Biomass Energy Production Co-Products

Turkey Feeding Trials

MINNESOTA AGRIPOWER PROJECT
TASK I RESEARCH REPORT

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Alfalfa Leaf Meal for Market and Breeder Hen Turkeys

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I. True Metabolizable Energy Content of ALM

A sample of ALM became available for testing in October, 1996. The sample was in pelleted form and contained 24.2% crude protein and a gross energy content of 4102 kcal/kg (as fed basis). To determine available energy, the true metabolizable energy assay as developed by Sibbald (Sibbald, I.R., 1983. The T.M.E. system of feed evaluation. A.R.C. #83-1, Research Branch, Ottawa, Canada) was used with some modifications as described below. As the ALM was in pellets too large to feed, the ALM pellets were crumbled or finely reground for the test.

Young turkeys (6 wks of age, Nicholas females) were placed in individual cages and allowed to acclimate for 5 days. The turkeys weighed 2.4 kg. The turkeys were fasted for 40 hrs and precision fed 36 g of either crumbled (C) or finely (F) reground ALM. Due to the larger volume of the fine ground ALM, a smaller portion was fed and averaged 28 g. The control turkeys received an equivalent amount of glucose. There were 6 replicates for each ALM source and control turkeys. Excreta was collected for 60 hrs after feeding, consistent with recommendations for a longer collection period for fibrous materials. After the collection period ended, the excreta was quantitatively collected and all material was freeze dried. Each sample was allowed to reach equilibrium with atmospheric conditions and then weighed. The excreta was finely ground and analyzed for moisture, protein and gross energy. Samples of the fed ALM were treated in a similar manner.

The true metabolizable energy content (nitrogen corrected) of the C and F ALM was 1012 (SE 50) and 1578 (SE 159) kcal/kg, respectively. Form of ALM significantly affected TME value ($P<.01$). The difference in TMEn due to form was most likely due to the difference in amount fed. The crumbled form of ALM allowed the full amount to be fed and could have changed passage rate of the ALM through the digestive tract.

When the TMEn of the F ALM is adjusted for dry matter content, the value is 1679 kcal/kg dry matter. This value compares well with TMEn for higher protein type dehyd. alfalfa meal. Sibbald (1977) found the TMEn of several dehyd. alfalfa meal samples averaged 1470 kcal/kg dry matter. Lower protein meal (15-16% CP) averaged 1210 kcal while higher protein meal (21-22%) averaged 1790 kcal/kg dry matter.

II. Alfalfa Leaf Meal in Market Turkey Diets-Feeding Trial

Dehydrated alfalfa meal has been used in the past in poultry diets as a source of xanthophyll (source of yellow carcass or egg yolk pigmentation) or "unidentified growth factor" for growing or breeding turkeys. Its use has been limited to low levels due to a relatively low protein and energy content. Dehydrated alfalfa meal is produced from the alfalfa plant and is dried artificially. For the 17% protein product, the NRC (1994) lists a crude fiber content of 24% and a metabolizable energy content of 544 kcal/lb (as fed basis).

Alfalfa leaf meal (ALM) is a product produced by separation of the leaf portion of the plant from the stems. Trial separations of the leaf from the stem portion of the plant indicate that the protein content could be increased considerably (H. G. Jung, Personal communication, University of Minnesota). Mechanical separation of leaves and stem produced a product containing 25.2% protein (dry matter basis) while hand separation produced a product containing 30% protein (dry matter basis). Fiber content was decreased in the leaf portion as compared to the stem. Thus the ALM becomes a more valuable feed ingredient. Determining the feeding value of the ALM is an important part of this project.

Research conducted at the University of Minnesota-Rosemount Agricultural Experiment Stations indicates that ALM can be incorporated into market turkey diets up to 7.5% of the diet. The best performance was obtained by the 2.5% inclusion level as early feed intake and growth rates were increased over that of the control.

Four dietary treatments were fed: control (without ALM), and ALM inclusion levels of 2.5, 5.0 and 7.5% of the diet. The diets were corn-soybean meal based and contained some meat and bone meal. Diets were pelleted and the energy level allowed to decrease with ALM addition. Each percentage addition of ALM replaced .45-.55% corn and .4-.5% soybean meal (47%) depending on the age of the bird. Diets were adjusted for nutrient content for each 4-week feeding period (Tables 1a-1d). In November (1996), male poults (Nicholas strain) were placed into 32 pens (19/pen) and were fed the dietary treatments to 16 weeks of age.

Body weights (Table 2):
At 2, 4, and 8 weeks of age, weights of tom turkeys were increased by inclusion of 2.5% ALM over that of the control ($P<.05$). At 12 and 16 wks, 2.5% ALM treatment continued to be the heaviest.

Body weight gain (Table 3):
During brooding (0-4wks) and early growout (4-8 wks) rate of gain was increased by inclusion of 2.5% ALM over that of the control. After 8 weeks, rate of gain tended to be greater than that of the control.

Feed intake (Table 4):
Feed intake was increased by ALM feeding during 0-4 and 4-8 wks especially for the 7.5% ALM level. This tended to result in greater feed intake for the entire 16 weeks.

Feed efficiency (Table 5):
Feed efficiency (feed/gain) was significantly affected by ALM inclusion during 4-8 and 8-12 wks of age when feed efficiency was somewhat poorer in the 7.5% ALM group. As a result this group also tended to have poorer feed efficiency for the 0-16 wk trial period.

Other measurements:
Other measurements taken during the trial such as mortality (Table 6), incidence of breast blisters and FUD (Table 7), and litter moisture (Table 8) generally showed no treatment effect.

Economics of ALM in market turkey diets (Tables 9 and 10)

Value of ALM in market turkey diets can be influenced by many different facets depending on the goals of the nutritionist regarding ingredient use and feed conversion. When ALM is substituted into the diet, levels of corn and soybean meal decrease as the ALM is replacing protein provided by those ingredients. However, a decrease in energy also occurs and dietary energy level is important for determining overall feed conversion. If the drop in dietary energy is undesirable then additional supplemental fat will be needed thus increasing the cost of the ration. Thus, ingredient prices for corn, soybean meal, supplemental fat and supplemental amino acids as well as the desired dietary energy level or nutrient density will influence use of ALM.

