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A. B. CONNER, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

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DIVISION OF POULTRY HUSBANDRY

The Effect of Cottonseed Meal and Other Feeds on the Storage Quality of Eggs

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
T. O. WALTON, President

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**In cooperation with U. S. Department of Agriculture.

†As of July 1, 1931.

In a study during 1928, 1929, and 1930 to determine the effect of various food materials on the storage quality of eggs, it was found that a number of these materals, when used in feeds for laying hens caused the eggs to deteriorate in storage. Hens receiving daily 2 to 12 grams of cottonseed meal, laid eggs in which the percentage of seconds and discards ranged from 8 to 97 per cent, after about 8 months in storage. Hens which received mash mixtures containing 9 to 30 per cent of cottonseed meal laid eggs in which the loss in storage ranged from 57 to 95 per cent. The yolks of the eggs became discolored and in many cases they absorbed material from the white; in some cases the whites of the eggs became discolored also. For that reason the Texas Station is no longer recommending the use of cottonseed meal for laying hens during the seasons when eggs are being put in storage.

In the case of eggs that were broken out and stored in a frozen condition for a period of five months, the mixed yolk and white of those laid by hens fed cottonseed meal became much darker in color than did those laid by hens fed no cottonseed meal but otherwise handled in a similar way.

The substance in cottonseed meal that causes eggs to deteriorate in storage is probably something closely associated with the cottonseed oil. The feeding of extracted cottonseed meal which contained a very small amount of oil caused practically no loss of eggs in storage, while the eggs from hens fed one gram daily of either crude cottonseed oil or partially refined cottonseed oil deteriorated in storage. Feeding the soap stock which is secured in partially refining crude cottonseed oil with sodium hydroxide and which contains a large percentage of the impurities and coloring matter of the crude oil, did not cause losses in storage. The eggs laid by hens which were fed refined cottonseed oil (Wesson oil), did not deteriorate in storage. This suggests that the later processes used to manufacture this highly refined oil remove or change the substance that injures the storage quality of the eggs.

Results indicate that the feeding of one gram daily of cod liver oil, which is the equivalent of about 2 to 3 per cent in a mash mixture, causes no injurious effect on the storage quality of eggs.

Studies were also made on the effect of raw linseed oil, linseed meal, and soybean meal on the storage quality of eggs, but further experimentation is needed to determine whether they have any injurious effect.

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BULLETIN NO. 429 JULY, 1931

THE EFFECT OF COTTONSEED MEAL AND OTHER FEEDS ON THE STORAGE QUALITY OF EGGS

ROSS M. SHERWOOD

Experiments have been conducted at the Texas Station for a number of years on cottonseed meal as a feed for laying hens. The cottonseed meal used in these studies was 43 per cent protein cottonseed meal, prime quality, unless otherwise stated. The meat and bone scraps used was 50 per cent protein meat and bone scraps. No serious discoloration of yolk or white of the eggs, when freshly laid, resulted from the combinations of feeds used at the Texas Station, and from correspondence it was learned that this was true at the Oklahoma, Missouri, Indiana, Ohio, and Alabama Stations. The Texas Station did not use over thirty-two pounds of cottonseed meal in one hundred pounds of mash.

Thompson (1) reported cottonseed meal spots on the yolks of eggs from hens but none on the yolks of the eggs from pullets. Later the New Mexico Station (2) reported as follows: "The pen which received 38 per cent of cottonseed meal in the mash, produced eggs which were so badly affected by the cottonseed meal spots as to be unmarketable. The yolk of these eggs turned black in color, as the eggs were kept for a few days, so that when a week old the yolk was almost entirely black." It is noted that 38 per cent of the mash was cottonseed meal. The following description of this cottonseed meal was secured by correspondence with Mr. Berry of the New Mexico Station: "The meal is prime and carries a guaranteed analysis of 43 per cent protein. It has a bright greenish-yellow color, and is different from any that I have seen elsewhere in this respect. It is practically all Acala cotton and is grown under irrigation."

In the spring of 1926, Sherwood (3) found that the yolks and whites of eggs laid by hens fed cottonseed meal did not hold their color in cold storage. The yolks of the storage eggs ranged from salmon to dark green, or almost black in color, and the whites varied from normal color to pink. No bacteriological decomposition was evident and no abnormal odor was detected.

Later Sherwood (4) reported that the eggs laid by hens which received a mash containing 20 or 32 per cent of cottonseed meal, or an "all mash" feed containing 9 per cent or more of cottonseed meal, did not store well; the loss due to discolored yolks and whites of these eggs was very heavy.

Walker, Berry, and Anderson (5) reported that hens receiving a mash containing 5 per cent or more of cottonseed meal, produced eggs that did not hold up in storge.

