A STUDY OF DEHYDRATED FORAGE PRODUCTS IN SWINE RATIONS

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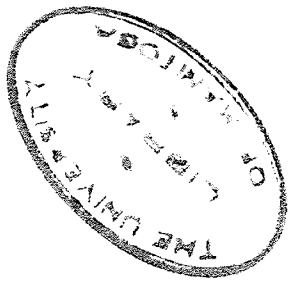

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ABSTRACT

TITLE - A study of dehydrated forage products in swine rations.

AUTHOR - John Cameron Brown

SUMMARY OF RESULTS - A comparison was made of dehydrated cereal grass meal and dehydrated alfalfa meal in rations for growing-fattening swine fed under dry-lot conditions. The results of this investigation are as follows:-

1. The addition of either dehydrated alfalfa meal or cereal grass meal up to and including 10% of the total ration did not significantly affect the rate of gain.

2. Rates of gain and feed efficiency tended to decrease with increasing levels of forages in the ration.

3. Dehydrated cereal grass meal was superior at all levels to dehydrated alfalfa meal in growing-fattening rations with respect to rate of gain, feed efficiency and carcass quality.

4. Dehydrated cereal grass meal and dehydrated alfalfa meal were comparable in value in finishing rations at levels up to 20% of the total ration with respect to rate of gain, feed efficiency and carcass quality.

5. Dehydrated cereal grass meal was superior to dehydrated alfalfa meal with respect to rate of gain, feed efficiency, and carcass quality in all trials at the 40% level of inclusion.

6. When compared to the barley, oats, soybean oil meal basal ration in no case did the inclusion of dehydrated alfalfa meal or dehydrated cereal grass meal result in an improvement in rate of gain or feed efficiency.

7. Gilts produced carcasses of higher quality than did the barrows.

8. Carcass quality improved with the increase in level of forages up to 20% of the total ration.

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INTRODUCTION

The value of any domestic animal is directly related to its ability to convert feedstuffs into more refined products suitable for utilization by man. The more efficient the conversion the greater is the economy of production. Because swine and poultry compete with man for grains, their ability to utilize forages is especially important in the interest of economical production. The utilization of such products in rations for monogastric animals has been extended by an increasing knowledge of animal nutrition. Forages are relatively high in fibre which swine and poultry are able to utilize to a limited extent only. However, as a result of research with these products their use has increased.

It is well known that vitamin A is essential for normal physiological processes of the body. Carotene, the precursor of vitamin A, is found in quantity in alfalfa and cereal grasses. For many years succulent and dried forages have been an important source of carotene for swine and poultry. For this reason alone they are commonly added to the diet of these animals to ensure an adequate supply of vitamin A. These products are usually purchased on the basis of their guaranteed carotene content. However, the synthetic production of vitamin A on a commercial scale has made available another economic source. Alfalfa and cereal grass are known to contain many other nutrients such as riboflavin, thiamine, ascorbic acid, tocopherol, amino acids, mineral salts, fats, waxes, sugars, and as yet unidentified growth factors. Most of these nutrients are required in properly balanced rations and hence add to the value of dehydrated products over and above their potential carotene content.

Individual feedstuffs seldom constitute an adequate ration balanced

for vitamins, minerals, and proteins; forages are no exception particularly for swine and poultry. However, the extent to which such feedstuffs can be utilized by swine and poultry is of fundamental physiological and economical importance. Since forage crops play an important role in the economy of agriculture, their maximum utilization by farm animals is highly desirable.

Under many conditions natural curing is not conducive to the production of high quality forage products due to heavy losses of nutrients occasioned by bleaching, leaching, and leaf loss. Mechanical dehydration has overcome these losses to a large extent and thus increased considerably the value of the products so produced. In most respects dehydrated cereal grass meal and dehydrated alfalfa leaf meal appear to be of similar nutritional value.

OBJECT OF THE STUDY

In view of the foregoing, and particularly because there has been little research work reported on the relative nutritional value of alfalfa and cereal grass the experiments described herein were undertaken to determine the comparative nutritional value of dehydrated alfalfa leaf meal and dehydrated cereal grass meal in rations for growing and fattening swine, with respect to rate of gain, feed efficiency, and carcass quality.

