13th International Workshop on Essential Oils

Würzburg/Germany
September 7—11th, 1982

ABSTRACTS

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Isolation of essential oil constituents by droplet counter current chromatography (DCCC)

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Droplet counter-current chromatography (DCCC) is a liquid-liquid partition technique. Separation is accomplished by passing droplets of a suitable mobile phase through a column of a surrounding stationary liquid phase. This system has been successfully adapted to separation of many natural products. Up to now the limitation of the method has been, that only relatively polar substances could be separated. It has been difficult to develop suitable solvent systems for the separation of less polar components because of the lack of formation of droplets, that have more or less the same diameter as the tubes.
Using a new developed water-free solvent system for DCCC (n-hexane-ethyl acetate-nitromethane-methanol)[3] a complex mixture of common constituents of essential oils could be well separated. In addition to the separation of this artifical mixture, some examples of essential oil fractionations will be demonstrated.

3) H.Becker, J.Reichling and W.-Ch. Hsieh: J. Chromatogr. 237, 307 (1982)

Structure elucidation of new types of sesquiterpenes from compositae

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For a few examples the structure elucidation of new sesquiterpens wi ll be discussed in detail. Furthermore the proposed biogenetic pathway for several different types of sesquiterpenes with new carbon skeletons mostly from South African and South American Compositae will be presented.
Finally the necessity of synthetic contributions for final stucture proof will be demonstrated for a typical example.

Identification of valerenane sesquiterpenoids from Valeriana off. L. s.l. by means of IR, ^{1}H-NMR, ^{13}C-NMR, EI- and NICI-MS

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The presence of valerenal, valerenic acid, hydroxy valerenic acid and acetoxy valerenic acid in Valeriana off. L.s.l. was known (3,4).
Our investigation of the oil of Valeriana off. L.s.l. (5) gave besides those a sesquiterpene alcohol with a valerenane skeleton and its esters.
GC-MS of a column chromatography fraction showed five components with similar mass spectra, the highest mass at m/e 202 and a base peak at m/e 187. One of these compounds was isolated by TLC and identified as valerenol by comparing spectra with published spectral data (6). Two other compounds were isolated by prep. GC and spectroscopically identified as valerenyl acetate and isovalerate. NICI-MS (7) identified two minor components as valerenyl-valerate and hexanoate.

Other constituents of this oil are bornyl acetate, terpenyl acetate, citronellyl- isovalerate and hexanoate and methyl citronellate.

3. A. Stoll, E. Seebeck and D. Staufacher, Schweizerische Apotheker-Zeitung, Feb. 1957, 115-120
4. G. Büchi, T.L. Popper and D. Staufacher, J. Am. Chem. Soc. 82, 2962 (1960)
5. V.N.K., P.O. Box 1, NL-8080 AA Alburg
6. F. Bohlmann and M. Lonitz, Chem. Ber. 113, 2410-2423 (1980)
7. A.P. Bruins, Anal. Chem. 51, 967 (1979)

New terpenes from the resin of Elemi

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Elemi is the resin from trees of several Canarium species, belonging to the family of Burseraceae. Former the resin was a component of skin irritating oinments but in our time the industries of perfume and of varnish are interested in it. By steam-destillation the odoriferous, viscous resin can be separated in a volatile fraction, the essential oil, and in a solid residue. To test the hitherto existing data of the literature the resin was subjected to CC on silica gel and developed with solvents of increasing polarity. The first unpolar fraction contained manifold brached terpene alkanes like phytane, pristane and norpristane. In the fraction of monoterpenes the four compounds mentioned in literature could be confirmed and completed by further eleven monoterpenes. The type of sesquiterpene alkenes and by further three sesquiterpene alcohols. For the first time a dimeric phellandrene was indicated as a natural product. It should originate by photosensitized cyclo-dimerisation at the Δ^1double bond of the α-phellandrene of the essential oil fraction. The dimeric phellandrene prepared in the laboratory by irridation of α-phellandrene with a high pressure mercury lamp was identical in GC, in the ^{1}H-NMR and ^{13}C-NMR spectra with the dimeric phellandrene isolated from the resin of Elemi.

Constituents of East Indian Sandalwood oil

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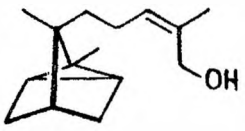
East Indian sandalwood oil, the essential oil of Santalum album L., is important as ingredient of several perfumes. The main constituents are the well known sesquiterpene alcohols α-santalol (1) and β-santalol (2). In addition, epi-β-santalol (3) and trans-β--santalol (4) were isolated by repeated distillation and $AgNO_3$-chromatography. The absolute configuration of the β-santalols was demonstrated by partial synthesis starting with α-santalol (1) and ORD-measurements. The known sesquiterpenoids cis-lanceol (5) and cis-nuciferol (6) as well as the new natural products spiro-santalol (7) and (Z)-α-trans-bergamotol (8) were isolated from sandalwood oil for the first time. The structures of (7) and (8) were demonstrated by total syntheses. The acid fraction of sandalwood oil mainly consists in degradation products of the sesquiterpene alcohols.



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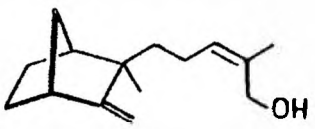

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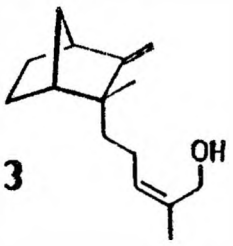

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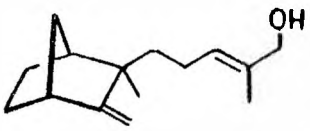

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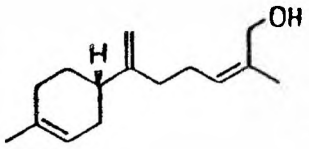

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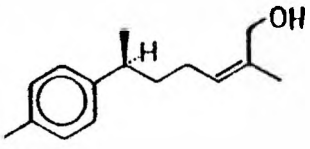

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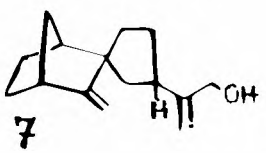

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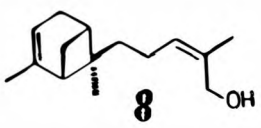

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Biology and essential oil of Ruta graveolens L.

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Ruta graveolens, a medicinal herb was well known already in Antiquity and the Middle Ages. Also it was used as a spice and scent herb. Its origin is south east Europe.

The herb has been studied intensively by many scientists. Besides the essential oil it contains the flavonol glycoside rutin, several coumarins, and various alcaloids. The coumarins reveal a phototoxic effect; touching the plant causes red pustules in the human skin. Recent scientific work has been concerned with the rue's alcaloids; one of these is reported to show outstanding antimicrobial properties.

Since two years we cultivate the rue in the Aromagarten of the University at Erlangen-Nürnberg in an area which covers about 40 m^2. From May till November 1981 we gathered samples of leaves each week and determined the content of the essential oil quantitatively by steam distillation. We could observe two slight maxima in oil production; the first was reached at the end of June when the rue was flourishing and the second in late fall when the fruits were fully ripened.

Every second week blossoms and fruits, respectively, were collected and extracted in the same way. We saw two rather distinct maxima in oil production, the first correlating with the appearance of the young fruit, the second appearing shortly before the ripening process was finished. In general, the blossoms and fruits contained 3 times the amount of oil when compared to the leaves.