Kempster (6) reported that hens receiving a mash containing 30 per cent of cottonseed meal laid eggs that did not store well. He reported a heavier loss from eggs laid in July than from eggs laid in April. Kempster (6) also reported a small loss from eggs laid in July by hens being fed a mash containing 30 per cent of soybean meal, and a rather significant loss from eggs produced in July by hens fed a mash containing 30 per cent of ground soybeans. The soybean meal contained 7.4 per cent of fat and the ground soybeans contained 17.5 per cent of fat. This would suggest that either soybean oil or something closely associated with the soybean oil is injurious to the storage quality of eggs.

Sipe (7) stated that when large quantities of cottonseed meal are fed to hens, the eggs produced by them develop green or olive yolks when in storage. Quoting from him concerning a test in 1929 as follows: "The results of this test showed no olive-colored yolks when 4 per cent of the mash ration was composed of cottonseed meal; 33 per cent olive-colored yolks when 10 per cent of cottonseed meal was used; and 70 per cent olive-colored yolks when 26 per cent of cottonseed meal was used in the ration."

Upp (8) reported the storage of one case of eggs laid by hens receiving an all-mash feed containing 17 per cent of cottonseed meal in which the loss in storage was very light.

Thompson (9) reported that 7 per cent of cottonseed meal in a laying mash produces an egg that is excellent for storage purposes. "Thirty-three and one-third per cent of cottonseed meal in a laying mash produces an egg that develops an olive-green yolk when placed in storage. Discoloration of the yolk will show without being placed in storage. The maximum amount of cottonseed meal it is possible to feed without producing olive yolk eggs has not been determined."

METHOD OF WORK

Stock and Methods of Feeding: Single Comb White Leghorn fowls were used in all of these studies. In each of the experiments all of the hens were fed the same mixture except for the variable feeds being studied. In some cases the hens were pen-fed, while in other cases the fowls were pen-fed a ration deficient in protein. The protein feed, including the variable feeds, was in these cases fed each hen individually twice daily in gelatin capsules. About two-thirds of this feed was fed in the morning and one-third late in the afternoon. A one-half-ounce capsule was used for the morning feeding and a one-fourth-ounce capsule for the afternoon feeding.

Storage Conditions: The eggs from the hens fed the various feeds were stored in the cold storage plant at the Experiment Station. In 1928 this plant was not equipped with automatic temperature control. The temperature normally ranged between 30 and 40 degrees Fahren-

heit; however, on a few occasions the temperature ran somewhat higher than this. All eggs were stored in the same room; therefore all were exposed to these changes. The eggs were placed in storage during February, March, and April, and were removed and graded during the last of October, November, and early December.

In 1929 the eggs were stored in June and removed and graded in November. The storage plant was equipped with automatic temperature control, but the range of temperature was between 35 and 42 degrees. This temperature is too high for this length of storage. This temperature and incorrect humidity favored the growth of molds, which caused a rather heavy loss of eggs. This loss of moldy eggs may have vitiated the data slightly, on account of the number of eggs thrown out and errors made in grading some other eggs that possibly should have been eliminated.

In 1930 the eggs were stored in May and June and removed and graded during November. The temperature in 1930 was the same as in 1929, but the humidity was more satisfactory and the loss due to molds was not excessive.

Grades of Eggs: All eggs, except those furnished Dr. Fraps, State Chemist, for analysis, were broken and graded as Firsts, Seconds, and Discards. Those graded as firsts were of normal color and consistency. The yolks of those graded as seconds were slightly off color; they were slightly greenish-yellow or reddish-yellow, but the eggs were still used for cooking purposes. The yolks of the eggs graded as discards varied in color from yellowish-green to green, and in some cases were almost black. Some of the yolks were red in color, while others were almost salmon-colored.

The color of a number of yolks of storage eggs was studied with a color analyzer. Chart 1 shows the color curve for a rich yellow yolk produced by a hen receiving meat and bone scraps, and Chart 2 shows the curve for a dark yolk classed as a green yolk and produced by a hen receiving cottonseed meal. This would indicate that the difference in color between the yolks of the storage eggs from hens fed meat and bone scraps and the dark-green ones from the hens fed cottonseed meal may be due to a large reduction in the amount of red, orange, and yellow pigments, and a smaller reduction in the amount of green pigment in the yolks of the cottonseed-meal eggs while they are being held in storage.

The consistency of the yolks varied in the eggs classed as discards; some were watery, while others were more firm and tougher than normal yolks. The size of the yolk in proportion to the white was much greater in many discard eggs from hens fed cottonseed meal than in eggs from hens fed meat and bone scraps. In many cases the vitelline membrane was broken, probably because of the tension due to the absorption of part of the white by the yolk.

