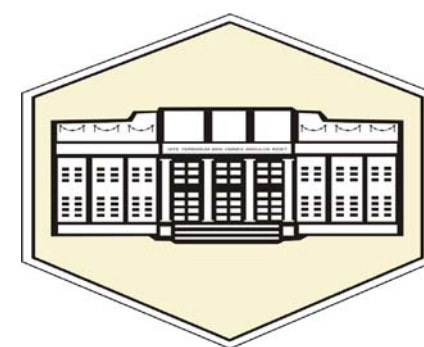


# CARBOHYDRATE CONTENT-BASED ASSESSMENT OF HONEY

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## THE AIM OF THIS STUDY

1. Assaying the following products for carbohydrate contents: starch syrup which has been tried to be used by beekeepers as bee food for several years; enzymatically inverted sucrose syrup; food processed from those syrups and deposited by bees as winter stores; samples of unifloral honeys of proven quality and botanical origin.
2. Comparison of sugar compositions of those products and an answer to the questions - to what extent does the HPLC method to assay individual sugars aid the identification of admixtures of bee-inverted starch and sucrose syrup in honey?

## MATERIALS AND METHODS

Sugar composition was determined in three product groups: syrups used to be fed to bees in autumn (I starch (maltose) syrups, II sucrose syrup, III enzymatically inverted sucrose syrup), winter stores processed from those syrups (winter food for the bees) and honeys.

By means of HPLC with a refractometric detector the content of following sugars were determined: fructose, glucose, sucrose, maltose, izomaltose, turanose, trehalose, total trisaccharides and maltodextrins (with other column). In addition, the use of capillary gas chromatography to assay carbohydrates permitted the determination of erlose.

## RESULTS

Compilation of the data on the content of individual sugars in the products under comparison permitted several significant differences to be found between the bee-processed syrups and honey. The differences concerned fructose content (Fig. 1), fructose-to-glucose ratio (Fig. 2) and for disaccharides: sucrose (Fig. 4), maltose (Fig. 5) and sucrose-to-maltose ratio (Fig. 6).

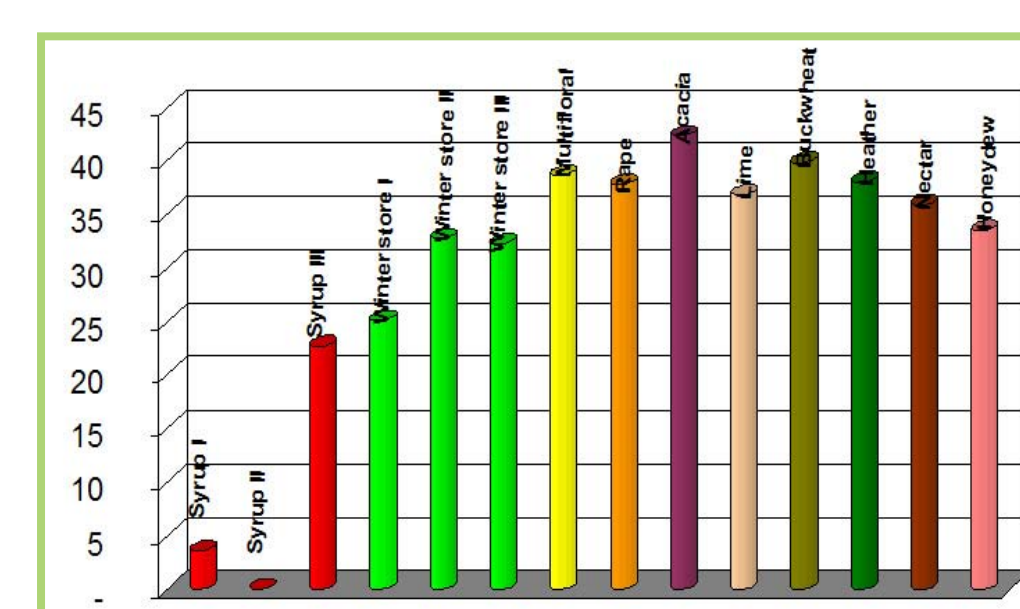


Fig. 1. Fructose content of syrups, winter stores and honeys (%).

