tion or from distillation with steam, in such amounts that the tests, quantitatively applied, can serve easily to distinguish between products to which it has, and those to which it has not been added (Nos. 2, 10 and 13, and Nos. 1, 4, 7 and 12). From these acidified formaldehyde solutions, the formaldehyde comes off most copiously in the first fractions. When not acidified this is less marked and the total recovery is less in the same total volume of distillate (cf. Nos. 3 and 9). When made alkaline with NaOH, as we did in some preliminary trials, the tendency to hold back formaldehyde in the sugar solution was many fold greater.

Coming now to the main question which concerned us, *viz.*, Does formaldehyde added to juice in the sugar-house all boil away or does it persist in any final salable products? we seek the answer in tests Nos. 14 to 17.

Runs 5 and 6 were made at the small mill of the Louisiana Sugar Experiment Station, the former without the addition of any formaldehyde either in that or the immediately preceding run, and the latter with the addition of formaldehyde to the fresh juice in the proportion of about 1 part of formalin (40 per cent. sol. of formaldehyde) to 160,000 parts of juice, or 25 parts CH_2O to a million. The clarification in each run was as usual with sulphurous acid, followed by liming back almost to neutrality. The concentration was accomplished as usual with reduced pressure in the "effects" and vacuum pan. The sugars used in these experiments (Nos. 14 and 15) are the first sugars, testing about 96 per cent., and the molasses samples (Nos. 16 and 17) are of the first molasses in each case, testing about 43 per cent. sucrose and 58 purity. In the distillation with superheated steam and the formaldehyde determination in these samples, carried out as above described, a peculiar condition developed which was not noted in the previous samples with pure sugar solutions. The first one, or two fractions of the distillate, were slightly cloudy, and these same fractions, which should have been highest in formaldehyde, gave no reaction, or only very weak ones for that substance. This leads us to suspect that our test in these cases does not show the total quantities of formaldehyde present. Suspecting that the interfering substance may be sulphurous acid, or possibly other sulphur compounds, tests were made and it was found that the addition of sodium sulphite strongly interfered, that sodium thiosulphate completely prevented the color development, and that hydrogen sulphide but slightly affected the intensity of the reaction. Notwithstanding these probable shortages in the total formaldehyde recovered, we still find evidence of an excess of formaldehyde in the products from juice to which it had been added, very small in the case of the 1st sugar, but more pronounced in the case of

the 1st molasses. In the 1st sugar it amounts to 12.8 parts CH_2O per million as against 9.5 parts per million in 1st sugar from juice without added formaldehyde, or an excess of 3.3 parts per million. In the first molasses it amounts to 31.2 parts per million as against 6.1 parts per million in 1st molasses from juice without added formaldehyde, or an excess of 25.1 parts per million. The molasses is thus found to be as strongly charged with this excess of formaldehyde as was the juice from which it was made. Assuming that the yields of 1st sugar and 1st molasses are 9.5 per cent. and 6 per cent., respectively, of the juice, then the amounts of formaldehyde retained by them are about 1.2 per cent. and 6 per cent., respectively, of that added to the juice, or a total of 7.2 per cent., which, as far as these tests show, was not boiled away. It is probable, as pointed out above, that these tests show only part of that actually retained. The small quantity left in this 96 per cent. sugar may justify the conclusion that in refining the sugar this excess is all eliminated.

If the sugar is the only product used for food, then there need be no hesitation, on the score of health considerations, in using formaldehyde as a preservative in juice in the sugar mill. If, however, the molasses is also to be used for food, or if table syrup is to be manufactured, then the question of the permissibility of its use may reasonably be raised. To this question we deem the data now at hand to be insufficient basis for a definite answer. We should have the results from further tests of final and of intermediate products. We should develop a method to circumvent the interference of sulphurous acid or other substances in the distillates, in the formaldehyde determination. We should make comparative tests also with syrup or molasses and sugar made by the open kettle method of boiling, with and without formaldehyde. We should, moreover, know in what form or combination the formaldehyde is held back in these sugar solutions, and whether it is deleterious to health in this form or combination.

SOME EFFECTS OF FEEDS UPON THE PROPERTIES OF LARD.

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It is well known that in the feeding of hogs different feeds produce varying effects upon the carcasses of the animals and upon the characteristics of the fats produced.

The Department of Animal Industry of the Alabama Polytechnic Institute has through a series of years made extended experiments in pork production, particularly from an economic standpoint.

Working in coöperation with that department, there have been encountered lards which show interesting effects of the feeds used in their production.

The following is a preliminary account of the investigation undertaken to point out some changes in properties so brought about.