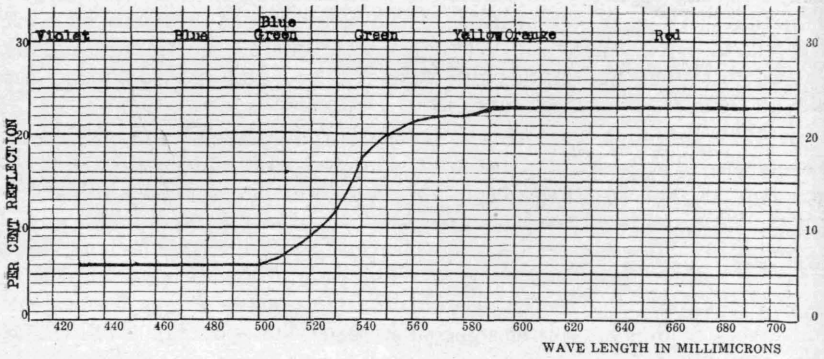

Figure 1. Color curve for rich yellow yolk.

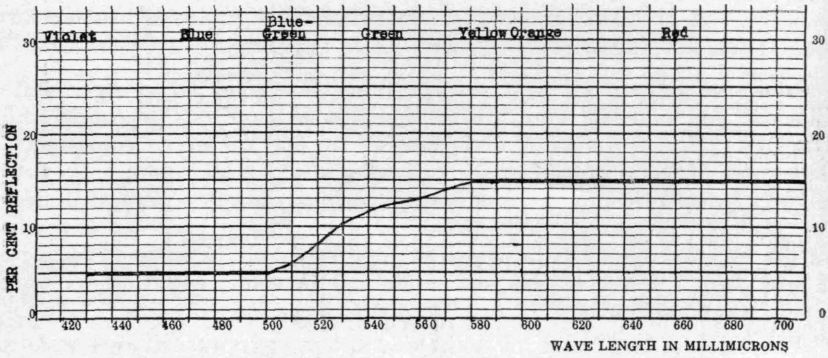

Figure 2. Color curve for very dark green yolk.

The color of the white of the eggs graded as discards varied from normal color to a distinct pink.

Effect of Various Amounts of Cottonseed Meal on the Storage Quality of Eggs

The work reported in Bulletin No. 376 of this Station showed that the storage quality of the eggs was affected by the amount of cottonseed meal fed, but the lower limit of safety was not established; therefore in 1928 ten different rations were fed to hens individually and four mash mixtures were pen-fed. Rations 1 to 10, Table 1, show the amount of variable feeds used in the individual feeding; and Mash Mixtures 13 to 16, Table 2, are the ones studied in the pen feeding.

Table 3 gives the chemical analysis of the variable feeds used in this study.

Table 1. Grams of meat and bone scraps and cottonseed meal fed each hen daily in addition to the basal ration

(1928)

	Ration Number											
	1	2	3	4	5	6	7	8	9	10	11	12
Meat and bone scraps	6	5½	5	4½	4	3½	3	2	1	....	6	....
Cottonseed meal	....	1	2	3	4	5	6	8	10	12	....	....
Cottonseed meal with low fat content	....	....	....	....	....	....	....	....	....	....	....	12
Crude cottonseed oil	....	....	....	....	....	....	....	....	....	....	1	....

Table 2. Composition of mash mixtures fed Lots 13 to 17

(1928)

	Mash Mixtures Number				
	13	14	15	16	17*
Ground kafir	36.5	27.8	22.5	31.5	31.5
Wheat gray shorts	20.0	20.0	25.0	16.0	16.0
Wheat bran	15.0	15.0	15.0	12.0	12.0
Meat and bone scraps	20.0	14.0	7.5	.....	.....
Cottonseed meal	.....	9.0	20.0	32.0	32.0
Alfalfa-leaf meal	8.0	8.0	8.0	6.0	6.0
Oyster shell	.....	0.7	1.5	2.0	2.0
Salt	0.5	0.5	0.5	0.5	0.5

*Lot 17 had free access to fresh lettuce.

Table 3. Analysis of feeds*

(1928)

	Protein	Fat	Crude fiber	Nitrogen-free extract	Water	Ash
Meat and bone scraps	51.8	6.9	1.9	2.8	5.2	31.4
Cottonseed meal	43.7	6.8	8.8	28.4	6.2	6.1
Cottonseed meal with low fat content	44.2	1.3	10.9	31.1	6.3	6.2

*Analysis made under the direction of Dr. G. S. Fraps, State Chemist.

A report of the number and percentage of the eggs of the three grades from hens fed the various amounts of cottonseed meal is given in Table 4. It is noted that a few eggs from the hens receiving as small an amount as 2 grams of cottonseed meal daily were classed as seconds. When 4 grams of cottonseed meal were fed daily one-third of the eggs were either seconds or discards. The loss increased as the amount of cottonseed meal fed increased.

