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Shiraishi, Shin-ichi
University Farm, Faculty of Agriculture, Kyushu University

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Similarity of Amino Acid Patterns in the Grapes (*Vitis* spp.)

Shin-ichi Shiraishi

University Farm, Faculty of Agriculture,
Kyushu University, Kasuyamachi, Fukuoka 811-23, Japan.

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Similarity of 17 grape amino acid patterns was calculated among 75 commercial grape cultivars. And 2775 similarity coefficients thus calculated were compared with the histogram of the components, and had been intuitively clarified to be similar with total shapes of their histograms. The results seem to indicate the similarity of pattern shapes between two grape cultivars.

Similarity coefficients for amino acid patterns were higher in intraspecific hybrids, and lower in interspecific hybrids. The similarity coefficient may have a potential role in grapevine identification, classification, and possibly breeding.

INTRODUCTION

Chemical components such as polyphenols, sugars, flavonoids, anthocyanins and isozymes have been shown to be effective in plant identification and classification (Bassiri 1977 : Catlin et al. 1965 : Crawford 1978). With the availability of autoanalyzer of amino acid, studies on amino acids are becoming more important in the field of fermentation and breeding of grapes.

The author tried to correlate the organoleptic properties with the quantity and quality of amino acids in the grapes. And the present paper deals with the similarity of amino acid patterns in grape cultivars in Japan.

MATERIALS AND METHODS

Sample of 75 grape cultivars for amino acid analysis were taken from randomly selected vines of the vineyards of the Fukuoka Horticuture Experiment Station at Fukuoka and Akitsu Branch of the Fruit Tree Research Station at Akitsu in 1977 and 1978.

Similarity coefficients for amino acid patterns were calculated according to Tamura et al. (Tamura et al. 1969). Pattern similarity S (A, B) between pattern A ($a_1, a_2, a_3 \ldots a_n$) and B($b_1, b_2, b_3 \ldots b_n$) was thought to be a cosine of angle θ between vector $\overrightarrow{OA}$ and $\overrightarrow{OB}$ in n dimensional space.

$$S(A,B) = \cos\theta = \frac{\sum_{i=1}^{n} a_i b_i}{\sqrt{\sum_{i=1}^{n} a_i^2}\sqrt{\sum_{i=1}^{n} b_i^2}}$$

The data of author's previous report (Shiraishi 1991) were used for calculation. Names of grape cultivars in the pattern similarity table are as follows.

1. Campbell Early 2. Yates 3. Pusa seedless 4. Neo Muscat 5. Bath 6. Pione 7.

Cannon Hall Muscat 8. Kokuhō 9. Kyohō 10. Buffalo 11. Himrod seedlees 12. Russki Concord 13. Kendaia 14. Nehelescol 15. Red Millennium 16. Romulus 17. Schuyler 18. Tachikawa No. 3 19. Violet Uehara 20. Italia 21. Interlaken seedless 22. Delaware 23. Koshu 24. Black Olympia 25. Corna Neagra 26. Alden 27. Cabernet franc 28. Tachikawa No. 5 29. Pierce 30. Urbana 31. Mase No. 5 32. Keuka 33. Hiro Hamburg 34. Anab-e-shahi 35. Concord 36. Captivator 37. Ishihara wase 38. Sheridan 39. Nyora 40. Koshu sanjaku 41. Olympia 42. Katta Kurgan 43. Purple Damascus 44. Hanover 45. Black queen 46. Rose queen 47. Pecocede Marengre 48. Naples 49. Muscat Hamburg 50. Black prince 51. Roode Hanepoot 52. Gros Colman 53. Pinot blanc 54. Rosaki 55. Chasselas rose 56. Ontario 57. Niagara 58. Monukka 59. Merlot 60. Golden Muscat 61. Canada Muscat 62. Rizamat 63. Athens 64. Gros Semillon 65. Riesling Italico 66. Black Hamburg 67. Flame Tokay 68. Pizzutello bianco 69. Black Cornichon 70. Ryugan 71. Königin der Weingarten 72. Centennial 73. Chardonnay 74. Grüner Sylvaner 75. Olivette rose

RESULTS AND DISCUSSION

Similarity in free amino acid patterns among 75 grape cultivars is shown in Table 1. If pattern A equals to pattern B, pattern S (A, B) becomes 1, and in case where pattern A and pattern B do not contain same component at all, S (A, B) becomes 0. Numerics on the diagonal line from the upper left side to the down right are absent because pattern S (A, B) becomes 1 between the same cultivars. The total data generated were 2,775 ($_{75}C_2$).

