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Descriptive sensory analysis with integrated quality rating as a tool for quality testing of commercial food products

Beschreibende sensorische Analyse mit integrierter Qualitätsbeurteilung als Methode der Qualitätsbewertung kommerzieller Lebensmittel

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Summary

About 25,000 food samples are submitted annually for quality testing of DLG by around 3,000 independent, certified and specialised expert assessors. Depending on the food, tests are carried out in panels of three to ten panellists, with each expert performing and documenting a 'descriptive analysis with integrated quality rating' as described in DIN 10975. If the judgements differ, a consensus is reached under the supervision of a mediator. The consensus usually means a harmonisation of the mental standards.

The sensory principles (including assessment method, qualification of experts and their training) of the DLG quality tests and, specifically, the importance of the internal standard of the experts in terms of achieving an objective sensory assessment of product quality are discussed in detail.

Keywords: Sensory analysis, DLG quality tests, expert product assessor, descriptive panel, product rating, mental sensory product standard

Zusammenfassung

Ungefähr 25.000 Lebensmittelproben werden jährlich zu den freiwilligen Qualitätswettbewerben der DLG eingesandt und von ca. 3.000 unabhängigen, zertifizierten Experten getestet. In Abhängigkeit vom Lebensmittel umfassen die Prüferpanels drei bis zehn Personen, wobei jeder Experte für jedes Lebensmittel eine „Beschreibende Analyse mit integrierter Qualitätsbeurteilung“ nach den Prinzipien der DIN 10975 durchführt und dokumentiert. Falls die individuellen Bewertungen differieren, wobei es sich meist um Unterschiede im inneren Standard handelt, wird ein Konsens unter Aufsicht eines Mediators herbeigeführt.

Die Voraussetzungen für eine neutrale Qualitätsbewertung einschließlich der vielfältigen organisatorischen Maßnahmen sowie der Expertenauswahl und -schulung werden eingehend beschrieben. Als wesentliche Voraussetzung für eine objektive Bewertung der jeweiligen sensorischen Lebensmittelqualität müssen die DLG-Experten einen aktuellen und repräsentativen inneren Standard der Beschaffenheit eines einwandfreien, vom Verbraucher in allen Merkmalen akzeptierten Produktes besitzen.

Schlüsselwörter: Sensorische Analyse, DLG-Qualitätswettbewerbe, deskriptives Panel, integrierte Qualitätsbeurteilung, innerer sensorischer Lebensmittel-Standard

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Introduction

"Salus populi suprema lex" (the welfare of people is the most important law) was the motto of the engineer, author, traveller and painter Max Eyth who founded the German Agricultural Society, DLG, (Deutsche Landwirtschafts Gesellschaft) in 1885. He modelled this national association for agricultural exhibitions on the Royal Agricultural Society of England (RASE).

Max Eyth's objectives included providing long-term support for food producers' quality initiatives and making quality more transparent for all market players. As early as 1891, the DLG began its first quality test, which involved carrying out a sensory assessment on 500 samples of storable food for export and for on-board provisions (Fig. 1). The demand from food producers for the DLG's quality tests has risen continuously over the years, and 25,000 samples are now submitted annually from across the food industry (Fig. 2; Tab. 1).

Other food producers from Europe and beyond are increasingly becoming involved (Hildebrandt et al., 2011). Any manufacturer can voluntarily register and submit products for the DLG quality tests. The DLG experts give the food samples a gold, silver or bronze quality grading, depending on the degree to which they meet the sensory standard of a perfect and faultless item. Unsatisfactory samples remain ungraded. The requirements for the product test and evaluation are defined by the DLG certification unit and are accredited in accordance with the international standards DIN EN 45011 and DIN EN ISO/IEC 17024.

To establish confidence in the objectivity of the quality tests, this quality grading was designed from the outset as a descriptive assessment which is carried out by experts who are familiar with the products and are trained in sensory analysis. Authorised representatives with a scientific background review the results.

That is why scientists have always been appointed as the voluntary scientific authorised representatives of the corresponding DLG quality tests for the products, and also why this will not change in the future. The scientific representatives maintain the DLG's sensory testing method, which is a descriptive sensory analysis with integrated quality rating (expert opinion), and adapt it to the latest scientific findings and market requirements.

