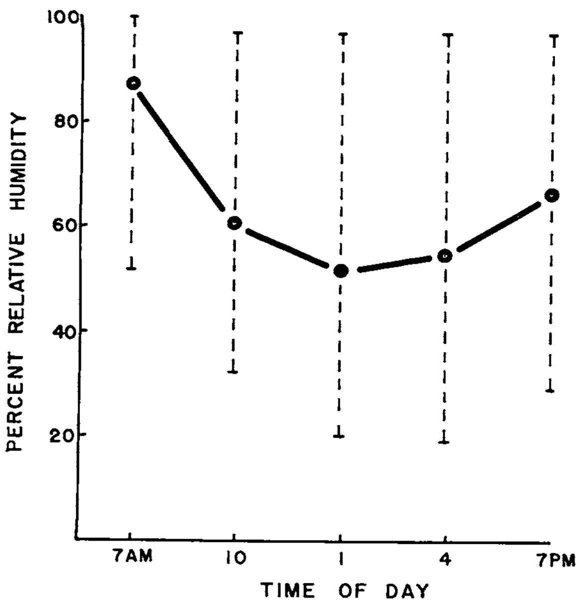

Fig. 4.—Mean percent relative humidity and range during daylight hours at Jacksonville, Florida. May 1957-1966.

It is therefore concluded that freshly dug Florida potatoes, both red and white varieties, are subject to surface browning if epidermal tissue is injured and they are exposed to brief periods when the evaporation rate is high. On a very dry, hot day potatoes may be injured by exposure for as little as 15 minutes. In general it takes at least 2 hours to initiate browning. Dry conditions are most prevalent between 10 A.M. and 4 P.M. during which time growers, particularly those not harvesting in bulk, should provide immediate protection to skinned tubers. During extremely dry conditions growers might curtail harvesting until more favorable conditions exist.

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FACTORS AFFECTING THE PHYSICAL AND NUTRIENT COMPOSITION OF DRIED CITRUS PULP

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Dried citrus pulp has been shown by both research (1, 3, 5, 7, and 9) and practical feeding to be a valuable feedstuff for ruminants. Specific processing procedures vary from one production source to another and may vary within the same source throughout the season. The basic procedure consists of grinding or chopping and then dehydrating the fruit residue. The fruit residue is either dehydrated as such, or it is pressed and molasses is produced from the press liquor. A portion of the molasses is sometimes added back to the pulp in the drying process. The finer particles of the dried pulp are often removed and either sold as citrus meal or pelleted and added back to the pulp. These and other differences in processing, in source and variety of fruit, and in type of canning operation from which the fruit residue is obtained, may result in variations in the nutrient content of dried citrus pulp.

The objectives of this study were to determine: (1) physical characteristics of dried citrus pulp, (2) nutrient content and the contribution of the various physical fractions to the total nutrient composition of pulp, and (3) variability in the nutrient composition of citrus pulp marketed within the state.

Experimental Procedure

Twenty-four, 100-pound samples of dried citrus pulp representing thirteen production

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sources were obtained during midseason (January and February) for the determination of physical and nutrient composition. The density of each sample was determined, as received, by three weighings using a one cubic foot box. The container was filled by allowing the pulp to flow freely with no vibration of the container. Two, 200-gram samples of each citrus pulp were separated into two fractions using a U.S. Bureau of Standards Number 10 Sieve. The fraction retained on the sieve was separated further into pellets or visually detectable seed or seed particles with the remainder considered to be primarily peel plus pulp. The seed fraction was separated further on the basis of broken or intact seeds. The weight of each fraction was obtained and with the intact and broken seeds recombined, the four fractions were ground and prepared for chemical analysis

A second study was conducted to ascertain the variability in the nutrient composition of dried citrus pulp marketed within the state. The proximate analyses of 989 samples of citrus pulp obtained by the Feed Laboratory, Division of Chemistry, Florida Department of Agriculture, were summarized. These samples included 299 samples collected during 1963, 310 during 1964, and 380 during 1965. To make comparisons in nutrient composition of pulp between production sources, the analysis for 904 samples representing 17 production sources were suitable for use.

