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The Chemical Composition of Korean Honey

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Abstract

Quality of five kinds of honey, from acacia, bush clover, chestnut, rape and polyflower sources, were evaluated by physicochemical methods in respect to some chemical constituents. The average values for the tested honeys were: moisture, 19.5%; fructose, 33.74% ; glucose, 35.03%; sucrose, 4.67%; hydroxymethylfurfural, 6.17mg/kg; total nitrogen, 0.027%; proline, 23.67mg%; lactone, 4.09meq/kg; free acidity, 11.37meq/kg; and total acidity, 15.46meq/kg.
Key words: honey, chemical analysis, sugars

Introduction

Honey, as a natural sweetener, enjoying an enhanced popularity with today's consumer. It has a very high invert sugar content, approximately 75% and as such is hygroscopic and therefore useful as a moisture retainer, although this is, of course, overshadowed by its distinctive flavour property.

Honey consists essentially of different sugars, predominantly glucose and fructose. Besides these, honey contains protein, amino acids, enzymes, organic acids, mineral substances, pollen and oligosaccharides[1-3].

In particular during the fast few years, the honey business has undergone significant changes on both the supply and the demand side. However, limited availability and increased price have provided major incentives for falsification with other carbohydrate materials. As a result, bulk honey markets are being lost to mixtures and substitutes in the form of sugar cane and corn-derived syrups. High fructose corn syrup represented a major problem until recent research provided a definitive test for its presence in honey[4-6].

The composition of honey depends upon two most important factors, the floral sources and the composition of the nectar. Less important are certain external factors, including climate and differences in processing[5,7].

The main purpose with which the work was undertaken was two fold: First, to determine the proximate composition of our native honeys, with particular reference to the effects of different floral nectars. Second, to establish a general range for variation in the composition of Korean honeys.

Materials and Methods

All honeys used in this investigation were collected over a period of two years from the Korea Beekeeping Association in Seoul. Samples were refrigerated immediately when received and were not heated.

Moisture content was determined by the reflectometer method(AOAC method se. 31.119)[8]. The nitrogen concentration of the samples were determined by the micro-Kjeldahl method, and proline and acidity (lactone, free and total), by the AOAC method(se. 31.124-126 and se. 31.168).

The Winkler method[9], using barbituric acid and p-toluidine, was used for hydroxymethylfurfural.

Sugars in honey were measured by high performance liquid chromatography(HPLC) following a modified procedure by Conrad et al.[10], and AOAC method. The HPLC system used in this work was a Waters Association(Model 244). Sugar separa-

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tion was carried out on a μ-Bondapak/Carbohydrate column(300×40mm ID). Mobile phase was followed and proceeded by 75:25 acetonitrile: water until a stable baseline was established.

The results were statistically analyzed using the VAX 11/785 computer system for variance and correlation coefficients. Means were compared by the least significant differences at the 5 and 1% levels.

Results and Discussion

Moisture content is a value of great importance to the honey producer, packer, and merchant, because it bears a direct relation to liability to undesired fermentation. It is generally in the range of 15-25%, but to ensure good keeping quality and to avoid fermentation, 18-20% is the practical maximum. Normally ripened honey has a moisture content of 17.5-18% with a water activity of 0.58[11].

The distribution of moisture content for 148 samples closely approaches a normal distribution(Fig. 1). The average moisture content of the honeys in the fig. was 19.5%, with a range of from 17.0 to 22.6%. About 9% of honey samples which were unripe, exceeded 21% of water. Codex Alimentarius limit[12] requires that honey contain no more than 21% water to quality for grading.

Since the sugars are by far the most important constituents, the gross physical attributes of honey are largely determined by the kinds and concentrations of the carbohydrates.

