A STUDY OF DEHYDRATED FORAGE PRODUCTS IN POULTRY RATIONS

by

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ABSTRACT

A study of dehydrated forage products in poultry rations

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A comparative study was undertaken to evaluate dehydrated alfalfa leaf meal and dehydrated cereal grass meal in poultry rations. These investigations were designed to determine the relative effect of these products on palatability, growth, feed conversion, mortality, hatchability, egg production and egg quality. Diets containing graded levels of alfalfa and cereal grass were fed separately, combined and incorporated into standard rations for day old chicks and breeding hens. One experiment was conducted with turkey poults.

Results indicate that chicks showed preference for alfalfa over cereal grass when these products were offered separately free choice in dry form, but they showed no preference when each of the two forage meals were included separately at various levels in rations. The inclusion of alfalfa and cereal grass up to the 5 per cent level produced equivalent growth rate and feed conversion in chicks to that obtained on the basal ration devoid of all forage products. At levels above 5 per cent there was a progressive decline in growth rate and a lowering of feed efficiency. Although these conditions were evident for both forages, the alfalfa diets caused a more severe depressing effect than the cereal grass rations. Chick mortality was not influenced by the inclusion of either forage meal up to the 20 per cent level.

Increasing levels of alfalfa in breeding rations improved hatchability while similar levels of cereal grass resulted in a depressing

effect on hatchability. The inclusion of cereal grass in breeding rations had a significantly greater effect than alfalfa on intensifying yolk color. Egg production was not affected by the use of either forage product in the ration. A separate study on the rate of carotene destruction in these two forage meals was conducted. The rate of carotene destruction of these two forage meals were very similar although in all cases the dehydrated cereal grass meal initially contained substantially more carotene than the dehydrated alfalfa meal.

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INTRODUCTION

Prior to the discovery of vitamins and their function in poultry nutrition, fresh succulent pasture was regarded as being indispensable for profitable poultry production. As early as 1905, Jaffa spoke of the "hygienic value" that fresh succulent pasture provided for poultry. The importance placed on fresh forage, by practical poultry men, in the past has now been elucidated with increasing knowledge of nutrition. Today it is known that fresh pasture is not only an excellent source of vitamin A (carotene), riboflavin, vitamin E, vitamin K and many other of the B-complex vitamins but also of proteins, minerals and other nutrients, some of which have not as yet been identified.

The incorporation of dry forage products into poultry rations is practised mainly as a pasture substitute when fresh green forage is not available. This is of prime importance in Western Canada as fresh green pasture is only accessible to poultry from 4 to 6 months of the year. Early management practices proved the value of feeding ground alfalfa hay to poultry during the winter months. As the poultry industry grew and the demand for a pasture substitute increased, sun-cured alfalfa meal appeared on the market. This product was mentioned in the poultry text written by Lippincott (1916). It is of interest to note that the production of sun-cured alfalfa meal in the United States reached a peak of 573,700 tons in 1945-46. As early as 1930 processing by dehydration began and, at present in the United States, dehydrated alfalfa leaf meal is the main forage product used. In Canada, dehydrated cereal grass and dehydrated alfalfa leaf meal are extensively used as green feed substitutes.

Economically these two forage products are valued for their

vitamin A activity. The incorporation of them into poultry rations is based mainly on their vitamin A (carotene) riboflavin and vitamin K content. With the increasing commercial production of vitamin A and riboflavin the importance of dehydrated alfalfa leaf meal and dehydrated cereal grass as constituents of poultry rations requires reappraisal. It is important to ascertain if a basis exists other than carotene content which justifies a price differential between the meals or whether the meals could be used interchangeably or combined in poultry rations as is the present practice.

While there are many published reports on the value of alfalfa meals, there are few dealing with cereal grass in poultry rations. This research work has been conducted mainly in the United States. In neither Canada nor the United States are there reports dealing extensively with the comparative feeding value of dehydrated alfalfa leaf meal and dehydrated cereal grass.

This comparative study was undertaken to evaluate dehydrated alfalfa leaf meal and dehydrated cereal grass* in poultry rations. An attempt was made to measure their effect on rate of growth, feed conversion, palatability, hatchability, mortality, egg production and egg quality. In addition to the foregoing a separate study of a chemical nature was undertaken to ascertain the rate of destruction of carotene in these two products when dry stored under natural conditions.

* The products used in all the experiments in this study are sold commercially in Canada under the trade name, Vita-Greens (dehydrated alfalfa leaf meal) and Vita-Gras (dehydrated cereal grass meal). The Vita-Greens consisting of alfalfa (Medicago sativa) and Vita-Gras of orchard grass (Dactylis glomerata) and New Zealand rye grass (Lolium sp.). The manufacturer of these products states that in their dehydration process no chemicals or antioxidants are used.

REVIEW OF LITERATURE

Extensive research has been conducted to determine the value of alfalfa in poultry rations. There is a paucity of information concerning the use of cereal grass. In view of this the literature will be dealt with under the following general headings:

(a) Alfalfa meal in chick rations

(b) Alfalfa meal in laying rations

(c) Alfalfa meal in turkey growing rations

(d) Cereal grass in poultry rations

(a) Alfalfa meal in chick rations

An early reference to the use of alfalfa meal was made by Lippincott (1916) in which was stated, "During the last few years finely ground alfalfa hay has appeared on the market as alfalfa meal, and if of good quality is a good substitute for wheat bran as it is high in protein, ash and fat." Twenty-three years later Kennard and Lingle (1928) reported that the best substitute for green feed undoubtedly is a high quality immature cut legume hay which may be regarded as dried green feed.

The first paper dealing with the availability of vitamin A from alfalfa meal was by Heywang and Titus (1932). They observed that the inclusion of sun-cured alfalfa leaf meal in a chick ration at the 10 per cent level did not provide sufficient vitamin A to maintain life. Paley (1938) reported, on the other hand, that a basal ration supplemented with only 3 per cent alfalfa leaf meal provided ample vitamin A for chicks. More recent work by Bolin et al (1943) and Farrin and associates (1949) indicated that carotene supplied by alfalfa leaf meal was an adequate source of vitamin A for growing chicks.

A number of workers have measured the value of alfalfa meal in chick rations by determining its effect on rate of growth and feed conversion. Cooney et al (1948), Jensen (1947), and Heywang (1950) all reported that as the level of alfalfa meal was increased in a chick ration above 5 per cent there was a gradual decrease in growth rate and a lowering of feed efficiency.

German and Couch (1954) used two samples of dehydrated alfalfa, one designated as inhibitory, the other non-inhibitory. These were included in chick rations at a 10 per cent level with and without the Animal Protein Factor. The inhibitory sample depressed growth with and without the Animal Protein Factor, while the non-inhibitory one produced growth depression only when the Animal Protein Factor was excluded from the ration.

Kodras et al (1951 a) stated that fibre does not appear to be the depressing agent in alfalfa leaf meal because, on equal feed intake, the rate of growth for chicks receiving a basal ration plus either 20 per cent sun-cured or dehydrated alfalfa was less than for chicks receiving a basal ration plus 20 per cent mill run. It was found that the addition of 1 per cent cholesterol was effective in counteracting growth depression effects.

Kodras (1951 b) reported further that alfalfa leaves caused a greater depression in chick growth than an equivalent weight of alfalfa stems. This substantiated his contention that fibre is not the only growth depressing factor in alfalfa meal.

Lepkovsky and associates (1950) observed that the growth depressing effects of alfalfa meal were not altered by different drying temperatures and periods of storage. The following were their conclusions:

(1) Dehydrated alfalfa contains a substance or substances probably organic in nature which depresses growth in chicks.

(2) Storage of alfalfa meal at room temperatures or in cold at 16° F. has little effect on the growth depressing substance of alfalfa meal.

(3) The growth depressant is apparently stable to existing methods of preparing alfalfa meal and to autoclaving in neutral, alkaline or acid medium.

(4) The depressing agent can be removed from alfalfa by repeated extraction with hot water.

(5) Vitamins of the B-complex in the amount fed had no effect in counteracting the depressing agent.

Wilgus and Madsen (1954) conducted an intensive study using 100 different samples of alfalfa meal to determine the inhibiting effect on chick growth. When the alfalfa samples were incorporated in the ration at the 10 per cent level, approximately one fifth of them depressed early growth, one third exhibited moderate depression and one half showed no appreciable effect. They concluded that the inhibition was not due to fibre per se nor was it related to ash constituents.

Peterson (1950 a) obtained a growth depression in chicks by feeding them an aqueous extract of alfalfa meal. The strong foaming properties of this fraction suggested saponins as the growth depressing agent. In a later study Peterson (1950 b) found that the depression of growth caused by the inclusion of 20 per cent dehydrated alfalfa leaf meal in a chick ration was more completely counteracted when a combination of 4 per cent cotton seed oil and 1 per cent cholesterol was added to the diet than when cholesterol was used alone as the counteracting agent. Heywang and

Bird (1954), following Peterson's (1950) work, fed saponin extract from alfalfa to day-old chicks. Their results showed that the saponin in alfalfa retarded growth and feed consumption, and reduced efficiency of feed utilization. The lowest level at which there was an unmistakable inhibition of growth was at the 0.20 per cent level. This amount of saponin extract was equivalent to that contributed by feeding 25 per cent of this particular alfalfa.

Some workers have found that the inclusion of dehydrated alfalfa leaf meal in purified and semi-purified basal rations stimulated growth in chicks. Scott (1952) tested the difference between sun-cured and dehydrated alfalfa leaf meal by adding these ingredients to a purified basal ration at the 5 per cent level, replacing an equivalent amount of cerelose. The results showed that with the six samples tested both types of alfalfa meal gave significantly improved growth over the basal diet and that the sun-cured meal exhibited growth promoting properties superior to those of the dehydrated meal.

Hansen et al (1953) concurred with Scott (1953) and postulated that both dehydrated and sun-cured alfalfa meal contain a factor, probably unidentified, that improves chick growth and that sun-cured meal is a better source of the factor than dehydrated leaf meal.

Vavich et al (1953) related the growth stimulation in chicks to unknown growth factors in the dehydrated alfalfa leaf meal. Greatest stimulation was observed when the chicks were held on a vitamin A depleted diet prior to the test.

Ackerson et al (1951) found no depression of growth using 2, 3, 4, 5, 6, 9, 10, 12 and 15 per cent dehydrated alfalfa leaf meal in high corn chick rations. The rations were fed in pellet form to chicks in

individual cages, each chick being allotted 920 grams. It was found that the lots receiving alfalfa ate more readily than the lots without the alfalfa and consumed the allotted amount 3 to 6 days earlier. The pelleted feed was quite readily accepted even when it contained up to 15 per cent of alfalfa.

(b) Alfalfa meal in laying rations

One of the earliest investigations to determine the effect of green feed substitutes on egg production and hatchability was conducted by Stuart (1929). Various substitutes were tested including alfalfa leaves, alfalfa meal and sprouted oats. It was found that alfalfa meal fed hens were the third highest in egg production whereas in incubation studies the eggs from such hens gave the highest hatchability.

Heywang (1933) tested sun-cured alfalfa leaf meal, sun-cured alfalfa meal and alfalfa hay as green feed substitutes for layers and found in hatchability studies that the group receiving the alfalfa leaf meal produced a much greater percentage of hatchable eggs than the group receiving a similar amount of alfalfa meal. The alfalfa hay proved to be an unreliable substitute.

Nestler and associates (1936), Hunt and associates (1939), and Bethke et al (1946) stated that there is a factor or factors in alfalfa leaf meal other than riboflavin which appears to improve the hatchability of eggs from hens receiving the meal.

Heywang (1950) found that when dehydrated alfalfa meal was included above the 5 per cent level and sun-cured alfalfa meal was included above the 10 per cent level there was a decrease in egg production. In another test he fed dehydrated alfalfa meal at 10, 15, 20 and 25 per cent levels and observed that as the amount of alfalfa meal was increased egg

production decreased. However, the average total feed consumption was about the same in all groups.

Jensen and workers (1952) conducted production tests with laying pullets fed diets containing levels of alfalfa meal varying from 2.5 to 25.0 per cent in both mash and pellet form. All groups fed pellets made substantial gains in body weight during the experiment and all the groups fed mash except the one at the 2.5 per cent alfalfa level lost weight in direct proportion to the amount of alfalfa meal included in the diet. Total feed consumption increased in the pelleted diets as the level of alfalfa increased. No significant difference in egg production or egg weight was evident among the various treatments. An increase in egg yolk color was noted with the higher levels of alfalfa.

Jacobs and associates (1953) conducted a production and hatchability test with White Leghorn pullets reared in individual cages on raised screen floors. The ration used was a corn-soybean basal diet with alfalfa included at the 5 per cent level and the diet fortified with 50 micrograms of B_{12} per kilogram. The hatchability results were:

Basal ration (no alfalfa nor B_{12})	51.59 per cent
Basal ration + Vitamin B_{12}	59.14 per cent
Basal ration + Vitamin B_{12} and alfalfa meal	68.89 per cent

Alfalfa meal alone did not improve hatchability but in combination vitamin B_{12} and alfalfa leaf meal did, which suggests a relationship between vitamin B_{12} and alfalfa leaf meal. Jacobs et al, in contrast to Ayala (1951), did not detect any vitamin B_{12} activity in alfalfa leaf meal as there was an increase in the number of embryos showing vitamin B_{12} deficiency symptoms when dehydrated alfalfa leaf meal was added to the ration.

