RS6-24

Re-Aimed Sensory Testing Aids Food Analysis, Formulation

By isolating flavor "notes" of natural products, researchers guide makeup of synthetic foods—and even give advice on selecting final processing methods

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Respectively, Chief, Organic Chemistry Research, QMC Research & Development Command, Natick, Mass.; Vice-President, Evans Research & Development Corp., N. Y. C.; and Evans project leaders

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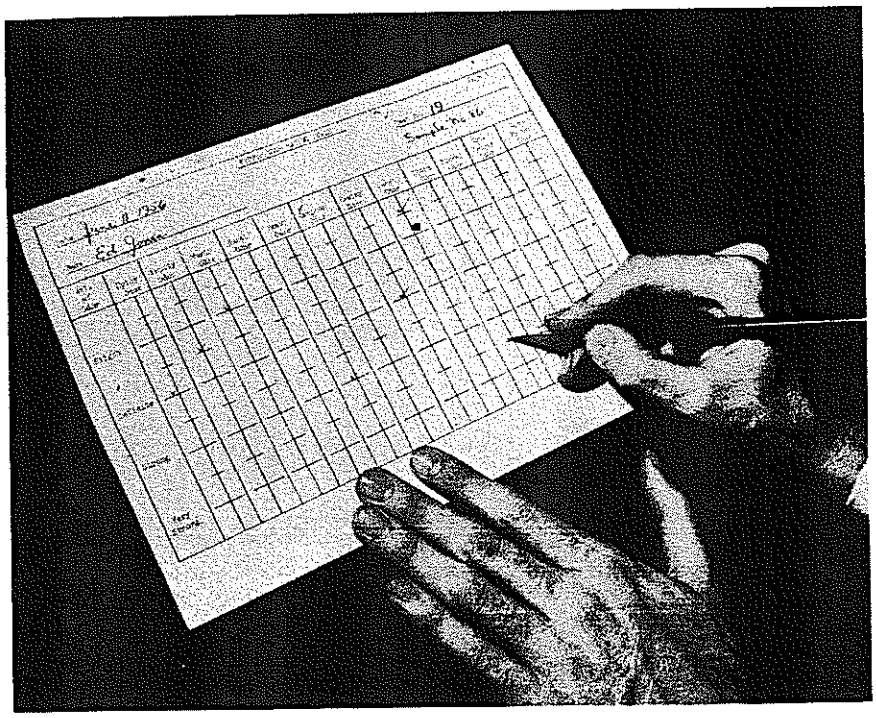

FILLING IN general score sheet. It lists pertinent food product characteristics agreed upon by panelists, in horizontal line. Their intensity is then checked on vertical scale. Followed through from original product to lab-separated fractions, method helps trace movement of vital odor constituents.

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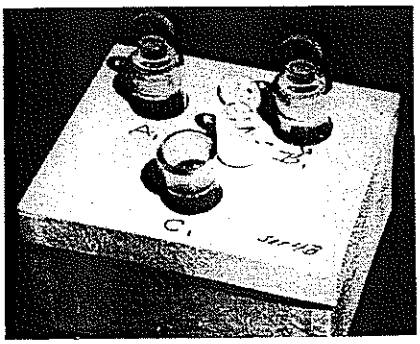
HERETOFORE, sensory tests have been used only to evaluate food tastes and odors, to compare competitive goods, and for quality control of both raw materials and finished products.

Now, we have developed a new application for these standard panel techniques that greatly speeds chemical analysis of flavor constituents—then guides formulation of imitation food products, from first lab experiments to final production methods.

However, before this goal was reached, we had to perform some basic groundwork. For, it was necessary to select a method for picking panel judges, and then develop a list of descriptive terminology for the sensory characteristics of each food tested. Previously contrived methods covering this latter point were found generally unsatisfactory.



TRIANGLE TEST KIT is used to screen judges for panel work. Two of the three samples are identical.

Panel members were screened by means of the triangle test, because its results could be conveniently analyzed through statistical methods*. And also, because the test had been used previously for the same purpose**.

With this gage, prospective judges are presented three samples, two of which are identical. Test materials are placed in 250-ml., glass-stoppered Erlenmeyer flasks. Wire-mesh screens are suspended in the necks of these flasks so judges cannot see samples.