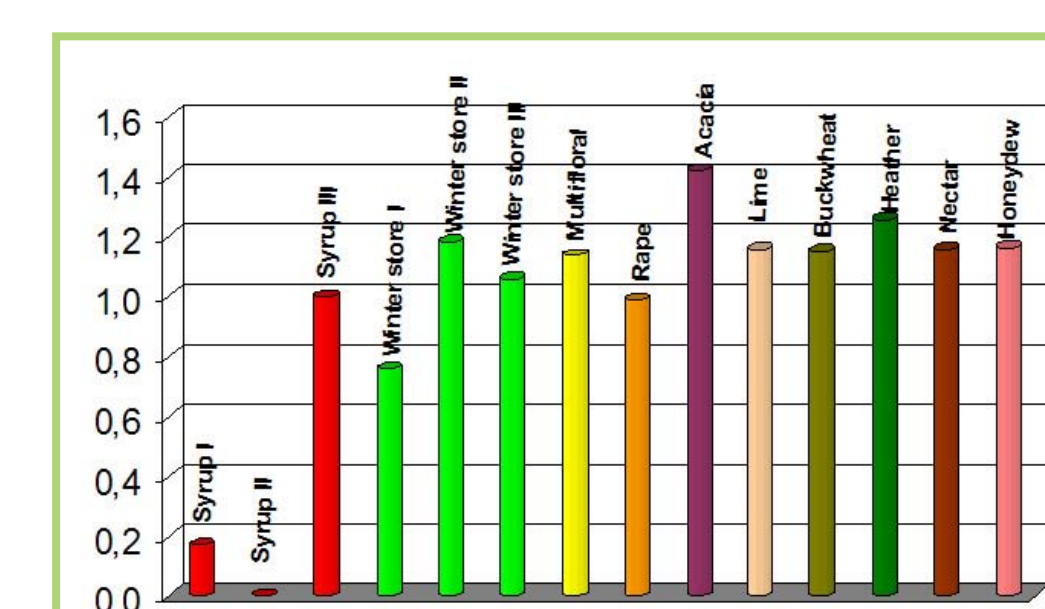


Fig. 2. Fructose/Glucose ratio of syrups, winter stores and honeys.

Table 1. Carbohydrate contents of starch syrup and of winter stores made from that syrup by the bees.

Content (%)	Starch syrup I			Winter store I		
	From - to	SD	Mean	From - to	SD	Mean
Water	19.8 - 21.2	0.6	20.3 a*	14.2 - 20.8	3.0	16.9 a
Fructose (F)	3.3 - 4.1	0.3	3.7 a	23.1 - 27.8	4.7	22.1 b
Glucose(G)	22.0 - 22.4	0.2	22.2 a	30.9 - 42.7	5.0	38.0 b
Monosaccharides ( G + F)	25.3 - 26.3	0.4	25.9 a	58.7 - 62.4	1.6	60.1 b
Fructose/Glucose	0.01 - 0.19	0.01	0.17 a	0.39 - 0.90	0.22	0.6 b
Sucrose	25.6 - 29.3	1.5	27.4 b	2.2 - 7.6	2.3	4.8 a
Turanose	nd*	-	-	0.0 - 1.4	0.6	0.7
Maltose	16.7 - 20.5	1.7	18.3 b	6.0 - 10.5	1.9	8.0 a
Trehalose	nd	-	-	0.6 - 1.0	0.2	0.7
Izomaltose	nd	-	0.0	0.3 - 0.7	0.2	0.5
Raphinose and melecitose	nd	-	-	0.3 - 1.2	0.5	0.6
Total saccharides	70.4 - 75.2	2.2	72.0 a	74.0 - 78.7	2.2	75.5 a
Dextrins						
Dp 4 (4 glucose molecules)	0.9 - 1.2	0.15	1.01 a	0.3 - 1.0	0.28	0.70 a
Dp 5 (5 glucose molecules)	0.7 - 1.1	0.15	0.87 b	0.2 - 0.7	0.21	0.54 a
Dp 6 (6 glucose molecules)	0.6 - 1.0	0.13	0.78 b	0.2 - 0.5	0.17	0.44 a
Dp 7 (7 glucose molecules)	0.5 - 0.7	0.08	0.63 b	0.1 - 0.6	0.17	0.35 a
Total Dp 4 to Dp 7	2.8 - 4.0	0.50	3.29 b	0.9 - 2.6	0.79	2.02 a

\*a,b – differences statistically significant between means in rows at  $\alpha=0.05$ .

