Leibniz Institut
Deutsche Forschungsanstalt für Lebensmittelchemie

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Summaries

1. FOOD ANALYSIS

1.1. Flavour compounds as indicators of the oxidative fat deterioration

Oxidative fat deterioration was studied with butter oil as example. The volatiles of fresh and stored butter oil were compared by aroma extract dilution analysis (AEDA). AEDA of the fresh sample resulted in 19 odour compounds with dilution factor (FD) values between 32 and

4096. Of these compounds, 16 were identified as: diacetyl, acetic and butyric acid, 1-hexen-3-one, (Z)-3-hexenal, 1-octen-3-one, (Z)-1,5-octadien-3-one, guaiacol, (Z)- and (E)-2-nonenal, (E,E)-2,4-decadienal, skatole, vanillin, (Z)-6-dodecen-gama-lactone, delta-octalactone and delta-decalactone. The concentrations of 1-octen-3-one, (E)-2-nonenal and (Z)-1,5-octadien-3-one increased during the storage of the butter oil at room temprature. After 42 days they had the greatest odour unit values among the volatiles formed by lipid peroxidation.

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1.2. A comparative study on the potent odorants of different virgin olive oils

The flavour of virgin olive oil from Italy (fruity, green, fatty) and Spain (black currant-like, fruity, fatty) differed significantly. A aroma extract dilution analysis of these oil samples indicated that the following odorants were mainly responsible for the odour notes given in brackets: (Z)-3-hexenol, hexanal, (E)-2-hexenal and (Z)-3-hexenal (green), ethyl 2-methylbutyrate, (Z)-3-hexenyl acetate and ethyl cyclohexanoate (fruity), (E,E)-2,4-decadienal, (E)- and (Z)-2-nonanel (fatty) and 4-methoxy-2-methyl-2-butanethiol (black currant-like).

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1.3. Investigation into the ripening of cheddar

Analytical methods, which give insight into the ripening state of cheese are important for processing. A control is possible via the protein degradation, especially by following degradation products with chromatographic and electrophoretic methods.

The ripening of two Cheddar samples of German and English provenience was followed by RP-HPLC of the pH 4.6-soluble fraction. Some characteristic peptides were isolated, sequenced and attributed to the corresponding casein sequences. The peptide patterns were very clearly dependent on ripening time, origin, and water and salt content of the cheeses. The concentrations and proportions of defined peptides are suitable for the description of the stage of ripening.

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1.4. Microvariant of the rapid-mix-test

The German wheat varieties are classified according to the loaf volumes in the Rapid-Mix-Test. Each test needs 200-1000 g flour for technical reasons. For wheat breeding and also for research a microvariant of the standard baking test would be desirable.

A 10 g-microvariant of the Rapid-Mix-Test was developed on the basis of a systematic investigation of all steps of the baking process. The quality of 31 wheat varieties from the crop 1990 was compared by using macro and micro versions of the baking test. The loaf volumes obtained with the two methods were correlated very highly ($r = 0.904$). The reproduceability of the microvariant was also very good.

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1.5. Thin-layer electrophoresis of thickening agents

Thin-layer electrophoresis is a suitable method for the analysis of thickening agents in foodstuffs. Thickening agents of high viscosity must be partially degraded prior to their separation by thin-layer electrophoresis. It could be shown that the treatment of the polysaccharides in borate buffer pH 10/H2O2 for 1-6 h at 100°C essentially improved their separation by electrophoresis. Sharp zones were obtained in most cases, which allowed the identification of the polysaccharides without any difficulties.

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1.6. Detection of soya in sausage after electrophoretic separation

Soya proteins in foodstuffs are detectable by unspecific staining methods after electrophoretic separation. Disturbances may be caused by matrix proteins. Therefore some specific detection methods for soya proteins were tested in combination with SDS-PG-PAGE. Two methods for the specific staining of glycoproteins allowed the detection of soya in emulsion type sausages via the conglycinin alpha' down to 0.5 %. The glycinines as well as the con-glycinines were detected with the immunogold/silver staining. The detection limit for soya with this method was lower than 0.2 %.

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1.7. Detection of raw potatoes in doughs for dumplings

Doughs for dumplings made with rough potatoes ("Rohe Klöße") are industrially produced by mixing of raw and cooked potatoes, but also solely from partial cooked potatoes. An analytical method has been developed for the differentiation between the two products, which is based on activities of phosphatases and proteinase inhibitors of different thermal stability.

