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**CITRUS**



**RESEARCH**



**CONFERENCE**

**1961**



UNITED STATES DEPARTMENT OF AGRICULTURE  
Agricultural Research Service  
Western Utilization Research and Development Division

PROGRAM AND ABSTRACTS OF PAPERS

CITRUS RESEARCH CONFERENCE

October 10, 1961

Fruit and Vegetable Chemistry Laboratory  
263 South Chester Avenue  
Pasadena, California

This program contains abstracts of papers to be presented. Material in these abstracts should not be reproduced without the permission of the author and organization involved. The report was prepared for those attending the conference and is not for publication or general distribution.

## FOREWORD

This Citrus Research Conference is being held to bring to members of the citrus and allied industries in Southern California and Arizona the latest results of research on the chemistry, pharmacology, and technology of citrus fruits and their products carried on by laboratories of Utilization Research and Development, Agricultural Research Service, U. S. Department of Agriculture. The following Divisions are participating in this year's conference.

Western Utilization Research and Development Division:  
Western Regional Research Laboratory (Division  
headquarters), 800 Buchanan Street, Albany 10,  
California

Fruit and Vegetable Chemistry Laboratory, 263 South  
Chester Avenue, Pasadena, California

Southern Utilization Research and Development Division:  
U. S. Fruit and Vegetable Products Laboratory,  
600 Avenue S, N. W., Winter Haven, Florida

U. S. Fruit and Vegetable Products Laboratory,  
509 West Fourth Street, Weslaco, Texas

PROGRAM  
CITRUS RESEARCH CONFERENCE  
Tuesday, October 10, 1961

9:30 a. m.

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Laboratory, Pasadena, California - Presiding

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Fred Stitt, Assistant Director, Western Utilization Research and  
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# RECENT ADVANCES IN THE CHEMISTRY OF THE CITRUS FLAVONOIDS

Robert M. Horowitz and Bruno Gentili

Western Utilization Research and Development Division  
Fruit and Vegetable Chemistry Laboratory  
Pasadena, California

Work has continued on the nature of the sugar constituents present in the flavonoid glycosides of citrus fruits. The types of glycosides now known to occur are the following: the rhamnoglucosides (including both rutinoides and neohesperidosides); simple glucosides; and carbon-carbon linked glycosides. Some recently found examples of these will be discussed.

The flavonols limocitrin and limocitrol (both from lemons) have been mentioned in previous reports. These compounds are 3, 5, 7, 4'-tetrahydroxy-8, 3'-dimethoxyflavone and 3, 5, 7, 4'-tetrahydroxy-6, 8, 3'-trimethoxyflavone, respectively. A third new flavonol from lemons, isolimocitrol, has been found recently and its structure shown by means of ultraviolet spectra. It appears to be 3, 5, 7, 3'-tetrahydroxy-6, 8, 4'-trimethoxyflavone. Limocitrin, limocitrol, and isolimocitrol have all been isolated in the form of their glucosides, which have been found to be, in each case, the 3-beta-D-glucoside. The chemical and spectral evidence for these structures will be discussed.

Study of the flavonoid glycosides of oranges has revealed the occurrence of naringenin 7-rhamnoglucoside and isosakuranetin 7-rhamnoglucoside. As neither of these compounds is bitter, it may be inferred that the sugars are in the form of rutinose rather than neohesperidose. (The corresponding neohesperidose derivatives, which are found in grapefruit, are the bitter flavanones naringin and poncirin.) A summary of the available information on the occurrence of neohesperidose and rutinose derivatives in citrus will be given.

The carbon-carbon glycosides of flavonoid compounds have been shown to occur in several plant species but never in citrus. Vitexin, the most thoroughly studied of these compounds, has long been known as a constituent of the tree Vitex lucens. However, its structure is not known with complete certainty. Recently, we have isolated vitexin in small yield from Valencia oranges and have also obtained several similar C-C glycosides of flavones from other citrus fruits.

A number of derivatives of various rutinose and neohesperidose glycosides have been prepared in order to study the relations between chemical constitution and taste in these compounds. These data will be discussed briefly.