On the other hand there was an increase in the vitamin B_{12} content of the eggs when B_{12} was added to the diet.

Cravens and associates (1942) conducted a series of experiments to determine the effect of alfalfa leaf meal and dried cereal grass on egg production and hatchability. Cereal grass was fed at a 2.5 per cent level and alfalfa was included at levels of 0.5, 2.5, 5.0 and 10 per cent. It was observed that in egg production there was very little difference between the alfalfa fed and cereal grass fed hens but in hatchability the alfalfa diets proved superior. In further tests the manganese and riboflavin levels of the diets were increased but these ingredients had no additional effect on hatchability. It was concluded that rations composed largely of grains, grain by-products, minerals and fish oil were deficient in some factor or factors supplied by alfalfa leaf meal and to a lesser extent by cereal grass. These workers suggest that at least 2 per cent alfalfa leaf meal is essential for maximum hatchability.

(c) Alfalfa meal in turkey rations

A number of workers have investigated the value of including dehydrated alfalfa leaf meal in turkey rations. Alder (1949) suggested that starting mashes for poults should contain 15 to 18 per cent by weight of alfalfa meal for best results. In growing mashes there was no difference in final growth weight and finishing conditions of turkeys when alfalfa meal was included at varying levels from 5 to 40 per cent.

Using a mixture of equal parts of dehydrated alfalfa leaf meal and dehydrated cereal grass, Slinger et al (1949) reported no significant depression of growth in turkey poults fed this mixture at levels of 10, 15 and 20 per cent in both pelleted and unpelleted form. They found greater differences between the pelleted and unpelleted mashes than

between the levels of dehydrated products fed.

German and Couch (1950) obtained detrimental results on growth when 8 per cent and 20 per cent dehydrated alfalfa leaf meal replaced ground grain and grain products in a poult ration. The incorporation of these two levels in poult rations decreased growth respectively by 18 and 36 per cent.

Draper (1952) showed that the inclusion in a poult starter ration of alfalfa meal in varying levels from 10 to 22 per cent gave comparable gains and feed efficiencies. Alfalfa at levels in excess of 25 per cent definitely depressed the weight and efficiency of gain. Mortality was not affected in any of the lots.

(d) Dehydrated cereal grass in poultry rations

Lampman and associates (1938) observed that orchard grass contained four times as much manganese as did alfalfa meal. A perosis producing ration was used replacing 5 per cent alfalfa meal with cereal grass. They found that the latter proved as efficient in preventing perosis as manganese salt. Cravens and workers (1941) found that 1 per cent dried cereal grass or 2 per cent alfalfa meal supplied sufficient vitamin K in a breeding ration for hens to maintain normal blood clotting time of day-old chicks. This suggests that cereal grass contains a higher content of this vitamin than does alfalfa meal.

With reference to the value of cereal grass in starting rations Slinger et al (1949) stated that unpublished results from their department indicate that one pound of dehydrated cereal grass can replace two pounds of dehydrated alfalfa meal in practical poultry starting rations and that a mixture of the two supplements gives superior results than either one alone. Hansen et al (1953) found that chick growth was less on 5 per cent

dehydrated cereal (oat) grass than on 5 per cent forage juice concentrate. These workers postulated that dehydration destroys the growth activity of the cereal grass.

Scott and co-workers (1948) substituted 6 per cent "Cerograss" for an equal weight of red dog flour and found no significant difference in growth rate in comparison with that produced by the high energy basal ration. Scott (1951 a) observed that the addition of 5 per cent oat grass to a poult starter ration resulted in no increase in growth of turkey poults up to four weeks of age. On the other hand the inclusion of 5 per cent alfalfa juice or grass juice resulted in a marked gain in weight of the turkey poults. It was concluded that the unknown factor was not stable under the conditions used for the dehydration of the grass. Using a corn-soybean basal with and without aureomycin, Scott and associates (1951 b) found no significant difference in growth rate in turkey poults over the basal ration when dehydrated alfalfa leaf meal and dehydrated cereal (rye) grass were included at the 5 per cent level.

EXPERIMENTAL PROCEDURE

A. Alfalfa meal and cereal grass in chick rations

Experiment I - Palatability studies

Graham (1932) in his classic studies concerning the ability of chickens to balance their own rations when given free access to separate feed ingredients showed that alfalfa meal was the least consumed with the sole exception of sodium chloride. These findings suggest that the alfalfa meal offered was either not palatable or that the birds had little physiological need for alfalfa. Dove (1935) stated that chicks showed a strong dislike for alfalfa leaf meal. Large numbers of chicks were exposed to a wide variety of feed stuffs including alfalfa leaf meal. Over a period of 11 weeks no alfalfa leaf meal was consumed.

Experiment I was conducted to compare the palatability of dehydrated alfalfa leaf meal and dehydrated cereal grass. These dry forage meals were offered to chicks free choice and constituted their only source of vitamin A.

The experiment was performed with 160 White Leghorn chicks of mixed sex. These were individually wing-banded, weighed and randomly distributed at hatching time into 8 equal lots. Each lot was placed in a separate compartment of an electrically heated battery brooder. Four of the lots were subjected to four different dietary treatments. Each treatment was replicated once.

The basal ration (see Table I) conformed to the 1950 recommendations of the National Research Council's Nutrient Allowance for poultry*

* Recommended Nutrient Allowances for Poultry. Issued by the National Research Council, 2101 Constitution Avenue N.W., Washington 25, D.C. 1950.

TABLE 1

Composition of Basal Diet used in Experiment I

Ingredients	%
Wheat	49.12
Oat-groats	24.00
Soybean oil meal (41% protein)	18.00
Meat meal (50% protein)	5.50
Fish meal (65% protein)	1.00
Milk Powder	1.00
Salt (iodized)	0.50
Limestone	0.88
	gms/100 lbs.
Manganese sulphate	10.00
Choline chloride	24.00
Riboflavin premix*	4.00
Dry vitamin D_3**	3.20
Dry vitamin A***	40.00
Vitamin B_{12} and antibiotic supplement****	25.00
Calculated Analysis	%
Protein	21.02
Fat	4.17
Fibre	2.73
Calcium	1.01
Phosphorous	0.72

* Riboflavin premix - 1 oz. of premix contains 1 gram of pure riboflavin

** Dry vitamin D_3 - 11,000,000 units per pound

*** Dry vitamin A - 5,000 I.U. per pound

**** Vitamin B_{12} and antibiotic supplement - 3 mgs. of vitamin B_{12} and 4 gms. of procaine penicillin per pound.

with the vitamin A allowance being met by use of dry vitamin A.

Treatment A - basal ration

Treatment B - basal ration devoid of vitamin A but the chicks were permitted free choice of dehydrated alfalfa leaf meal.*

Treatment C - basal ration devoid of vitamin A but the chicks were permitted free choice of dehydrated cereal grass.*

Treatment D - basal ration devoid of vitamin A but the chicks were permitted free choice of both alfalfa and cereal grass.

In the case of treatments B, C and D separate feed troughs contained the basal ration, the alfalfa and the cereal grass. The troughs were rotated weekly to preclude habit forming tendencies that might develop due to the location of the feeders. At the termination of the experiment the amount of each of basal ration, alfalfa and cereal grass consumed on each treatment was determined.

Experiment II - Palatability studies extended

Experiment II was conducted to obtain information on the relative palatability of alfalfa and cereal grass when these two ingredients are incorporated at increasing levels into the basal chick starter used in Experiment I.

One hundred Rhode Island Red day-old male chicks were distributed at random into two lots of 50 chicks each. All the chicks were floor

* Hereafter referred to as alfalfa and cereal grass. These products contained by analysis a minimum of 20 per cent protein and 21 and 33 milligrams carotene per 100 grams respectively.

TABLE 2

Composition of Diets used in Experiment II

Ingredients	Treatments A %	B %	C %	D %	E %	F %	G %
Wheat	49.12	48.62	48.62	46.62	46.62	44.60	44.20
Oat groats	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Soybean oil meal	18.00	17.50	17.50	15.50	15.50	13.00	13.00
Meat meal (50% protein)	5.50	5.50	5.50	5.50	5.50	5.50	5.50
Fish meal (65% protein)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Milk powder	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Salt (iodized)	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Limestone	0.88	0.88	0.88	0.88	0.88	0.40	0.80
Dehyd. alfalfa leaf meal	--	1.00	--	5.00	--	10.00	--
Dehyd. cereal grass	--	--	1.00	--	5.00	--	10.00
	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.
Manganese sulphate	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Choline chloride	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Riboflavin premix*	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Dry vitamin D_3**	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Dry vitamin A***	40.00	20.00	20.00	--	--	--	--
Vitamin B_{12} and sntibiotic supp.****	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Calculated Analysis	%	%	%	%	%	%	%
Protein	21.02	20.98	20.97	20.74	20.74	20.52	20.53
Fat	4.17	3.41	3.42	3.32	3.41	4.16	4.34
Fibre	2.73	2.86	2.85	3.35	3.28	3.98	3.85
Calcium	1.01	1.00	1.44	1.10	1.04	1.03	1.08
Phosphorous	0.72	0.72	0.72	0.73	0.75	0.75	0.76

* Riboflavin premix - 1 oz. of premix contains 1 gram of pure riboflavin

** Dry vitamin D_3 - 11,000,000 units per pound

*** Dry vitamin A - 5,000 I.U. per pound

**** Vitamin B_{12} and antibiotic supp. - contains 3 mg. vit. B_{12} per lb. and 4 gms. of procaine penicillin per lb.

brooded in 2 pens of equal size throughout the 6 week experimental period.

Seven different treatments were tested. Treatment A consisted of the basal ration alone. Treatments B, C, D, E, F and G consisted of the basal ration with alfalfa and cereal grass respectively being incorporated into the basal ration at the 1, 5, and 10 per cent levels (see Table 2). The alfalfa and cereal grass were incorporated into the basal ration at the expense of ground wheat and ground oat groats in such proportions and amounts that would balance the protein in all diets at the 20 per cent level. The vitamin A level supplied by carotene in the alfalfa and cereal grass was calculated and dry vitamin A was added in sufficient amount to each treatment to maintain a constant level of vitamin A in each of the rations.

Thus each lot of chicks was given access to the seven treatments by placing each ration in a separate feed trough. The troughs were so positioned that the chicks had free and equal access to any feed they desired. The troughs were rotated systematically each week to obviate habit forming tendencies that might occur. At the termination of the experiment the quantity of each ration consumed was ascertained.

Experiment III - Growth and feed efficiency studies

Following the palatability studies a series of experiments were undertaken to determine if differences exist between alfalfa and cereal grass with respect to their ability to promote rapid and economical growth.

Four hundred and forty White Leghorn day-old chicks of mixed sex were distributed at random into 22 equal lots which were subjected to eleven different replicated treatments. All the chicks were reared in battery brooders to 5 weeks of age, with feed and water being supplied ad libitum. The chicks were weighed and wing-banded individually when hatched and

TABLE 3

Composition of Diets used in Experiment III

Ingredients	Treatments A %	B %	C %	D %	E %	F %	G %	H %	I %	J %	K %
Wheat	49.12	48.62	48.62	46.62	46.62	44.60	44.20	37.80	37.50	34.00	33.80
Oat-groats	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Soybean Oil Meal (41% protein)	18.00	17.50	17.50	15.50	15.50	13.00	13.00	15.00	15.00	14.00	14.00
Meat meal (50% protein)	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
Fish meal (65% protein)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Milk powder	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Salt (iodized)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Limestone	0.88	0.88	0.88	0.88	0.88	0.40	0.80	0.20	0.50	--	0.20
Dehyd. alfalfa leaf meal	--	1.00	--	5.00	--	10.00	--	15.00	--	20.00	--
Dehyd. cereal grass	--	--	1.00	--	5.00	--	10.00	--	15.00	--	20.00
	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.
Manganese sulphate	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Choline chloride	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Riboflavin premix*	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Dry D_3**	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Dry vitamin A***	40.00	20.00	20.00	--	--	--	--	--	--	--	--
Vitamin B_{12} and **** antibiotic supplement	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Calculated Analysis	%	%	%	%	%	%	%	%	%	%	%
Protein	21.02	20.98	20.97	20.74	20.74	20.52	20.53	21.60	21.60	21.70	21.70
Fat	4.17	3.41	3.42	3.32	3.41	4.16	4.34	3.43	3.51	4.41	4.51
Fibre	2.73	2.86	2.85	3.35	3.28	3.98	3.85	5.21	5.03	5.92	5.89
Calcium	1.01	1.00	1.44	1.10	1.04	1.03	1.08	1.02	1.04	1.08	1.08
Phosphorous	0.72	0.72	0.72	0.73	0.75	0.75	0.76	0.76	0.77	0.77	0.78

* Riboflavin premix - 1 oz. of premix contains 1 gram pure riboflavin
** Dry vitamin D_3 - 11,000,000 units per pound
*** Dry vitamin A - 5,000 I.U. per pound
**** Vitamin B_{12} and antibiotic supplement - contains 3 mgs. of vitamin B_{12} and 4 gms. of procaine pencillin per pound

weighed weekly thereafter until the experiment was terminated. Feed conversion, body weight and mortality data were recorded at weekly intervals for each lot.