FIGURE 1: *DLG-tests in the beginning.*

FIGURE 2: *DLG-test today.*

TABLE 1: *Summary of the product categories tested each year and total sample figures from 2011.*

Product category	Samples tested in 2011
Hams and sausages	7300
Ready to eat meals and delicatessen	5000
Bakery and confectionery products	6000
Dairy products	3950
Wines and sparkling wines	4700
Other beverages (juices, spirits, water ...)	2550
Organic products	1000
Edible oils	100
Coffee	50

Methods and requirements of DLG sensory quality tests

Product standards

There is a certain ideal quality for every clearly defined and distinguishable product group. This ideal is shaped by *bona fide* manufacturing custom and valid customary consumer acceptance, and could be described as the 'consumer's idea of a product in perfect condition'. Any deviation from this reference product, i.e. any difference between the actual condition and the ideal for the type of product concerned, is regarded as a defect (or 'negative attribute' or 'fault' or 'deviation'). These quality deviations can be categorised into two main types. The first are production defects resulting from unsatisfactory choice of raw materials or inadequate technology, and the second are 'recipe defects' (inaccurate choice of ingredients or proportions).

The decision to measure the sensory quality of a product sample against a standard for that product class is merely a first step. The next step is to make a fundamental choice between a specific reference sample and an abstract, notional ideal. A narrowly limited standard would seem to be the appropriate choice for internal company quality assurance, either in the form of a tangible gold standard or an intangible precise specification, which includes at most the raw material and manufacturing process variations tolerated by the company. For industry-wide and cross-organisational quality tests or quality comparisons, however, it makes no sense to hold up real reference samples as representatives of an ideal product. What is needed here is a mental standard of the sensory profile of a product without any defect. This benchmark must not be selective; it must satisfy the requirement for a "correct picture of the cluster of defect-free items which correspond to the general consumer perception in terms of all sensory product qualities". Such specifications must *a priori* include both the range of product-specific characteristics as claimed by the variability of consumer expectations, and the company-specific spread for appearance, texture, aroma, and flavour. In terms of sensory aspects, this range of market-compliant products represents the 'hedonic range' and includes the unique selling propositions of many manufacturers. So, for example, within this range of product qualities, milk chocolate that is soft and melts in the mouth, and that which is firm to the bite can both be perfect. But consumers do not expect dark chocolate to be soft. Despite differences in the sweetness and carbonation, Coca Cola® cannot be said to be inferior to Pepsi Cola® or vice versa, because worldwide consumer acceptance decrees that both caffeinated soft drinks have been legitimised as being without defects. In a free market economy differences in the sensory profiles, which are specific for different brands, enable consumers to make an informed choice.

The basis of an 'analytical' sensory test is that a sensory panel determines the intensity of stimuli of given descriptors. To enable a decision to be made about the quality of the sample, the descriptive results are compared with a predetermined standard by an independent person. However, the requirement to describe and document product-class-specific standards with hedonic range (which also applies to quality tests such as done by the DLG) must be measured against the following specific features of these product tests (Hildebrandt, 2000):

- Hundreds of food types are subjected to the DLG quality tests. This would require the same number of product standards to be written, including the hedonic range of the descriptors, even though in many cases only single samples are tested for each product type.
- For most food types, the samples have to be tested for at least 80 possible sensory defects, which all have to be documented in the test report. Moreover, particular defects (such as 'unbalanced seasoning') have to be further specified. Finally, 'miscellaneous' defects also have to be noted. Selecting only characteristics of higher incidence is not appropriate for DLG quality tests, because any non-conformity with the sensory expectation of the consumer must be identified.
- The acceptance of a sample also requires the intercorrelation of various stimuli. It is almost impossible to identify this from the evaluation of individual descriptors, but it would be possible to address it in the relevant standard.
- The requirements concerning sensory quality are constantly changing, so the descriptive standards would have to be continuously adapted. This is not practical at all.

In practice, only in very rare cases will an expert assessor be capable of writing specifications that meet the requirements of a quality test and would be accepted as a basis for assessment by all clients.