Table 4. Breaking record of eggs from various rations

(1928)

Ration No.	Variable feeds (Grams fed daily)	Number of Eggs				Per cent		
		Total	Firsts	Seconds	Discards	Firsts	Seconds	Discards
1	Meat and bone scraps 6, cottonseed meal 0	108	108	.....	.....	100.0	.....	.....
2	Meat and bone scraps 5½, cottonseed meal 1	80	80	.....	.....	100.0	.....	.....
3	Meat and bone scraps 5, cottonseed meal 2	85	78	7	.....	91.8	8.2	.....
4	Meat and bone scraps 4½, cottonseed meal 3	47	36	7	4	76.6	14.9	8.5
5	Meat and bone scraps 4, cottonseed meal 4	106	71	23	12	67.0	21.7	11.3
6	Meat and bone scraps 3½, cottonseed meal 5	70	22	30	18	31.4	42.9	25.7
7	Meat and bone scraps 3, cottonseed meal 6	67	28	28	11	41.8	41.8	16.4
8	Meat and bone scraps 2, cottonseed meal 8	106	1	8	97	.9	7.5	91.5
9	Meat and bone scraps 1 cottonseed meal 10	97	1	1	95	1.0	1.0	97.9
10	Meat and bone scraps 0, cottonseed meal 12	97	2	5	90	2.1	5.2	92.8
11	Meat and bone scraps 6, crude cottonseed oil 1	55	3	6	46	5.5	10.9	83.6
12	Meat and bone scraps 0, cottonseed meal with low fat content 12	41	34	6	1	82.9	14.6	2.4
	Per cent of Variable Feeds in Rations							
13	Meat and bone scraps 20, cottonseed meal 0	25	25	.....	.....	100.0	.....	.....
14	Meat and bone scraps 14, cottonseed meal 9	268	114	32	122	42.5	11.9	45.5
15	Meat and bone scraps 7½, cottonseed meal 20	316	39	27	250	12.3	8.5	79.1
16	Meat and bone scraps 0, cottonseed meal 32	333	15	17	301	4.5	5.1	90.4
17	Meat and bone scraps 0, cottonseed meal 32 and lettuce	29	1	3	25	3.4	10.3	86.2

Changes in Size and Composition of Yolk During Storage

It was noted in breaking the eggs that in many cases the yolks of the eggs from the hens fed cottonseed meal were larger in proportion to the whites than in eggs from hens fed meat and bone scraps. The vitelline membranes of these eggs broke readily. The separation data as given in Tables 5, 10, and 16 show that the size of the yolks in storage eggs from hens fed cottonseed meal are larger than from hens fed meat and bone scraps. In Table 5 it is noted that the size of the yolk increases when the amount of cottonseed meal fed increases to 9 per cent or more of the ration. Tables 6, 11, and 16 show that the larger yolk has a smaller percentage of fat and a larger amount of water. Tables 6 and 11 do not show that the percentage of protein in the yolk varies with the water and the fat. This suggests that water and albuminous material may be taken up by the yolk in the eggs from hens receiving the cottonseed meal.

Table 5. Per cent of yolk, white, and shell in eggs from various rations*

(1928)

Ration No.	Variable feeds (Grams fed daily)	Per cent yolk	Per cent white	Per cent shell
1	Meat and bone scraps 6, cottonseed meal 0	37.8	50.7	11.5
2	Meat and bone scraps 5½, cottonseed meal 1	35.4	52.5	12.1
3	Meat and bone scraps 5, cottonseed meal 2	39.4	49.9	10.7
4	Meat and bone scraps 4½, cottonseed meal 3	37.4	51.9	10.7
5	Meat and bone scraps 4, cottonseed meal 4	37.7	51.1	11.2
6	Meat and bone scraps 3½, cottonseed meal 5	37.8	50.1	12.1
7	Meat and bone scraps 3, cottonseed meal 6	38.0	49.9	12.1
8	Meat and bone scraps 2, cottonseed meal 8	46.0	43.4	10.7
9	Meat and bone scraps 1, cottonseed meal 10	46.6	42.0	11.5
10	Meat and bone scraps 0, cottonseed meal 12	52.4	36.3	11.3
11	Meat and bone scraps 6, crude cottonseed oil 1	47.3	40.6	12.1
12	Meat and bone scraps 0, cottonseed meal with low fat content 12	43.6	45.8	10.6
	Per Cent of Variable Feeds in Rations			
13	Meat and bone scraps 20%, cottonseed meal 0	36.6	51.2	12.2
14	Meat and bone scraps 14%, cottonseed meal 9%	43.3	44.9	11.8
15	Meat and bone scraps 7½%, cottonseed meal 20%	49.3	38.5	12.2
16	Meat and bone scraps 0, cottonseed meal 32%	52.5	35.1	12.3
17	Meat and bone scraps 0, cottonseed meal 32% and lettuce	55.7	32.9	11.4

*Separations made under the direction of Dr. G. S. Fraps, State Chemist.