Similarity in amino acid patterns has been compared with the histogram of the amino acid components as in Fig. 1, and has been intuitively clarified to be similar with total shapes or their histograms. Pattern S_1 ("Concord", "Russki Concord") becomes 0.293 between very different pattern shapes, and pattern S_2 ("concord", "Anab-e-shahi") becomes 0.786 between similar pattern shapes. Pattern S_3 ("Concord", "Cannon Hall Muscat") is 0.515, and pattern S_4 ("Concord", "Katta Kurgan") is 0.512, but pattern S_5 ("Cannon Hall Muscat") is 0.840. These results seem to indicate the similarity of pattern shapes between any two grape cultivars.

Higher similarity coefficients for American grape cultivar "Concord" were in decreasing order 0.994 ("Niagara"), 0.993 ("Yates"), 0.986 ("Sheridan"), 0.985 ("Hanover"), 0.984 ("Bath"), 0.976 ("Ishihara wase"), 0.973 ("Naples"), 0.965 ("Ontario"), 0.960 ("Campbell Early"), and 0.937 ("Athens"), respectively. These cultivars are all American grapes. On the other hand, the lower similarity coefficients for "Concord" were in increasing order 0.293 ("Russki Concord"), 0.337 ("Nehelescol"), 0.340 ("Violet Uehara"), 0.340 ("Interlaken seedless"), 0.352 ("Merlot") and 0.399 ("Pinot blanc"), respectively. These cultivars are all *vinifera* or hybrid cultivars more resembling to *vinifere*.

The higher similarity coefficients for *vinifera* cultivar "Cannon Hall Muscat" were in decreasing order 0.987 ("Gros Semillon"), 0.984 ("Black Hamburg"), 0.975 ("Koshu"), 0.970 ("Pinot blanc"), 0.967 ("Nyora"), 0.964 ("Chasselas rose"), 0.962 ("Black Cornichon"), 0.952 ("Chardonnay"), 0.951 ("Corna Neagra") and 0.941 ("Koshu sanjaku"). Also, the higher levels of similarity for the Russian cultivar "Katta Kurgan" were in decreasing order 0.991 ("Olivette rose"), 0.985 ("Pizzutello bianco"), 0.981 ("Muscat