Among the available pork producing feeds some of the most important economically are corn, peanuts, soy beans, cottonseed-meal and tankage, the three last being relatively rare as constituents of rations for hogs.

The results here given were secured on lards resulting from three series of feeding experiments in each of which series these feeds were used.

In the first series of experiments examination was made of lards from thirty-six hogs.

The pigs in this series were divided into six lots and the feeding so conducted as to show the effect upon the lards of corn, cottonseed-meal, tankage, soy beans and peanuts. The lots were further subdivided so as to show the effect of corn following peanuts, of cottonseed-meal following peanuts, and of tankage following soy beans and peanuts.

In the second feeding trials results were again obtained on thirty-six pigs—the feeding in this series being intended to show the effects of, 1st corn, 2nd cottonseed-meal, 3rd tankage, 4th soy beans with varying rations of corn, 5th soy beans and peanuts, 6th soy beans and peanuts with a finishing ration of corn, 7th soy beans and peanuts with a finishing ration of corn and cottonseed-meal, 8th soy beans and peanuts with a finishing ration of corn and tankage.

The third experiment included twenty-three pigs and data were secured illustrating the effects of, 1st, corn; 2nd, tankage, 3rd, cottonseed-meal; 4th, soy beans with varying amounts of corn; 5th, soy beans with a finishing ration of corn; 6th, soy beans with a finishing ration of corn and cottonseed-meal; and 7th, soy beans with a finishing ration of corn and tankage.

Corn being the universal hog feed, one corn-fed lot was carried in each series as a basis of comparison—the corn lards being used as standards.

In every series of experiments the feeding of each lot was so conducted and the slaughtering so regulated in point of time that the full effect of the ration might be observed. Thus, in the corn-fed lot of series No. 1 the pigs were slaughtered at intervals—the first at the end of thirty-five days and the last at the end of one hundred and forty-seven days.

Slaughtering one pig from each lot at stated intervals furnished lards on which comparable results could be secured from all pigs in the different lots as well as in the same lot.

The period of feeding in days for each pig is indicated in the tables.

The rations of corn, cottonseed-meal and tankage were fed soaked.

The pigs were made to graze the soy beans and peanuts.

All pigs in each series entered the feeding trials at a fairly uniform age and weight.

All lards were rendered from the kidney fat and thus represent uniformly the firmest fat obtainable from the pig.

Since the melting points and iodine values of lards are more notably affected by feeds than are the other characteristics, and at the same time probably furnish a more accurate index to the qualities of lards than do the other constants, these values were selected as giving a sufficient showing of the changes produced.

In Table I are found results on lards from hogs which had been fed on corn for periods varying from 35 to 150 days. The results include lards from three feeding trials.

The lards in series 2, with the exception of those numbered 61, 42, 53, 15, 23, and 34, had become slightly rancid when the iodine values were determined, but it is not thought that the oxidation had proceeded so far as to seriously affect those values.

TABLE I.

No. days fed.	No. of pig.	Melting point.	Iodine value.	Series.	Ration.
63	101	43.5	53.87	1	Cornmeal
91	103	43.4	58.68		
119	106	44.2	57.60		
140	105	41.6	57.37		
147	104	40.5	57.10		
		Av.,	56.92		
35	72	43.1	56.50	2	Cornmeal
70	71	44.8	51.50		
84	73	44.0	49.70		
112	75	43.0	56.00		
134	74	....	56.57		
		Av.,	54.05		
75	69		64.79	3	Cornmeal
110	36	....	63.07		
125	42	....	60.04		
150	8	....	60.07		
		Av.,	61.98		
		Average,	57.35		

Examination of these figures seems to show that corn as fed in these trials has not the effect of softening pork to the extent indicated by results secured by some investigators, notably those of Shutt¹

On the other hand, the iodine values are somewhat below the average value of that constant for lards—this being particularly true of the lards in series 2, which gave an average iodine value of only 54.05. Not only do the melting points and iodine values indicate relatively firm lards throughout but the pigs which were fed corn continuously for a period of five months show no greater degree of softness than those fed for shorter periods on this ration.

In fact, the pigs in series 3 show an increasing firmness in the fat, though this may be attributed to the increasing age of the animal.

Table II shows the effect upon the two constants under consideration of a ration containing much cottonseed-meal.

¹ Canada Cent. Ex. Sta., Bull. 38.

TABLE II.

