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Effect of Processing Method and Variety on Niacin and Ether Extract Content of Green and Roasted Coffee[a, b]

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SUMMARY

The effect of variety and coffee cherry processing methods on the ether extract and niacin content of green and roasted coffee was studied. Methods of processing the cherry affected neither in green coffee, but did affect niacin content in roasted coffee. Alkaline treatment of the cherry generally resulted in a lower niacin content than found in the naturally fermented samples. Coffee varieties in the green state contained 7.66–11.10% of ether extract, and niacin varied from 1.05 to 1.81%. This variation was attributed to genetic differences. Roasting increased both substances significantly. No relation in niacin content was found between roasted samples and green coffee bean. A positive correlation was found between green and roasted coffee samples in ether-extractable material. Since the increase in ether extract in roasted coffee is not all accounted for by the decrease in the moisture content, roasting must convert organic substances into ether-soluble compounds, and trigonelline into niacin.

BRESSANI AND NAVARRETE (1959) recently reported that variety and method of processing could significantly affect the niacin content of both green and roasted coffee. Hughes and Smith (1946), however, reported that the niacin content of green coffee beans is not dependent on variety. One of the important factors determining the niacin content of coffee is the roasting temperature. Several authors (Adamo, 1955; Hughes and Smith, 1946; Teply *et al.*, 1945) found that, during roasting, trigonelline is converted into nicotinic acid. Therefore, the final content of niacin in samples roasted under standard conditions can be influenced by the trigonelline content of the green coffee. This substance, in turn, may be dependent on the variety of cherry and the method of processing it.

The present study was undertaken to find out whether processing methods and variety were important factors in determining the final concentration of niacin in roasted coffee. Also included are further observations on the increase in ether-extractable substances of coffee with roasting previously described by Bressani and Navarrete (1959) and Bressani *et al.* (1961).

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MATERIALS AND METHODS

Variety differences. The material used in the chemical analysis of coffee beans from different varieties was received in 1957 from the collection of the IIAS (Interamerican Institute of Agricultural Sciences). This variety collection, grown under light legume shade at an elevation of 2,000 feet, is at Turrialba, Costa Rica. At sampling, the trees varied in age between 4 and 8 years from seed. The subsamples were from a composite sample of several pickings during the 1956–57 harvest season. As soon as the ripe cherries were picked, they were taken to the pilot processing plant of the IIAS. Overripe cherries (espumas) were removed by flotation in water, and the remaining cherries were immediately pulped. Mucilage was removed by mechanical abrasion in a specially adapted Hobart mixer. Drying was begun no later than 6 hr after harvest. Drying was in the sun in sample-drying trays until the samples reached a final bean moisture of 12% as determined in a Steinlite moisture tester.

The dried samples were stored in paper bags in an automatically controlled dry room maintaining 12% bean moisture. Before shipment the beans were hulled, and complete data were collected on their size and shape. The samples were then packaged and shipped to Guatemala by air. On receipt at INCAP they were divided into two subsamples: one was ground to pass a 40-mesh screen, and the other was saved for roasting. Both subsamples were stored at 4°C until analyzed.

Processing methods. The samples for the processing study also came from IIAS; their preparation was the same as that described for the variety samples. The following methods were tried for mucilage removal:

Sodium hydroxide. Samples were pulped and placed in a 12-qt metal bowl in a Hobart mixer. Sodium hydroxide solution of a specific concentration (4, 2, 1, 0.5% and 0.25%) was added to just cover the coffee. A wire stirrer was attached to the mixer, and the coffee and solution were stirred for 4 or 5 min or until all of the mucilage was removable from the beans as determined by a small sample washed in clear water. The sodium hydroxide and mucilage were then separated from the coffee samples by washing with three changes of clean water, each stirred with the coffee for 1 or 2 min. After the mucilage was removed, the samples were placed on wire-screen-bottomed trays and placed in the sun daily to dry until they reached a 12% bean moisture.