Table **1.** Similarity coefficients for amino acid patterns in 75 grape cultivars. * (**1**:*vinifera*, **2**: *labrusca*)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
1. Campbell early[2]	1.000																		
2. Yates[2]	.940																		
3. Pusa seedless'	.714	.781																	
4. Neo Muscat'	.592	.641	.961																
5. Bath[2]	.909	.985	.836	.720															
6. Pione[2]	.807	.893	.917	.864	.954														
7. Cannon Hall Mus.[1]	.533	.455	.842	.917	.506	.649													
8. Kokuhō[2]	.773	.790	.822	.730	.751	.707	.719												
9. Kyohō[2]	.883	.790	.831	.823	.821	.855	.898	.716											
10. Buffalo[2]	.890	.872	.863	.773	.840	.791	.752	.959	.840										
11. Himrod seedless[2]	.844	.922	.954	.878	.957	.980	.704	.841	.862	.888									
12. Russki Concord'	.263	.287	.621	.616	.261	.311	.724	.767	.331	.669	.464								
13. Kendaia[2]	.941	.919	.538	.373	.843	.658	.280	.768	.685	.817	.695	.204							
14. Nehelescol'	.677	.307	.701	.746	.309	.402	.881	.761	.505	.708	.528	.957	.197						
15. Red Millennium'	.893	.846	.865	.796	.822	.789	.798	.990	.880	.995	.849	.654	.790	.723					
16. Romulus'	.872	.804	.895	.868	.835	.873	.840	.778	.980	.886	.896	.439	.675	.595	.919				
17. Schuyler[2]	.761	.708	.915	.911	.723	.778	.936	.905	.877	.930	.828	.732	.562	.844	.925	.928			
18. Tachkawa No. 3[2]	.886	.867	.887	.856	.912	.941	.746	.759	.966	.844	.901	.709	.710	.462	.868	.972	.836		
19. Violet Uehara[1]	.886	.982	.826	.716	.990	.936	.546	.812	.874	.869	.915	.263	.872	.330	.860	.879	.737	.935	
20. Italia[1]	.577	.455	.835	.915	.640	.810	.649	.494	.865	.602	.764	.309	.279	.527	.658	.869	.795	.871	.660
21. Interlaken seedl.[1]	.328	.324	.671	.671	.303	.363	.792	.831	.426	.715	.492	.989	.239	.977	.711	.529	.771	.389	.315
22. Delaware[2]	.949	.899	.855	.799	.916	.905	.719	.812	.942	.893	.918	.330	.798	.471	.913	.974	.842	.986	.412
23. Kōshu[1]	.500	.417	.789	.852	.441	.551	.975	.809	.710	.771	.641	.834	.288	.954	.808	.773	.934	.657	.886
24. Black Olympia[2]	.953	.950	.879	.794	.960	.931	.680	.868	.933	.922	.925	.377	.838	.470	.926	.947	.834	.968	.980
25. Corna Neagra[1]	.732	.668	.915	.949	.722	.825	.951	.800	.928	.838	.822	.574	.489	.744	.879	.958	.936	.914	.757
26. Alden[2]	.767	.816	.791	.721	.847	.851	.561	.701	.765	.745	.852	.296	.660	.369	.736	.784	.683	.830	.344
27. Cabernet flanc[1]	.489	.425	.754	.785	.420	.490	.917	.868	.629	.800	.613	.919	.335	.985	.820	.707	.887	.579	.955
28. Tachikawa No. 5[1]	.919	.963	.881	.788	.982	.964	.620	.841	.894	.885	.945	.339	.817	.408	.879	.906	.782	.947	.991
29. Pierce'	.960	.996	.747	.604	.973	.869	.438	.819	.816	.867	.899	.249	.943	.274	.846	.807	.674	.862	.292
30. Urbana[1]	.955	.962	.871	.777	.971	.939	.646	.853	.923	.910	.927	.343	.849	.431	.912	.935	.809	.964	.990
31. Mase No. 5[2]	.820	.765	.912	.926	.815	.887	.883	.797	.963	.857	.867	.468	.596	.639	.893	.982	.913	.670	.847
32. Keuka[2]	.840	.714	.743	.763	.757	.800	.587	.622	.980	.738	.753	.193	.619	.405	.792	.944	.781	.944	.819
33. Hiro Hamburg'	.587	.447	.710	.787	.525	.667	.836	.470	.883	.575	.615	.247	.293	.491	.650	.873	.742	.819	.589
34. Anab-e-shahi[1]	.705	.752	.971	.971	.833	.951	.836	.753	.879	.783	.942	.466	.484	.598	.803	.911	.849	.928	.528
35. Concord'	.960	.993	.804	.676	.984	.905	.515	.840	.846	.889	.932	.293	.911	.337	.873	.856	.728	.905	.340
36. Captivator[2]	.754	.723	.925	.926	.745	.813	.915	.912	.882	.911	.846	.695	.576	.800	.931	.911	.945	.861	.772
37. Ishihara wase[2]	.976	.976	.682	.537	.933	.798	.410	.817	.788	.871	.813	.247	.979	.272	.851	.786	.662	.830	.953
38. Sheridan[2]	.978	.980	.757	.616	.951	.846	.494	.846	.842	.899	.858	.294	.948	.332	.886	.849	.720	.878	.974
39. Nyora'	.650	.628	.930	.952	.666	.765	.967	.889	.822	.869	.804	.773	.445	.884	.892	.881	.955	.815	.686
40. Kōshu sanjaku[1]	.518	.533	.900	.922	.569	.684	.941	.871	.692	.812	.741	.864	.332	.937	.825	.777	.910	.696	.900