CHAPTER II

REVIEW OF LITERATURE

Historical

The efficiency of swine production has been increased as a result of experimental work on the value of forages in swine rations. These investigations deal particularly with alfalfa, as a supplement in rations, with a consideration of nutrients such as protein, minerals, carotene, B complex vitamins, and as yet unknown factors. Reference is also made to growth depressant factor (s) believed to be present in alfalfa. Only a very limited amount is reported on the use of cereal grass as a supplement to rations. A number of investigators have studied the oxidation of carotene of alfalfa under various conditions of storage and their findings are reported herein.

Early workers in the field investigated the feeding value of forages for sows and growing-fattening swine on pasture and in dry-lot. Wilson (1914), Peters and Geiken (1916), and Evvard (1917) reported improved performance with sows and growing-fattening swine with alfalfa hay as part of the ration. Kuhlman (1926) and Headley (1932) found that alfalfa hay improved hog rations by increasing rate of gain and improving feed efficiency. Evvard (1929) obtained satisfactory results with alfalfa hay and alfalfa leaves as supplements in dry-lot rations for fattening swine. Nordley (1929) stated that alfalfa hay or alfalfa leaves should not comprise more than 5% of the ration for growing-fattening swine and in addition reported that alfalfa fed with barley and tankage was superior to barley and tankage alone. Evvard (1929) emphasized the deleterious effects of the increased fibre in rations if the level was much over 5% of the total feed. According to Oliver and Potter (1930), long alfalfa

hay, as a supplement to grain, induced greater daily feed consumption and larger and cheaper gains. Similar results were obtained when ground alfalfa hay was mixed in the ration. It was suggested that alfalfa meal should not comprise more than 5% of the ration because of its bulkiness.

Ellis et al (1942) reported the results of replacing corn in a corn, tankage and linseed oil meal basal ration with soybean, alfalfa, and lespedeza hay meals at levels of 0, 5, 10, 15, and 20 per cent respectively for each hay. They found that level of replacement had little effect upon rate of gain; however, feed efficiency decreased with the increasing levels of hay meals. Fargo and co-workers (1941) reported that a "trio mixture" of tankage, linseed meal, and alfalfa hay resulted in a significantly greater rate of gain than tankage alone when fed with corn in drylot. The Wisconsin Station (1943) also reported that 5% and 15% levels of ground alfalfa hay, with corn, gave satisfactory results; the 15% level of alfalfa hay proved to be the most economical. A ration consisting of 15% alfalfa meal, 30% oats, and 55% corn decreased rate of gain and feed efficiency. This decrease was attributed to the high level of fibre in the ration.

Keith et al (1942) fed a concentrate mixture of corn, tankage, soybean oil meal, 4% suncured ground alfalfa, and salt, to hogs averaging 70 to 100 pounds in weight. They observed a stiffness in gait developing before the pigs reached 150 pounds. The ration was found to be low in manganese, and the addition of manganese sulphate prevented the occurrence of the stiffness, but did not cure the condition once it had developed. Pigs started on this ration at 20 to 35 pounds in weight developed anorexia, mild dermatitis, emaciation, weakness, and diarrhea, indicating that the

level of alfalfa did not supply the factor or factors necessary to prevent the condition. Krider et al (1947) reported that the addition of 4% dehydrated alfalfa meal to a basal ration of ground yellow corn, meat scraps, soybean meal, iodized salt, and vitamins A and D, when fed to pigs between weaning and 100 pounds in weight produced a greater rate of gain and used 13% less feed per 100 pounds of gain than the basal ration without the alfalfa. The addition of 10% dehydrated alfalfa meal produced even better results than 4%. Two or 4% fish solubles were both equal in feeding value to 10% dehydrated alfalfa meal. Four % fish solubles alone produced as rapid gains as 6% dehydrated alfalfa meal and 4% fish solubles. Apparently both the alfalfa and fish solubles contained factors necessary for satisfactory growth.

Fairbanks and associates (1944) observed that the addition of hulled oats to a corn, beef meal, soybean meal, alfalfa meal basal ration, had a significant positive effect on rate of gain and feed efficiency when fed to pigs weighing initially 30 to 75 pounds. The adding of dried skimmilk or dried corn distillers solubles did not appear to improve the nutritive properties of the basal ration and the pigs exhibited emaciation, diarrhea, anorexia, weakness, mild dermatitis, and retarded growth. The inclusion of alfalfa in the ration did not alleviate the condition.

