Chemical Composition of Florida Orange Juices and Concentrates

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Authentic samples of Florida orange juices and concentrates were analyzed for ash, K_2O, P_2O_5, acidity, sugars, amino acids (formol), polyphenolics (UV absorbance), and total chlorine. Samples of oranges and orange juices were collected to correlate as closely as possible with the finished concentrates to determine the effects of concentration on chemical composition. No significant effects of concentration were found in the chemical composition of orange juice concentrates as compared to single strength juice.

Adulteration of orange juice is a continuing problem for food law enforcement and commercial quality control laboratories. Chemical composition values of suspect products are generally compared with values obtained on juices of known origin in order to confirm adulteration.

Evaluation of orange juice often involves comparison of data obtained on fresh orange juice with data obtained on reconstituted concentrates. It is essential, therefore, to know the effects of concentration if data obtained on fresh orange juices and concentrates are to be used interchangeably for direct comparison.

The purpose of the work reported here was to determine the effect of concentration on the chemical composition of reconstituted orange juice. Data are presented on the chemical composition of authentic samples of Florida orange juices and concentrates. These data are not proposed as a means for regulatory agencies to judge juice.

EXPERIMENTAL

Samples and Methods. Samples of juices and concentrates for this study were collected from orange juice processing plants in Florida. These samples represent juice extracted by commercial reamers. Each sample of concentrate was collected to represent as closely as possible samples of fresh oranges and extracted juices being processed at the same time. Freshly extracted juices and finished chilled and heat-treated uices were also collected for comparison.

During May 1965, a limited number of samples were collected from three manufacturers. Each sample consisted of two subdivisions, one of commercially extracted juice and the other of closely correlated concentrate. Concentrates were diluted with distilled water to a soluble solids content of about 11.8% prior to preparation, and the samples were analyzed by methods published in "Official Methods of Analysis," 10th Edition, 1965, as follows: Sample preparation, 20.003 (a); soluble solids by refractometer, 20.016; ash, 20.017; K_2O by flame photometer, 20.025; P_2O_5 (volumetric), 20.031, 20.032; total chlorine, 20.038, 6.065, 6.067 (Volhard); titratable acidity by potentiometric titration to pH 8.4, 20.043; invert sugar before and after inversion (Munson-Walker), 20.069, 29.038 to 29.040; and sucrose by difference, 29.032. Total polyphenolics (UV absorbance) and total amino acids (formol titration) were determined by methods of Vandercook *et al.* (1963). Results of analysis are presented in Table I. Table II presents the same analysis with all results calculated to a common basis of 11.8% soluble solids, for comparison.

In 1966, this study was continued by collection and analysis of more samples. These samples were collected in essentially the same manner as in 1965. Twelve samples with a total of 30 subdivisions were collected during January, February, and March. These samples represent eight orange juice processors in Florida.

The samples were analyzed by the methods previously cited. Results of analysis are presented in Table III.

Symbols Used in Tables

Symbol	Definition
SSOJ	Single strength orange juice after finishers
SSOJC	Single strength orange juice after chiller
SSOJC + A	Single strength orange juice after chiller including "add back"[a]
SSOJ − HT	Single strength orange juice, heat-treated in commercial bottles
C − A	Concentrate before "add back"
C + A	Concentrate after "add back"
CC	Commercial pack, finished concentrate in 6- or 9-oz. containers, packed 2-9-66
FOJ	Fresh oranges: juice extracted on hand reamer
	Fruit Variety
1	Pineapple
2	Hamlin
3	Seedling
4	Navel
5	Parson Brown
6	Valencia
7	Unknown

[a] "Add back" is a term generally used in the citrus industry and applies to single strength juices and oils added to adjust the soluble solids and flavor of concentrates and juices prior to commercial packaging.

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Table I. Composition Data on Commercial Florida Orange Juice and Concentrates (Samples Collected during May 1965)