Treatment A consisted of the same basal ration used in Experiments I and II. Treatments B, C, D, E, F, G, H, I, J and K consisted of the basal ration with alfalfa and cereal grass included separately at levels of 1, 5, 10, 15 and 20 per cent respectively. In this experiment as with the foregoing the alfalfa and cereal grass were incorporated into the basal ration at the expense of ground wheat and soybean oil meal (see Table 3).

Experiment IV - Growth and feed efficiency studies extended

The object was to study further the effect of varying levels of alfalfa and cereal grass on growth and feed efficiency in chicks. This experiment differed from Experiment III in that the range of inclusion of dried forage products was reduced from 0 to 20 per cent to a range of 0 to 10 per cent. Moreover this test investigated the effect on chick growth, mortality and feed conversion when alfalfa and cereal grass were mixed together in proportions of 1:1 and 3:1.

The same experimental set up used in Experiment III was employed with the exception that the experimental stock in each lot consisted of 12 day-old White Leghorn female chicks. The duration of the experiment was 5 weeks.

The alfalfa and cereal grass were again incorporated into the different diets at the expense of ground wheat and soybean oil meal. The eleven replicated treatments or diets comprising the basis for this experiment were as follows:

Treatment A - Basal ration containing no dry forage (used in Experiment I and II)

Treatment B - Basal ration plus 1.00% alfalfa and 0.00% cereal grass

Treatment C - " " " 0.75% " " 0.25% " "

Treatment D - " " " 0.50% " " 0.50% " "

Treatment E - " " " 0.25% " " 0.75% " "

Treatment F - " " " 0.00% " " 1.00% " "

Treatment G - " " " 10.00% " " 0.00% " "

Treatment H - " " " 7.50% " " 2.50% " "

Treatment I - " " " 5.00% " " 5.00% " "

Treatment J - " " " 2.50% " " 7.50% " "

Treatment K - " " " 0.00% " " 10.00% " "

Experiment V - Growth and feed efficiency studies extended

In experiment IV it was observed that there was a significant difference in growth rate and feed efficiency between the chicks fed on the diets containing the 1 per cent level and 10 per cent level of dry forage meals. Experiment V was therefore undertaken to determine the effect on chick growth and efficiency of feed conversion when the levels of inclusion of alfalfa and cereal grass were reduced to a range of 0 to 5 per cent and using the same ratio for mixing the two ingredients that were used in Experiment IV.

The experimental set up employed was identical to Experiment IV with no exceptions.

Treatments A, B, C, D, E and F all were identical to the corresponding treatments used in the former trial. Treatments G, H, I, J and K were the same as their counterparts in Experiment IV with the exception

that the level of inclusion of alfalfa and cereal grass in the basal ration was 5 per cent instead of 10 per cent as used formerly.

Treatment A - Basal ration - no dry forage included in the diets

Treatment B - Basal ration plus 1.00% alfalfa plus 0.00% cereal grass

Treatment C - " " " 0.75% " " 0.25% " "

Treatment D - " " " 0.50% " " 0.50% " "

Treatment E - " " " 0.25% " " 0.75% " "

Treatment F - " " " 0.00% " " 1.00% " "

Treatment G - " " " 5.00% " " 0.00% " "

Treatment H - " " " 3.75% " " 1.25% " "

Treatment I - " " " 2.50% " " 2.50% " "

Treatment J - " " " 1.25% " " 3.75% " "

Treatment K - " " " 0.00% " " 5.00% " "

Experiment VI - Growth and feed efficiency data extended

The object of this experiment was to determine the effect on chick growth and efficiency of feed conversion when alfalfa and cereal grass were incorporated into a chick ration at the same levels as used in their maternal diets.

To produce chicks for this experiment eight breeding pens of White Leghorns were fed for 16 weeks on rations containing the same levels of alfalfa and cereal grass as were to be fed to the resulting progeny, namely 0.0, 0.5, 2.0 and 4.0 per cent and a combination of these two forages in the proportion of 1 part of alfalfa to 1 part of cereal grass at the 2.0 per cent level. During the 16th week the eggs from each breeding pen were saved, trayed separately and set. At hatching time 50 chicks were selected at random from each of these trays and placed on their respective diets.

Basically the eight experimental diets or treatments were as follows: (see Table 4)

Treatment A - Basal ration (same basal ration used in all former experiments)

Treatment B - Basal ration plus 0.50% alfalfa

Treatment C - " " " 0.50% cereal grass

Treatment D - " " " 2.00% alfalfa

Treatment E - " " " 2.00% cereal grass

Treatment F - " " " 1.00% alfalfa plus 1.00% cereal grass

Treatment G - " " " 4.00% alfalfa

Treatment H - " " " 4.00% cereal grass

The eight lots composed the experiment. No replicates were used in this test as it was felt that 50 chicks per lot would be a valid test. The usual experimental procedure was followed with the chicks being weighed and wing-banded when put on test and then weighed weekly thereafter for five weeks, the duration of the test. Feed and water were supplied ad libitum.

TABLE 4 — Composition of Diets used in Experiment V

Ingredients	Treatments A %	B %	C %	D %	E %	F %	G %	H %
Wheat	49.12	49.04	49.04	48.29	48.22	48.15	47.11	47.05
Oat groats	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Soybean oil meal (41% protein)	18.00	17.66	17.66	16.99	16.99	16.99	16.33	16.33
Meat meal (50% protein)	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
Fish meal (65% protein)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Milk powder	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Limestone	0.88	0.80	0.80	0.72	0.79	0.86	0.56	0.62
Dehyd. alfalfa leaf meal	--	0.50	--	2.00	--	1.00	4.00	--
Dehyd. cereal grass	--	--	0.50	--	2.00	1.00	--	4.00
	gms per 100 lbs	gms per 100 lbs	gms per 100 lbs	gms per 100 lbs	gms per 100 lbs	gms per 100 lbs	gms per 100 lbs	gms per 100 lbs
Manganese sulphate	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Choline chloride	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Riboflavin premix*	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Dry D_3 vitamin**	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
Dry vitamin A***	40.00	20.00	20.00	--	--	--	--	--
B_{12} and antibiotic supplement****	17.50	17.50	17.50	17.50	17.50	17.50	17.50	17.50
Calculated Analysis	%	%	%	%	%	%	%	%
Protein	20.79	20.75	20.73	20.70	20.73	20.71	20.72	20.72
Fat	4.17	4.16	4.17	4.17	4.19	4.20	4.18	4.17
Fibre	2.73	2.80	2.78	2.99	2.96	2.97	3.24	3.20
Calcium	1.01	1.14	1.15	1.10	1.13	1.14	1.10	1.27
Phosphorous	0.72	0.72	0.73	0.73	0.71	0.72	0.73	0.76

* Riboflavin premix - 1 oz. of premix contains 1 gram pure riboflavin
** Dry vitamin D_3 - 11,000,000 units per pound
*** Dry vitamin A - 5,000 I.U. per pound
****Vitamin B_{12} and antibiotic supplement - contains 3 mgs. of vitamin B_{12} and 4 gms. of procaine pencillin per pound.

B. Alfalfa meal and cereal grass in poult rations

Experiment I - Poult growth and feed efficiency study

The object of this experiment was to gather information on the comparative value of alfalfa and cereal grass as they affect growth and efficiency of feed conversion when included in a turkey poult ration.

The experimental stock consisted of 120 Broad Breasted Bronze one week old poults of mixed sex. These were individually weighed, banded and randomly distributed into 12 lots. The poults were floor brooded in equal size pens containing identical accessories (feed troughs, water fountains, brooders). Six lots of poults were subjected to six treatments, and replicated once. Treatments A, C and D (Table 5) contained soybean oil meal and meat meal as the main protein source. Treatments B, E and F contained soybean oil meal only as the protein concentrate. The forage meals were included in treatments C, D, E and F at the 8 per cent level. Ground whole oats were added to treatments A and B to raise the fibre levels of these two rations to the same level as the other treatments. Sulfa quinoxaline and 2 amino - 5 nitrothiazole were added to all diets as prophylactic agents to control coccidiosis and enterohepatitis.

The experiment was conducted for a period of five weeks. Feed conversion, body weight and mortality data were calculated for each lot of poults at weekly intervals. Feed and water were supplied ad libitum to all lots of poults during the experimental period.

TABLE 5

Composition of Rations used in Turkey Experiment I

Ingredients	Treatments A %	B %	C %	D %	E %	F %
Wheat	18.17	8.00	33.00	33.00	29.37	29.37
Oat groats	20.00	20.00	20.00	20.00	20.00	20.00
Whole oats	24.00	26.00	--	--	--	--
Soybean oil meal (41% protein)	16.00	38.00	24.50	24.50	33.63	33.63
Meat meal (50% protein)	18.00	--	10.00	10.00	--	--
Whey powder	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	1.33	2.67	2.00	2.00	2.00	2.00
Bonemeal	--	3.33	--	--	4.50	4.50
Salt (iodized)	0.50	0.50	0.50	0.50	0.50	0.50
Dehydrated alfalfa leaf meal	--	--	8.00	--	8.00	--
Dehydrated cereal grass	--	--	--	8.00	--	8.00
	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.	gms. per 100 lbs.
Dry vitamin A*	80.0	80.0	80.0	80.0	80.0	80.0
Dry vitamin D_3**	9.9	9.9	9.9	9.9	9.9	9.9
Riboflavin premix***	5.6	5.6	5.6	5.6	5.6	5.6
Choline chloride	103.0	103.0	103.0	103.0	103.0	103.0
Manganese Sulphate	10.0	10.0	10.0	10.0	10.0	10.0
Niacin	1.25	1.25	1.25	1.25	1.25	1.25
Methonine	25.0	25.0	25.0	25.0	25.0	25.0
Vitamin B_{12} supplement****	25.0	25.0	25.0	25.0	25.0	25.0
Aurofac*****	22.0	22.0	22.0	22.0	22.0	22.0
Calculated Analysis	%	%	%	%	%	%
Protein	24.00	23.20	23.90	23.90	23.20	23.20
Fat	4.22	4.81	4.56	4.61	4.01	4.15
Fibre	5.53	5.54	5.37	5.37	5.88	5.88
Calcium	2.02	2.02	2.02	2.05	2.03	2.03
Phosphorous	0.95	0.93	0.95	0.95	0.98	0.98

* Dry vitamin A - 5,000 I.U. per pound

** Dry vitamin D_3 - 11,000,000 units per pound

*** Riboflavin premix - 1 ounce of premix contains 1 gram of pure riboflavin

**** Vitamin B_{12} supplement - 6 mgs. of B_{12} per pound

***** Aurofac - 10 grams of aureomycin per pound

C. Alfalfa and cereal grass in laying rations

Experiment I - Egg production and hatchability studies

In November, 1953, the first tests were initiated to ascertain what effect, if any, the inclusion of increasing levels of alfalfa and cereal grass in the diet of laying hens, would have on subsequent rate of production and hatchability. The experiment was conducted in a poultry house having thermostatically controlled steam heat. The heat was held constant at 50° F. The house was equipped with sixteen pens of equal dimensions, each pen containing identical accessories including feeders, waterers and a three-compartment trap nest but no roosts. Lighting arrangements were such that all pens were subjected to the same intensity of illumination. By random distribution each of the sixteen pens received nine White Leghorn pullets and one cockerel. All the birds were procured from the University poultry flock. Until the commencement of the trial they had been reared and fed under regular university supervision and conditions. As this experiment was designed to test the effect of different levels of both alfalfa and cereal grass with respect to rate of production and hatchability, it was deemed desirable to replicate each treatment once. As a means of eliminating infertility due to incompatability, all males were systematically introduced into a new pen of pullets three times per week. The duration of the experiment was 120 days. During this period the birds received all mash rations and water ad libitum. The eight replicated treatments or diets comprising the basis for this experiment were as follows:

Treatment A - Basal ration containing no dry forages

Treatment B - " " plus 0.50 per cent alfalfa

Treatment C - " " " 0.50 per cent cereal grass

Treatment D - " " " 2.00 per cent alfalfa

Treatment E - Basal ration plus 2.00 per cent cereal grass

Treatment F - " " " a mixture composed of 1.0 per cent alfalfa and 1.0 per cent cereal grass

Treatment G - Basal ration plus 4.00 per cent alfalfa

Treatment H - " " " 4.00 per cent cereal grass

The basal ration conformed in composition to the Required Nutrient Allowances of the National Research Council 1950 for breeding hens, with a protein content of 15 per cent. The alfalfa and cereal grass were incorporated into the various diets at the expense of ground wheat and soybean oil meal (see Table 6). To maintain a constant level of vitamin A in all the diets, the vitamin A activity supplied by the alfalfa and cereal grass was calculated and dry vitamin A was added to the various rations where required.