Ross et al (1944) observed that a corn-soybean meal diet did not support normal gestation in sows, as indicated by congenital malformations, i.e. syndactylism, talipes, and paralysis agitans, in the offspring. Alfalfa restored normal gestation, wholly or in part, depending on the quality fed. Earlier Ross et al (1942) found that 15% alfalfa, added to an ordinary ration, at the expense of corn, provided for normal reproduction.

In the investigation it appeared that the basal ration was deficient in at least two factors, one of which had to do with gestation and the other with lactation. Two of the factors necessary for lactation appeared to be para-aminobenzoic acid and inositol. This work suggested that alfalfa is a source of some of the valuable B complex vitamins. Krider et al (1946) found that a ration of ground yellow corn, soybean oil meal, 5% dehydrated alfalfa meal, minerals, and cod liver oil, was inadequate for proper gestation and lactation. The deficiencies of this ration were corrected by supplementing with rye pasture, 10% alfalfa, or 2 % or 4% condensed fish solubles.

Levels of alfalfa up to 30% of the ration gave comparable results with growing-fattening swine according to Bohman et al (1953). When alfalfa comprised 50% of the ration only fair results were obtained. A significantly greater rate of gain and superior feed efficiency was obtained with 50% pelleted alfalfa as compared with 50% ground alfalfa. While there was a marked enlargement of the stomach and intestines in the groups receiving 30% and 50% alfalfa there were no significant differences in dressing percentages or in carcass quality. In this connection Forbes and Hamilton (1952) found that pelleting alfalfa increased the fibre utilization by swine and demonstrated that the source of fibre affects its utilization. When alfalfa provided 23.6% of the total ration and 42.5% of the crude fibre, 49.7% of the cellulose was digested.

In general many beneficial results have been obtained through the use of alfalfa in rations for growing-fattening and gestating-lactating swine. Recently, investigators in the poultry nutrition field have indicated that there is a growth depressant in alfalfa. Working with growing-fattening

swine Dinusson et al (1953) reported that the addition of 5% dehydrated alfalfa meal of excellent quality to a corn-soybean meal ration significantly decreased the rate of gain. The dehydrated alfalfa appeared to reduce palatability and promote "sorting" and waste of feed. However, the deleterious effect of the alfalfa could not be explained on this basis. Feed efficiencywas noticeably inferior for lots receiving alfalfa. Dinusson (1955) concluded after several years experimentation that 5% dehydrated alfalfa meal proved to be of no benefit and in some cases definitely harmful in fattening rations. Furthermore, the harmful effect was apparently more than could be explained on the basis of lowered energy and the effectswere more noticeable when feeds such as barley and oats were the main grains. This conclusion does not agree with results obtained by other workers and no explanation for the discrepancy seems plausible at the present time. However, investigators in poultry nutrition have suggested possible explanations that might apply to the inconsistent results in swine. Cooney et al (1948) found that rations containing 5% dehydrated alfalfa were no better than the basal ones containing no alfalfa. A depression of growth and a general lowered feed efficiency occurred when the levels of dehydrated alfalfa were increased beyond 5%. Cooney concluded that there are differences in alfalfa meal of apparently similar quality and that there are factors in alfalfa meal which appreciably depress growth when added in excess of 10% of the total ration.

A number of investigations have been conducted dealing specifically with the inhibiting factor or factors. Lepkovsky et al (1950) reported the growth depressing effect of alfalfa was not affected by different dry temperatures and periods of storage. Storage at low temperatures and low

moisture did not alter the effect of the depressant, although ashing destroyed it, indicating that it is organic in nature. In conclusion he stated the following:

1. "Dehydrated alfalfa contains a substance or substances probably organic in nature which depresses growth in chicks.
2. Storage of alfalfa meal at room temperature 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 the 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."

Peterson (1950a) observed a growth depression in chicks fed an aqueous extract of alfalfa meal. The strong foaming properties of this extract suggested saponins as the growth depressing agent. The addition of cholesterol to the rations containing the alfalfa extract counteracted the growth depressing effect on the chicks.