\*\*nd – below detectability threshold which for turanose, trehalose, raphinose and melecitose is 0.2 %

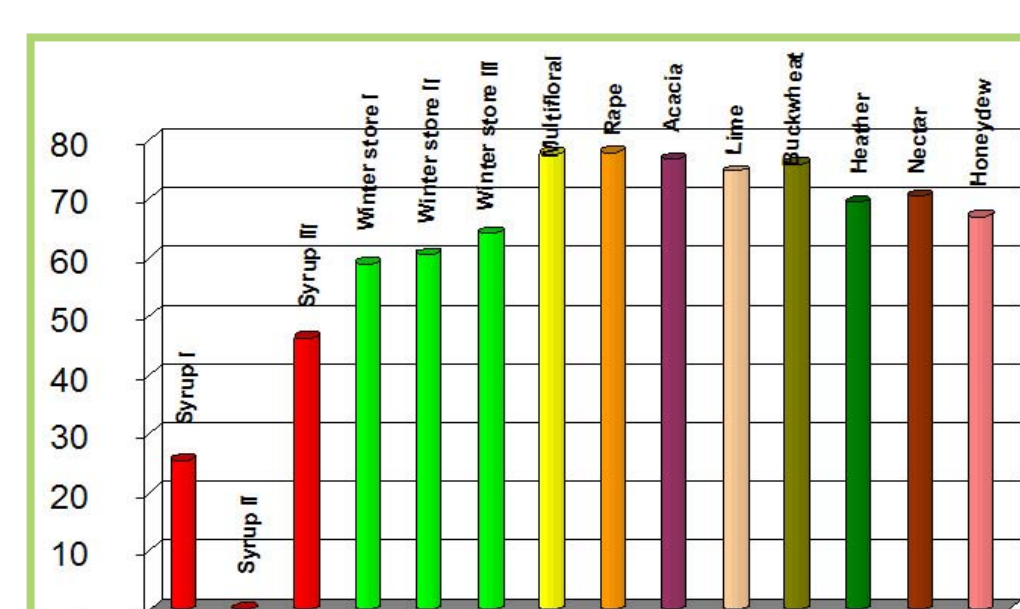


Fig. 3. Glucose + Fructose content of syrups, winter stores and honeys (%).

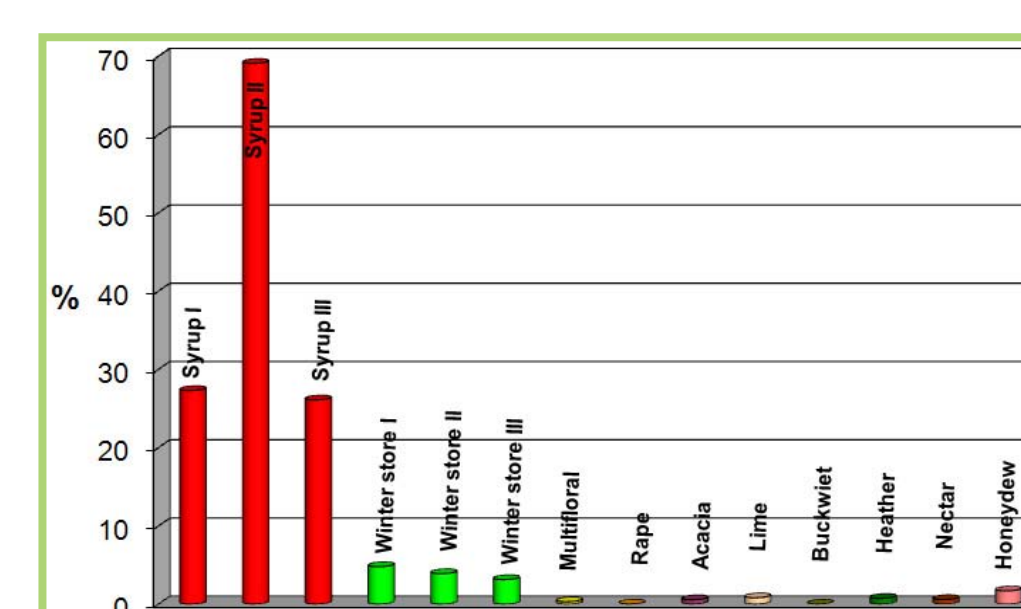


Fig. 4. Sucrose content of syrups, winter stores and honeys (%).