Expert panels

The small differences between average, good and superior quality are especially difficult to locate and describe (Powers, 1981). A sensory method must therefore be found which takes account of the purpose and intention behind the quality tests. Such a solution is offered by the use of expert product assessors trained in sensory testing and who are referred to below as experts (Hildebrandt et al., 2010). This resolving is based on the successful model applied in quality inspection (Hughson and Boakes, 2002; Lawless and Heymann, 1998; Piana et al., 2004; Stone and Sidel, 1993). The superiority of experts over non-experts has already been established for many questions of sensory analysis (Bende and Nordin, 1997; Bitnes et al., 2007; Clapperton and Piggott, 1979; Labbe et al., 2004; Lawless, 2006; Lehrer, 1975; Moskowitz et al., 1979; Par et al., 2004; Roberts and Vickers, 1994; Schifferstein, 1996; Wolters and Allchurch, 1994).

Experts carry out both, the sensory testing and the rating of the samples. According to DIN 10975 "Sensory testing – expert judgement according to food law" (DIN, Deutsches Institut für Normung, German Institute for Standardisation) the definition of an expert runs as follows: "The expert is a tester who is qualified as a sensory assessor and who also has the knowledge and skills of a specialist assessor i.e. has received product-specific training and has knowledge and experience of the product group. He or she should also be capable of assessing, based on the findings of the sensory test, whether a sample is marketable under food law. This requires the tester to have a representative and up-to-date mental standard of the general consumer perception of the sensory quality of the food he or she is to test, acquired through professional experience, training and continuing professional development."

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This definition also applies to expert opinion in the DLG quality tests, with the difference that the mental standard does not refer to conditions of products as consumable and edible, where minor negative deviations are tolerated, but to good manufacturing practice for a class of products. The experts either confirm the absence of any deviation from the sensory specification or they supply to the submitter of the sample specific information on how to improve the quality of the product and which non-conformities have been identified and specified. By combining the functions of describing and rating into one person, the expert opinion resembles the integrated opinion-forming of consumers, albeit this is done at a level that is as objectively rational as possible rather than individually affective. Sulmont-Rossé and Köster (2009) also confirmed the importance of the internal standard when they said: "… indications have been obtained that methods based on food memory may be more important for the measurement and prediction of food appreciation than the traditional methods based on perception".

The DLG has a pool of more than 3,000 voluntary experts whose characteristics are largely congruous with the definition of 'specialized expert assessors' pursuant to ISO 8586-2:2008. The majority of them have a background in industrial or artisanal food production, but there are also experts from retail, academia, food laboratory services and governmental food control. It is almost impossible to find consumers who fulfil the requirements made of experts, due to their lack of product knowledge and technological expertise. But the very high percentage of experts from food enterprises ensures that the market requirements are taken into account and the mental standard of the experts represents that of the relevant consumers too. On the other hand experts are receptive to the changes and needs of producers (Piana et al., 2004).

Test method and tools

The test method used by DLG is a "descriptive sensory analysis with integrated quality rating". Sensory expert panels and standardised test schemes are the main characteristics of this quality product test, which scientific basis lies within the Karlsruhe quality scale, developed in 1942. This concept of the early days of sensory quality test methods, also referred to as an 'evaluating test with scale' is a two-dimensional system (Paulus et al., 1969). One axis, which represents the specific part of the scale, shows the quality features which characterise the product concerned. The other, non-specific axis shows the measure chosen to assess all these features, the scale. Generally, high numerical scores represent high quality in the characteristic.

The variety of foods tested by the DLG necessitates a compromise between lists of characteristics exactly tailored to each specific class of product on the one hand, and a universally applicable terminology on the other. The test sheets, which are used today, have been developed for categories or groups of items which group together products with a similar profile of characteristics. These test sheets, known as the DLG 5-point test scale *(DLG-5-Punkte-Prüfschemata®),* list all the descriptors which are important for the assessment, regardless of whether they are of relevance for all product types or just individual classes. The test sheets are usually designed exclusively as defect lists. They therefore enumerate all known material-related and technology-related effects that can have a negative influence on the sensory profile of the test subject and which have to be identified by the expert. However, such tables make no claim to be exhaustive, which is why a 'miscellaneous defects' section is needed. Hedonic attributes such as those used by the Irish National Food Awards (O'Sullivan et al., 2011) are absent. For the subsequent evaluation the individual descriptors are summarised on a product-specific basis into three up to six test characteristics (e. g. appearance, texture, odour, and taste) and, as mentioned above, grouped into the product-specific DLG test sheets, the DLG 5-point test scale. All DLG test scales are aggregated in the DLG test regulations which are updated annually (DLG Certification Unit, 2012). A booklet on basic terminology for sensory analysis has recently been published (Jacob et al., 2012), which should help to bring about additional transparency and standardise the description of the sensory perceptions of the experts.