We found that weather conditions did influence the oil content. Humid or hot and dry weather diminished the amount of oil. Moreover, it seems to be advisable not to harvest in full glare but under an overcast sky.

Our results by use of GC analysis revealed that the main components of the oil from the leaves were 2-nonanone, 2-nonylacetate, and 2-undecylacetate. Further it was observed that dried leaves showed a remarkable decrease in oil content concerning especially 2-nonanone. Blossoms and fruits contained 2-nonanone and 2-undecanone as the main components. – Likewise we found differences in the quantitative amount of oil from young leaves, leaves taken from flourishing sprouts, and older leaves from sprouts with fruits. Old leaves generally contained less volatile oil than young leaves.

GC-IR Coupling and Spectral Library Search

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With all the advantages of the Michelson interferometer (speed, throughput and wavelength accuracy) the possibility for a coupling of the gaschromatograph with the interferometer is given.
So it is possible that besides the information of the gaschromatogram the chemist gets a complete IR spectrum from the separated compounds.
Due to the speed of the interferometer-system it is possible to detect the chromatographic separation with a good time resolution. Modern and fast scanning interferometer-systems are running with a speed up to 60 scans/sec. This means the IR system takes up to 60 compete IR spectra with a resolution of 8 - 4 cm^{-1}/sec. In this method the sample tube consists out of an internal gold coated pyrex glas tube of different length (15 - 42 cm) and different diameter (1 - 3 mm).
The gaschromatograph is directly connected with this cell.
If capillary columns are used, these columns end at the inlet of the probe cell.
Due to the very low throughput in higher temperature measurements (up to 400^{o}C) high sensitive detectors like HgCdTe-Detectors are necessary.
Extensive software packages allow different methods to get the results. One possibility is the so-called chemigram, where the recorder plots a 5-channel-chromatogram (with different wavenumber windows) in real time. The spectral data are stored as interferograms in a good resolution. In real time the low resolution spectrum of the measured compounds is shown on the screen and stored as a secret file after the interferogram.

A second way is the reconstruction of the chromatogram with the Gram-Smith-Method.
The big computer flexibility of these systems allows the search in a spectral library at the same time. Even if the compounds are not found in the library, the chemist gets information about similar compounds and about characteristical functional groups.
It is evident that with these software programs a HPLC-coupling is also possible. The problem with the HPLC is to find a solvent which has not too much strong absorbing bands, otherwise too much informations out of the different spectral ranges are lost due to the absorbance of the solvent. Unfortunately, the reversed phase chromatography gives with this method very hard problems, because these solvents like water, methanol, etc. are very strong IR absorbers.

Genetic control of the biosynthesis of bisabololoxides A/B in Chamomilla recutita (L.) Rauschert (syn. Matricaria chamomilla L.)

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The essential oil of camomile flowers contains the four bisaboloids bisabolol, bisabololoxide A and B and bisabolonoxide in varying concentrations as main compounds. In consequence of previous investigations on the heredity of these substances (FRANZ & WICKEL 1980, FRANZ 1981) the relation of the bisabololoxides A and B to each other has to be cleared up.

Both, oxide A as well as B were found dominant against bisabolol and recessive against bisabolonoxide. Crossing progenies of oxide A and oxide B plants showed in general oxide A as main component but there were also few individua containing both substances. Two theories will be discussed to interprete the results:

a) Both oxides will be synthesized independent from each other and are in competition to each other concerning bisabolol as substrate. Becuuse of the higher activity of gene A resp. its enzyme, oxide A will be synthesized preferably also if both genes (A and B) are present.

b) One gene is responsible concerning the oxidation, a second gene controls the position of oxidation and depends in his effect from the first one.

FRANZ, Ch., I. WICKEL: Planta med. 39, 287 (1980)
FRANZ, Ch.: Habil.-Schrift TU München (1981)

Phthalides in Umbelliferae; a chemotaxonomical survey

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The classification of the Umbelliferae was based upon the system of Drude (1), supplemented with data from Wolff (2), Thellung (3), Tutin et al. (4) and Hiroe (5). Mostly roots of Umbelliferous plants were investigated for the presence of phthalides. The data obtained sofar, combined with literature data, indicate that the distribution of phthalides in this family is related with the taxonomical classification of Drude. The value of the finding of one phthalide-positive species within a genus is briefly discussed.

(1) O. Drude in: Die natürlichen Pflanzenfamilien, Band III, 8 (1898), A. Engler and K. Prantl (Eds.), Verlag Wilhelm Engelmann, Leipzig

(2) H. Wolff in: Das Pflanzenreich, Band 43 (IV, 228) (1910)
Band 61 (IV, 228) (1913)
Band 90 (IV, 228) (1927)
A. Engler (Ed.), Verlag Wilhelm Engelmann, Leipuig

(3) A. Thellung in: Illustrierte Flora von Mitteleuropa, Band V, 2, G. Hegi (Ed.), Verlag Paul Parey, Berlin u. Hamburg (1925)

(4) T.G. Tutin et al. in: Flora Europaea, Vol. 2, T.G. Tutin et al. (Eds.), Cambridge University Press (1968)

(5) M. Hiroe: Umbelliferae of the World, Ariake Book Company, Tokyo (1979)

Three new essential oil crops from the Ciskei (Southern Africa)

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The Ciskei Essential Oil Project was established to investigate potentially important local essential oils crops that can contribute to the development of rural Ciskei - a typical Southern African Development situation.
The poster deals with the development of new essential oil crops and provides details regarding the ecology, production, processing and chemical nature of three promising local essential oil crops viz. Lanyana (Artemisia afra), Pteronia (Pteronia incana) and Eriocephalee (Eriocephalus punctulatus).

Distillation, extraction, separation technology

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Lucknow - 22 60 04 (INDIA)

Valeriana species and their essential oils

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After the discovery of the valepotriates, which were kept responsible for the sedative properties of Valeriana preparations, the interest in essential oil research decreased. However, other species belonging to the Valerianaceae like Nardostachys jatamansii DC are also used for their tranquillizing activity, but they do not contain detectable amounts of valepotriates. Afterwards, it also seemed that the sedative properties of Valeriana preparations could not be fully explained by the presence of the valepotriates.
After a short botanic introduction a survey is given concerning the chemical composition of the essential oil of some species belonging to the Valerianaceae and concerning the contribution of the essential oil to the sedative properties.
Concerning the chemical composition of the essential oil, the conclusion can be drawn, that compounds which are kept characteristic for one species (or variety) e.g. valerenic acid etc. for Valeriana officinalis L. s.l., patchouli alcohol for V. wallichii DC, kesso compounds for V. officinalis L. var. angustifolia Miq. and valeranone for Nardostachys jatamansii DC may be absent in that species (variety) or be present in other species (variety). Though chemotypes exist within the species it has to be kept in mind, that a great number of data have been obtained from commercial plant material from unknown geographic origin.
From the data obtained with different pharmacological experiments, it becomes clear that certain essential oil compounds, like valerenal, valerenic acid, acetylhydroxy-valerenic acid, a number of kesso compounds clearly show a sedative and/or spasmolytic activity.
Therefor it ist necessary to pay attention to the essential oil compounds, which may occur in several pharmaceutical preparations.