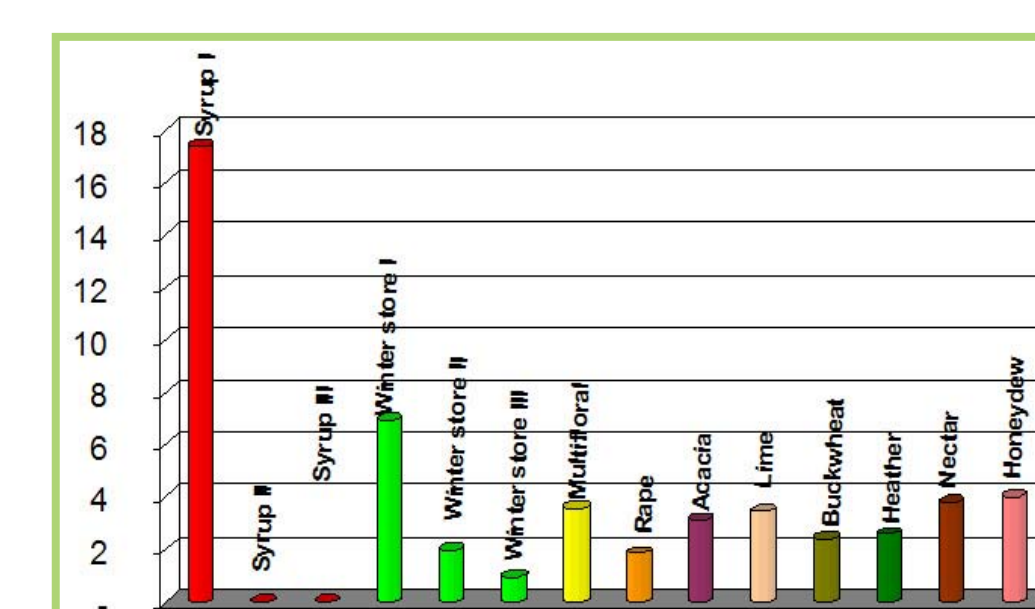


Fig. 5. Maltose content of syrups, winter stores and honeys (%).

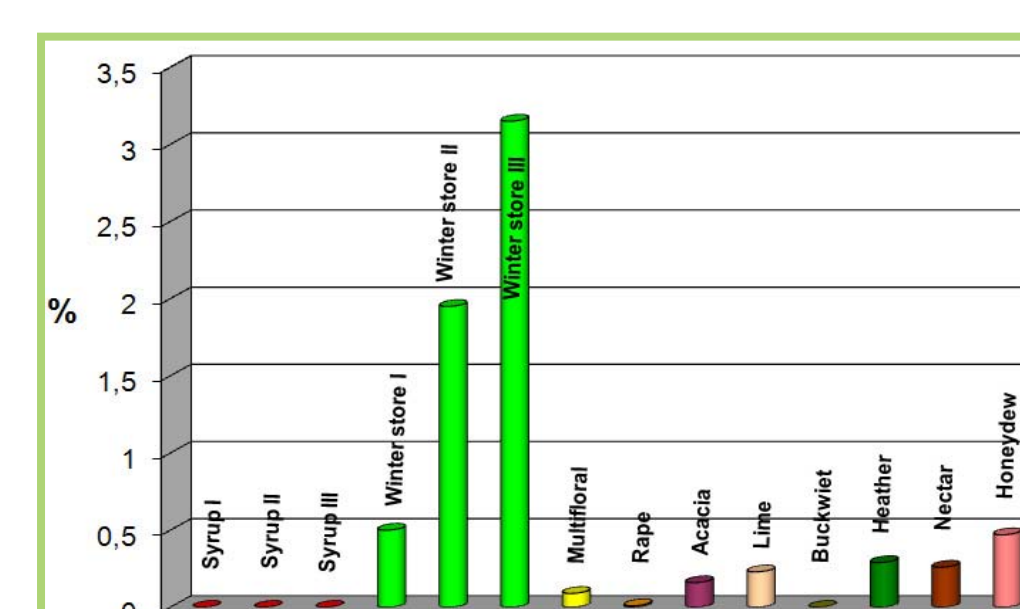


Fig. 6. Sucrose/maltose ratio of syrups, winter stores and honeys.

