Table IV. Comparison of Ultraviolet Absorbance Ratios of Isolated Compounds With Hypoxanthine and Inosine

Compound	Ratios		2N HCl	pH 2.0	pH 7.0	pH 11	R_f 1-Butanol-H_2O Isolated	Known
Inosine	250:260	*i*	1.22	1.58	1.42	1.08		
		k	1.20	1.51	1.45	1.14		
	280:260	*i*	0.10	0.29	0.37	0.28	0.16	0.15
		k	0.21	0.28	0.36	0.25		
	290:260	*i*	0.03	0.11	0.12	0.13		
		k	0.10	0.10	0.19	0.13		
Hypoxanthine	250:260	*i*	1.46	1.36	1.11	0.88		
		k	1.48	1.52	1.33	0.91		
	280:260	*i*	0.01	0.19	0.22	0.21		
		k	0	0.14	0.19	0.16	0.39	0.38
	290:260	*i*	0	0.08	0.13	0.11		
		k	0	0.05	0.11	0.08		

i = Isolated.
k = Known.

acteristics changed so that the desired fraction was no longer retained. This occurred, although the roll of casing was left in a moisture-proof bag and placed in a refrigerator. The molecular weight of the fraction desired is apparently such that a slight increase in the pore size of the casing prevents its retention. Efforts are being made to standardize this phase of the procedure for isolation of fraction Aa_2.

Since all of these compounds can be readily obtained, including the glycoprotein which is easily isolable, it would therefore seem likely that this mixture could be applied to any food material, or meat, prior to cooking to impart a meat flavor, or to enhance the natural flavor of meat. It would also seem likely that a mixture of these precursors could be injected into the blood stream of meat animals just prior to slaughter to enhance the meat flavor as well as to ensure a constant flavor quality.

Conclusions

Some of the precursors of meat (beef) flavor have been found to be a relatively simple mixture of glucose, inosinic acid, and a glycoprotein. While the quantitative relationships among these compounds have not been established, variations in meaty flavor or odor produced on heating in fat or water have been observed when the composition of mixtures of these compounds is varied.

When mixtures of amino acids, found as components of the glycoprotein, are used in conjunction with glucose, inosine, and inorganic phosphate, meaty odors and flavors are also produced upon heating in fat or water. It may therefore be surmised that only certain of the amino acids in the glycoprotein are necessary precursors of meat flavor.

Acknowledgment

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FAT FLAVOR

Effect of Free Fatty Acid on Flavor of Fat

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Since rancid flavor of highly saturated, low molecular weight fats, such as butter and coconut oil, has been associated with liberation of fatty acids, hydrolysis generally is regarded with disfavor in all edible fats. Yet, in three separate projects of widely different nature, the initial development of free fatty acid has been attended by increased flavor scores for the fat. This relation was observed with fat acidity developed in vivo by nutritional depletion and by feeding wheat to pigs, and in deep-fat frying of potatoes.

Nutritional Depletion in Hogs

When heavy hogs were hauled 50 miles before slaughter and rested for 16 hours without feed, the raw back fat in many cases had higher acid numbers than those found in fed animals, or hogs rested for shorter periods (*1*). The fats with higher acid numbers rated higher flavor scores.

To test the extent of this relation, a scattergram of raw-fat acid numbers was plotted against flavor scores for the cooked fat from all fresh samples from all lots pertaining to feed and rest (Figure 1). Broken lines were drawn parallel to the axes so as to extend the left and upper boundaries of the unoccupied area *D* as far as possible. The absence of points in this area indicated that none of the acid numbers above 0.35 was associated with flavor scores below 6.0. Highest possible score was 7. Acid numbers were milligrams of KOH per gram of fat. With lower acid numbers in areas *A* and *B*, flavor scores ran from lowest to highest, and obviously no relation to acidity

Initial increases in free fatty acid in back fat attending in vivo modulation of metabolic processes in hogs were related to rise in desirability of flavor of the cooked fat. This relation was reversed with increased acidity brought about by post-mortem autolysis. Flavor of French fried potatoes improved as the acidity of the frying fat increased with repeated use until the acid number reached approximately 5.5. Thereafter, this relation reversed as the acidity continued to rise.

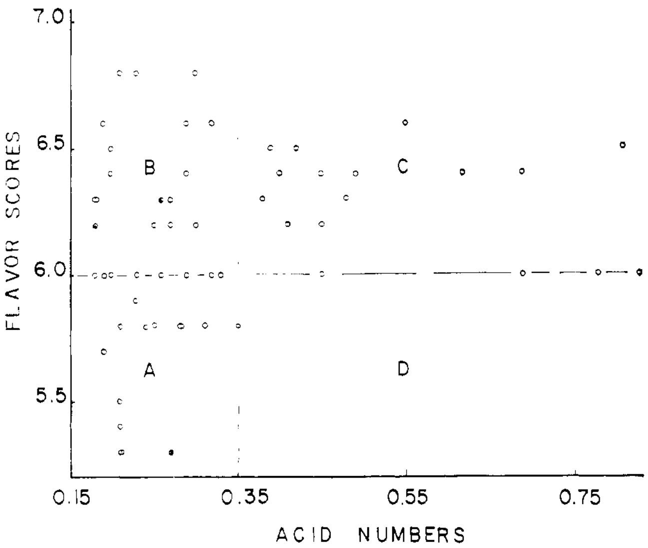

Figure 1. Scattergram showing relation between acid numbers in fresh raw back fat and flavor of cooked fat from hogs in various states of nutritional depletion