No. of days fed.	No. of pig.	Melting point.	Iodine value.	Series.	Ration.
35	112	47.7	61.00	1	Cornmeal 2/3, cotton- seed-meal 1/3.
63	109	49.8	53.57		
91	111	49.3	53.57		
119	110	48.3	57.58		
140	108	50.0	55.16		
147	107	46.8	55.95	2	
35	61	49.2	48.44		
70	65	50.8	51.20		
84	64	50.0	51.60		
112	62	49.6	50.22		

Average, 53.80

This mixture contains a very little more oil than the corn ration but constitutes a much higher protein ration. It will be observed that the melting points are materially elevated, while the iodine values suffer a corresponding depression.

This tendency has been often observed in this as well as in other rations where the protein content has been increased—*e. g.*, corn and skim-milk, and is even more apparent in a ration containing much smaller amounts of cottonseed meal than the above.

Table III gives results on lards produced by a ration consisting of corn 9/10 and cottonseed-meal 1/10.

TABLE III.

No. of days fed.	No. of pig.	Melting point.	Iodine value.	Series.	Ration.
70	45	48.6	53.80	2	Cornmeal 9/10, cotton- seed-meal 1/10.
84	41	48.4	50.60		
112	44	47.6	55.0		
134	40	49.0	52.0		
99	42	49.7	41.85		
75	39		49.23	3	

Average, 52.13

Here we find the results on iodine values lower than where a more concentrated cottonseed-meal ration was fed. It is, however, probable that with results on a larger number of lards from this ration more comparable figures would be secured, as there is no apparent explanation of this slight difference in properties.

In order to test further the effects of a feed containing more protein than corn, one lot of pigs in each series was fed a mixture consisting of corn 9/10 and tankage 1/10. Table IV gives analytical results on the lards produced.

TABLE IV.

No. of days fed.	No. of pig.	Melting point.	Iodine value.	Series.	Ration.
35	131	43.1	59.08	1	Cornmeal 9/10 Tankage 1/10
63	132	45.6	50.06		
91	136	42.5	56.59		
119	135	41.6	57.80		
140	133	45.1	57.77		
35	53		49.85	2	
70	54	43.0	56.80		
84	51	42.9	56.53		
112	52	....	56.53		
91	50	42.2	52.40		
91	55	41.4	58.80	3	Same
75	1	....	57.02		
110	43	....	61.25		
125	37	....	52.26		
150	2	....	53.61		

Average, 55.67

The figures in this table again seem to indicate that the introduction of a high protein feed into the ration produces an elevation of the melting point and depression of the iodine value of lards. While the effect upon these two constants is not so pronounced as in the case of cottonseed-meal they are nevertheless significant and would seem to point to the presumption that the changes in properties brought about in fats by cottonseed meal are, at least in part, due to the protein content of that feed.

For purposes of comparison, the averages on all lards produced from the four rations so far discussed are presented in Table V:

TABLE V.

Ration.	Iodine value.	Average of
Cornmeal.....	57.35	14 lards
Cornmeal 2/3 } Cottonseed-meal 1/3 }	53.83	10 lards
Cornmeal 9/10 } Cottonseed-meal 1/10 }	52.13	5 lards
Cornmeal 9/10 } Tankage 1/10 }	55.67	15 lards

The increasing use of soy beans as a hog feed makes necessary the determination of the effect of this ration upon the finished product and a study of rations which may be suited to finishing hogs which have been fattened thereon.

Table VI gives figures obtained on lards from pigs grazed on soy beans and at the same time fed part rations of cornmeal:

Table VI.

No. of days fed.	No. of pig.	Melting point.	Iodine value.	Series.	Ration.
35	34	33.6?	100.5	2	Soy beans and 1/4 ration of corn
75	76	?	94.86	3	
35	125	41.8	71.09	1	Soy beans and 1/2 ration of corn
35	23	40.0	80.60	2	
75	87	?	82.70	3	Soy beans and 3/4 ration of corn
35	15	40.7	79.0	2	
75	68	?	84.32	3	

Average, 84.72

Representing as these values do results on lards the firmest obtainable from the pigs—that rendered from the kidney fat—they illustrate the very great softening effect of this feed upon the fat.

Some of the lards in this lot remain semi-fluid throughout the winter months and are too soft for melting point determinations.

Whether the softness is due solely to the oil in the feed or in part to the fact that it is grazed as a green feed has not yet been determined. It is probable, however, that both factors influence the properties of the lard. This would be in keeping with Shutt's results on pigs grazed on clover. Further, his observations that certain other green crops, as turnips and sugar beets, have no softening effect upon lards are confirmed by data secured in this laboratory from pigs grazed on sorghum.

This leads to the suggestion of the possibility that

the legumes when fed green to hogs have a softening effect upon the fat.