The birds were trap-nested 5 days per week. The eggs were marked, gathered and stored daily including Sundays in an egg room that was maintained at average temperature of 62± 7° F. At intervals of two weeks, the eggs were incubated in a 2940 Jamesway unit after being candled to remove cracks and double yolks.

On the eighteenth day of incubation the eggs were candled. Infertile and dead germs were removed from the machine, broken open and classified into 4 groups, namely, (a) infertile, (b) dead in shell first week, (c) dead in shell second week, (d) dead in shell 14th to 18th day. In all, 8 hatches were satisfactorily completed.

Experiment II - Egg production and hatchability studies extended

In October 1954 the second test using Leghorn pullets was undertaken. This experiment was designed to extend the results obtained from

TABLE 6

Composition of Diets used in Laying Experiments I and II

	Treatments							
Ingredients	A %	B %	C %	D %	E %	F %	G %	H %
Wheat	61.56	61.26	61.26	59.86	59.86	59.86	59.10	59.10
Oat groats	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Soybean oil meal (41% protein)	4.30	4.15	4.15	4.10	4.10	4.10	3.00	3.00
Meat meal (50% protein)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Bonemeal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	3.64	3.59	3.59	3.54	3.54	3.54	3.42	3.42
Salt (iodized)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Granite grit (insoluble)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Dehydrated alfalfa leaf meal	--	0.50	--	2.00	--	1.00	4.00	--
Dehydrated cereal grass	--	--	0.50	--	2.00	1.00	--	4.00
	gms/100 lbs	gms/100 lbs	gms/100 lbs	gms/100 lbs	gms/100 lbs	gms/100 lbs	gms/100 lbs	gms/100 lbs
Manganese sulphate	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Riboflavin premix*	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Dry vitamin D_3**	2.74	2.74	2.74	2.74	2.74	2.74	2.74	2.74
Dry vitamin A ***	274.70	256.70	240.30	203.30	137.30	170.30	131.10	--
Calculated Analysis	%	%	%	%	%	%	%	%
Protein	15.00	15.05	15.04	15.19	15.16	15.15	15.05	15.05
Fat	2.75	2.75	2.76	2.75	2.74	2.74	2.76	2.76
Fibre	3.29	3.39	3.34	3.33	3.34	3.34	3.45	3.45
Calcium	2.25	2.25	2.25	2.25	2.25	2.25	2.25	2.25
Phosphorous	0.75	0.75	0.75	0.75	0.75	0.76	0.77	0.77

* Riboflavin premix - 1 ounce of premix contains 1 gram of pure riboflavin
** Dry vitamin D_3 - 11,000,000 units per pound
*** Dry vitamin A - 5,000 I.U. per pound

the 1953 trials. The same experimental house and equipment were used as in the previous year. The pullets on this test were grown from day old chicks procured from the last hatch of Experiment I. These chicks were reared to maturity on rations containing identical levels of alfalfa and cereal grass as included in their respective maternal diets.

At six months of age 16 of the best pullets were selected from each lot. These pullets were randomly distributed into two pens of equal size. This made a total of 16 pens containing 8 pullets and one cockerel each. The same experimental procedure was followed as outlined in Experiment I with the exception that eggs were stored prior to incubation at a constant temperature of 50° F.

Attention is here drawn to one of the main differences between the birds used in Experiments I and II. Neither the birds used in Experiment I nor their parents had been subjected to specific levels of alfalfa or cereal grass in their diets prior to being placed on test. The maternal diets of birds on Experiment II and their own starting and growing rations contained exactly the same levels of alfalfa and cereal grass as they themselves were offered during the 98 day production and hatchability study here reported. Experiment II, furthermore, included a study of the effect of the two forage meals on interior egg quality as determined by candling in accordance with the official Canadian Government egg grading regulations* in so far as they relate to Grade A and B for yolk shadow and air cell size.

* Regulations respecting the grading, packing and marking of eggs. Canada Department of Agriculture, Ottawa, Canada, (1951).

RESULTS

A. Alfalfa and cereal grass in chick rations

Experiment I

The results of Experiment I are shown in Table 7. No statistical analyses were made as the data gathered did not lend themselves to this form of analysis. In all cases the chicks preferred alfalfa to cereal grass. In treatment B (cereal grass), the average consumption of cereal grass was 860 grams while in treatment C (alfalfa) the average consumption of alfalfa was 920 grams. In treatment D, where the chicks had access to both alfalfa and cereal grass as the vitamin A supplement, the average consumption of alfalfa by the two replicates was 627 grams, while the average consumption of cereal grass was only 454 grams, a difference of 173 grams.

Treatment C produced the greatest rate of gain and efficiency of feed conversion, while treatment A (the basal ration) produced the least, a difference of 36 grams in mean growth weight at 6 weeks and a difference of 0.66 grams of feed per gram of gain in feed efficiency. Treatment C and D show very little difference in growth weight and feed efficiency. The fact that in both of these treatments the chicks had access to alfalfa may have had some bearing on the results. The mortality that occurred in this experiment could not be attributed to the diets fed.

Experiment II

The results of this experiment (see Table 8) indicate that the inclusion of alfalfa and cereal grass in a chick ration at varying levels up to 10 per cent did not reduce the palatability of the diets. The chicks consumed as much of treatments F and G (the 10 per cent level of alfalfa and cereal grass) as they did of treatment A(the basal ration). Furthermore there did not appear to be any measurable difference in the palatability

TABLE 7

Summary of effects on growth, feed consumption, feed conversion and mortality - Experiment I

Items	Treatments A Basal	B Cereal grass	C Alfalfa	D Cereal grass and alfalfa
Lbs. of mash consumed - rep. 1	52.6	58.0	53.4	56.0
Lbs. of mash consumed - rep. 2	58.7	58.8	51.5	55.0
Average	55.6	58.4	52.4	55.5
Gms. of cereal grass consumed - rep. 1	--	750	--	305
Gms. of cereal grass consumed - rep. 2	--	970	--	240
Average		860		272
Gms. of alfalfa consumed - rep. 1	--	--	970	495
Gms. of alfalfa consumed - rep. 2	--	--	870	760
Average			920	627
Mean wt. @ 6 weeks in gms. - rep. 1	399	467	466	473
Mean wt. @ 6 weeks in gms. - rep. 2	460	423	465	454
Average	429	445	465	463
Gms. of feed/gm. gain - rep. 1	3.65	3.24	2.97	2.74
Gms. of feed/gm. gain - rep. 2	3.53	3.44	2.89	2.98
Average	3.59	3.34	2.93	2.86
Mortality - rep. 1	3	1	0	1
Mortality - rep. 2	1	0	2	0

TABLE 8

Feed consumption and mortality results - Experiment II

Item	Treatments A Basal	B Basal + 1% Alfalfa	C Basal + 1% Cereal	D Basal + 5% Alfalfa	E Basal + 5% Cereal	F Basal + 10% Alfalfa	G Basal + 10% Cereal*
Feed consumption (lbs.) rep. 1	21.05	19.75	18.35	17.20	17.45	21.90	22.20
Feed consumption (lbs) rep. 2	26.70	14.60	13.64	16.90	14.60	24.30	25.20
Average	23.87	17.17	16.00	17.05	16.02	23.10	23.70
Mortality - rep. 1	0	0	0	0	0	0	0
Mortality - rep. 2	0	0	0	0	0	0	0

* Cereal grass

of diets containing alfalfa or cereal grass as the average consumption in treatment F was 23.10 pounds and the average consumption in treatment G 23.70 pounds. This conclusion is substantiated by the fact that the average consumption of all the diets containing alfalfa was 57.32 pounds and the average consumption of all the diets containing cereal grass was 55.72 pounds, a difference of only 1.60 pounds between 50 chicks.

Experiment III

The summary of effects on chick growth, feed efficiency and mortality are presented in Table 9. The statistical analysis of this data is shown in Tables 9, 10, 11, 12 and 13. To overcome the problem of unequal numbers resulting from sporadic mortality in the lots the analysis of variance of body weights was based on weights of 8 females and 5 males selected at random from each lot. The analysis was conducted on the combined data of males and females and on the two sexes separately. Least significant differences were calculated in each case.

The analysis of variance reveals a significant difference in body weights between diets and between replicates when the analysis was conducted on the combined weights of both sexes and on the males alone. However the analysis of body weight data on the females shows a significant difference between rations whereas replicate differences are not significant. The calculated least significant differences at the 5 per cent level for the average means were 29 grams for the combined males and females, 35 grams for females while for males alone it was 46 grams.

The alfalfa and cereal grass rations gave the highest body weight when 1 per cent of the green feed was included in the diet. Body weight on the basal ration (Treatment A) which contained no green feed was 16 grams and 4 grams lower respectively when compared to the 1 per cent level of alfalfa (Treatment B) and the 1 per cent level of cereal grass

TABLE 9

Summary of effects on chick growth, feed efficiency and mortality (to 5 weeks)
Experiment III

Items	Treatments A Basal	B Basal + 1% alfalfa	C Basal + 1% cereal	D Basal + 5% alfalfa	E Basal + 5% cereal	F Basal + 10% alfalfa	G Basal + 10% cereal	H Basal + 15% alfalfa	I Basal + 15% cereal	J Basal + 20% alfalfa	K Basal + 20% cereal *
Mean wt. (gms), both sexes - rep. 1	337	388	371	328	356	300	339	282	288	235	282
Mean wt. (gms), both sexes - rep. 2	377	359	351	315	309	272	320	238	301	209	277
Average	357	373	361	321	332	286	329	260	294	222	279
Mean wt. (gms.) females - rep. 1	301	361	354	309	327	299	308	273	277	227	265
Mean wt. (gms.) females - rep. 2	355	342	338	297	305	280	295	240	299	206	266
Average	328	351	346	303	316	289	301	256	288	216	265
Mean wt. (gms.) males - rep. 1	398	412	391	361	359	300	386	289	310	250	302
Mean wt. (gms.) males - rep. 2	396	337	376	342	321	262	350	234	304	214	291
Average	397	374	383	351	340	281	368	261	307	232	296
Gms. feed/gram gain - rep. 1	2.72	2.62	2.92	2.67	2.71	3.19	2.78	2.91	3.88	3.57	3.69
Gms. feed/gram gain - rep. 2	2.69	2.81	2.25	2.85	2.61	3.26	2.60	3.65	2.79	3.78	3.03
Average	2.70	2.71	2.58	2.76	2.66	3.22	2.69	3.28	3.33	3.67	3.36
Mortality - rep. 1	1	1	5	0	1	0	0	1	4	0	1
Mortality - rep. 2	1	0	0	0	0	1	0	0	0	0	1

* cereal grass

TABLE 10

Analysis of variance of body weights in grams at 5 weeks of age (both sexes)

Source of Variation	D.F.	Mean Square	F. Value
Treatments	10	59,894.79	19.83**
Replicates	1	17,922.010	6.03**
Interaction (TXR)	10	2,374.045	0.79
Error	264	2,969.400	
Total	285		

** Significant at the 1 per cent level

Least significant difference for means at 5% level = 29 grams

TABLE 11

Analysis of variance of body weights in grams at 5 weeks of age (females)

Source of Variation	D.F.	Mean Square	F. Value
Treatments	10	25,912.00	10.02**
Replicates	1	761.100	0.29
Interaction (TXR)	10	2,114.810	0.82
Error	154	2,584.140	
Total	175		

** Significant at 1 per cent level

Least significant difference for means at 5 % level = 35 grams.

TABLE 12

Analysis of variance of body weights in grams at 5 weeks of age (males)

Source of Variation	D.F.	Mean Square	F. Value
Treatments	10	38,503.76	14.37**
Replicates	1	32,887.30	12.27**
Interaction (TXR)	10	160.27	0.06
Error	88	2,678.54	
Total	109		

** Significant at 1 per cent level

Least significant difference for means at 5% level = 46 grams.

TABLE 13

Analysis of variance of feed efficiencies at 5 weeks of age

Source of Variation	D.F.	Mean Square	F. Value
Treatments	10	0.2872	2.19
Replicates	1	0.0810	0.00
Error	10	0.1310	
Total	21		

(Treatment C). There was a gradual decline in body weight of the chicks as the level of alfalfa and cereal grass increased from 1 to 20 per cent. The rate of decline in body weight was accelerated with increasing levels of alfalfa and cereal grass above 10 per cent. There was a greater growth depressing effect on body weight when alfalfa was added above 10 per cent than when cereal grass was fed over this level. As the level of alfalfa meal increased from 1 to 5, 5 to 10, 10 to 15 and 15 to 20 per cent, mean body weights of chicks decreased 52, 35, 26 and 38 grams, respectively. When similar comparisons between increasing levels of cereal grass were made, mean body weights of chicks decreased 29, 3, 35 and 15 grams respectively.

The analysis of variance of feed efficiency indicated no significant difference between treatments. However as levels of alfalfa and cereal grass increased there was a consistent decrease in feed efficiency. The one per cent cereal grass diet (Treatment C) resulted in the highest feed conversion (2.58) while the 20 per cent alfalfa diet was the least (3.67). At any given level of inclusion of the forage products, the resultant average feed conversion of the replicated lots was in favor of the cereal grass fed chicks. At the 1, 5, 10 and 20 per cent levels, the chicks on cereal grass gave higher efficient feed conversion by 0.13, 0.10, 0.53 and 0.31 grams respectively. Only at the 15 per cent level, was the average feed efficiency in favor of the chicks fed alfalfa (Treatment H) by 0.05 grams.