41. Olympia*	.904	.914	.869	.746	.894	.845	.670	.976	.832	.963	.894	.567	.828	.585	.948	.871	.837	.846	.606
42. Katta Kurgan'	.514	.444	.769	.872	.557	.739	.840	.439	.830	.530	.661	.265	.201	.504	.596	.829	.730	.825	.358
43. Purple Damascus'	.550	.530	.852	.865	.540	.619	.927	.913	.688	.849	.703	.906	.392	.966	.861	.766	.920	.665	.941
44. Hanover[2]	.959	.984	.749	.603	.947	.833	.427	.982	.798	.908	.856	.342	.955	.354	.885	.807	.710	.840	.379
45. Black queen[1]	.817	.761	.924	.916	.792	.844	.911	.889	.942	.916	.863	.602	.621	.737	.944	.974	.951	.929	.672
46. Rose queen'	.854	.803	.893	.881	.854	.912	.813	.757	.983	.834	.877	.354	.641	.522	.869	.986	.862	.987	.440
47. Pecocede Marengre[1]	.502	.377	.667	.779	.482	.650	.798	.361	.823	.471	.571	.172	.185	.433	.549	.805	.677	.786	.274
48. Naples[2]	.991	.957	.709	.583	.920	.806	.511	.836	.854	.894	.822	.274	.952	.328	.888	.845	.717	.867	.328
49. Muscat Hamburg[1]	.635	.533	.801	.877	.618	.760	.883	.560	.911	.649	.733	.329	.342	.561	.715	.910	.809	.881	.429
50. Black prince'	.723	.640	.829	.876	.721	.832	.837	.592	.944	.696	.765	.244	.447	.501	.744	.941	.810	.928	.373
51. Roode Hanepoot[1]	.808	.795	.936	.907	.849	.923	.830	.792	.954	.841	.898	.423	.602	.566	.868	.974	.869	.959	.503
52. Gros Colman'	.501	.371	.736	.848	.459	.629	.918	.506	.830	.576	.595	.403	.192	.642	.650	.833	.789	.772	.500
53. Pinot blanc[1]	.437	.330	.758	.849	.409	.588	.970	.583	.757	.608	.584	.588	.139	.793	.672	.785	.831	.708	.666
54. Rosaki	.682	.694	.961	.951	.742	.838	.913	.882	.849	.864	.861	.691	.487	.784	.880	.898	.921	.847	.744
55. Chasselas rose	.325	.516	.826	.904	.590	.731	.964	.645	.897	.703	.709	.473	.336	.686	.765	.909	.866	.855	.564
56. Ontario[2]	.938	.941	.870	.797	.966	.955	.652	.798	.931	.870	.923	.290	.806	.400	.877	.936	.769	.981	.358
57. Niagara[2]	.946	.986	.830	.731	.990	.938	.723	.851	.867	.887	.941	.307	.882	.365	.894	.872	.844	.937	.361
58. Monukka[2]	.531	.516	.851	.854	.526	.606	.919	.906	.668	.838	.693	.911	.376	.962	.848	.753	.906	.646	.944
59. Merlot[1]	.347	.342	.628	.606	.300	.325	.736	.852	.393	.728	.470	.990	.294	.954	.717	.498	.754	.354	.993
60. Golden Muscat'	.866	.678	.924	.885	.926	.972	.744	.774	.944	.842	.930	.341	.686	.473	.859	.955	.830	.988	.414
61. Canada Muscat'	.843	.840	.944	.911	.891	.953	.883	.809	.959	.861	.924	.413	.648	.551	.884	.977	.871	.981	.488
62. Rizamat[1]	.584	.464	.757	.857	.560	.716	.869	.436	.870	.586	.566	.303	.237	.544	.613	.863	.772	.768	.369
63. Athens[2]	.939	.895	.884	.812	.906	.897	.744	.854	.965	.921	.895	.402	.796	.520	.938	.980	.865	.971	.484
64. Gros Semillon[1]	.653	.581	.887	.927	.619	.722	.987	.840	.861	.841	.786	.714	.424	.859	.880	.904	.950	.820	.784
65. Riesling Italico[1]	.674	.566	.803	.696	.642	.769	.888	.580	.932	.686	.727	.347	.392	.572	.749	.924	.827	.892	.441
66. Black Hamburg[1]	.466	.327	.612	.771	.430	.607	.813	.345	.806	.452	.553	.196	.145	.460	.533	.781	.673	.752	.299
67. Flame Tokay[1]	.559	.520	.887	.934	.563	.685	.984	.836	.770	.808	.756	.799	.338	.918	.839	.834	.933	.749	.854
68. Pizzutello bianco'	.575	.474	.781	.871	.567	.729	.882	.518	.881	.602	.698	.325	.272	.560	.670	.875	.783	.843	.423
69. Black Cornichohon[1]	.528	.419	.795	.896	.499	.663	.962	.602	.836	.650	.646	.514	.230	.730	.715	.858	.848	.790	.602
70. Ryugan'	.698	.692	.937	.921	.714	.785	.925	.946	.823	.911	.836	.778	.527	.858	.924	.885	.949	.729	.825
71. Königin der Wein[1]	.694	.664	.932	.955	.577	.867	.562	.729	.921	.776	.838	.482	.441	.652	.816	.947	.881	.918	.565
72. Centennial[1]	.680	.726	.904	.876	.796	.893	.766	.741	.843	.750	.866	.420	.486	.528	.768	.873	.786	.865	.472
73. Chardonnay[1]	.463	.362	.772	.889	.452	.636	.952	.551	.800	.594	.613	.500	.156	.717	.660	.816	.814	.750	.585
74. Grüner Sylvaner[1]	.575	.534	.744	.721	.571	.670	.713	.645	.742	.645	.677	.445	.384	.523	.663	.723	.684	.666	.492
75. Olivette rose'	.552	.455	.752	.846	.559	.724	.839	.453	.861	.549	.653	.249	.244	.490	.619	.853	.737	.835	.347

