



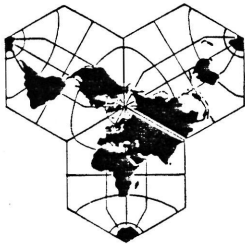
Eva Crane Trust

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HONEY SOURCES SATELLITE 3.

CHEMICAL COMPOSITION OF SOME HONEYS

by Eva Crane and Penelope Walker

London 1986

International Bee Research Association

GENERAL INTRODUCTION TO HONEY SOURCES SATELLITES

The "Directory of important world honey sources" by Eva Crane, Penelope Walker and Rosemary Day was published by the International Bee Research Association in 1984, with financial support from the International Development Research Centre, Ottawa. This Directory, and the database from which it was produced, contain much concentrated information which will be of value to certain specialists. IBRA is therefore publishing a series of Honey Sources Satellites on topics of special interest, giving information extracted from the database.

Satellites 1 and 2 are relevant to the whole database. Satellite 1 will be especially useful to readers using Satellites 3-6 who do not have access to the 1984 Directory, and Satellite 2 also to botanists and others concerned with the plant origins of honeys.

Titles of the Honey Sources Satellites are:

1. Bibliography (with author reference codes); country codes; other abbreviations
2. Plants listed alphabetically and by family; common name index; pollen grain information
3. Chemical composition of some honeys
4. Physical properties, flavour and aroma of some honeys
5. Honeydew sources and their honeys
6. Drought-tolerant and salt-tolerant honey sources.

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1. INTRODUCTION

The main entries for plants in the 1984 Directory included the chemical composition of the honey, in so far as this could be established from the literature. Section 2 here gives the printouts for the composition of these honeys, 107 in all†. They are listed in the same order as in the Directory, in which 001 to 452 are nectar-secreting plants and 01D to 15D (at the end) yield honeydew only.

The content of each of the following constituents is given, as % by weight of honey unless otherwise stated (* indicates search code - see below):

Water*. Sugars, total. Glucose*. Fructose*. Sucrose*.
 Reducing sugars*. Maltose. Higher sugars. Dextrin
 Ash. Inorganic constituents
 pH. Total acid (meq/kg). Free acid* (meq/kg). Lactone
 (meq/kg)
 Amylase* (Gothé). Sucrase (units given). Glucose oxidase
 and other enzymes (units given). HMF* (ppm)
 Nitrogen. Amino acids. Protein. Colloids
 Fermentation* (whether likely or unlikely on storage)
 Vitamins* (if present)
 Other constituents

For each constituent marked *, a search code enabled us to identify honeys with an especially high or low content. The boundaries we chose to separate classes (high, medium, low) are explained on pages 35-36. In Section 2, brackets are used as indicated in the

† The author reference codes in Section 2 lead to the full references in the Bibliography, published in both the Directory and Satellite 1. Data for which no reference is given are from the last reference quoted.

following examples:

(low) = the author quoted refers to the content as "low";

[low] = the figure(s) quoted place the honey in our "low" class.

In compiling Section 3, we used search codes to identify individual honeys that are likely, or unlikely, or never known to ferment on storage. Ten honeys are reported as likely to ferment, two as unlikely, one as never known to ferment. We do not know how many other honeys - about which knowledge is lacking - would fall into these classes.

Section 4 discusses the data presented in Section 2 in relation to limits laid down by the European Communities Council Directive (1974) for nine constituents of honey.

2. PRINTOUTS GIVING CHEMICAL COMPOSITION OF INDIVIDUAL HONEYS

014 Acer pseudoplatanus L.; Aceraceae

Water [medium] 17.3% (Kir/60)

Dextrin 1.85% of dry matter

Ash [medium] 0.79%

pH 4.37

Colloids 1.5% of dry matter

016 Actinodaphne angustifolia Nees; Lauraceae

Water [medium] 18.72% (8 samples, Pha/67; same data also in Naa/70)

Glucose [medium] 35.55%. **Fructose** [medium] 38.15%. **Melezitose, raffinose** present (Pha/70). **Dextrin** 0.669%

Ash [medium] 0.494% (Pha/67); Na, K, Ca, Mg, Fe, P, Si contents (Pha/70)

Free acid [medium] 36.8 meq/kg (Pha/67); citric, malic, succinic acids present (Pha/70)

Amino acids 9 identified including glycine (Pha/70). **Protein** 1.111% (Pha/67)

Vitamins in "pisa" honey (plant source may be this sp or A. hookerii, Kai/65)

017 Actinodaphne hookerii Meissn.; Lauraceae

Water [medium] 19.37% (Pha/62)

Sugars, total 73.50%. **Glucose** [medium] 33.73%. **Fructose** [medium] 35.71%. **Reducing sugars** 69.44%. **Dextrin** 1.98%

Ash [medium] 0.478%

Free acid [medium] 24.5 meq/kg. **Protein** 1.135%

Vitamins present in "pisa" honey (plant source may be this sp or A. angustifolia, Kai/65)

021 Aesculus turbinata Bl.; Hippocastanaceae

Water [medium] 19.55% (Aso/60); 19.2% (Ech/75)

Sugars, total 80.8% (Ech/75). **Glucose** [medium] 33.30% (Aso/60); 32.11% (Ech/77). **Fructose** [low] 33.60% (Aso/60); 36.34% (Ech/77).

Sucrose [medium] 3.53% (Aso/60); 1.20% (Ech/77). **Reducing sugars** 69.63%. **Maltose** 4.05% (Ech/77). **Higher sugars** 1.21% of total sugars (Ech/75)

pH 3.8 (Ech/75)

Amylase 86 900 units/100 ml honey (Ech/75); 435 units/mg protein (Ech/77). **Sucrase** 2.37 units/mg protein. **Glucose oxidase** 13 200 units/100 ml honey (Ech/75); 66.0 units/mg protein (Ech/77).

Catalase 0.01 unit/mg protein. **Acid phosphatase** 2.06 units
Protein 0.18% (Ech/75)
Vitamins pantothenic acid 0.7-11.5 ppm (Waa/56)

023 Aloe davyana Schonl.; Liliaceae

Glucose [medium] 39.1% (Joh/76a). **Fructose** [medium] 36.2%.
Sucrose [medium] 3.5%
pH 3.5. **Total acid** 42.2 meq/kg
Amylase 13.3. **HMF** 1.3 ppm

031 Anchusa officinalis L.; Boraginaceae

Sugars (as % of total, Maz/64): **glucose** 37.5%; **fructose** 47.6%;
sucrose 7.5%; **maltose** 3.7%; **fructomaltose** 3.7%

033 Angelica archangelica L.; Umbelliferae

Sugars (as % of total, Maz/64): **glucose** 30.6%; **fructose** 57.3%;
sucrose 2.3%; **maltose** 9.8%

034 Antigonon leptopus Hook. & Arn.; Polygonaceae

Water [medium] 16.3, 17.2% (2 samples, age 14, 2 mths (Whi/62);
also [high] over 20% in Cuba (Ord/83)
Glucose [low] 28.68, 28.24% (Whi/62). **Fructose** [low] 34.87,
34.84%. **Sucrose** [low] 0.60, 0.62%. **Maltose** 6.16, 6.05%.
Higher sugars 3.05, 3.01%. **Melezitose** 3.15, 3.06%
Ash [medium] 0.616, 0.567%
pH 4.35, 4.30. **Total acid** 54.81, 55.41 meq/kg. **Free acid**
[high] 45.51, 46.91 meq/kg. **Lactone** 9.30, 8.50 meq/kg
Nitrogen 0.039, 0.074%

035 Asclepias syriaca L.; Asclepiadaceae

Sugars (as % of total, Maz/64): **glucose** 33.4%; **fructose** 48.2%;
sucrose 4.5%; **maltose** 7.1%; **fructomaltose** 6.8%

036 Astragalus sinicus L.; Leguminosae

Water [high] 22.0% (3 samples, Aoy/68); 26.20% (Aso/60); 20.4%
(Ech/75)
Sugars, total 79.6% (Ech/75). **Glucose** [medium] 30.77% (Aso/60);
33.06% (Ech/77). **Fructose** [medium] 35.56% (Aso/60); 39.63%

(Ech/77). **Sucrose** [medium] 3.85% (Aso/60); 0.80% (Ech/77).
Reducing sugars 66.33% (Aso/60). **Maltose** 3.23% (Ech/77)
Ash [low] 0.03-0.06% (Aoy/68)
pH 3.20-3.75 (5 samples, Aoy/68); 3.8 (Ech/75). **Total acid** 29.1-61.3 ?meq/kg (Aoy/68). **Free acid** [medium] 25.7-58.0 ?meq/kg.
Lactone 3.3-4.0 ?meq/kg. Results for 9 organic acids (Ech/77)
Amylase 9.1-30.0 (6.6-27.2 after 2 mths, 8.1-25.0 after 4 mths, Aoy/68); results also in Ech/75, Ech/77, Mau/71. **Sucrase** 0.47 unit/mg protein (Ech/77); trace, 2.55 g/100g/h (Mau/71).
Glucose oxidase 800 units/100 ml honey (Ech/75); 4.0 units/mg protein (Ech/77). **Catalase** 0.015 unit/mg protein. **Acid phosphatase** 1.21 unit/mg protein (Ech/77); 22.6, 62.8 μ moles/100g/h (Mau/71)
Nitrogen 0.022-0.044% (Aoy/68). **Amino acids** 0.07% (Ech/77); contents of individual acids (Aoy/68; Ech/77). **Protein** 0.21% (Ech/75); 0.10, 0.16% (Mau/71)
Other constituents - compounds probably contributing to flavour (Wab/80)

037 Avicennia germinans (L.) L.; Avicenniaceae

Water [high] 24% (Lov/58a)
Glucose [high] (Lov/61)
Fermentation on storage likely (Cra/75)

039 Azadirachta indica A. Juss.; Meliaceae

Water [high] 22.88% (Sig/62)
Sucrose [high] ?7.46%
Ash [low] 0.06%
Free acid [medium] 20.8 meq/kg

047 Borago officinalis L.; Boraginaceae

Sugars (as % of total, Maz/64): **glucose** 31.6%; **fructose** 54.8%;
sucrose 3.8%; **maltose** 7.5% **fructomaltose** 2.3%

054 Brassica campestris L.; Cruciferae

Water [medium] 18.1% (1 sample, age 17 mths, Whi/62)
Glucose [low] 26.43%. **Fructose** [medium] 37.26%. **Sucrose** [low] 0.45%. **Maltose** 11.11%. **Higher sugars** 1.68%
Ash [medium] 0.324%
pH 4.38. **Total acid** 34.55 meq/kg. **Free acid** [medium] 30.00 meq/kg. **Lactone** 4.55 meq/kg
Amylase 18.8
Nitrogen 0.070%

060 Brassica napus L. var. oleifera DC.; Cruciferae

Water [medium] 17.6-18.8% (4 samples, Dus/67); can be >18% (Lou/80)
Glucose [medium] 35.22% ("rape" honey, Ech/77); 39.6-42.6% (6 samples, Gon/79); 35.13% (Mur/76); also "high" (Cab/61).
Fructose [medium] 37.25% (Ech/77); 36.9-40.2% (Gon/79); 39.69% (Mur/76). **Sucrose** [low] 0.40% (Ech/77). **Reducing sugars** 70.15% (Mur/76). **Maltose** 5.80% (Ech/77). Contents of individual sugars as % of total sugars (Maz/59; Maz/64)
Ash [low] 0.53% (Mur/76). Fe, Cu, Mn, Mg contents (36 samples, Pos/72)
pH 4.6 (Dus/72); approx 4 (Lou/80). **Free acid** [medium] approx 15 meq/kg
Sucrase 7.2-15.4 (Dus/67). **Catalase** 0-2.1 (Dus/67). **Peroxide number** ($\mu\text{g/g/h}$) 41.8-125 (Dus/67); 73.3 (25.1 after 10 minutes in sunlight, Dus/72)
Amino acids 0.00037% dry wt, also contents of individual acids (Moo/65). **Protein** 0.220% (Ber/75)
Other constituents - formaldehyde, acetaldehyde, acetone, isobutyraldehyde, diacetyl present (Hoo/63)