Table 6. Analysis of yolks of eggs from various rations*

(1928)

Ration No.	Variable Feeds (Grams fed daily)	Per cent fat	Per cent protein	Per cent water	Per cent ash
1	Meat and bone scraps 6, cottonseed meal 0	30.1	14.7	52.5	1.5
2	Meat and bone scraps 5½, cottonseed meal 1	30.5	16.0	51.7	1.5
3	Meat and bone scraps 5, cottonseed meal 2	29.6	15.5	52.7	1.6
4	Meat and bone scraps 4½, cottonseed meal 3	27.4	15.9	52.6	1.6
5	Meat and bone scraps 4, cottonseed meal 4	29.1	16.3	51.8	1.7
6	Meat and bone scraps 3½, cottonseed meal 5	28.5	15.6	53.8	1.5
7	Meat and bone scraps 3, cottonseed meal 6	26.8	15.8	54.6	1.7
8	Meat and bone scraps 2, cottonseed meal 8	23.6	14.2	58.8	1.5
9	Meat and bone scraps 1, cottonseed meal 10	22.3	15.1	60.5	1.5
10	Meat and bone scraps 0, cottonseed meal 12	21.7	14.6	61.0	1.5
11	Meat and bone scraps 6, crude cottonseed oil 1	29.1	15.4	53.3	1.6
12	Meat and bone scraps 0, cottonseed meal with low fat content 12	25.6	14.7	57.3	1.5
	Per Cent of Variable Feeds in Rations				
13	Meat and bone scraps 20%, cottonseed meal 0	30.1	15.1	52.9	1.5
14	Meat and bone scraps 14%, cottonseed meal 9%	24.8	14.7	58.9	1.4
15	Meat and bone scraps 7½%, cottonseed meal 20%	23.2	15.4	58.8	1.4
16	Meat and bone scraps 0, cottonseed meal 32%	20.1	15.1	62.2	1.2
17	Meat and bone scraps 0, cottonseed meal 32% and lettuce	21.0	15.1	61.4	1.3

*Analysis made under the direction of Dr. G. S. Fraps, State Chemist.

Green Feed Does Not Prevent Losses from Eggs Produced by the Feeding of Cottonseed Meal

In order to secure information as to whether the losses from eggs produced by hens fed cottonseed meal would be lower if the hens were fed green feed, two lots received the mash rations noted as Rations 16 and 17, Table 2. The only difference is that Lot 17 had free access to green leafy lettuce, and Lot 16 received none. Tables 4, 5, and 6 do not disclose any beneficial effect from the feeding of the lettuce.

The Injurious Substance in Cottonseed Meal Is Associated with the Oil

During the year 1928 four rations were fed to learn whether the injurious substance of cottonseed meal was associated with the oil. These are shown as Rations 1, 10, 11, and 12 in Table 1. Ration 1 was a meat and bone-scrap ration, while Ration 11 was similar except that one gram of crude cottonseed oil was fed daily. The difference between Rations 10 and 12 are that in the one case the meal contained 6.8 per cent of fat while in the other case it contained only 1.3 per cent of fat. The data as reported in Table 5 show a heavy loss in the eggs from the hens fed the cottonseed meal and from those fed the meat and bone scraps with cottonseed oil, but a very light loss in the eggs from the hens fed the extracted cottonseed meal with a low fat content, and no loss from the eggs from the hens fed meat and bone scraps.

Table 14, Ration 3 shows a very light loss caused by the feeding of extracted cottonseed meal with a low fat content, as compared with a heavy loss from Ration 2, in which the same quantity of cottonseed meal containing the usual amount of fat was fed.

Table 7. Grams of feed fed each hen daily in addition to the basal ration (1929)

	Ration Number									
	1	2	3	4	5	6	7	8	9	10
Meat and bone scraps	7.5		7.5	7.5	7.5		7.5	7.5	7.5	
Cottonseed meal		12								
Ether extract of C. S. M.			Yes*							
Benzol extract of C. S. M.				Yes*						
Water extract of C. S. M.					Yes*					
Residue†						8.3				
Refined cottonseed oil (Wesson oil)							1			
Cod liver oil								1		
Raw linseed oil									1	
Soybean meal										12

*The amount of water extract, ether extract, benzol extract, and residue fed is the amount equivalent to that contained in 12 grams of 43% protein cottonseed meal.

†Residue refers to the cottonseed-meal material remaining after the ether extract, benzol extract, and water extract were removed. These separations made under the direction of Dr. G. S. Fraps, State Chemist.

During the year 1929 cottonseed meal was treated to obtain various extracts to again study the location of the substance causing the injury to eggs in storage. First, an ether extract was made, then a benzol extract of the residue from the ether extract; this was followed by a water extract of the benzol-extracted residue. The material called "residue" is the material remaining after these three extracts had been made. Refined cottonseed oil (Wesson oil) was also studied.