Mechanical abrasion. This is essentially the same procedure as the sodium hydroxide treatment except that the mucilage was removed in a special attachment designed for the Hobart mixer by the Maxwell House Division of General Foods Corporation. The attachment was a rubber-lined cylinder and roller between which the coffee beans were placed. As the roller passed over the beans, the mucilage was removed by mechanical abrasion.

Natural fermentation. After pulping, the coffee beans were placed in small cement tanks to remove mucilage by natural fermentation. The mucilage was completely decomposed in 24–30 hr. The coffee beans were then washed and sun-dried to 12% bean moisture.

Natural coffee. Refers to coffee dried in the cherry (without pulping) and hulled after it had reached 12% moisture content.

Roasting. Subsamples of 50 g of green coffee from each sample received were roasted. Roasting time was 8 min at

Table 1. Moisture, ether extract and nicotinic acid in green coffee processed under different conditions, and losses in roasting.

Samples	Treatment	Moisture (%)	Ether extract (%)	Niacin (mg/100 g)	Roasting losses			
					Weight (%)	Moisture (%)	Ether extract (%)	Niacin (mg/100 g)
1-15-1-J	4% NaOH	11.86	10.20	1.07	8.0	5.07	15.80	17.06
I-15-2-J	2% NaOH	11.75	11.02	1.16	8.0	4.76	16.28	18.30
I-15-3-J	1% NaOH	11.68	10.90	1.25	7.7	4.74	15.83	13.85
I-15-4-J	0.5% NaOH	11.69	10.85	1.16	9.0	4.89	16.00	16.92
I-15-5-J	Mechanical abrasion	11.71	10.70	1.18	8.6	4.54	16.12	14.58
I-15-6-J	0.25% NaOH	11.32	10.25	1.21	9.0	4.96	15.99	18.15
I-15-7-J	Fermented	11.22	9.40	1.13	8.7	4.79	15.58	19.38
I-15-1	4% NaOH	11.31	9.50	1.23	10.0	5.10	14.81	21.35
I-15-2	2% NaOH	11.53	9.25	1.18	10.5	4.78	14.94	24.25
I-15-3	1% NaOH	11.48	9.40	1.18	11.6	4.59	15.34	28.82
I-15-4	0.5% NaOH	11.86	8.55	1.23	11.6	2.82	15.43	30.75
I-15-5	Mechanical abrasion	11.48	8.45	1.17	10.6	2.68	15.15	26.19
I-15-6	0.25% NaOH	11.69	8.35	1.19	9.4	3.25	16.09	30.99
I-24-1	Patio drying	10.34	10.39	1.27	10.5	3.12	16.75	31.12
I-24-2	1% NaOH	10.35	12.19	1.33	7.5	4.46	18.24	20.22
I-24-3	Mechanical abrasion	10.66	11.47	1.41	9.1	4.22	18.40	24.47
I-24-4	Fermented	11.36	11.39	1.39	9.5	4.56	18.35	25.67
I-24-1 A	Natural	11.39	9.73	1.49	9.1	4.61	19.71	25.95
I-24-2 A	1% NaOH	9.71	10.55	1.40	10.9	7.57	19.40	33.87
I-24-3 A	Mechanical abrasion	9.78	10.62	1.30	10.0	4.86	20.45	28.57
I-24-4 A	Fermented	9.58	9.83	1.32	9.1	3.80	20.29	35.22
Av.		11.13	10.14	1.25	9.4	4.48	16.90	24.08

180°C. The roasted samples were cooled, weighed, ground to pass a 40-mesh screen, and stored at 4°C until analysis.

Chemical methods. The moisture content was obtained by the vacuum oven method (A.O.A.C., 1955), and ether extract determinations were carried out according to the AOAC procedure. Niacin was determined microbiologically using Difco media and *Lactobacillus arabinosus* 17-5 (The Pharmacopoeia of the United States of America, 1950).