The use of GC-FTIR in the analysis of essential oils

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The informative content of an IR-spectrum is very high: each molecule is possessing its characteristic "IR-fingerprint". The coupling of separation techniques with IR-spectroscopy produces a promising tool for analytical chemist work. First appoaches to the technique date back to 1967. Afer years of evaluation, the technique has reached a level of usability that makes it more and more common in research and industrial labs.
But the coupling of high resolution GC with a FTIR-spectrometer is more than a combination of two instruments. Optimization of the "hyphenated technique" HRGC-FTIR has to take care of a number of bondary conditions. Some of these will be discussed and applications using fused silica columns will be presented. The value of IR spectra library systems will be shown.

Biology and essential oil content of Ocimum basilicum

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Ocimum basilicum represents one of the most famous spices of today and it is known that it has been used already by the Romans. Its origin is the Indian subcontinent.

Today it is grown commercially in the mediterranian region, especially in Greece.

It has been observed that Ocimum represents the only Lamiaceae which produced essential oil optimally under best conditions of growth in contrast to the other species which develop a better oil the more they have to struggle under environmental circumstances.

The biosynthesis of its essential oil undergoes a distinct seasonal dependence. So far about 70 different components of the oil have been identified, including, e.g., thymol, nerolidol, eugenol, geraniol, geranyl acetate, estragole, borneol, linalool, camphor, p-cymene, cineol, ocimene, myrcene, sabinene, β-pinene and α-pinene. Anethole could be identified in cell-callus and cell-suspension cultures. – The antiseptic property of its oil is well known.

Also Ocimum basilicum is available now in seven different varieties such as americanum, canum, citriodorum, gratissimum, kilimandscharicum and sanctum.

We succeeded in growing the var. sanctum in rather big amounts in the Aromagarten at Erlangen. Its origin likewise is India and Pakistan where it is well known as "Tulsi". Its mass production can be stimulated remarkably by cutting off the main stem during the early period of growth. Its oil is characterized by an intense odour after cloves and olibanum.

We are involved in the study of its oil production, its constituents and its antimicrobial actions.

Investigation on the biosynthesis of the Chamomile essential oil

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The biosynthesis was persecuted by the use of labelled ^{14}C- and ^{3}H-compounds. For the investigations substances, which believed to be presursors, were fed to intact plants during flower development. The rates of incorporation were measured after different incubation times. To investigate if any compound of the essential oil is transformed to theoretical resultant products in the progress of biosynthesis, pure compounds with high specific activity were necessary. High incorporation was achieved by using Chamomile-types with quite different composition of the essential oil and by variety of temperature and light. Whether the bisaboloids could be synthetized in sequence was of central interest. To clarify this problem a labelled Bisabolol was fed to a Chamomile-type with Bisaboloxid A and also a labelled Bisabolol-oxid A to a Bisabolon-type.
With these experiments it was demonstrated, that Bisabolol and Bisabololoxid were partially metabolised to polare substances. By analysing the labelled compounds of the essential oil no results were obtained that Bisaboloids are synthesized in a sequential manner.

On the essential oil from Majorana hortensis Moench

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Institut für Organische Chemie der Universität Erlangen-Nürnberg, Henkestr. 42, D-8520 Erlangen

Majorana hortensis Moench has been investigated concerning its content of essential oil depending on the season. Seven samples from different origin were grown under similar conditions in 1980. The essential oil was extracted from leaves and blossoms by steam distillation for 2 h and determined quantitatively.

A distinct seasonal dependence of essential oil production was observed.

By use of GC-MS and GLC analysis, 75 compounds, mainly mono- and sesquiterpenes, were identified.

Plants from different origin revealed qualitatively the same spectrum of their oil components. However, the different constituents of the oil did not show a similar synthesis over the season.

We found two chemical varieties of majoram which differ in the synthesis of cis-sabinene hydrate and terpinen-4-ol, respectively.

The sesquiterpenes, monoterpene-acetates and the acyclic monoterpenes did not undergo a distinct seasonal dependence in their biosynthesis.

The synthesis of monoterpene hydrocarbons and monoterpene alcohols on one hand, and of monocyclic and bicyclic monoterpenes on the other, revealed pronounced differences in their biosynthesis over the season. In addition, their seasonal depending occurance represented a mirror reflecting pattern.

Optimization of gas chromatographic analysis of essential oils

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While it is widely recognized that the open tubular (capillary) column is capable of achieving a much higher degree of resolution, the advantages of shorter analysis times, higher sensitivities and improved quantitation in these more inert systems can be even more important. Particularly in some industrial applications, overall resolution may be less important than the rapid and unambiguous separation of selected key components, on highly stable, long-life columns. Toward these goals, some of the newer liquid phases now available on fused silica capillary columns are attracting considerable interest.

True system optimization, however, usually requires the use of binary mixtures of selected liquid phases. The simplest method for achieving such mictures is the use of sequentially coupled dissimilar capillary columns. Equations for calculating the appropriate length ratio of the two columns, and methods of correcting for the velocity gradient in the coupled column, have been presented elsewhere (1).

The present paper explores the separation of several essential oils on some of the newer bonded-phase fused silica columns, and the application of sequentially coupled columns to yield analyses that are optimized in terms of the separation of critical components, analysis times, and sensitivities.

(1) D.F. Ingraham, C.F. Shoemaker and W. Jennings (1982) J. Chromatogr. 239, 39.

Some new results concerning the chemical composition of Lavender oil

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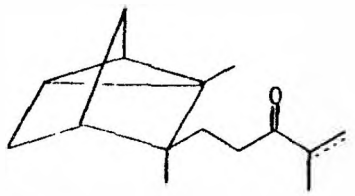
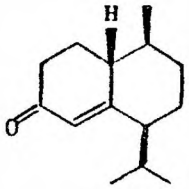
The careful work-up of a high boiling carbonyl fraction obtained by distillation and subsequent Girard reaction followed by column chromatography and preparative GLC made it possible to isolate and identify a plurality of new carbonyl components which derive from sesquiterpene hydrocarbons like santalene, cadinene, caryophyllene, cedrene and others.



A, B



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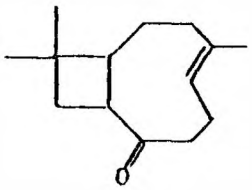

D

Discussed in more detail are the (-)-α-santalan-12-one (A) and the (-)-α-santal-13-en-12-one (B), the (+)-14--nor-cadin-5-en-4-one (C) and other related derivatives, a series of oxygenated products derived from (-)-caryophyllene, e.g. the (-)-12-nor-caryophyllen-2-one (D), various oxidation and degradation products of partially aromatized sesquiterpene hydrocarbons and other nor-sesquiterpene ketones.

Study on the distillation parameters of the essential oil of Mentha Piperita

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In the determination of the essential oil content reported in the various pharmacopoeias, there are several references to the distillation parameters. The degree of comminution of the plant material, the distillation time and the distillation rate are the three parameters which influence the quantity and mainly the quality of the distilled essential oil, although they do not remain constant in the distillation conditions reported in the various pharmacopoeias. In the present study the effect of these parameters on the quality of the essential oil obtained from the leaves of Mentha piperita is investigated. The experimental program has been designed according to the latin square method and the determination of the percentage composition carried out by means of gas-liquid chromatography. The statistical analysis of the results showed that the degree of comminution of the leaves influences the quality of the distilled oil much more than the other two parameters, although for one component the distillation rate was found to be the determining factor. Finally, the optimum distillation conditions are suggested in order to obtain essential oil enriched every time in a certain component.

