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Flavor
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in
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Cigarettes**

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THE FLAVOR CONTRIBUTION OF TURKISH TOBACCO

III

BLENDED CIGARETTES

R. L. Stedman and C. D. Stills

ABSTRACT

A study was made of the effect of added isovaleric and β -methylvaleric acids on the flavor of smoke from blended cigarettes that did not contain Turkish tobacco. The smoke from blended cigarettes containing flue-cured, burley, and Maryland tobaccos with added acids had organoleptic properties that were identical to the smoke from a blend containing flue-cured, burley, Maryland, and Turkish tobaccos. Thus, isovaleric and β -methylvaleric acids are important constituents in the smoke flavor contributed by Turkish tobacco in blended cigarettes containing the four major cigarette tobaccos.

Most cigarettes made in the United States for domestic consumption contain blends of different tobacco types. The important types used in these blends are flue-cured, burley, Maryland, and Turkish tobaccos.* Each type is believed to contribute specific physical or organoleptic properties to the finished product resulting in the overall aroma, flavor, and burn characteristics typical of domestic cigarettes (3).**

Flue-cured tobacco is believed to contribute most of the aroma of the cigarette and a large amount of the smoke flavor; this type is the major component in domestic cigarette tobacco blends and is used in amounts ranging from approximately 45 to 75 percent of the blend. Burley tobacco is added to the blend to improve the burn rate, to contribute bulk to the cigarette, and to give strength to the smoke; the levels of burley

* "Bright" and "Virginia" are frequently used synonyms for flue-cured tobacco, and "Oriental" and "Aromatic" are similarly used for Turkish tobacco.

**Numbers in parentheses refer to literature cited at end of this report.

in blends are usually 15 to 45 percent. Maryland tobacco contributes filling power to the cigarette and is believed to improve generally the smoke flavor; this type is added in small amounts, 1 to 5 percent, to domestic blends. Turkish tobacco imparts aroma, mildness, and a distinctive, pleasant taste to the smoke; this tobacco is used in amounts ranging from about 5 to 15 percent in blends.

Although these generalized contributions of the tobacco types are known, little information is available on the specific chemical components that are responsible for the flavor imparted to smoke by the types. In fact, fundamental chemical differences in the smoke of different tobacco types have been investigated only recently. Although of significant value, such chemical differences may not be related to observed differences in smoke flavor since the chemical components in question may play no role in the overall smoke flavor. The present report describes an attempt to relate previous findings on Turkish tobacco smoke composition to the organoleptic properties of smoke from blended cigarettes containing such tobacco.

RESULTS AND DISCUSSION

Technical background

As a result of basic studies on the composition of tobacco leaf and smoke conducted recently at this Division, certain fundamental differences were found in the chemical composition of the various tobacco types and the smoke produced from such types. Included in this work were comparative studies of the steam-volatile neutrals of leaf (1) and cigarette smoke (2) and steam-volatile acids of leaf (4, 5) and smoke (7). Among the significant findings was the observation that Turkish tobacco leaf and cigarette smoke were strikingly different from other cigarette tobacco types in the amounts and proportions of β -methylvaleric and isovaleric acids (4, 5, 6, 7). Table 1 presents pertinent data on this point in the case of cigarette smoke. Also, it was shown that the addition of Turkish tobacco to blends of bright, burley, and Maryland tobaccos resulted in an increase in the amounts of the steam-volatile acids found in the smoke compared to the levels expected from an additive contribution of each tobacco (7). For isovaleric and β -methylvaleric acids, increases of 48 to 62 percent greater than expected were obtained.

These unusual properties of Turkish tobacco prompted further investigations of the influence of isovaleric and β -methylvaleric acids on the flavor of cigarette smoke which are described below.

Table 1 -- Quantitative differences in certain volatile acids of smoke condensates from various blended or unblended cigarettes.

