

Rate of Gain and Utilization of Feed as Affected by Different Levels of Sugarcane Molasses in Starting, Growing and Fattening Diets for Birds of a Laying and a Broiler Stock

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INTRODUCTION

The annual production of blackstrap molasses in Puerto Rico during the year 1966-67 was approximately 49 million gallons. This perhaps is the only energy source produced locally in large quantities at a reasonable price (2.9 cents/K.), providing approximately 536 calories of productive energy per penny *vs.* 292 for yellow corn.

Rosemberg and Palafox (6)² reported cane molasses can be fed to growing pullets at concentrations up to 34.5 percent of the diet. Similar results were reported for broilers (8). Efficiency of feed conversion was inversely proportional to the concentration of molasses. Rosemberg and Palafox (7) reported the potassium salts in molasses as the probable cause of diarrhea. This condition causes a managerial problem of wet litter and reduces efficiency of feed utilization due perhaps to the frequent voiding of the intestinal content. Further mention is made that the water content in molasses also impairs efficiency by reducing the caloric value of the ration.

Unpublished results of 10 of our previous studies, in which diets containing different levels of molasses were evaluated, were inconsistent. Such inconsistency probably can be ascribed to our inability to add molasses homogeneously to the other ingredients, which previously were homogenized for 10 minutes by using a semiautomatic incorporator attached to a 1-ton capacity, single spiral, vertical mixer. Remixing of the diets in an effort to homogenize the feed molasses resulted in the build up of particles against the inner surfaces of the mixer and in some cases clogged the mixer when diets were used containing levels as low as 15-percent molasses. At lower levels, many of the molasses-containing feed masses became attached to the inner walls of the mixer.

The objectives of the studies reported herein were to determine the maximum and optimum levels of cane molasses that may be used in starting, fattening and growing diets for broilers and laying stock.

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² *Italic numbers in parentheses refer to Literature Cited, p. 169.*

MATERIAL AND METHODS

CHICKS OF A LAYING STRAIN

Two studies were completed during the starting and growing periods using female chicks of the Dekalb strain. During the starting period, the birds were housed in floor pens 3.6 x 2.3 m. in a barn located at the Lajas Substation. Artificial heat was provided during the first 2 weeks. Five levels of molasses (0, 5, 10, 15, and 20 percent) were evaluated using a random block design with three replications of 20 birds each for each of the five treatments. The basal diet is described in the upper part of table 1.

During the growing period the birds were also housed in floor pens 3.6 x 2.3 m. in a barn located at the Lajas Substation. Five levels of molasses (0, 5, 10, 15, and 20 percent) were also evaluated using a random block design with three replications of 20 birds each for each of the five treatments. The basal diet used in the growing period is described in the upper part of table 1.

CHICKS OF A BROILER STRAIN

Two studies were completed during the starting and fattening periods with broiler chicks of the Vantress strain. The birds were housed in floor pens 3.6 x 1.8 m. in a barn located at the Main Station in Río Piedras.

Artificial heat was provided during the initial 2 weeks of the starting period. Five levels of molasses (0, 5, 10, 15, and 20 percent) were evaluated in two simultaneous studies using a random block design with three replicates of 20 birds each for each of five treatments. Diets based on yellow corn (A) were used in one of the studies; diets containing yellow corn plus 20 percent coconut meal (B) were used in the other. The two basal diets used in the starting period are described in the lower portion of table 1.

During the fattening period five levels of molasses (0, 5, 10, 15, and 20 percent) were evaluated. A random block design of three replications of 20 birds each for each of five treatments was used. The basal diet used in the fattening study is described in the lower portion of table 1.

The molasses containing diets used in the four studies reported were prepared using a new technique developed in our laboratory. The use of this technique resulted in homogeneous dispersion of molasses in levels as high as 20 percent. The technique consisted in preparing homogeneous primers of corn and molasses by adding a maximum amount of molasses to a minimum amount of ground yellow corn. This primer was added in predetermined amounts to the remaining ingredients and mixed in a 100-pound capacity, bowl-type mixer.