The fructose and glucose contents of the tested honeys are shown in Fig. 2 and summrized in Tables 1 and 2. The mean fructose content of the samples was 33.74%. The coefficient of variation for fructose content by floral sources ranged from 1.9 to 4.6%. It was the highest for acacia and the second for polyflower. The average glucose content was 35.03%, range 25.9-42.2%. Rapeseed

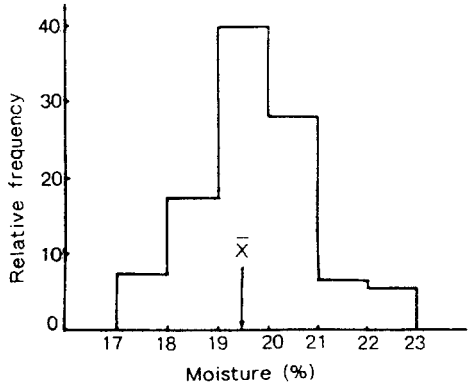

Fig. 1. Frequency distribution of moisture content in the honey.

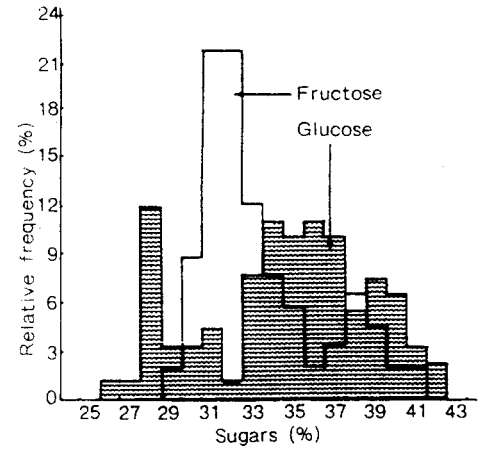

Fig. 2. Frequency distribution of fructose and glucose content in the honey.

Table 1. Fructose content in honey by floral sources

Floral sources	Fructose, %		C.V. %
	Mean±SD	Range	
Acacia	38.33 ± 1.75	35.4 - 41.4	4.6
Bush clover	31.94 ± 0.60	30.8 - 32.8	1.9
Rape	31.07 ± 0.89	29.4 - 33.0	2.9
Polyflower	33.64 ± 0.82	31.8 - 35.0	2.4
Total mean	33.74 ± 3.03	29.4 - 41.4	9.0
L.S.D. 0.05	0.65		
L.S.D. 0.01	0.86		

Table 2. Glucose content in honey by floral sources

Floral sources	Glucose, % Mean±SD	Range	C.V. %
Acacia	29.19 ± 1.36	25.9 - 31.4	4.7
Bush clover	36.61 ± 1.29	34.1 - 39.5	3.5
Pape	39.92 ± 1.30	37.4 - 42.2	3.3
Polyflower	34.40 ± 1.00	32.8 - 36.6	2.9
Total mean	35.03 ± 4.11	25.9 - 42.2	11.7
L.S.D. 0.05	0.73		
L.S.D. 0.01	0.97		

Table 3. Sucrose content in honey by floral sources

Floral sources	Sucrose, % Mean±SD	Range	C.V. %
Acacia	5.98 ± 1.12	3.2 - 8.0	18.7
Bush clover	4.80 ± 1.06	2.8 - 6.7	22.1
Rape	1.82 ± 0.50	1.0 - 3.0	27.4
Polyflower	6.08 ± 0.75	4.8 - 7.8	12.3
Total mean	4.67 ± 1.94	1.0 - 8.0	41.6
L.S.D. 0.05	0.52		
L.S.D. 0.01	0.69		

honey, known to granulate rapidly, would also be expected to be high in glucose.

The fructose/glucose ratio for the sample is shown in Fig. 3. The ratio in acacia honey and chestnut honey averaged 1.32 and 1.29, respectively. Average fructose/glucose ratio of bush clover, rapseed and polyflower honey were below 1.0.

The average sucrose content of the honey in the table was 4.67%, the samples varying from 1.0 to 8.0%(Table 3). The coefficents of variation for acacia, clover, rape and polyflower were 18.7%, 22.1%, 27.4% and 12.3% of the respective means.

Withe *et al.*[2] gave for 490 samples a mean of 1.31%, range 0.25-7.57%. The advisory FDA definition of honey allows a maximum of 8% sucrose. The Codex Alimentarius limit[12] for apparent sucrose is 5; but 10% is permitted for specified floral types known frequently to be high in sucrose. In the work, the high sucrose values for several samples in Table 3 is contributory evidence of their falsification.