Although a variety of descriptors is used in the product-specific DLG 5-point test scale, DLG quality tests always use a non-specific evaluation system with a 6-point scale for all products. According to this scale, a score of between 0 and 5 can be awarded according to the intensity of the characteristic being graded. Each of these scores is associated with a verbal descriptor in the style of a school grades system, a general description of the property and an indication of the probability of detecting a deviation from the internal mental standard (Tab. 2). The scores awarded during the testing are added up and a weighting is given, based on the groups of characteristics. The total quality score thus produced determines what award the product will be given. For some tests laboratory ratings are also included in the final grade. Only when the mental specification is completely met a product can be described as defect-free and given the maximum score of 5.0. Such

TABLE 2: *Nonspecific evaluation scale.*

Points	Quality description	General description of characteristic
5	Very good	Does not deviate at all from expected quality
4	Good	Slight deviations
3	Satisfactory	Moderate deviations [1])Dairy products
2	Less satisfactory	Notable deviations
1	Not satisfactory	Clear defects [2])Wine
0	Fail	unfit for evaluation

[1]): Dairy products: minor defects; [2]): Wine: wine defects ascertained

Deviations from mental standard:	
slight (4 points)	Is detected by a panel of expert assessors with certainty.
moderate (3 points)	Is detected by an individual expert with certainty, and with a high degree of probability by a non-professional assessor with product experience.
clear (2 points)	Is detected by the average consumer with high level of probability; the product is categorised by the expert as failing to reach the minimum standard for grading, because the deviation is so pronounced.
strong (1 point)	Is categorised by all testers as failing to reach the minimum standard for grading because the deviation is so pronounced.
fail/excluded from testing (0 points)	Describes a product which is unfit for consumption because it is spoiled or because the sensory deviations are so serious, that it cannot be marketed according to food laws.

products achieve the gold DLG award (or gold medal), while products with minor or moderate deviations (defects) receive the silver or bronze DLG award. If there are major defects or an accumulation of defects, the product does not receive any award at all.

The standardised concept of the DLG test sheets and assessment method ensures clarity and transparency while taking account of the characteristic properties of each class of product. An example of a test sheet is given as Fig 3. “Test schedule of cooked ham”. A standardized wording enables the producer to do corrective actions concerning the raw material and/or the technological process on the basis of the identified sensory deviation. In the case of Frankfurter and Mortadella-type sausages a computer program was developed which helps the enterprise to draw the right conclusions from the DLG-report (Kaiser et al., 2001).

Organisation and procedure of sensory quality tests

Under the auspices of the DLG society, the Test Centre Food and the certification unit are responsible for the quality tests. Product tests for each product group are organised annually, which can involve up to 1,500 samples and last for one or two days. All the tests are carried out by independent, external, voluntary, unpaid experts. Depending on the product group, the experts work in panels of three, four, five or ten (beer only) that generally test 20–25 samples per cycle (three to four hours). The test takes place in two stages as a sensory analysis with integrated quality rating. The first stage is an independent individual test in which each expert assesses the sample for him- or herself, identifies any deviation from his/her mental standard and notes his/her finding in the test report (DLG 5-point scale). In the second stage, the individual results are compared and the panel has to agree on a group score. If there are differences between the individual findings concerning the identified deviation and/or the affiliated scoring, the differences are discussed in the panel. In a regulated problem-solving process which may be overseen by a mediator and involves additional experts being called in, discrepancies are eliminated in order to achieve a unanimous score. Costell (2002) has pointed out that the mental expert standards often show a lack of concordance. The resultant risk of an incorrect judgement is reduced to the greatest extent possible in the DLG quality tests by the testing being carried out independently by several experts and followed by a consensus-finding process. Experience has shown that for simply structured (often homogenous) foods, such as milk, butter, and mineral water expert opinions are rarely divergent. As the matrix or the sensory product qualities becomes more complex – the extreme case being multi-component dishes in the area of convenience food – the incidence of different individual findings (scores) increases. In these cases the experts have to question their mental specification and ultimately agree on a common standard or a common test result.