072 Calluna vulgaris (L.) Hull; Ericaceae

Water [high] 19.2-21.6% (3 samples, Dus/67); 19.69-20.45% (Feo/71); 17.6-26.7% (27 samples, Mic/54); 16.0-24.8% (25 samples, Mic/55)
Sugars, total 72.0, 76.7% (Ver/65). **Glucose** [medium] 33.3-34.0% (Feo/71); 31.2-32.9% (5 samples, Gon/79). **Fructose** [medium] 37.5-39.3% (Feo/71); 41.4-42.6% (Gon/79). **Sucrose** [medium] 0.5-0.9% (Feo/71); 3.39, 1.78% (Ver/65). **Reducing sugars** 71.5-72.9% (Feo/71). **Maltose, lactose, galactose** present (Wan/64).
Dextrin 4.8-5.9% (Feo/71)
Ash [medium] 0.18-0.69% of dry wt (Mic/54); see also Feo/71
pH 4.5 (Dus/72); 4.1-4.3 (Feo/71); 4.0-4.6 (Lou/77); 3.69-12.9 (Mic/54); 4.20-5.36 (25 samples, Mic/55). **Total acid** 2.3-3.5 (degrees, by Polish standard method, Feo/71). **Alkalinity number** 11.3-13.4 (Feo/71)
Amylase 21.0-36.9 (Polish standard method, Feo/71); 40 (Lou/66). **Sucrase** 31.0-35.5 (Gontarski 1957 method, Dus/67); 24.7 (Dus/72a); 45.8-49.5 (Feo/71). **Catalase** 0.1-3.6 (Dus/67).
Peroxide number ($\mu\text{g/g/h}$) 29.0-33.6 (Dus/67); 111.8 (Dus/71); 132.2 (103.2 after 10 minutes in sunlight, Dus/72)
Nitrogen 0.97-1.09% (Feo/71); 0.13-0.38% (17 samples, Mic/54).
Amino acids 0.000526% dry wt, also contents of 9 individual acids given (Moo/65); 12, 13 individual acids identified in 2 samples (Kum/74). **Protein** 1.3-1.8% (How/79). **Colloids** 4.1-8.8% (Feo/71); 0.48-3.34% of dry wt (Mic/54); 1.35-3.9% (Mic/55)
Vitamins C 40-52 ppm (Feo/71)

077 Carvia callosa (Nees) Brem.; Acanthaceae

Water [medium] 18.33% (Pha/62); 19.08% (8 samples, Pha/67; Pha/70)
Sugars, total 77.82% (Pha/62). **Glucose** [medium] 28.17% (Pha/62); 31.21% (Pha/67). **Fructose** [medium] 38.29% (Pha/62); 35.24% (Pha/67). **Sucrose** [high] >10% (Pha/67). **Reducing sugars** 66.46% (Pha/62); 66% (Pha/67). **Maltose, melezitose, raffinose** present (Pha/67). **Dextrin** 2.14% (Pha/62); 1.92% (Pha/67)
Ash [medium] 0.298% (Pha/62); 0.248% (Pha/67). Na, K, Ca, Mg, Fe, P, Si contents (Pha/67)
Free acid [medium] 36 meq/kg (Pha/62; Pha/67). **Citric, malic, succinic acids** present (Pha/70)
Amylase 6.22 (Sur/78). **Sucrase** 24.38
Amino acids glutamic acid, tyrosine, valine, leucine present (Naa/70). **Protein** 0.817% (Pha/62); 0.734% (Pha/67); 1.02% (Sur/78)
Vitamins C 113.5 ppm (Sur/78)
 Indian Standard for this honey, see Ini/77

080 Castanea sativa Mill.; Fagaceae

Water [medium] 17.6-19.1% (5 samples, Dus/67); 17.1-19.3% (10 samples, Iva/78); 15.7% (Kir/60); 16.0% (Mal/77); 18-19% (Shl/81)
Sugars, total 71.46-75.30% (Iva/78); 70.2-71.2% (Shl/81); 76.8, 79.6% (Ver/65). **Glucose** [medium] 32.4-33.5% (5 samples, Gon/79); 32.15% (Mur/76); 25.22-30.80% (Shl/81); 22.29% (2 samples, Tou/80). **Fructose** [medium] 42.5-44.4% (Gon/79); 36.74% (Mur/76); 35.00-44.68% (Shl/81); 39.19, 39.37% (Tou/-80). **Sucrose** [medium] 0.00-6.17% (Iva/78); 0.35, 0.33% (Tou/-80); 2.21, 2.62% (Ver/65). **Reducing sugars** 67.80-72.50% (Waa/-78); 69.64% (Mur/76). Contents of individual sugars expressed as % of total sugars (Bat/73; Maz/59); also **maltose, isomaltose, trehalose, gentiobiose** (Bat/73). **Dextrin** 2.71% (Kir/60)
Ash [medium] 0.70-1.20% (Iva/78); 1.28% (Kir/60); 0.77% (Mal/77); 0.28% (Mur/76); 0.45-0.98% (20 samples, Pes/80); 0.25-0.42% (Shl/81)
pH 4.5 (Dus/72); 5.45 (Had/63); 5.15 (Kir/60); 5.87 (Mal/77).
Total acid (meq/kg) 10.6 (Had/63); 8.5-13.0 (Iva/78); 12.94 (Mal/77). **Free acid** (meq/kg) [low] 6.8 (Had/63); 10.69 (Mal/77); 25-35 (Shl/81). **Lactone** (meq/kg) 3.8 (Had/63); 2.25 (Mal/77). **Citric acid** 0.017% (Tou/80). **Malic acid** 0.064%
Amylase 13.0-18.4 (Iva/78); 17.7 (Mal/77). **Sucrase** 19.0-32.8 (Dus/67); 28.7 (Dus/72a). **Catalase** 0.0-0.2 (Dus/67). **Per-oxide number** ($\mu\text{g/g/h}$) 100-285 (Dus/67a); 391.5 (294.0 after 10 minutes in sunlight, Dus/72); results for honeydew honey (Dus/67a; Dus/71). **HMF** 0.38 ppm (Mal/77)
Nitrogen 0.036% dry wt (Bos/78); 0.12% (Kir/60). **Amino acids**, free 0.201%, protein 0.118% (Bos/78); 11, 15 individual acids identified in 2 samples (Kum/74). **Protein** 0.375% (Ber/75). **Colloids** 0.48% (Kir/60)
Fermentation on storage unlikely, low yeast count (Maa/73)
 Honey may be derived from both nectar and honeydew if flows coincide (Klo/65)

081 Catunaregam spinosa (Thunb.) Tirvengadam; Rubiaceae

Water [medium] 17.23% (Naa/70); 16.09% (Pha/62); 17.19% (Raj/70)
Sugars, total 79.89% (Pha/62). **Glucose** [medium] 5.70% (Naa/70); 35.26% (Pha/62). **Fructose** [medium] 41.17% (Naa/70); 42.54% (Pha/62). **Reducing sugars** 77.80% (Pha/62). **Maltose, melezitose, raffinose** present (Pha/70). **Dextrin** 1.80% (Naa/70); 1.89% (Pha/62)

Ash [medium] 0.169% (Naa/70); 0.167% (Pha/62). Contents of Na, K, Ca, Mg, Fe, P, Si (Pha/62)

Free acid [medium] 12.9 meq/kg (Pha/62); 16.4 meq/kg (Naa/70).

Citric, malic, succinic acids present (Pha/70)

Amino acids glutamic acid, tyrosine, leucine present (Pha/70); glycine, tyrosine, serine, proline not present (Kai/64). **Protein** 0.486% (Naa/70); 0.419% (Pha/62)

Vitamins 8 µg thiamine/100 g; riboflavin (in bound form), ascorbic acid, niacin also present (Kai/65)

083 Centaurea cyanus L.; Compositae

Glucose 37.4% of total sugars (Maz/64). **Fructose** 44.0%.

Sucrose 6.3%. **Maltose** 7.9%. **Fructomaltose** 4.4%

pH 4.3 (Dus/72)

Amylase 41 (Dus/69). **Sucrase** 35.5 (Dus/72a). **Peroxide number** (µg/g/h) 624.0 (Dus/71); 624.5 (308.5 after 10 minutes in sunlight, Dus/72)

090 Citrus deliciosa Ten.; Rutaceae

Water [high] 18.72, 26.27% (Waa/61)

Glucose [medium] 36.46, 38.62%. **Fructose** [medium] 34.00, 37.60%. **Sucrose** [medium] 0.95, 1.60%. **Reducing sugars** 72.77, 79.02%

097 Citrus sinensis (L.) Osb.; Rutaceae

Water [medium] 15.4-17.5% (11 samples, The/77); 17.1% (1 sample, age 19 mths, Whi/62)

Glucose [low] 28.2-30.9% (The/77); 31.49% (Whi/62). **Fructose** [medium] 35.1-39.5% (The/77); 38.23% (Whi/62). **Sucrose** [high] 9.1-10.3%, unusually high (but 1.6-4.2% after 7 mths at room temp, Kal/77); 3.63-8.44% (1.80-6.51% after 1 mth at 27°, 0.63-6.1% after 2.5 mths, The/77); 2.68% (Whi/62). **Maltose** 2.6-3.5% (The/77); 7.41% (Whi/62). **Higher sugars** 1.47%

Ash [low] 0.084%

pH 3.60. **Total acid** 35.89 meq/kg. **Free acid** [medium] 22.77 meq/kg. **Lactone** 13.12 meq/kg

Amylase low (Ske/72). **HMF** 1-5 ppm (12-16 ppm after 7 mths at room temp, Kal/77)

Nitrogen 0.029% (Whi/62)

Other constituents - methyl anthranilate 0.084-3.90 µg/g (6 samples, Whi/66)

098 Citrus unshiu (Mak.) Marc.; Rutaceae

Glucose [low] 30.49% (Ech/77). **Fructose** [medium] 38.20%.

Sucrose [low] 0.91%. **Maltose** 5.19%

Other constituents - compounds probably contributing to flavour (Wab/80)

099 Clethra alnifolia L.; Clethraceae

Water [medium] 17.8% (1 sample, age 12 mths, Whi/62)

Glucose [medium] 31.30%. **Fructose** [medium] 36.30%. **Sucrose** [low] 0.81%. **Maltose** 7.11%. **Higher sugars** 1.63%

Ash [medium] 0.235%

pH 4.18. **Total acid** 32.03 meq/kg. **Free acid** [medium] 21.85 meq/kg. **Lactone** 10.18 meq/kg

Amylase 12.0

Nitrogen 0.053%

114 Coriandrum sativum L.; Umbelliferae

Water [medium] 16.80-18.48% (6 samples, Iva/78)

Sugars, total 72.25-73.70% (Iva/78). **Sucrose** [low] 0.00-2.18% (Iva/78). As % of total sugars (Maz/64): **glucose** 35.2%; **fructose** 48.1%; **maltose** 14.1%; **oligosaccharides** 1.1%

Ash [medium] 0.10-0.25% (Iva/78)

Total acid 21.0-33.0 meq/kg

Amylase 9.7-16.4. **HMF** 0.96-3.84 ppm (Iva/78)

Protein 0.0044, 0.0065% (Gen/67)

117 Cucumis melo L.; Cucurbitaceae

Water [low] 15.4% (1 sample, age 11 mths, Whi/62)

Glucose [medium] 34.51%. **Fructose** [medium] 37.00%. **Sucrose** [medium] 2.85%. **Maltose** 5.41%. **Higher sugars** 1.10%

Ash [medium] 0.203%

pH 3.80. **Total acid** 41.57 meq/kg. **Free acid** [medium] 31.28 meq/kg. **Lactone** 10.20 meq/kg

Amylase 8.1

Nitrogen 0.021%

122 Dalbergia sissoo DC.; Leguminosae

Water [medium] 18.75% (Sig/48)

Glucose [medium] 34.6%. **Fructose** [medium] 39.1%. **Sucrose** [medium] 1.04%

Ash [medium] 0.18%

135 Dracocephalum moldavica L.; Labiatae

Sugars (as % of total, Maz/64): **glucose** 29.8%; **fructose** 53.5%; **sucrose** 2.8%; **maltose** 8.9%; **fructomaltose** 5.0%

140 Echium vulgare L.; Boraginaceae

Water [medium] 16.4% (1 sample, age 17 mths, Whi/62)

Glucose [medium] 31.27%. **Fructose** [medium] 37.30%. **Sucrose** [medium] 1.28%. **Maltose** 8.43%. **Higher sugars** 2.53%. Contents of individual sugars expressed as % of total sugars (Maz/64)

Ash [low] 0.039%

pH 3.8 (Lan/66); 3.88 (Whi/62). **Total acid** 16.50 meq/kg (Whi/62).