Rations 1 to 7, inclusive, Table 7, give the amount of variable feeds fed each hen daily. Table 8 gives the chemical analysis of the variable feeds used in this part of the study.

Table 8. Analysis of feeds*
(1929)

	Protein	Fat	Crude fibre	Nitrogen-free extract	Water	Ash
Meat and bone scraps	55.93	8.39	1.20	4.57	5.70	24.21
Cottonseed meal	43.27	5.75	10.57	28.47	6.71	5.23
Soybean meal	47.19	.56	5.83	31.20	9.03	6.19

*Analysis made under the direction of Dr. G. S. Fraps, State Chemist.

Table 9 shows definitely that the injurious substance of cottonseed meal is associated with the oil, because the loss is heavy in the eggs from the hens fed the ether extract, and light in the eggs from other preparations. In this case the Wesson oil caused no trouble. This suggests that the manufacturing processes used to manufacture this highly refined oil removes or changes the substance that injures the storage quality of the eggs.

Table 9. Breaking record of eggs from various rations
(1929)

Ration No.	Variable feeds (Grams fed daily)	Number of Eggs				Per cent		
		Total	Firsts	Seconds	Discards	Firsts	Seconds	Discards
1	Meat and bone scraps 7½, cottonseed meal 0	34	34	.....	.....	100.0	.....	.....
2	Meat and bone scraps 0, cottonseed meal 12	12	.....	6	6	.....	50.0	50.0
3	Meat and bone scraps 7½, ether extract	37	10	20	7	27.0	54.1	18.9
4	Meat and bone scraps 7½, benzol extract	30	27	2	1	90.0	6.7	3.3
5	Meat and bone scraps 7½, water extract	28	24	4	.....	85.7	14.3	.....
6	Meat and bone scraps 0, C. S. M. residue 8.3	27	25	.....	2	92.6	.....	7.4
7	Meat and bone scraps 7½, Wesson oil 1	34	33	.....	1	97.1	.....	2.9
8	Meat and bone scraps 7½, cod liver oil 1	37	35	.....	2	94.6	.....	5.4
9	Meat and bone scraps 7½, raw linseed oil 1	35	20	9	6	57.1	25.7	17.1
10	Meat and bone scraps 0, soybean meal 12	33	26	6	1	78.8	18.2	3.0

Table 10. Per cent of yolk, white, and shell of eggs from various rations*
(1929)

Ration No.	Variable feeds (Grams fed daily)	Per cent		
		Yolk	White	Shell
1	Meat and bone scraps 7½, cottonseed meal 0	33.2	57.2	9.6
2	Meat and bone scraps 0, cottonseed meal 12	35.1	54.4	10.6
3	Meat and bone scraps 7½, ether extract	34.0	54.9	11.2
4	Meat and bone scraps 7½, benzol extract	34.8	55.1	10.1
5	Meat and bone scraps 7½, water extract	34.5	54.1	11.3
6	Meat and bone scraps 0, C. S. M. residue 8.3	32.9	56.7	10.5
7	Meat and bone scraps 7½, Wesson oil 1	36.9	55.1	10.1
8	Meat and bone scraps 7½, cod liver oil 1	35.8	53.9	10.4
9	Meat and bone scraps 7½, raw linseed oil 1	32.3	57.7	10.0
10	Meat and bone scraps 0, soybean meal 12	33.2	55.6	11.2

*Separations made under the direction of Dr. G. S. Fraps, State Chemist.

Table 11. Analysis of yolks of eggs from various rations*
(1929)

Ration No.	Variable feeds (Grams fed daily)	Per cent			
		Fat	Protein	Water	Ash
1	Meat and bone scraps 7½, cottonseed meal 0	30.0	15.0	51.5	1.4
2	Meat and bone scraps 0, cottonseed meal 12	28.2	15.7	53.3	1.6
3	Meat and bone scraps 7½, ether extract	28.6	16.0	52.9	1.5
4	Meat and bone scraps 7½, benzol extract	29.2	15.6	52.6	1.4
5	Meat and bone scraps 7½, water extract	29.2	16.4	51.7	1.6
6	Meat and bone scraps 0, C. S. M. residue 8.3	28.9	15.6	52.7	1.4
7	Meat and bone scraps 7½, Wesson oil 1	29.0	15.8	52.2	1.5
8	Meat and bone scraps 7½, cod liver oil 1	29.4	15.6	52.7	1.5
9	Meat and bone scraps 7½, raw linseed oil 1	28.8	15.9	52.6	1.5
10	Meat and bone scraps 0, soybean meal 12	29.2	16.2	51.8	1.6

*Analysis made under the direction of Dr. G. S. Fraps, State Chemist.

