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STUDIES ON HONEY AND POLLEN

V. ON THE SUGAR COMPOSITION OF HONEY (2)

By

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Previously, we (1) have reported that 15 honey samples produced mainly in the Tohoku region of Japan, viz., bush-clover (*Lespedeza bicolor Turcz. var. japonica Nakai*), straw-berry (*Fragaria chiloensis Duch. var. ananassa Bailey*)+hakuunboku (*Styrax obassia Sieb. et Zucc*), clover (*Trifolium repens L.*)+Japanese persimmon (*Diospyros Kaki Thunb.*), pumpkin (*Cucurbita moschata Duch var. Toonaa Makino.*), chestnut (*Castanea pubinervis Schneid.*), horse-chestnut (*Aesculus turbinata Blume.*), rapeseed (*Brassica campestris L.*), buckwheat (*Fagopyrum esculentum Moench*), Chinese milk vetch (*Astragalus sinicus L.*), hyotanboku (*Lonicera Morrowii A. Gray*) and four kinds of marketed honey were analysed, and the sugar components of one kind of honey (*Lespedeza bicolor Turcz. var. japonica Nakai.*) were fractionated by chromatography using a carbon-Celite column, and the sugars in each fraction were estimated. We (2) have also reported that kojibiose, nigerose, maltose and isomaltose were isolated from honey (*Lespedeza bicolor Turcz. var. japonica Nakai.*) as their crystalline octaacetates by the application of carbon-Celite column and Magnesol-Celite column chromatographic procedures.

We now report on the sugar composition of hitherto unreported ten kinds of honeys from the floral source peculiar to Japan.

Experimental

I. Analyses of Honey.

Ten kinds of honey samples produced in Japan were analysed. Tables 1 and 2 represent the properties and sugar compositions.

Analytical methods were as follows. Moisture: toluene distillation method; invert sugar: after heating with 0.1 per cent HCl on the boiling water bath for 30 minutes followed by neutralization with NaOH, determined by the Bertrand-Henmi method (as invert sugar); reducing sugar: Bertrand-

The original Japanese report was published in the *Hakko-Kogaku Zasshi* 39, 433 (1961).

Table 1. Floral source, crop year, productive place, appearance of honey.

Sample No.	Floral source	Crop year	Productive place	Color	Appearance
1	Cherry blossom	1960	Kajigawa	Pale yellow	Viscous liquid Large amount of glucose crystals
2	Cherry	1960	Kajigawa	Pale yellow	Viscous liquid No crystal
3	<i>Lactuca dentata Makino.</i>	1960	Oguni	Pale brown	Viscous liquid No crystal
4	<i>Clethra barbinervis Sieb. et Zucc.</i>	1959	Oguni	Yellow	Viscous liquid No crystal
5	<i>Reynoutria japonica Houtt.</i>	1959	Oguni	Pale brown	Viscous liquid No crystal
6	<i>Kalopanax ricinifolium Miquel.</i>	1959	Hida	Pale yellow	Viscous liquid No crystal
7	Mandarin orange A	1959	Shizuoka	Pale yellow	Viscous liquid No crystal
8	Mandarin orange B	1959	Shimizu	Pale yellow	Viscous liquid Large amount of glucose crystals
9	<i>Betula Tauschii Koidz.</i>	1959	Shizuoka	Pale brown	Viscous liquid No crystal
10	Mixed weeds honey	1959	Katsuro	Dark brown	Viscous liquid No crystal

Table 2. Sugar composition of honey.

Honey (Floral source)	Moisture %	Invert sugar %	Reducing sugar %	Glucose %	Fructose %	Sucrose %	Quantity ratio of G and F	Specific gravity	Baume	$[\alpha]_{590}$
1. Cherry blossom	20.00	78.57 98.21	78.07 97.59	40.39 50.49	35.21 44.01	0.45 0.56	G>F	—	—	-13.19
2. Cherry	26.28	71.31 96.73	70.71 95.92	31.66 42.95	36.42 49.40	0.54 0.73	G<F	1.394	39.10	-28.93
3. <i>Lactuca dentata Makino.</i>	23.94	74.58 98.05	72.33 95.10	37.59 49.42	32.63 42.90	2.41 3.17	G>F	1.405	41.90	-10.36
4. <i>Clethra barbinervis Sieb. et Zucc.</i>	20.23	77.68 97.38	77.22 96.80	37.44 46.93	37.92 47.54	0.25 0.31	G≤F	1.396	41.85	-23.34
5. <i>Reynoutria japonica Houtt.</i>	19.45	80.85 100.37	78.11 96.97	36.69 45.55	38.50 47.80	2.44 3.03	G<F	1.378	34.35	-27.50
6. <i>Kalopanax ricinifolium Miquel</i>	21.07	78.11 98.96	76.94 97.48	37.35 47.32	36.88 46.72	1.05 1.33	G≥F	1.382	40.81	-16.76
7. Mandarin orange A	26.27	73.81 100.10	72.77 98.70	36.46 49.45	34.00 46.11	0.95 1.29	G>F	1.359	39.74	-12.29
8. Mandarin orange B	18.72	80.85 99.47	79.02 97.22	38.62 47.51	37.60 46.26	1.60 1.97	G>F	1.394	42.65	-13.14
9. <i>Betula Tauschii koidz.</i>	21.07	78.69 99.70	76.95 97.49	37.54 47.56	36.74 46.55	1.57 1.99	G>F	1.395	41.75	-16.91
10. Mixed weeds honey	19.43	79.54 98.72	73.06 90.68	35.76 44.38	34.87 43.28	5.81 7.21	G>F	1.427	43.45	-13.85
Average	21.65	77.40 98.79	75.52 96.39	36.95 47.16	36.08 46.05	1.71 2.18		1.392	40.62	—