Product	% Soluble Solids	% Ash	K_2O, Mg. per 100 Grams	K_2O, % of Ash	P_2O_5, Mg. per 100 Ml.	Acid as Citric, Mg. per 100 Ml.	% Invert Sugar: Before inversion	% Invert Sugar: After inversion	% Invert Sugar: Sucrose by difference	Amino Acids (Formol) Meq. of NaOH per 100 Ml.	Polyphenolics (UV A. at 325 mμ)	Total Chlorine, Mg. per 100 Ml.
SAMPLE 1, FRUIT VARIETY 6												
SSOJ	13.1	0.488	264	54	40	660	4.30	10.22	5.62	2.48	0.934	4.8
C – A	11.8	0.442	248	56	39	598	3.91	9.00	4.84	2.28	0.600	6.0
SAMPLE 2, FRUIT VARIETY 7												
SSOJ	12.1	0.427	248	58	34	845	4.41	9.26	4.61	2.43	0.710	6.2
C – A	11.9	0.427	231	54	38	717	4.18	9.18	4.75	2.34	0.661	5.3
SAMPLE 3, FRUIT VARIETY 7												
SSOJ	12.5	0.454	253	56	32	800	4.44	9.70	5.09	2.64	0.685	6.0
C – A	11.7	0.454	269	59	39	698	3.98	8.90	4.67	2.42	0.590	5.2
SAMPLE 4, FRUIT VARIETY 6												
SSOJ	13.0	0.483	277	57	31	768	4.73	10.16	5.16	2.42	0.765	3.8
C – A	11.7	0.444	248	56	32	602	3.87	8.78	4.66	2.54	0.623	3.7
SUMMARY												
Min.	11.7	0.427	231	54	31	598	3.87	8.78	4.61	2.28	0.590	3.7
Max.	13.1	0.488	277	59	40	845	4.73	10.22	5.62	2.64	0.934	6.2
Av. (8)	12.2	0.452	255	56	36	711	4.23	9.40	4.92	2.44	0.696	5.1
Av. (4)												
SSOJ	12.7	0.463	260	56	34	763	4.47	9.84	5.12	2.49	0.774	5.2
C – A	11.8	0.442	249	56	37	654	3.98	8.96	4.73	2.40	0.618	5.0

Table II. Results of Analyses in Table I Calculated to a Common Basis of 11.8% Soluble Solids

Product	% Ash	K_2O, Mg. per 100 Grams	K_2O, % of Ash	P_2O_5, Mg. per 100 Ml.	Acid as Citric, Mg. per 100 Ml.	% Invert Sugar: Before inversion	% Invert Sugar: After inversion	% Invert Sugar: Sucrose by difference	Amino Acids (Formol) Meq. of NaOH per 100 Ml.	Poly phenolics (UV A. at 325 mμ)	Total Chlorine, Mg. per 100 Ml.
SAMPLE 1, FRUIT VARIETY 6											
SSOJ	0.440	238	54	36	596	3.87	9.21	5.07	2.23	0.841	4.3
C – A	0.442	248	56	39	598	3.91	9.00	4.84	2.28	0.600	6.0
SAMPLE 2, FRUIT VARIETY 7											
SSOJ	0.416	242	58	33	826	4.30	9.03	4.50	2.37	0.692	6.0
C – A	0.420	227	54	37	704	4.11	9.03	4.67	2.30	0.650	5.2
SAMPLE 3, FRUIT VARIETY 7											
SSOJ	0.418	233	56	30	736	4.09	8.94	4.69	2.43	0.632	5.5
C – A	0.457	271	59	39	704	4.01	8.98	4.70	2.44	0.595	5.2
SAMPLE 4, FRUIT VARIETY 6											
SSOJ	0.432	248	57	27	685	4.23	9.08	4.61	2.16	0.684	3.4
C – A	0.448	250	56	32	608	3.90	8.85	4.70	2.56	0.628	3.7
SUMMARY											
Min.	0.416	227	54	27	596	3.87	8.85	4.50	2.23	0.595	3.4
Max.	0.457	271	59	39	826	4.30	9.21	5.07	2.56	0.841	6.0
Av. (8)	0.434	245	56	34	682	4.05	9.01	4.72	2.35	0.665	4.9
Av. (4)											
SSOJ	0.426	240	56	32	711	4.12	9.06	4.72	2.30	0.712	4.8
C – A	0.442	249	56	37	654	3.98	8.96	4.73	2.40	0.618	5.0

Table III. Composition Data on Commercial Florida Orange Juices and Concentrates Collected during January–March 1966