# METABOLISM OF THE PHLOROGLUCINOL RING OF FLAVONOIDS

M. S. Masri, A. N. Booth, and Floyd DeEds

Western Utilization Research and Development Division  
Western Regional Research Laboratory  
Albany, California

The metabolism and physiological effects of flavonoids have been the subject of extensive study in our laboratory. Our metabolic studies have been very helpful in explaining and suggesting mechanisms of physiological action. Our recent discovery of the effects of flavonoids on the pituitary-adrenal axis is an example of a mechanism of physiological action suggested from the results of metabolic studies. Although we know a great deal about the metabolic fate of ring B of flavonoids, the fate of the phloroglucinol ring (ring A) has been particularly enigmatic: in no instance were we able to find a urinary phenolic fragment corresponding to this ring, while a variety of phenolic fragments corresponding to the other portion of the molecule (ring B) can be readily detected in the urine. This fact, together with other observed distinctive features of flavonoid metabolism, suggested an hypothesis for the degradation of these compounds in mammals involving a sequence of metabolic steps. An essential feature of this hypothesis involves ring opening of the phloroglucinol moiety followed by oxidation to three 2-carbon fragments and ultimately to carbon dioxide. This feature, as well as certain predictions derived from the hypothesis have been tested successfully.

Evidence in support of the hypothesis is as follows: (a) an intact phloroglucinol pattern of hydroxylation has been found essential for the degradation of flavonoids and chalcones; (b) some flavonoids give rise to  $C_6-C_3$  fragments, while others yield  $C_6-C_2$  fragments (arising from ring B); (c) expired air contains  $C^{14}O_2$  after administration of  $C^{14}$ -quercetin; (d) the hypothesis is compatible with the reported isolation of certain key metabolites of catechin.

Although fission of aromatic compounds is common in microorganisms, this is a difficult task indeed for the mammalian organism. Thus, the ability to oxidize the phloroglucinol moiety of flavonoids in the manner proposed is novel. Biochemically it is another interesting reaction to be added to the well-known classical example of ring fission of homogentisic acid in mammals.

## PROGRESS IN FOAM-MAT DRYING

R. P. Graham

Western Utilization Research and Development Division  
Western Regional Research Laboratory  
Albany, California

Foam-mat drying is a new way of producing instant food powders by air drying stable foams. Foams can be made by adding a small proportion of an edible foam stabilizer. One such stabilizer is a combination of solubilized soya protein and methyl cellulose. In various proportions and types, these two edible substances can be used to stabilize a wide variety of fruit and vegetable purees and concentrates, including those of the various citrus fruits.

In order to be dried quickly, these foams must be spread out in such a way that they are in good contact with the drying air. Air flowing through a thin air-punctured mat of foam lying on a perforated plate or tray is one effective way of getting good contact. In order to use the air repeatedly and efficiently, a deep bed can be formed by stacking these trays up in the duct through which the air flows. A good arrangement involves a concurrent flow of fast hot air followed by a countercurrent flow of decreasing velocity and temperature. This has been done by continuously raising the trays through the duct, removing them dry at the top. Hot air flows into the bottom of the stack through the fresher trays and out at a central exit. Warm air enters the top of the stack and flows through the oldest trays. Some of the hot air enters the stack midway in this countercurrent section joining the warm air. The mixture flows through the remaining trays of the countercurrent section, leaving the stack at the same exit as the spent concurrent air from below.

Several pilot plant dryers of this type have been built, including one at WRRL. The WRRL unit is arranged for continuous and automatic operation beginning with food at one end and yielding dry powder at the other end. A continuous foaming device meters food stabilizer and gas together, produces a foam, and delivers it to the feeder. This unit extrudes the foam on perforated trays and punctures or craters the mat. The trays then move through the dryer proper. Filtered hot air is delivered to the dryer by the blower unit. The dry material is conveyed to the detraying unit, which is located in a low-humidity room. The detrayer plows off the product and brushes the trays clean for reuse. The powder is filled into bags by gravity, while being flushed with nitrogen. The Albany unit can produce about 20 lbs. of orange juice powder per hour.