The mortality data did not indicate any trend. In replicate one 14 chicks died, while in replicate two, the number of deaths was only 3, for the same total number of chicks put on test.

Experiment IV

Summary of the effects on chick growth, feed efficiency and mortality are shown in Table 14. The analysis of variance of body weights at 5 weeks of age (Table 15) indicated a significant difference between treatments, the calculated least significant difference between means being 33 grams at the 5 per cent level. The chicks on treatment D, containing a mixture of 0.50% alfalfa and 0.50% cereal grass, produced the most rapid growth (363 grams) in 5 weeks, closely followed by treatments C and F. The smallest gains in body weight occurred in the lots fed the diet containing 10 per cent alfalfa (Treatment G) where the mean body weight of the two replicates at 5 weeks of age was 266 grams. There was a trend at the 10 per cent level of inclusion of the dry forage meals towards greater gains as the percentage of cereal grass in a ration increased and that of the alfalfa decreased. Through treatments G to K the amount of cereal grass increased as follows: 0, 2.5, 5.0, 7.5 and 10 per cent while the amount of alfalfa in these diets decreased in converse order. The average body weights of chicks on these respective treatments increased by 19, 6, 18 and 23 grams.

Although Table 16 reveals no significant difference in efficiency of feed utilization between the diets, there was evidence of declining feed efficiencies in the lots fed on diets containing the forage meals at the 10 per cent level. The feed efficiencies ranged from a high of 2.65 grams in treatment E to a low of 3.30 grams of feed per gram of gain in treatment H.

TABLE 14

Summary of effects on chick growth, feed efficiency and mortality (5 weeks) - Experiment IV

Items	Treatments A Basal	B Basal + 1% alfalfa	C Basal +.75% alfalfa + .25% cereal	D Basal + .50% alfalfa + .50% cereal	E Basal + .25% alfalfa + .75% cereal	F Basal + 1 % cereal	G Basal + 10% alfalfa	H Basal + 7.50% alfalfa + 2.50% cereal	I Basal + 5.0% alfalfa + 5.0% cereal	J Basal + 2.5% alfalfa + 7.5% cereal	K Basal + 10.0% cereal *
Mean wt. (gms.) - rep. 1	292	321	349	370	309	370	275	265	291	315	334
Mean wt. (gms.) - rep. 2	330	320	361	357	317	341	257	305	294	303	331
Average	311	320	355	363	313	355	266	285	291	309	332
Gms. of feed per gm. gained - rep. 1	2.89	2.64	2.93	2.52	2.72	2.94	3.06	3.55	3.32	3.16	3.05
Gms. of feed per gm. gained - rep. 2	2.72	3.05	2.71	3.06	2.58	2.58	3.40	3.06	3.12	3.19	3.00
Average	2.80	2.84	2.82	2.79	2.65	2.76	3.23	3.30	3.22	3.17	3.02
Mortality	0	0	0	0	0	0	0	0	0	0	0

* cereal grass

TABLE 15

Analysis of variance of body weights at 5 weeks of age.

Source of variation	D.F.	Mean Square	F. Value
Treatments	10	23,116.15	6.56**
Replicates	1	1,432.70	0.47
Interaction (TXR)	10	2,780.78	0.79
Error	242	3,519.49	
Total	263		

** Significant 1 per cent level

L.S.D. (5 per cent level) for average means = 33 grams.

TABLE 16

Analysis of variance of feed efficiencies at 5 weeks of age.

Source of variation	D.F.	Mean Square	F. Value
Treatments	10	0.1062	1.97
Replicates	1	0.0044	<1
Error	10	0.5383	
Total	21		

Experiment V

In Table 17 is a summary of the effects on chick growth, feed efficiency and mortality as observed in Experiment V. For reasons similar to those stated in the results of Experiment III, the analysis of variance of body weights (Table 18) was conducted on 10 chicks selected randomly from each lot. There were no significant differences in body weights. However an observation of the body weights indicated that the growth of chicks in this experiment was below normal for White Leghorn females of this age. The chicks on treatment B produced the highest body weight (249 grams) while poorest results occurred in lots on treatment J (218 grams).

Differences in feed efficiencies due to rations were not statistically significant (Table 19). Furthermore the efficiencies in all the lots were low for chicks of this age.

TABLE 17

Summary of effects on chick growth, feed efficiency and mortality at 5 weeks - Experiment V.

Items	Treatments A Basal	B Basal + 1% alfalfa	C Basal + .75% alfalfa + .25% cereal	D Basal + .50% alfalfa + .50% cereal	E Basal + .25% alfalfa + .75% cereal	F Basal + 1% cereal	G Basal + 5% alfalfa	H Basal + 3.75% alfalfa + 1.25% cereal	I Basal + 2.5% alfalfa + 2.5% cereal	J Basal +1.25% alfalfa +3.75% cereal	K Basal + 5% cereal*
Mean wt. (gms.) - rep. 1	241	249	221	218	216	213	242	228	220	238	235
Mean wt. (gms.) - rep. 2	218	250	203	236	234	242	217	211	224	198	218
Average	229	249	212	227	225	227	229	219	222	218	226
Gms. feed/gm. gain - rep. 1	3.51	2.98	3.24	3.19	3.33	3.61	3.11	3.22	3.72	3.17	3.26
Gms. feed/gm. gain - rep. 2	3.60	3.07	3.24	3.29	3.21	3.05	3.29	3.43	3.24	3.61	3.20
Average	3.55	3.02	3.24	3.24	3.27	3.33	3.20	3.32	3.48	3.39	3.23
Mortality - rep. 1	2	0	0	0	0	0	0	2	0	1	0
Mortality - rep. 2	0	0	1	0	0	1	0	0	1	1	0

* cereal grass

TABLE 18

Analysis of variance of body weights at 5 weeks of age

Source of variation	D.F.	Mean Square	F. Value
Treatments	10	1,997.359	1.17
Replicates	1	1,730.410	1.02
Interaction (TXR)	10	2,753.574	1.62
Error	198	1,694.020	
Total	219		

TABLE 19

Analysis of variance of feed efficiencies at 5 weeks of age

Source of variation	D.F.	Mean Square	F. Value
Treatments	10	0.0411	<1
Replicates	1	0.0000	
Error	10	0.0429	
Total	21		

Experiment VI

The inclusion of alfalfa and cereal grass in chick starter diets at identical levels as was formerly included in the maternal diets did not significantly affect growth as illustrated by the statistical analysis of the data as shown in Table 21. However a close scrutiny of the data in Table 20 indicated a trend towards heavier body weights for chicks fed on the rations containing cereal grass. At the 0.50, 2 and 4 per cent levels the average body weights of the chicks fed cereal grass were heavier than the respective lots fed alfalfa by 28, 43 and 24 grams. Similar comparisons in feed efficiency data were in favor of the chicks fed cereal grass by .09, .17 and .22 grams of feed per gram gained.

TABLE 20

Summary of effects on chick growth, feed efficiency and mortality - Experiment VI

	Treatments							
	A	B	C	D	E	F	G	H
Items	Basal	Basal + 0.5% alfalfa	Basal + 0.5% cereal	Basal + 2% alfalfa	Basal + 2% cereal	Basal + 1% cereal + 1% alfalfa	Basal + 4% alfalfa	Basal + 4% cereal *
Mean wt.(gms.)- males	317	286	329	235	322	330	235	287
Mean wt. (gms.)-females	287	280	293	270	269	277	289	289
Average	302	283	311	252	295	303	262	288
Gms. feed/gm. gain	2.16	2.27	2.18	2.42	2.25	2.11	2.49	2.27
Mortality	2	0	2	1	1	1	2	0

* cereal grass

TABLE 21

Analysis of variance of body weights in grams at 5 weeks of age

Source of variation	D.F.	Mean Square	F. Value
Between treatments	7	4,384.25	1.01
Within treatments	264	4,315.90	
Total	271		

B. Alfalfa meal and cereal grass in poult rations

Experiment I

A summary of the effects on poult growth, feed efficiency and mortality are found in Table 22. The analysis of variance of body weights (Table 23) was conducted on 9 poults selected at random from each lot. The results of the analysis revealed a significant difference between treatments and between the interaction of treatments and replicates. The calculated least significant difference between treatments was 113 grams. The heaviest body weights occurred in the lots fed treatment D (919 grams) whereas the poorest results occurred on treatment A(656 grams). When comparing treatments A, C and D (similar composition) the inclusion of 8 per cent alfalfa (Treatment C) in the ration increased growth by 201 grams, whereas the inclusion of 8 per cent cereal grass (Treatment D) increased poult growth by 263 grams over treatment A which contained no dry forage meals. When comparing treatments B, E and F (similar composition) the inclusion of alfalfa and cereal grass at the 8 per cent level (Treatments E and F) depressed growth by 185 and 24 grams respectively in comparison with treatment B which contained no dry forage meals.

Table 24 reveals no significant difference in feed utilization. However the poults on treatment D produced the most efficient feed conversion (2.26) closely followed by the poults on treatment B (2.28). The lowest feed conversion occurred in the poults fed treatments A and E which had feed efficiencies of 2.67 and 2.64 respectively. Mortality data did not indicate any trend due to diets fed.

TABLE 22

Summary of effects on poult growth, feed efficiency and mortality.

Items	Treatments A Soybean + meat meal	B Soybean only	C Soybean + meat meal + 8% alfalfa	D Soybean + meat meal + 8% cereal grass	E Soybean + 8% alfalfa	F Soybean + 8% cereal grass
Mean wt. (gms.) - rep. 1	641	911	825	831	802	749
Mean wt. (gms.) - rep. 2	671	861	886	1008	601	976
Average	656	886	855	919	701	862
Gms. feed/gm. gain - rep. 1	3.07	2.13	2.67	2.25	2.39	2.61
Gms. feed/gm. gain - rep. 2	2.27	2.43	2.31	2.28	2.90	2.27
Average	2.67	2.28	2.49	2.26	2.64	2.44
Mortality - rep. 1	0	0	0	0	1	0
Mortality - rep. 2	0	0	1	0	1	1

TABLE 23

Results of analysis of variance of body weights of poults at 6 weeks of age.

Source of variation	D.F.	Mean Square	F. Value
Treatments	5	208.947.45	7.06**
Replicates	1	44,611.25	1.50
Interaction (TXR)	5	98,070.81	3.31**
Error	96	29,595.31	
Total	107		

** Significant at 1 per cent level

Least significant difference for average means at 5 per cent level = 113 grams

TABLE 24

Results of analysis of variance of feed efficiencies of poults at 6 weeks of age.

Source of variation	D.F.	Mean Square	F. Value
Treatments	5	0.0599	0.509
Replicates	1	0.0363	0.308
Error	5	0.1175	
Total	11		

C. Alfalfa and cereal grass in laying rations

Experiment I

A summary of the results on egg production, feed consumption, body weight, fertility and hatchability are given in Table 25. Hatchability is considered the most critical criterion in studying the effect of rations on laying hens. While the experiment was conducted for a period of 17 weeks, the statistical analysis of the hatchability data was conducted on the results of the last 10 weeks (5 hatches). The first 7 weeks of the trial was used as a "tempering period" to eliminate any effect that the former diet may have had on hatchability. To obtain information on the effect of the interaction of treatments and storage periods on hatchability the two week intervals for which the eggs were kept prior to incubation were divided into 4 periods, namely: all eggs layed for the first 3 days of each 2 week interval constituted the first period, the next successive 4 days, the second period, the next 3 days the third period and the last 4 days prior to incubation the fourth period. The complete statistical analysis, as shown in Table 26, tested four main effects: rations, replicates, storage periods and hatches. Statistical analysis revealed a significant difference between treatments, between storage periods and between hatches. Interactions of hatches with storage periods and replicates with treatments were also significant. On the other hand rations had no significant effect on storage periods nor on hatches.

The rations (Table 25) did not show any definite trend in the effect of either of the dry forage meals on hatchability of the eggs. With reference to cereal grass, the 2 and 4 per cent levels (Treatments E and H) gave higher hatchability by 5.13 and 1.10 per cent respectively than the basal diet which contained no green feed. The 0.50 per cent level resulted

in 4.15 per cent lower hatch than the basal diet. On the other hand alfalfa meal at levels of 0.50 and 4 per cent resulted in higher hatchability than the basal diet by 4.25 and 9.83 per cent respectively, but when this ingredient was included in the ration at the level of 2 per cent the hatchability of the eggs was 2.23 per cent lower than on the basal diet. Comparing the two forage meals, at the 0.50 and 4 per cent levels, the alfalfa diets gave higher hatchability than the cereal grass by 8.40 and 8.66 per cent respectively, whereas at the 2 per cent level the alfalfa resulted in 7.36 per cent lower hatchability. The highest hatchability for all diets was obtained on the ration containing the highest level of alfalfa (4 per cent) whereas a mixture of 1 per cent alfalfa and 1 per cent cereal grass (Treatment F) resulted in the lowest hatchability.