Product	% Soluble Solids	% Ash	K_2O, Mg. per 100 Grams	K_2O, % of Ash	P_2O_5, Mg. per 100 Ml.	Acid as Citric, Mg. per 100 Ml.	% Invert Sugar: Before inversion	% Invert Sugar: After inversion	% Invert Sugar: Sucrose by difference	Amino Acids (Formol) Meq. of NaOH per 100 Ml.	Polyphenolics (UV A. at 325 mμ)	Total Chlorine, Mg. per 100 Ml.
SAMPLE 1, FRUIT VARIETIES 1, 2, 3												
SSOJ	9.6	0.384	215	56	32	704	3.34	7.45	3.90	1.64	0.420	5.8
C – A	12.2	0.433	232	54	36	858	4.16	9.31	4.89	1.97	0.510	4.7
SAMPLE 2, FRUIT VARIETY 1												
SSOJ	10.8	0.399	224	56	40	794	3.74	8.36	4.39	1.82	0.440	7.7
C – A	12.0	0.467	248	53	42	858	4.00	9.05	4.80	2.00	0.473	7.2
C + A	12.2	0.465	258	55	40	909	3.98	9.12	4.89	2.14	0.492	7.2
SAMPLE 3, FRUIT VARIETY 1												
SSOJ	11.8	0.416	223	54	35	890	4.02	8.98	4.71	1.91	0.444	8.7
SSOJC	12.9	0.468	240	51	40	967	4.31	9.97	5.38	2.06	0.520	6.9
SAMPLE 4, FRUIT VARIETIES 2, 5												
FOJ	12.0	0.412	237	58	39	768	4.15	8.80	4.42	2.20	0.615	6.8
SSOJ	10.3	0.384	211	55	27	640	3.49	7.96	4.25	1.53	0.440	5.6
SSOJC	11.0	0.404	220	54	28	717	3.82	8.56	4.50	1.55	0.452	5.8
SAMPLE 5, FRUIT VARIETIES 1, 4												
SSOJ	13.8	0.469	250	53	32	1044	5.30	11.07	5.48	2.02	0.505	5.5
C – A	12.2	0.407	218	54	33	903	4.32	9.14	4.58	1.78	0.530	5.5
SAMPLE 6, VARIETY 1												
SSOJ	12.2	0.409	215	52	34	756	4.47	9.51	4.79	1.96	0.599	9.9
C – A	12.2	0.434	217	50	40	730	4.43	9.45	4.77	1.96	0.595	6.1
SAMPLE 7, FRUIT VARIETY 6												
SSOJ	11.5	0.397	238	60	39	1178	3.81	8.91	4.84	1.83	0.560	6.8
SSOJC	11.5	0.395	227	57	37	1056	3.86	8.72	4.62	1.78	0.520	4.8
SSOJ C + A	10.4	0.337	204	60	31	858	3.57	7.82	4.04	1.61	0.435	6.6
FOJ	10.6	0.347	199	57	38	1082	3.73	8.09	4.14	1.51	0.580	6.8
SAMPLE 8, FRUIT VARIETY 1												
SSOJ	10.6	0.422	235	56	32	756	3.53	8.44	4.66	1.90	0.490	7.3
SSOJ – HT	10.6	0.403	234	58	33	717	3.76	8.13	4.15	1.74	0.470	8.4
SAMPLE 9, FRUIT VARIETY 1												
SSOJ	11.5	0.373	218	58	28	775	4.00	9.06	4.81	1.69	0.480	5.2
C – A	12.2	0.407	233	57	34	756	4.11	9.49	5.11	1.93	0.493	4.4
CC	12.9	0.430	246	57	38	858	4.34	9.70	5.09	2.11	0.570	7.2
SAMPLE 10, FRUIT VARIETIES 1, 2, 5												
SSOJ	11.6	0.385	210	55	32	775	4.05	8.74	4.45	2.01	0.565	4.8
C – A	12.2	0.400	222	56	33	756	4.12	9.25	4.91	1.96	0.585	4.9
CC	11.9	0.411	225	55	35	762	4.11	9.35	4.98	2.06	0.575	4.9
SAMPLE 11, FRUIT VARIETIES 4, 6												
SSOJ	10.5	0.371	203	55	30	852	3.27	8.00	4.49	1.67	0.525	4.6
SSOJC	11.6	0.414	212	51	35	864	3.63	8.60	4.72	2.01	0.535	5.1
SAMPLE 12, FRUIT VARIETIES 3, 6												
SSOJ	12.1	0.411	206	50	36	948	3.80	8.52	4.49	2.18	0.625	5.2
SSOJC	12.1	0.409	218	53	38	941	3.79	8.36	4.33	2.20	0.625	5.6
SUMMARY												
Min.	9.6	0.337	199	50	27	640	3.27	7.45	3.90	1.51	0.420	4.4
Max.	13.8	0.469	258	60	42	1178	5.30	11.07	5.48	2.20	0.625	9.9
Av. (30)	11.6	0.409	225	55	35	849	3.97	8.86	4.64	1.89	0.522	6.2
SSOJ Av. (12)	11.4	0.402	221	55	33	843	3.90	8.75	4.60	1.85	0.508	6.4
C – A Av. (6)	12.2	0.425	228	54	36	810	4.19	9.40	4.84	1.93	0.531	5.5
SUMMARY, RESULTS CALCULATED TO A COMMON BASIS OF 11.8% SOLUBLE SOLIDS												
SSOJ Av. (12)	11.8	0.416	228	55	34	873	3.99	8.92	4.74	1.90	0.522	6.6
C – A Av. (6)	11.8	0.408	220	54	35	783	4.03	8.92	4.66	1.86	0.510	5.3

CONCLUSIONS

The results of analysis presented in this paper offer no evidence of any significant effects of concentration on the chemical composition of orange juice concentrates as compared to fresh juices. There is some evidence of lower results for acidity in the concentrates for both 1965 and 1966. However, results are still within the normal ranges for orange juice. Lower results for polyphenolics found in the 1965 concentrates, when compared to single strength juice for this year, were not supported by results in 1966. Even with some loss of polyphenolics, a minimum value well within the normal range for orange juice can still be established.

Analytical data presented here shows the chemical composition of fresh juices (chilled or heat-treated) and reconstituted concentrates to be similar enough so that chemical data may be used interchangeably for comparison.

It must be emphasized, however, that these conclusions apply only to those analyses reported. Loss of orange oils and other volatile constituents during the concentration process are to be expected.

LITERATURE CITED

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