It is best to pack fruit powders as dry as possible in order to retard spoilage or caking. It seems difficult to get foam-mat dried products below 2.5 percent moisture without scorching them. We therefore have added small amounts of various solvents to these powders to facilitate final drying. A weight of a very hydrophilic solvent equal to 10 percent of the powder may be sprayed on the powder without clumping it. This solvent, together with most of the remaining water, can be easily and completely removed at room temperature in vacuum or a gentle air stream. Ethanol is a good choice for the purpose, although methanol is even faster. This technique is also usable for removing residual moisture from freeze-dried food pieces. We suggest the term "extractive drying" for this method. We hope that in-package desiccants can be avoided with the help of extractive drying, since orange powders at moisture contents below 1.0 percent can be achieved.

FOAM-MAT DRYING OF ORANGE JUICE: PROGRESS  
IN FOAM PREPARATIONS, DRYING, STORAGE, AND EQUILIBRIUM  
MOISTURE CONTENT STUDIES

Owen W. Bissett, James H. Tatum, and Charles J. Wagner, Jr.

Southern Utilization Research and Development Division  
U. S. Fruit and Vegetable Products Laboratory  
Winter Haven, Florida

At the last conference, the installation of foam-mat drying equipment and early experiments were discussed. The process had been developed at the Western Regional Research Laboratory, Albany, California, and personnel of that laboratory designed the equipment installed at Winter Haven. The Florida Citrus Commission defrayed the cost of the equipment and has contributed otherwise to the project.

Investigations have continued at Winter Haven and emphasis has been placed on studies dealing with foam preparation, drying of the foam, packaging of the product, storage, and equilibrium moisture content at different relative humidities. Progress to date will be discussed.

Foam stabilizers must permit the formation of a foam which can be handled without breaking down, permit rapid drying, and yield a satisfactory dried product. A number of stabilizers were tried, but most were discarded because the foam degraded before it could be dried. In the early experiments a monoglyceride from hydrogenated lard was used. It permitted rapid dehydration, but imparted a slight milky appearance and the powder was not always easy to reconstitute. During the past year most work has been done with a modified soya protein along with about one-fourth its weight of methyl cellulose. While the drying rate is somewhat slower, the density of the foam is greater and permits heavier belt loading so drier capacity remains about the same. The use of soya protein results in improved color of the reconstituted product and easier reconstitution. Neither stabilizer contributed appreciably to flavor.

Modifications were made to the equipment which permit more accurate control of belt loading rate and of air temperatures and air speeds. The drier is divided into four sections, each with separate temperature control. In the first section temperatures of 200° to 220° F. may be used where moisture content is comparatively high and evaporation limits product temperature. Subsequent sections are controlled at lower temperatures depending on conditions and the results desired.

Drying studies were conducted including use of both soya protein and monoglyceride stabilizers. Maximum foam temperatures during drying were 155°, 170°, and 185° F. These foam temperatures were then maintained for periods of 2 to 10 minutes. Moisture content of the dried products varied from 1.5 to 4 percent with soya protein and from 0.5 to 3 percent with monoglyceride. All products dried at 185° F. had a definite scorched flavor. In products dried at lower temperatures another flavor was observed which has been associated with dried orange juice. It was present in varying degree depending on the drying conditions. With the lower drying conditions, it was obscured by the addition of locked-in oil used for flavor fortification. These data indicate that 185° F. is too high a drying temperature for satisfactory flavor.

Preliminary studies on the effects of nitrogen gas and air packaging on flavor have been made. It had been thought that the presence of oxygen in the package would favor oxidative changes which would be detected as a flavor difference by the taste panel. Products were stored at -90°, -40°, 0°, and 70° F. and observed for flavor changes for periods up to 8 weeks. No flavor differences were noted between similar powders packed in air or nitrogen. Additional studies are planned.

In storage studies, powders with soya protein and monoglyceride stabilizers of about 2.2 percent moisture were packaged with a desiccant and stored at 70° and 85° F. The taste panel observed a flavor change in both products after 2 weeks at 85° F. At 70° F. a difference was noted in products containing monoglyceride after 8 weeks and in those with soya protein after 16 weeks. Thus a greater stability was indicated for the soya protein stabilized materials even though moisture release was more rapid in products containing the monoglyceride.