Free acid [low] 11.81 meq/kg. **Lactone** 4.69 meq/kg

Nitrogen 0.033% (Whi/62)

144 Epilobium angustifolium L.; Onagraceae

Water [medium] 16.6% (1 sample, age 12 mths, Whi/62)

Glucose [low] 28.82%. **Fructose** [medium] 40.00%. **Sucrose** [low] 0.82%. **Maltose** 8.45%. **Higher sugars** 2.62%. Contents of individual sugars expressed as % of total sugars (Maz/64)

Ash [medium] 0.110%

pH 4.10. **Total acid** 19.68 meq/kg. **Free acid** [medium] 16.28 meq/kg. **Lactone** 3.40 meq/kg

Amylase 17.6

Nitrogen 0.027%

145 Erica arborea L.; Ericaceae

Sucrose [low] 0.30% (Spe/82). **Reducing sugars** approx 75%. As % of total sugars (7 samples, Bat/73): **glucose** 51.03%; **fructose** 43.76%; **sucrose** 0.20%; **maltose** 2.03%; also **isomaltose**, **trehalose**, **gentiobiose**

Nitrogen 0.04% dry wt (Bos/78). **Amino acids**, free 0.141%, protein 0.190%

146 Erica cinerea L.; Ericaceae

Water [medium] 17.8% (5 samples, Gon/65)

Total acid 61.5-63.0 meq/kg. **Free acid** [medium] 37.0 meq/kg (42.59 after 2 yrs at 20°). **Lactone** 25.3 meq/kg
Inhibine 187.2 ug hydrogen peroxide/g/h (Dus/71). **HMF** 18.2-25.0 ppm

152 Eucalyptus albens Benth.; Myrtaceae

Water [medium] 17.8% (Woo/76)
Sugars, total 77.5% (75.1% after 44 days at 50°, Woo/76a).
Glucose [low] 29.6% (28.7%). **Fructose** [medium] 36.4% (37.0%).
Sucrose [medium] 1.4% (0.8%). **Maltose** 2.9% (3.1%). **Melezitose** 1.1% (0.9%). **Turanose** 5.8% (6.3%)
pH 4.22 (4.25 after 44 days at 50°, Woo/76); 3.9 (Woo/78).
Total acid 35.6 (34.0) meq/kg. **Free acid** [medium] 28.9 (28.0) meq/kg. **Lactone** 6.5 (6.0) meq/kg
Amylase 17.8 (Edw/75)
Nitrogen 0.033% (0.034% after 44 days at 50°, Woo/76). **Amino acids**, free 1688.1 (297.3) uM/100 g, also contents of individual acids (proline 80% of total) (Woo/76a)
Volatile compounds 43 present, 12 named (Woo/78a)

156 Eucalyptus camaldulensis Dehnh.; Myrtaceae

Water - refractive index 1.4935 (Moh/82)
Glucose [medium] 32.70%. **Fructose** [medium] 38.20%. **Sucrose** [medium] 1.79-2.30%. **Reducing sugars** 68.82%. **Maltose** 6.60%.
Raffinose 1.60%. Contents of sugars as % of total sugars (Peo/72)
Ash [medium] 0.12% (Moh/82); K 0.148%, Na 0.0079%, Ca 0.001%
pH 4.2 (Lan/66); 5.3 (Moh/82). **Free acid** [medium] 20.70 meq/kg (Moh/82)
Amylase 29.4 (Lan/66)
Nitrogen 0.035% dry wt (Bos/78). **Amino acids**, free 0.157, protein 0.120% dry wt (Bos/78); 0.68%, also contents of 15 individual acids (Peo/72a; Peo/74)

158 Eucalyptus cladocalyx F. Muell.; Myrtaceae

Water [low] 14.6% (by gravimetry), 15.4% (by refractometry) (Anr/74)
Glucose [low] 25.2%. **Fructose** [medium] 41.9%. **Maltose** 12.2%
Ash [medium] 0.3%. **Nitrogen** 0.02%

164 Eucalyptus fasciculosa F. Muell.; Myrtaceae

Water [low] 15.8% (Che/74)
Glucose [low] 25.5%. **Fructose** [high] 45.1%. **Sucrose** [low] 0.6%. **Reducing sugars** 70.6%
Ash [low] 0.04%
pH 3.88. **Total acid** 11.8 meq/kg. **Free acid** [low] 8.6 meq/kg.

Lactone 3.2 meq/kg
Amylase 18. **HMF** 2.0 ppm

172 Eucalyptus leucoxylon F. Muell.; Myrtaceae

Water [medium] 15.4, 16.8% (Che/74; also gives data for samples age 5-12 mths)
Glucose [medium] 27.7, 30.6%. **Fructose** [medium] 43.7, 40.7%.
Sucrose [medium] 1.0, 4.8%. **Reducing sugars** 71.4, 71.3%
Ash [medium] 0.24, 0.11%
pH 5.19, 3.88 (Che/74); 4.3 (Lan/66). **Total acid** 10.6, 32.2 meq/kg (Che/74). **Free acid** [low] 8.6, 22.8 meq/kg
Amylase 28 (Che/74); 13.9 (Lan/66). **HMF** 2.0, 1.4 ppm

174 Eucalyptus macrorhyncha F. Muell. ex Benth.; Myrtaceae

Ash sulphated 0.337% (also ash analysis, Peo/70)
pH 6.0-6.4 (3 samples, Lan/66)
Amylase 23.8-38.5
Amino acids 16 acids identified (Peo/71)

175 Eucalyptus maculata Hook.; Myrtaceae

Water [medium] 16.8% (Che/74)
Glucose [medium] 31.2%. **Fructose** [high] 45.9%. **Sucrose** [low] 0.3%. **Reducing sugars** 77.1%
Ash [medium] 0.30%
pH 4.24 (Che/74); 4.7 (Woo/78). **Total acid** 26.6 meq/kg (Che/74).
Free acid [medium] 20.1 meq/kg. **Lactone** 6.5 meq/kg
Amylase 22. **Inhibine number** 2 (Woo/78). **HMF** 3.1 ppm (Che/74)
Nitrogen 0.025-0.043%

176 Eucalyptus melliodora A. Cunn. ex Schauer; Myrtaceae

Water [low] 14.0% (Che/74; also gives data for 2 samples age 5-12 mths); 17.2% (Woo/76; Woo/76a)
Sugars, total 79.5% (77.6% after 44 days at 50°, Woo/76a).
Glucose [medium] 30.4% (Che/74); 33.3% (28.0%, Woo/76a).
Fructose [medium] 42.9% (Che/74); 36.1% (38.2%, Woo/76a).
Sucrose [medium] 5.1% (Che/74); 1.2% (0.7%, Woo/76a). **Reducing sugars** 73.3% (Che/74). **Maltose** 5.1% (4.2%, Woo/76a). **Melezitose** 2.3% (2.0%). **Turanose** 0.0% (4.5%)
Ash [low] 0.06%
pH 4.10 (Che/74); 4.18 (4.05, Woo/76); 4.4 (Woo/78). **Total acid** meq/kg 17.2 (Che/74); 22.3 (21.5, Woo/76). **Free acid** (meq/kg) [medium] 12.2 (Che/74); 17.8 (16.5, Woo/76). **Lactone** (meq/kg) 5.0 (Che/74); 4.5 (5.0, Woo/76)
Amylase 30 (Che/74); 26.1 (Edw/75). **HMF** 1.9 ppm

Nitrogen 0.025-0.043% (Che/74); 0.020% (Woo/76). **Amino acids**, free 579.8 μM /100g (237.9, Woo/76); contents of individual acids (proline 80% of total, Woo/76a)

Volatile compounds, major: acetoin and ?hexenyl butyrate; also 6 other compounds (Grd/79); 48 present, 13 named (Woo/78a)

184 Eucalyptus robusta Smith; Myrtaceae

Water [medium] 17.0, 17.5% (Fle/63)

Ash [medium] 0.211, 0.201%

pH 4.2, 4.3

198 Euphoria longan (Lour.) Steud.; Sapindaceae

Water [medium] 18% (THA, Cra/84); [high] 21.4-23.2% (4 samples, THA, Lin/77)

Glucose [medium] 29.9-35.2%. **Fructose** [medium] 38.6-39.4%.

Sucrose [low] 0.1-0.8%

Ash [medium] 0.09%-0.25%

pH 4.4-4.7. **Free acid** [medium] 16.1-17.7 meq/kg (19.0-24.8 after 1 yr storage)

199 Fagopyrum esculentum Moench.; Polygonaceae

Water [high] 20.5% (Aso/60); sometimes 33% (Roo/74); 20.42-22.14% (Ryc/65); 18.5-20.5% (Sha/79); 16.2% (1 sample, age 12 mths, Whi/62)

Glucose [medium] 33.40% (Aso/60); 33.38% (Whi/62). **Fructose** [medium] 33.35% (Aso/60); 37.05% (Whi/62). **Sucrose** [medium] 2.46% (Aso/60); 0.57% (Whi/62). **Reducing sugars** 66.75% (Aso/60). Contents of these sugars also given as % of total sugars (Ryc/65).

Maltose 5.69% (Whi/62). **Higher sugars** 1.18%

Ash [medium] 0.118%

pH 3.62-4.19 (Ryc/65); 3.98 (Whi/62). **Total acid** 54.23 meq/kg (Whi/62). **Free acid** [high] 46.29 meq/kg. **Lactone** 7.94 meq/kg.

Alkalinity number 6.81-14.08 (Ryc/65)

Amylase, **sucrase** values, but method not stated (Ryc/65)

Nitrogen 0.124% (Whi/62). **Protein** 0.0095-0.0167% (17 samples, Gen/67). **Lipids** identified (Pop/79a). **Colloids** 3.40-4.58 mm (Lund, Ryc/65); data for 3 colloidal constituents (Hel/53)

Vitamins C 41-82 ppm (Ryc/65)

Other constituents - rutin in 6 of 10 samples, quercetin in others; after 4 days quercetin (only) present in all (Zbo/68)

202 Geranium pratense L.; Geraniaceae

Sugars (as % of total, Maz/64): **glucose** 34.9%; **fructose** 47.6%; **sucrose** 10.4%; **maltose** 5.5%; **fructomaltose** 1.6%

206 Gliricidia sepium (Jacq.) Walp.; Leguminosae

Water [high] 23.57% (Sig/62)
Sucrose [high] ?7.91%
Ash [medium] 0.15%
Free acid [medium] 18.72 meq/kg

210 Gossypium hirsutum L.; Malvaceae

Water [low] 15.6, 16.2% (2 samples, age 24, 5 mths, Whi/62)
Glucose [medium] 33.40% (Moh/82); 33.39, 36.93% (Whi/62).
Fructose [medium] 39.70% (Moh/82); 36.97, 39.91% (Whi/62).
Sucrose [medium] 1.13-1.68% (Moh/82); 3.02, 2.32% (Whi/62).
Reducing sugars 71.43% (Moh/82). **Maltose** 1.80% (Moh/82); 5.56, 4.59% (Whi/62). **Melezitose** 0.00, 0.68% (Whi/62)
Ash [medium] 0.38 (Moh/82); 0.146, 0.402% (Whi/62). K, Na, Ca contents (Moh/82)
pH 5.9 (Moh/82); 4.10, 4.20 (Whi/62). **Total acid** 20.37, 35.52 meq/kg (Whi/62). **Free acid** (meq/kg) [medium] 30.00 (Moh/82); 16.59, 28.69 (Whi/62). **Lactone** 3.78, 6.63 meq/kg (Whi/62)
Nitrogen 0.030, 0.018% (Whi/62)

220 Hedysarum coronarium L.; Leguminosae

Water [medium] 15.3-20.3% (19 samples, Fin/74)
Sugars, total 71.30-79.30%. **Sucrose** [medium] 1.42-5.20% (Fin/74).
 Sugars (as % of total): **glucose** 44.57% (Bat/73); 47.0% (Maz/59);
fructose 46.44% (Bat/73); 49.2% (Maz/59); **maltose** 3.9% (Maz/82);
 also contents of **isomaltose**, **trehalose** and **gentiobiase** (Bat/73)
Ash [low] 0.060% (10 white samples, Fin/74); 0.044% (17 samples, Pes/80); [medium] 0.169% (9 light amber samples, Fin/74)
Total acid 24.38, 32.19 meq/kg. **Free acid** [medium] 14.41, 21.94 meq/kg. **Lactone** 9.97, 10.25 meq/kg
Amylase 15.85, 26.92. **HMF** 1.68, 1.04 ppm
Nitrogen 0.032% dry wt (Bos/78). **Amino acids**, free 0.145%, protein 0.120%

221 Helianthus annuus L.; Compositae

Water [medium] 14.70-18.58% (15 samples, Bac/61); 15.60-20.96% (28 samples, Iva/78)
Sugars, total 74.24-79.30% (Iva/78). **Glucose** [medium] 34.72-42.33% (Bac/65); 31.09% (Mur/76). **Fructose** [medium] 34.75-40.28% (Bac/65); 41.16% (Mur/76). **Sucrose** [medium] 1.32-3.60% (Bac/65); 0.00-6.65% (Iva/78). **Reducing sugars** 69.40-77.76% (Iva/78); 72.86% (Mur/76). **Dextrin** 1.00-5.30% (Bac/65)

223 Hevea brasiliensis Muell. Arg.; Euphorbiaceae

Water [high] 25% (Fer/78)

Glucose [high] 40.7%. **Fructose** [low] 27.2% [sic]. **Sucrose**

[high] 4.0%. **Reducing sugars** 67.9%

pH 4.6

229 Hyssopus officinalis L.; Labiatae

Glucose 36.6% of total sugars (Maz/64). **Fructose** 54.6%.