Heywang (1950) fed chicks levels of 5, 10, 15, 20 and 25% of sun cured alfalfa meal and dehydrated alfalfa meal. The growth depression of the sun cured meal was greater than that of the dehydrated meal at 15, 20 and 25% levels. In general, the efficiency of feed utilization decreased as the level of either kind of alfalfa meal in the diet increased. The growth depressant was quite evident at four weeks of age at the 25% level. However, at 12 weeks, the differences among average weights of the pullets receiving the basal diet and those receiving 5, 10, 15 or 20% dehydrated meal were not statistically significant. Kodras et al (1951a) obtained de-

pressed growth with chicks fed rations containing fresh alfalfa, alfalfa meal, alfalfa leaves, and alfalfa stems which were cut in the bud and full bloom stage. Alfalfa leaves depressed growth to a greater extent than the stems which supports the view that fibre per se is not the depressant factor. The depressant is apparently present in greater quantities in the leaves than in the stems. In another report Kodras et al (1951 b) compared sun cured with dehydrated alfalfa on the growth of chicks at 20% level in rations. The depression of growth was greater with normal sun cured alfalfa than with early sun cured alfalfa. It appeared that the fibre level was not responsible for the depressing effect on chick growth. The addition of 1% cholesterol counteracted the growth inhibition, but the addition of glycerol, butanol, octanol, and vitamins had no effect on the depressant. Wilgus and madsen (1954), in an extensive study using 100 different samples of alfalfa meal fed to chicks at a 10% level found that the inhibition was not caused by the fibre per se nor was it related to the ash constituents. Alfalfa meal below 5% appeared to improve early growth but as the levels increased beyond 5% growth declined proportionately. These investigators concluded, however, that fibre content and bulk of alfalfa meal are probably more important than the so-called inhibitory factor in limiting amounts of alfalfa to be used in a chick ration.

Peterson (1950 b) found that growth depression of chicks by alfalfa meal was counteracted by cholesterol at levels of 0.5%, 1.0% and 1.5% and that the addition of fat enhanced this counteraction since cholesterol is more readily absorbable in the presence of fat.

Haywang and Bird (1954) investigated theeffect of alfalfa saponin on the growth and feed efficiency of chicks, and found that a level of 0.2%

was required to produce an unmistakable inhibition of growth. In relation to alfalfa meal, 0.2% saponin was equivalent to a 25% level of alfalfa in the diet. The data did not indicate that saponin was the only component of alfalfa causing depression of growth.

It is fairly well established in poultry nutrition that alfalfa at levels higher than 5% will appreciably depress growth and that this growth depression is more likely due to saponins than to fibre. Generally, in growing-fattening swine the same experience has not been obtained with higher levels of alfalfa. Inclusion of alfalfa up to 15% of the ration in most cases was not deleterious; results comparable to those on a basal ration were obtained by most investigators with the exception of Dinusson (1953, 1955). It is possible that swine may have a greater tolerance for this growth depressing factor. Wilgus and Madsen (1954) and Cooney et al (1948) suggested there is extreme variability in alfalfa quality with consequent differences in chick growth. This may explain, in part at least, the results obtained by Dinusson et al (1953, 1955).

Dehydrated Cereal Grasses

The literature reviewed revealed no reference to the use of dehydrated cereal grasses in rations for growing-fattening swine and very little is reported with respect to its use in poultry rations. However, Slinger et al (1949) reported that one pound of dehydrated cereal grass could replace two pounds of dehydrated alfalfa meal in practical poultry starting rations and that a mixture of the two supplements gave superior results to either one alone. Lampman et al (1938) reported that dehydrated orchard grass, the primary constituent of dehydrated cereal grass meal, contained sufficient manganese to prevent perosis. By analysis the orchard

grass contained four times as much manganese as alfalfa. Young (1955) reported that the addition of dehydrated alfalfa leaf meal and dehydrated cereal grass meal in chick starter rations resulted in a depression of growth and lowered feed efficiency as the levels were increased from 0 to 20%. There appeared to be little difference between the alfalfa and cereal grass on growth rate when included up to 10%. However, above that level the depression of growth was not as marked for the cereal grass fed chicks. It would seem that a factor or factors other than fibre was responsible for this result. It was postulated that the cereal grass contained less of the inhibiting factor than is reported to be present in alfalfa.