In-package desiccation is expensive, bothersome, and a sales hazard; and its elimination would be a distinct advantage. It is not feasible to reduce the moisture content during regular drying to less than about 2.25 percent. Such products have limited storage life; hence, the in-package desiccant is used to gradually decrease the moisture content in the package. A possible alternate procedure might be to reduce the moisture content to some lower figure by a secondary drying process before packaging. Powders of low moisture content have been produced by maintaining the product at low humidity under vacuum over a period of time at 70° F. Powders with moisture contents of 1.37, 1.24, and 0.92 percent have been prepared and additional lots with lower moisture content are to follow. Storage life at 70° and 85° F. will be determined. Several methods of rapidly reducing powdered orange juice to low moisture levels are being tried.

The equilibrium moisture contents of two foam-mat dried orange juice powder products were obtained for various storage conditions. Both soya protein and monoglyceride powders were used. Storage conditions for the two products consisted of 70°, 85°, and 100° F. temperatures and six relative

humidities in the range of 1.5 to 17 percent. This work was to be basic to finding the relationship between caking, moisture content, and flavor stability. A modified Wink's equilibrium weight method was used. Results indicate that the moisture exchange mechanism in each of the products differed. Monoglyceride products, stored at 70° F. and at the several relative humidities, contained at equilibrium less moisture than the modified soya protein product. This was true also in 85° F. storage at low humidities, but at relative humidities higher than 7.4 percent the opposite was true. This reversal continued at 100° F. over the relative humidities studied with the protein stabilized product retaining less water than the monoglyceride. The results indicate that at 15 percent relative humidity and at the temperatures studied no moisture would be absorbed by normal foam-mat-dried products. However, in order to provide a margin of safety, it is suggested that the powder packaging area be designed for 10 percent or lower relative humidity.

# APPLICATION OF THE DUAL FLAME GAS CHROMATOGRAPH TO FLAVOR ANALYSIS

Roy Teranishi and Ron G. Buttery

Western Utilization Research and Development Division  
Western Regional Research Laboratory  
Albany, California

Simple but effective chromatographic equipment has been built in our laboratory for food vapor analyses. The equipment, including dual flame detectors and dual columns, is described, and some of the operational considerations necessary for stability at high sensitivity are discussed. Chromatograms, called aromagrams, of the volatiles from fruits and vegetables show the number and amount of various compounds. Differences in concentration in different tissues of fruit can be demonstrated. Since only vapors are necessary, "zero-time" analyses of the living fruit or vegetable are available for the first time. Some examples of application given are vapor aromagrams showing differences due to variety and storage of product. Results obtained by the system described indicate that this method will have many applications in aroma quality control.

# INVESTIGATIONS OF THE ESTERS AND ALCOHOLS OF LEMON OIL

Robert M. Ikeda and Elizabeth M. Spitler

Western Utilization Research and Development Division  
Fruit and Vegetable Chemistry Laboratory  
Pasadena, California

Work has continued on the isolation and identification of the constituents in lemon oil as a basis for improving their quality and establishing their authenticity. Esters and alcohols have been isolated from lemon oil by removing the carbonyl compounds with Girard's T reagent, the terpene hydrocarbons by silicic acid chromatography, followed by gas chromatographic analysis of the ester-alcohol fraction. Seven components were shown to be present. Saponification of the fraction indicated that three of the components were esters.

For isolation and identification of the esters and alcohols, several pounds of lemon oil were treated as described above. The individual esters and alcohols were separated either by silicic acid column chromatography or by vacuum fractional distillation. These compounds were further purified by preparative-scale gas chromatography and their infrared spectra compared with known compounds similarly purified by gas chromatography. The following esters and alcohols were identified: citronellyl acetate, neryl acetate, geranyl acetate, linalool, terpinene-4-ol, and  $\alpha$ -terpineol. This is the first time terpinene-4-ol has been reported in lemon oil.

A synthetic mixture of the esters and alcohols found in lemon oil was prepared. This mixture was diluted to approximately the same concentration found in the oil and the individual esters and alcohols were isolated following the procedures described above. No change in composition of the individual components in the synthetic mixture was observed.

For the quantitative estimation of the esters and alcohols in lemon oil, 1 percent by volume of n-propyl benzoate was added to the oil and ester-alcohol fraction isolated as described previously and gas chromatographed. With the 1 percent n-propyl benzoate peak on the resulting chromatogram used as the internal standard, the amounts of each of the esters and alcohols were calculated from the areas under their respective peaks on the chromatogram.