Unsaturated components in the essential oil of Anthemis nobilis L.

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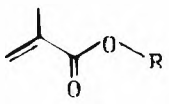
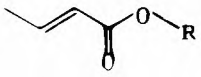
GIVAUDAN Research Company Ltd., CH-8600 Dübendorf-Zürich

Esters play a predominant role in Roman chamomile oil. The main components are derivatives of (Z)-2-methyl-2--butenoic acid (angelic acid). These angelates are accompanied by a lot of other esters. With respect to incomplete results published by Georges and Fellous (Parf., Cosm., Aromes No. 43, 37 (1982)) the present communication will give a detailed description of some methacrylates (A), crotonates (B), tiglates (C) and new angelates (D). The mass spectra together with IR and NMR spectroscopical data lead in a concise manner to correct structural assignments of all these components. Final proof was established by comparison with an authentic synthetically prepared specimen.



A



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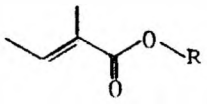

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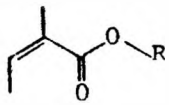

D

Biology and essential oil from Humulus lupulus var. neomexicanus

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Humulus lupulus L. var. neomexicanus Nels. & Cockerell is the only native genus and species of the Cannabaceae family within the central Rocky Mountains, where it grows at an altitude of 1 300 to 3 000 m.

It is found in canyons and foothills and is sometimes seen climbing over bushes. The annual aerial climbing stems arize from the perennial rhizome and become 5 to 10 m long. The opposite leaves are lobed palmately. Two of the female flowers sit together under a large persistent bract. At maturity the bracts from the conelike "hops" change colors and appear as papery and conspicuous clusters known as strobiles.

The essential oil is produced by the female inflorescences, the strobiles which contain the oil bearing glands. The strobiles produce a different scent if compared to H. lupulus L. So far nothing is known on the composition of its essential oil.

Quantitative determinations on the essential oil of the hops revealed a seasonal dependence in oil biosynthesis. It was observed that samples taken in October were already airdried due to the arid climate of Central Colorado. The hops content in essential oil was about 1 to 2 µl per 1 g of airdried samples collected during the winter season, and obviously stayed at this level until end of July. Biosynthesis of the oil in female buds during the next vegetation period started again in early August and reached a maximum of 6 to 8 µl per 1 g of dried material in late summer depending very likely on the year's climatic data.

The main components of the essential oil were identified structurally by means of GC and GC-MS analysis. About 40 different compounds, including monoterpenoic hydrocarbons and alcohols, ketones, methylesters of saturated and unsaturated carboxylic acids were detected. Other substances were esters of short chain acids with monoterpene alcohols, plus sesquiterpene hydrocarbons.

Organ specific accumulation of volatile compounds in Dictamnus albus L. (Rutaceae)

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Dictamnus albus contains essential oil in all parts of the plant. The oil is accumulated in distinct morphological structures such as secretory cavities, spouting glands and oil cells. These different secretory tissues are spread among the single plant organs. The upper parts of the plant posses spouting glands, while secretory cavities are found in leaves and the lower stem-parts. The essential oil of the roots is deposited in oil cells.

The type of the secretory tissue determines the composition of the essential oil qualitatively and quantitatively. The oil of the spouting glands, corresponding to the upper parts of Dictamnus albus, contains mainly (up to 90 %) monoterpene hydrocarbons, whereas the oil of the leaves with secretory cavities is characterized by sesquiterpene hydrocarbons. The oil of the roots is quite different from the other parts of the plant and contains nor-sesquiterpenoids and furanoids besides monoterpene hydrocarbons.

Study of the distillation conditions for the best yield of the essential oil of Mentha Piperita

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The essential oil content obtained from the distillation of a plant material depends mostly on the degree of comminution, the time of distillation and the rate of distillation. In the present study the simultaneous influence of the rate of distillation, with respect to the time of distillation and the degree of comminution, on the yield of the distilled essential oil from the leaves of Mentha piperita is investigated. The statistical analysis of the results showed that the rate of distillation does not influence significantly the quantity of the obtained essential oil. However, the influence of the distillation rate is relatively more significant than the distillation time, when the rate is between the limits suggested by the various pharmacopoeias of 0.5 ml/min - 5 ml/min and the time between 1 h - 4 h, respectively. Finally the optimum conditions for the best yield of essential oil from Mentha piperita are suggested.

Essential oils analysis, state-of-the-art

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The usual procedures for analysing essential oils can be divided into two different groups:

1. Spectroscopic investigations of total oils without any separation into individual compounds.
2. The use of chromatography, especially gaschromatography for separation and spectrometry for identification and structure elucidation of individual components.

According to this classification the different methods used in essential oils analysis will be discussed briefly. Emphasis will be given to some newly, developed techniques from the authors group, such as ^{13}C-NMR spectoscopy of total unseparated oils and HPLC.
As will be schown, ^{13}C-NMR spectroscopy -usually used for identification and structure elucidation of isolated compounds- is a valuable method for qualitative and with certain limitations quantitative analysis of total essential oils. The advantages of the mentioned technique in comparison to GLC is that direct information about the complete mixtures including both non volatile and thermally unstable compounds, can be obtained.
For chromatographic separation of essential oils the practicability of HPLC has been investigated, especially for separating thermally unstable constituents. Using a combination of reversed-phase and adsorbtion chromatography, even complex mixtures could be well separated. The discussed HPLC-technique can be used in a semi-preparative scale for isolation of oil constituents and for pre-separation of essential oils prior to GLC.

Quality Criteria for Oleoresins of Capsicum, Black Pepper and Nutmeg

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The quality criteria for oleoresins, that are commonly applied in commercial practice are in fact not quite appropriate to discriminate between the products available on the market. Furthermore, the parameters concerned are not always measured in the most reliable way.
The results of an attempt to find other criteria and new or improved methods for the assessment of the quality of capsicum, black pepper and nutmeg oleoresins will be reported.
The pungent principles of capsicum and black pepper oleoresins were determined by adopted HPLC methods, which proved to be quick and reliable. For capsicum a good relation was found between the content of capsaicinoids and the Scoville Index. The determination of the Scoville Index for the black pepper oleoresins gave no reliable results, so that the pungency could not be related with the piperine content.
The odour character of black pepper oleoresins was found to differ considerably. Nutmeg samples were different in odour as well as in flavour character.
GC fingerprints of the volatile oils of the black pepper and nutmeg samples showed large differences.
No relations were found between the organoleptic properties of the black pepper and nutmeg and their content of volatile oil and/or the composition of the oil. The GC fingerprints can be used to check on possible adulterations and on constant composition of successive batches.

On the essential oil from Artemisia dracunculus L.