Honeys are considered adulterated in Korea if they do not meet the requirements of the honey standards regarding hydroxymethylfurfural(HMF) content. Table 4 summarized the means, range and C.V. of the HMF content produced from four floral sources. Statistical analysis showed that these were significant difference between floral sources for HMF.

According to Schade *et al.*[13] and White *et al.*[14], the rate of formation of HMF was shown to vary among honeys under similar treatments of heat and storage and to be greatly influenced by the moisture content of the honey and by the concentration of HMF initially present.

Statistical data to the relation between sugars and HMF for honeys are presented in Table 5. HMF had a correlation coefficient of -0.270** with

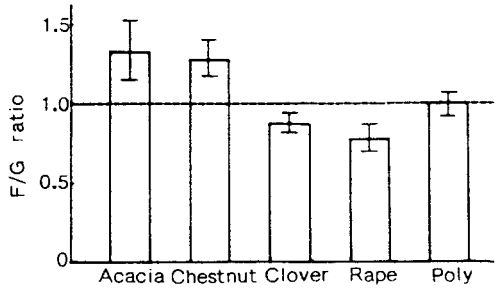

Fig. 3. Fructose/glucose ratio of the honeys by floral sources.

Table 4. Hydroxymethylfurfural(HMF) content in honey by floral sources

Floral sources	HMF, mg/kg Mean±SD	Range	C.V. %
Acacia	4.74 ± 1.45	2.1 - 7.5	30.5
Bush clover	6.32 ± 1.95	3.8 - 11.9	30.8
Rape	2.97 ± 1.23	1.0 - 5.7	41.3
Polyflower	10.61 ± 1.74	8.0 - 15.4	16.4
Total mean	6.17 ± 3.25	1.0 - 15.4	52.8
L.S.D. 0.05	0.95		
L.S.D. 0.01	1.25		

Table 5. Correlation coefficients among hydroxymethylfurfural(HMF), sugars and fructose/glucose(F/G) ratio of the honeys

	Correlation coefficients				
	(1)	(2)	(3)	(4)	(5)
HMF(1)	-				
Invert sugar(2)	-0.270**	-			
Fructose(3)	0.049	-0.313**	-		
Glucose(3)	-0.166	0.717**	-0.887**	-	
F/G ratio(5)	0.051	-0.516**	0.970**	-0.963**	-
Sucrose(6)	0.052**	-0.847**	0.495**	-0.776**	0.615**

D.F.=90

invert sugar content and of 0.502** with sucrose content. There were also significant relationship between sugars.

The total nitrogen contents of these honeys ranged from 0.017% to 0.05% and averaged 0.027% (Table 6). Total nitrogen content showed also somewhat fluctuation among honeys with the same floral sources. It was the highest for chestnut and the second for bush clover. White *et al.*[2] noted that nitrogen content of the United States honey averaged 0.041%, with a standard deviation of 0.026.

The amino acid proline is present in unusually high levels in honey and absent from high fructose corn syrup or sugar. The concentration and the statistical comparison of proline by floral sources are presented in Table 7. The proline contents of these honeys varied between 12.4mg% as the mean. Acacia honeys showed a lower proline content with 20.50mg% as the mean, but chestnut exceeded the average proline. All agree that proline predominates, representing 50-85% of the total.

The lactone content, free and total acidity of the honey by floral sources is shown in Tables 8, 9 and 10. For 58 samples the standard deviation of the mean lactone was 0.67, that of free acidity, 3.35 and that of total acidity, 3.65 meq/kg.