# NEW THEORIES ON CAROTENE BIOGENESIS AND THE ROLE OF CHROMOPLASTS

Albert E. Purcell

Southern Utilization Research and Development Division  
U. S. Fruit and Vegetable Products Laboratory  
Weslaco, Texas

As a result of basic research on carotene biogenesis, data have been obtained and interpretations formulated which are not sufficiently supported to merit publication. These data and interpretations form the basis of future research.

It is believed a twenty-carbon isoprene alcohol pyrophosphate is formed by the same mechanism as has been demonstrated for farnesyl pyrophosphate in sterol producing systems. This pyrophosphate ester is then dephosphorylated to yield an isoprene hydrocarbon with a terminal methylene group. Another molecule of the pyrophosphate ester condenses with the hydrocarbon by the phosphate attacking at the terminal methylene bond. This reaction is presumed to occur on the chains of the protein stroma forming a chromoplast.

The particular site on the stroma determines the specific nature of the carotene formed. The nature of the chromoplasts also determines to a certain extent the specificity and activity of various substrates.

The development of chromoplasts in colored and white grapefruit has been followed for one season. It appears that chromoplasts are formed by the deposition of carotenes into fragments of ruptured chloroplasts. When lycopene is being rapidly accumulated the chromoplasts of red grapefruit appear as red needles. The color of the needles fades to pink as lycopene content declines. As carotene content increases and begins to exceed lycopene content, pink platelets appear.

In white grapefruit it appears that at least some of the chloroplasts do not rupture. No chromoplasts have been observed in white grapefruit.

# CHARACTERIZATION OF LEMON JUICES AND CONCENTRATES BY THEIR MALIC ACID/TITRATABLE ACIDITY RATIOS

Carl Vandercook

Western Utilization Research and Development Division  
Fruit and Vegetable Chemistry Laboratory  
Pasadena, California

For the past several years, work has been in progress at this laboratory on the chemical composition of lemon juices and concentrates as a basis for the development of methods to establish their authenticity. Emphasis has been on the determination of the amino acid/titratable acidity ratios, and more recently work has been in progress to study the organic acids of the juice. Since malic acid is closely associated to citric acid in the Krebs cycle, it was decided to investigate the malic acid content of lemon juice.

The most satisfactory method of analysis appears to be a modified AOAC procedure using the enhancement of the optical rotation of l-malic acid by uranyl acetate. The uranyl-malic acid complex increases the rotation about 20 times and thereby makes it useful in determining the malic acid. Citric acid also forms the complex, but this can be overcome by adding an excess of uranyl acetate. It has been shown by measuring the change in rotation with increasing uranyl acetate concentrations that the maximum rotation occurs when the uranyl acetate and malic acid are present in equal molar amounts.

In general, the procedure is to clarify and neutralize the juice, measure its initial optical rotation, and then measure the increase in rotation with uranyl acetate. The malic acid concentration is proportional to the change in rotation and may be calculated from a standard curve.

It is expected that the malic acid/titratable acidity ratios will be of value in characterizing lemon juices and concentrates.

LIST OF CITRUS PUBLICATIONS  
AND PATENTS\*  
September 1, 1960 to August 31, 1961

Western Utilization Research and Development Division  
Fruit and Vegetable Chemistry Laboratory  
263 South Chester Avenue, Pasadena, California

FLAVONOIDS OF CITRUS. IV. ISOLATION OF SOME AGLYCONES FROM  
THE LEMON (CITRUS LIMON)

