Leibniz Institut
Deutsche Forschungsanstalt für Lebensmittelchemie

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Contents

Summaries

1. STUDIES ON THE HEDONIC VALUE OF FOOD - AROMA AND TASTE (FLAVOUR) AS PARAMETERS FOR FOOD QUALITY

1.1. Aroma of heated meat

The research on the aroma of heated meat was continued with a study on the juice which was formed during the stewing of beef. The potent odorants of stewed beef juice (SBJ) were screened by aroma extract dilution analysis and static headspace analysis which was performed in combination with GC-sniffing. The potent odorants were identified and then quantified by stable isotope dilution assays. The odorants were added to an oil in water

emulsion of pH 5.7 in various combinations and in concentration levels equal to those in SBJ. The aroma of each model was compared with that of the original SBJ. The results indicated 12 volatiles, e.g. methanethiol, 4-hydroxy-2,5-dimethyl-3(2H)-furanone, 12-methyltridecanal, as the character impact odour compounds of SBJ.

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1.2. Rapid detection of high volatile odorants causing odour differences in foods

Gas chromatography/olfactometry of headspace samples (GCO-H) was used to

- detect the high volatile odorants responsible for odour defects in boiled cod (Gadus morhua) and boiled trout (Salmo fario);
- compare the high volatile odorants of roasted coffee powders and brews.

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1.2.1. Fish

The most potent high volatile odorants occurring in the air above boiled cod and trout were evaluated by GCO of decreasing headspace volumes. Acetaldehyde, dimethylsulfide, dimethyltrisulfide and (Z)-1,5-octadien-3-one were found in the smallest headspace samples of boiled cod, and acetaldehyde, propionaldehyde, methional, 1-octen-3-one and (Z)-1,5-octadien-3-one in those of boiled trout. Storage of the raw material at -13°C led to odour defects in the boiled fish. The increase of trimethylamine, butane-2,3-dione, methylpropanal, 2- and 3-methylbutanal in cod, and that of acetaldehyde, propionaldehyde, butane-2,3-dione, pentane-2,3-dione, C6-, C8- and C9-carbonyl compounds in trout contributed to the formation of the odour defects.

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1.2.2. Coffee

2,3-Butanedione, 2,3-pentanedione, 3-methyl-2-butenthiol (I), methional, 2-furfurylthiol (II) and 3-mercapto-3-methylbutylformate (III) were the key odorants of both, the powders of Arabica and Robusta coffee. 2-Methyl-3-furanthiol (IV), 2,3-diethyl-5-methylpyrazine and an unknown compound were additional key odorants of the latter. An increase in the odour potencies of acetaldehyde, propanal, methylpropanal, 3-methylbutanal and dimethyltrisulfide as well as a decrease in the odour potencies of the thiols I to IV in the brews were the major differences compared to the powders.

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1.3. Studies on the flavour of puff-pastry

The most important odorants in aroma extracts of puff pastries prepared by using butter (I) or margarine (II) were compared by application of aroma extract dilution analyses. The data revealed high FD-factors for delta-decalactone, (E)-2-nonenal, 4-hydroxy-2,5-dimethyl-3(2H)-furanone (HDF), butanoic acid and 3- and 2-methylbutanoic acid in I, while (Z)-2-nonenal, 4,5-epoxy-(E)-2-decenal, (E,Z)-2,4-decadienal, (E)-2-nonenal and HDF were the most odour-active compounds in II. A calculation of odour activity values (OAV; ratio of

concentration to odour thresholds) confirmed that, compared to I, especially the significantly higher OAV's of the metallic smelling 4,5-epoxy-(E)-2-decenal and the fatty, green smelling (E,Z)-2,4-decadienal in II are mainly responsible for the differences in the overall flavours of both products. Model experiments in which several possible precursors of trans-4,5-epoxy-(E)-2-decenal were singly degraded, revealed that the odorant is formed in significant yields from 13-hydroperoxy-9,11- (13-HPOD) and 9-hydroperoxy-10,12-octadecadienoic acid (9-HPOD). The key intermediates in the generation of the epoxyaldehyde were found to be 2,4-decadienal (9-HPOD) and 12,13-epoxy-9-hydroperoxy-10-octadecenoic acid (13-HPOD). Isolation and characterization of the precursors from a commercial baking margarine confirmed glycerine bound 9- and 13-HPOD as the intermediates in the formation of the epoxyaldehyde during heating of fats, e.g. during baking.