All ingredients and diets were analyzed for nitrogen, calcium and phosphorus following the methods of the A.O.A.C. (1). The caloric content was

TABLE 1.—*Basal diets used during starting and growing periods of laying stock, and starting and fattening periods in the broiler studies*

<i>Laying Stock</i>			
Diet, Ingredients and Composition	Starting I	Growing II	
<i>Ingredients</i>	<i>Percent</i>	<i>Percent</i>	
Corn, Dent No. 2, ground	68.6	80.5	
Cane molasses ¹	.0	.0	
Soybean meal	17.7	7.7	
Tuna fishmeal	11.0	11.0	
Skimmed milk, dried	2.0	.0	
Dicalcium phosphate	.0	.0	
Limestone, feed grade, ground	.0	.0	
NaCl	.5	.5	
Premix	.2 ²	.3 ³	
<i>Composition</i>			
Crude protein, analyzed	20.19	18.25	
Calcium, analyzed	.97	.91	
Phosphorus, analyzed	.71	.69	
Calories, calculated ⁵	1004	1045	

<i>Broiler Stock</i>			
Diet, Ingredients and Composition	Starting IV A	Starting IV B	Fattening V
<i>Ingredients</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Corn, Dent No. 2, ground	68.5	49.6	80.5
Coconut meal	.0	20.2	.0
Cane molasses ¹	.0	.0	.0
Soybean meal	17.7	11.4	7.7
Tuna fishmeal	11.0	11.0	11.0
Skimmed milk, dried	2.0	2.0	.0
Animal grease, stabilized	.0	5.0	.0
NaCl	.5	.5	.5
Premix	.3 ²	.3 ²	.3 ⁴
<i>Composition</i>			
Crude protein, analyzed	20.19	19.94	18.25
Calcium, analyzed	.97	1.15	.91
Phosphorus, analyzed	.71	.78	.69
Calories, calculated ⁵	1003	1012	1045

¹ Molasses added at expense of corn.

² Contains 0.0006 vitamin A/D₂ (500,000/100,000 I.U./g.); 0.0002 riboflavin; 0.0015 niacin; 0.0004 calcium pantothenate; 0.0250 manganese sulfate (75 percent); 0.0500 choline chloride (25 percent); 0.1000 terramycin (6.6 g. oxytetracycline and 6.6 mg. vitamin B₁₂/kg.); 0.0750 coccidiostat.

³ Contains 0.0006 vitamin A/D₂ (500,000/100,000 I.U./g.); 0.0004 riboflavin; 0.0008 niacin; 0.0004 calcium pantothenate; 0.0750 coccidiostat; 0.0250 manganese sulfate (75 percent); 0.0850 terramycin (12 g. oxytetracycline + 4 mg. vitamin B₁₂/kg.).

⁴ Contains 0.0006 vitamin A/D₂ (500,000/100,000 I.U./g.); 0.0002 riboflavin; 0.0005 calcium pantothenate; 0.0020 niacin; 0.0250 manganese sulfate (75 percent); 0.1000 choline chloride (25 percent); 0.1700 terramycin (7.7 g. oxytetracycline and 5.5 mg. vitamin B₁₂/kg.).

⁵ Based on data from National Research Council, Publication 1232, 1964.

calculated from tabulated values reported by the National Research Council (5).

In all studies the isonitrogenous and isocaloric diets and the water were offered *ad libitum*. Net liveweight gains and feed utilization were used as comparison criteria. The statistical evaluation of the data was based on the methods of Bose *et al.* (2), Zelem, (10) and Snedecor (9) using a program developed for Computer 1620.

RESULTS AND DISCUSSION

CHICKS OF A LAYING STRAIN

The results from study I, conducted during the starting period, are described in table 2. The data demonstrate that all diets were superior ($P < .01$) to the diet containing 20 percent molasses; and those containing none or a low level (5 percent) of molasses were superior ($P < .01$) to the ones containing 10- and 15-percent molasses, while the diet without molasses was better ($P < .05$) than the one containing 5 percent when growth rate was used as the criterion for comparison. There was a trend for decreased growth with increased level of molasses that was accentuated between the diets containing 5 and 10 percent molasses. There were no differences when the diets were compared as to feed utilization. The overall performance in this study was similar to the results published by Rosemberg (8).

The results from study II, conducted during the growing period, are shown in the middle of table 2. There were no statistical differences between the treatments in either of the criteria evaluated, although a downward pattern of growth and utilization became apparent with increasing levels of molasses. Nevertheless, the birds grew comparatively better when they consumed the diets containing high levels of molasses, when compared to the performance during the starting period.

The combined data for the starting and growing periods from study III are described in the bottom part of table 2. A nonsignificant decrease in feed utilization with increased level of molasses was noted. When growth rate was compared, the diet containing 0-percent molasses was statistically better ($P < .05$) than those containing 15- and 20-percent molasses. The diet containing 5 percent was better ($P < .05$) than the one containing 20 percent.

The combined data from study III followed a similar growth trend, imparted during the starting period in study I, while the utilization data follows a similar decrease pattern with increased molasses level in all periods.