R. M. Horowitz and Bruno Gentili  
Jour. Org. Chem. 25(12): 2183-2187, Dec. 1960

PHENOLIC GLYCOSIDES OF GRAPEFRUIT: A RELATION BETWEEN BIT-  
TERNESS AND STRUCTURE

R. M. Horowitz and Bruno Gentili  
Arch. Biochem. and Biophys. 92(1): 191-192, Jan. 1961

ALDEHYDES IN LEMON, ORANGE AND GRAPEFRUIT OILS BY GAS CHRO-  
MATOGRAPHY

W. L. Stanley, R. M. Ikeda, S. H. Vannier, and L. A. Rolle  
Jour. Food Sci. 26(1): 43-48, Jan-Feb. 1961

SPECTRAL STUDIES ON FLAVONOID COMPOUNDS. II. ISOFLAVONES AND  
FLAVANONES

R. M. Horowitz and Leonard Jurd  
Jour. Org. Chem. 26(7): 2446-2449, July 1961

SPECTRAL STUDIES ON FLAVONOID COMPOUNDS. III. POLYHYDROXY-  
CHALCONES

Leonard Jurd and R. M. Horowitz  
Jour. Org. Chem. 26(7): 2561-2563, July 1961

FLAVONOIDS OF CITRUS. V. STRUCTURE OF LIMOCITRIN

R. M. Horowitz and Bruno Gentili  
Jour. Org. Chem. 26(8): 2899-2902, Aug. 1961

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\*Reprints are available at the addresses indicated; patents are avail-  
able only by purchase at 25¢ a copy from the U. S. Patent Office, Washington,  
D. C.

## OILS IN PEEL, JUICE SAC, AND SEED

J. G. Kirchner

Chapter 9 of THE ORANGE. ITS BIOCHEMISTRY AND PHYSIOLOGY, W. B. Sinclair, ed., pp. 265-301, Agricultural Publications, Univ. of Calif., Berkeley, 1961

## THE CITRUS FLAVONOIDS

R. M. Horowitz

Chapter 11 of THE ORANGE. ITS BIOCHEMISTRY AND PHYSIOLOGY, W. B. Sinclair, ed., pp. 334-372, Agricultural Publications, Univ. of Calif., Berkeley, 1961

## NITROGENOUS CONSTITUENTS

L. B. Rockland

Chapter 8 of THE ORANGE. ITS BIOCHEMISTRY AND PHYSIOLOGY, W. B. Sinclair, ed., pp. 230-264, Agricultural Publications, Univ. of Calif., Berkeley, 1961

Western Utilization Research and Development Division  
Western Regional Research Laboratory  
800 Buchanan Street, Albany 10, California

## ALKALINE REARRANGEMENT OF PARA-AROYLOXY-ORTHO-HYDROXYACETOPHENONES

Leonard Jurd

Chem. and Indus. 30: 965-966, July 23, 1960

## \*PURIFICATION OF FRUIT ESSENCES AND PRODUCTION OF SOLID COMPOSITIONS THEREFROM

K. P. Dimick and Benjamin Makower

U. S. Patent No. 2,949,368, Aug. 16, 1960

## URINARY PHENOLIC ACID METABOLITES OF TYROSINE

A. N. Booth, M. S. Masri, D. J. Robbins, O. H. Emerson,  
F. T. Jones, and Floyd DeEds

Jour. Biol. Chem. 235(9): 2649-2652, Sept. 1960

## FRACTIONATION OF CAROTENOIDS. TWO NEW SOLVENT SYSTEMS FOR THE COUNTERCURRENT DISTRIBUTION OF CAROTENOIDS

A. Laurence Curl

Jour. Agr. and Food Chem. 8(5): 356-358, Sept.-Oct. 1960

\*CONTINUOUS PROCESS OF DEHYDRATED FRUIT AND VEGETABLE JUICES

A. I. Morgan, Jr. and L. F. Ginnette  
U. S. Patent No. 2,955,046, Oct. 4, 1960

\*DEHYDRATION OF FRUIT AND VEGETABLE JUICES

A. I. Morgan, Jr. and L. F. Ginnette  
U. S. Patent No. 2,955,943, Oct. 11, 1960

USE OF DIRECT STEAM INJECTION IN FOOD PROCESSING

A. I. Morgan, Jr.  
Jour. Dairy Sci. 43(11): 1693-1696, Nov. 1960

FOULING INSIDE HEAT EXCHANGER TUBES

A. I. Morgan, Jr. and R. A. Carlson  
Food Technol. 14(11): 594-596, Nov. 1960

\*DEHYDRATION OF FRUIT AND VEGETABLE JUICES

S. I. Strashun and W. F. Talburt  
U. S. Patent No. 2,959,486, Nov. 8, 1960

CHROMATOGRAPHY OF PHENOLIC COMPOUNDS ON BORATE IMPREGNATED PAPER

Leonard Jurd  
Jour. Chromatog. 4(5): 369-375, Nov. 1960

RECENT DEVELOPMENTS IN FOAM-MAT DRYING

A. I. Morgan, Jr., R. P. Graham, L. F. Ginnette, and  
G. S. Williams  
Food Technol. 15(1): 37-39, Jan. 1961

\*PROCESS OF DEHYDRATING FRUIT AND VEGETABLE JUICES

A. I. Morgan, Jr., J. M. Randall, and R. P. Graham  
U. S. Patent No. 2,967,109, Jan. 3, 1961

DETERMINATION OF THE RELATIVE CONCENTRATIONS OF THE MAJOR ALDEHYDES IN LEMON, ORANGE AND GRAPEFRUIT OILS BY GAS CHROMATOGRAPHY