Carotene

The importance of forages, dehydrated or otherwise, in rations for swine and poultry is due largely to their carotene content. Curing and storage to preserve carotene is a major problem in the production of quality forages for use in livestock rations.

Intensive investigation into the loss of carotene and vitamin A in different feeds was conducted by Fraps and Kemmerer (1937), Wierer and Bethke (1941), and Bernstein and Thompson (1947) all of whom reported similar results on the destruction of carotene under various conditions of storage and temperature. Generally, high temperatures and light are conducive to destruction of carotene. Low temperatures and darkness reduce the rate of destruction. In this connection Seshon and Sen (1942) found that atmospheric oxygen plays the predominant part in the destruction of carotene and that heat, light, and moisture, act as accelerating agents. Halverson and Hart (1948) and Nelson et al (1948) postulated that the preservation

of carotene is accomplished by increasing the respiratory enzyme action within the alfalfa leaf meal which in turn consumes the available oxygen supply and thus prevents the oxidative destruction of carotene. For this respiratory enzyme action the alfalfa leaf meal should contain approximately 12.5% moisture.

Hentges et al (1952) investigated various feeds as sources of carotene and indicated that dehydrated alfalfa meal and pellets, crystallized carotene in cotton seed oil, sun cured alfalfa hay, and yellow corn, ranged in that order in carotene content as well as in effectiveness in preventing or correcting a vitamin A deficiency. Generally, 5 grams of good quality dehydrated alfalfa meal per day or 32 grams of good quality ground sun cured alfalfa meal supplied sufficient carotene for 90 pound pigs.

CHAPTER III

EXPERIMENTAL PROCEDURE

Experiment I

To obtain data on the comparative nutritional value of dehydrated alfalfa meal* and dehydrated cereal grass meal* for growing-fattening swine, a feeding trial involving 72 pigs of purebred Yorkshire and Yorkshire x Tamworth breeding from the University herd was undertaken in the fall of 1953. The pigs had been raised to weaning by sows on adequate rations and creep fed during the nursing period. The average initial weight of the pigs placed on trial was approximately 44 pounds. The seventy-two pigs were allotted to 9 lots of 8 pigs each on the basis of total weight per lot, sex, and breeding.

The basal portion of the ration was made up of wheat, oats, and barley, in approximately equal amounts, grading No. 3 Northern, No. 1 Feed, and No. 1 Feed, respectively. The protein supplement for all rations was three parts soybean oil meal and one part meat meal. (Table 1). Protein and fibre values cited by Morrison (1951) were used in the formulations. Two stages were employed in the feeding regime: weaning to approximately 105 pounds, during which period the pigs received an 18% protein ration, and 105 pounds to market weight, when they received a 14% protein ration.

The pigs were bedded with straw and self-fed in dry lot on concrete

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*Referred to hereafter as alfalfa, Medicago sativa, and cereal grass, consisting of Orchard Grass, Dactylis glomerata and New Zealand Rye Grass, Lolium sp. The products are sold commercially in Canada under the trade name Vita-Greens(dehydrated alfalfa leaf meal) and Vita-Gras (dehydrated cereal grass meal). The alfalfa and cereal grass contained by analysis a minimum of 20% protein and 21 and 33 milligrams of carotene per 100 grams, respectively. The manufacturers of these two products state that in the dehydration process no chemicals or anti-oxidants are used.

Experiment I

Table 1. Composition of Meal Mixtures

Treatments	A		B		C		D		E	
Calculated % protein	18	14	18	14	18	14	18	14	18	14
Wheat	22.0	27.0	22.0	27.0	32.5	29.0	32.5	29.0	32.0	30.0
Oats	23.5	26.0	23.5	26.0	15.0	29.0	15.0	29.0	17.0	31.0
Barley	23.0	26.0	23.0	26.0	28.0	29.0	28.0	29.0	30.0	31.0
Dehydrated cereal grass meal	-	-	20.0	20.0	-	-	10.0	10.0	-	-
Dehydrated alfalfa leaf meal	20.0	20.0	-	-	10.0	10.0	-	-	5.0	5.0
Meat meal	2.6	-	2.6	-	3.3	0.5	3.3	0.5	3.7	0.5
Soy bean oil meal	7.9	-	7.9	-	10.2	1.5	10.2	1.5	11.3	1.5
Ground limestone	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Iodized salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Dry vitamin D_3*	5.7grams	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Dry vitamin A**	-	-	-	-	-	-	-	-	-	-

* 24,800 I.U. per gram
** 5,000 I.U. per gram

Continued...