CHICKS OF A BROILER STRAIN

Two concurrent studies, IV, were completed during the starting period and the results obtained are presented in table 3. In study IV A, the inclu-

TABLE 2.—Rate of gain, utilization of feed, and comparative feed costs of different diets used in studies conducted during starting, growing, and combined periods with birds of a laying stock

Diet	Molasses	Net gain ² , *	Average cost/ pound of feed ⁴	Efficiency of utilization ² , *, *	Feed cost/pound produced ⁶
Number	Percent	Pounds	Cents	Feed/Gain Ratio	Cents
<i>Starting Period—Study I¹</i>					
1	0	1.12a	5.075	2.92a	14.82
2	5	1.10b	5.017	2.86a	14.35
3	10	1.04c	4.961	2.95a	14.63
4	15	1.04c	4.904	3.11a	15.25
5	20	1.01d	4.848	3.09a	14.98
<i>Growing Period—Study II¹</i>					
6	0	1.17a	4.426	5.08a	22.48
7	5	1.14a	4.371	5.43a	23.73
8	10	1.14a	4.315	5.17a	22.31
9	15	1.12a	4.259	5.85a	24.92
10	20	1.13a	4.203	5.80a	24.38
<i>Combined Periods—Study III</i>					
1 & 6	0	2.29a	4.650	4.03a	18.74
2 & 7	5	2.24ab	4.588	4.17a	19.13
3 & 8	10	2.18ab	4.538	4.11a	18.65
4 & 9	15	2.16b	4.475	4.53a	20.27
5 & 10	20	2.14c	4.431	4.50a	19.94

¹ Studies conducted at Lajas Substation: Starting period from March 18 to April 29, 1968; growing period from April 29 to June 10, 1968.

² Adjusted values.

³ Means followed by the same letter do not differ significantly ($P < .05$).

⁴ Based on values calculated using average prices paid by the Agricultural Experiment Station during 1967 for ingredients used in preparing all diets, plus \$0.50 for mixing and handling costs. The commercial equivalent costs \$6.30 and \$6.08/hundredweight for the starting and growing mashes, respectively.

⁵ Kg. of feed/kg. of liveweight gained.

⁶ Obtained by multiplying efficiencies times values described under average cost/lb. feed.

sion of any amount of molasses in the diets based on corn resulted in a downward trend in growth and utilization with increased levels of molasses. All diets were statistically superior ($P < .01$) to the one containing 20-per cent molasses, and the one containing 0-percent was better ($P < .05$) than the ones containing 10- and 15-percent molasses when growth was evaluated.

Then diet containing no molasses was superior ($P < .01$) to all others when utilization of feed was evaluated.

In study IV B, when a diet based on corn plus 20-percent coconut meal was used, inconsistent trends resulted both in growth rate and utilization of feed. There were no statistical differences between the treatments.

The data from the fattening period presented in the upper part of table 4 was inconsistent and no statistical differences were found in either criteria evaluated. Nevertheless, the birds grew more comparatively and utilized

TABLE 3.—Rate of gain, utilization of feed, and comparative feed costs of different diets used in studies conducted during starting period with birds of a broiler strain

Diet	Molasses	Net gain ^{2, 3}	Average cost/pound of feed ⁴	Efficiency of utilization ^{2, 3, 5}	Feed cost/pound produced ⁶
Number	Percent	Pounds	Cents	Feed/Gain/Ratio	Cents
<i>Starting period—Corn diets—Study IV A¹</i>					
1	0	1.47a	4.974	2.55a	12.68
2	5	1.42ab	4.917	2.79b	13.72
3	10	1.39b	4.861	2.80b	13.61
4	15	1.39b	4.804	2.75b	13.21
5	20	1.23c	4.748	2.78b	13.20
<i>Starting period—Coconut diets—Study IV B¹</i>					
6	0	1.43a	4.715	2.50a	11.79
7	5	1.45a	4.684	2.53a	11.85
8	10	1.51a	4.653	2.41a	11.21
9	15	1.37a	4.622	2.53a	11.69
10	20	1.36a	4.591	2.45a	11.25

¹ Conducted simultaneously at the Main Station (Río Piedras) from March to April, 1968.

^{2, 3, 4, 5, 6} See ^{2, 3, 4, 5, 6} table 2.

the high level of molasses in the diets better, when contrasted to the starting period performance. The pattern of better growth with high level molasses-containing diets, with increased age, also was apparent in birds of a laying strain.

When the combined data from the starting and fattening periods was evaluated, as shown in the lower part of table 4, the combination of diets containing no molasses was superior ($P < .01$) to the one containing 10 percent molasses, and better ($P < .05$) than all the others, when efficiency was evaluated. The combination containing 5-percent molasses was better ($P < .05$) than the one containing 10 percent. When rate of gain was eval-

uated, the combinations containing 0- and 5-percent molasses were superior ($P < .01$) to the one containing 20 percent, while the diet containing no molasses was better ($P < .05$) than the diets containing 10 and 15 percent.