Distribution of points: *A*, 25%; *B*, 45%; *C*, 30%; *D*, 0%

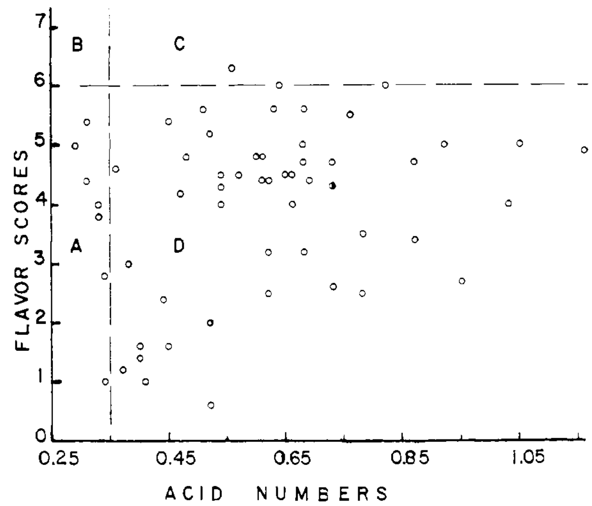

Figure 2. Scattergram showing relation between acid numbers in raw fat frozen, stored for 24 weeks and flavor of cooked fat; same carcasses used as for Figure 1

Distribution of points: *A*, 14%; *B*, 0%; *C*, 5%; *D*, 81%
Area boundaries located as in Figure 1

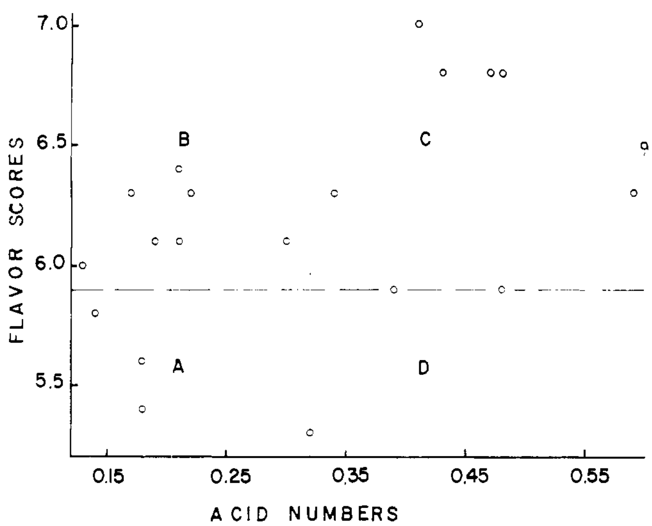

Figure 3. Scattergram showing relation between acid numbers in fresh raw back fat and flavor of cooked fat from hogs on various grain rations

Distribution of points: *A*, 20%; *B*, 35%; *C*, 45%; *D*, 0%

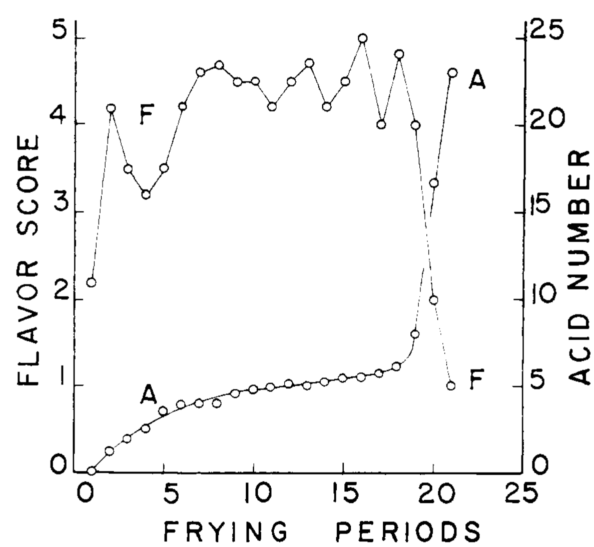

Figure 4. Relation of flavor scores of French fried potatoes to acid numbers of frying fat used repeatedly

Score range: 5, superior; 1, unacceptable
A Acid numbers
F Flavor scores

existed. With 30% of all points in area *C*, it appeared that free fatty acid did not prevent high flavor score.

Since ammonia and a trace of methylamine have been found by Hornstein, Crowe, and Sulzbacher (*3*) in the volatile constituents of heated, dry beef, it seems reasonable to expect that similar material may appear in roasted pork. The material having the desirable meaty aroma was reported to be in the high-boiling fraction, which would eliminate ammonia and the lower aliphatic amines. These basic volatiles more likely detract from the desirability of flavor and aroma, and would be more strongly retained in fat tissue having more free fatty acid. Not only would their volatility be reduced, but their flavor as salts would be altered, thereby affecting the flavor and aroma of the fat.