Sucrose 1.2%. **Maltose** 6.0%. **Fructomaltose** 1.6%

230 Ilex glabra (L.) A. Gray; Aquifoliaceae

Water [medium] 15.4-19.6% (4 samples, age 8-20 mths, Whi/62)

Glucose [low] 27.45-32.24%. **Fructose** [medium] 39.63-40.89%.

Sucrose [low] 0.35-1.20%. **Maltose** 6.42-10.44%. **Higher sugars**

0.89-1.66%. **Melezitose** 0.43% (1 sample, Whi/62)

Ash [medium] 0.072-0.247% (4 samples, Whi/62).

pH 3.81-4.75. **Total acid** 10.13-23.48 meq/kg. **Free acid** [medium]

8.89-23.66 meq/kg. **Lactone** 1.24-6.17 meq/kg

Amylase 12.5-21.4

Nitrogen 0.018-0.044%

237 Ipomoea batatas (L.) Lam.; Convolvulaceae

Water [high] 24.3% (Lin/77)

Glucose [medium] 33.4%. **Fructose** [medium] 37.0%. **Sucrose**

[medium] 0.1%

pH 3.9. **Free acid** [medium] 30.9 meq/kg (39.8 after 1 yr)

250 Knightia excelsa R.Br.; Proteaceae

Water [medium] 16.0% (K. excelsa "probable source", Kir/60)

Reducing sugars 87.4% of dry wt. **Dextrin** 2.18% of dry wt

Ash [medium] 0.69% of dry wt

pH 4.00

Nitrogen 0.10% of dry wt. **Colloids** 0.62% of dry wt

252 Lavandula angustifolia Miller; Labiatae

Water may be high (Cra/75)

Glucose [medium] 32.4-33.8% (8 samples, Gon/79). **Fructose**

[medium] 38.7-40.9%. **Sucrose** may be high (Cra/75)

Other constituents - trace of methyl anthranilate (Des/62).

Acceptable characteristics for lavender honey (from this sp), and

for lavandin honey (256), have been published in the Proceedings

of the International Beekeeping Congress, 1975 (Int/75)

256 Lavandula angustifolia Miller x latifolia Medicus; Labiatae

Glucose [medium] 32.3-34.1% (5 samples, Gon/79). **Fructose** [medium] 36.2-39.7%

Acceptable characteristics for this honey have been published in Proceedings of the International Beekeeping Congress, 1975 (Int/75)

257 Leonurus cardiaca L.; Labiatae

Sugars (as % of total, Maz/64): **glucose** 31.8%; **fructose** 57.7%; **sucrose** 1.7%; **maltose** 6.2%; **fructomaltose** 2.6%

259 Leptospermum scoparium J. & G. Forst.; Myrtaceae

Water [medium] 20.6% (Woo/76; Woo/76a)

Sugars, total 72.9% (70.9% after 44 days at 50°, Woo/76a).

Glucose [medium] 31.4% (31.8%). **Fructose** [medium] 36.4% (35.2%).

Sucrose [low] 0.9% (0.6%). **Maltose** 2.5% (1.8%). **Melezitose** 0.9% (0.5%). **Turanose** 0.5% (1.0%)

pH 4.23 (4.25, Woo/76). **Total acid** 46.4 (47.0) meq/kg. **Free acid** [medium] 38.0 (39.0) meq/kg. **Lactone** 8.4 (8.0) meq/kg

Amylase 27.6 (amylochrome method), 27.5 (Codex method, Edw/75)

Nitrogen 0.063% (Woo/76). **Amino acids**, free 839.2 (621.1) $\mu\text{M}/100$ g (Woo/76a); also contents of individual acids (proline 30% of total). **Protein** high, 1.0-1.2% (Pry/50)

Other constituents 47 volatile compounds present, 9 named (Woo/78a)

265 Lippia nodiflora (L.) Michx.; Verbenaceae

Water [high] 22.3% (1 sample, age 6 mths, Whi/62)

Glucose [medium] 31.61%. **Fructose** [medium] 36.05%. **Sucrose** [low] 0.45%. **Maltose** 5.18%. **Higher sugars** 0.59%

Ash [medium] 0.119%

pH 3.93. **Total acid** 28.89 meq/kg. **Free acid** [medium] 22.28 meq/kg. **Lactone** 6.61 meq/kg

Amylase 24.0

Nitrogen 0.17%

267 Liriodendron tulipifera L.; Magnoliaceae

Water [medium] 16.9-18.2% (4 samples, age 5-18 mths, Whi/62)

Glucose [low] 23.08-27.35%. **Fructose** [low] 32.74-36.11%.

Sucrose [low] 0.14-1.11%. **Maltose** 9.63-14.64%. **Melezitose** 0.29% (1 sample). **Higher sugars** 2.19-4.23% (4 samples)

Ash [medium] 0.308-0.620%

pH 4.21-4.65. **Total acid** 28.45-50.43 meq/kg. **Free acid** [medium] 26.15-45.24 meq/kg. **Lactone** 2.30-7.10 meq/kg

Amylase 13.2-33.3 (3 samples, age 14-18 mths)

Nitrogen 0.052-0.098% (4 samples). **Protein** content, before and after dialysis (Whi/67)

268 Litchi chinensis Sonner.; Sapindaceae

Water [medium] 18.5% (1 sample, Lov/67a)

Amylase 28.8 (after dialysis, Mau/71). **Invertase** 1.63 g glucose/100 g/h. **Acid phosphatase** 75.1 μ moles/100 g/h

Protein 0.18% (Mau/71)

Fermentation on storage - never if kept airtight (Koh/58)

272 Lotus corniculatus L.; Leguminosae

Sugars (as % of total sugars): **Glucose** 42.9, 48.2% (Maz/59); 33.8% (Maz/64). **Fructose** 52.3, 50.3% (Maz/59); 54.8% (Maz/64). **Sucrose** 4.8, 1.5% (Maz/59); 4.6% (Maz/64). **Maltose** 4.7% (Maz/64). **Fructomaltose** 2.1%

274 Lythrum salicaria L.; Lythraceae

Water [medium] 18.6% (1 sample, age 8 mths, Whi/62)

Glucose [medium] 31.34%. **Fructose** [medium] 38.51%. **Sucrose** [low] 0.31%. **Maltose** 5.87%. Also as % of total sugars (Maz/64)

Ash [low] 0.083%

pH 3.88. **Total acid** 31.27 meq/kg. **Free acid** [medium] 21.91 meq/kg. **Lactone** 9.36 meq/kg

Nitrogen 0.049%

286 Marrubium vulgare L.; Labiatae

Glucose 26.6% of total sugars (Maz/64). **Fructose** 52.8%. **Sucrose** 1.9%. **Maltose** 14.0%. **Fructomaltose** 2.7%. **Oligosaccharides** 2.0%

290 Medicago sativa L.; Leguminosae

Water [low] 14.4-17.5% (6 samples, age 7-15 mths, Whi/62); [medium] 18.6% (Woo/76)

Sugars, total 79.4% (77.7% after 44 days at 50°, Woo/76a).

Glucose [medium, also low] 22.30% (Moh/82); 32.62-35.01% (Whi/62); 35.1% (33.2%, Woo/76a). **Fructose** [medium, also low] 36.20% (Moh/82); 38.37-40.87% (Whi/62); 34.8% (36.0%, Woo/76a). **Sucrose** [medium] 5.21-6.80% (Moh/82); 2.05-4.80% (Whi/62); 2.5% (0.8%, Woo/76a). **Reducing sugars** 71.60% (Moh/82). **Maltose** 9.00% (Moh/82); 4.72-6.87% (Whi/62); 4.0% (5.1%, Woo/76a). **Iso-maltose** 0.27%, **trehalose** 1.92%, **gentiobiose** 0.24%, **raffinose** 0.17% of total sugars (Bat/73). **Melezitose** 1.6%, **turanose** 1.4% (Woo/76a)

Ash [low] 0.10% (Moh/82); 0.035-0.078% (Whi/62)
pH 5.5 (Moh/82); 3.60-4.05 (Whi/62); 3.80 (3.45 after 44 days at 50°, Woo/76). **Total acid** (meq/kg) 17.81-33.89 (Whi/62); 15.5 (16.5, Woo/76). **Free acid** (meq/kg) [low] 16.70 (Moh/82); 9.22-22.23 (Whi/62); 11.1 (12.5, Woo/76). **Lactone** (meq/kg) 3.24-12.06 (Whi/62); 4.4 (4.4, Woo/76)
Amylase 7.6-7.7 (Edw/75); 12.8 (after dialysis, Mau/71); 18.2 (Sce/66); 12.9-21.9 (Whi/62). **Sucrase** trace (Mau/71). **Acid phosphatase** 8.8 μ moles/100 g/h (Mau/71)
Nitrogen 0.025% dry wt (Bos/78); 0.018-0.039% (Whi/62); 0.18% (0.17%, Woo/76). **Amino acids**, free 0.110% dry wt (Bos/78); 741.7 μ M/100 g (261.2, Woo/176a); protein 0.099% dry wt (Bos/78). Contents of individual acids (proline 80% of total, Woo/76a).
Protein 0.0052-0.0065% (4 samples, Gen/67); 0.18% (Mau/71)
Volatile compounds - 46 present, 13 named (Woo/78a)

296 *Melilotus alba* Desr.; Leguminosae

Water [medium] 18.8% (1 sample, 5 mths, Whi/62)
Glucose [medium] 33.72%. **Fructose** [medium] 36.77%. **Sucrose** [medium] 1.00%. **Maltose** 5.51%. **Higher sugars** 0.79%. Also contents as % of total sugars (Maz/64)
Ash [low] 0.041% (Whi/62)
pH 3.65. **Total acid** 19.37 meq/kg. **Free acid** [medium] 15.62 meq/kg. **Lactone** 3.75 meq/kg
Amylase 20.4
Nitrogen 0.010%

300 *Metrosideros umbellata* Cav.; Myrtaceae

Water [medium] 16.8% (M. umbellata is "suggested source of sample", Kir/60)
Reducing sugars 92% of dry wt (Kir/60). **Dextrin** 1.80% of dry wt
pH 4.27. **Free acid** [high] 40 meq/kg
Nitrogen 0.16% of dry wt. **Colloids** 0.44% of dry wt

309 *Nicotiana tabacum* L.; Solanaceae

Water [medium] 17.00-17.96% (4 samples, Iva/78)
Sugars, total 73.56-74.50%. **Sucrose** [low] 0.18-2.56%. **Reducing sugars** 71.00-74.10%
Ash [medium] 0.10-0.12%
Total acid 22.0-33.0 meq/kg
Amylase 13.2-18.4. **HMF** 4.8-19.2
Other constituents - ?nicotine (Cra/73)

311 Nyssa ogeche Bartram; Nyssaceae

Water [medium] 17.4-18.5% (6 samples, age 10-19 mths, Whi/62)
Glucose [low] 23.83-29.37%. **Fructose** [high] 42.25-44.26%.
Sucrose [medium] 0.94-1.31%. **Maltose** 6.89-8.53%. **Higher sugars** 0.82-1.22%
Ash [medium] 0.108-0.149%
pH 3.80-4.09. **Total acid** 30.27-45.14 meq/kg. **Free acid** [medium] 20.41-30.58 meq/kg. **Lactone** 8.03-14.56 meq/kg
Amylase 15.8-19.1
Nitrogen 0.029-0.060%. **Protein** content before dialysis (Whi/62) and after (Whi/67)
Other constituents - methyl anthranilate 0.05 µg/g (Whi/66)