A very important management consideration became apparent. Under the conditions of our combined broiler study where, allowing 0.19 m.² (2 feet²) per bird in contrast to 0.09 m.² (1 foot²) recommended under practical conditions, the group receiving the diet containing 20-percent molasses produced a caked litter (wood shavings). The group receiving 15-percent

TABLE 4.—Rate of gain, utilization of feed and comparative feed costs of different diets used in studies conducted during fattening and combined periods with birds of a broiler strain

Diet	Molasses	Net gain ^{2, 3}	Average cost/ pound of feed ⁴	Efficiency of utilization ^{2, 3, 5}	Feed cost/pound produced ⁶
Number	Percent	Pounds	Cents	Feed/Gain/Ratio	Cents
<i>Fattening Period—Study VI</i>					
11	0	1.28a	4.426	2.82a	12.48
12	5	1.31a	4.371	2.70a	11.80
13	10	1.21a	4.315	2.88a	12.43
14	15	1.22a	4.259	2.80a	11.93
15	20	1.20a	4.203	2.72a	11.43
<i>Combined Periods—Study VI</i>					
1 & 11	0	2.75a	4.712	2.67a	12.58
2 & 12	5	2.73ab	4.651	2.75b	12.79
3 & 13	10	2.61bc	4.615	2.83c	13.06
4 & 14	15	2.61bc	4.552	2.77bc	12.61
5 & 15	20	2.44c	4.484	2.75bc	12.33

¹ Conducted at the Main Station (Río Piedras) April, 1968.

^{2, 3, 4, 5, 6.} See ^{2, 3, 4, 5, 6} table 2.

molasses produced litter approaching a caked state. If a higher density of birds had been used, the 15-percent molasses diet would most likely have produced caked litter, so it appears that a 10-percent molasses diet is marginal. This problem will have to be solved prior to making a final recommendation of optimum levels of molasses to use in practical-type diets. The level of usage of molasses in practical-type diets, and up to the limit imposed by managerial considerations, will be determined by the cost of the ration per unit liveweight produced.

Feed-cost data and their relationship to the efficiency of utilization, shown in tables 2, 3, and 4, indicate the importance of producing least-cost

rations by using the maximum permissible amounts of cheaper ingredients in diets formulated to maintain proper rate of growth and efficiency of conversion in the animals receiving it. For every set of conditions (ingredient prices, efficiency of utilization obtained and market price for the birds produced) a new economical analysis and evaluation is mandatory.

SUMMARY

In several studies conducted during the starting and fattening periods of broiler stock, and the starting and growing periods of laying stock, levels as high as 20-percent sugarcane molasses were utilized satisfactorily in practical-type diets by the birds. Variations obtained in the different studies were discussed.

Caked litter resulted with population densities of 0.19 m.² (2 feet²) per bird when a 20-percent molasses diet was used, while semi-caked litter resulted with a level of 15-percent molasses. These results imply that with densities of 0.09 m.² (1 foot²), equivalent to practical management conditions, a level of 10-percent molasses in diets appears borderline. Further corroboration studies seem to be indicated, to determine and recommend the maximum economical level of molasses in the diet which will not result in a compact litter.

Feed cost data and their relation to the efficiency of utilization in these studies were evaluated. Inconsistent experimental data from previous experiments is discussed. A new technique for the homogeneous dispersion of molasses is described.

RESUMEN

En varios estudios conducidos durante los períodos inicial y de engorde con aves asaderas, y durante los períodos inicial y de crecimiento con aves de líneas ponedoras, niveles tan altos como 20 por ciento de miel de caña en dietas prácticas fueron utilizados satisfactoriamente por las aves. Se discutieron las variaciones observadas en los diferentes estudios.

En este estudio se usó aserrín como camada, asignándose un área promedio de 0.19 m.² por ave, o sea, el doble de lo que generalmente se recomienda para condiciones (0.09 m.²) comerciales. En esas condiciones, el nivel de un 20 por ciento de miel en la dieta causó una camada compacta y el de un 15 por ciento una semi-compacta. Estos resultados indican que de usarse una densidad poblacional equivalente a la que se acostumbra comercialmente, los niveles de un 15 y un 10 por ciento de miel en la dieta hubiesen causado una camada compacta. Es necesario determinar cual es el nivel máximo económico de miel en la dieta que no causa una camada compacta antes de poder hacer recomendaciones definitivas sobre el particular en el caso de las dietas de las aves para asar.

Se evaluaron los datos en cuanto al costo del alimento y su relación con la eficiencia de su utilización. Se discutió la inconsistencia de ciertos datos obtenidos en experimentos previos y se describió una nueva técnica para la incorporación homogénea de la miel.

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