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Artemisia dracunculus L. (tarragon) has been investigated concerning its content of essential oil and its composition depending on the season (June-September 1980). The essential oil was extracted from the leaves by steam distillation and determined quantitatively. No significant maximum of essential oil production was found.
By use of dry-column chromatography the rapid separation of the complex oil of tarragon into 5 fractions of different polarities was possible. With GLC and GC/MS analyses, 31 components, mainly monoterpene hydrocarbons and phenolic compounds, were identified.
A new example of the temperature function of elution sequence of monoterpene hydrocarbons in GLC (SE 30) was found with limonene and Z-ocimene.
The main components analyzed were sabinene, methyl eugenol, estragol, and elemicine. The percentage of these 4 components in the essential oil differed depending on the time of harvest. The content of estragol was very low, when the content of elemicine reached its maximum. However, the sabinene and methyl eugenol amount changed synchronously.
The seasonal dependence of oil composition allows conclusions on the biogenesis of the single components. The biosynthesis of the phenolic compounds was in accordance with the shikimate pathway. Elemicine is likely to be a metabolic product of shikimic acid with no further mono- or bisphenolic intermediates involved.

Minor volatile components of clove essential oil: terpenic and sesquiterpenic fraction

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The presence of 70 to 90 % of eugenol in clove essential oil makes the identification of minor volatile components very difficult.
In order to study these compounds the neutral fraction of clove oil obtained by two ways, hydrodistillation and solvent extraction with Freon 11, was prepared by elimination of phenolics.
The non polar fraction obtained after fractionation on silica using Freon 11 and diethyl ether in Freon was studied by G.L.C.-S.M. Three terpenic and ten sesquiterpenic hydrocarbons were identified, ten of them being new compounds for this oil: α-thujene, β-pinene, myrcene, α-cubebene, β-ylangene, α- and γ-muurolene, β-selinene, δ-cadinene, cubebene, calamenene.
The use of Freon 11 for oil obtention shows that caryophyllene is realy a normal constituent of clove buds. On contrary calamenene was found to be an artefact formed by oxydation of cubebene. This reaction occurs during air drying of clove buds or during hydrodistillation process.

Chemical and morphological studies on Zingiber zerumbet (Linne) Smith and its proposed variety (Fam. Zingiberaceae)

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University of the Philippines System, Quezon City

This study on the chemistry of the volatile oils and morphology of Zingiber zerumbet (L.) Sm. and its proposed variety reveals significant differences between these two plants. Their main chemical differences are the following: dried rhizomes of Zingiber zerumbet (L.) Sm. yield a volatile oil which is dextrorotatory, congealing at $3^{o}C$, and having zerumbone as its main constituent. Rhizomes of the proposed variety yield an oil which is levorotatory, congealing at $-27^{o}C$, and having 4-terpinenol as its main constituent.

The morphological differences between Zingiber zerumbet (L.) Sm. and its proposed variety are the following: Zingiber zerumbet (L.) Sm. has ovate lanceolate leaves, about 5 times longer than wide; a prominent ligule, about 1.5 to 3.5 cm long; an inflorescence which is ovoid to oblong with an obtuse apex; bracts which are green, pink-edged, obovate mucronate; pale yellow rhizomes; and oil cells measuring from 30-90 µ. The proposed variety, on the other hand, has oblong lanceolate leaves, about 8 times longer than wide; a small ligule, about 1 to 2 mm long; a cone-like inflorescence with an acute apex; obovate acute bracts which are brownish-purple and green-edged; yellow-orange rhizomes; and oil cells measuring from 50-136 µ.

The occurence and systematic importance of chromenes and benzofurans in the Asteraceae

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Chromenes and benzofurans are acetate and terpenoid derived natural products that are present in certain tribes of the Asteraceae. Many of these compounds are volatile and found in essential oils and resins. Recent findings show several of these compounds to exhibit insecticidal and phototoxic activities. Isolation techniques by chromatographic methods as well as analytical and separation methods using HPLC are described. The distribution of chromenes and benzofurans in the Asteraceae based on a presence or absence distinction suggests a biphyletic grouping of the family with the tribes Astereae, Eupatorieae, Heliantheae, Inuleae and Senecioneae being the main sources of these compounds. Chromenes primarily found in the Heliantheae and Inuleae are suggested to be evolutionary more primitive than benzofurans which seem more common in the Astereae, Eupatorieae and Senecioneae. Chromenes and benzofurans seem to be very useful in chemosystematic studies of the Asteraceae, particularly at tribal or generic levels. At the generic level detailed phytochemical studies of the genus Encelia (Heliantheae) indicate that the chromene and benzofuran chemistry is in agreement with the phylogenetic relationships in the genus as proposed by cladistical analysis.

Production of seeds and essential oil from sweet fennel growing in Israel

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The essential oil of sweet fennel (Foeniculum vulgare var. dulce) from various parts of plant was studied from both quantitative and qualitative points of view. Unripe umbels were found to contain the highest yield of essential oil. Differences of oil yield and percentage of main constituents were detected during maturing stages of the plant.
The maximum yield of trans-anethole (81-83 %) was found in ripe umbels in the late harvest stage. The content of trans-anethole in other parts of the plant was lower and its content in leaves and stems decreased during seed ripening. The limonene content was low in ripe umbels and its content decreased during plant development.
Oleoresins of ripe umbels were obtained by two extraction methods, using dichloromethane and supercritical carbon dioxide as solvents. The economical aspects of essential oil and trans-anethole production are discussed.

New sesquiterpenes from Aristolochia debilis (Aristolochiaceae)

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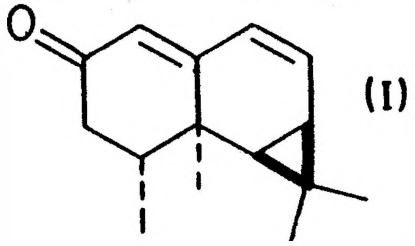
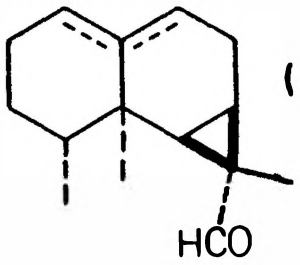
From the roots of Aristolochia debilis Sieb u. Zucc. four sesquiterpene ketones with an Aristolane skeleton have been isolated so far. In course of a reexamination of the petrol ether/ether extract of this material, four further compounds could be found, their chemical structure has been elucidated.

One of these compounds (I) has been isolated earlier from Nardostachys chi Bat. (Valerianaceae) by the same working team. Compound IV shows to be an epimere of the already known Debilone. The compounds II and III exhibit oxidation in an unexpected position of the Aristolane skeleton.
It is being referated about the structure elucidation of these substances by means of spectroscopical methods.