Chemical analyses for moisture, ash, protein, ether extract, and crude fiber on all samples were conducted according to AOAC (4). Calcium and magnesium were determined with an atomic absorption spectrophotometer using methods outlined by Parker (8). The data were subjected to analysis of variance with significant differences between means determined by the multiple range test of Duncan (6).

Results and Discussion

The physical characteristics of twenty-four samples of dried citrus pulp collected in midseason are shown in table 1. Average density for all samples was 18.70 pounds per cubic foot with a range of 12.54 to 22.66 pounds indicating wide differences in density. The presence of pelleted material did not appear to influence greatly the density of the citrus pulp. The material which would pass a No. 10 sieve (minus 10 mesh fraction) was considered to include both fines and pellets since the pellets represented the fine particles initially sifted from the pulp, pelleted, and then added back. Considering all samples, the fines represented 40.31% and the pellets 5.32% for an average of 45.63% of the original citrus pulp which would have passed a 10 mesh screen. Variability in the quantity of the total minus 10 mesh fraction is illustrated by the range of 26.88 to 68.20%. As shown in table 1, only eight of the twenty-four samples contained pellets. These samples contained an average of 15.96% pellets with 3.40 to 38.61% of the total citrus pulp represented by pellets.

The material retained on a No. 10 sieve (plus 10 mesh fraction) included peel plus pulp and seeds, and represented an average of 54.37% of the total sample. The range in this fraction was 31.80 to 73.12%. Seeds represented 4.75% of the total sample with 44.63% being intact seeds.

Several factors may have contributed to the differences observed in density and physical composition. The type and degree of chopping or grinding prior to dehydrating influences particle size of the resulting dried pulp. Also, the finer particles are sometimes screened from the dried pulp and sold separately as citrus meal. Thus, coarser grinding of the wet pulp and removal of citrus meal would decrease the density of the pulp and result in less of the "minus 10 mesh fraction." The amount of seeds present in the sample would depend in part on variety of fruit and on the type of canning operation providing the wet fruit residue.

The average nutrient composition of the component fractions of citrus pulp is shown in table 2. Seeds were considerably higher in protein and ether extract and lower in ash, crude fiber, and nitrogen-free extract than the other fractions. The remaining fractions including peel plus pulp, fines, and pellets were rather similar in nutrient composition. All fractions differed significantly ($P < .05$) in ash content with pellets containing the highest level, 7.69%, and seeds the lowest, 2.97%. Fines and pellets were significantly higher in calcium and phosphorus and were numerically higher in ether extract and protein than was the peel plus pulp fraction. These data suggest that more of the inorganic matter remained with the finer particles and also that the fines and pellets may have contained small broken particles of seeds as evidenced by the slightly higher protein and

TABLE 1. PHYSICAL CHARACTERISTICS OF DRIED CITRUS PULP[1]

Characteristic	Number of Samples[2] 8	16	24	Range
Density (Samples with pellets), lb/cu ft	19.30	-----	-----	15.62 - 22.66
Density (Samples without pellets), lb/cu ft	-----	18.39	-----	12.54 - 22.22
Density (All samples), lb/cu ft	-----	-----	18.70	12.54 - 22.66
Minus 10 Mesh Fraction[3]				
Fines (Samples with pellets), %	35.06	-----	-----	9.45 - 64.80
Fines (Samples without pellets), %	-----	42.93	-----	26.88 - 51.60
Fines (All samples), %	-----	-----	40.31	9.45 - 64.80
Pellets (Samples with pellets), %	15.96	-----	-----	3.40 - 38.61
Pellets (All samples), %	-----	-----	5.32	----- - -----
TOTAL			45.63	26.88 - 68.20
Plus 10 Mesh Fraction[3]				
Peel plus Pulp (Samples with pellets), %	44.98	-----	-----	28.50 - 55.90
Peel plus Pulp (Samples without pellets), %	-----	51.93	-----	----- - -----
Peel plus Pulp (All samples), %	-----	-----	49.62	28.50 - 68.71
Seeds (All samples), %	-----	-----	4.75	1.83 - 8.27
TOTAL			54.37	31.80 - 73.12
Seed Condition				
Whole (All samples), %			2.12	0.45 - 4.50
Broken (All samples), %			2.63	1.09 - 6.14