In addition to the use of standardised test reports, selected specialised expert assessors and a strictly regulated decision-making process, there are a number of additional measures that help to ensure the objectivity of the test. These include regulated standardised procedures for transport, storage, presentation and appropriate preparation of the items. All samples must be neutralised in order to exclude expectations associated with brand (Cardello, 1995; Lawless, 1995) or warranty (Blair and Innis, 1996). Before each testing event the main principles, which have been standardised by the DLG, are recalled again to the experts. As a kind of 'warm up' and to ensure homogeneity among the experts, the sensory testing itself starts with the assessment of a calibration sample by several panels. This provides a good basis for comparison and enables a plausibility check of the mental standard of each expert.

In cases of doubt, e.g. where heterogeneous defects are assumed, reserve samples can be requested, thereby enabling several samples to be tested and their quality compared.

Following the quality test there are a number of activities to verify and validate the system. These include a general final meeting of all experts and complaint procedures for the submitters. Independent institutes carry out sensory testing on a representative number of samples, the quantity of which depends on the total number of samples to be tested.

Annual meetings of the scientific authorised representatives, who also regularly publish their experience of the annual DLG quality tests in professional food journals, help to ensure that the tests are continuously improved. Additional measures include the creation of a DLG Sensory Centre, scientific support by a sensory working committee, scientific seminars and congresses, publication of the DLG test magazine, various brochures and the 'Worlds of Taste' book (Hildebrandt, 2008). Last, but not least, relevant research assignments are awarded to other institutes.

Additional laboratory tests are carried out for most beverages, although only in the case of beer and milk/milk products are these directly included in the overall assessment. If there is any suspicion or indication of deterioration or adulteration during the sensory assessment, additional chemical, physical or microbiological tests can be performed on the samples for all product categories.

Panel training, calibrating and monitoring

Only well-trained panellists who carry out sensory assessments as part of their job are recruited for the DLG quality tests. However, additional training is still necessary. This primarily focuses on applying the DLG testing system, particularly the use of the test sheets (DLG 5-point scale), understanding of the decision-making rules, individual testing, and consensus-forming within the panel. The training ends with a qualification test. This starts by testing the candidate's general ability to identify and quantify sensory stimuli using recognition, ranking and triangle testing. These tests are necessary as a means of calibrating the testers (Tempere et al., 2011). Then the product-specific part follows, where expert opinions are delivered in respect of food samples, some of which may contain deliberate defects. Provided a threshold score is achieved, an independent examination and award committee comprising external experts confers a certificate which attests to the sensory and product-specific competence of the successful participant.

The exams also provide information on the precision and trueness of the expert opinions. For example, during the training of meat product expert assessors it was possible to calculate the differences between the panellists in the