W. L. Stanley, R. M. Ikeda, S. H. Vannier, and L. A. Rolle  
Jour. Food Sci. 26(1): 43-48, Jan. 1961

INCREASING EVAPORATOR CAPACITY WITH POLISHED TUBES

P. W. Kilpatrick and Edward Breitwieser  
Indus. and Engin. Chem. 53(2): 119-120, Feb. 1961

SYNTHESIS OF SOME IODO-HYDROXY-FLAVONES AND POLYHYDROXYBI-  
FLAVONYLS

Leonard Jurd

Chem. and Indus. 10: 322-323, March 11, 1961

PREPARATION OF LOCKED-IN CITRUS OILS WITH "MIXED SUGARS"

T. H. Schultz and W. F. Talburt

Food Technol. 15(4): 188-190, April 1961

A MODIFIED GIBBS METHOD FOR THE DETERMINATION OF 1 P. P. M. OR  
LESS OF O-PHENYLPHENOL IN FRUITS

L. R. Leinbach and J. E. Brekke

Jour. Agr. and Food Chem. 9(3): 205-206, May-June 1961

WALL TEMPERATURE AND HEAT FLUX MEASUREMENT IN A ROUND TUBE

A. I. Morgan, Jr. and R. A. Carlson

Jour. Heat Transfer, pp. 105-110, May 1961

Southern Utilization Research and Development Division  
U. S. Fruit and Vegetable Products Laboratory  
600 Avenue S, N. W., Winter Haven, Florida

THE DETERMINATION OF SOLUBLE SOLIDS IN CITRUS JUICES. I. THE  
EFFECT OF NON-SUCROSE COMPONENTS ON REFRACTOMETER VALUES

W. Clifford Scott, D. A. Morgan, and M. K. Veldhuis

Food Technol. 14(9): 423-428, Sept. 1960

EFFECT OF CITRIC ACID CONCENTRATION ON THE FORMATION OF  
DIACETYL BY CERTAIN LACTIC ACID BACTERIA

N. B. Rushing and V. J. Senn

Appl. Microbiol. 8(5): 286-290, Sept. 1960

A MICRO-SCALE COLLECTION TUBE FOR GAS CHROMATOGRAPHY

H. J. Gold

Chemist Analyst 49: 112, Sept. 1960

NOBILETIN FROM THE PEEL OF THE VALENCIA ORANGE (CITRUS  
SINENSIS, L.)

L. J. Swift

Jour. Org. Chem. 25: 2067, 1960

CITRUS PECTINESTERASE INHIBITOR IN GRAPE LEAF EXTRACT

T. J. Kew and M. K. Veldhuis

Proc. Florida State Hort. Soc. 73: 293-297, 1960

THE DETERMINATION OF SOLUBLE SOLIDS IN CITRUS JUICES. II. COR-  
RECTION OF REFRACTOMETER VALUES OF CONCENTRATED JUICES  
W. Clifford Scott, D. A. Morgan, and M. K. Veldhuis  
Food Technol. 15(4): 180-186, April 1961

DETERMINATION OF LINALOÛL AND  $\alpha$ -TERPINEOL IN FLORIDA ORANGE  
PRODUCTS

L. J. Swift

Jour. Agr. and Food Chem. 9(4): 298-301, July-Aug. 1961

Southern Utilization Research and Development Division  
U. S. Fruit and Vegetable Products Laboratory  
509 West 4th Street, Weslaco, Texas

A CAROTENE PRECURSOR: ITS PROPOSED STRUCTURE AND PLACE IN  
BIOSYNTHETIC SEQUENCE

G. A. Thompson, Jr., A. E. Purcell, and James Bonner  
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