The Injurious Substance of Cottonseed Oil is Not Removed by Partial Refining with Sodium Hydroxide

In 1930 a study was made to determine whether the substance in cottonseed oil causing the trouble with the storage quality of eggs was removed by the treatment of the oil with sodium hydroxide. In this study crude cottonseed oil, cottonseed oil which had been treated with sodium hydroxide, and the soap stock resulting from the action of the sodium hydroxide were tested. The soap stock was neutralized with hydrochloric acid before it was fed.

Table 12, Rations 4, 5, and 6 give the amount of the variable feeds fed to hens individually, and Table 13, Rations 3, 4, and 5 give the mash mixtures fed to the different pens.

Table 12. Grams of feed fed each hen daily in addition to the basal ration (1930)

	Ration Number								
	1	2	3	4	5	6	7	8	9
Meat and bone scraps	7½			7½	7½	7½	7½	7½	4
Cottonseed meal		12							
Cottonseed meal with low fat content			12						
Crude cottonseed oil				1					
Partially refined cottonseed oil					1				
Soap stock						2			
Cod liver oil							1		
Linseed oil (raw)								1	
Linseed meal									4

Table 13. Rations fed in pen feeding (1930)

	Ration Number							
	1	2	3	4	5	6	7	8
Kafir	20	20	20	20	20	20	20	20
Wheat bran	20	10	17	19½	17	17	17	16
Wheat gray shorts	20	20	20	20	20	20	20	20
Ground oats	20	20	20	20	20	20	20	20
Meat and bone scraps	20		20	20	20	20	20	12
Cottonseed meal		30						
Cottonseed oil (crude)			3					
Soap stock				½				
Partially refined cottonseed oil					3			
Cod liver oil						3		
Raw linseed oil							3	
Linseed meal								12

Table 14. Breaking record of eggs from hens fed individually (1930)

Ration No.	Variable feeds (Grams fed daily)	Number of Eggs				Per cent		
		Total	Firsts	Seconds	Discards	Firsts	Seconds	Discards
1	Meat and bone scraps 7½, cottonseed meal 0	99	95	2	2	96.0	2.0	2.0
2	Meat and bone scraps 0, cottonseed meal 12	52	9	6	37	17.3	11.5	71.2
3	Meat and bone scraps 0, cottonseed meal with low fat content 12	20	17	1	2	85.0	5.0	10.0
4	Meat and bone scraps 7½, crude cottonseed oil 1	72	16	7	49	22.2	9.7	68.1
5	Meat and bone scraps 7½, partially refined cottonseed oil 1	78	27	2	49	34.6	2.6	62.8
6	Meat and bone scraps 7½, soap stock .2	98	92	3	3	93.9	3.1	3.1
7	Meat and bone scraps 7½, cod liver oil 1	77	74	.....	3	96.1	.....	3.9
8	Meat and bone scraps 7½, raw linseed oil 1	85	81	.....	4	95.3	.....	4.7
9	Meat and bone scraps 4, linseed meal	60	59	1	.....	98.3	1.7	.....

Tables 14 and 15 show definitely that the injurious substance in the cottonseed oil is not removed by the treatment of the oil with sodium

hydroxide. The eggs from the hens fed the partially refined cottonseed oil deteriorated in storage almost as badly as those from the hens receiving the crude cottonseed oil, and the loss of eggs trom hens receiving soap stock was very low.

Table 15. Breaking record of eggs from the hens fed in pens

(1930)

Ration No.	Variable feeds (Per cent in ration)	Number of Eggs				Per cent		
		Total	Firsts	Seconds	Discards	Firsts	Seconds	Discards
1	Meat and bone scraps 20, cottonseed meal 0	194	185	3	6	95.4	1.5	3.1
2	Meat and bone scraps 0, cottonseed meal 30	170	39	15	116	22.9	8.8	68.2
3	Meat and bone scraps 20, crude cottonseed oil 3	164	30	15	119	18.3	9.1	72.6
4	Meat and bone scraps 20, soap stock ½	207	197	3	7	95.2	1.4	3.4
5	Meat and bone scraps 20, partially refined cottonseed oil 3	211	44	32	135	20.9	15.2	64.0
6	Meat and bone scraps 20, cod liver oil 3	242	240	.....	2	99.2	.....	.8
7	Meat and bone scraps 20, raw linseed oil 3	238	234	2	2	98.3	.8	.8
8	Meat and bone scraps 12, linseed meal 12	290	287	1	2	99.0	.3	.7

Table 16. Per cent of yolk and white, and yolk analysis*

(1930)

Lot No.	Variable feeds	Per cent of whole egg		Analysis of yolk	
		Yolk	White	Per cent fat	Per cent moisture
1	Meat and bone scraps	35.3	53.3	26.5	55.2
2	Cottonseed meal	40.5	47.5	25.8	56.7
3	Meat and bone scraps and crude cottonseed oil	39.6	49.8	25.3	56.6
4	Meat and bone scraps and soap stock of C. S. oil	32.4	57.1	30.3	52.0

*Analysis made under the direction of Dr. G. S. Fraps, State Chemist.