(I)



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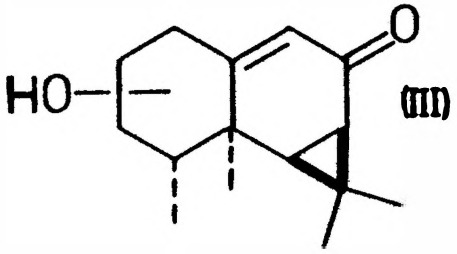

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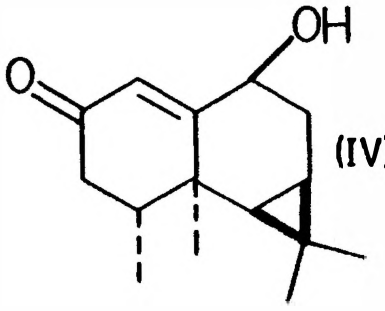

(IV)

Essential oils in plant cell cultures

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A review is giben of those publications dealing with the presence of volatile compounds in plant cell cultures. First some problems will be discussed, e.g. definition of the terms "essential oil" and "undifferentiated tissue" and the difficulties which arise in the comparison of the results of different groups.
Then the results of the most important investigations will be reported chronologically. Between 1961-1965 the studies of several scientists (STEWART, HOWE, CRANE, RABSON, von WANG, STABA, KRIKORIAN) indicated that calli derived from different Mentha species did not produce detectable quantities of volatile compounds.
Based on these results and their own investigations some authors (CAREW and STABA, 1965; KRIKORIAN and STEWARD, 1969; BECKER, 1970; NAGEL und REINHARD, 1975) stated that the production of essential oils by callus tissue is correlated to special sites of accumulation (e.g. glands, oil cells etc.)
Meanwhile, however, it was shown that some morphologically undifferenciated cell cultures did produce volatile oils, though they lacked any special structures of accumulation: for instance, cultures of Pogostemon cablin (HART, WOODCOCK and WILSON, 1970), Andrographis paniculata (BUTCHER and CONOLLY, 1971), Tanacetum vulgare (BANTHORPE and WIRZ-JUSTICE, 1972), Perilla frutescens (SUGISAWA and OHNISHI, 1975) and Ocimum basilicum (LANG and HÖRSTER, 1977).
Our own investigations, concerning undifferenciated cell cultures of Peucedanum cervaria (Apiaceae), Melissa officinalis (Lamiaceae), Poncirus trifoliata (Rutaceae) led to analogous results: although no organized structure could be detected microscopically, a complex mixture of volatile compounds was isolated from each culture.

Finally, the influence of some environmental and other conditions concerning the oil composition in tissue cultures are discussed, and some special problems involved with the analysis of such "steam-distillates" are demonstrated.

On the essential oil of Ziziphora taurica M. Bieb. ssp. taurica J.R. Edmonson

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The chemical structure and physical properties of the essential oil obtained from Ziziphora taurica M. Bieb. ssp. taurica J.R. Edmonson are investigated.
The GLC is carried out using FID, copper columns (8 m x 1.5 mm I.D.) and five different systems which are as follows: I (PEG2OM, 50°C), II (β,β' ODPN, 30°C), III (SF96, 80°C), IV (PEG2OM, 140°C), V (SF96, 120°C).
In the composition of the essential oil α-pinene (1,25 %), camphene (0.45 %), β-pinene (1,4 %), Δ^4-carene (0.73 %), sabinene (0,34 %), myrcene (0,46 %), limonene (3,91 %), β-phellandrene (0,08 %), γ-terpinene (0,05 %), cis-β-ocimen (0,43 %), terpinolene (0,02 %), trans-β-ocimen (0,33 %) which are MTHC and 1,8-cineol (1,08 %), fenchone (2,35 %), thujone (1,99 %), menthone (0,27 %), isomentone (2,89 %), linalool (2,17 %), menthyl acetate (0,72 %), isopulegone (4,88 %), menthol (0,54 %), pulegone (38,4 %), α-terpineol 2,17 %), borneol (0,90 %), piperitone (2,00 %), carvone (0,81 %), thymol (0,19 %) which are OCMT were determined.
The physical properties and specific values of the volatile oil were found as follows: specific gravity (0,9475), optical rotation (+22,72°), refractive index (1,4782), solubility in ethanol (turbid in 2 volumes of 80 % ethanol, turbid with more, up to 10 volumes, no separation observed after 24 hours), acid index (2,06), acid value (3,78), saponification index (10,64), esterification index (8,58), acetylation index (156,8).
The dominant component, pulegon, was isolated by an air jacketed column (18 x 500 mm), carrying kieselgel G60, 0.063-0.200 mm (70-230 mesh ASTM) and structure was identified by UV, IR spectra and by preparing semicarbazide compound.

Essential oils from fungi - recent results and prospects for application

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During the last years, many volatile metabolites hitherto unknown in fungi have been identified in fruit bodies and cultures of basidio- and ascomycetes. Today several hundreds of them are already known. With a few exceptions, however, thorough investigations into these compounds have been restricted to two groups of fungi:

(a) the more important edible fungi, and

(b) some wood-destroying fungi and related species.

The elucidation of volatile constituents in the first group is quite obvious in regard to their possible importance as aroma compounds. The reasons for studying volatile metabolites of the second group are very different. Besides the well known wealth of information derived from general and special metabolic studies c out on fungi, two other aspects concerning these substances have been brought into the discussion:

(1) their use as a tool to solve taxonomical problems, and

(2) the large-scale production of odorous substances by certain fungi.

Our own investigations were carried out with ascomycetes of the genus Ceratocystis (Microascales), and with some Aphyllophorales. The results revealed a pronounced strain specific accumulation of volatile metabolites, strongly influenced by culture condition From this point of view, the fundamental possibilities of a large-scale production of fungal aroma compounds are discussed, and also the significance of these substances for the solution of taxonomic problems.

Separation, Isolation and Identification of the Sesquiterpene Alcohols in the Essential Oil from Thymus praecox Opiz subsp. arcticus (E. Durand) Jalas

E. STAHL

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The essential oil of the above ground parts fro Thymus praecox subsp. arcticus, a widely distributed plant in Iceland and South-Greenland, was proved to contain linalyl acetate (70%), ß-caryophyllene (4%), germacrene D (3%), ß-bisabolene (2%), ß-sesquiphellandrene (1%), ɣ-cadinene (0,5%) and a couple of oxygenated sesquiterpenes (13%). Four of them were isolated by means of Lobar Pre-packed columns (LiChroprep Si 60, n-hexane-ethyl acetate 80+20; LiChroprep RP-8, methanol-water 75+25, 80+20). The IR, MS, ^{1}H NMR and ^{13}C NMR data of these four compounds proved nerolidol, T-cadinol, hedycaryol, and 7-hydroxygermacrene to be the main components of the oxygenated sesquiterpene fracti Caryophyllene epoxid, cubenol, elemonl and α-cadinol, which were present in much lower concentrations, could be identified only by IR and mass spectrometry.

As well the mass spectra of hedycaryol and 7-hydroxygermacrene as their unusual broad peaks within the gas chromatogram of the essential oil from T praecox subsp. arcticus illustrates the thermolabile character of these two germacrene-type sesquiterpenes. Under thermal conditions they are converted to the corresponding elemene-type sesquiterpenes elemol and shyobunol by Cope rearrangement. Thus in addition to the GLC of the oxygenated sesquiterpenes a separation was carried out by high performance liquid chromatography (HPLC) using Nucleosil^{R} C8 as stationary phase and methanol-water (65+35) as mobile phase.

On the essential oils from some Salvia species growing in SW Anatolia

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There are two endemic Salvia species growing near Ermenek (Konya, Turkey): Salvia albimaculata Hedge and Hub. Mor. (at about 1100-1400 m) and Salvia aucherii Bent. var. canestens Boiss. et Helder. (at about 650-1000 m). The leaves of these two species have almost same camphor like odour and the latter is widely used in folk medicine like Folia Salviae and as a kind of tea locally.

Volatile oil contents of these plants are 0.8 per cent in S. albimaculata and 1.5 per cent in S. aucherii var. canestens.

The volatile oil of S. albimaculata (I) contains 13 per cent monoterpenic hydrocarbons and 87 per cent oxygenated compounds; in S. aucherii var. canestens oil (II) this proportion is 18 % and 82 % respectively.