314 Onobrychis viciifolia Scop.; Leguminosae

Water [medium] 17% (Dul/68); 16.39% (Sac/55)
Sugars (as % of total sugars): **glucose** 41.89% (9 samples, Bat/73); 40.8-42.9% (3 samples, Maz/59); **fructose** 50.26% (Bat/73); 51.3-55.0% (Maz/59); 51.6% (Maz/64); **sucrose** 0.43% (Bat/73); 2.2-8.4% (Maz/59); 2.0% (Maz/64); **maltose** 3.41% (Bat/73); 4.8% (Maz/64); **isomaltose** 0.23% (Bat/73); **fructomaltose** 2.0% (Maz/64); **trehalose** 1.57% (Bat/73); **gentiobiose** 0.14%; **melezitose** 0.81%; **raffinose** 0.15%
Nitrogen 0.038% dry wt (Bos/78). **Amino acids**, free 0.180%, protein 0.130%
Fermentation likely (Pia/81)

316 Oxydendron arboreum (L.) DC.; Ericaceae

Water [medium] 16.6, 17.8% (2 samples, age 7, 15 mths, Whi/62)
Glucose [low] 25.48, 25.23%. **Fructose** [medium] 40.73, 39.20%.
Sucrose [low] 0.97, 0.85%. **Maltose** 10.47, 11.38%. **Higher sugars** 2.35, 2.29%
Ash [medium] 0.217, 0.259%
pH 4.65, 4.47%. **Total acid** 16.13, 20.06 meq/kg. **Free acid** [low] 14.89, 14.92 meq/kg. **Lactone** 1.23, 5.14 meq/kg
Amylase 21.7, 15.6
Nitrogen 0.026, 0.014%
Other constituents - small amount of oxalic acid (Mei/71)

324 Phacelia tanacetifolia Benth.; Hydrophyllaceae

Sugars (as % of total, Maz/64): **glucose** 35.0%; **fructose** 49.7%; **sucrose** 7.5%; **maltose** 4.9%; **fructomaltose** 2.9%. **Galactose** present (Wan/64)
Amino acids 0.000489% dry wt, also contents of 9 individual acids (Moo/65)

342 Prunus x yedoensis Matsum.; Rosaceae**Water** [medium] 20% (1 sample, Waa/61)**Glucose** [high] 40.39, 50.9% (2 samples, Waa/61). **Fructose** [medium] 35.21, 44.01%. **Sucrose** [low] 0.45, 0.56%. **Reducing sugars** 78.07, 97.59%**347 Rabdosia rugosa (Wall. ex Benth.) Hara; Labiatae****Water** [medium, also low] 17.5-19.0% (Sha/79); 15.0% (Sig/48); 14.87% (8 samples, Sig/62)**Glucose** [medium] 38.4% (Sig/48); 35.35% (Sig/62). **Fructose** [medium] 40.0% (Sig/48); 41.21% (Sig/62). **Sucrose** [medium] 3.30% (Sig/48); 2.15% (Sig/62)**Ash** [medium] 0.310%**Free acid** [medium] 31.20 meq/kg (Sig/62)**354 Robinia pseudoacacia L.; Leguminosae****Water** [medium] 15.2-20.4% (34 samples, Iva/78); 15.8% (1 sample, age 13 mths, Whi/62); other published results range from 14.5 to 20.4% (Bac/65; Cer/64; Dus/67; Mal/77; Pae/77; Sha/79)**Glucose** [low] 29.02% (Ech/77); 24.49% (Tou/80); 24.34% (Whi/62); other results 23.7 to 39.9% (Bac/65; Bat/73; Cer/64; Gon/79; Pae/77). **Fructose** [high, also medium] 41.42% (Ech/77); 43.02, 42.84% (Tou/80); 43.29% (Whi/62); other results 30.1 to 47.9% (references as for glucose). **Sucrose** [medium, also low] 1.01% (Ech/77); 2.20, 2.07% (Tou/80); 0.63% (Whi/62); other results 0.15 to 13.41% (Bac/65; Bat/73; Bon/66; Cer/64; Iva/78; Pae/77). **Maltose** 6.51% (Bat/73); 5.44% (Ech/77); 10.14% (Whi/62). **Isomaltose** 0.40% (Bat/73). **Trehalose** 2.98%.**Gentiobiose** 0.27%. **Raffinose** 0.27%. **Melezitose** 1.35-3.89% (Pae/77). **Erllose** present (Bel/79). **Dextrin** 1.45-5.93% (Bac/65)**Ash** [low] 0.04-0.21% (Iva/78); 0.043% (Whi/62); other results 0.017 to 0.80% (Bac/65; Cer/64; Pae/77; Pes/80). Contents of elements (Cer/64; Var/70)**pH** 3.68 (Ech/77); 4.30 (Whi/62); other results 3.56 to 4.5 (Dus/72; Pae/77; Sha/79). **Total acid** (meq/kg) 12.99-28.03 (Pae/77); 9.88 (Whi/62). **Free acid** (meq/kg) [low] 10.53-16.71 (Pae/77); 7.64 (Whi/62). **Lactone** (meq/kg) 0.5-6.0 (Pae/77); 2.15 (Whi/62); other results for acid contents (Cer/64; Mal/77)**Amylase** 5.2-14.8 (Iva/78); 7.5 (Whi/62); other results 2.5 to 17.9 (Bac/65; Bon/66; Mal/77; Pae/77). **Invertase** 3.9-5.8 (Gontarski 1957 method, Dus/67); also Bon/66. **Glucose oxidase** 214 units/100 ml honey (Ech/75). **Peroxide number** 17.5-32.2 $\mu\text{g/g/h}$ (Dus/67); also Dus/72. **HMF** 0.19-10.98 ppm (Iva/78); also Mal/77; Pae/77**Nitrogen** 0.009, 0.011% dry wt (Bos/78); 0.19% (Whi/62). **Amino acids**, free 0.037, 0.060%, protein 0.035, 0.036% dry wt (Bos/78). **Protein** 0.20-1.90% (Cer/64); 0.24% (Ech/75). **Lipids** (Pop/79a)

Fermentation on storage unlikely, yeast count low (Maa/73)
Vitamins 260 ppm (180 ppm after 30 min at 50°, Ech/77)
 Compounds probably contributing to flavour (Wab/80)

355 Rosmarinus officinalis L.; Labiatae

Water [low] usually <17.5% (Int/75 - see note at end of section); refractive index 1.5007 (Moh/82)
Glucose [medium] 36.9-38.5% (7 samples, Gon/79); 24.95% (Moh/82).
Fructose [medium] 39.0-41.3% (Gon/79); 32.90% (Moh/82). **Sucrose** [medium] 1.49-3.04% (Moh/82). **Reducing sugars** 76.58%. **Maltose** 10.10%. **Raffinose** 11.90% [sic] (Moh/82); but usually 0% (Int/75). **Erllose** present (Pou/70); usually 0.8-3.0% (Int/75).
Melezitose 0% (Int/75)
Ash [low] 0.11% (Moh/82); usually <0.10% (Int/75)
pH 6.1 (Moh/82); 6.40 (Pan/59). **Total acid** range 8.7-19.1 meq/kg (Int/75). **Free acid** (meq/kg) [low] 13.10 (Moh/82); range 4.0-11.0 (Int/75). **Lactone** range 1.0-10.4 meq/kg (Int/75)
Amylase not less than 10, usually 10-20 (Int/75)
Nitrogen 0.012% dry wt (Bos/78). **Amino acids**, free 0.040, protein 0.060% dry wt
 Acceptable characteristics for this honey have been published in the Proceedings of the 25th International Beekeeping Congress 1975 (Int/75); reprinted in French (Lav/76; Uni/83); and in Spanish (Sau/82c). Some of the data are quoted above and below

358 Rubus idaeus L.; Rosaceae

Water [medium] 15.35-20.82% (10 samples, Bac/65); 18.7, 19.5% (Dus/67)
Glucose [medium] 32.90-38.80% (Bac/65). **Fructose** [medium] 34.96-41.34%. **Sucrose** [medium] 1.43-5.20%. Also contents as % of total sugars (Maz/64). **Dextrin** 1.80-5.10% (Bac/65)
Ash [medium] 0.08-0.41%
Amylase 10.9-38.5 (Bac/65). **Invertase** 11.5, 17.2 (Gontarski 1957 method, Dus/67). **Peroxide number** 158, 277.5 µg/g/h
Protein 0.0019-0.0047% (6 samples, Gen/67)

361 Sabal palmetto (Walt.) Lodd. ex Schultes; Palmae

Water [high] can be v high (Lov/55e); 19.7% (1 sample, age 13 mths, Whi/62)
Glucose [medium] 31.20% (Whi/62). **Fructose** [medium] 37.96%.
Sucrose [low] 0.63%. **Maltose** 6.25%. **Higher sugars** 0.99%
Ash [low] 0.084%
pH 3.61. **Total acid** 44.94 meq/kg. **Free acid** [medium] 37.62 meq/kg. **Lactone** 6.97 meq/kg
Amylase 20.1
Nitrogen 0.099%

Fermentation (alert to beekeepers) - likely, even in capped cells of comb (Lov/65a; Mot/64)

369 Salvia nemorosa L.; Labiatae

Sugars (as % of total, Maz/64): **glucose** 27.7%; **fructose** 56.4%; **sucrose** 1.5%; **maltose** 14.0%

370 Salvia officinalis L.; Labiatae

Glucose [medium] 34.41% (Mur/76). **Fructose** high (Maz/82); 40.56% (Mur/76). Also contents of these sugars, and **sucrose**, **maltose**, **fructomaltose**, as % of total sugars (Maz/59; Maz/64)
Ash [medium] 0.38% (Mur/76)

373 Sapindus mukorossi Gaertn.; Sapindaceae

Water [medium] 15.43, 17.0% (sample perhaps not monofloral, Sig/62)
Glucose [medium] 35.40%. **Fructose** [medium] 41.80%. **Sucrose** [high] 5.39, 4.94%
Ash [medium] 0.30, 0.14%
Free acid [medium] 37.44 meq/kg

381 Scrophularia nodosa L.; Scrophulariaceae

Sugars (as % of total, Maz/64): **glucose** 32.0%; **fructose** 51.9%; **sucrose** 2.8%; **maltose** 8.2%; **fructomaltose** 5.1%

382 Serenoa repens (Bartr.) Small; Palmae

Water [low, also medium] 15.1, 18.0% (age 7, 8 mths, Whi/62)
Glucose [low] 30.88, 30.96%. **Fructose** [medium] 37.40, 39.07%.
Sucrose [low] 0.62, 1.04%. **Maltose** 5.60, 7.36%. **Higher sugars** 1.67, 1.70%
Ash [medium] 0.458, 0.245%
pH 3.89, 4.10. **Total acid** 46.78, 35.71 meq/kg. **Free acid** [medium] 31.48, 21.59 meq/kg. **Lactone** 15.29, 14.12 meq/kg
Amylase 21.1, 7.7
Nitrogen 0.019, 0.024%

395 Syzygium cuminii (L.) Skeels; Myrtaceae

Water [medium] 18.4% (8 samples, Naa/70); 18.85% (Raj/70)
Glucose [medium] 32.26% (Naa/70). **Fructose** [high] 43.30%.
Sucrose, **maltose**, **raffinose**, **melezitose** present (Pha/70).
Dextrin 1.555% (Naa/70)

Ash [medium] 0.182% (Naa/70); see also Kal/64; Pha/70
Amino acids qualitative analysis (Kal/64). **Protein** 0.655% (Naa/70)
Fermentation on storage likely after a few mths (Koh/58)
Vitamins riboflavin present, also ascorbic acid, thiamine, niacin (Kal/65)

396 *Syzygium jambos* (L.) Alston; Myrtaceae

Water [medium] 18.15% (Pha/62)
Sugars, total 78.25%. **Glucose** [medium] 36.09%. **Fructose** [medium] 39.72%. **Reducing sugars** 75.81%. **Dextrin** 1.15%
Free acid [low] 13.1 meq/kg