In the most simplified case ALM can be priced according to its value as protein supplement disregarding other changes it may cause in the diet. In this case pricing can be looked at relative to unit price per lb of protein supplied. Thus when SBM (47% CP as fed) is priced at $280/ton, ALM (20% CP as fed) could be priced at $119/ton.

The next level of value assessment would be to look at it terms of least feed formulation which is usually used in commercial poultry feed business. Now the interactions between ingredient costs and nutrient specifications can be examined. In this system with corn at $2.31/bu ($4.13/100lbs), fat at $14/100 lbs, and soy at $280/ton, the value for ALM in starter diets will range from $49 to $127/ton depending on the energy level and in finisher diets from $45 to $126/ton. Here the value is dependent on the specified energy level of the diet and price of supplemental fat. ALM can be more easily incorporated into the low energy diet and thus has more value. When high-energy diets are used, the value of ALM decreases because of its low energy value.

The final level of value assessment would be to incorporate the least cost feed formulation with expected performance. To do this I took the data from the research trial and used a simulation program (P. Waibel, University of Minnesota, TURKS, Version 1, 1985) to calculate costs and returns. Using feed ingredient prices as specified earlier, and with ALM priced at $100/ton; simulated returns ($/turkey marketed) were 1.19, 1.33, 1.28, and 1.25 for ALM inclusion levels of 0, 2.5, 5, and 7.5%, respectively. When price of ALM was increased to $200/ton, respective returns were 1.19, 1.24, 1.1, and .97. The better profitability at $100/ton was primarily due to the heavier market weights of the turkeys fed ALM.

The data indicate that ALM could be included to 7.5% of the diet for market tom turkeys depending on economic and performance considerations. The best performance was obtained by the 2.5%

inclusion level as early feed intake and growth rates were increased over that of the control. Inclusion at 2.5% remained profitable although less so when the price of ALM increased from 5 to $10/cwt.

III. Alfalfa leaf meal in turkey breeder hen diets

Dehydrated alfalfa meal has been used in the past in poultry diets primarily for factors called "unidentified growth or hatchability factors". Due to its low energy (high fiber content) and moderate protein level its use in commercial market diets is limited. Its use would be more likely in lower energy diets fed to either breeder candidates or breeder hens. General recommendations are to use two sources of UGF in the diet. In this study, the effect of inclusion of alfalfa leaf meal in turkey breeder hen diets alone and in combination with other UGF sources was determined.

Alfalfa leaf meal will be incorporated into corn-soybean meal based diets for a 24 week production period. Levels of 0, 2.5 and 5% will be used. Each diet will be fed to 8 replicate pens of hens with 12 hens/pen. During the breeder study, measurements of egg production, egg condition, egg weight, fertility and hatchability will be taken. Body weight, feed intake and mortality of the hens will be monitored as well.

Materials and Methods:

Turkeys and Management. Large white Nicholas strain hens (female line females) were used in the study. Hens were housed in a breeder facility in pens measuring 9' by 7'. Each pen was bedded with wood shavings and contained 3 nest boxes (semi-trap). There were 12 hens per pen. Hens were maintained under a light schedule of 15L:9D at 7-8 FC of incandescent light. Hens were inseminated weekly with pooled semen. If hens could not be opened for insemination they were recorded as a non-opener (out-of-production). Broody hens were identified by nesting frequency and removed from the pen for 3-5 days in an attempt to break the broody cycle. Barn temperatures varied with outside temperature. A minimum room temperature of 55 F was held during colder weather. Each day, eggs were collected hourly. Eggs are washed and disinfected after collection and stored at 58 F. Eggs were picked up by a commercial hatchery on a weekly basis.

Diet. The diets used in the experiment differed in the source of UGF. The corn-soybean meal based diet (Table 11) was formulated to contain 15% protein, 2.5% calcium, and .44% available phosphorus. ALM was included in the diet at levels of 2.5 and 5%. In addition the 2.5% level of ALM was tested in combination with corn distillers dried grains, fish solubles, and fermentation residue product (Fermacto). Diets were fed in pelleted form and fed to the hens from 30 to 57 weeks age (0-24 weeks of production).

Measurements. Hens were individually weighed and feed intake recorded at 4-week intervals. Egg production, egg condition, and broodiness as well as mortality was recorded daily. Eggs were classified as non-settable if they had one of the following conditions: soft (membranous) shell, broken, peewee (small in size), double yolk, deformed (eg., slab sided) or dirty. For one week of each 4 week production period, settable eggs were marked with pen number, weighed, and shell

quality assessed by specific gravity. The eggs were shipped to a commercial hatchery (Willmar Poultry Company, Foley, MN) for determination of hatchability and fertility. Data is summarized for purposes of analyses and presentation into three 4-week production periods.

Experimental design and analyses. Each pen of hens is considered to be the experimental unit. Each dietary treatment was fed to 8 replicate pens of hens. Diets were assigned randomly to the 48 pens of hens. For each 4-week production period, ANOVA (one-way) was used to determine if treatment effects exist for rate of egg production, incidence of abnormal eggs, incidence of broodiness, egg weight, hen feed intake, hen body weight, egg specific gravity, fertility and hatchability.

Results:

Egg production (Table 12): Rate of egg production was statistically similar among the hens. Egg production during 16-20 and 20-24 weeks tended to be greater for 2.5% ALM with higher overall rate of egg production.

Egg weight (Table 13): During the period of time that the eggs were pen marked, each pen of eggs was weighed daily as a group. Egg weight tended to be less for the 2.5 and 5% ALM treatments throughout the experiment. However, as the egg weight was quite acceptable at the start this was not anticipated to be a problem.

Fertility (Table 14). Hens fed the 2.5% ALM diets tended to have better fertility over the six periods of production while inclusion at 5% tended to depress fertility.

Hatchability of fertile eggs (Table 15). Hatchability was not affected by any treatment nor were any trends apparent.

Other measurements (Tables 16-19). Egg condition, hen mortality, hen body weight and feed intake were not affected by any of the dietary treatments.