Table 1. Similarity coefficients for amino acid patterns in 75 grape cultivars (continued).

	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)
20. Italia	1.000																		
21. Interlaken seedl.	.398																		
22. Delaware	.798	.412																	
23. Koshu	.730	.886	.650																
24. Black Olympia	.739	.441	.985	.625															
25. Corna Neagra	.924	.655	.890	.895	.856														
26. Alden	.665	.344	.820	.494	.842	.719													
27. Cabernet franc	.564	.955	.595	.978	.592	.821	.458												
28. Tachikawa No. 5	.718	.394	.954	.553	.990	.808	.854	,521											
29. Pierce	.519	.292	.905	.397	.950	.655	.802	.403	.960										
30. Urbana	.773	.409	.982	.585	.999	.822	.847	.554	.993	.963									
31. Mase No. 5	.920	.549	.951	.814	.921	,984	.779	.735	.880	.755	.903								
32. Keuka	.877	.296	.939	.646	.867	.893	.713	.537	.825	.735	.865	,936							
33. Hiro Hamburg	.938	.361	.783	.720	.694	.892	.569	.581	.639	.460	.673	,877	.912						
34. Anab-e-shahi	.925	.528	.874	.743	.877	.934	.796	.663	.888	.724	.869	.946	.828	.802					
35. Concord	.723	.340	.936	.468	.974	.723	.827	.462	.980	.995	.983	.813	.778	.531	.786				
36. Captivator	.805	.755	.862	.889	.861	.946	.720	.867	.830	.713	.843	.928	.799	.747	.895	.762			
37. Ishihara wase	.453	.291	,890	.389	.929	.624	.689	.408	.916	.990	.937	.726	.724	.428	.649	.976	.686		
38. Sheridan	.540	.346	.929	.460	.965	.697	.794	.465	.954	.545	.970	.786	.772	.519	.725	,989	.746	,990	
39. Nyora	.823	.828	.798	.957	.794	.961	.670	.928	.752	.504	.765	.917	.745	.756	.895	.626	.964	.570	.641
40. Kōshusanjaku	.506	.900	.674	.954	.687	.889	.591	.948	.656	.791	.658	.822	.596	.646	.834	.563	.916	,455	.530
41. Olympia	.587	.606	.890	.662	.942	.788	.776	.682	.941	.609	.789	.822	.723	.550	.806	.932	.865	.893	.932
42. Katta Kurgan	.992	.358	,746	,715	.672	.898	.601	.567	.640	.391	.653	.886	.861	.949	.874	.512	.754	,373	,460
43. Purple Damascus	.664	.941	,668	,969	.681	.867	.557	.984	.631	.502	.647	.797	.443	.609	.767	.561	.963	.486	,550
44. Hanover	.166	.379	.895	.454	.944	.664	.781	.478	.943	.993	.952	.752	.714	.440	.703	.985	.743	.990	.991
45. Black queen	.856	.672	.928	.873	.920	.979	.756	.825	.871	.757	.892	.977	.886	.830	.918	.811	.963	.735	.799
46. Rose queen	.909	.440	,971	,721	.947	.949	.799	,634	.918	,805	.934	.984	.961	.883	.940	.855	.888	.768	.831
47. Pecocede Marengre	.957	.274	.719	.670	.629	.856	.534	.510	.576	.380	.602	.847	.879	.971	.791	.459	.684	.339	.424
48. Naples	.575	.328	.929	.468	.951	.694	.765	.470	.929	.979	.955	.784	.797	.530	.689	.973	.739	.989	.990
49. Muscat Hamburg	,981	.429	.833	.775	.760	.948	.648	.645	.712	.531	.739	.939	.929	.980	.885	,606	.823	,492	,576
50. Black prince	.975	.373	.894	.725	.629	.935	.713	.599	.787	,639	.809	.953	.949	.946	.913	,706	.818	.593	,667
51. Roode Hanepoot	.897	,503	.942	.742	.934	.944	.798	.663	.926	,792	.925	.964	.909	.861	.963	,844	.899	.737	.815
52. Gros Colman	.947	.500	.719	.829	.639	.919	.528	.701	.573	.370	.604	.876	.850	.693	.812	.453	.797	.337	.429
53. Pinot blanc	.898	.666	,656	.921	.492	.759	.520	.311	.550	.852	.752	.878	.797	.399	.829	.283	.367		
54. Rosaki	.833	.744	,827	.875	.841	.940	.722	.837	.477	.677	.821	.912	.762	.759	.938	.738	.956	.622	,706
55. Chasselas rose	.956	.564	.815	.867	.752	.972	.626	.758	.696	.521	.723	.942	.895	.955	.882	.590	.874	.480	.565
56. Ontario	.774	.358	.983	.574	.991	.845	.851	.522	.983	.939	.992	.920	.890	.709	.891	.965	.828	.908	.942
57. Niagara	.652	.361	.946	.501	.991	.769	.843	.484	.999	.985	.999	.854	.822	.568	.833	.994	.927	.968	.985
58. Monukka	.649	.944	.649	.958	.668	.850	.546	.976	.621	.489	.633	.776	.558	.597	.757	.548	.909	.469	.539
59. Merlot	,313	.993	.395	.848	.435	.602	.325	.936	.383	.314	.403	.505	.255	.290	.467	.352	.722	.324	.369
60. Golden Muscat	.871	.414	.967	.649	.965	.904	.845	.578	.963	.866	.963	.957	.903	.790	.955	.907	.875	.816	.871
61. Canada Muscat	.891	.488	,963	.723	.692	.942	.827	.651	.953	.834	.953	.975	.913	.833	.971	.882	.912	,782	,849
62. Rizamat	.977	.369	.781	.760	.621	.869	.599	.620	.558	.462	.599	.848	.878	.956	.856	.729	.724	.367	.444
63. Athens	.785	.484	.992	.683	.988	.896	.817	.641	.958	.891	.981	.944	.911	.772	.879	.934	.897	,887	.936
64. Gros Sémillon	.618	.784	.809	.965	.781	.977	.639	.916	.727	.569	.751	.930	.805	.818	.874	.637	.954	.544	.621
65. Riesling Italico	.964	.441	.854	.787	.792	.954	.657	.663	.741	.570	.765	.949	.945	.973	.886	.646	.839	.534	.613
66. Black Hamburg	.947	.299	.687	.690	.586	.849	.496	.531	.531	.331	.561	.829	.861	.861	.765	.410	.688	.295	.378
67. Flame Tokay	.812	.854	.726	.980	.849	.942	.597	.947	.664	.493	.679	.878	.700	.759	.851	.566	.939	.464	.542
68. Pizzutello bianco	.981	.423	.787	.769	.712	.929	.608	.634	.670	.473	.690	.911	.900	.976	.871	.551	.810	.428	.517
69. Black Cornichon	.943	.602	.743	.892	.674	.953	.562	.734	.611	.409	.640	.905	.836	.939	.847	.493	.850	377	.466
70. Ryugan	.765	.825	.816	.921	.829	.932	.694	.909	.804	.674	.807	.900	.726	.708	.886	.729	.968	.639	.708
71. Königin der Wein.	.960	.565	.878	,818	.853	.975	.737	.725	.830	.653	.833	.967	.884	.909	.968	.722	.917	.596	.686
72. Centennial	.891	.472	.831	.677	.855	.867	.747	.599	.877	.719	.843	.873	.787	.764	.940	.774	.826	.635	.722
73. Chardonnay	.941	.585	.692	.876	.622	.929	.527	.760	.568	.350	.588	.873	.803	.927	.833	.473	.823	,310	,402
74. Griiner Sylvaner	.683	.492	.662	.628	.674	.723	.563	.578	.689	.551	.655	.701	.656	.677	.745	.585	.781	,488	,571
75. Olivette rose	.984	.347	.769	.714	.697	.901	.599	.566	.653	.454	.670	.892	.893	.973	.858	.533	.757	,405	,495