Acid	Milligrams per 105 cigarettes (flue-cured)*	Ratios of amounts**					
		F	B	M	T	FBM	FBMT
Isobutyric	2.4	1.0	0.78	0.71	1.03	0.74	1.17
n-Butyric	4.6	1.0	.36	.53	.58	.46	.87
Isovaleric	5.9	1.0	.84	.88	1.81	.77	1.63
Unidentified A	0.6	1.0	.38	.77	.63	.50	.94
n-Valeric	1.0	1.0	.38	.46	.50	.61	.68
Unidentified B	0.2	1.0	.37	.57	.62	.89	1.11
beta-Methylvaleric	2.6	1.0	.70	.76	8.7	.70	3.93
Isocaproic	1.7	1.0	.64	.90	-	.80	-
n-Caproic	0.6	1.0	.58	1.07	.97	.75	1.23
Unidentified C	0.9	1.0	.48	.97	1.00	.73	.96
Unidentified D	0.9	1.0	.17	.91	.78	.68	.77
Unidentified E	3.0	1.0	.35	.83	.95	.62	.90
n-Heptylic	5.0	1.0	.46	.68	.60	.65	1.23
Unidentified F	1.2	1.0	.12	1.32	.72	.74	1.02

* Total weights (milligrams per 105 cigarettes) for indicated acids were as follows: Turkish 48.3; flue-cured, 30.6; Maryland, 23.7; burley, 16.5; FBM blend, 20.5; FBMT blend, 40.5. See footnote below for blend compositions. Unidentified acids were calculated as n-caproic acid.

**Relative amounts based on the levels in flue-cured cigarettes. Weights were based on smoking 55 percent of cigarette length. F = flue-cured, B = burley, M = Maryland, T = Turkish, FBM = blend (60 percent flue-cured, 35 percent burley, 5 percent Maryland), FBMT = blend (40 percent flue-cured, 35 percent burley, 5 percent Maryland, 20 percent Turkish).

Organoleptic studies

Essentially, the studies were designed to compare by panel test the flavor of cigarettes containing Turkish tobacco to cigarettes containing isovaleric and β -methylvaleric acids in place of Turkish tobacco. Initially, candidates for the test panel were screened repeatedly by the Triangle Method, using one cigarette of a blend containing flue-cured, burley, Maryland, and Turkish tobaccos and two cigarettes containing the same blend except that the Turkish was replaced with an equivalent amount of flue-cured. Eight out of twenty-five prospective panelists were ultimately accepted in this screening and used in the tests described below.

In subsequent tests, the Paired Comparison Technique was employed, using two cigarettes. The first cigarette contained flue-cured, burley, Maryland, and Turkish tobaccos. The second cigarette had the same composition as the first cigarette except that the Turkish tobacco was replaced by a comparable amount of flue-cured tobacco and a combination of isovaleric and β -methylvaleric acid. Panelists were asked to smoke the two cigarettes and indicate whether or not the cigarettes were identical in organoleptic properties. If differences were found, the panelists were requested to describe the difference in detail. Various control tests of acuity were presented periodically to the panelists as a check on the well-known daily fluctuations in human sensitivities. When a panelist was found to be relatively insensitive, his results were discarded. The inadequacies of panel testing are well known and should be realized in evaluating such data.

A wide range of concentration of constituent tobaccos and of added acids was investigated. Table 2 contains data on some combinations of tobaccos with or without added acids which were tested comparatively for similarities in smoke flavor. The cigarettes in test No. 3 were commercially manufactured; all other cigarettes were hand-rolled in the laboratory. The low grade flue-cured tobacco was a sample previously judged to be flavor-deficient in panel tests by a domestic manufacturer. The cigarettes contained no filters, humectants, or flavoring agents other than the added acids, and the moisture contents were adjusted to 13.0 percent before panel testing. The acids were added to the cigarettes by injection of an acetone solution containing 0.026 percent isovaleric and 0.094 percent β -methylvaleric acids, respectively, using a 50-microliter hypodermic syringe. The syringe was provided with a 19-gage needle having 4 holes of 1/32-inch diameter uniformly distributed along the needle with the original aperture sealed. The solvent was removed from each cigarette by a gentle stream of warm air or nitrogen.