The analysis of variance showing the effect of ingredients and levels on hatchability is contained in Table 27. The results indicate no significant difference between ingredients, levels nor between interaction of levels and ingredients.

Percentage egg production was calculated on a hen-day basis and the data listed in Table 25 are for the two periods, namely the first 7 weeks and the last 10 weeks. The analysis of variance data (Table 28 and 29) indicated no significant difference among treatments for either of the periods.

Feed consumption data were for the entire period of the trial as no provisions were made to record feed consumption at the beginning of the hatchability period. Inspection of this data would indicate that there is no association between levels of forage meals fed and feed consumption as the variations between replicates are generally greater than difference between diets.

Feed efficiency as shown in Table 25 is based on the number of pounds of feed per dozen eggs laid. The analysis of variance (Table 30) revealed no significant differences between treatments. The 2 per cent alfalfa ration gave the best results (6.34) closely followed by the 2 per cent cereal grass and the 4 per cent alfalfa diets with efficiencies of 6.54 and 6.66 respectively. The poorest results occurred on the 4 per cent cereal grass diet (Treatment H) which was 2.08 lbs. per dozen eggs higher in comparison with same level of alfalfa.

TABLE 25

Effect of various levels of alfalfa and cereal grass on performance of breeding hens - Experiment I

Treatment	Feed Consumption per hen day	Feed Consumption per doz. eggs	Gain or loss in body wt. per bird	Egg Production*** First period	Egg Production*** Second period	Eggs set	Fertility	Hatchability****
	lbs	lbs	lbs			No.	%	%
A (Basal)	0.287	6.54	0.085	55.7	47.5	531	85.9	82.49
A	0.289	7.48	0.042	42.6	47.3	445	83.2	69.32
Average	0.288	7.01	0.063	49.1	47.4	488	84.5	75.90
B (Basal +	0.287	7.12	-0.022	50.08	44.6	499	68.2	74.71
B .5% a*)	0.328	7.79	0.200	47.9	50.2	380	82.8	85.60
Average	0.307	7.45	0.089	48.9	47.4	439	75.5	80.15
C (Basal +	0.275	6.60	-0.155	49.14	47.9	528	69.0	78.10
C .5% c**)	0.283	7.37	0.044	41.6	46.3	475	75.8	65.41
Average	0.279	6.98	- .055	45.3	47.1	501	72.4	71.75
D (Basal +	0.280	5.40	-0.011	63.4	57.7	656	85.3	77.34
D 2% a)	0.293	7.28	0.042	46.6	47.0	504	94.7	70.00
Average	0.286	6.34	0.015	55.0	52.3	580	90.0	73.67
E (Basal +	0.303	6.50	-0.044	53.7	52.5	591	87.9	81.06
E 2% c)	0.270	6.59	0.144	53.7	43.9	483	82.6	81.00
Average	0.286	6.54	0.050	53.7	48.2	537	85.2	81.03
F (Basal +	0.283	6.68	0.100	54.1	47.3	533	82.0	72.17
F 1%a + 1%c)	0.304	6.79	- .114	58.8	43.8	441	78.9	71.20
Average	0.293	6.73	- .007	56.4	45.5	487	80.4	71.68
G (Basal +	0.305	7.12	0.244	49.1	50.7	543	80.1	82.67
G 4% a)	0.314	6.20	0.233	61.4	56.5	634	90.7	88.79
Average	0.309	6.66	0.238	55.2	53.6	588	85.4	85.73
H (Basal +	0.290	7.18	0.000	46.9	47.6	447	90.9	74.80
H 4% c)	0.315	10.10	-0.228	35.7	37.5	308	82.5	79.34
Average	0.302	8.64	-0.114	41.3	42.5	377	86.7	77.07

* Alfalfa

** Cereal

*** First period covers first 7 weeks of trial
Second period covers last 10 weeks of trial

**** Hatchability on the basis of fertile eggs

TABLE 26

Analysis of variance of hatchability of eggs

Source of variation	D.F.	Mean Square	F. Value
Treatments	7	929.14	6.09**
Replicates	1	405.81	2.66
Storage periods	3	1,863.38	12.22**
Hatches	4	2,748.47	18.03**
Treatments x storage periods	21	163.10	1.07
Treatments x hatches	28	224.10	1.47
Hatches x storage periods	12	1,727.49	11.33**
Replicates x treatments	7	753.65	4.94**
Replicates x storage periods	3	129.14	0.84
Replicates x hatches	4	164.72	0.27
Error	229	152.40	
Total	319		

** Significant at 1 per cent level

TABLE 27

Analysis of variance showing the effects of ingredients and levels on hatchability

Source of variation	D.F.	Mean Square	F. Value
Ingredients	1	10,817.50	0.58
Levels	3	16,353.56	0.89
Interaction (In x L)	3	16,908.94	0.90
Error	8	18,623.87	
Total	15		

TABLE 28

Analysis of variance of egg production for the first period of trial

Source of variation	D.F.	Mean Square	F. Value
Between treatments	7	58.193	1.14
Within treatments	8	50.833	
Total	15		

TABLE 29

Analysis of variance of egg production for the second period of trial

Source of variation	D.F.	Mean Square	F. Value
Between treatments	7	25.015	1.08
Within treatments	8	23.145	
Total	15		

TABLE 30

Analysis of variance of feed consumption per dozen eggs laid

Source of variation	D.F.	Mean Square	F. Value
Between treatments	8	0.9283	
Within treatments	7	1.0595	1.14
Total	15		

Experiment II

The summary of results on egg production, feed consumption, body weight, fertility, hatchability and egg equality are found in Table 31. The analysis of variance of hatchability as shown in Table 32 tested the difference between treatments, replicates, storage periods, hatches and the first order interaction of these main effects. In Experiment I it was observed that the interaction of treatments with storage periods had no significant effect on hatchability. In view of this it was felt that sufficient information could be obtained by using two storage periods; namely all eggs layed the first 7 days of the two week interval constituted the first period and the eggs layed the last 7 days the second period. By analysis of variance marked significant differences existed between treatments, storage periods, hatches and the interaction of treatment and hatches. However, as found in Experiment I, the interaction of treatments and storage period was not significant.

Referring to the effect of cereal grass (Treatments C, E and H, Table 31), the hatchability of the eggs decreased progressively as the amount of cereal grass in the ration increased from 0.50 to 4 per cent. On the alfalfa diets (Treatments B, D and G), the 0.50 and 4 per cent levels (Treatments B and G) maintained the same per cent hatchability whereas the ration containing 2 per cent alfalfa (Treatment D) was 6.28 and 7.44 per cent lower than the 0.50 and the 4 per cent levels respectively. In comparing the cereal grass diets with the basal ration, the 0.50 and 2 per cent levels (Treatments C and E) gave higher hatchability than the basal by 8.47 and 5.92 per cent respectively. At the 4 per cent level cereal grass resulted in 6.25 per cent lower hatchability than the basal ration. All levels of alfalfa, namely 0.5, 2 and 4 per cent, resulted in higher hatchability than

the basal by 10.93, 4.49 and 10.87 per cent respectively.

Comparing the two forage meals, at the 0.50 and 4 per cent levels the alfalfa rations gave higher hatchability than the cereal grass by 2.46 and 17.02 per cent respectively. At the 2 per cent level the alfalfa diet resulted in 1.43 per cent lower hatchability than the 2 per cent level of cereal grass. The highest hatchability for all rations was obtained on treatments B and G (0.50 and 4 per cent alfalfa) whereas the 4 per cent cereal grass diet (Treatment H) yielded the lowest hatchability. The mixture of 1 per cent alfalfa and 1 per cent cereal grass (Treatment F) was the second lowest and was only 3.28 per cent higher in hatchability than the 4 per cent cereal grass ration.

Results of the analysis of variance indicating the effect of the two ingredients and levels on hatchability is shown in Table 33. This table shows a significant difference between ingredients, between levels and the interaction of ingredients and levels.

Table 34 indicates no significant difference in egg production between treatments. However, there was a slight rise in egg production as the level of either forage product increased in the ration. The highest production was obtained on the 4 per cent cereal grass diet (Treatment H) whereas the lowest result occurred in the ration containing the mixture of alfalfa and cereal grass (Treatment F).

The analysis of variance of the feed consumption data (Table 35 and 36) indicated no significant difference in either feed consumption per hen-day or feed consumption per dozen eggs laid. However, there was a slight rise in total feed consumption per hen-day as the level of cereal grass increased in the diet. There was no such trend in evidence with the birds on alfalfa diets. For example at the 2 per cent level of alfalfa

(Treatment D) the consumption per hen-day was 0.010 pounds higher than the ration containing 4 per cent alfalfa (Treatment G). In regard to feed consumption per dozen eggs laid all the diets containing forage meals exhibited improvement in feed efficiency over the basal ration, with the 0.50 per cent level of alfalfa being the most efficient.

In determining the effect of varying levels of alfalfa and cereal grass on interior egg quality the last two setting of eggs were graded prior to incubation. By using this procedure, replicated lots of eggs held from 0 to 7 days and from 8 to 14 days were obtained for each treatment. The Chi-Square method of analysis was employed (Tables 37 and 38). It indicated that the proportion of grade A eggs decreased significantly as the level of alfalfa or cereal grass increased in the ration. These results hold true regardless of the length of the storage period.

An analysis of variance was conducted to determine the effect on egg quality of ingredients, levels and storage period. The Chi-Square analysis indicated that as the level of both alfalfa and cereal increased in the ration the number of grade A eggs decreased. The analysis of variance revealed that the effect of cereal grass on decreasing egg quality was significantly greater than the alfalfa meal (Table 39).

TABLE 31

Effect of various levels of alfalfa and cereal grass on performance of breeding chickens - Experiment II

Treatment	Feed Consumption per hen-day lbs.	Feed Consumption per doz. eggs lbs.	Gain or loss in body wt. per bird-lbs	Egg Production %	Eggs Set No.	Fertility %	Hatchability % of fertile eggs - %	Egg Quality 0 - 7 days A No.	0 - 7 days B No.	8 - 14 days A No.	8 - 14 days B No.
A (Basal)	0.286	6.52	0.615	52.7	393	93.56	75.67	46	2	44	8
A	0.286	5.59	0.203	61.5	464	86.91	76.88	61	0	57	3
Average	0.286	6.05	0.409	57.1	428.5	90.23	76.27	51.0	1.0	50.5	5.5
B (Basal + 0.5%	0.266	5.42	0.257	59.2	448	89.89	86.90	60	0	70	1
B alfalfa)	0.278	5.31	0.148	63.0	459	87.50	87.50	74	2	68	5
Average	0.272	5.36	0.202	61.1	453.5	88.74	87.20	67.0	1.0	69.0	3.0
C (Basal + 0.5%	0.258	5.00	0.273	62.0	466	93.86	84.39	53	1	56	1
C cereal grass)	0.289	6.35	0.132	54.7	411	83.85	85.09	53	0	59	2
Average	0.273	5.67	0.202	58.3	438.5	88.85	84.74	53.0	.5	57.0	1.5
D (Basal + 2%	0.297	6.21	0.312	57.5	433	93.42	78.68	54	3	54	4
D alfalfa)	0.296	5.82	-0.223	61.7	452	93.08	82.85	59	4	58	2
Average	0.296	6.01	.089	59.6	442.5	93.25	80.76	56.5	3.5	56.0	3.0
E (Basal + 2%	0.291	5.42	0.250	64.5	490	87.60	77.98	55	10	50	24
E cereal grass)	0.276	5.44	0.156	61.1	459	93.78	86.41	52	6	61	6
Average	0.283	5.43	0.203	62.8	474.5	90.69	82.19	53.5	8.0	55.5	15.0
F (Basal + 1% alfalfa	0.253	6.23	0.132	48.7	368	91.07	69.07	42	2	50	9
F + 1% cereal grass)	0.285	5.65	0.117	60.7	450	91.53	77.54	65	6	49	10
Average	0.269	5.94	0.124	54.7	409.0	91.30	73.30	53.5	4.0	49.5	9.5
G (Basal + 4%	0.296	5.95	0.092	61.0	472	93.18	89.50	45	12	41	21
G alfalfa)	0.277	5.10	-0.050	65.2	497	90.30	84.59	70	9	61	18
Average	0.286	5.52	.042	63.1	484.5	91.74	87.04	57.5	10.5	51.0	19.5
H (Basal + 4%	0.296	5.45	0.272	65.2	501	89.49	71.37	54	18	35	35
H cereal grass)	0.305	5.75	0.195	63.6	491	89.48	68.67	46	17	26	40
Average	0.300	5.60	0.233	64.4	496	89.48	70.02	50.0	17.5	30.5	37.5

TABLE 32

Analysis of variance of hatchability of eggs - Experiment II

Source of variation	D.F.	Mean Square	F. Value
Treatments	7	1,104.99	13.47**
Replicates	1	178.00	2.17
Storage periods	1	1,081.74	13.18**
Hatches	6	260.65	3.18**
Treatments x storage periods	7	42.94	0.52
Treatments x hatches	42	153.32	1.86**
Hatches x storage periods	6	10.31	0.12
Replicates x treatments	7	154.88	1.89
Replicates x storage periods	6	0.56	0.06
Replicates x hatches	6	31.94	0.39
Error	134		
Total	223		