Table 1. Similarity coefficients for amino acid patterns in 75 grape cultivars (continued).

	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)	(55)	(56)	(57)
39. Nyora	1.000																		
40. Kōshu sanjaku	.978																		
41. Olympia	.803	.745																	
42. Katta Kurgan	.782	.694	.503																
43. Purple Damascus	.968	.984	.760	.621															
44. Hanover	.635	.540	.941	.396	.563														
45. Black queen	.954	.879	.883	.813	.877	.775													
46. Rose queen	.852	.793	,840	.870	.709	.789	.954												
47. Pecocede Marengre	.710	.600	.444	.979	.543	.347	.773	.842											
48. Naples	.627	.505	.916	.454	.537	.983	.796	.999	.436										
49. Muscat Hamburg	,835	.734	.616	.981	.689	.512	.891	.975	.975	.580									
50. Black prince	.813	.699	.674	.935	.653	.606	.898	.956	.942	.667	.990								
51. Roode Hanepoot	.876	.787	.874	.849	.747	.780	.954	.983	.806	.798	.904	.927							
52. Gros Colman	.824	.754	,515	,963	.712	,366	.838	.363	.955	.440	.977	.925	.821						
53. Pinot blanc	.898	.858	.511	.909	.831	.328	.842	.778	.882	.375	.919	.852	.771	.958					
54. Rosaki	,964	.933	,867	,778	.909	.696	.955	.887	.706	.678	.830	.828	.932	.802	.827				
55. Chasselas rose	.900	.818	.654	.953	.790	.513	.925	.912	.941	.572	.986	.953	.899	.985	.960	.882			
56. Ontario	.760	.644	,894	.710	.620	,917	.890	.950	.662	.927	.779	.848	.929	.638	.582	.812	.753		
57. Niagara	,715	.617	,958	.599	.600	.999	.846	.900	.508	.981	.651	.748	.870	.528	.464	.771	.633	.985	
58. Monukka	.956	.980	,758	.604	.995	.552	.864	.692	.523	.521	.671	.634	.739	.697	.812	.906	.773	.603	.569
59. Merlot	.786	.860	,622	.267	.915	.410	.641	.399	.188	.356	.355	.309	.462	.416	.589	.702	.496	.341	.357
60. Golden Muscat	,824	,723	,864	,590	.679	,841	.920	.975	,752	.848	.858	.905	.968	.738	.691	.873	.833	.977	.966
61. Canada Muscat	,873	.781	,887	.839	.741	,820	,956	.991	.771	.832	.892	.925	.998	,798	.751	.924	.882	.778	.957
62. Rizamat	.744	.636	.477	.933	.611	.373	.803	.830	.963	.470	.956	.927	.787	,965	.900	.719	.947	.645	.500
63. Athens	.825	.716	.923	.727	.716	.903	.944	.964	.692	.925	.821	.867	.950	.717	.695	.864	.815	.971	.990
64. Gros Sémillon	,985	.944	,775	.827	.940	,602	.961	.874	.784	.624	.889	.865	.889	.895	.934	.948	.946	.748	.672
65. Riesling Italico	.845	.740	,663	.960	.703	.557	.911	.943	.960	.628	.994	.976	.923	.977	.907	.847	.986	.800	.690
66. Black Hamburg	.711	.605	.408	.974	.555	.303	.758	.815	.993	.387	.968	.933	.776	.974	.902	.692	.940	.620	.465
67. Flame Tokay	.992	.763	,729	.784	.973	.534	.921	.801	.717	.531	.829	.796	.828	.855	.929	.941	.903	.675	.608
68. Pizzutello bianco	.821	.726	,575	.985	.677	.454	.866	.900	.979	.521	.996	.975	.881	.985	.926	.823	,983	.733	.602
69. Black Cornichon	,895	.835	.580	,949	.803	.416	.888	.856	.933	.472	.969	.918	.846	.992	.989	.856	.992	.672	.556
70. Ryugan	.981	.961	,879	.712	.958	.712	.953	.851	.639	.694	.782	.775	.891	.755	.819	.977	.851	.786	.784
71. Königin der Wein.	.918	.845	.774	.927	.798	.644	.951	.957	.879	.664	.957	.951	.969	.915	.884	.945	.961	.851	.813
72. Centennial	.819	.762	,834	,785	.699	,704	,875	.902	.731	.696	.817	.944	.957	,739	.698	.918	.821	.846	.829
73. Chardonnay	.877	.665	,531	.950	.781	,354	.854	.823	.933	.408	.957	.900	.819	,991	.989	.840	.981	.629	.509
74. Griiner Sylvaner	,710	.665	,681	.633	.649	,558	.761	.729	.603	.565	.686	.675	.786	,632	.622	.804	.715	.643	.746
75. Olivette rose	.775	.673	.532	.991	.615	.424	.831	.887	.990	.495	.990	.965	.864	.962	.899	.785	.965	.722	.598