Then flasks are placed in cardboard boxes. Their necks protrude through the top (see photo). Boxes are permanently coded, but positions of odd samples in the different sets are randomized. To avoid bias, candidates are isolated in separate booths while attempting to pick the odd sample.

From these tests, we chose only the highest-scoring men for our panel. Only those tests where the significance level was less than 5% were taken into consideration. And tests having more

*K. S. Konigsbacher, W. H. Danker, and R. L. Evans, *Proceedings of the Scientific Section of the Toilet Goods Assn.*, 16:11-15, 1951.

**E. Helm and B. Trolle, *Wallerstein Laboratory Communication*, 9 (28): 181, 1946.

than 90% correct answers were discarded, because the right choice was too obvious.

Odor Factors Pinpointed

Then came the matter of terminology. Since different materials obviously cannot be rated by the same characteristics, judges were instructed to list every distinct odor "note" that they perceived when examining each product.

Their suggestions were tabulated and discussed in a round-table session. Those notes considered pertinent by a majority of judges were made up into a score sheet. On this sheet, intensity of each odor characteristic was defined over a 9-point scale, ranging from none (0) to very strong (8).

Actual ratings, made on natural pepper and on chemical fractions prepared from it (Table I), show that some odor characteristics distribute themselves between all three fractions. Some are concentrated in only a single fraction. But most important, the tests disclosed that spiciness and true pepper aroma are combinations of different notes—in all fractions.

Further, comparisons between natural black peppers revealed that each one was characterized by a different odor pattern. As expected, there was a greater variation in some characteristics than in others.

Breakdown Aids Analyst

These flavor facts were put to good use in subsequent chemical analysis of the foods—particularly in selecting the fractions and principles to be examined by the chemist.

For, flavor characterization aids greatly in determining degree of separation attained by fractional distillation, chromotagraphy, and exhaustive extraction.

Fractions found by the panel to contain the more important flavor notes were investigated first, while the others were set aside for possible future examination. This selective technique has cut research time 25%.

Building the Synthetics

After aromatic constituents were isolated, the newly-modified panel techniques were found to be invaluable in preparing good imitation products.

Here, first requirement was an adequate qualitative and quantitative definition of desired aroma, since a natural material varies considerably in odor notes, depending on its source.

The panel was a valuable asset in defining these variations, setting up

Table I — How pepper odor notes breakdown in product fractions

Characteristics	Pepper A			Fraction 1			Fraction 2			Fraction 3		
	N*	Total score	Average	N*	Total score	Average	N*	Total score	Average	N*	Total score	Average
Spicy	22	115	5.2	22	41	1.9	22	59	2.7	22	49	2.2
Fruity	22	32	1.5	22	38	1.7	22	40	1.8	22	15	0.68
Musty	22	11	0.50	22	56	2.6	22	16	0.73	22	43	2.0
Burnt	22	7	0.32	22	51	2.3	22	27	1.2	22	27	1.2
Heavy	22	8	0.36	22	18	0.82	22	34	1.6	22	24	1.1
Camphor	22	18	0.82	22	22	1.0	22	45	2.1	22	22	1.0
Resiny	22	30	1.4	22	24	1.1	22	42	1.9	22	35	1.6
Sweet	22	43	1.9	22	28	1.3	22	48	2.2	22	27	1.2
Sharp	22	51	2.4	22	26	1.2	22	60	2.7	22	38	1.7
Floral	22	14	0.64	22	14	0.64	22	18	0.82	22	10	0.45
True pepper	20	100	5.0	22	46	2.1	22	48	2.2	22	51	2.3
Non-pepper	20	21	1.1	22	80	3.6	22	92	4.2	22	72	3.3

Table II — Characteristics compared, naturals vs. synthetics

Characteristics	Pepper A			Pepper B			Imitation A			Imitation B		
	N*	Total score	Average	N*	Total score	Average	N*	Total score	Average	N*	Total score	Average
Spicy	22	115	5.2	25	104	4.2	8	37	4.6	9	39	4.3
Fruity	22	32	1.5	25	78	3.1	8	31	3.9	9	40	4.4
Musty	22	11	0.50	25	7	0.28	8	21	2.6	9	8	0.89
Burnt	22	7	0.32	25	4	0.16	8	6	0.75	9	6	0.67
Heavy	22	8	0.36	25	32	1.3	8	34	4.3	9	23	2.6
Camphor	22	18	0.82	25	50	2.0	8	13	1.6	9	16	1.8
Resiny	22	30	1.4	25	19	0.76	8	17	2.1	9	25	2.8
Sweet	22	43	1.9	25	56	2.2	8	37	4.6	9	39	4.3
Sharp	22	51	2.4	25	44	1.8	8	25	3.1	9	19	2.1
Floral	22	14	0.64	25	28	1.1	8	18	2.3	9	20	2.2
True pepper	20	100	5.0	23	115	5.0	8	24	3.0	9	27	3.0
Non-pepper	20	21	1.1	23	25	1.1	8	37	4.6	9	34	3.8