While the soy bean feed is high in oil content, it is also relatively high in protein. The results therefore in a measure contradict the assumption that protein in the feed induces hardness in the fat. This further suggests the question whether the protein molecule in this feed breaks down into cleavage products differing from those formed by cleavage of the protein molecule of corn and tankage and, in turn, produces radically different effects upon the fat.

In order to determine the persistence of the softness of fat produced by soy beans, three different finishing rations were employed: corn, cottonseed-meal and tankage.

Table VII illustrates the effect of corn in hardening the fat:

TABLE VII.

Ration—Soy bean grazing and 1/4 ration of corn followed by corn.

No. of days fed soy beans.	No. of pig.	Iodine value.	Series.	Finishing ration.
75	76	94.86	3	Corn 35 days Corn 50 days Corn 75 days
75	98	83.92		
75	88	69.77		
75	7	70.31		
Average of corn-fed lot in this series		61.98		

The limited number of pigs in this lot renders the results none the less valuable, inasmuch as they are fully confirmed by the figures in Table XI, which show the effect of corn following soy beans and peanuts.

Although these results show that corn produces a marked hardening effect, yet a comparison of the iodine values on numbers 88 and 7 with the average value of the corn-fed lot of this series, indicates that the properties conferred by the soy bean ration have in some measure persisted even after a period of 75 days' feeding on corn.

Some difficulty was experienced in testing the hardening effect of cottonseed-meal as in this series nearly all pigs on a ration of this feed died of cottonseed-meal poisoning.

However, two cottonseed-meal pigs in this trial made good growth and Table VIII sets forth the results secured on these:

TABLE VIII.

Preliminary ration soy bean grazing and 1/2 ration of corn.

No. of days fed soy beans.	No. of pig.	Iodine value.	Series.	Finishing ration.
75	87	82.70	3	Cornmeal 2/3 Cottonseed-meal 1/3 for 35 days
75	88	73.41		
75	56	65.46		Cornmeal 2/3 Cottonseed-meal 1/3 for 50 days
Average of corn lards of this series,		61.98		

The effect of the cottonseed-meal ration is what

was expected and the hardening effect would possibly have been greater could the time of feeding cottonseed-meal have been extended.

The softness induced by the soy bean ration is somewhat in evidence after 50 days' feeding on cottonseed-meal.

The effect of tankage, the third finishing ration used in these experiments, is set out in Table IX:

TABLE IX.

Preliminary ration—Soy bean grazing and a 3/4 ration of corn.

No. of days fed soy beans.	No. of pig.	Iodine value.	Series.	Finishing ration.
75	68	84.32	3	Cornmeal 2/3 Tankage 1/3 for 35 days
75	57	68.83		
75	66	72.67		Cornmeal 2/3 Tankage 1/3 for 50 days
75	77	74.0		Same 75 days
Average values corn lards,		61.98		

Here again there is illustrated the pronounced hardening effect of a high protein ration.

For some unexplained cause the hardening effect in this trial with tankage seems to be greatest at the end of 35 days' feeding period and the lards to increase in softness for longer periods of feeding. This is probably due to individual peculiarities of the pigs. There still appears a persistence of the properties originally contributed by soy beans.

A study was also made of the persistence of the properties conferred upon lards by a ration of soy beans followed by peanut grazing.

There is first given in Table X values obtained from pigs slaughtered off peanuts following soy beans:

TABLE X.

Ration—Soy bean grazing followed by peanut grazing.

No. of days fed soy beans.	No. of pig.	Melting point.	Iodine value.	Series.	Finishing ration.
35	127	40.6	79.61	1	Peanuts 28 days
35	25	31.2?	89.84	2	Peanuts and 1/2 ration corn 35 days
35	14	37.0	76.94	2	Same
35	33	?	89.70	2	Same
Average,			84.02		

A comparison of these lards with those from the soy bean fed pigs, as shown in Table VI, demonstrates that while the average results of the two sets are practically the same, yet some of the individual soy bean lards are very materially softer than the softest of this lot, and that as between soy beans and peanuts the former has probably the greater softening effect.

In efforts to harden the fat of the pigs fed upon both soy beans and peanuts, use was again made of corn, cottonseed-meal and tankage.

The effect of corn is shown in Table XI:

TABLE XI.

Ration—Soy beans followed by peanuts followed by corn.

No. days fed soy beans and peanuts.	No. of pig.	Melting point.	Iodine value.	Series.	Finishing ration.
70	14	37.0	76.94	2	
70	10	36.9	82.80	2	Corn 14 days
70	12	36.8	73.93	2	Corn 42 days
70	11	39.0	70.1	2	Corn 64 days

There is found here a confirmation of the results recorded in Table VII, which illustrate the hardening effect of corn as well as the difficulty of hardening the fats to a normal firmness—using the corn lards as standard.