In summary, inclusion of ALM (2.5%) tended to increase egg production and fertility. This would result in a higher number of fertile eggs for setting. For comparison purposes, the calculated fertile egg numbers for the control and 2.5% ALM treatments were 99 and 105 eggs/hen, respectively. Inclusion of 2.5% ALM with other UGF sources did not result in any additional benefits in reproductive performance.

Table 1a. 0-4 Week Diet Summary for Experiment M-964

Ingredient	Trt 1	Trt 2	Trt 3	Trt 4
			%	
Corn, ground yellow	46.2690	45.1507	44.0479	42.9345
Soybean meal (46.5%)	43.0539	41.8475	40.6343	39.4257
Meat and bone meal	7	7	7	7
Alfalfa (MNVAP)	0	2.5	5	7.5
Dicalcium phosphate	1.0387	.9779	.9168	.8600
Calcium carbonate	.7066	.6004	.4942	.3880
Salt	.2582	.2491	.2399	.2308
DL-Methionine (99%)	.2018	.1967	.1916	.1866
Trace mineral mix (MNTM)	.13	.13	.13	.13
Vitamin mix (MTS)	.25	.25	.25	.25
Choline chloride (50%)	.10	.10	.10	.10
Animal fat	.99	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00
Nutrient:				
Protein (%)	27.7	27.5	27.4	27.2
Metabolizable Energy (kcal/kg)	2830	2799	2767	2736
Calcium (%)	1.333	1.318	1.303	1.288
Phosphorus, total (%)	.946	.931	.916	.901
Phosphorus, inorganic (%)	.668	.661	.653	.646
Potassium (%)	1.110	1.136	1.162	1.188
Sodium (%)	.173	.171	.169	.167
Chloride (%)	.260	.265	.271	.276
Choline (mg/kg)	2102	2098	2093	2089
Methionine + Cystine (%)	1.061	1.050	1.038	1.026
Lysine (%)	1.616	1.598	1.580	1.562
Nutrient per therm:				
Protein	9.780	9.832	9.886	9.941
Metabolizable Energy	1000	1000	1000	1000
Calcium	.471	.471	.471	.471
Phosphorus, total	.334	.333	.331	.329
Phosphorus, inorganic	.236	.236	.236	.236
Potassium	.392	.406	.420	.434
Sodium	.061	.061	.061	.061
Chloride	.092	.095	.098	.101
Choline	743	750	757	764
Methionine + Cystine	.375	.375	.375	.375
Lysine	.571	.571	.571	.571

Table 1b. 4-8 Week Diet Summary for Experiment M-964

Ingredient	Trt 1	Trt 2	Trt 3	Trt 4
			%	
Corn, ground yellow	49.4916	48.3126	47.1445	45.9870
Soybean meal (47%)	39.4768	38.3147	37.1480	35.9768
Meat and bone meal	7	7	7	7
Alfalfa (MNVAP)	0	2.5	5	7.5
Dicalcium phosphate	.6197	.5638	.5077	.4514
Calcium carbonate	.5391	.4349	.3305	.2261
Salt	.3000	.3000	.3000	.3000
DL-Methionine (99%)	.1393	.1350	.1307	.1264
Trace mineral mix (MNTM)	.12	.12	.12	.12
Vitamin mix (MTS)	.22	.22	.22	.22
Choline chloride (50%)	.10	.10	.10	.10
Animal fat	1.99	2.00	2.00	1.99
Total	100.00	100.00	100.00	100.00
Nutrient:				
Protein (%)	26.2	26.1	25.9	25.8
Metabolizable Energy (kcal/kg)	2931	2899	2866	2833
Calcium (%)	1.172	1.16	1.146	1.133
Phosphorus, total (%)	.855	.841	.827	.813
Phosphorus, inorganic (%)	.586	.58	.573	.567
Potassium (%)	1.047	1.074	1.101	1.27
Sodium (%)	.189	.19	.192	.194
Chloride (%)	.285	.296	.307	.317
Choline (mg/kg)	2025	2021	2017	2014
Methionine + Cystine (%)	.961	.951	.940	.929
Lysine (%)	1.515	1.499	1.482	1.465
Nutrient per therm:				
Protein	8.948	8.999	9.050	9.103
Metabolizable Energy	1000	1000	1000	1000
Calcium	.400	.400	.400	.400
Phosphorus, total	.292	.290	.289	.287
Phosphorus, inorganic	.200	.200	.200	.200
Potassium	.357	.371	.384	.448
Sodium	.064	.066	.067	.068
Chloride	.097	.102	.107	.112
Choline	691	697	704	711
Methionine + Cystine	.328	.328	.328	.328
Lysine	.517	.517	.517	.517

Table 1c. 8-12 Weeks Diet Summary for Experiment M-964

Ingredient	Trt 1	Trt 2	Trt 3	Trt 4
			%	
Corn, ground yellow	56.4490	55.1976	53.9360	52.6933
Soybean meal (47%)	33.8928	32.7955	31.7022	30.6015
Meat and bone meal	6	6	6	6
Alfalfa (MNVAP)	0	2.5	5	7.5
Dicalcium phosphate	.3748	.3248	.2749	.2247
Calcium carbonate	.5383	.4394	.3405	.2415
Salt	.3060	.3060	.3060	.3060
DL-Methionine (99%)	.0934	.0900	.0866	.0831
Trace mineral mix (MNTM96)	.10	.10	.10	.10
Vitamin mix (MNVIT96)	.21	.21	.21	.21
Choline chloride (50%)	.05	.05	.05	.05
Animal fat	1.99	1.99	2.00	1.99
Total	100.00	100.00	100.00	100.00
Nutrient:				
Protein (%)	24.0	23.9	23.8	23.6
Metabolizable Energy (kcal/kg)	3082	3047	3013	2978
Calcium (%)	1.004	.993	.982	.97
Phosphorus, total (%)	.744	.731	.718	.706
Phosphorus, inorganic (%)	.496	.491	.485	.479
Potassium (%)	.915	.943	.971	.999
Sodium (%)	.185	.187	.188	.19
Chloride (%)	.27	.28	.291	.3
Choline (mg/kg)	1645	1643	1641	1639
Methionine + Cystine (%)	.822	.813	.803	.794
Lysine (%)	1.335	1.32	1.305	1.29
Nutrient per therm:				
Protein	7.792	7.838	7.885	7.934
Metabolizable Energy	1000	1000	1000	1000
Calcium	.326	.326	.326	.326
Phosphorus, total	.241	.240	.238	.237
Phosphorus, inorganic	.161	.161	.161	.161
Potassium	.297	.309	.322	.335
Sodium	.060	.061	.062	.064
Chloride	.088	.092	.097	.101
Choline	534	539	545	550
Methionine + Cystine	.267	.267	.267	.267
Lysine	.433	.433	.433	.433

