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The Place of Corn Distillers Dried Solubles in Dog Feeds

C. M. MCCAY, G. L. RUMSEY,
A. C. STEVENS and J. K. LOOSLI

Cornell University
Ithaca, New York

C. M. MCCAY

J. K. LOOSLI



For the past 7 yr studies have been in progress at Cornell University to determine the value of corn Distillers Dried Solubles in dog feeds. At 7% of the diet it has given favorable results when used in feeds for growing pups to replace dried skimmed milk and tomato pomace (McCay *et al*, 1957). Females used in growth trials were kept on the same feeds to test reproductive performance (Wanner *et al*, 1958; Wanner and McCay, 1960) and balance trials were carried out to measure the utilization of nutrients in diets containing large amounts of corn Distillers Dried Solubles.

DIGESTION AND BALANCE STUDIES

McCay *et al* (1957) reported that adding 30% corn Distillers Dried Solubles lowered the average digestibility of the dry matter by adult dogs fed a widely used dog food from 77 to 74%. A level of 15% corn Distillers Dried Solubles gave intermediate values between high levels of corn Distillers Dried Solubles and the basal ration. Since digestibility of fat increased from 92% on the control diet to 95% on the high level of corn Distillers Dried Solubles, and protein values were similar, the availability of energy did not differ appreciably among the diets.

Calcium balances on these adult dogs showed that those on the control diet were in positive balance while those on 15 or 30% corn Distillers Dried Solubles were in slight negative balance for the 4-day periods of the test. A question was raised about the possible presence of oxalates or phytin in the corn Distillers Dried Solubles, since these compounds have been shown to depress calcium and phosphorus absorption and retention in other

TABLE I
COMPOSITION OF DIETS USED IN METABOLISM EXPERIMENTS

Ingredients	Diet Number			
	1	2	3	4
Basal mixture ¹	36.5	36.5	36.5	36.5
Kibbled corn	30.0	15.0	00.0	00.0
Wheat sculp	18.0	18.0	18.0	18.0
Wheat germ	8.5	8.5	8.5	8.5
Corn Distillers Dried Solubles	0.0	15.0	30.0	0.0
Non-fat dry milk solids	5.0	5.0	5.0	5.0
Tomato pomace	2.0	2.0	2.0	2.0
Sucrose	0.0	0.0	0.0	30.0

¹ The basal mixture consisted of (in percent): kibbled corn, 46.0; soybean meal, 17.5; tallow, 12; wheat flakes, 6; brewers dried yeast, 4.7; alfalfa meal, 3.5; cheese meal, 3.5; fish meal, 3.5; liver meal, 1.2; dicalcium phosphate, 1.2; iodized salt, 0.5; cod liver oil concentrate, 0.2 and irradiated yeast, 0.2.

animal species. At a level of 7% corn Distillers Dried Solubles negative calcium balances did not occur in the adult dogs. Additional balance studies have been carried out with growing pups to obtain more information on the digestibility of various nutrients and in particular to re-examine the calcium and phosphorus balances as affected by corn Distillers Dried Solubles. Eight pure bred Beagle pups approximately 12 wk of age were used. The diets fed are shown in table I. The amount of kibbled corn in the diets was varied in relation to the levels of sucrose and corn Distillers Dried Solubles. The chemical composition of the 4 diets studied is presented in table II.

In the course of the studies the pups were fed the diets in a series of 4

TABLE II
PROXIMATE ANALYSIS OF DIETS

Diet	Water					
	Protein	Fat	Fiber	Ash		
1. Control	8.17	29.49	7.95	4.04	3.10	
2. 15% Corn DDS ¹	8.49	32.30	8.97	4.52	3.99	
3. 30% Corn DDS	9.05	32.20	10.39	4.79	7.91	
4. 30% Sucrose	4.95	21.68	7.91	3.35	7.38	

¹ DDS = Distillers Dried Solubles.

consecutive 10-day balance periods. Three days served as a preliminary period followed by a 7-day period when feces and urine were collected. Feed intakes were constant during the balance period, but allowances were adjusted for the different periods to supply approximately 100 cal of gross energy per pound of body weight to the individual dogs per day. The average results of the digestion and balance studies are summarized in table III.

Table IV presents the apparent digestibility of dry matter for the individual dogs. It is evident that 7 of 8 pups digested the control diet slightly

TABLE III
DIGESTIBILITIES OF DRY MATTER AND FAT AND UTILIZATION OF PROTEIN, CALCIUM AND PHOSPHORUS IN DOGS FED DIFFERENT LEVELS OF CORN DISTILLERS DRIED SOLUBLES (DDS) AND SUCROSE

Diet	Digestibility		Retention		
	Dry matter	Fat	Nitrogen	Calcium	Phosphorus
1. Control	78.0	87.3	21.6	33.8	28.0
2. 15% Corn DDS	74.1	88.4	17.4	47.0	24.6
3. 30% Corn DDS	66.0	86.4	15.9	22.3	59.1
4. 30% Sucrose	74.9	84.4	22.4	12.3	65.3

better than diet 2, which contained 15% corn Distillers Dried Solubles. The average decrease of 4.0% is probably not large enough to have much practical importance in dog foods. In comparing diets 3 and 4 it is seen that 7 of 8 dogs digested the dry matter better in the diet containing 30% sucrose (diet 4) than diet 3 with 30% corn Distillers Dried Solubles. The difference of 9% is probably enough to have practical importance and suggests that 30% corn Distillers Dried Solubles is too high a level to recommend for general use in foods for growing pups.