Effect of Cottonseed Meal on the Storage Quality of Frozen Eggs

In order to study whether eggs from hens fed cottonseed meal deteriorate in color when frozen, sixty dozen eggs from hens receiving a mash containing 20 per cent of meat and bone scraps, and sixty dozen eggs from hens receiving a mash containing 32 per cent of cottonseed meal, were broken out and stored in a frozen condition for five months. When inspected after that length of storage, it was found that the eggs produced by the hens fed meat and bone scraps had kept their normal color, but the eggs from the hens fed cottonseed meal were dark-red or reddish-brown in color. Bacterial counts were made after freezing, but they showed no significant difference in the eggs produced by the two feeds.

Effect of Cod Liver Oil on Storage Quality of the Eggs

Three studies were made on the effect of cod liver oil on the storage quality of eggs. The rations studied are given in Tables 7, 12, and 13. It is noted in Tables 9, 14, and 15 that the eggs from hens fed cod liver oil in the amounts shown did not deteriorate in storage.

Effect of Raw Linseed Oil and Linseed Meal on the Storage Quality of the Eggs

Three studies were made on raw linseed oil and two on linseed meal. The rations are given in Tables 7, 12, and 13. The results for the study with the oil are somewhat in conflict because Table 9 shows a loss from the use of raw linseed oil, but Tables 14 and 15 show that the feeding of neither raw linseed oil nor linseed meal injured the storage quality of the eggs.

Effect of Soybean Meal on the Storage Quality of the Eggs

One study was conducted on this point in 1929, the ration being shown in Table 7. Table 9 shows that a small loss resulted from the feeding of the soybean meal. The number of eggs in this study was small; therefore the results are not conclusive.

CONCLUSIONS

1. Eggs from hens fed meat and bone scraps hold up well in storage.

2. Eggs from hens fed cottonseed meal, crude cottonseed oil, partially refined cottonseed oil, and ether extract of cottonseed meal deteriorate in storage. The color of the yolk varies from salmon to dark-green, or nearly black. The white of the eggs vary from normal color to pink in color.

3. Studies of the color of egg yolk with a color analyzer indicate that the difference in color between the yolks of the storage eggs from hens fed meat and bone scraps and the dark green ones from the hens fed cottonseed meal may be due to a large reduction in the amount of red, orange, and yellow pigments, and a smaller reduction in the amount of green pigment in the yolks of the cottonseed-meal eggs while they are being held in storage.

4. The feeding of mash containing 9 per cent or more of cottonseed meal causes the yolks of the eggs to increase in size during storage, and the yolks of these eggs contain a smaller percentage of fat than do the yolks of the eggs from hens fed meat and bone scraps. As the amount of cottonseed meal in the feed increases the percentage of fat in the yolk decreases. The percentage of water in the yolks increases as the fat decreases, but the percentage of protein remains rather constant. This may indicate that albuminous material is absorbed by the yolk along with water from the white.

5. A small percentage of the eggs laid by hens receiving 2 grams of cottonseed meal daily graded as seconds when they were removed from storage; when 3 grams of cottonseed meal was fed daily the hens produced a larger percentage of eggs which graded as seconds when removed from storage, and a few which graded as discards.

6. Hens receiving 8, 10, and 12 grams daily of cottonseed meal produced eggs that did not store well. Over 90 per cent of the eggs deteriorated in storage, and nearly one-half of the eggs from hens receiving a mash containing 9 per cent of cottonseed meal were also deteriorated in storage. As the amount of cottonseed meal increased the percentage of deteriorated eggs increased.

7. Eggs from hens which were fed extracted cottonseed meal with a low fat content did not deteriorate in storage to the extent of those from hens that received the 43 per cent protein cottonseed meal. Eggs from hens fed 1 gram daily of refined cottonseed oil (Wesson oil) and cod liver oil did not deteriorate in storage.

8. The mixed yolk and white of eggs from hens fed cottonseed meal when broken out and stored in a frozen condition for five months were dark-red in color after that length of storage.

9. The substance in cottonseed meal that causes the deterioration in quality of eggs in storage is either the oil or something closely associated with the oil which is removed in the final refining, because it is present in both crude cottonseed oil and partially refined cottonseed oil, but is not contained in the soap stock; neither is it found in extracted cottonseed meal having a low fat content, nor in highly refined cottonseed oil (Wesson oil).

10. The feeding of lettuce did not correct the injurious effects of cottonseed meal on the storage quality of eggs.

11. Because of the small number of eggs used and because in one case somewhat conflicting results were secured, conclusive evidence has not yet been secured at the Texas Station on the effect of soybean meal, raw linseed oil, and linseed meal on the storage quality of eggs.

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