** Significant at 1 per cent level

TABLE 33

Analysis of variance showing the effect of ingredients and levels on hatchability

Source of variation	D.F.	Mean Square	F. Value
Ingredients	1	15,218.27	10.09*
Levels	3	13,145.93	8.71**
Interaction (I x L)	3	14,262.09	9.45**
Error	8	1,508.19	
Total	15		

* Significant at 5 per cent level
** Significant at 1 per cent level

TABLE 34

Analysis of variance of egg production

Source of variation	D.F.	Mean Square	F. Value
Between treatments	7	22.067	1.04
Within treatments	8	21.116	
Total	15		

TABLE 35

Analysis of variance of feed consumption per hen-day

Source of variation	D.F.	Mean Square	F. Value
Between treatments	7	0.000262	1.51
Within treatments	8	0.000173	
Total	15		

TABLE 36

Analysis of variance of feed consumption per dozen eggs laid

Source of variation	D.F.	Mean Square	F. Value
Between treatments	7	0.1454	0.581
Within treatments	8	0.2500	
Total	15		

TABLE 37

Chi-square test showing the relationship between grades of eggs and levels of cereal grass for two storage periods

I 0 - 7 days storage

Grade	Treatments			
	A	C	E	H
A	51.0	53.0	53.5	50.0
B	1.0	0.5	8.0	17.5

$X^2 = 24.46$ $X^2_{.01} = 11.34$

II 8 - 14 days storage

Grade	Treatments			
	A	C	E	H
A	50.5	57.0	55.5	30.5
B	5.5	1.5	15.0	37.5

$X^2 = 58.12$ $X^2_{.01} = 11.34$

TABLE 38

Chi-square test showing the relationship between grades of eggs and levels of alfalfa for two storage periods

I 0 - 7 days storage

Grades	Treatments			
	A	B	D	G
A	51.0	67.0	56.5	57.5
B	1.0	1.0	3.5	10.5

$X^2 = 13.70$ $X^2_{.01} = 11.34$

II 8 - 14 days storage

Grades	Treatments			
	A	B	D	G
A	50.5	69.0	56.0	51.0
B	5.5	3.0	3.0	19.5

$X^2 = 23.41$ $X^2_{.01} = 11.34$

TABLE 39

Analysis of variance of egg quality

Source of variation	D.F.	Mean Square	F. Value
Ingredients	1	812.250	4.38*
Levels	3	2,838.187	15.33**
Storage period	1	976.562	5.27*
Ingredients x levels	3	324.542	1.75
Ingredients x storage period	1	56.250	0.30
Levels x storage period	3	294.438	1.59
Error	51		
Total	63		

* Significant at 5 per cent level

** Significant at 1 per cent level

DISCUSSION

The role played by these two forage products in poultry rations is based on the growth response and feed efficiency elicited from chicks and poults as well as on the rate of egg production and per cent hatchability accruing from breeding hens that were fed varying levels of alfalfa and cereal grass in non-purified diets. The diets used may be broadly categorized as follows:

(a) Chick rations

(b) Poult rations

(c) Laying rations

(a) Chick rations

In Experiments I and II, an attempt was made to ascertain the individual palatability of the forage meals. From Experiment I, where the two forages were both offered free choice to chicks, it was evident from the consumption data that the birds preferred the alfalfa to the cereal grass. In view of the fact that each feed trough containing their respective forage meal was rotated daily from one side of the battery to the other it is logical to assume that a real difference in palatability exists between alfalfa and cereal grass. No attempt was made to ascertain the flavor ingredient contained in the alfalfa that made it more palatable than cereal grass.

In Experiment II where these two forage meals were separately mixed at varying levels into the basal ration, the preference for the rations containing the alfalfa ration rather than the cereal grass was not detected. This experiment suggests that the palatability factor in alfalfa was not sufficiently well defined to permit detection, or that other feed ingredients were sufficiently palatable to mask the undesirable flavor attributed

in Experiment I to the cereal grass.

Cooney et al (1948), Jensen (1947) and Heywang (1950) all reported that as the level of alfalfa meal was increased in a chick ration above 5 per cent there was a gradual decrease in growth rate and a lowering of feed efficiencies. Their observations are supported in Experiment III for not only alfalfa but also for cereal grass. However, the greater growth depressions observed in the chicks fed alfalfa than in the chicks fed cereal grass when levels exceeded 10 per cent is difficult to explain. Under the conditions of this experiment it cannot be attributed to the fibre content of the diets as at any given level of inclusion of alfalfa and cereal grass, the fibre content of the rations containing these forages were essentially the same. It may be postulated that the growth depressing factor found in alfalfa by Petersen (1950 a) is present in lower concentration in cereal grass. No evidence can be gleaned from this experiment to support the contentions of Scott (1952), Hansen et al (1953) and Vavich et al (1953) that alfalfa meal contains unidentified growth factors. Only by the use of purified or semi-purified diets have the above workers obtained growth stimulation by using alfalfa meal in chick diets.

The effect of using a combination of alfalfa and cereal grass in chick rations was tested in Experiments IV and V. No marked superiority resulted when a combination of the two products were used in a chick ration in place of either product separately. These results were in contradiction to the findings of Slinger et al (1949) who reported that a mixture of equal parts of alfalfa and cereal grass gave better chick growth than using either product separately in chick rations. It was found in Experiment IV that the growth depression was greater at the 10 per cent level when the amount of alfalfa in the ration increased and the amount of cereal

grass decreased which supports the contention made in Experiment III that alfalfa has a greater growth depressing effect than cereal grass.

With regard to feed efficiency data very little information can be obtained from the results. Although there were marked differences in the feed efficiencies between treatments, the differences between replicates within treatments were just as great resulting in non-significant difference between treatments. However, there was a trend in Experiment III and IV towards less efficient utilization of diets as the levels of forage meals rose above 1 per cent.

The reason for the retardation of growth and low feed conversions in Experiment V is obscure. One possibility appears to be that the chicks used in this experiment were hatched from pullet eggs in the month of November and environmental effects due to season and due to maternal effects may have affected their normal growth. In contrast, the chicks used in Experiment IV were hatched in April from eggs layed by hens that had been in production for 5 months. In view of this no conclusions can be drawn from Experiment V.

Observation of the results of Experiment VI indicated that the practice of including alfalfa and cereal grass in breeding rations has no significant effect on the growth of the resulting progeny. In this experiment the chicks hatched from hens that received the basal ration, and those chicks fed a basal ration containing no dry forage meal grew equally as well as the chicks fed on the same levels of forage meals contained in their maternal diets. Kohler and Graham (1952) reported a growth factor or factors in fresh pasture which may be passed from the breeding hen to the chick. As indicated by the results of Experiment IV neither of the dehydrated forages appear to contain this growth factor or factors.

A plausible explanation why the dry forage meals are not equivalent in growth promoting ability to fresh pasture or forage juice was reported by Scott (1951 a) and Hansen et al (1953). These investigators postulated that dehydration destroys the growth promoting activity of alfalfa meals. This could apply equally to cereal grass.

(b) Poult rations

In this experiment the inclusion of 8 per cent alfalfa or cereal grass in a poult ration depressed growth and lowered feed efficiency when included in an all vegetable diet and stimulated growth when included in a diet containing vegetable and animal protein. Cereal grass gave better growth than alfalfa when the products were included in the ration containing vegetable and animal protein and had a lesser depressing effect on growth than alfalfa when the forage meals were included in the ration containing all vegetable protein. Observation of these results would indicate that the source of protein in the ration is an important factor in determining the effect of alfalfa and cereal grass on poult growth.

(c) Laying rations

The data of both experiments revealed some consistent trends in hatchability. In both trials the ration containing 4 per cent alfalfa produced the highest hatchability. The 4 per cent cereal grass diet produced lowest hatchability in Experiment II and was only 1.17 per cent higher in hatchability than the basal ration in Experiment I. The mixture of 1 per cent alfalfa and 1 per cent cereal grass in the ration did not maintain hatchability as well as either product when used separately in rations at this level. This was consistent for both trials. The combined effect of all diets containing alfalfa and cereal grass on hatchability shows no significant difference between the two products in Experiment I but in

Experiment II there was a significant difference between the two ingredients. The alfalfa diets exhibited superior results in this case.

In Experiment II there was a gradual decline in hatchability as the levels of cereal grass increased in the diet. This would suggest that there is a deleterious factor in cereal grass that has a depressing effect on hatchability. On the other hand the inclusion of increasing levels of alfalfa in the diets appeared to promote higher hatchability.

The forage meals did not significantly affect egg production in either of the trials. In Experiment II there was a slight rise in egg production as the level of either forage meal increased in the ration.

Feed consumption per hen day did not reveal any marked differences between the alfalfa and cereal grass diets in either trial. However, in the second year trial there was a gradual rise in total feed consumption per hen day as the level of cereal grass increased in the diet.

Feed efficiency data (pounds of feed per dozen eggs laid) were not significant for either trial. There was a marked improvement in feed efficiency in the second trial over those in the first experiment. This was due to the higher egg production that occurred in the second year trial.

The analysis of egg quality data revealed that the increasing levels of alfalfa and cereal grass increased the number of grade B eggs. Furthermore, the deleterious effect on egg quality was more pronounced for cereal grass than it was for the same level of alfalfa. This is probably due to the higher content of xanthophyll in the cereal grass than in the alfalfa.

Carotene deterioration in alfalfa and cereal grass under farm storage conditions*

In conjunction with the study of the effect of alfalfa and cereal grass on growth, feed efficiency, egg production and hatchability, the effect of storage on carotene content of these two products was investigated. It was felt that a study of this nature would provide valuable data on these products as sources of carotene since length and condition of storage have a marked influence on carotene content and also because alfalfa and cereal grass are sold on a guaranteed carotene basis.

The study divided itself into two phases: 1. The monthly loss of carotene in alfalfa and cereal grass after a 12 month storage period. Samples were analysed at 6 consecutive monthly intervals and 2. The rate of carotene destruction in freshly processed samples of alfalfa and cereal grass. These samples were obtained from early, medium and late season crops respectively, and were analysed at four consecutive monthly intervals.

A chromatographic technique** was employed in determining the carotene content. One to three grams of the meal samples were extracted with a mixture of Skellysolve B and acetone in a Soxhlet apparatus. The extract was evaporated to a small volume and the residue was passed through an adsorption column of celite and activated magnesia. The cartenoid pigments which were not absorbed were then collected and their transmittance measured in a spectrophotometer and compared with that of a standard.

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* This portion of the investigation was a combined project with Mr. J. C. Brown, Graduate Assistant, Department of Animal Science, University of Manitoba.

** Methods of Vitamin Assay, Prepared and Edited by the Association of Vitamin Chemists, Inc., Second Edition. Revised and Supplemented, 1951. Inter-science Publishers Inc., New York.

The carotene content of cereal grass and alfalfa dropped from 33 and 21 milligrams of carotene to 19 and 6 milligrams of carotene per 100 grams respectively, during the 12 month storage period. While the loss in carotene value was 44 per cent for cereal grass, the alfalfa meal loss was almost 73 per cent. These samples did not deteriorate markedly during the 6 monthly (30 day) intervals when the determinations were made following the storage period. The alfalfa dropped from 6 to 4.5 milligrams of carotene per 100 grams and the cereal grass dropped from 19 to 14 milligrams per 100 grams during the period.