Henmi method (as glucose); glucose: Willstätter-Schudel method; fructose: reducing sugar minus glucose; sucrose: (invert sugar minus reducing sugar) $\times 0.95$.

The average moisture content was 21.65 per cent which was a few per cent higher than that reported in foreign countries (3), because the humidity of our country is much higher than that of foreign countries.

The main sugars were glucose and fructose and their contents occupied more than 90 per cent of the total sugar and average sucrose content including other oligosaccharides was 1.71 per cent.

From the results of Table 2, it was observed that in the honeys of cherry blossom (*Prunus yedoensis* Matsum.), *Lactuca dentata* Makino., mandarin orange (*Citrus deliciosa* Tenore.), *Betula Tauschii* Koidz. and mixed weeds honey, glucose content is higher than that of fructose; in honeys of cherry (*Prunus avium* L.) and *Reynoutria japonica* Houtt., the former is less than the latter; in the honeys of *Kalopanax ricinifolium* Miquel. and *Clethra barbinervis* Sieb. et Zucc., both sugar contents are almost equal.

The content ratio of glucose and fructose in honey is different according to the variety of the floral source.

From the previous report (1) and present analysis, the content ratio of glucose and fructose in honeys are shown in Table 3.

Table 3. The content ratio of glucose and fructose in honeys.

	Floral source
Glucose > Fructose	Rape seed (<i>Brassica campestris</i> L.) Clover (<i>Trifolium repens</i> L.) Japanese persimmon (<i>Diospyros Kaki</i> Thunb.) Hyotanboku (<i>Lonicera Morrowii</i> A. Gray.) Cherry blossom (<i>Prunus yedoensis</i> Matsum.) <i>Lactuca dentata</i> Makino Mandarin orange (<i>Citrus deliciosa</i> Tenore.) <i>Betula Tauschii</i> Koidz Mixed weeds honey
Glucose < Fructose	Bush-clover (<i>Lespedeza bicolor</i> Turcz. var. <i>japonica</i> Nakai) Chinese milk vetch (<i>Astragalus sinicus</i> L.) Pumpkin (<i>Cucurbita moschata</i> Duch. var. <i>Toonas</i> Makino.) Chestnut (<i>Castanea pubinervis</i> Schneid.) Straw-berry (<i>Fragaria chiloensis</i> Duch. var. <i>ananassa</i> Bailey) Hakuunboku (<i>Styrax obassia</i> Sieb. et Zucc.) Cherry (<i>Prunus avium</i> L.) <i>Reynoutria japonica</i> Houtt.
Glucose = Fructose	Buckwheat (<i>Fagopyrum esculentum</i> Moench.) Horse-chestnut (<i>Aesculus turbinata</i> Blume.) <i>Kalopanax ricinifolium</i> Miquel. <i>Clethra barbinervis</i> Sieb. et Zucc.

Summary

The sugar composition of hitherto unreported ten kinds of honeys from the floral source peculiar to Japan was analysed.

The average moisture content was 21.65 per cent which was a few per cent higher than that reported in foreign countries, because the humidity of our country is higher than that of foreign countries.

From the previous and present analyses, the content ratio of glucose and fructose in honeys are as follows.

In the honeys of rape-seed (*Brassica campestris* L.), clover (*Trifolium repens* L.) + Japanese persimmon (*Diospyros Kaki Thunb.*), hyotanboku (*Lonicera Morrowii* A. Gray.), cherry blossom (*Prunus yedoensis* Matsum.), *Lactuca dentata* Makino., mandarin orange (*Citrus deliciosa* Tenore.), *Betula Tauschii* Koidz., and mixed weeds honey, glucose content is higher than that of fructose; in the honeys of bush-clover (*Lespedeza bicolor* Turcz. var. *japonica* Nakai), Chinese milk vetch (*Astragalus sinicus* L.), pumpkin (*Cucurbita moschata* Duch. var. *Toonasa* Makino.), chestnut (*Castanea pubinervis* Schneid.), straw-berry (*Fragaria chiloensis* Duch. var. *ananassa* Bailey.) + hakuunboku (*Styrax obassia* Sieb. et Zucc.), cherry (*Prunus avium* L.), and *Reynoutria japonica* Houtt., the former is less than the latter; in the honeys of buckwheat (*Fagopyrum esculentum* Moench.), horse-chestnut (*Aesculus turbinata* Blume.), *Kalopanax ricinifolium* Miquel., and *Clethra barbinervis* Sieb. et Zucc., both sugar contents are almost equal.

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