398 *Taraxacum officinale* Weber; Compositae

Sugars (as % of total, Maz/64): **glucose** 40.1% ; **fructose** 49.9%; **sucrose** 6.3%; **maltose** 2.0%; **fructomaltose** 1.7%; **melezitose** 0.27% (Hir/51)
pH 4.3 (Dus/72)
Peroxide number 243.7 µg/g/h (186.2 after 10 minutes in sunlight, Dus/72)
Amino acids - 12 identified (Kum/74)
Fermentation on storage unlikely, low yeast count (Maa/73); likely (Pia/81)

401 *Terminalia chebula* Retz.; Combretaceae

Water [medium] 17.2% (8 samples, Naa/70); 17.13% (Pha/62); 18.21% (Raj/60)
Sugars, total 79.06% (Pha/62). **Glucose** [medium] 35.69% (Naa/70); 34.06% (Pha/62). **Fructose** [medium] 40.23% (Naa/70); 41.30% (Pha/62). **Sucrose, maltose, melezitose** present (Pha/70).
Reducing sugars 75.36% (Pha/62). **Dextrin** 1.80% (Naa/70); 1.49% (Pha/62)
Ash [medium, also low] 0.162% (Naa/70); 0.014% (Pha/62).
 Contents of Ca, P, Fe, Mg (Kal/64); Na, K, Ca, Mg, Fe, P, Si (Naa/70); see also Pha/70
Free acid [low] 7.7 meq/kg (Pha/62). Tartaric, citric, malic, succinic acids present (Naa/70; Pha/70)
Amino acid analysis (Kal/64; Pha/70). **Protein** 0.8% (Kal/64); 0.530% (Naa/70); 0.61% (Pha/62)
Vitamins niacin, riboflavin (Kal/65)

403 *Thelepaepale ixiocephala* (Benth.) Bremk.; Acanthaceae

Water [medium] 18.30% (8 samples, Naa/70); 19.11% (Pha/62)
Glucose [medium] 38.31% (Naa/70); 38.32% (Pha/62). **Fructose** [medium] 39.48% (Naa/70); 39.80% (Pha/62). **Sucrose, maltose,**

raffinose, melezitose present (Pha/70). **Reducing sugars** 78.12% (Pha/62). **Dextrin** 1.105% (Naa/70); 1.08% (Pha/62)
Ash [medium] 0.147% (Naa/70); 0.138% (Pha/62); Na, K, Ca, Mg, Fe, P, Si contents (Naa/70; Pha/70)
Free acid [medium] 23.3 meq/kg (Pha/62). Citric, malic, succinic acids present (Pha/70)
Amino acids (Pha/70). **Protein** 0.522% (Naa/70); 0.579% (Pha/62)

406 Thymus serpyllum L.; Labiatae

Water [medium] 16.8% (20 mths, ?heated, Whi/62)
Glucose [medium] 31.20%. **Fructose** [medium] 37.13%. **Sucrose** [low] 0.85%. **Maltose** 8.83%. **Higher sugars** 1.70%. **Melezitose** 0.34%
Ash [medium] 0.384%
pH 4.80. **Total acid** 27.88 meq/kg. **Free acid** [medium] 22.41 meq/kg. **Lactone** 5.47 meq/kg
Nitrogen 0.035% dry wt (Bos/78); 0.057% (Whi/62). **Amino acids**, free 0.91, protein 0.103% dry wt (Bos/78)

407 Thymus vulgaris L.; Labiatae

Water: refractive index at 20°, 1.5017 (Moh/82)
Glucose [low] 24.30%. **Fructose** [medium] 36.60%. **Sucrose** [medium] 1.55-2.29% (3 samples, Moh/82). **Reducing sugars** 77.88% (Moh/82). **Maltose** 9.30%. **Raffinose** 11.10% [sic]
Ash [low] 0.06%. K, Na, Ca contents
pH 6.2. **Free acid** [low] 11.50 meq/kg
 "Rich in enzymes" (Cra/75)
Other constituents carbonyl compounds identified (Hoo/63)

408 Tilia americana L.; Tiliaceae

Water [medium] 17.0% (1 sample, age 15 mths, Whi/62).
Glucose [low] 30.12%. **Fructose** [medium] 36.99%. **Sucrose** [low] 0.63%. **Maltose** 8.02%. **Higher sugars** 1.87%
Ash [low] 0.068%
pH 4.28. **Total acid** 25.74 meq/kg. **Free acid** [medium] 17.84 meq/kg. **Lactone** 7.89 meq/kg
Nitrogen 0.024%
Other constituents methyl anthranilate 0.04 µg/g (Whi/66)

410 Tilia cordata Mill.; Tiliaceae [honeydew honey]

Glucose [low] 30.09, 30.28% (Tou/80). **Fructose** [medium] 40.01, 39.62%. **Sucrose** [medium] 0.89, 1.00%. Contents of these sugars and of **maltose, fructomaltose** as % of total sugars (Maz/64).
Melezitose present (Bel/79). Sugar analysis (Bel/79; Lom/77);
 "lime" honeydew honey contains up to 10% dextrin (How/79)

Malic acid 0.12, 0.13% (Tou/80). **Citric acid** 0.043%
Other constituents calcium oxalate crystals (Maz/82)

411 Tilia japonica (Miq.) Simonk.; Tiliaceae

Water [high] 21.7% (Ech/75)
Sugars, total 78.3% (Ech/75). As % of total (Ech/75): **glucose** 38.86%; **fructose** 47.83%; **sucrose** 3.36%; **maltose** 8.36%; **higher sugars** 0.56%. **Lactose** present (Wan/64)
pH 3.9 (Ech/75)
Amylase 55 500 units/100 ml honey. **Glucose oxidase** 2100 units
Protein 0.19%
Other constituents 27 compounds identified: alcohols (mainly 8-p-menthene-1,2-diol), ketones, esters and acids, and (in aroma) 4-isopropylidene-2-cyclo-hexene-1-one (Tsu/74)

422 Tournefortia argentea L.f.; Boraginaceae

Water [medium] 18.6, 16.3% (Hit/76)
Glucose [low] 28.6%. **Fructose** [medium] 38.2%. **Sucrose** [high] 5.1%
Fermentation on storage may sometimes occur

426 Trifolium alexandrinum L.; Leguminosae

Water [low] 15.6-16.8% (39 samples, almost certainly from this sp, Els/79)
Sugars, total 73.4-83.0%. **Glucose** [medium] 31.6-35.8% (Els/79); 30.18% (Moh/82). **Fructose** [medium] 38.2-42.5% (Els/79); 38.80% (Moh/82). **Sucrose** [medium] 3.6-4.7% (Els/79); 1.67-2.30% (3 samples, Moh/82). **Reducing sugars** 71.82% (Moh/82). **Maltose** 3.30%. **Raffinose** 3.90%
Ash [low] 0.085-0.098% (Els/79); 0.06% (Moh/82). Contents of K, Na, Ca, Mg, Fe, Cu, Mn, P (Els/79); K, Na, Ca (Moh/82)
pH 5.0 (Moh/82). **Free acid** [medium] 21.00 meq/kg
Nitrogen 0.340-0.470% (Els/79)

428 Trifolium hybridum L.; Leguminosae

Water [medium] 16.6% (1 sample, age 12 mths, Whi/62)
Glucose [medium] 31.03%. **Fructose** [medium] 38.37%. **Sucrose** [medium] 1.53%. **Maltose** 7.59%. **Higher sugars** 1.58%
Ash [low] 0.090%
pH 3.86. **Total acid** 27.97 meq/kg. **Free acid** [medium] 17.91 meq/kg. **Lactone** 10.06 meq/kg
Amylase 17.6
Nitrogen 0.032%

429 Trifolium incarnatum L.; Leguminosae

Water [medium] 15.8-19.1% (4 samples, age 10-22 mths, Whi/62)
Glucose [high] 29.31-32.81%. **Fructose** [medium] 36.72-39.66%.
Sucrose [low] 0.73-1.29%. **Maltose** 6.26-10.27%. **Higher sugars** 1.14-2.26%
Ash [low] 0.040-0.080%
pH 3.63-3.83. **Total acid** 17.19-28.13 meq/kg. **Free acid** [medium] 12.81-20.64 meq/kg. **Lactone** 4.38-7.49 meq/kg
Amylase 16.7-31.9
Nitrogen 0.021-0.036%

430 Trifolium pratense L.; Leguminosae

Sugars, total 79.6% (Ver/65). **Glucose** 49.0% of total sugars (Maz/59). **Fructose** 50.1% of total. **Sucrose** [medium] 2.28% (Ver/65)
pH 4.2 (Dus/72); 3.40 (Had/63)
Peroxide number 114.2 µg/g/h (72.1 after 10 minutes in sunlight, Dus/72)
Nitrogen 0.045% dry wt (Bos/78). **Amino acids**, free 0.120%, protein 0.234% dry wt (Bos/78); 12-14 individual acids (8 samples, Kum/74)
Other constituents - carbonyl compounds identified (Hoo/63)

431 Trifolium repens L.; Leguminosae

Water [medium, also high] 19.4-21.3% (Rav/75); 17.5% (Sci/81); 16.4-21.0% (5 samples, age 3-15 mths, Whi/62)
Glucose [low, also medium] 28.13-32.13% (Whi/62). **Fructose** [medium] 37.62-39.93%. **Sucrose** [medium, also low] 0.74-1.35%.
Maltose 6.86-9.20%. **Higher sugars** 1.35-1.83%. Also contents as % of total sugars (Maz/59; Maz/64; Peo/72). **Lactose** present (Wan/64)
Ash [medium, also low] 0.087-0.618% (Whi/62); see also Peo/70; Ver/65; Zie/79
pH 4.0, 4.1 (Dus/72); 4.0 (Lan/66); 3.3-3.92 (Rav/75); 3.62-4.08 (Whi/62). **Total acid** 18.27-50.72 meq/kg (Whi/62). **Free acid** [medium] 13.69-31.35 meq/kg. **Lactone** 3.27-19.37 meq/kg
Amylase 23.8, 29.4 (Lan/66); 10.6-61.2 (Whi/62). **Sucrase** 30.2 (Dus/72a). **Peroxide number** 332.5 µg/g/h (44.1 after 10 minutes in sunlight, Dus/72). **HMF** 9.6 ppm (Sci/81)
Nitrogen 0.022% dry wt (Bos/78); 0.031-0.055% (Whi/62). **Amino acids**, free 0.123%, protein 0.073% dry wt (Bos/78); 0.101% (also contents of individual acids, Peo/74); 12 acids present (Moo/65); 16 acids present (Peo/71). **Protein** content before dialysis (Whi/62), and after (Whi/67)

Volatile constituents in sample 1, major: phenol, minor: furfuraldehyde + 9 others (trace); sample 2, major: 5-hydroxymethyl-2-furaldehyde, minor: methyl syringate + 6 others (trace) (Grd/79)

434 Turbina corymbosa (L.) Raf.; Convolvulaceae

Water [medium] 17.8% (Ord/83)

Sucrose [medium] 2.3%. **Reducing sugars** 71.24%

Ash [low] 0.0193%

440 Vicia villosa Roth; Leguminosae

Water [medium] 15.8-17.2% (5 samples, age 12-19 mths, Whi/62)

Glucose [low] 25.51-32.86%. **Fructose** [medium] 36.55-40.34%.