[1]All values obtained on citrus pulp samples under air-dry conditions.

[2]Twenty-four samples of pulp examined with only eight containing pellets.

[3]Dried citrus pulp separated using U.S. Bureau of Standards No. 10 Sieve. Although pellets were retained, they were considered as part of the minus 10 mesh fraction.

TABLE 2. AVERAGE PERCENT NUTRIENT COMPOSITION ON A DRY MATTER BASIS OF DRIED CITRUS PULP FRACTIONS[1]

Citrus pulp fraction	Proximate Composition, %: Ash	Ether extract	Protein[2]	Crude fiber	Nitrogen-free extract	Mineral Composition, %: Calcium	Phosphorus	Magnesium
Minus 10 Mesh[3]								
Fines	6.55^{b}	2.14^{b}	7.16^{b}	12.58^{a}	71.57^{a}	2.36^{a}	0.11^{bc}	0.15^{b}
Pellets	7.69^{a}	2.13^{b}	7.44^{b}	12.91^{a}	69.83^{a}	2.37^{a}	0.13^{b}	0.15^{b}
Plus 10 Mesh[3]								
Peel plus Pulp	5.09^{c}	1.78^{b}	6.50^{b}	13.79^{a}	72.84^{a}	1.68^{b}	0.09^{c}	0.13^{b}
Seeds	2.97^{d}	47.96^{a}	17.31^{a}	8.06^{b}	23.70^{b}	0.57^{c}	0.30^{a}	0.25^{a}

[1]All values based on twenty-four samples except those for pellets. Only eight of the twenty-four samples contained pellets. Means in the same column with different superscripts are significantly ($P<.05$) different.

[2]Kjeldahl nitrogen x 6.25.

[3]Samples separated using U.S. Bureau of Standards No. 10 Sieve. Although pellets were retained, they were considered as part of the minus 10 mesh fraction.

ether extract. With total removal of the seed fraction, the peel plus pulp contained 6.50% protein on a dry matter basis while the fines and pellets contained 7.16% and 7.44%, respectively. The seeds in this study contained higher levels of protein, ether extract, and nitrogen-free extract and lower levels of ash and crude fiber than reported previously by Ammerman, *et al.* (2) for whole citrus seeds. This can be explained by the many broken seed kernels included in the present samples without the corresponding seed hull.

The percentage of total nutrients contributed by each fraction of citrus pulp was calculated and recorded in table 3. These values were calculated from physical composition (table 1) and nutrient composition of each physical fraction (table 2). Except for seeds with their higher protein, ether extract, magnesium, and phosphorus content, the average contribution of each fraction to the total nutrient composition of the citrus pulp tended to be about the same as that fraction's average representation on a quantitative basis. Thus for ash, crude fiber, nitrogen-free extract and calcium, about 50% of the nutrients came from peel plus pulp, 40% from fines, and 5% from pellets. The seeds contributed approximately 56% of the ether extract and 12% of both the protein and phosphorus present in the total pulp, but contributed relatively little of the ash, crude fiber, and nitrogen-free extract fractions. The contribution of seeds to the total composition of citrus pulp is shown further by the observation that for each 1% increment of seed substitution for peel plus pulp (table 2), ether extract will be increased by about 0.39% and protein by 0.09%. The content of ash and crude fiber will remain essentially unchanged while nitrogen-free extract will decrease in amounts comparable to the combined increases in ether extract and protein. These values were calculated assuming 90% dry matter in the feedstuff and using the data for peel plus pulp shown in table 2, which were considered to reflect very limited amounts of seeds. The nutrient composition data for whole citrus seeds obtained by Ammerman, *et al.* (2) were used.