The direct effect of the free fatty acids themselves on flavor and aroma would depend on the kind of acids liberated. The metabolic liberation of fatty acids to supply energy in the depleted live pig may produce a pattern of acids different from that produced by autolysis in post-mortem fat. Relation of fat acidity to depletion was evident from the following observation. In the 14 back fat samples having acid numbers above 0.40, the liver glycogen values in milligrams per gram were distributed as follows: 7 at 2 or lower; 2 at 4 to 8; 3 at 12; and 2 at 25. In the 16 samples having acid numbers below 0.25, the liver glycogen values were: 13 at 41 to 97; 1 at 28; and 2 at 12 to 14.

A scattergram for fat flavor and acid numbers after a 24-week frozen storage (Figure 2) gave a strikingly different pattern from that shown in Figure 1. At that time, traces of peroxide had appeared in only four samples, but the flavor had deteriorated so far that 81% of the points were located in the region comparable to area *D* (Figure 1). Free fatty acid had increased 50 to 100% in most samples. Many acid numbers were still below the high values found in fresh samples, but corresponding flavor scores had dropped as much as 5 points in a total range of 7. Therefore, it was evident that relation of free fatty acid to flavor was not dependent on quantity alone.

Wheat Ration for Hogs

In a project on relation of pork quality to ration based respectively on soybeans, corn, sorghum grain, and wheat, acidity of back fat varied with the ration (*2*). Average acid numbers for back fat with ration were: soybean, 0.15; sorghum grain, 0.21; corn, 0.38; and wheat, 0.50. A scattergram of fat flavor scores *vs.* acid numbers is shown in Figure 3 and is treated as in Figure 1.

The distribution of points is similar in the two diagrams. The boundaries of the two blank areas, *D*, intersected within 0.1 score unit and 0.03 acid unit of each other. All but one of the soybean points fell in area *A*. All of the sorghum grain points fell in area *B*. All of the wheat points fell in area *C*. The corn points were distributed among areas *A*, *B*, and *C*. Fat flavor scores for the wheat ration average 6.7; sorghum grain, 6.2; corn, 5.9; and soybean, 5.7. (Highest possible score, 7.) Lean flavor for wheat ration was also highest, 6.9, and lowest for soybeans, 5.4.

The variation in fat acidity in this case attended a variation in feed rather than in stress and depletion, as in the previous case. Nevertheless in both cases, the acid changes were brought about by normal in vivo metabolic processes and were attended by similar flavor responses. In this case, as in the previous one, post-mortem changes in the stored fat were attended by increase in acidity and lower flavor scores. However, flavor of fat from wheat ration maintained its superior position over those from other rations during storage.

Deep-fat Frying

In a third project, variation in fat acidity was brought about by external treatment, not metabolic and not autolytic (*4*). The flavor of French fried potatoes prepared in fresh, neutral, hydrogenated vegetable fat was scored only average. But with repeated use of the fat, the flavor score of the potatoes and acidity of the fat increased simultaneously. The flavor reached a maximum (superior) rating when the acid number of the fat reached approximately 5.5 with 16 frying periods of the same fat (Figure 4). Each frying period included the following conditions: 3 hours of preheating at 93° C., one quarter hour to raise to 185° C., 2 hours at 185° C., and $2^3/_4$ hours at 93° C. Thereafter occurred a rapid increase in fat acidity and a rapid decline in desirability of potato flavor with repeated use of the frying fat.

Reactions, other than hydrolysis, probably occurred in the fat as indicated by the deepening color of the fat and fading color of the potatoes, which may have affected the flavor. But significantly, an increase in flavor score was at least coincidental with, and not inhibited by, an increase in free fatty acid up to a certain point. It would not be justifiable to assume that this point of acidity was the same in the fat absorbed by the potato as it was in the frying fat. The potato slice is essentially an aqueous system, and may be expected to adsorb preferentially the free fatty acid molecules through their hydrophyllic free carboxyl groups. This behavior would tend to increase the percentage of free fatty acid in the fat held by the potato even above that in the frying fat.

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LEMON OIL COMPOSITION

Isolation and Identification of Aldehydes in Cold-Pressed Lemon Oil

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It is generally assumed that aldehydes are responsible for the characteristic aroma of lemon oil. The part played by individual aldehydes in this respect is not well established, although it is generally recognized that citral is the most important component contributing to the aroma of lemon oil. One of the objective measures of the quality of lemon oil is the determination of the total aldehyde content calculated as citral. However, the nature and relative amounts of individual aldehydes must be determined before any correlation can be made between organoleptic properties and composition. Recently, a specific method of analysis for citral was developed (*15*), and analyses of citral and total aldehyde content of lemon oils have shown notable variations in the ratios of citral to total aldehydes (*16*). These ratios were found to vary from 0.60 to 0.80. Changes in individual aldehydes other than citral have not been determined because specific methods of analysis were not available. This investigation was made to isolate and identify individual aldehydes in lemon oils as a basis for further studies on changes in their composition or amounts as related to changes in organoleptic and other quality factors.

Poore (*12*) reported the presence of