Sucrose 1.09 (3 samples). **Higher sugars** 1.64-2.78%

Ash [low] 0.039-0.081% (5 samples)

pH 3.70-4.00. **Total acid** 14.14-33.16 meq/kg. **Free acid** [low, also medium] 11.25-22.48 meq/kg. **Lactone** 2.45-10.68 meq/kg

Amylase 6.1-11.3 (3 samples)

Nitrogen 0.017-0.044%

448 Ziziphus mauritania Lam.; Rhamnaceae

Water [high] 23.0% (TAI, Lin/77)

Glucose [medium] 31.5%. **Fructose** [medium] 35.3% (Lin/77); "high" (Mad/81). **Sucrose** [low] 0.1% (Lin/77)

Ash [medium] 0.63%

pH 5.9. **Free acid** [medium] 15.4 meq/kg (28.0 after 1 yr)

HONEYS FROM PLANTS YIELDING HONEYDEW ONLY

Old Abies alba Miller; Pinaceae

Water [low] 16.1%, 14.2% (insect not specified, AUT, GFR, Kir/61)
Sugars (insect not specified, ITA, Bat/73): **glucose** [medium] 36.90%; **fructose** [low] 33.86%; **sucrose** [low] 0.40%; **maltose** 9.05%; **isomaltose** 1.45%; **trehalose** 4.88%; **gentiobiose** 0.64%; **raffinose** 1.57%; **melezitose** 8.10%. **Dextrin** 2.98%, 4.45% dry wt (Kir/61)

Ash 1.14%, 1.01% dry wt (Kir/61)

pH 4.78, 4.96 (Kir/61)

Sucrase high (Vor/68)

Amino acid analysis (GFR, Kum/74). **Colloids** 0.31%, 0.24% dry wt (Kir/61)

04D Calocedrus decurrens (Torr.) Florin; Cupressaceae

Water [low] 12.2, 15.2% (2 samples, age 9, 18 mths, insect not specified, USA/CA, Whi/62)
Glucose [low] 23.34, 27.94%. **Fructose** [low] 23.91, 26.22%.
Sucrose [low] 0.83, 0.74%. **Maltose** 5.85, 6.08%. **Higher sugars** 11.50, 8.70%
Ash [high] 1.097, 1.047%
pH 4.42, 4.71. **Total acid** 76.49, 56.08 meq/kg. **Free acid** [high] 66.02, 49.91 meq/kg. **Lactone** 10.47, 6.16 meq/kg
Nitrogen 0.049, 0.047%

06D Larix decidua Miller; Pinaceae

Glucose 15.94, 13.70% (dry wt, 2 samples, *Cinara laricis*, ITA/W Alps, Mal/79). **Fructose** 29.18, 24.33%. **Sucrose** 0.73, 4.16%.
Meso-inositol 0.05, 0.06%. **Turanose** 2.49, 1.29%. **Raffinose** 2.13, 2.00%. **Melezitose** 44.47, 42.76%; "high" (*Cinara cuneomaculata*, mid EUR, Klo/65)

07D Nothofagus solandri var. cliffortioides (Hook. f.) Poole; Fagaceae

Water [medium] 19% (beech honeydew honey, plant and insect not specified, NEZ, Dal/75)
Sugars, total 64%. **Fructose** [medium] 35.6%. **Sucrose** [medium] 1%. **Reducing sugars** [low] 63%
Ash [low] 0.79%
Free acid [medium] 32 meq/kg
Amylase 20. **HMF** 0 ppm

08D Picea abies (L.) Karsten; Pinaceae

Water [medium] 17.4% (insect not specified, AUT, Kir/61)
Reducing sugars 76.9% dry wt. **Dextrin** 3.57% dry wt
Ash 0.85% dry wt
pH 4.74
Colloids 0.24% dry wt. **Amino acid** analysis (insect not specified, GFR, Kum/74)

09D Pinus halepensis Miller; Pinaceae

Nitrogen 14 mg/100 g dry wt (insect not specified, ?ITA, Bos/78).
Amino acids free 54, protein 64 mg/100 g dry wt (Bos/78)

10D Pinus sylvestris L.; Pinaceae

Water [medium] 20.2, 20.5% (insect not specified, Dus/67)
Glucose [medium] 30.05% (presumed *P. sylvestris*, CZE, Svo/56).
Fructose [medium] 38.25%. **Dextrin** 3.11%
Ash [medium] 0.44%
Invertase 46, 47.3. **Peroxide number** 418.7, 662.5 $\mu\text{g/g/h}$
Amino acid analysis (Kum/74)

14D Quercus virginiana Mill.; Fagaceae

Water [medium] 18.2, 16.2% (2 samples, age 8,9 mths, USA/FL, Whi/62, who says "*Quercus fagaceae*", presumably *Quercus* (family Fagaceae) and we assume it to be *Q. virginiana*)
Glucose [low] 29.51, 26.61%. **Fructose** [medium] 38.12, 34.59%.
Sucrose [medium, also low] 1.14, 0.63%. **Maltose** 8.67, 10.59%.
Higher sugars 1.28, 2.47%. **Melezitose** (1 sample) 0.38%
Ash [medium] 0.212, 0.799%
pH 3.90, 4.70. **Total acid** 50.71, 67.27 meq/kg. **Free acid** [medium, also high] 36.62, 64.57 meq/kg. **Lactone** 14.09, 2.58 meq/kg
Amylase 6.7, 41.4
Nitrogen 0.053, 0.223%

See also entry for *Tilia cordata* (honeydew honey), p.28

3. LISTS OF HONEYS LIKELY OR UNLIKELY TO FERMENT

Honeys reported as likely to ferment:

- 028 *Ampelopsis arborea* (L.) Koehne; Vitaceae
- 037 *Avicennia germinans* (L.) L.; Avicenniaceae
- 061 *Brassica nigra* (L.) Koch; Cruciferae
- 177 *Eucalyptus moluccana* Roxb.; Myrtaceae
- 201 *Fuchsia excorticata* (J. & G. Forst.) L.f.; Onagraceae
- 243 *Ixerba brexioides* A. Cunn.; Saxifragaceae
- 314 *Onobrychis viciifolia* Scop.; Leguminosae
- 360 *Sabal florida* Becc.; Palmae
- 361 *Sabal palmetto* (Walt.) Lodd. ex Schultes; Palmae
- 422 *Tournefortia argentea* L.f.; Boraginaceae

Honeys reported as unlikely (080, 354) or never (268) to ferment:

- 080 *Castanea sativa* Mill.; Fagaceae
- 268 *Litchi chinensis* Sonner.; Sapindaceae
- 354 *Robinia pseudoacacia* L.; Leguminosae

5. DISCUSSION PAPER*

COMPOSITION OF HONEYS FROM SOME IMPORTANT HONEY SOURCES

by EVA CRANE AND PENELOPE WALKER

Data used

The *Directory of important world honey sources*³, published earlier this year, gives data on 452 nectar sources and 15 honeydew sources of honey. In addition to information on the plants and the nectar (or honeydew) and pollen from them, data on the physical properties and the chemical composition of the honeys were included where available.

The chemical composition of honey in general has been reviewed by White¹⁰. The present paper is concerned with 101 honeys for which the *Directory* gives the content of two or more constituents. All are from nectar plants; honeydew honeys will be discussed in a subsequent paper. The *Directory* should be consulted for numerical results of individual chemical analyses, and for the publications from which they were taken. Many results were obtained by standard methods; however, some authors did not state their methods, and in some languages we were unable to ascertain them. A published chemical composition of certain honeys was omitted from the *Directory* if the samples were stated to have been aged or subjected to high temperatures, or to be granulated.

In the literature there are reports of analyses of many other honey samples that are identified only by place of origin, and such honeys are, of course, not represented in the *Directory*. Nor are honeys from mixed sources, for example some of the many USA honeys analysed by White⁹.

Individual honey constituents

In 1983 a 'Proposed draft Codex standard for honey (world-wide standard)' was issued by the Joint FAO/WHO Food Standards Programme¹. The present paper shows how the honeys whose composition was reported in the *Directory* match up to this proposed Codex.

Table 1 is derived from data in the *Directory*, and relates to 9 constituents of honey. Limits for six of them are given in the proposed Codex, and for one other (HMF) in an EEC Directive⁴. Table 1 also includes separate columns for the two main reducing sugars, glucose and fructose.

In compiling the *Directory*, honeys for which a chemical analysis was available were recorded as follows. The content of each constituent was quoted (usually % by weight of honey), and was assigned to one of two (or three) classes—low, (medium), high—and the class was entered on word-processor discs in code form so that programmed searches could subsequently be made. For the content of water, sucrose, ash and free acid, three classes were used, with the proposed Codex limit as the boundary between medium and high classes. We had no guidelines for boundaries between low and medium classes, nor for any boundaries for glucose and fructose, so these were set arbitrarily. For total reducing sugars, amylase (diastase) and HMF, two classes were used, separated by the proposed Codex or the EEC limit.

* Reprinted from *Bee World* 65(4): 167-173 (1984)

The plant sources of the honeys are listed in Table 1, with their families and entry numbers in the *Directory*. In the columns headed *W, R, . . . D, H*, symbols are used to indicate the class, i.e. the range within which the constituent is present in the honey. For instance, *g* = low glucose content (<31%), *G* = medium glucose content (31–40%), **G** = high glucose content (40% +). Any value outside the proposed limit is denoted by *.

Boundaries set between classes were as follows:

	low	boundary	medium	boundary	high
water	w	16%	W	21%	*
glucose	g	31%	G	40%	G
fructose	f	35%	F	43%	F
sucrose	s	1%	S	5%	*
ash	a	0.1%	A	1.0%	*
free acid (meq/kg)	c	15	C	40	*
			Codex or EEC limit		
reducing sugars	*		65%		high R
amylase (Gothé scale)	*		3		D
HMF (ppm)	H		40		*

Water content

The water content of honey is most important in determining whether or not the honey is likely to suffer spoilage through fermentation. The presence of yeasts also affects the likelihood of fermentation, and so do the glucose and fructose contents through their relative solubilities in water.

Lochhead⁶ and Stephen⁷ investigated the relation between water content and fermentation in 319 and 700 Canadian honey samples, respectively. From their results it seems that honeys containing less than 16% water are virtually safe from fermentation regardless of yeast content. Of those containing more than 18% water (3% lower than the Codex limit) two-thirds of Stephen's samples fermented, and Lochhead considered such honeys safe only if their yeast count was low (less than 10/g); at above 20% water, honeys were regarded as 'always in danger'.

In Table 1 the class for the water content is given for 75 honeys; 13 of them contained more than 21% water, 54 contained 16–21%, and 8 less than 16%. Of the honeys with more than 21% water, 3 were produced in the tropics from *Apis cerana*, 2 were from Taiwan, and 8 from the north temperature zone. The honeys with a low water content (117, 158, 164, 176, 210, 290, 355, 426) can be identified from Table 1; all were probably produced in conditions of low atmospheric humidity.

For *Calluna vulgaris* the maximum water content in the proposed Codex is 23%, and some samples reported in the *Directory* exceeded this level. The same maximum of 23% is allowed for 'clover honey'. The water content was reported for four clovers (*Trifolium* spp.) listed in Table 1 and for *Melilotus alba* (sweet clover); none had more than 21% water except 2 out of 13 samples of *T. repens*; these contained 21.2% and 21.3% water.

Entry no. and plant name	W	R	G	F	S	A	C	D	H
152 <i>Eucalyptus albens</i> Benth.; Myrtaceae	W		g	F	S		C	D	152
156 <i>Eucalyptus camaldulensis</i> Dehnh.; Myrtaceae		R	G	F	S	A	C	D	156
158 <i>Eucalyptus cladocalyx</i> F. Muell.; Myrtaceae	w		g	F		A			158
164 <i>Eucalyptus fasciculosa</i> F. Muell.; Myrtaceae	w	R	g	F	s	a	c	D	H 164
172 <i>Eucalyptus leucoxylon</i> F. Muell.; Myrtaceae	W	R	G	F	S	A	c	D	H 172
174 <i>Eucalyptus macrorhyncha</i> F. Muell. ex Benth.; Myrtaceae								D	174
175 <i>Eucalyptus maculata</i> Hook.; Myrtaceae	W	R	G	F	s	A	C	D	H 175
176 <i>Eucalyptus melliodora</i> A. Cunn. ex Schauer; Myrtaceae	w	R	G	F	S	a	C	D	H 176
184 <i>Eucalyptus robusta</i> Smith; Myrtaceae	W					A			184
198 <i>Euphoria longan</i> (Lour.) Steud.; Sapindaceae	W		G	F	s	A	C		198
199 <i>Fagopyrum esculentum</i> Moench.; Polygonaceae	*	R	G	F	S	A	*		199
202 <i>Geranium pratense</i> L.; Geraniaceae			x	x	x				202
206 <i>Gliricidia sepium</i> (Jacq.) Walp.; Leguminosae*	*				*	A	C		206
210 <i>Gossypium hirsutum</i> L.; Malvaceae	w	R	G	F	S	A	C		210
220 <i>Hedysarum coronarium</i> L.; Leguminosae	W		x	x	S	a	C	D	H 220
221 <i>Helianthus annuus</i> L.; Compositae	W	R	G	F	S	a		D	H 221
223 <i>Hevea brasiliensis</i> Muell. Arg.; Euphorbiaceae*	*	R	G	f	*				223
229 <i>Hyssopus officinalis</i> L.; Labiatae			x	x	x				229
230 <i>Ilex glabra</i> (L.) A. Gray; Aquifoliaceae	W		g	F	s	A	C	D	230
237 <i>Ipomoea batatas</i> (L.) Lam.; Convolvulaceae	*		G	F	S		C		237
250 <i>Knightia excelsa</i> R.Br.; Proteaceae	W	R				A			250
252 <i>Lavandula angustifolia</i> Miller; Labiatae	(*)		G	F	(*)				252
256 <i>L. angustifolia</i> x <i>latifolia</i> Medicus; Labiatae			G	F					256
257 <i>Leonurus cardiaca</i> L.; Labiatae			x	x	x				257
259 <i>Leptospermum scoparium</i> J. & G. Forst.; Myrtaceae	W		G	F	s		C	D	259
265 <i>Lippia nodiflora</i> (L.) Michx.; Verbenaceae	*		G	F	s	A	C	D	265
267 <i>Liriodendron tulipifera</i> L.; Magnoliaceae	W		g	f	s	A	C	D	267
268 <i>Litchi chinensis</i> Sonner.; Sapindaceae	W							D	268
272 <i>Lotus corniculatus</i> L.; Leguminosae			x	x	x				272
274 <i>Lythrum salicaria</i> L.; Lythraceae	W		G	F	s	a	C		274
286 <i>Marrubium vulgare</i> L.; Labiatae			x	x	x				286
290 <i>Medicago sativa</i> L.; Leguminosae	w	R	G	F	S	a	c	D	290
296 <i>Melilotus alba</i> Desr.; Leguminosae	W		G	F	S	a	C	D	296
300 <i>Metrosideros umbellata</i> Cav.; Myrtaceae	W	R					*		300
309 <i>Nicotiana tabacum</i> L.; Solanaceae	W	R			s	A		D	H 309
311 <i>Nyssa ogeche</i> Bartram; Nyssaceae	W		g	F	S	A	C	D	311