Table 1d. 12-16 Weeks Diet Summary for Experiment M-964

Ingredient	Trt 1	Trt 2	Trt 3	Trt 4
			%	
Corn, ground yellow	65.8282	64.4562	63.0882	61.7021
Soybean meal (47%)	24.4401	23.4622	22.4829	21.5097
Meat and bone meal	5	5	5	5
Alfalfa (MNVAP)	0	2.5	5	7.5
Dicalcium phosphate	.4736	.4257	.3777	.3300
Calcium carbonate	.5366	.4390	.3414	.2439
Salt	.3324	.3324	.3324	.3324
DL-Methionine (99%)	.0571	.0541	.0510	.0481
Trace mineral mix (MNTM96)	.10	.10	.10	.10
Vitamin mix (MNVIT96)	.20	.20	.20	.20
Choline chloride (50%)	.04	.04	.04	.04
Animal fat	3.00	3.00	2.99	3.00
Total	100.00	100.00	100.00	100.00
Nutrient:				
Protein (%)	19.9	19.8	19.7	19.6
Metabolizable Energy (kcal/kg)	3226	3190	3154	3118
Calcium (%)	.898	.887	.877	.867
Phosphorus, total (%)	.678	.667	.655	.643
Phosphorus, inorganic (%)	.455	.45	.445	.44
Potassium (%)	.742	.772	.802	.832
Sodium (%)	.187	.189	.19	.192
Chloride (%)	.277	.288	.299	.309
Choline (mg/kg)	1375	1376	1376	1376
Methionine + Cystine (%)	.677	.669	.661	.654
Lysine (%)	1.041	1.029	1.017	1.006
Nutrient per therm:				
Protein	6.155	6.199	6.243	6.289
Metabolizable Energy	1000	1000	1000	1000
Calcium	.278	.278	.278	.278
Phosphorus, total	.210	.209	.208	.206
Phosphorus, inorganic	.141	.141	.141	.141
Potassium	.230	.242	.254	.267
Sodium	.058	.059	.060	.062
Chloride	.086	.090	.094	.099
Choline	426	431	436	441
Methionine + Cystine	.210	.210	.2106	.210
Lysine	.323	.323	.3235	.323

Table 2. Body Weight Summary for Experiment M-964

Treatment Number	Description	Average Body Weight for Weeks: Day 0	2 wks	4 wks	4 wks	8 wks	12 wks	16 wks
		g			kg			
1	Control	62.5	339.4	1067.4	1.07	4.17	9.07	13.15
2	2.5% Alfalfa meal	62.4	357.8	1120.3	1.12	4.27	9.23	13.46
3	5.0% Alfalfa meal	62.1	319.8	1032.9	1.03	4.02	8.98	13.22
4	7.5% Alfalfa meal	61.6	356.4	1089.7	1.09	4.22	8.95	13.26
	Average	62.1	343.3	1077.6	1.08	4.17	9.06	13.27
Room 1 (pens 1-16)								
1	Control	----	----	----	1.06	4.16	9.01	13.18
2	2.5% Alfalfa meal	----	----	----	1.13	4.29	9.20	13.49
3	5.0% Alfalfa meal	----	----	----	1.03	3.96	8.84	13.10
4	7.5% Alfalfa meal	----	----	----	1.09	4.28	8.88	13.18
	Average	----	----	----	1.08	4.17	8.98	13.24
Room 2 (pens 17-32)								
1	Control	----	----	----	1.07	4.18	9.13	13.12
2	2.5% Alfalfa meal	----	----	----	1.11	4.25	9.26	13.44
3	5.0% Alfalfa meal	----	----	----	1.04	4.07	9.13	13.33
4	7.5% Alfalfa meal	----	----	----	1.09	4.16	9.01	13.33
	Average	----	----	----	1.08	4.17	9.13	13.31
Statistics								
Pvalue								
Treatment		.0196	.0012	.0022		.0005	.0270	.2052
Room		----	----	----		.8794	.0272	.5318
Treatment x Room		----	----	----		.1628	.6007	.7086
Least significant difference								
Treatment		.6	19.3	42.3		.11	.19	.31
Room		----	----	----		.08	.13	.22
Error mean square		.3	350.0	1686.8		.0104	.03	.04
Standard error of means		.3	9.4	20.5		.05	.09	.10