Table 1. Similarity coefficients for amino acid patterns in 75 grape cultivars (continued).

	(58)	(59)	(60)	(61)	(62)	(63)	(64)	(65)	(66)	(67)	(68)	(68)	(70)	(71)	(72)	(73)	(74)	(75)
58. Monukka	.1000																	
59. Merlot	.921																	
60. Golden Muscat	.484	.377																
61. Canada Muscat	.731	.450	.990															
62. Rizamat	.590	.297	.722	.766														
63. Athens	.707	.469	.962	.968	.707													
64. Gros Sémillon	.927	.740	.816	.876	.824	,832												
65. Riesling Italico	.684	.377	.868	.909	.950	,838	,902											
66. Black Hamburg	.532	.211	.719	.756	.966	,662	,789	,952										
67. Flame Tokay	.965	.806	.758	.818	.756	.760	.983	.834	.725									
68. Pizzutello bianco	.662	.343	.826	.856	.958	.780	.877	.986	.977	.823								
69. Black Cornichon	.788	.528	,771	.826	.940	,946	.944	.961	.941	.916	.972							
70. Ryugan	.953	.800	,834	.889	.677	.854	.963	.807	.632	.961	.764	.835						
71. Königin der Wein.	,791	,503	,927	.969	.861	,893	.033	955	.864	.898	.949	.936	.899					
72. Centennial	.699	.432	.897	.945	.692	.845	.821	.847	.690	.774	.808	.769	.858	.917				
73. Chardonnay	.766	.503	,737	.794	.934	.695	.923	.948	.945	.902	.968	.998	.808	.921	.758			
74. Grüner Sylvaner	,667	,461	.718	.764	.598	,714	.732	.719	,608	.705	.708	.678	.753	,787	,781	.682		
75. Olivette rose	.600	.263	.815	.848	.956	.756	.833	.977	.981	.776	.994	.951	.716	.932	.799	.950	.7	0 1.000