RESULTS

As shown in Table 1, none of the pulp treatments had a statistically significant effect on moisture content, ether extract, or niacin. Variation in niacin content was greater between varieties than between processing methods. Even so, the varietal differences (Table 2) for the three substances were not significant.

Table 1 shows the weight loss due to roasting of samples processed by different treatments and also the changes in moisture, ether extract, and niacin content. Roasting caused an average loss equivalent to 18.8% of the original weight of the bean sample. The moisture content dropped to about half of the pre-roasting value, the ether extract increased one and a half times, and the niacin content increased twentyfold. Variation was small in ether extract and relatively large in niacin content. The higher niacin concentrations in the roasted bean tended to result from lower concentrations of sodium hydroxide in the cherry treatment. Also, the roasted beans from the fermented cherries contained more niacin.

Table 2 shows weight losses and changes in moisture, ether extract, and niacin contents resulting from roasting. The loss in weight averaged 9.7% of that of the coffee bean before roasting. The average moisture content dropped with roasting, while ether extract and niacin increased. The variation among varieties after roasting was similar to that resulting from different treatments. The variation in ether extract was greater between varieties than between processing methods.

DISCUSSION

In a study of Bressani and Navarrete (1959), roasting temperature and type and variety of coffee appeared important in determining the amount of niacin produced by roasting. The present results agree with their findings. The large increase in niacin concentration also corroborates results of other workers (Adamo, 1955; Bressani and Navarrete, 1959; Bressani *et al.*, 1961; Cravioto *et al.*, 1955; Gross Daum, 1955; Hughes and Smith, 1946; Teply *et al.*, 1945). Roasted beans from cherries processed by natural fermentation also tend to contain more niacin than those from cherries processed by the sodium hydroxide treatment. Furthermore, higher concentrations of sodium hydroxide resulted in lower niacin concentrations in the roasted material. This may be due to a destruction of nicotinic acid itself, but is more probably the result of the destruction of nicotinic acid precursors, such as trigonelline (Hughes and Smith, 1946). Similarly the variation in the niacin content of the roasted varieties is probably due to a genetic variation in the trigonelline content of the green coffee bean varieties.

As in previous studies (Bressani and Navarrete, 1959; Bressani *et al.*, 1961), the ether extract portion increased with roasting of the samples. The increase ranged from 10.1 to 16.9% among treatments and 8.9 to 15.7% among varieties. This increase cannot be accounted for by either the decrease in moisture content or increase in solid matter during roasting. Thus, roasting converts organic substances into compounds soluble in ethyl ether. This increase in ether-extractable substances appears to have originated from both "crude fiber" and nitrogen-containing compounds in the green coffee bean (Bressani *et al.*, 1961).

Correlation coefficients (Table 3) were calculated between the ether extract portion and the niacin content for both treatment and variety, both green and roasted. Ether extract and niacin were not related in the green samples as a result of treatment or in the roasted samples as a result of variety. The two substances showed a significant positive correlation, however, in the roasted samples as a result of treatment, and a highly significant negative correlation in the green coffee samples.

Table 3 also shows the correlation coefficients of the ether extract and the niacin content of samples in the green and roasted state. Neither the ether extract nor the niacin content of green coffee samples treated in various ways correlated with that of the correspond-

Table 2. Moisture, ether extract, and nicotinic acid in 32 varieties of green coffee, and losses during roasting under uniform conditions.