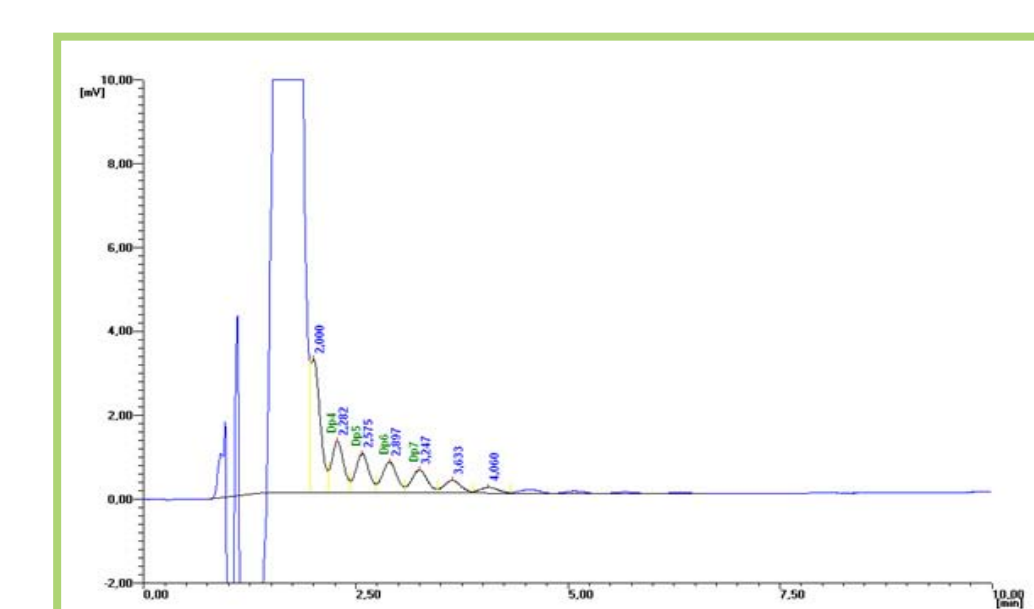


Fig. 7. Chromatogram of maltodextrins in starch syrup.

Table 2. Sugar composition of the winter store sampled in early spring vs. that of the first honey recovered from the same colonies (%).

Sugar composition	Syrup II (70% sucrose solution)	Winter store II		Spring honey (from the same colonies)	
		from - to	mean	from - to	mean
Fructose	-	31.5 - 33.8	32.7 a	30.3 - 42.4	36.8 a
Glucose	-	26.9 - 28.9	27.7 a	26.4 - 29.6	27.6 a
Sucrose	69.1	1.9 - 6.2	3.9 b	0.2 - 1.9	0.7 a
Maltose	-	1.7 - 2.3	1.9 a	1.3 - 2.3	1.8 a
Izomaltose	-	0.5 - 0.7	0.5 a	0.7 - 0.8	0.7 b
Turanose	-	0.5 - 4.0	2.7 a	2.6 - 3.6	3.1 a
Erlose	-	2.8 - 5.2	3.9 b	0.6 - 1.0	0.9 a
Total	69.1	72.1 - 78.6	73.6 a	63.8 - 78.1	71.9 a
F/G	-	1.1 - 1.3	1.2 a	1.2 - 1.5	1.3 a
Sucrose/Maltose	-	1.1 - 3.6	2.0 b	0.1 - 0.8	0.4 a

\*a,b – differences statistically significant between means in lines at  $\alpha=0.05$ .

Table 3. Sugar composition of enzymatically inverted syrup and of the bee-inverted winter store vs. that of honey (%).

Sugar composition	Syrup III	Winter store II		Spring honey (from the same colonies)	
		from - to	mean	from - to	mean
Fructose	22.7	31.9 - 35.5	32.9 a *	35.00 - 35.59	35.3 a
Glucose	23.7	29.0 - 33.7	31.2 a	27.52 - 37.41	31.43 a
Sucrose	26.1	2.2 - 4.3	3.2 b	0.08 - 1.32	0.7 a
Maltose	-	1.7 - 2.3	2.0 b	0.47 - 1.84	1.1 a
Izomaltose	-	0.2 - 0.4	0.3 a	0.21 - 0.73	0.51 a
Turanose	-	1.6 - 2.2	1.9 a	1.06 - 3.07	1.9 a
Erlose	-	0.6 - 1.4	1.0 a	0.15 - 0.88	0.6 a
Total	72.4	68.7 - 79.0	72.5 a	67.87 - 74.64	71.7 a
F/G	0.96	1.0 - 1.2	1.0 a	0.95 - 1.30	1.1 a
Sucrose/ Maltose	-	1.3 - 1.9	1.6 b	0.17 - 0.71	0.6 a

\*a, b\*- significant differences between means in lines at  $\alpha=0.05$ .

## CONCLUSIONS

1. Fructose content below 30%, maltose content over 5% and fructose-to-glucose ratio (F/G) below 1 can be used as a distinguisher of adulteration with winter stores from starch syrup in honey.
2. As a distinguisher to identify inverts processed by bees from sucrose syrups can be used: erlose content (over 2%), sucrose content (over 3%) and sucrose-to-maltose ratio approaching 1 or higher, except acacia (*Robinia pseudoacacia*) honey and some others from the nectars with a high natural sucrose content.
3. In the samples of the winter stores bee-processed from starch syrup the average maltodextrins content was ca. 2% (associations of 4 to 7 glucose molecules, Table 1 and Fig 7).