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1.8. Nutrition tables

Food composition and nutrition tables 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 data bank LINDAS. 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 preparation of the manuscript for the 5th edition of the large table has been continued. Focal points of activity were fatty acids, trace elements (selenium, copper, zinc, manganese, iron, nickel, chromium, and iodine), vitamins (E, A, and A-active carotinoids), and purines.

The 2nd edition of the small table was published in March 1991.

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2. FOOD CHEMISTRY, BIOCHEMISTRY AND MICROBIOLOGY

2.1. Sensory study on the character-impact flavour compounds of dill herb (Anethum graveolens L.)

The dependence of the characteristic odour note of dill herb from the concentration levels of five compounds, having the highest odour units in an extract obtained from the fresh material, was studied. (S)-alpha-Phellandrene was evaluated as the character-impact compound of the dill flavour which was rounded off by an additive effect of (3R,4S,8S)-3,9-epoxy-1-p-menthene (dill ether). The contributions of myristicin, methyl 2-methylbutanoate and (R)-limonene to the dill flavour appeared less significant.

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2.2. Potent odorants causing the warmed-over flavour in boiled beef

The flavour compounds showing higher odour units and resulting from a peroxidation of unsaturated fatty acids were comparatively analysed in freshly boiled beef and in a stored (48 h, 4°C) sample exhibiting WOF. The results obtained by aroma extract dilution analysis revealed that hexanal, 1-octen-3-one, (E)- and (Z)-2-octenal, (Z)-2-nonenal, (E,E)-2,4-nonadienal and trans-4,5-epoxy-(E)-2-decenal contribute significantly to the formation of WOF.

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2.3. Detection of furanoid fatty acids in soya-bean oil. Cause for the light-induced off-flavour

The following furanoid fatty acids were detected in soya-bean oil (SBO), wheat germ oil, rapeseed oil and corn oil: 10,13-epoxy-11-methyloctadeca-10,12-dienoic acid (I), 10,13-epoxy-11,12-dimethyloctadeca-10,12-dienoic acid (II), 12,15-epoxy-13,14-dimethyleicosa-12,14-dienoic acid (III). A model experiment indicated that II and III were quickly photooxidized with formation of the intense flavour compound 3-methyl-2,4-nonanedione (MND) as secondary product. MND causes the light-induced off-flavour of SBO. A method for the quantification of the three furanoid fatty acids in vegetable oils was developed. The amounts of II and III were relatively high (0.02-0.04 %) in unprocessed and refined SBO and in one sample of wheat germ oil and quite low (0.0015-0.0035 %) in corn oil and rapeseed oil. The furanoid fatty acids I, II and III were absent in olive and sunflower oils.

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2.4. Identification of volatile compounds having a roasty smell

Application of an aroma extract dilution analysis to freshly prepared popcorn revealed 23 odorants among which 2-acetyl-1-pyrroline (roasty, popcorn-like), (E)- 2,4-decadienal (fatty), 2-furfurylthiol (coffee-like) and 4-vinyl-2-methoxyphenol (spicy) predominated with the highest FD-factors. Further potent flavor compounds showing roasty odors were 2-acetyltetrahydropyridine and 2-propionyl-1-pyrroline. The latter compound showed a very low odor threshold of 0.02 ng/L (air), which was in the same magnitude as that reported for the 2-acetyl-1-pyrroline homologue. Sensory analysis of homologues 2-butanoyl- and 2-hexanoyl-1-pyrroline revealed that a longer alkyl side chain cancelled the roasty flavor note and increased the odor thresholds by a factor of 105.

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2.5. Studies on the formation of wheat bread flavour

Recently we could establish bakers yeast as a potent source of precursors for the roast-smelling odorants 2-acetyl-1-pyrroline (ACPY) and 2-acetyltetrahydropyridine (ACTPY) in wheat bread crust.

To reveal their role in the formation of both odorants, the concentrations of free amino acids occurring in bakers yeast were determined. Eleven amino acids present in concentrations above 60 mg/100 g of dry yeast were separately reacted with 2-oxopropanal in model solutions and the amounts of ACPY and ACTPY formed, determined by a stable isotope dilution assay. ACPY was formed from proline and ornithine, while ACTPY was exclusively liberated from proline. The remaining amino acids were ineffective. Further experiments revealed that the formation of ACPY from ornithine proceeds via 4-aminobutyraldehyde and 2-pyrroline as intermediates.

