network with professionals in the field of sensory evaluation. These interactions have helped me grow as a professional, listening to how others frame up a problem or outline a solution, and listening to or participating in those spirited debates. I can then leverage those differing points of view to align with colleagues at Kraft on the best ways to move forward on the issue at hand.

I hope I have given you a taste (pun intended) of what ASTM E18 has to offer the sensory evaluation professional. New members are always welcome and can participate as much or as little as they choose to. As the sensory evaluation field grows, it is exciting to see new standards being developed and older standards being revised to reflect current theory and practice. I hope to see your name on the 'new members' list at our next meeting on 27th October in Tampa, FL.

About the Author

Lori Rothman is a Certified Food Scientist*, who has been practicing sensory evaluation for over 30 years. With degrees in Nutrition and Food Science and global experience in sensory evaluation at several food companies, she has seen how using proper sensory evaluation procedures and practices can benefit the food industry in areas such as innovation, brand renovation, quality assurance, brand maintenance and margin enhancement.

**The Certified Food Scientist (CFS) credential is a formal global certification program, administered by the International Food Science Certification Commission, which recognises the practical, applied scientific knowledge and skills possessed by food science professionals. CFS credential holders must pass a rigorous exam that tests them on the core professional competencies of a food scientist, and their ability to put that knowledge and skills into practice in a work environment.*

11th Pangborn Sensory Science Symposium

SIK – The Swedish Institute for Food and Biotechnology – is pleased to be hosting the 11th Pangborn Sensory Science Symposium in Gothenburg, Sweden from 23-27 August 2015.

Now recognised as a leading international event in sensory and consumer research, the conference takes its name from Rose Marie Pangborn, the pioneer who led the way in developing the sensory field into the interdisciplinary science it is today. From its beginning as a small, memorial symposium in 1992, the conference now brings together the world's leading experts in sensory science to present and discuss the latest knowledge and results.

The event will highlight new and innovative industrial applications, recognise students and young scientists, give exhibitors the opportunity to meet their customers, and expose Nordic sensory research to a wider international audience. Sensory and consumer science has had, and will continue to have, a major influence on how we can meet the future challenges of a sustainable world, where the interaction between human beings and products, food and non-food, and services and technology is of utmost importance.

The symposium will include a comprehensive conference programme, featuring research presentations under the subjects of: 'Sensory and consumer science in a changing world'; 'Sensory drivers for health and wellbeing'; 'Advances in sensory and consumer tools and methods'; 'Age-related sensory perception and behavior'; 'Sensory-driven product design'; 'Culinary arts and science'; 'Challenges in emerging markets'; 'Food choice and consumer behavior'; 'Sensory fundamentals'; 'Beyond food – Applying sensory science in other contexts'; 'Frontiers in sensometrics'; and 'Cross cultural sensory and consumer research'.

Keynote speakers include:

- Professor Steven Nordin, Department of Psychology, Umeå University, Sweden
  Human olfaction: For better for worse
- Professor Larry Lockshin, University of South Australia, Australia
  West versus east: The development of sensory and non-sensory preferences in Chinese wine consumers
- Dr Henriette de Kock, University of Pretoria, South Africa
  Challenges in emerging markets
- Anne Goldman, Consumer Research ACCE International, Canada
  Beyond food: Has sensory science achieved its potential?
- Richard Juhlin, Champagne Club, Sweden
  The world's champagne nose: Experiences and expectations
- Professor Richard Mattes, Department of Food and Nutrition, Purdue University, USA
  Weight management: Taste compounds that activate the senses and debate
- Dr Nathalie Martin, Nestlé Research Center, Lausanne, Switzerland
  Consumer driven product and communication design
- Dr Sophie Nicklaus, INRA, Dijon, France
  The role of sensory pleasure in driving eating behaviour in infants and children
- Dr Dag Piper, Head of Sensory & Consumer Science, MARS, Germany
  Sensory Recall: Forgotten sensory cues in the context of culture and media in our daily lives
- Dr Michael Siegrist, Consumer and Behavior ETH, Zurich, Switzerland
  Critical thinking about food choice experiments: The crucial role of models used
- Professor Dana Small, Department of Psychiatry, Yale University, USA
  Deconstructing flavour
- Dr Paula Varela, Nofima, Norway
  Advances in sensory and consumer tools and methods: "From rating to not asking and back again"
- Thierry Worch, Project Manager, QI Statistics Reading, UK
  Use of statistics in sensory science: Dos and don'ts

The organisers are planning to make Pangborn 2015 an extraordinary meeting place for scientists, students, sponsors and companies by facilitating unexpected meetings and contacts which may initiate new collaborations and new networks. For more information, and for details on how to register, please visit the conference website.

Date: 23-27 August **Location:** Gothenburg, Sweden
Website: www.pangborn2015.com

Q&A

Lukas Märk, CEO of proton transfer reaction–mass spectrometry (PTR-MS) specialist IONICON, discusses how the technology has advanced the field of sensory science.

What is PTR-MS and how has it revolutionised aroma and flavour profiling?

PTR-MS is a soft chemical ionisation mass spectrometry technique allowing for detection and analysis of low concentrated volatile organic compounds (VOCs) in real time without sample preparation. This is not necessarily possible with traditional methods such as gas chromatography MS (GC-MS) etc., where highly relevant dynamic information from the experiment could be lost during the sample pre-treatment.

IONICON PTR-MS instruments can capture dynamic VOC fingerprints with a high time resolution directly where the aroma originates, enabling the operator to collect e.g. the head-space of an espresso coffee or even mouth/nose-space of a panellist tasting a fruit. Flavour profiles can subsequently be created from quantitative real time data using chemometric methods.

Can you provide some examples of applications?

In food and flavour science, typical applications of PTR-MS are the analysis of coffee, olive oil, butter, cheese, wine, fruits, herbal extracts etc. Sometimes, also convenience products such as detergents, air fresheners, shampoo or fragrances make it to our lab. Nowadays, even the sensory impact of car interiors or aircraft cabins is subject to scientific analysis with our solutions. There is an infinite range of applications for PTR-MS, in the lab but also in the field. In general, whenever there is a smell or taste, IONICON instruments can capture it. Our quadrupole and time of flight-based PTR-MS systems quantify VOC concentrations as low as 1pptv and provide immediate feedback to the operator.

About the Author

Lukas Märk started his professional career at IONICON in 2005 as Marketing and Sales Manager. His focus was to establish a balanced marketing and sales strategy for the unique PTR-MS technology that was commercialised by IONICON in 1998, find new application areas and develop new market driven products, as well as to implement a worldwide distribution network.

In 2011 he became CEO of IONICON, which had grown more than two times in turnover and employees since 2005. It emerged from a PTR-MS manufacturer to a service, solutions and R&D oriented trace gas analysis company that now also produces its own time of flight mass spectrometers. As CEO, he dedicates a lot of his work to new business and market development including many collaborative projects with academic and industrial partners. He holds a Master's degree in International Business Sciences.