Table 6. Total nitrogen content of honey by floral sources

Floral sources	Total nitrogen, %		C.V. %
	Mean±SD	Range	
Acacia	0.024 ± 0.004	0.017 - 0.028	14.6
Bush clover	0.029 ± 0.008	0.022 - 0.046	28.4
Chestnut	0.039 ± 0.009	0.028 - 0.050	19.6
Polyflower	0.026 ± 0.004	0.017 - 0.033	16.0
Total mean	0.027 ± 0.007	0.017 - 0.050	24.9
L.S.D. 0.05	0.008		
L.S.D. 0.01	0.010		

Table 7. Proline content of honey by floral sources

Floral sources	Proline, mg %		C.V. %
	Mean±SD	Range	
Acacia	20.50 ± 5.35	12.4 - 30.2	26.5
Bush clover	24.68 ± 7.72	17.5 - 39.3	31.3
Chestnut	27.07 ± 12.74	16.0 - 46.2	47.1
Polyflower	24.23 ± 3.63	19.3 -34.5	14.9
Total mean	23.67 ± 6.53	12.4 - 46.2	29.5
L.S.D. 0.05	1.50		
L.S.D. 0.01	2.75		

Table 8. Lactone content of honey by floral sources

Floral sources	Lactone, meq/kg		C.V. %
	Mean±SD	Range	
Acacia	4.21 ± 0.48	3.6 - 5.2	11.5
Bush clover	4.00 ± 0.76	3.1 - 5.5	19.1
Chestnut	4.47 ± 0.68	3.5 - 5.6	15.2
Polyflower	4.02 ± 0.70	3.0 - 5.5	17.5
Total mean	4.09 ± 0.67	3.0 - 5.6	16.3
L.S.D. 0.05	0.68		
L.S.D. 0.01	0.92		

Table 9. Free acidity of honey by floral sources

Floral sources	Free acidity, meq/kg		C.V. %
	Mean±SD	Range	
Acacia	10.12 ± 2.08	6.3 - 13.4	20.6
Bush clover	10.27 ± 2.41	8.6 - 15.4	23.5
Chestnut	17.92 ± 5.32	11.2 - 24.0	29.7
Polyflower	11.05 ± 3.35	7.4 - 14.3	16.4
Total mean	11.37 ± 3.35	6.3 - 24.0	29.5
L.S.D. 0.05	3.78		
L.S.D. 0.01	5.16		

Table 10. Total acidity of honey by floral sources

Floral sources	Total acidity, meq/kg		C.V. %
	Mean±SD	Range	
Acacia	14.35 ± 2.21	10.1 - 17.0	15.4
Bush clover	14.27 ± 3.00	11.7 - 20.0	20.8
Chestnut	22.38 ± 5.82	15.6 - 28.6	26.0
Polyflower	14.98 ± 2.01	10.8 - 18.6	13.5
Total mean	15.46 ± 3.65	10.1 - 28.6	23.6
L.S.D. 0.05	4.22		
L.S.D. 0.01	5.76		

Table 11. Correlation coefficients between nitrogen and acidity in the honeys

	Correlation coefficients			
	(1)	(2)	(3)	(4)
Total nitrogen(1)	-			
Proline(2)	0.545**			
Free acidity(3)	0.758**	0.596**		
Lactone(4)	0.373**	0.474**	0.374**	
Total acidity(5)	0.764**	0.633**	0.986**	0.526**

D.F.=56

The correlations between nitrogen and acidity of 58 honeys are presented in Table 11. Total nitrogen, proline and acidity were highly positive correlated at 1% level.

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한국산 꿀의 화학적 조성

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아카시아, 싸리, 유채, 밤 및 잡화의 5개 밀원꿀 152종을 공시재료로 하여 수분, 당류, hydroxymethylfurfural, 질소, 프로린, 산도에 대한 정량분석과 각 성분간의 상관관계를 조사하였다. 평균 수분함량은 19.5%, 과당은 33.74%, 포도당은 35.03%, 자당은 4.67%, hydroxymethylfurfural은 6.17mg/kg, 질소는 0.027%, 프로린은 23.67mg%, 락톤은 4.09meq/kg, 유리산은 11.37meq/kg, 및 총산은 15.46meq/kg으로서 밀원에 따라 차이가 있었다. 특히 아카시아와 밤꿀은 fructose/glucose ratio가 각각 1.32 및 1.29로서 높은 반면 싸리와 유채꿀은 1.0이하로서 저장중 결정석출의 원인이 되었다.