According to our GLC studies, the main components of (I) seemed to be α-pinene, camphene, β-pinene (totally 65 % of the hydrocarbon fraction and almost in equal proportions) and limonene; whereas in the other oil (II), main component of the fraction is limonene (34 %), this is followed by α-pinene (18 %) but camphene and β-pinene do not reach 10 % of the fraction totally.

These oils seemed to be quiet different from the point of view oxygenated compounds. So that, the main component l-borneol (20 %) of (I), is hardly found (0.4 %) in the other oil (II) which is rich in terpi (21 %); terpineol is found only 6 % in (I).

Camphor and eucalyptol contents of these oils are also different: (II) is rich in camphor (22 % against to 15), (I) is rich in eucalyptol (12 % against to 5.2).

Analysis of essential oil in pharmaceuticals

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The qualitative and quantitative estimation of essential oils and their main components in pharmaceuticals is difficult, because of their well known oxidative instability, their volatility, and the problems of extraction from lipophilic galenical preparations. Particulary in mixtures of several essential oils with other natural products or plantextracts the proof of one single oil is rather problematic.

Considering literature and own experimental experiences, this lecture discusses these problems and possible way for correct quantitative analysis.

The following points are mainly of main importance:

1. Because of the greatly different galen preparations there is no unique sample preparation technic prior to the chromatographic separation.
   Respecting the complex composition of a pharmaceutical and the mode of the galenical form, either water-steam-destillation, or solvent-extraction is favourable.
   Though water-steam-destillation is the best method to isolate a pure oil-fraction from the pharmaceutical, its use for quantitative analysis is restricted, because losses of more than 25% are observed.
2. Besides GC, HPLC becomes more and more important for separation of essential oils.
   Especially in pharmaceutical analysis HPLC is prefered because of its enormous selectivity which is founded in photometric detection at changeable wavelengths.
3. For exact estimation of the essential oils and of the content of main terpenoids in pharmaceutical mixtures, it is necessary to compare the chromatographic separation with those of an identically produced reference-mixture, analysed under identical conditions. By this way the loss of oil and of terpenoids during sample preparation is compensated.

The actual position of citrus oil analysis

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The actual state of citrus oil analysis is presented. Preference is given to investigations with capillary gas liquid chromatography. By means of this method the following oils has been analysed:

Orange peel oil cold pressed (c.p.)
Orange juice oil
Orange oil distilled
Lemon peel oil c.p.
Mandarine peel oil c.p.
Grape fruit peel oil c.p.
Limette peel oil c.p.
Limette peel oil distilled

After identification and quantitative determination of the main constituents and comparison with authentic standards and objective judgement is possible in respect to:

provenience
kind of production
possible age
possible adulterations
possible concentration and similar procedures.

Development in the production of medicinal and aromatic plants in Egypt

A. EL-HAMIDI and BAHAA M.H. ATTAWEYA

Kato Aromatic, Harranya, Giza, Egypt

The fertile land Egypt depending mainly upon the Nile water and the more than 300 sunny days in the year with mild winter, the geographical situation of the land with its Suez Canal, helped the native farmer since ansient time cultivate his land 3-4 times in the year.

These edaphic, climatic and geographical factors give a unique favour for the local agricultural production to reach the foreign markets at comparatively earlier dates according to the horticultural crops and commadities where the needs of such production is urging.

The Egyptian flora contains some native plants reputed for their medicinal aromatic and colouring proparties. Only to mention; for medicinal uses, Ammi, Hyoscyamus, Ephedra, Trigonella, Cassia, Ruta, Urginea, for aromatic uses, Apium, Artemisia, Cymbopogon, Cuminum, Carum, Coriandrum, Foeniculum, Geranium, Jasminum, Matricaria, Mentha, Ocimum, Origanum, Rosa, Thymus and for colouring uses, Alkanna, Carthamus, Hibiscus, Capsicum, Lawsonia.

In the past few years new exotic plants were introduced by KATO AROMATIC for their trials; lemon verbena, estragon. The preiminary results of these trials are enconraging. Research work is carried out in government institutions and private firms to raise the productivity of these plants. The pharmaceutical, cosmetic and food industries consume a portion of the local production while considerable quantities are exported. Modern distillation and extraction facilities are owned by the private sector, e.g. KATO AROMATIC.

The tables, graphs and photo explain the results of the activities in this development.

The occurrence of some chemotypes in the genus Pinus

M. von SCHANZ

Pharmazeutisches Institut, Fabiansq. 35, 00330 Helsinki 33
Finnland

Gas chromatographic studies on the essential oil of Pinus sylvestris L. showed that the Scots pine vegetation in Scandinavia can be devided into two district groups: a high and a low 3-carene group. These chemotypes were confirmed by full-sib progenies obtained by conttrolled crosses and they have been shown to be stable.
The needle oils isolated from Pinus kesiya, P. oocarpa and P. caribaea growing in Zambia were also investigated. The tree-to-tree variation and the distribution patterns in these three species suggest that also here different chemotypes exist.

XIIITH INTERNATIONAL WORKSHOP ON ESSENTIAL OILS

UNIVERSITY WÜRZBURG (GERMANY)

SEPTEMBER 7 - 11TH, 1982

PROVISIONAL PROGRAM

MONDAY	SEPTEMBER 6TH	
	19.00	INFORMAL WELCOME
TUESDAY	SEPTEMBER 7TH	
	9.30 - 10.00	OPENING
	10.30 - 12.00	ORAL PRESENTATIONS
	14.00 - 18.00	ORAL PRESENTATIONS
WEDNESDAY	SEPTEMBER 8TH	
	9.00 - 12.00	ORAL PRESENTATIONS
	14.00 - 16.00	ORAL PRESENTATIONS
	16.00 - 18.00	POSTER SESSION
	19.30	BARBECUE (BOTANICAL GARDEN)
THURSDAY	SEPTEMBER 9TH	
	9.00 - 12.00	ORAL PRESENTATIONS
	14.00 - 16.00	ORAL PRESENTATIONS
	16.00 - 18.00	POSTER SESSION
	19.30	CONGRESS DINNER (MARIENBERG CASTLE)
FRIDAY	SEPTEMBER 10TH	
	9.00 - 12.00	ORAL PRESENTATIONS
	14.00 - 17.00	ORAL PRESENTATIONS

GENERAL INFORMATION

LOCATION AND TIME:

The conference and poster sessions will be held at the University Würzburg, main building, Sanderring 2, Würzburg, in the center of the city. The conference will commence at 9.30, Tuesday, September 7th and close at approx. 17.00, Friday, September 10th,1982.

CONGRESS-OFFICE:

Monday, September 6th, 1982, 17.00-20.00 in Hofkellerei-Weinstuben (restaurant), Residenzplatz 1, Würzburg.
Tuesday - Friday in the university main-building, Sanderring 2, Würzburg.

REGISTRATION:

Registrations forms are enclosed. The registration fee is 100,--DM for participants, 60,--DM for accompanying members. The fee includes one copy of lecture and poster abstracts and attendance at the informal welcome (Hofkellerei Weinstuben, Residenzplatz 1), Barbecue (Botanical Garden), congress dinner (Marienberg Castle); beverages not included.