The average nutrient composition of 989 citrus pulp samples analyzed by the Feed Laboratory, Florida Department of Agriculture, for a three-year period is shown in table 4. The moisture content of the pulp as collected varied from 3.5 to 13.4% with an average of 8.62%. The ranges in nutrient composition listed for the air-dry samples suggested considerable variation in nutrient content. Expressed on a dry matter

TABLE 3. AVERAGE PERCENT NUTRIENT CONTRIBUTION FROM EACH CITRUS PULP FRACTION TO THE TOTAL NUTRIENT COMPOSITION OF THE PULP[1]

Citrus pulp fraction	Percent of Nutrients Contributed: Ash	Ether extract	Protein[2]	Crude fiber	Nitrogen-free extract	Calcium	Phosphorus	Magnesium
Minus 10 Mesh[3]								
Fines	46.15	20.32	38.60	38.58	41.13	49.08	40.23	41.75
Pellets	7.17	3.17	5.12	5.01	5.35	6.51	6.27	5.52
TOTAL	53.32	23.49	43.72	43.59	46.48	55.59	46.50	47.27
Plus 10 Mesh[3]								
Peel plus Pulp	44.23	20.58	44.34	53.33	51.85	43.01	40.60	44.52
Seeds	2.45	55.93	11.94	3.08	1.67	1.40	12.90	8.21
TOTAL	46.68	76.51	56.28	56.41	53.52	44.41	53.50	52.73

[1]All values based on twenty-four samples except those for pellets. Only eight of the twenty-four samples contained pellets.

[2]Kjeldahl nitrogen x 6.25.

[3]Samples separated using U.S. Bureau of Standards No. 10 Sieve. Although pellets were retained, they were considered as part of the minus 10 mesh fraction.

basis, the average nutrient composition for all samples was as follows: ash, 5.12; ether extract, 4.27; protein, 6.81; crude fiber, 13.38; and nitrogen-free extract, 70.42%. The average nutrient composition of dried citrus pulp varied only slightly from year to year (table 4).

The average nutrient composition of the citrus pulp samples according to production source is shown in table 5. Significant ($P < .05$) differences were found between production sources for all nutrients. The average ether extract content by production source varied from 3.47 to 5.85%, and the standard deviation within production source was ±1.36%. Protein content varied also according to source and was highly correlated ($r = 0.78$) with the content of ether extract when the average values for the seventeen production sources were compared. The level of crude fiber and level of nitrogen-free extract were shown to be inversely correlated ($r = -0.98$). Citrus pulp from source number 11 had a crude fiber content of 16.14% and a nitrogen-free extract content of 61.71% while the pulp from source number 6 contained only 11.92% crude fiber and 72.14% nitrogen-free extract. Most of the pulp samples containing high levels of crude fiber and low levels of nitrogen-free extract were from production sources known to be producing molasses. A portion of the molasses, however, may have been added back to the pulp in the drying process .

Summary

Samples of dried citrus pulp were examined to determine their physical and chemical composition. Twenty-four samples, from thirteen production sources were examined to determine density and physical composition. The samples were separated into two fractions using a U.S. Bureau of Standards Number 10 Sieve. The fraction retained on the sieve was separated further into pellets, visually detectable seeds or seed particles, and peel plus pulp· Considering all twenty-four samples, an average of 40.3% passed the sieve, and 59.7% was retained. The latter fraction, when expressed on the basis of the whole sample, consisted of seeds, 4.8%; pellets, 5.3%; and peel plus pulp, 49.6%. Only eight of the twenty-four pulp samples contained pellets with an average pellet content of 16.0% by weight. In another study, analyses of 989 samples of dried citrus pulp obtained by the Feed Laboratory, Division of Chemistry, Florida Department of Agriculture, were summarized. These samples were collected during 1963, 1964, and 1965. The average moisture content for all samples was 8.62% and, exposed on a dry