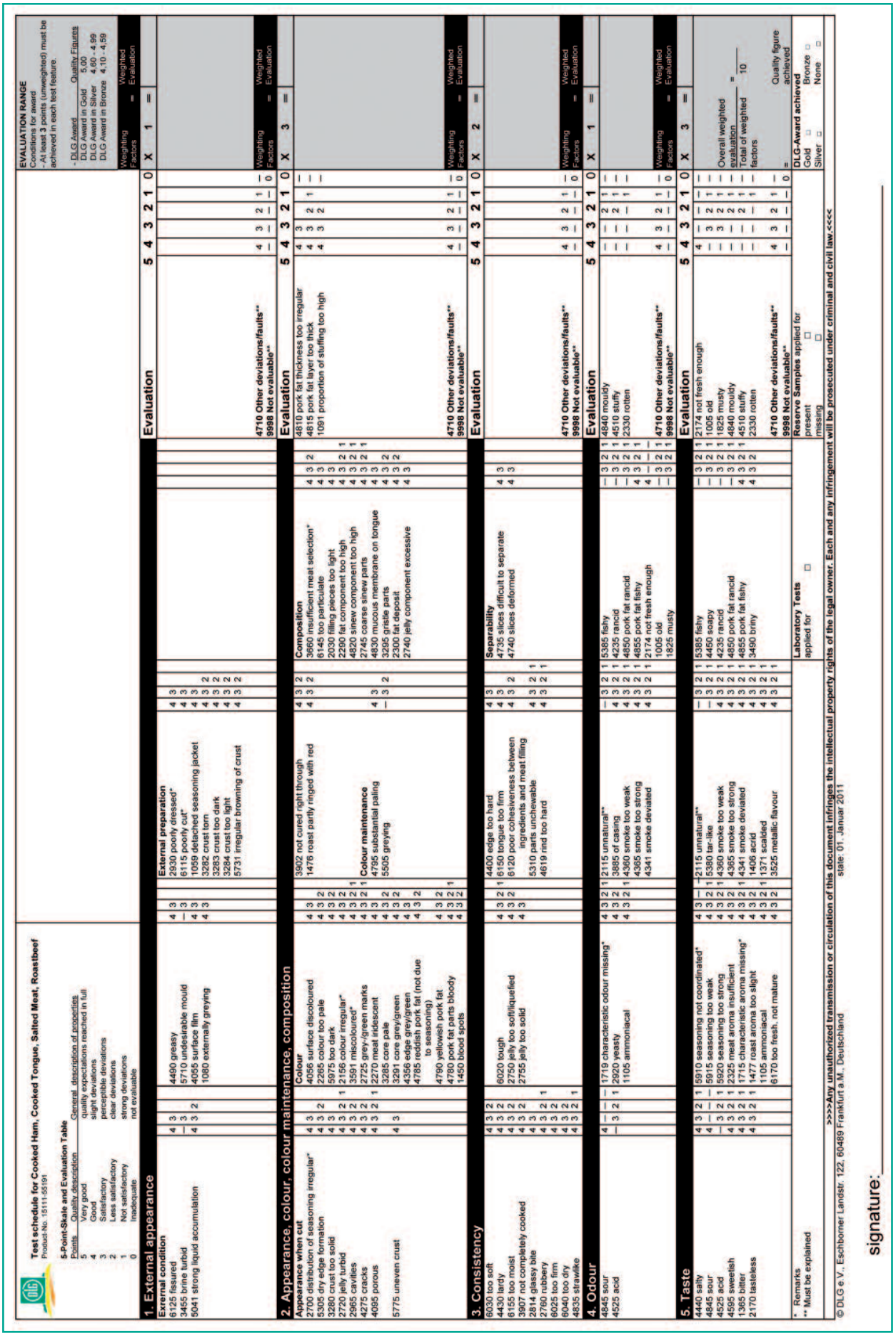

FIGURE 3: *Example for a test schedule on cooked ham (DLG-5 point test scale DLG-5-Punkte-Prüfschemata®).*

award of overall scores between 0 and 5 using the difference matrix. This parameter R is based on the scoring difference of each tester with every other tester. The median for the 32 sets of data was between R=0.1 and R=0.4, whereby the values for salami sausage were higher than those for spreadable liver sausage and blood sausage, which in turn were higher than those for frankfurters/wieners. Additionally it was shown with the help of the difference matrix that tests in panels of three produced less variable scoring than individual tests (Hildebrandt et al., 2010). To quantify the influence of tester, manufacturer and batch on the DLG 5-point scale, 14 cycles have been carried out using the example of spreadable liver sausage. As shown by ANOVA, in eight out of 14 cycles the rating variations attributed to the panellists were >50 %. In four cycles, a significant difference was detected between parallel samples of one batch (Bracher-Schroedl et al., 2010). Working with well-trained panels, the use of DIN 10975 'Descriptive analysis with integrated quality rating'/ expert opinion – as is the case for DLG quality tests – leads to virtually the same results as applying DIN 10969 'Descriptive analysis with added quality judgement' (Franke, 2001; Hildebrandt, 2000).

Conclusions

Costell (2002) does not trust in the trueness and precision of sensory expert opinions. He emphasizes that the use of mental standards by one or several experts to define a quality of a food product presents two serious problems, derived from the possible difference between the mental standard used by the experts and from the fact that their opinions are not representative of consumer opinion. On the other hand the author postulates that this position must be reconsidered because in some cases the performance of experts is not only admissible but recommendable. One of these situations is when the characteristics of the product will not be directly evaluated by the consumer (e. g. raw materials and ingredients) and another situation is when small differences between quality grades of exceptional sensory characteristics must be evaluated (e. g. wine, coffee, olive oil). This statement calls into question the DLG's claim to have found the appropriate and universal solution for food quality contests with the help of the descriptive sensory analysis with integrated quality rating (expert opinion). However, an evolutionary process lasting more than 100 years means that the DLG assessments have become increasingly reliable for all tested foods. The selection and training of the experts and the standardisation of the test procedure in particular are among the aspects which have been optimized. One characteristic that all tests have in common is the documentation of the individual expert opinions with a subsequent consensus judgement.