Table 3. Average Daily Gain for Experiment M-964

Treatment Number	Description	Average Daily Gain During Weeks: 0-2	2-4	0-4	4-8	8-12	12-16	4-16	0-16
		g							
1	Control	19.7	51.4	35.6	109.1	170.4	146.9	141.9	115.5
2	2.5% Alfalfa meal	21.1	53.3	37.2	110.8	173.8	147.5	144.0	117.3
3	5.0% Alfalfa meal	18.4	50.0	34.2	105.2	173.5	148.5	142.4	115.4
4	7.5% Alfalfa meal	21.1	51.8	36.4	111.3	166.5	152.1	143.1	116.6
	Average	20.1	51.6	35.9	109.1	171.0	148.8	142.8	116.2
Room 1 (pens 1-16)									
1	Control	----	----	35.1	108.6	167.0	144.4	139.9	113.8
2	2.5% Alfalfa meal	----	----	37.3	114.2	176.7	152.4	147.7	120.2
3	5.0% Alfalfa meal	----	----	33.9	103.6	170.7	151.2	141.8	114.9
4	7.5% Alfalfa meal	----	----	36.3	112.5	161.7	151.6	141.9	115.5
	Average	----	----	35.6	109.7	169.0	149.9	142.8	116.1
Room 2 (pens 17-32)									
1	Control	----	----	36.1	109.6	173.8	149.4	143.9	117.2
2	2.5% Alfalfa meal	----	----	37.1	107.5	170.9	142.6	140.2	114.5
3	5.0% Alfalfa meal	----	----	34.5	106.8	176.2	145.9	143.0	115.9
4	7.5% Alfalfa meal	----	----	36.6	110.1	171.2	152.7	144.4	117.7
	Average	----	----	36.1	108.5	173.1	147.6	142.9	116.3
Statistics									
Pvalue									
Treatment		.0010	.0326	.0034	.0287	.0651	.7290	.8576	.7209
Room		----	----	----	.3896	.0608	.5307	.9718	.8695
Treatment x Room		----	----	----	.1167	.0691	.4814	.1396	.1385
Least significant difference									
Treatment		1.4	2.1	1.5	4.2	6.0	10.4	5.3	4.1
Room		----	----	----	3.0	4.2	7.4	3.8	2.9
Error mean square		1.8	4.3	2.2	16.6	33.3	100.7	26.2	15.7
Standard error of means		.7	1.0	.7	2.0	2.9	5.0	2.6	2.0

Table 4. Average Daily Feed Intake for Experiment M-964

Treatment Number	Description	Average Daily Feed Intake During Weeks: 0-4	4-8	8-12	12-16	4-16	0-16
		g					
1	Control	57.5	202.5	382.1	529.4	368.9	292.8
2	2.5% Alfalfa meal	61.1	210.3	391.0	535.8	378.5	299.5
3	5.0% Alfalfa meal	56.9	207.0	390.3	547.7	380.3	300.5
4	7.5% Alfalfa meal	60.6	219.0	399.8	552.8	388.9	308.0
	Average	59.0	209.7	390.8	541.4	379.1	300.2
Room 1 (pens 1-16)							
1	Control	57.4	196.7	380.5	520.8	365.3	288.9
2	2.5% Alfalfa meal	61.1	215.0	401.5	546.3	387.2	306.0
3	5.0% Alfalfa meal	56.8	208.2	387.3	543.5	378.6	299.0
4	7.5% Alfalfa meal	60.6	214.9	395.4	543.6	383.5	303.6
	Average	59.0	208.7	391.2	538.6	378.6	299.4
Room 2 (pens 17-32)							
1	Control	57.5	208.2	383.7	537.9	372.5	296.8
2	2.5% Alfalfa meal	61.1	205.5	380.5	525.3	369.7	293.1
3	5.0% Alfalfa meal	56.9	205.8	393.3	552.0	382.0	302.0
4	7.5% Alfalfa meal	60.5	223.0	404.3	561.9	394.3	312.4
	Average	59.0	210.6	390.4	544.3	379.6	301.1
Statistics							
Pvalue							
Treatment		.0001	.0065	.1256	.3920	.1080	.1159
Room		----	.5264	.8825	.5909	.8569	.6830
Treatment x Room		----	.0825	.1583	.5279	.2811	.2567
Least significant difference							
Treatment		1.9	8.8	14.6	30.8	16.0	12.3
Room		----	6.2	10.3	21.8	11.3	8.7
Error mean square		3.6	72.1	196.8	878.6	235.5	139.3
Standard error of means		.9	4.2	7.0	14.8	7.7	5.9

Table 5. Feed Efficiency for Experiment M-964

Treatment Number	Description	Feed Efficiency During Weeks: 0-4	4-8	8-12	12-16	4-16	0-16
		Feed/Gain					
1	Control	1.618	1.855	2.244	3.607	2.600	2.331
2	2.5% Alfalfa meal	1.644	1.900	2.249	3.635	2.629	2.357
3	5.0% Alfalfa meal	1.664	1.968	2.251	3.689	2.671	2.393
4	7.5% Alfalfa meal	1.663	1.968	2.406	3.642	2.716	2.420
	Average	1.647	1.923	2.337	3.643	2.654	2.375
Room 1 (pens 1-16)							
1	Control	1.635	1.811	2.280	3.607	2.611	2.333
2	2.5% Alfalfa meal	1.638	1.884	2.271	3.585	2.620	2.345
3	5.0% Alfalfa meal	1.676	2.009	2.269	3.594	2.670	2.387
4	7.5% Alfalfa meal	1.669	1.911	2.447	3.596	2.701	2.406
	Average	1.655	1.903	2.317	3.595	2.651	2.368
Room 2 (pens 17-32)							
1	Control	1.593	1.900	2.208	3.607	2.590	2.327
2	2.5% Alfalfa meal	1.647	1.917	2.227	3.684	2.638	2.369
3	5.0% Alfalfa meal	1.649	1.928	2.232	3.785	2.673	2.399
4	7.5% Alfalfa meal	1.653	2.026	2.364	3.689	2.731	2.433
	Average	1.636	1.943	2.258	3.691	2.658	2.382
Statistics							
Pvalue							
Treatment		.2364	.0013	.0004	.6329	.0037	.0098
Room		----	.0649	.0317	.0437	.7241	.4385
Treatment x Room		----	.0120	.9028	.5267	.8345	.8957
Least significant difference							
Treatment		.051	.059	.075	.131	.060	.052
Room		----	.042	.053	.093	.043	.037
Error mean square		.002	.003	.005	.016	.003	.002
Standard error of means		.024	.028	.036	.063	.029	.025