Considerable difficulty was experienced in palatability with the diet containing 30% corn Distillers Dried Solubles. Intakes were appreciably lower than for the other diets and they varied somewhat from day to day. Collections were more difficult during the balance periods because certain pups exhibited diarrhea at times. Problems of this type were less frequent and not as extensive with 15% corn Distillers Dried Solubles, but there was enough of a problem with palatability to suggest that such a level would be too high for use in practical types of dry dog meals.

After the digestion and balance studies had been completed and the chemical analyses became available, we were surprised to find that diets 3 and 4 contained twice as much ash as diets 1 and 2. It was discovered that the ash content of the meat scraps used in the diets was sufficient to explain the difference, although the two different shipments carried the same guaranteed analyses and were thought to be the same product when the diets were mixed. While it is not entirely clear what influence this difference might have on the results, it seems safest to make direct comparisons only between diets 1 and 2 and between diets 3 and 4.

In table V the individual data are shown for the dietary nitrogen re-

TABLE IV
APPARENT DIGESTIBILITY OF DRY MATTER BY INDIVIDUAL DOGS

Diet	Digestibility of Dry Matter									
	Dog number									
	84	85	86	87	92	93	94	100	Av	Av
1. Control	79	80	71	84	75	77	82	76	78.0	78.0
2. 15% Corn DDS ¹	75	75	65	77	71	75	76	79	74.1	74.1
3. 30% Corn DDS	69	67	51	74	60	67	77	63	66.0	66.0
4. 30% Sucrose	76	67	67	82	67	76	77	77	74.9	74.9

¹ DDS = Distillers Dried Solubles.

tained. The differences between the diets are relatively small and they suggest that there was no significant difference in the value of nitrogen furnished by corn Distillers Dried Solubles and kibbled corn for growing pups. This result would be anticipated on the basis of the wide variety of protein from other sources used in the diets. The possible exceptions to

TABLE V
NITROGEN RETENTION BY INDIVIDUAL DOGS

Diet	Nitrogen Retention									
	Dog number									
	84	85	86	87	92	93	94	100	Av	Av
1. Control	23	19	5	27	13	24	35	27	21.6	21.6
2. 15% Corn DDS ¹	21	12	-2	21	15	1	38	33	17.4	17.4
3. 30% Corn DDS	18	16	-10	32	15	16	23	17	15.9	15.9
4. 30% Sucrose	20	23	6	41	3	29	22	35	22.4	22.4

¹ DDS = Distillers Dried Solubles.

this conclusion might relate to pup no. 86 (table V) in which some diarrhea occurred on the diets containing corn Distillers Dried Solubles.

The data for digestibility of fat are surprisingly uniform for all pups on all 4 diets (table VI), no appreciable differences being evident.

TABLE VI
DIGESTIBILITY OF FAT BY INDIVIDUAL DOGS

Diet	Digestibility of Fat									
	Dog number									
	84	85	86	87	92	93	94	100	Av	Av
1. Control	88	87	81	90	86	89	90	87	87.3	87.3
2. 15% Corn DDS ¹	89	89	85	88	88	89	88	91	88.4	88.4
3. 30% Corn DDS	87	88	79	89	84	87	90	87	86.4	86.4
4. 30% Sucrose	88	87	75	89	79	85	85	86	84.4	84.4

¹ DDS = Distillers Dried Solubles.

CALCIUM AND PHOSPHORUS BALANCES

Calcium retention data are shown in table VII. All of the pups were in positive balance on every diet. The percentage of the dietary calcium retained was highest on the 15% corn Distillers Dried Solubles and the control diet, intermediate on 30% corn Distillers Dried Solubles and lowest on the 30% sucrose diet. These data clearly show that corn Distillers Dried Solubles does

TABLE VII
CALCIUM RETENTION BY INDIVIDUAL DOGS

Diet	Calcium Retention									
	Dog number									
	84	85	86	87	92	93	94	100	Av	Av
1. Control	33	37	35	34	34	28	35	34	35.8	35.8
2. 15% Corn DDS ¹	48	49	50	43	44	48	46	48	47.0	47.0
3. 30% Corn DDS	24	19	27	22	27	19	21	19	22.3	22.3
4. 30% Sucrose	14	11	8	16	16	12	9	12	12.3	12.3

¹ DDS = Distillers Dried Solubles.

not interfere with calcium absorption and retention as suggested by the original preliminary observations of McCay *et al.* (1957). These workers noted that mature dogs stored small amounts of calcium on a control diet, but when 15 or 30% corn Distillers Dried Solubles replaced an equal amount of kibbled corn the dogs appeared to lose calcium from their bodies. Since mature dogs were used, whose skeletal growth had stopped, small losses or retentions of calcium over short experimental periods of a few days have no nutritional significance, except as they might indicate the possibility of depletion of bone mineral stores following long-time, continuous, feeding of a particular diet. The present data show that growing pups stored calcium and made normal bone growth on all of the diets tested, and that those containing corn Distillers Dried Solubles were at least equal to the control diet in calcium availability.