The effect of the corn is progressive and is greatest as in Table VII during the first forty to fifty days.

Still further confirmatory results on the effect of corn were secured from a third trial with four pigs. The results are recorded in Table XII:

TABLE XII.

Ration—Sorghum and 1/2 corn 35 days. Peanuts and 1/2 corn 28 days (preliminary).

No. days fed preliminary ration.	No. of pig.	Melting point.	Iodine value.	Series.	Finishing ration.
63	113	40.8	70.08	1	
63	116	41.8	62.15	1	Corn 28 days
63	117	42.3	60.67	1	Corn 56 days
63	118	42.7	60.60	1	Corn 77 days

In Table XIII are given results secured on the soy bean peanut pigs, finished on a ration of $\frac{2}{3}$ corn and $\frac{1}{3}$ cottonseed-meal.

TABLE XIII.

Days fed soy beans and peanuts.	No. of pig.	Melting point.	Iodine value.	Series.	Finishing ration.
70	25	31.2	89.84	1	
70	22	42.4	76.1	2	$\frac{2}{3}$ corn and $\frac{1}{3}$ Cottonseed-meal for 42 days
70	21	41.5	79.22	2	Same for 64 days

These results are not so striking as those found in Table VIII, but the one set is confirmatory of the other. Cottonseed-meal in the ration exercises its usual function of firming the fat.

The lot in this series finished on tankage puts this feed in a most favorable light as a finishing ration, as will be observed by inspection of the figures in the following table:

TABLE XIV.

Preliminary ration—Soy beans 35 days followed by peanuts 35 days.

No. days fed soy beans and peanuts.	No. of pig.	Melting point.	Iodine value.	Series.	Finishing ration.
70	33	....	89.70	2	
70	35	39	74.35	2	Corn and $\frac{1}{3}$ tankage 42 days
70	31	41.0	70.65	2	
63	127	40.6	79.61	1	Corn and $\frac{1}{6}$ tankage 28 days
63	126	41.9	66.40	1	
63	130	42.9	64.69	1	Same 77 days

While, as before stated, these results point to tankage as a desirable ration for hardening the fat of soft hogs yet, on considering them in connection

with the results in Table IX, it is seen that confirmatory feeding trials are necessary before the results in Table XIV can be accepted.

Tankage, however, is free from the toxic effect which renders cottonseed-meal a dangerous hog feed and the data secured are sufficient to emphasize its value as a finishing ration. The results too show that it compares favorably with cottonseed-meal in its hardening effect on the fats. This, however, is not verified by examination of the carcasses nor by the results on pigs fed these rations without a prior softening ration—see Table V—and further comparative feeding trials are in progress.

Below is given a further comparison of lards from the two feeds:

TABLE XV.

Preliminary ration—Soy beans 35 days. Peanuts 35 days. Corn 14 days

Days fed soy beans, peanuts and corn.	No. of pig.	Melting point.	Iodine value.	Series.	Finishing ration.
84	32	36.9	82.80	2	
84	10	39.2	71.60	2	Corn $\frac{2}{3}$, tankage $\frac{1}{3}$ for 14 days.
84	20	44.4	71.80	2	Corn $\frac{2}{3}$, Cottonseed-meal $\frac{1}{3}$ for 14 days.

The results on this lot of three pigs but serve to further confirm results recorded in the foregoing tables illustrative of favorable changes produced in the properties of lards by these two rations.

Summarizing the results, it is found that corn may be fed without regard to time limit in so far as concerns any unfavorable effect on the properties of the lard.

Soy beans and peanuts both produce oiliness in the hogs and the lards resulting are extremely soft.

The fat of oily hogs can be hardened by rations of corn, cottonseed-meal or tankage—the two latter producing unusually firm lards.

The possibility is suggested that legumes when fed green may produce soft fats.

In connection with the general subject here discussed, there are presented below results which accentuate the extreme differences in properties which may be conferred upon lards by different feeds:

No. of pig.	Melting point.	Iodine value.	Iodine value of liquid fatty acids.	Saponification value.
34	?	100.5	119	197.5
100	48.2	40.35	78	203.2

Pig No. 34 is selected from the soy bean fed lot.

No. 100 was fed throughout its life on slaughter pen refuse and weighed about 200 pounds when slaughtered.

This lard presents much the appearance of beef tallow and its constants possess much the same value as those of beef fat. It further responds readily to the Belfield test for beef fat.