MAILING ADRESS:

Organizer: Prof.Dr. K.-H.Kubeczka,
Department of Pharmaceutical Biology
University of Würzburg
Mittlerer Dallenbergweg 64
D-8700 Würzburg (FRG)

ACCOMODATION:

Registrants are expected to make their own arrangements for hotel accomodations. Reservation forms are enclosed.

ABSTRACTS:

Participants wishing to present a communication or a poster are requested to submit an abstract in English of about 200 words not later than July 31, 1982. Please type title followed by the names and initials of authors and institution.

POSTER PRESENTATIONS:

The poster boards will be approximately 1.25 to 1.25 m. Prepare in advance for the top of your poster space a large label indicating the title of your contribution, authors and affiliation.

CONFERENCE LANGUAGE:

The official language of the conference will be English and no translation service will be provided.

SOCIAL EVENTS:

Monday, September 6th, 1982 from 19.00 h
Informal welcome (free; beverages not included)
in Hofkellerei-Weinstuben (Residenzplatz 1)

Wednesday, September 8th, 1982, 19.30 h
Barbecue (free) in the Botanical Garden
(Mittlerer Dallenbergweg 64)

Thursday, September 9th, 1982, 19.30 h
Congress dinner (free; beverages not included)
Ascent to the Marienberg Castle with cars or
by foot (walking time about 15 min.).

Saturday, September 11th, 1982, 9.00 h
Trip to the picturesque medieval town Rothenburg.
Departure 9.00 h from Residenzplatz in the center
of the city. (fee per person DM 25,-- including
transport and guided tour; lunch at the participant's
own expense). Minimum number of participants
25 persons. Retour to Würzburg about 20.00 h.

LADIES' PROGRAM:

Sightseeing tour Würzburg
(fee for transport and guided tour DM 10,--)

Visit of the Residence
(palace of the bishops; built in the mid eighteenth century
by Balthasar Neumann)
and the university museum
(fee for admission and guided tour DM 5,--)

C H E M I S T R Y/ T E C H N O L O G Y S E C T I O N

BECKER, H.; Heidelberg (FRG)
Isolation of essential oil compounds by droplet counter current chromatography (DCCC)

BOHLMANN, F.; Berlin (FRG)
Structure elucidation of new types of sesquiterpenes form compositae

BRIESKORN, C.-H.; Würzburg (FRG)
New terpenoids of elemi resin

BRUNKE, E.-J.; Holzminden (FRG)
Constituents of East Indian Sandalwood oil

BRUNS, K.; Düsseldorf (FRG)
Composition of the essential oil of Artemisia afra (compositae)

CROUZET, J.; Montpellier (France)
Minor volatile components of clove essential oil

EBEL, S.; Marburg (FRG)
Identity and quality of essential oil by TLC

GUPTA, D.; Lucknow (India)
Distillation, extraction, separation technology

HENDRIKS, H.; Groningen (NL)
Valeriana species and their essential oils

ICONOMOU-PETROVICH, N.; KATSIOTIS, S.; KOSMIDIS, P.; KTISTIS, G.; Thessaloniki (Greece)
Study on the distillation parameters of the essential oil of Mentha pip.

IHM, H.; Erlangen (FRG)
On the essential oil from Majorana hortensis Moench

JENNINGS, W.; Davis (USA)
Recent developments in high reolution gas chromatography as applied to the analysis of essential oils

KAISER, R.; Dübendorf-Zürich (CH)
Some new results concerning the chemical composition of lavender oil (Lavandula officinalis Chaix)

KUBECZKA, K.-H.; Würzburg (FRG)
Essential oils analysis, state-of-the-art

LAMPARSKY, D.; Dübendorf-Zürich (CH)
Unsaturated components in the essential oil of Anthemis nobilis L.

MAARSE, H.; Zeist (NL)
Quality aspects of Spice oleoresins

SCHULTZE, W.; Würzburg (FRG)
^{1}H-NMR-Spektroskopische Enentiomerenbestimmung bestimmter optisch aktiver Terpenalkohole

STAHL, E.; Hamburg (FRG)
Sesquiterpenes in the essential oil of Thymus praecox subsp. arcticus

TITTEL, G.; München (FRG)
Analysis of essential oils in pharmaceuticals

VERZAR-PETRI, G.; Budapest (Hungary)
Standardization of essential oils

B O T A N I C A L S E C T I O N

ASCENCAO, L.; PAIS, S.; Lissabon (Portugal)
Differentiation and ultrastructure of secretory Trichomes in Artemisia campestris

CZYGAN, F.-C.; Würzburg (FRG)
Essential oils and fragrances-subjects of literature

FRANZ, CH.; WICKEL, I.; Freising-Weihenstephan (FRG)
Genetic control of the biosynthesis of bisabololoxides A/B in Chamomilla recutita (L.) Rauschert (syn. Matricaria chamomilla L.)

HERRMANN, B.; Erlangen (FRG)
Biology and essential oil content of Ocimum basilicum var. sanctum

HÖLZL, J.; Marburg (FRG)
Investigation on the biosynthesis of the Chamomile essential oil

KNOBLOCH, K.; Erlangen (FRG)
Biology and the essential oil from Humulus lupulus var. neomexicanus

PAPANICOLAOU, K.; KOKKINI, S.; Thessaloniki (Greece)
A taxonomic revision of the genus Origanum section Origanum in Greece

Karyotype analysis of two endemic species of Allium in Greece

PENKA, M.; Brno (CSSR)
Changes in the content of essential oils in plants

PROKSCH, P.; RODRIGUEZ, E.; Irvine (USA)
The occurence and systematic importance of benzopyrans and benzofurans in the Asteraceae

PUTIEVSKY, E.; RAVID, U.; Haifa (Israel)
Production of seeds and essential oil from sweet fennel growing in Israel

SCHULTZE, W.; KOCH, I.; Würzburg (FRG)
Essential oils in tissue cultures from plants

SPRECHER, E.; HANSSEN, H.O.; Hamburg (FRG)
Essential oils from fungi. Recent results and prospects of application

P O S T E R

BOS, R.; Groningen (NL)
Spectroscopy, structure elucidation

CLAßEN, B.; Erlangen (FRG)
Biology and essential oil of Ruta graveolens L.

GRAVEN, E.H.; Kingwilliamstown (South Africa)
Three potentially important new aromatic crops (Hanyana; Preronia, Eriocephalee)from the eastern seaboard areas of Southern Africa

HOLZKE, F., Hamburg (FRG)
Neuere Ergebnisse von der GC/MS-Untersuchung von Riech- und Geschmacksstoffen

LÖPPERT, CH.; Erlangen (FRG)
On the essential oil from Thymus species.

OLIVEROS, M.; Diliman (Philippines)
The essential oils of Zingiber zerumbet (L.) Sm. and its proposed variety Zingiber zerumbet (L.) Sm. var. valenzuelae Oliveros & Cantoria

PAULINI, H.; Erlangen (FRG)
On the essential oil from Artemisia species

ROCKER, G.; Bonn-Poppelsdorf (FRG)
New sesquiterpenes from Aristolochia debilis

SCHLEGELMILCH, F.; GONTHER, W.; Krefeld (FRG)
Analytical methods, separation techniques, spectroscopy, structure elucidation

SEZIK, E.; Ankara (Türkei)

VOKOU, D.; Thessaloniki (Greece)
Seasonal variation of volatile oil concentration of Thymus capitatus, Satureia thymbra, Teucrium polium and Rosmarinus officinalis