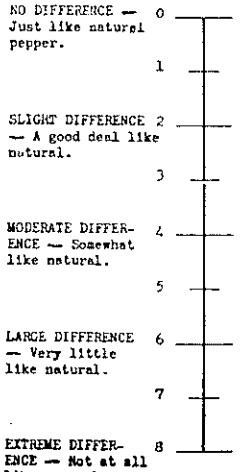
Table III — Synthetics rate higher than real peppers, odor-wise

Product	Trained panel				Novice panel			
	N*	Natural	Synthetic	Rating	N*	Natural	Synthetic	Rating
Pepper S	10	6	4	2.1	67	34	33	2.5
Pepper A	10	10	0	1.2	33	24	9	2.0
Pepper L	18	13	5	1.5	39	22	17	2.8
Pepper T	28	25	3	1.5	20	19	11	1.7
Pepper M	30	24	6	0.7	31	19	12	2.2
Imitation D	38	9	29	4.1	34	10	24	3.1
Imitation E	38	15	23	3.9	34	9	25	4.0
Imitation F	38	14	24	4.3	34	7	27	4.3
Imitation G	38	14	34	4.7	20	1	19	4.6
Imitation H	20	5	15	4.0	34	7	27	3.9
Imitation I	18	0	18	5.1	19	2	17	4.0
Imitation J	18	2	16	4.8	19	5	14	4.9

* Number of observations

Score sheet for comparing imitations

Number checked by panelists on scale are averaged to get ratings in table (left)



Re-Aimed Sensory Testing

—*Continued*

practical standards for natural vs. synthetic comparisons, and in establishing correct goals. These latter are vital. For if the aim is too broad, an unacceptable product will result—if too narrow, a needless perfection is attained that is inside the variations of even natural products.

Thus, the new imitation foods were graded qualitatively by the panel. These men then suggested materials that would provide or modify specific flavor notes. And these were added to supplement the components that had been found in chemical analysis. This was especially necessary, since many flavors derive from extremely complex materials rather than from simple chemical compounds.

An example is the comparison between two natural black peppers and two imitations (Table II). Here, it can be seen that while imitation A has more of the musty, heavy, sweet, sharp, and floral notes than natural product B, nevertheless it does have the correct amount of spiciness, fruitiness, and camphor.

In addition to guiding formulation, expert panels are useful in comparing and selecting production methods. Often flavors of products made by different methods of mixing, distilling, grinding, etc., vary appreciably.

In practice, our panels were even able to define important differences within production cycles, such as distillations and heat treatments.

Synthetics Compared

After production methods are chosen, sensory panels can be used to check synthetics by making direct comparisons with natural standards.

In our case, judges were requested to rate samples quantitatively—identifying coded samples as either natural or synthetic. Then they were asked to rate each sample on another 9-point scale. This ranged from "just like natural product" (0) to "not at all like natural product" (8).

Both trained and novice panels were used in these final tests (see Table III). The figures show that novices were less certain of the odor from natural black peppers, hence scoring was more liberal. But imitations were rated similarly by both the trained and inexperienced groups.

Also revealed is the fact that none of the imitations scored as low as the natural black peppers on odor.

Experiments performed in Evans Research & Development Corp. labs were checked by the Quartermaster Food & Container Institute, Chicago. And although procedures varied slightly in some instances, findings were similar. This is a good indication that methods used were valid.

These panel methods have been applied—to a limited extent—in taste testing, too. However, in many cases fewer samples can be run in the same period of time, particularly if the product has secondary effects, such as pungency or astringency.

And because this time-lag in sampling can effect the panelist's flavor memory, it is helpful to give him characteristic reference samples with each unknown. These paired comparisons, combined with the rating chart of flavor characteristics, sharpen accuracy during evaluations.

End