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1.4. Important odorants in the crumb of French bread

The most important odorants in the crumbs of wheat breads (French-type) prepared from two different dough recipes using prefermentation (crumb I: liquid preferment, containing 0.25 % yeast and 1.5 % yeast in the final dough; crumb II: soft-dough preferment containing 15 % yeast and 4.6 % yeast in the final dough) were evaluated on the basis of aroma extract dilution analyses. In crumb I, exhibiting the more typical flavour, comparatively higher FD-factors were found especially for 2-phenylethanol and 3-methylbutanol, while in crumb II the FD-factors of methional, 1-octen-3-one, 4-hydroxy-2,5-dimethyl-3(2H)-furanone, butanoic acid and 2- and 3-methylbutanoic acid were higher than in crumb I. Quantitative studies (stable isotope dilution assays) on the formation of 2-phenylethanol (2-PE) and 3-methylbutanol (3-MB) in liquid preferments revealed that low concentrations of yeast (0.25 %) as well as anaerobic conditions favoured the production of both odorants. Model studies, in which either the 3-MB precursors L-leucine and 3-methylbutanal or the 2-PE precursors L-phenylalanine and phenylacetaldehyde had been added to the preferments indicated that bakers yeast significantly (15 to 55 %) converted these precursors into the respective odorant.

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1.5. Important odorants in roasted white and black sesame seeds

In the overall flavour of roasted black sesame seeds an unpleasant fatty-tallowy odour occurs, which is not detectable in roasted white seeds. Application of an aroma extract dilution analysis on an extract of roasted black sesame seeds revealed (E,E)-2,4-decadienal, 2-methoxyphenol, and 2-pentylpyridine followed by 2-furfurylthiol, 4-hydroxy-2,5-dimethyl-3(2H)-furanone, 2-ethyl-3,5-dimethylpyrazine and an unknown compound with a sulfurous note as the most important odorants in the overall flavour. A comparison with the key odorants previously identified in roasted white seeds on the basis of odour activity values (OAV: ratio of concentration/ odour threshold) indicated that the fatty, tallowy note predominant in the black seeds was mainly due to a comparatively higher OAV of the tallowy-smelling 2-pentylpyridine and a lower OAV of the roasty-smelling 2-furfurylthiol in the black seeds. Furthermore, unpleasant odour notes induced by roasting white seeds at temperatures above 200°C were well correlated with high OAVs of 2-phenylethylthiol, 2-methoxyphenol, and 2-pentylpyridine. The data suggest especially the three latter compounds as indicators for the assessment of sesame flavouring produced e.g., from different varieties of by application of different roasting conditions.

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1.6. Bitter taste of enzymic hydrolysates of casein

Casein and its major fractions, alphas1-, beta-, alphas2- and kappa-casein, which were obtained by anion exchange chromatography, were partially hydrolysed with five different proteases (trypsin, alpha-chymotrypsin, corolase PP, corolase PN and corolase 7092). The hydrolysates were then characterized by the determination of recognition thresholds for bitter taste. The results indicated that all hydrolysates did have a bitter taste, but only alphas1- and beta-casein contributed decisively to the overall bitterness of the casein hydrolysates. Generally, trypsin caused the most intense bitterness, whereas the bitter taste of the corolase hydrolysates was weak. The investigation of alphas1-casein hydrolysates obtained by the different proteases showed that only a few peptides contribute to bitterness. Typical for these bitter peptides was the high average hydrophobicity. The specifity of the protease determined hydrophobicity and amount of such peptides. The weak bitterness of the corolase hydrolysates could be explained by the higher degree of fragmentation and the decrease of the average hydrophobicity of peptides by cleaving off terminal hydrophobic amino acid residues.

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1.7. Furanoid fatty acids in oils from soybeans lacking lipoxygenase isoenzymes

The concentrations of 10,13-epoxy-11,12-dimethyloctadeca-10,12-dienoic acid (F20) and 12,15-epoxy-13,14-dimethyleicosa-12,14-dienoic acid (F22) were determined by a stable isotope dilution assay in oils extracted from the soybean cultivar Century and from five soybean genotypes lacking one or two of the three lipoxygenase isoenzymes. The concentrations of F20 and F22 ranged between 183 to 225 mg/kg oil and 91 to 132 mg/kg oil, respectively. The concentration differences were not correlated to the differences in lipoxygenase activities of the soybeans.

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2. STUDIES ON THE RELATIONSHIP BETWEEN THE STRUCTURE OF BIOPOLYMERS AND THEIR TECHNOLOGICAL PROPERTIES. TEXTURE AS QUALITY PARAMETER OF DOUGH AND BREAD

2.1. Glycoproteins in wheat gluten: studies on HMW subunits of glutenin

Recent studies have indicated that HMW subunits are, in fact, glycoproteins. For the qualitative and quantitative characterisation of protein bound carbohydrates, the HMW subunits of the wheat cultivars Apollo, CWRS and Monopol were isolated from corresponding glutens by a specific extraction/precipitation procedure. The determination of carbohydrates with thymol/sulfuric acid resulted in a content of about 1 %. The HMW subunits were S-alkylated, separated by RP-HPLC and, after methanolysis, analysed by GC/MS. The results demonstrated that all subunits contained glucose, in a few cases also mannose, xylose and galactose. The glucose content of the four HMW subunits of Apollo was in the concentration range of 0.10-0.24 %. These values were partially increased by a thermolytic digestion of HMW units and corresponded to 1-10 monosaccharide units per protein unit. The tryptic digest of HMW subunit 12 was separated by RP-HPLC and the peptides analysed for carbohydrates. The results indicated that every peptide fraction

contained glucose and small amounts of mannose and xylose; thus, a covalent bond between sugars and protein appears unlikely.