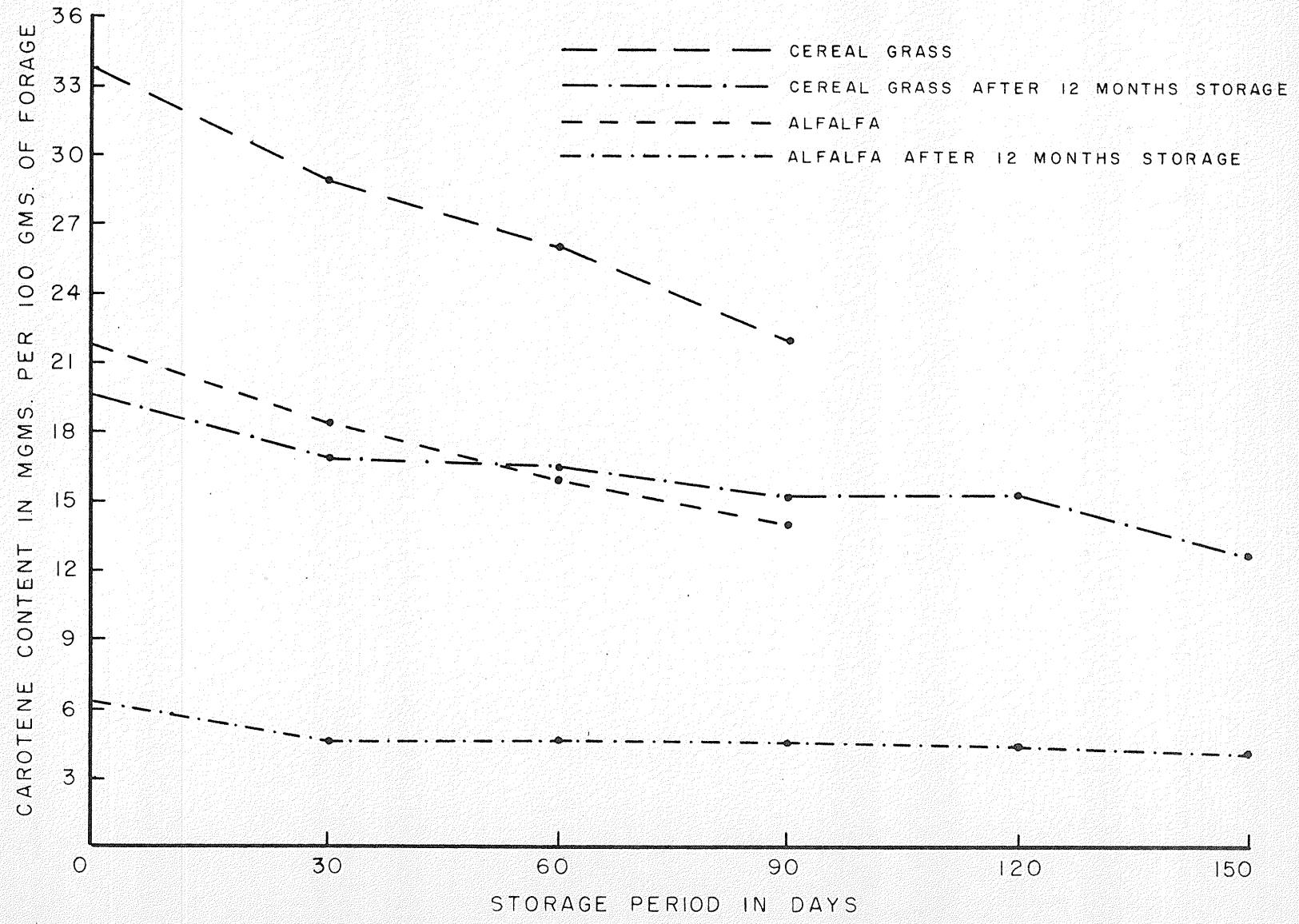
Three different shipments of each of the two meals were analysed and found to be very similar in carotene content and rate of distruction. Samples of the forages were analysed from the time of arrival and at 4 monthly (30 day) intervals. The analyses showed a fairly consistent rate of destruction. The average of these analyses were used in the preparation of the graph. The cereal grass dropped 33 to 21 milligrams of carotene per 100 grams and alfalfa from 22 to 14 milligrams of carotene per 100 grams in this period. This represents a loss of 35 and 36 per cent respectively of the original carotene content for cereal grass and alfalfa.

From these analyses it was apparent that the rate of destruction was fairly constant for about 13 months after which there was an apparent plateauing effect resulting in the retention of a constant level of carotene for a considerable period (see graph). This finding is in agreement with that of other investigators, notably Halverson and Hart (1947). From the graph it may be observed that cereal grass very nearly paralleled the alfalfa in rate of carotene destruction.

From the practical standpoint cereal grass and alfalfa can be stored rather successfully in sealed paper sacks under unheated, relatively

dry and dark conditions. However, as recommended carotene levels must be maintained in poultry rations, careful consideration of the length and condition of storage is of importance.

THE RELATION OF CAROTENE CONTENT IN ALFALFA AND CEREAL GRASS TO DURATION OF STORAGE PERIOD



SUMMARY AND CONCLUSION

A comparative study was undertaken to evaluate dehydrated alfalfa leaf meal and dehydrated cereal grass in poultry rations. These investigations were designed to determine the relative effect of these two products on rate of growth, food conversion, palatability, hatchability, mortality, egg production and egg quality. In this study nine separate trials were conducted, six with chicks, two with laying hens, and one with Broad Breasted Bronze turkey poults.

From the results of these experiments the following conclusions are drawn:-

1. When chicks are offered both alfalfa and cereal grass in dry form, free choice, they exhibit a distinct preference for alfalfa.

2. When alfalfa and cereal grass are separately mixed into chick starter rations at levels of 0, 1, 5 and 10 per cent, the chicks do not exhibit a preference for either of the forage meals.

3. When alfalfa and cereal grass are mixed separately into chick starter rations at levels of 10, 15 and 20 per cent there is a progressive decline in growth rate accompanied by a lowering of feed efficiency. These conditions are evident at all levels employed and by both forages.

4. When the forages made up 10 per cent or more of the total ration, the birds subjected to the alfalfa treatments exhibited a more severe decline in growth rate and less efficient feed conversion than did the chicks on corresponding levels of cereal grass.

5. The inclusion of alfalfa and cereal grass at the 1 and 5 per cent levels in chick rations produced equivalent growth and feed conversion to that obtained on the basal ration devoid of all forage

products.

6. The inclusion of a mixture of the two forages in the basal ration has no measurable influence on growth rate or feed conversion.

7. Chick mortality is not affected by the inclusion of either forage product in the diet.

8. The incorporation of alfalfa or cereal grass in the ration of breeding hens had no significant effect on the subsequent growth rate of their progeny.

9. When 0, 0.5, 2.0 and 4.0 per cent alfalfa and cereal grass respectively were included in the rations of breeding hens and the resultant eggs incubated there was a pronounced increase in hatchability from those pens fed alfalfa and a decline in hatchability from those pens receiving cereal grass. The effect of the two products on hatchability is clearly demonstrated in Experiment II although less evident in Experiment I. The result of the two years work with breeding hens showed that the cereal grass probably carried a factor or factors that depressed hatchability.

10. The inclusion of cereal grass in laying rations has a significantly greater effect on decreasing egg quality than has alfalfa, as measured by intensity of yolk color.

11. Egg production is not affected significantly by the inclusion of either forage product in a laying ration up to the 4 per cent level.

12. Although the cereal grass contained higher levels of carotene than alfalfa in all cases, the rate of destruction of carotene in the products was practically the same.

BIBLIOGRAPHY

Ackerson, C. W., R. L. Borchers and F. E. Massehl, 1951. The effect of additions of dehydrated alfalfa leaf meal to high corn chick rations. Neb. Agric. Res. Bull. 168: 1-10.

Alder, B., 1949. Alfalfa meal in turkey rations. Utah Agric. Expt. Farm and Home Sci. 10: 16-17.

Ayala, E., and E. T. Johnsen, 1951. Vitamin B_{12} and growth inhibiting properties of the diet juice of alfalfa. Poult. Sci. 30:893.

Bethke, R. M., D. C. Kennard and V. D. Chamberlin, 1946. Relation of nutrition to production and hatchability of chicken eggs: effect of protein supplements and alfalfa meal. Poult. Sci. 25: 570-578.

Bolin, D. W., C. E. Lampman and L. R. Berg, 1943. Influence of carotene intake on liver storage of vitamin A. Poult. Sci. 22: 348-353.

Cooney, W. T., J. S. Butts and L. E. Bacon, 1948. Alfalfa meal in chick rations. Poult. Sci. 27: 828-830.

Cravens, W. W., S. B. Randle, C. A. Elvehjem and J. G. Halpin, 1941. Effect of the vitamin K content of the hens ration on the clotting ability of chick blood. Poult. Sci. 20: 313-316.

_____, C. E. Holmes, J. G. Halpin and C. A. Elvehjem, 1942. The effect of alfalfa leaf meal and dried cereal grass on egg production and hatchability. Poult. Sci. 21: 301-305.

Dove, W. F., 1935. A study of the individuality in the nutritive instincts and of the causes and effects of variations in the selection of food. American Naturalist 69: 469-544.

Draper, C. J., 1952. Is alfalfa meal economical feed for turkey poults? Utah Farm and Home Sci. 13: 6.

Farrin, L. M., C. J. Draper, D. A. Greenwood and B. H. Crandall, 1949. The development of chicks fed different levels of sun-cured and dehydrated alfalfa and the vitamin A and carotene storage in the livers. Poult. Sci. 28: 603-609.

German, H. L., and J. R. Couch, 1950. The effect of feeding varying levels of dehydrated alfalfa leaf meal on the growth of chicks and poults. Poult. Sci. 29: 841-845.

Graham, W. R., 1932. Can we learn anything from a free choice of feeds as experienced by chickens? Poult. Sci. 11: 365.

Halverson, H. W., and E. B. Hart, 1947. The stabilization of carotene in dehydrated legumes (alfalfa) and cereal grass. Jour. of Dairy Sci. 30: 245.

Hansen, R. G., H. M. Scott, B. L. Larson, T. S. Nelson and P. Krichevsky, 1953. Growth stimulation and growth inhibition of chicks fed forage and forage juice concentrate. Jour. of Nutrition 49: 453-463.

Heywang, B. W., and H. W. Titus, 1932. Sources of vitamin A, particularly alfalfa products for maintaining the life of chicks. Poult Sci. 11: 234-238.

_____, 1933. Alfalfa products as green feed substitutes for layers. Poult. Sci. 12: 167-172.

_____, 1950. High levels of alfalfa meal in diets for chickens. Poult. Sci. 29: 804-811.

_____, and H. R. Bird, 1954. The effect of alfalfa saponin on the growth, diet consumption and efficiency of diet utilization on chicks. Poult. Sci. 33: 239-241.

Hunt, C. H., A. R. Winter and R. M. Bethke, 1939. Further studies of the riboflavin requirements of the chicken. Poult. Sci. 18: 330-336.

Jacobs, R. L., J. F. Elam, J. H. Quisenberry and J. R. Couch, 1953. Dehydrated alfalfa meal as a source of vitamins and unidentified factors for the mature fowl. Poult. Sci. 32: 812-816.

Jaffa, M. E., 1905. Poultry feeding and proprietary foods. Calif. Agric. Expt. Sta. Bull. 164: 1-29.

Jensen, L., and J. McGinnis, 1952. A comparison of feeding pelleted and unpelleted diets containing different levels of alfalfa to laying hens. Poult. Sci. 31: 307.

Kennard, D. C., and G. Lingle, 1928. Feeding legume hay to chickens. Ohio Agric. Expt. Sta. Bimonthly Bull. 130: 24-26.

Kodras, R., W. R. Cooney and J. S. Butts, 1951 (a) Chick growth depressing factor in sun-cured and dehydrated alfalfa meals. Poult. Sci. 30: 280-292.

_____, 1951 (b) Effect of alfalfa meal, alfalfa leaves, alfalfa stems and fresh alfalfa on chick growth. Poult. Sci. 30: 786-787.

Kohler, G. O., and W. R. Graham Jr., 1952. The seasonal responses of chicks to an unidentified growth factor found in forage juice. Poult. Sci. 31: 284-286.

Lampman, C. E., D. W. Bolin and Ella Woods, 1938. Orchard grass proves valuable in preventing perosis. Poult. Sci. 17: 434.

Lepkovsky, S., W. Shaleff, D. Petersen and R. Perry, 1950. Alfalfa inhibitor in chick rations. Poult. Sci. 29: 208-213.

Lippincott, W. A., 1916. "Poultry Production". Second Edition. Lea and Febriger Publishers, Philadelphia.

Nestler, R. B., T. C. Byerley, W. R. Ellis and H. W. Titus, 1936. A new factor not vitamin G, necessary for hatchability. Poult. Sci. 15: 67-70.

Paley, W. E., 1938. The utilization of wheat and wheat by-products in feeding young chickens. II Alfalfa leaf meal as a vitamin A supplement for ground wheat. Poult. Sci. 17: 334-337.

Petersen, D. W., 1950 (a) Some properties of a factor in alfalfa meal causing depression of growth in chicks. Jour. Biol. Chem. 183: 647-653.

_____, 1950 (b) Effect of sterols on growth of chicks fed a diet high in alfalfa meal or a diet containing a saponin. Poult. Sci. 29: 775.

Scott, M. L., G. F. Heuser and L. C. Norris, 1948. Energy, protein and unidentified vitamins in poult nutrition. Poult. Sci. 27: 773-780.

_____, 1951 (a) The grass juice factor in turkey nutrition. Poult. Sci. 30: 293-297.

Scott, H. M. , W. A. Glista and E. A. Goffi, 1951 b. Growth effects of certain supplements added to a corn-soybean oil meal chick ration with and without antibiotic. Poult. Sci. 30: 930.

_____, H. Fisher and J. M. Snyder, 1953. Alfalfa meal as a source of unidentified growth factors. Poult. Sci. 32: 555-556.

Slinger, S. J., K. M. Gartley and E. V. Evans, 1949. Pelleted and unpelleted diets high in dehydrated green feed for turkeys grown in confinement. Poult. Sci. 28: 556-561.

Stuart, H. O., 1929. Effect of certain green feed substitutes on egg production and hatchability. Poult. Sci. 8: 354-360.

Vavich, M. G., Anne Wertz and A. R. Kenner, 1953. Growth stimulating factors in alfalfa for chicks. Poult. Sci. 32: 433.

Wilgus, H. S., and I. L. Madsen, 1954. The effect of alfalfa meal on early chick growth. Poult. Sci. 33: 448-459.