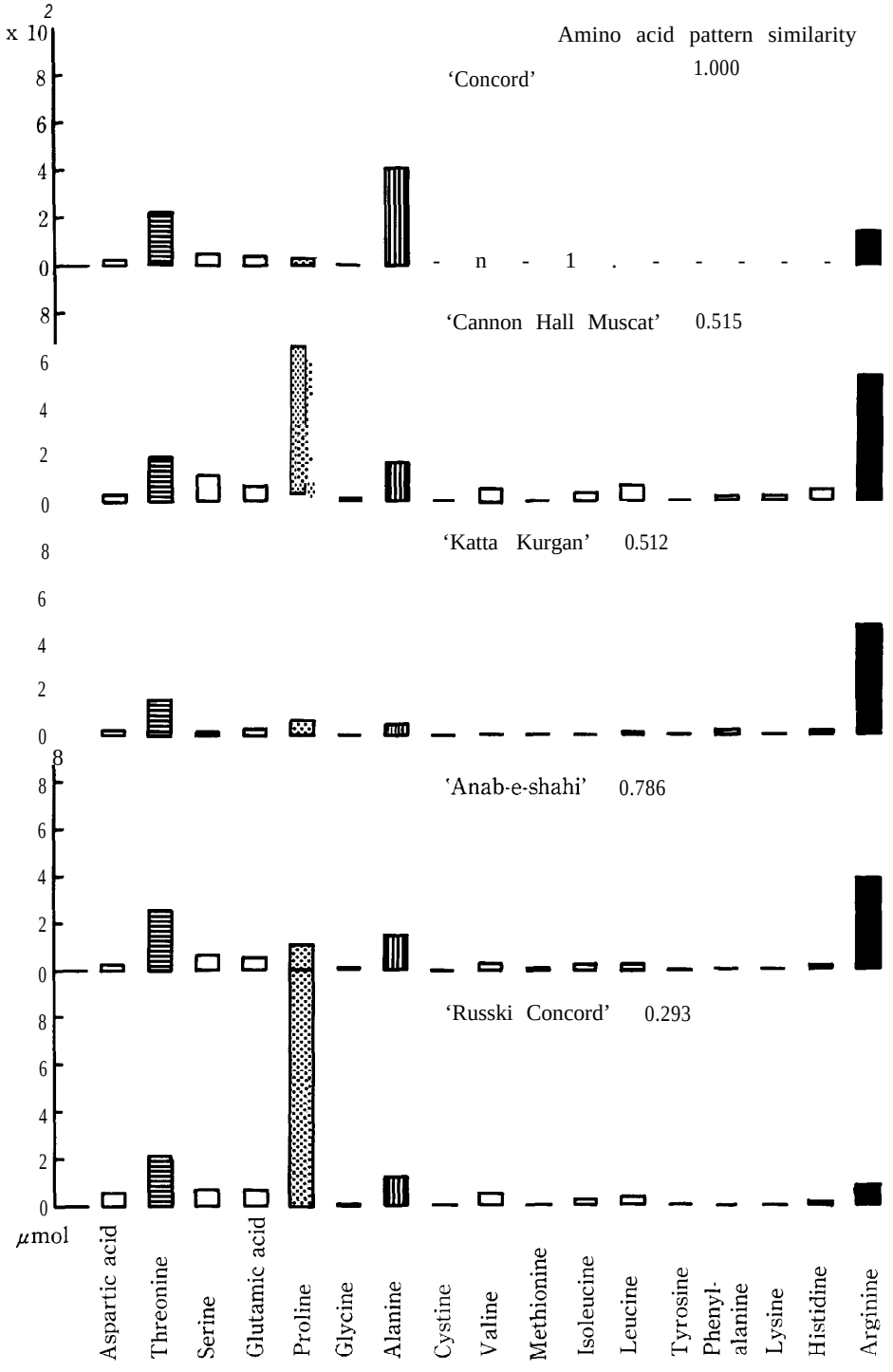

Fig. 1. Comparison between the histogram and the similarity of amino acids

Hamburg"), 0.979 ("Pecocede Marengre"), 0.974 ("Black Hamburg"), 0.963 ("Gros Colman"), 0.960 ("Riesling Italico"), 0.953 ("Chasselas rose"), 0.950 ("Chardonnay"), and 0.949 ("Hiro Hamburg"), respectively. Those for "Centennial" were 0.957 ("Roode Hanepoot"), 0.944 ("Black prince"), 0.940 ("Rose Queen"), 0.945 ("Canada Muscat"), 0.918 ("Rosaki") and 0.917 ("Kbnigin der Weingarten"), respectively. Similarity coefficients for the Indian cultivar "Anab-e-shahi" were 0.971 (Pusa seedless" and "Canada Muscat"), 0.968 ("Königin der Weingarten"), 0.951 ("Roode Hanepoot" and "Pione"), 0.946 ("Mase No. 5"), 0.955 ("Golden Muscat"), 0.942 ("Himrod seedless") and 0.925 ("Italia"). And those for "Russki Concord", a hybrid between *vinifera* and *V. amurensis*, were 0.990 ("Merlot"), 0.989 ("Interlaken seedless"), 0.957 ("Nehelescol"), 0.919 ("Cabernet franc"), and 0.911 ("Monukka").

Thus, the correlations between two cultivars expressed as the similarity coefficients proved to be useful in the classification of grapes. And furthermore,this similarity will also serve as a good indicator for the favorable amino acid combinations in the breeding of quality grapes.

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