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2.2. Disulfide bonds in wheat gluten

In continuation of previous studies, 29 further cystine peptides were isolated from a thermolytic digest of enriched glutenin, analysed and assigned to known sequences of gluten proteins. One cystine peptide was derived from the N-terminal region of HMW subunits and indicated that homologous cysteine residues of the HMW-subunits 5 and 7 are connected in different combinations. All other cystine peptides came from LMW subunits and confirmed the results obtained previously. Six out of eight cysteine residues are linked strongly directed and homologous to corresponding linkages of monomeric gliadins. The remaining two cysteine residues are unique for LMW subunits and form variable intermolecular linkages; they are responsible for the aggregation behaviour of LMW subunits. Gliadin from gluten was separated by RP-HPLC and two major components of gamma-gliadins were analysed for their disulfide structure. The results showed that gamma-gliadins have four disulfide linkages within the domains III and V. They are strongly directed and homologous to corresponding linkages of alpha-gliadins and LMW subunits.

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2.3. Characterization of wheat flour properties by optimized micro versions of extension and baking tests

Standard methods for the characterization of rheological and baking properties of wheat use doughs different in composition and treatment. Thus, the comparison of results is limited. To overcome this problem, dough composition and kneading conditions were adapted for both, micro extension and micro baking tests. Using these optimized methods, the flours of 26 European and American wheat cultivars were characterized by dough development time, extensibility and maximum resistance of dough and gluten and baking volume. Standard methods (rapid-mix-test, gluten index determination) were used for comparison. The results indicated that the correlation of rheological data with the optimized baking test is higher than with the standard test. If flour protein content is included in the correlations, the extension test of gluten, which can be performed easily and reproducibly, allows an exact estimation of the baking volume on the basis of micro-scale methods.

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2.4. Investigations of wheat-rye translocation cultivars

The replacement of the 1BL wheat chromosome by the 1RS rye chromosome offers potential agronomic advantages and resistance to stem and rust. The 1BL/1RS translocation, however, is combined with an inherent quality problem associated with reduced dough strength and dough stickiness. Among others, changes of the gluten protein compositions were discussed as reason for quality decrease, but amounts and proportions of gluten proteins have not been determined up to now. Four 1BL/1RS translocation lines and one corresponding wheat without translocation grown under the same conditions were therefore characterized by a detailed qualitative and quantitative protein analysis using the extraction/HPLC procedure development previously. Additionally, dough development time, maximum resistance and

extensibility of dough and gluten and baking volume were determined by optimized micro scale methods. The HPLC patterns of gluten proteins demonstrated that translocation caused typical changes among x-gliadins, gamma-gliadins and LMW subunits of glutenin. The amount of x1,2-gliadins was increased twofold, whereas the amount of LMW subunits was decreased and that of HMW subunits slightly increased. The effect of translocation on the rheological properties of dough and gluten was characterized by a strongly reduced maximum resistance and a higher extensibility. The baking volume was decreased by about 10 %. The amount of glutenin subunits was correlated to dough development time, resistance of dough and gluten and baking volume to a higher extent than that of gliadins. Compared with LMW subunits, the correlations coefficients of HMW subunits were lower including all five cultivars and higher, if only the translocation lines were considered.

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2.5. Microscopic studies on staling of wheat bread crumb

Fresh and 1, 3 and 5 days old wheat bread crumb was studied by determination of water content, firmness analysis and rasterelectron microscopy. Additionally, the effects of alpha-amylase, emulgator and reheating were compared. Fresh crumb is characterized by the accumulation of water in the starch granule periphery. During staling, water is bound by starch retrogradation, simultaneously a migration of water from the periphery towards the centre takes place. Both processes are important for crumb staling. Dependent on the water content, retrogradation or migration determines the course of staling. The accumulation of water at the starch granule periphery is associated with a soft texture, which allows the granules to glide along the gluten network during mechanical stress. After firming a stiff starch-gluten complex has formed. Studies on the effect of reheating, emulsifier and alpha-amylase confirmed the proposed mechanism of crumb staling.

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3. FOOD COMPOSITION AND NUTRITION TABLES

Food compositions are essential for administration, nutritional guidance, economy and science.

The large scientific work "Souci, Fachmann, Kraut": Food composition and Nutrition Tables" is kept up to date by a continuous survey of the scientific literature with the aid of the PC-data bank SFKDB. The same is true for the related small table "Der kleine 'Souci, Fachmann, Kraut': Lebensmitteltabelle für die Praxis" which was developed for the daily requirements of the consumer.

The 5th edition appeared together with a disk-version in October 1994. The preparation for the 6th edition began. The priority for updating is discussed now with the members of the working group for the SFK-Table in the BML.

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