Sample	Variety	Moisture (%)	Ether extract (%)	Niacin (mg/100 g)	Roasting losses			
					Weight (%)	Moisture (%)	Ether extract (%)	Niacin (mg/100 g)
I-18-13	PEI 194265 Ethiopia	9.96	9.48	1.23	8.9	3.41	18.18	25.87
I-18-16	Kona	9.90	10.18	1.20	8.6	4.77	18.65	16.16
I-18-19	N. 50	11.36	8.37	1.11	10.5	4.52	17.47	28.70
I-18-29	Sel. No. 197	10.73	9.00	1.06	11.0	4.15	17.02	24.75
I-18-34	Mibirizú	11.15	8.90	1.29	9.6	3.52	15.15	20.40
I-18-42	B. A. 13	11.37	9.44	1.25	9.8	3.62	15.92	19.52
I-18-43	B. A. 3	11.58	8.80	1.41	10.5	4.00	15.93	24.87
I-18-48	Sel. × 321	10.94	9.43	1.05	10.5	4.02	16.64	24.52
I-18-49	Dilla × Alghe	10.32	10.84	1.15	10.9	4.39	17.71	25.90
I-18-50	Erecta	10.13	10.22	1.16	9.0	3.01	16.57	18.77
I-18-52	Semperflorens (selfed)	10.47	9.68	1.14	9.3	3.97	15.92	17.87
I-18-55	Padang	9.42	9.62	1.28	9.2	3.86	20.19	26.24
I-18-39	Columnaris	10.15	9.36	1.34	10.0	3.74	18.44	22.40
I-18-68	Villalobos	10.14	7.66	1.21	8.8	2.55	17.37	20.35
I-18-1 A	Blue Mountain	12.12	9.21	1.11	9.8	3.52	17.22	24.20
I-18-8 A	PEI 191728 var. Geffel	11.76	9.35	1.19	10.2	4.21	16.57	28.60
I-18-11 A	PEI 194266 Ethiopia	11.65	9.53	1.32	9.8	3.81	15.76	25.55
I-18-12 A	PEI 194729	11.72	9.04	1.14	10.4	4.47	15.17	24.70
I-18-17 A	PEI S. L. 16	11.05	8.61	1.30	8.6	4.23	18.27	12.60
I-18-18 A	Salvador National	11.33	9.07	1.31	9.8	3.64	15.22	23.65
I-18-27 A	Tafari Kola	11.80	9.46	1.39	10.3	2.74	11.00	30.87
I-18-40 A	Kona	11.63	11.10	1.29	10.0	3.39	16.52	19.22
I-18-41 A	Amphilla	11.24	9.86	1.16	9.3	4.10	16.03	21.55
I-18-44 A	L. 60	11.27	9.42	1.20	9.9	3.71	16.13	18.42
I-18-47 A	F. 502	9.94	9.20	1.19	9.4	4.28	14.90	21.17
I-18-51 A	Maragogipe	9.56	9.99	1.18	10.1	4.25	15.86	23.95
I-18-53 A	Yellow Bourbon	9.96	9.16	1.26	11.7	4.41	15.09	30.65
I-18-54 A	Maragogipe	8.99	7.76	1.12	8.4	4.13	15.10	18.07
I-18-2	Caturra	9.50	7.22	1.21	9.5	4.20	15.20	17.70
I-18-69	*C. canephora* var. Uganda	9.70	4.66	1.81	8.7	3.92	8.10	16.07
I-18-70	*C. canephora* var. Quillou	9.31	6.13	1.56	8.8	4.35	9.97	20.17
I-18-71	*C. abeokutae*	9.46	6.00	1.80	8.2	4.34	9.26	21.47
Av.		10.61	8.93	1.26	9.6	3.91	15.70	22.34

Table 3. Correlation coefficients of ether extract and niacin in green and roasted coffee samples.

Samples	State of sample	Variables correlated	Correlation coefficient[a]
Treatments	Green	Ether extract and niacin	0.3682 NS
	Roasted		0.4519 *
Varieties	Green		—0.6824 **
	Roasted		0.0798 NS
Treatments	Green vs. roasted	Ether extract	0.4317 NS
		Niacin	0.4310 NS
Varieties		Ether extract	0.7073 **
		Niacin	—0.1733 NS

[a] NS, not statistically significant; *, significant at 5% level; **, significant at 1% level.

ing roasted samples, nor did the amount of niacin in the varieties of green coffee correlate with that in the same varieties after roasting. A highly significant positive correlation was found, however, between ether extract in samples of green and roasted coffee from different varieties.

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