Entry no. and plant name	W	R	G	F	S	A	C	D	H
314 <i>Onobrychis viciifolia</i> Scop.; Leguminosae	W		x	x	x				314
316 <i>Oxydendron arboreum</i> (L.) DC.; Ericaceae	W		g	F	s	A	c	D	316
324 <i>Phacelia tanacetifolia</i> Benth.; Hydrophyllaceae			x	x	x				324
342 <i>Prunus x yedoensis</i> Matsum.; Rosaceae	W	R	G	F	s				342
347 <i>Rabdosia rugosa</i> (Wall. ex Benth.) Hara; Labiatae*	W		G	F	S	A	C		347
354 <i>Robinia pseudacacia</i> L.; Leguminosae	W		g	F	S	a	c	D	H 354
355 <i>Rosmarinus officinalis</i> L.; Labiatae	w	R	G	F	S	a	c	(D)	355
358 <i>Rubus idaeus</i> L.; Rosaceae	W		G	F	S	A		D	358
361 <i>Sabal palmetto</i> (Walt.) Lodd. ex Schultes; Palmae	*		G	F	s	a	C	D	361
369 <i>Salvia nemorosa</i> L.; Labiatae			x	x	x				369
370 <i>Salvia officinalis</i> L.; Labiatae			G	F	x	A			370
373 <i>Sapindus mukorossi</i> Gaertn.; Sapindaceae*	W		G	F	*	A	C		373
381 <i>Scrophularia nodosa</i> L.; Scrophulariaceae			x	x	x				381
382 <i>Serenoa repens</i> (Bartr.) Small; Palmae	W		g	F	s	A	C	D	382
395 <i>Syzygium cumini</i> (L.) Skeels; Myrtaceae*	W		G	F		A			395
396 <i>Syzygium jambos</i> (L.) Alston; Myrtaceae*	W	R	G	F			c		396
398 <i>Taraxacum officinale</i> Weber; Compositae			x	x	x				398
401 <i>Terminalia chebula</i> Retz.; Combretaceae*	W	R	G	F		A	c		401
403 <i>Thelepaepale ixiocephala</i> (Benth.) Bremk.; Acanthaceae*	W	R	G	F		A	C		403
406 <i>Thymus serpyllum</i> L.; Labiatae	W	R	G	F	s	A	C		406
407 <i>Thymus vulgaris</i> L.; Labiatae		R	g	F	S	a	c		407
408 <i>Tilia americana</i> L.; Tiliaceae	W		g	F	s	a	C		408
410 <i>Tilia cordata</i> Mill.; Tiliaceae			g	F	S				410
411 <i>Tilia japonica</i> (Miq.) Simonk.; Tiliaceae	*		x	x	x				411
422 <i>Tournefortia argentea</i> L.f.; Boraginaceae	W		g	F	*				422
426 <i>Trifolium alexandrinum</i> L.; Leguminosae	w	R	G	F	S	a	C		426
428 <i>Trifolium hybridum</i> L.; Leguminosae	W		G	F	S	a	C	D	428
429 <i>Trifolium incarnatum</i> L.; Leguminosae	W		G	F	s	a	C	D	429
430 <i>Trifolium pratense</i> L.; Leguminosae			x	x	S				430
431 <i>Trifolium repens</i> L.; Leguminosae	W		g	F	S	A	C	D	H 431
434 <i>Turbina corymbosa</i> (L.) Raf.; Convolvulaceae	W	R			S	a			434
440 <i>Vicia villosa</i> Roth; Leguminosae	W		g	F	S	a	C	D	440
448 <i>Ziziphus mauritania</i> Lam.; Rhamnaceae	*		G	F	s	A	C		448

Reducing sugars

The percentage of reducing sugars was recorded for 31 honeys, and for all of them it was above the proposed Codex minimum of 65%. Amounts of the two main reducing sugars (glucose and fructose) vary according to the plant source, and affect granulation, hygroscopicity, sweetness and other characteristics of honey². We therefore assigned classes for these sugars, using the boundaries set out above. Out of 69 honeys, the glucose

content was within the range 31–40% for 45, above it for 4, and below it for 20. Out of 68 honeys, the fructose content was within the range 35–43% for 58, above it for 6 and below it for 4.

Sucrose

Determination of the sucrose content of honey was important in the past, as a means of detecting adulteration of honey by the addition of sucrose. The sucrose content was recorded for 65 honeys, and 7 exceeded the proposed Codex limit (5%); 33 contained 1–5%, and 25 less than 1%. Five of the 7 honeys with a high sucrose content (039, 077, 206, 223, 373) were produced by *Apis cerana* in India or Sri Lanka, and one was produced by *Apis mellifera* from *Tournefortia argentea* on Wake Island in the Pacific.

The proposed Codex lists certain other honeys by common name, for which a higher sucrose content is allowable. Among those with a permitted 10% sucrose maximum are several in Table 1 which in fact contained less than 5%: *Citrus deliciosa*, *C. unshiu*, *Eucalyptus camaldulensis*, *Medicago sativa*, *Melilotus alba* and *Robinia pseudacacia*. Samples of freshly extracted *C. sinensis* honey in Israel contained 9·1–10·3% sucrose, but in two USA analyses of honey from this source, levels were below this.

Further studies should be carried out on honeys produced in the tropics and subtropics, including those from other *Apis* species than *mellifera*, to establish the extent to which their sucrose content differs from that of honeys produced by *A. mellifera* in temperate zones.

Ash

The ash content was recorded for 63 honeys, and for all of them it was below the proposed Codex maximum of 1·0%; 41 contained 0·1–1·0% and 22 contained less than 0·1%. Plants in the Leguminosae were notable as yielding honeys with a low ash content. The 63 honey sources included 12 Leguminosae, of which 9 gave honeys containing less than 0·1% ash, whereas only 13 of the 52 non-legume sources did so.

Free acid

Honeys with a high free acid content have a sharp or slightly acid flavour; those with a low content are likely to be less stable towards micro-organisms in the honey. The free acid content was recorded for 56 honeys, of which 3 exceeded the proposed Codex limit of 40 meq/kg. For 42 honeys the value was between 15 and 40 meq/kg, and for 11 it was below 15 meq/kg.

Amylase

Amylase (diastase) is an enzyme capable of breaking down starch. It is gradually destroyed on long storage of honey at any temperature, and it is heat sensitive, for instance half is destroyed if honey is heated to 80°C for 70 minutes. A low amylase content of honey is therefore used as an indicator of improper heating or of long storage of honey. It is measured by the 'diastase number' on the Gothe scale. Values were recorded for 38 honeys, and all were above the proposed Codex minimum of 3.

HMF

HMF (5-hydroxymethylfurfuraldehyde) is a breakdown product of certain sugar solutions, particularly those containing glucose and fructose, stored at high temperatures or for a long time. A high HMF content has been used as an indicator of improper heating of honey, or of adulteration of honey with invert sugar prepared by acid hydrolysis at high temperatures. The allowable maximum set by the EEC Directive⁴ is 40 ppm, and the HMF value for all 14 honeys was below this limit.

Some other substances in honey

Whenever records were available, other constituents of honey samples were recorded in the *Directory*, although the content was not coded for programmed searches. These substances include: maltose, fructomaltose and several other sugars; 'bound' (i.e. not 'free') acid, and lactone; other enzymes, including sucrase, glucose oxidase; amino acids, nitrogen, protein; colloids; yeasts; vitamins.

In view of frequent references to vitamins in honey, details have been extracted from the *Directory* for inclusion here. It is not known how many of the honeys have been assessed for vitamin content with a negative result, but a positive quantified result was reported for six. Vitamin C (ascorbic acid) was found in *Calluna vulgaris* (40–52 ppm) and *Fagopyrum esculentum* (41–82 ppm) honeys in Poland, and *Carvia callosa* honey (113.5 ppm) in India. For comparison, contents quoted for vitamin C in some raw fruits are 200, 500 and 2000 ppm in tomato, orange and blackcurrant, respectively⁸. In India, vitamin B1 (thiamine) was found in *Catunaregam spinosa* honey (0.08 ppm). Wholemeal bread contains 2.4 ppm. Vitamin B5 (pantothenic acid) was present at 0.7–11.5 ppm in *Aesculus turbinata* honey in Japan. Beef liver contains 77, eggs 16, and avocado 10.7 ppm⁵. Honey from *Robinia pseudacacia* in Japan contained 260 ppm 'total' vitamins.

Substances not listed at the beginning of this section, but also recorded in the *Directory* in one or more of the honeys listed in Table 1, include the following.

The volatile compounds in the aromas of several honeys have been analysed: 060, 152, 176, 259, 290, 407, 411, 430, 431. Flavour and aroma are closely related, and 'compounds probably contributing to flavour' have been studied in some honeys: 036, 098 and 354.

Methyl anthranilate was first detected in 'orange' honey in 1930; its content (in honey presumed to be from *Citrus sinensis*) was reported to be 0.84–3.95 ppm. Traces of the compound have also been found in honeys from *Nyssa ogeche* (0.05 ppm), *Tilia americana* (0.04 ppm) and *Lavandula angustifolia* (amount unspecified).

Crystals of calcium oxalate were found in *Tilia cordata* honey; the compound originates from the nectar of the flowers in which it has also been identified. Oxalic acid was reported in honey from *Oxydendron arboreum*.

Of 10 samples of honey from *Fagopyrum esculentum*, 6 contained rutin and 4 quercetin; after 4 days only quercetin was present in all. Several pyrrolizidine alkaloids were found in honey from *Echium lycopsis*.

Conclusions and further information

Of the honeys discussed, all conformed with the proposed Codex (or the Directive) for content of total reducing sugars, ash, amylase (diastase) and HMF. For free acid, only 3

out of 56 honeys had more than the limit proposed. For sucrose 7 out of 65 contained more sucrose than the proposed 5% limit, of which most were produced in the tropics. For these constituents, almost all the honeys thus conformed to the proposed standard, except that a few tropical honeys contained excess sucrose. On the other hand 13 out of 75 honeys contained more water than the proposed maximum of 21%. This limit itself is higher than that considered by some scientists to provide security against fermentation.

The majority of the honeys discussed here were produced in temperate zones, but many important honeys from the tropics and subtropics still await analysis. A free leaflet is therefore being made available from IBRA, listing the honey sources in the *Directory* for which the honey composition seems to be unknown. IBRA would be glad to know of published (or unpublished) data for any of them, as well as additional data for the less well studied honeys in Table 1.

IBRA will shortly publish *Important honey sources: Satellite Directory 3. Composition of some honeys*. It will give printouts of the available data on the composition of the honeys listed in Table 1, together with lists of the plant sources of honey whose constituents exceed the several limits set in the proposed Codex. Further details can be obtained from IBRA. The physical properties of honey reported in the *Directory of important world honey sources* will be dealt with separately.

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*Water and sucrose contents of honey are discussed in relation to the proposed limits in ALINORM 85/20 and associated documents, which were received while this paper was in proof.