Table 2 -- Blend compositions used in panel tests.

Test No.	Cigarette	Blend composition (Percentage)*					Additives**	
		HGF	B	M	T	LGF	IV	BMV
1	Control	55	35	5	5	-	-	-
	Test	60	35	5	-	-	2.6	9.4
2	Control	50	35	5	10	-	-	-
	Test	50	35	5	-	10	5.3	9.0
3	Control	40	35	5	20	-	-	-
	Test	60	35	5	-	-	6.5	11.0
4	Control	75	15	5	5	-	-	-
	Test	80	15	5	-	-	2.6	9.4

* Blends composed of high grade flue-cured (HGF), burley (B), Maryland (M), Turkish (T) and/or low grade flue-cured (LGF) tobaccos. Cigarettes in test No. 3 were 85 millimeters in length and all others were 70 millimeters.

**Micrograms of isovaleric (IV) or beta-methylvaleric (BMV) acids added per cigarette.

The panel tests on all cigarettes in table 2 showed that no organoleptic differences could be detected between the test and control cigarettes in each combination. These findings indicate that isovaleric and β -methylvaleric acids are important constituents in the smoke flavor contributed by the Turkish tobacco in domestic blends of cigarettes. In addition, these constituents may contribute greatly to the distinctive aroma of the sidestream smoke of Turkish cigarettes and blended cigarettes containing Turkish tobacco.

Stability

Although isovaleric and β -methylvaleric acids are not highly volatile substances, it was of interest to determine the stability of the acids under certain conditions.

A series of stability tests was conducted on cigarettes containing a blend of tobaccos (60 percent flue-cured, 35 percent burley, and 5 percent Maryland) and the added acids (6.5 micrograms isovaleric acid and 11.0 micrograms β -methylvaleric acid per cigarette). The cigarettes were sealed in standard cigarette packages in the usual manner and then tested periodically by the panel for changes in organoleptic properties.

After a storage of 2 months, no changes in flavor were observed. These studies are continuing.

In another investigation, a series of cigarettes was prepared by spraying the acids on the burley tobacco to be used in the blend. The burley and other tobaccos used in the blend were then blended for 5 hours in a vigorous tumbling operation. Subsequently, the tobacco blend was made into cigarettes and tested by the panel. No difference in organoleptic properties was observed between these cigarettes and control cigarettes in which the additives were injected from an acetone solution in the usual manner.

Other considerations

Recently, there has been some interest in the addition of chemical substances to the filters of filter-tipped cigarettes to alter the flavor or other properties of the smoke. Also, there has been some effort in developing nonvolatile tobacco additives that release volatile flavoring agents on burning. In the present study, the effect of adding the calcium salt of isovaleric acid to the filter of filter-tipped cigarettes was investigated superficially. Although the calcium salts are known to decompose pyrolytically to ketones, it was felt that the moist, acidic condition of cigarette smoke might effect some hydrolysis of the salt and release free acid.

The calcium salt of isovaleric acid was prepared by the following method: 0.1 mole of the acid and 0.05 mole of calcium carbonate were added to 50 ml. of water and the mixture was refluxed for 5 hours. Thirty ml. of benzene were added to the reaction flask after cooling, and a benzene-water azeotrope was continuously distilled into a trap from which the water was separated. The salt was collected, washed several times with ether, and dried in a vacuum desiccator for 3 days. Although slightly low, the analytical value for the calcium content of the product was considered satisfactory: calculated, 16.5 percent; observed, 15.4 percent. The addition of approximately 0.5 milligram of this calcium salt to the filter of a filter-tipped cigarette produced some change in the flavor of a cigarette containing only flue-cured, burley, and Maryland tobaccos. The test panel reported the taste to be "different" than a control cigarette without added calcium salt and "somewhat similar to but not identical" with a control cigarette containing all four tobacco types.

Some difficulty was encountered in the synthesis of calcium β -methylvalerate by the above method and work on this problem is continuing.

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