Table 6. Mortality and Removals for Experiment M-964

Treatment Number	Description	Mortality During Weeks: 0-4	4-8	8-12	12-16	4-16	0-16	Live Removals During Weeks: 0-4	4-16
		%							
1	Control	1.85	.00	.63	.66	.43	.78	0	3.19
2	2.5% Alfalfa meal	1.28	.00	.00	.66	.22	.48	0	3.23
3	5.0% Alfalfa meal	1.91	.00	.00	1.35	.45	.82	0	1.91
4	7.5% Alfalfa meal	.63	.63	.66	.69	.66	.65	0	4.54
	Average	1.42	.16	.32	.84	.44	.68	0	3.22
Room 1 (pens 1-16)									
1	Control	3.70	.00	1.25	.00	.42	1.24	0	5.00
2	2.5% Alfalfa meal	1.23	.00	.00	1.32	.44	.64	0	3.82
3	5.0% Alfalfa meal	2.53	.00	.00	.00	.00	.64	0	1.32
4	7.5% Alfalfa meal	1.26	.00	.00	.00	.00	.32	0	6.45
	Average	2.18	.00	.31	.33	.21	.70	0	4.15
Room 2 (pens 17-32)									
1	Control	00	.00	.00	1.32	.44	.33	0	1.39
2	2.5% Alfalfa meal	1.33	.00	.00	.00	.00	.33	0	2.63
3	5.0% Alfalfa meal	1.30	.00	.00	2.70	.90	1.00	0	2.50
4	7.5% Alfalfa meal	00	1.25	1.32	1.39	1.32	.99	0	2.63
	Average	.66	.31	.33	1.35	.66	.66	0	2.29
Statistics									
Pvalue									
	Treatment	.7631	.4123	.5996	.8719	.8230	.9124	----	.6228
	Room	----	.3287	.9721	.1623	.1822	.9110	----	.1951
	Treatment x Room	----	.4123	.3095	.2646	.2418	.4209	----	.5524
Least significant difference									
	Treatment	2.79	.92	1.37	2.08	.96	1.06	----	4.08
	Room	----	.65	.97	1.47	.68	.75	----	2.88
Error mean square		7.36	.78	1.7	3.99	.85	1.03	----	15.42
Standard error of means		1.36	.44	.66	1.00	.46	.26	----	1.96

Table 7. Incidence of Breast Blisters and FUD for Experiment M-964

Treatment Number	Description	Breast Blister 12 wks	Breast Blister 16 wks	FUD 16 wks
		%	%	%
1	Control	18.62	10.23	10.16
2	2.5% Alfalfa meal	16.12	20.29	14.61
3	5.0% Alfalfa meal	18.27	15.62	12.62
4	7.5% Alfalfa meal	11.44	11.39	6.69
	Average	16.11	14.38	11.02
Room 1 (pens 1-16)				
1	Control	23.93	9.72	17.62
2	2.5% Alfalfa meal	15.54	19.02	17.00
3	5.0% Alfalfa meal	27.11	15.00	19.59
4	7.5% Alfalfa meal	8.33	17.36	2.64
	Average	18.73	15.28	14.21
Room 2 (pens 17-32)				
1	Control	13.31	10.75	2.70
2	2.5% Alfalfa meal	16.69	21.56	12.23
3	5.0% Alfalfa meal	9.43	16.25	5.65
4	7.5% Alfalfa meal	14.55	5.41	10.75
	Average	13.50	13.49	7.83
Statistics				
Pvalue				
	Treatment	.6894	.4986	.5158
	Room	.2777	.7274	.1125
	Treatment x Room	.2871	.7173	.1566
Least significant difference				
	Treatment	13.82	14.87	11.33
	Room	9.77	10.51	8.01
Error mean square		176.53	204.86	118.62
Standard error of means		6.64	7.16	5.45

Table 8. Litter Moisture for Experiment M-964

Treatment Number	Description	Litter Moisture 10 wks	14 wks
		%	
1	Control	35.19	35.30
2	2.5% Alfalfa meal	36.10	36.80
3	5.0% Alfalfa meal	36.79	37.50
4	7.5% Alfalfa meal	36.75	34.82
	Average	36.21	36.10
Room 1 (pens 1-16)			
1	Control	30.70	32.63
2	2.5% Alfalfa meal	35.13	39.28
3	5.0% Alfalfa meal	33.18	37.03
4	7.5% Alfalfa meal	32.73	33.10
	Average	32.93	35.51
Room 2 (pens 17-32)			
1	Control	39.68	37.97
2	2.5% Alfalfa meal	37.08	34.33
3	5.0% Alfalfa meal	40.40	37.98
4	7.5% Alfalfa meal	40.78	36.54
	Average	39.48	36.70
Statistics			
Pvalue			
Treatment		.0001	.2294
Room		.7494	.2004
Treatment x Room		.1781	.0074
Least significant difference			
Treatment		1.23	2.86
Room		.87	2.02
Error mean square		11.02	7.42
Standard error of means		1.66	1.36

Table 9. ALM diet costs ($/ton)

Turkey age (wks)	Alfalfa Leaf Meal Inclusion level (%) 0	2.5	5.0	7.5
0-4	194.24	192.09	189.90	187.74
4-8	186.36	184.32	182.26	180.18
8-12	171.23	169.34	167.48	165.58
12-16	151.53	149.89	148.24	146.43

Feed ingredient costs ($/cwt)

Corn	4.13
SBM, 47	14
Meat-bone meal	14
ALM	5
Animal fat	14
DL-Methionine	150

Table 10. Simulation (Turks Version 1, 1985) of ALM (5/cwt) in market tom diets to 112 days of age for a 10,000 bird flock.

ALM Inclusion Level (%)	0	2.5	5.0	7.5
Performance[1]				
Wt (lbs)	29.0	29.7	29.2	29.2
CFI (lbs)	72.2	74.4	73.7	74.9
FC	2.491	2.504	2.523	2.565
Flock Totals				
No. birds mrktd	9734	9734	9734	9735
Wt (lbs)	282,299	289,113	284,230	284,252
Feed (lbs)	708,534	729,400	722,690	734,722
FC, adjusted	2.510	2.523	2.543	2.585
Expenses ($) for flock				
Feed	58,968	60,026	58,710	59,590
Total	90,843	91,901	90,612	90,952
		(912)[2]	(1807)	(2755)
Income ($)				
Total	102,399	104,871	103,100	103,108
Returns ($)				
Per flock	11,556	12,969	12,487	12,156
		(12,057)[3]	(10,680)	(9401)
Per bird	1.19	1.33	1.28	1.25
		(1.24)	(1.10)	(.966)

[1] Wt (weight), CFI (cumulative feed intake), FC (feed conversion).