TABLE 4. AVERAGE NUTRIENT COMPOSITION OF CITRUS PULP SAMPLES COLLECTED OVER A THREE-YEAR PERIOD

			Nutrients %					
Year	Number of Samples		Moisture	Ash	Ether extract	Protein[1]	Crude fiber	Nitrogen-free extract
Air dry basis								
1963-1965	989	Average	8.62	4.68	3.90	6.22	12.22	64.36
		Range	3.5-13.4	3.1-8.2	1.3-9.1	5.1-8.4	7.6-16.8	54.2-70.2
Dry matter basis								
1963	299	Average	-	5.24	4.34	7.16	13.26	70.00
1964	310	Average	-	5.16	3.78	6.51	13.29	71.26
1965	380	Average	-	5.00	4.60	6.78	13.54	70.08
Combined	989	Average	-	5.12	4.27	6.81	13.38	70.42

[1]Kjeldahl nitrogen x 6.25.

TABLE 5. AVERAGE NUTRIENT COMPOSITION OF CITRUS PULP SAMPLES COLLECTED OVER A THREE-YEAR PERIOD EXPRESSED IN PERCENT ACCORDING TO PRODUCTION SOURCE[1]

Moisture		Ash		Ether extract		Protein[2]		Crude fiber		Nitrogen-free extract	
Source	Level	Source	Level	Source	Level	Source	Level	Source	Level	Source	Level
14	9.44	16	5.67	5	5.85	5	7.21	11	16.14	11	66.71
5	9.14	4	5.47	11	5.00	11	7.04	16	15.36	16	67.69
3	8.98	1	5.45	8	4.71	10	6.92	5	14.44	5	67.88
16	8.78	8	5.39	7	4.70	1	6.92	8	13.90	8	69.25
15	8.76	14	5.37	16	4.67	3	6.85	1	13.68	1	69.81
1	8.74	6	5.25	3	4.33	15	6.84	14	13.50	14	70.04
2	8.60	9	5.20	9	4.28	9	6.84	3	13.50	9	70.35
6	8.46	17	5.18	10	4.27	14	6.84	12	13.37	3	70.47
9	8.35	11	5.09	13	4.27	17	6.80	9	13.34	17	70.81
12	8.26	12	5.02	14	4.24	16	6.79	2	13.23	10	70.84
8	8.24	10	4.99	2	4.22	8	6.77	17	13.22	12	70.96
7	8.06	3	4.95	1	4.12	12	6.74	10	12.98	2	71.02
11	8.06	15	4.91	17	3.98	6	6.74	4	12.67	4	71.66
10	7.91	2	4.87	6	3.93	13	6.67	7	12.37	7	71.83
17	7.84	7	4.72	12	3.91	2	6.66	13	12.03	6	72.14
4	7.73	5	4.63	4	3.56	4	6.64	15	12.01	13	72.56
13	7.55	13	4.47	15	3.47	7	6.40	6	11.92	15	72.77
Std. Dev.[3]	1.22		0.54		1.36		0.38		0.91		1.78

[1]Twelve to 157 samples represented by each production source for a total of 904 samples. All values except moisture expressed on a dry matter basis. All values in the same column not covered by the same line are significantly (P<.05) different.

[2]Kjeldahl nitrogen x 6.25.

[3]Within production source standard deviation.

matter basis, the average proximate composition was as follows: ash, 5.1%; protein, 6.8%; ether extract, 4.3%; crude fiber, 13.4%; and nitrogen-free extract, 70.4%. Significant ($P < .05$) differences in the nutrient composition of the dried citrus pulp samples were found between production sources.

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