The amount of free ornithine in yeast was more than three times the amount of free proline. Furthermore, additions of either proline or ornithine to wheat doughs enhanced the amounts of ACPY in the bread crust by a factor of two or four, respectively. The data allowed the conclusion that ornithine is the most important precursor for the formation of ACPY during baking.

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2.6. Peptide patterns of HMW subunits of glutenin from different wheat varieties

Functional properties of wheat varieties have been often correlated more or less succesful with the pattern of HMW glutenin subunits, obtained by SDS-PAGE. In this connection it is unknown, if subunits from different varieties with the same mobility exhibit identical structures. To clarify this question, all important HMW glutenin subunits were isolated from 9 wheat varieties of different provenience. These subunits were hydrolyzed with chymotrypsin and the resulting peptide mixtures were separated by RP-HPLC. The comparison of the peptide patterns showed that complete identy of the amino acid sequences of the same subunits from different varieties seemed to be exceptional. Corresponding subunits from varieties of the same country seemed to be closer related than those of different countries.

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2.7. Breadmaking quality and HMW glutenin subunits of wheat v: qualitative and quantitative investigations by RP-HPLC

The significance of the type as well as of the amount of HMW glutenin subunits relatively to the functional properties is well known. Former results were reinvestigated with four varieties of known baking performance from the USA. The varieties were quantitatively analyzed for HMW glutenin subunits. The correlation between the amount of subunits of the X-type (2, 5, 7, 17) and the mixing time and the loaf volume was very high ($r = 0.997$ and 0.991, respectively), while subunits of the Y-type (8, 18) delivered significantly lower values ($r = 0.773$ and 0.791, respectively).

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2.8. Redox experiments with HMW glutenin subunits from wheat

In the literature, different bread making properties of wheat varieties have been related to the degree of polymerization of the HMW glutenin subunits, which may be dependent from the structure of these proteins. To get further insight, the reoxidation of reduced mixtures of subunits from strong (Rektor) and poor (Apollo) wheat varieties was followed by SH/SS-analysis and by gel permeation chromatography (GPC). Reoxidation under identical conditions was faster with KJO3 than with KBrO3, and delivered mostly intramolecular disulfide bonds, while intermolecular bonds dominated after oxidation with KBrO3. No significant differences between the two varieties were found in respect of kinetics of SH-oxidation and GPC pattern.

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2.9. Disulfide bonds in wheat glutelin

Inter- and/or intramolecular disulfide bonds of glutenin subunits are postulated to be structural elements of wheat gluten. Until now the experimental proof is lacking.

Therefore, the glutenin fraction of gluten from the wheat variety Rektor was hydrolyzed with trypsin. The hydrolyzate was separated by RP-HPLC. Cystine containing peptides were detected by difference chromatography before and after reduction, and then isolated and sequenced. In this way was shown that glutenin of the wheat variety Rektor contained intra- and intermolecular disulfide bonds. The HMW glutenin subunit 7 exhibited a disulfide bond between Cys 10 and Cys 17. Two disulfide bonds between parallel chains, involving Cys 44 and Cys 45, were detected for subunits 9, 10 and/or 12. The screening for disulfide bonds will be continued.

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2.10. Isolation and characterization of HMW-glutelin subunits from rye

Rye is phylogenetically closely related to wheat, but unable to form gluten. Structural differences of the HMW glutenin subunits of the two cereals may be responsible. To verify this hypothesis, the subunits of the rye variety Danko were isolated and compared with the subunits of the wheat variety Rektor. The amounts of HMW glutenins were different: Rektor contained the 2.5fold amount according to flour, and the 1.7fold amount according to protein. Four subunits were detected in Danko by SDS-PAGE, which exhibited rather similar mobilities and were localized in the X-type region of wheat. The amino acid composition of the isolated subunits was very near to that of wheat subunits. The subunits 3 and 4 of Danko exhibited the same N-terminal amino acid sequence over ten steps than the subunits 5, 7, 9 and 10 from Rektor.

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2.11. Sugars and sugar derivatives: structure-taste rellationships

The compatability of sugars and sugar derivatives with a recently developed basic model for sweet compounds should be proved. Sugars, sugar alcohols, anhydrosugars, glycosides and halogenated sugars interact with a receptor analog to diols via vicinal hydroxy groups. Sucrose could be inserted into the receptor model 1 (cf. DFA Bericht 1990, p. 162) with the groups OH3'/OH4' and OH3'/OH2, respectively, as e/n-systems. A distinction between the

two e/n-systems depends on the further characterization of the area of the model, which is occupied by the side chains of D-amino acids, in respect to forbidden positions.

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