[2] Value in parentheses is additional expense with ALM at $10/cwt.

[3] Value in parentheses is calculated with ALM at $10/cwt.

Table 11. Diet summary for Experiment TB971

Ingredient	Breeder Hen Treatment Number 1	2	3	4	5	6
	%					
Ground yellow corn	69.4507	69.999	67.3183	69.7582	69.9763	68.8333
Soybean meal (44%)	19.3508	19.4284	18.924	15.5682	18.986	17.5024
Corn distillers grain	0	0	0	0	0	3
Midds	3.0488	0	0	1.642	.2318	0
Fish solubles (FS.SBM)	0	0	0	2.5	0	0
Alfalfa (Alf1.MNVAP)	0	2.5	5	2.5	2.5	2.5
Fermacto	0	0	0	0	.25	0
Dicalcium phosphate	1.8309	1.8278	1.807	1.7342	1.826	1.7904
Calcium carbonate	5.3732	5.3002	5.1807	5.3207	5.2751	5.2964
Salt	.3	.3	.3	.3	.3	.3
DL-Methionine	.0955	.0946	.097	.1018	.0968	.0976
L-Lysine (74%)	0	0	0	.0249	.0079	.0376
Trace mineral mix (MNTM)	.15	.15	.15	.15	.15	.15
Vitamin mix (MNTB)	.3	.3	.3	.3	.3	.3
Choline chloride (50%)	.1	.1	.1	.1	.1	.1
Animal fat (%)	0	0	.8229	0	0	0
Nutrient:						
Protein (%)	15	15	15	15	15	15
Metab. Energy (kcal/kg)	2813	2813	2813	2813	2813	2813
Calcium (%)	2.5	2.5	2.5	2.5	2.5	2.5
Phosphorus, inorganic (%)	.44	.44	.44	.44	.44	.44
Methionine + Cystine (%)	.62	.62	.62	.62	.62	.62
Lysine (%)	.77	.77	.77	.77	.77	.77

Table 12. The effect of dietary treatments on average egg production (Exp. TB971)

Treatment Number	Description	Egg production during weeks: 0-4	4-8	8-12	12-16	16-20	20-24	0-24
		%						
1	Corn-Soy-Midds (Control)	73.09	70.72	65.83	61.14	59.47	55.33	64.58
2	As 1 + 2.5% Alfalfa meal	72.69	70.99	70.20	62.49	61.13	61.54	66.64
3	As 1 + 5.0% Alfalfa meal	71.71	70.46	67.08	58.02	58.10	58.47	64.14
4	As 2 + 2.5% Fish solubles	71.59	69.83	66.62	63.49	60.40	58.42	65.21
5	As 2 + .25% Fermacto	72.65	67.56	64.05	56.22	54.13	55.38	62.01
6	As 2 + 3.0 % Corn distillers grain w/ solubles	68.92	65.45	63.90	58.46	57.46	59.47	62.36
	Average	71.77	69.17	66.28	59.97	58.45	58.10	64.16
	Statistics							
	P value	.7565	.6471	.6158	.2042	.3483	.3756	.5882
	Least significant difference	6.02	7.71	7.87	6.58	6.72	6.59	5.78
	Error mean square	35.16	57.74	60.16	41.96	43.85	42.10	32.40
	Standard error of means	2.10	2.69	2.74	2.29	2.34	2.29	2.01

Table 13. The effect of dietary treatments on average egg weight (Exp. TB971)

Treatment Number	Description	Average Egg Weight during weeks: 0-4	4-8	8-12	12-16	16-20	20-24	0-24
		g						
1	Corn-Soy-Midds (Control)	90.68	93.19	94.36	96.44	97.28	97.31	94.75
2	As 1 + 2.5% Alfalfa meal	90.30	92.30	94.00	96.15	96.38	96.67	94.36
3	As 1 + 5.0% Alfalfa meal	90.14	91.56	93.80	95.36	96.98	98.02	94.30
4	As 2 + 2.5% Fish solubles	91.01	93.22	92.87	96.06	98.27	98.08	95.01
5	As 2 + .25% Fermacto	91.51	92.65	94.92	97.08	98.38	97.33	95.23
6	As 2 + 3.0 % Corn distillers grain w/ solubles	90.69	91.41	94.55	96.19	96.93	97.79	94.50
	Average	90.72	92.39	94.08	96.21	97.37	97.53	94.69
	Statistics							
	P value	.9034	.2460	.7648	.7330	.4318	.5435	.8136
	Least significant difference	2.55	1.89	2.86	2.15	2.28	1.70	1.60
	Error mean square	6.31	3.46	7.91	4.47	5.03	2.80	2.49
	Standard error of means	.89	.66	.99	.75	.79	.59	.56

Table 14. The effect of dietary treatments on fertility of eggs set (Exp. TB971).

Treatment Number	Description	Fertility during weeks: 0-4	4-8	8-12	12-16	16-20	20-24	0-24
		%						
1	Corn-Soy-Midds (Control)	94.64	93.90	94.06	90.36	85.59	88.89	91.60
2	As 1 + 2.5% Alfalfa meal	97.47	97.22	97.52	94.10	88.57	87.15	94.09
3	As 1 + 5.0% Alfalfa meal	94.39	91.71	91.02	85.08	87.64	79.73	88.90
4	As 2 + 2.5% Fish solubles	93.87	92.71	91.27	86.07	87.35	86.95	90.15
5	As 2 + .25% Fermacto	94.36	92.20	92.62	93.09	88.46	86.03	91.45
6	As 2 + 3.0 % Corn distillers grain w/ solubles	93.78	93.33	94.46	91.85	87.17	84.34	91.22
	Average	94.75	93.51	93.49	90.09	87.46	85.51	91.23
	Statistics							
	P value	.2955	.3208	.1884	.0656	.9715	.3309	.1844
	Least significant difference	3.49	5.15	5.51	7.06	7.50	8.40	3.92
	Error mean square	11.79	25.72	29.41	48.34	54.55	68.52	14.91
	Standard error of means	1.21	1.79	1.92	2.46	2.61	2.93	1.37