Table VIII summarizes the data for the individual pups for phosphorus metabolism. All animals stored phosphorus on all diets. Singen (1948) reported that of the 0.25% total phosphorus present in ground corn, 0.20% or

TABLE VIII
PHOSPHORUS RETENTION BY INDIVIDUAL DOGS

Diet	Phosphorus Retention									
	84	85	86	87	92	93	94	100	Av	
1. Control	30	26	25	26	27	34	25	25	31	28.0
2. 15% Corn DDS ¹	25	21	13	33	19	31	27	28	31	24.6
3. 30% Corn DDS	63	62	44	67	53	61	61	62	62	59.1
4. 30% Sucrose	69	66	66	71	54	65	62	69	69	65.3

¹ DDS = Distillers Dried Solubles.

81% of the total, was present as phytin. In corn Distillers Dried Solubles none of the 0.75% phosphorus was in the phytin form. On the basis of these data one would expect the phosphorus, as well as the calcium in corn Distillers Dried Solubles, to be fully as available, or even more so, than in kibbled corn.

STUDIES ON REPRODUCTION

Female Beagles have been maintained for several years on diets containing 7.0% corn Distillers Dried Solubles and they have shown satisfactory reproductive performance. In initial tests pups that had been used on growth studies were continued throughout several reproductive cycles (McCay *et al.*, 1958; Waner and McCay, 1960). Tests on reproduction have been continued and additional females used. The diets fed are shown in table IX.

TABLE IX
DIETS USED IN STUDIES ON REPRODUCTION

Ingredients	Diet Number			
	1	2	3	4
Basal mixture ¹	42.8	42.8	42.8	42.8
Kibbled corn	23.7	23.7	23.7	16.7
Meat scrap	11.0	18.0	18.0	18.0
Wheat germ	8.5	1.5	8.5	8.5
Corn Distillers Dried Solubles	7.0	7.0	7.0	7.0
Dried skimmed milk	5.0	5.0	0	5.0
Tomato pomace	2.0	2.0	0	2.0
Totals	100.0	100.0	100.0	100.0

¹The basal mixture contained 46.0% kibbled corn, 17.5% soybean meal, 12.0% tallow, 6.0% wheat flakes, 4.7% brewers dried yeast, 3.5% alfalfa meal, 3.5% fish meal, 3.5% cheese meal, 1.2% liver meal, 1.2% dicalcium phosphate, 0.5% iodized salt, 0.2% irradiated yeast and 0.2% fish liver oil concentrate.

Other females fed a stock diet served as controls. The average results are summarized in table X. The control females received a diet consisting of 21% kibbled corn, 20.5% corn flakes, 18% meat meal, 8.5% soybean meal, 8.5% wheat germ, 5% wheat flakes, 4% dried skimmed milk, 4% tallow, 2% cheese meal, 2% tomato pomace, 2% torula yeast, 1.5% fish meal, 1.5% alfalfa meal, 1% liver meal, 0.3% iodized salt, 0.1% irradiated yeast and 0.1% vitamin A feeding oil. This diet and others only slightly modified have been used for years with excellent results for pup production.

The data in table X clearly show that female Beagles fed diets containing 7.0% corn Distillers Dried Solubles produced as many pups per litter and weaned as many live, healthy pups as females fed the best stock diets

TABLE X
REPRODUCTIVE PERFORMANCE OF FEMALE BEAGLES
FED CORN DISTILLERS DRIED SOLUBLES

Diet no.	Number Of		Pups per Litter		Fertile breedings	Pup survival
	Females	Breedings	Born	Weaned		
1	12	53	3.6	3.8	68	70
2	11	46	3.6	5.1	78	77
3	9	39	3.3	3.9	85	75
4	8	41	2.9	4.1	71	85
Total	40	134	3.7	5.5	75	76
OR AV	37	47	3.7	5.2	79	89

known. Approximately 75% of all pups born survived to weaning age and 75% of all females mated produced live litters. This is an exceptionally high level of reproductive performance (McCay and Stevens, 1963) for kennels.

SUMMARY

The use of 7.0% corn Distillers Dried Solubles in meal type diets has given favorable results with growing Beagle pups and with females during reproduction over several years. Litters were as large and pup survival was as good on diets containing corn Distillers Dried Solubles as on control diets. The question as to whether more than 7% corn Distillers Dried Solubles would give favorable results in long time studies has not been answered.

Digestion and balance experiments have shown that the nutrients in corn Distillers Dried Solubles are well utilized by dogs. Growing pups stored approximately as much nitrogen, calcium and phosphorus from diets containing corn Distillers Dried Solubles as from control diets. At a level of 30% corn Distillers Dried Solubles, the diets were noticeably less palatable for pups and some cases of mild diarrhea occurred.

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