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Neue Waffe gegen die Krankenhauskeime? Studie weist MRSA-Schutz durch Vitamin B3 nach

Vitamin B3 schützt vor gefährlichen Keimen: Eine Forschergruppe um den Krebsforscher Privatdozent Dr. med. Nils Thoennissen von Universität Münster und seinen neuseeländischen Kollegen Dr. Pierre Kyme, PhD, hat in den USA herausgefunden, dass hohe Dosen von Nicotinamid (Vitamin B3) bei der Bekämpfung bestimmter Bakterien, die als „Krankenhauskeime" gefürchtet sind, helfen. Die Ergebnisse hat das Team nun im „Journal of Clinical Investigation" veröffentlicht.

Nicotinamid wirkt unter anderem gegen diejenigen Stämme des Bakteriums *Staphylococcus aureus (S. aureus)*, die gegen viele Antibiotika resistent sind und sich deshalb nur schwer bekämpfen lassen. Zwar tragen rund 70 Prozent aller Menschen *S. aureus* unbeschadet auf der Haut, bei bereits geschwächten Patienten kann das Bakterium jedoch zu Haut- und Weichgewebeinfektionen sowie zu Lungen- und Knochenentzündungen führen – deshalb sind die antibiotikaresistenten Stämme gerade in Krankenhäusern gefährlich.

„Bestimmte weiße Blutkörperchen – die neutrophilen Granulozyten – spielen im angeborenen Immunsystem eine wichtige Rolle bei der aktiven Bekämpfung schädlicher Mikroorganismen", erläutert Thoennissen. „In unseren Versuchen haben hohe Nicotinamid-Dosen die Neutrophile sowohl bei lebenden Mäusen als auch im menschlichen Blut im Reagenzglas gestärkt. Die Neutrophile schütteten dadurch vermehrt antibakteriell wirkende Stoffe aus." Die Vitamingabe wirkte in Experimenten gegen MRSA und gegen Pseudomonas, eine weitere Bakteriengattung, die zunehmend in antibiotikaresistenter Form auftritt.

Riskant scheinen die in den ersten Versuchen verwendeten Nicotinamid-Dosen nicht zu sein, in anderem Zusammenhang haben sie sich längst bewährt: „Vor der Bestrahlung von Krebspatienten kann Nicotinamid in hohen Dosen verabreicht werden, um das Ansprechen von bestimmten soliden Tumoren zu erhöhen", sagt der Krebsforscher Thoennissen. „Die bisher eingesetzten Dosen entsprechen etwa dem 300-fachen der von der Deutschen Gesellschaft für Ernährung empfohlenen Tageszufuhr". Nebenwirkungen, so Thoennissen, seien erst bei noch größeren Mengen zu erwarten, jedoch fehlen hier groß angelegte Studien. Der neue Angriffsweg gegen multiresistente Keime könnte in Zukunft in Krankenhäusern und anderen Risikoumgebungen sowohl vorbeugend als auch therapeutisch genutzt werden. Zuvor sind klinische Studien nötig, um die Wirksamkeit am lebenden Menschen zu belegen und mögliche Risiken und Nebenwirkungen aufzudecken.

Thoennissen forschte von Anfang 2008 bis Mitte 2010 an der University of California, Los Angeles (UCLA). Das Forschungsvorhaben, in dem die Forscher überraschend auf die Nicotinamid-Wirkung bei der Keimbekämpfung stießen, war ursprünglich ein Nebenprojekt zur Untersuchung von immundefekten Mäusen. Inzwischen arbeitet und forscht Thoennissen wieder in der Medizinischen Klinik A des Universitätsklinikums Münster.

Im Juni wurde er für für ein anderes Thema – solide Tumoren und Akute Myeloische Leukämie – mit dem mit 10.000 Euro dotierten Nachwuchsförderpreis der Universität Münster ausgezeichnet.

Weitere Informationen (Quelle):
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www.uni-muenster.de