Table 15. The effect of dietary treatments on hatchability of fertile eggs (Exp. TB971)

Treatment Number	Description	Hatchabilty of fertile eggs during weeks: 0-4	4-8	8-12	12-16	16-20	20-24	0-24
		%						
1	Corn-Soy-Midds (Control)	87.58	85.90	81.63	83.75	90.28	81.84	85.19
2	As 1 + 2.5% Alfalfa meal	80.13	85.14	85.97	85.03	85.12	81.80	83.96
3	As 1 + 5.0% Alfalfa meal	83.74	82.28	80.42	85.52	81.61	77.20	81.88
4	As 2 + 2.5% Fish solubles	83.63	84.58	84.46	81.72	86.69	82.42	83.92
5	As 2 + .25% Fermacto	86.72	87.37	86.55	87.26	82.42	77.25	85.16
6	As 2 + 3.0 % Corn distillers grain w/ solubles	83.58	85.10	80.31	84.21	85.49	75.22	82.48
	Average	84.23	85.06	83.22	84.58	85.27	79.29	83.76
	Statistics							
	P value	.3472	.6765	.4443	.7166	.4133	.3024	.3743
	Least significant difference	7.07	6.04	8.12	7.02	8.81	7.89	3.71
	Error mean square	48.52	35.45	63.91	47.83	75.36	60.43	13.35
	Standard error of means	2.46	2.11	2.83	2.45	3.07	2.75	1.29

Table 16. The effect of dietary treatments on egg condition (Exp. TB971)

Treatment Number	Description	Egg Condition for 0-24 weeks: Broken	Peewee	Soft Shell	Double Yolk	Deformed
				%		
1	Corn-Soy-Midds (Control)	4.17	.15	4.30	.33	.79
2	As 1 + 2.5% Alfalfa meal	3.75	.13	2.91	.34	1.29
3	As 1 + 5.0% Alfalfa meal	3.39	.13	3.75	.24	.89
4	As 2 + 2.5% Fish solubles	3.94	.13	5.28	.28	1.86
5	As 2 + .25% Fermacto	3.87	.19	3.34	.30	1.14
6	As 2 + 3.0 % Corn distillers grain w/ solubles	3.75	.22	4.85	.29	1.02
	Average	3.81	.16	4.07	.30	1.17
	Statistics					
	P value	.8632	.8801	.4724	.9758	.3242
	Least significant difference	1.22	.18	2.70	.26	1.00
	Error mean square	1.43	.03	7.07	.07	.97
	Standard error of means	.42	.06	.94	.09	.35

Table 17. The effect of dietary treatments on average daily feed intake (Exp. TB971)

Treatment Number	Description	Average daily feed intake during weeks: 0-4	4-8	8-12	12-16	16-20	20-24	0-24
		g						
1.0	Corn-Soy-Midds (Control)	233.1	258.0	280.0	304.1	306.9	298.7	278.7
2.0	As 1 + 2.5% Alfalfa meal	236.5	263.8	293.3	299.2	299.6	298.7	281.1
3.0	As 1 + 5.0% Alfalfa meal	234.4	268.0	295.6	296.1	296.7	301.9	281.5
4.0	As 2 + 2.5% Fish solubles	239.3	263.8	295.4	300.1	310.0	301.4	283.9
5.0	As 2 + .25% Fermacto	235.0	261.0	288.9	292.4	290.0	302.3	277.2
6.0	As 2 + 3.0 % Corn distillers grain w/ solubles	242.3	270.3	290.7	277.5	292.5	307.4	279.1
	Average	236.8	264.1	290.6	294.9	299.3	301.7	280.2
	Statistics							
	P value	.6009	.6990	.3018	.0688	.4637	.8496	.9178
	Least significant difference	11.5	16.6	14.9	17.9	23.3	14.6	12.9
	Error mean square	128.7	266.0	215.3	309.9	525.0	205.9	161.1
	Standard error of means	4.0	5.8	5.2	6.2	8.1	5.1	4.5

Table 18. The effect of dietary treatments on hen mortality and live/dead removal for prolapse (Exp. TB971)

Treatment Number	Description	During 0-24 weeks: Hen dead removed	Prolapse removed: dead	Prolapse removed: live
		---------- % ----------		
1	Corn-Soy-Midds (Control)	5.21	3.12	.00
2	As 1 + 2.5% Alfalfa meal	3.12	2.08	1.04
3	As 1 + 5.0% Alfalfa meal	5.21	2.08	.00
4	As 2 + 2.5% Fish solubles	6.25	6.25	.00
5	As 2 + .25% Fermacto	4.17	2.08	.00
6	As 2 + 3.0 % Corn distillers grain w/ solubles	4.17	1.04	.00
	Average	4.69	2.78	.17
	Statistics			
	P value	.9235	.3726	.4321
	Least significant difference	5.98	4.97	1.22
	Error mean square	34.68	23.97	1.45
	Standard error of means	2.08	1.73	.43

Table 19. The effect of dietary treatments on body weight (Exp. TB971)

Treatment Number	Description	Initial Weight	Average body weight during: 4 wks	12 wks	24 wks	Exp. Gain
		kg				
1	Corn-Soy-Midds (Control)	11.51	10.82	10.61	11.55	.04
2	As 1 + 2.5% Alfalfa meal	11.43	11.05	10.68	11.40	-.03
3	As 1 + 5.0% Alfalfa meal	11.52	10.53	10.73	11.34	-.19
4	As 2 + 2.5% Fish solubles	11.32	10.86	10.63	11.27	-.05
5	As 2 + .25% Fermacto	11.44	10.83	10.66	11.31	-.13
6	As 2 + 3.0 % Corn distillers grain w/ solubles	11.30	10.99	10.75	11.38	.08
	Average	11.42	10.85	10.67	11.37	-.05
	Statistics					
	P value	.6400	.0698	.9183	.4869	.3099
	Least significant difference	.33	.35	.29	.30	.26
	Error mean square	.24	.26	.18	.19	.15
	Standard error of means	.17	.18	.15	.15	.14