Experiment I

Table 1, continued.. Composition of Meal Mixtures

Treatments	F		G		H		I	
Calculated % protein	18	14	18	14	18	14	18	14
Wheat	32.0	30.0	29.0	31.5	29.0	31.5	27.0	31.0
Oats	17.0	31.0	23.0	31.5	23.0	31.5	27.0	32.0
Barley	30.0	31.0	29.0	31.5	29.0	31.5	27.0	31.0
Dehydrated cereal grass meal	5.0	5.0	-	-	1.5	1.5	-	-
Dehydrated alfalfa leaf meal	-	-	1.5	1.5	-	-	-	-
Meat meal	3.7	0.5	4.1	0.7	4.1	0.7	4.5	1.3
Soy bean oil meal	11.3	1.5	12.4	2.3	12.4	2.3	13.5	3.7
Ground limestone	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Iodized salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Dry vitamin D_3*	5.7 grams	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Dry vitamin A**	-	-	-	-	-	-	33.2 grams	33.2

* 24,800 I.U. per gram
  5,000 I.U. per gram

floors through the entire feeding period, with water available at all times. The pigs were weighed individually at the start of the test and at 14 day intervals thereafter with feed consumption being recorded at these intervals. As they approached market weight they were weighed more frequently to ensure proper marketing weight (200 ± 5 pounds). Upon reaching market weight they were slaughtered and the carcasses graded by representatives of the Marketing Service, Canada Department of Agriculture. After a 24 hour cooling period the carcasses were cut and scored according to the regulations set out for pigs on Advanced Registry test**. The following carcass data were recorded: carcass grade, carcass length, area of loin muscle, and thickness of backfat. Carcass length is the measurement in inches from the front of the first rib to the point of the aitch bone as exposed in the split carcass. Area of the loin muscle (longissimus dorsi) is the surface area of the cross section exposed when the right side is cut at the last rib. The fat measurements are taken at the maximum depth of the shoulder and loin and the minimum depth on the back.

** National Bacon Hog Policy, Record of Performance and Advanced Registry for Purebred Swine. Issued by the Production Service, Canada Department of Agriculture, Ottawa, Ontario - October, 1952.

Experiment II

The experiment was repeated in the summer of 1954 to gain further information on trends indicated by the first feeding trial and to extend the scope of the study.

The management, feeding regime, weighing procedure, ration formulation, carcass grading and scoring, described for the first trial was followed with the following exceptions: The basal portion of the ration consisted of two parts barley and one part oats both grading No. 1 Feed. The protein supplement used consisted of a mixture of three parts soybean oil meal and one part linseed oil meal except ration B which was supplemented by a mixture of three parts soybean oil meal and one part meat meal. Alfalfa and cereal grass were included at the levels outlined in Table 2. Rations containing 40% of these forages were included in this trial to determine the upper limits of economical use. The rations containing such high levels of alfalfa and cereal grass could not be formulated to contain less than a calculated 15.6% protein in the finishing stage of the feeding regime.

Experiment II

Table 2. Composition of Meal Mixtures

Treatments	A		B		C		D		E	
Calculated % protein	18	14	18	14	18	14	18	14	18	14
Ingredients										
Barley	58.0	69.0	60.0	70.0	56.0	68.0	56.0	68.0	54.0	64.0
Oats	19.0	23.0	20.0	23.0	18.0	23.0	18.0	23.0	16.0	21.0
Dehydrated cereal grass meal	-	-	-	-	-	-	1.5	1.5	-	-
Dehydrated alfalfa meal	-	-	-	-	1.5	1.5	-	-	10.0	10.0
Linseed oil meal	5.4	1.6	-	-	5.7	1.5	5.7	1.5	4.6	1.9
Meat meal	-	-	4.6	1.4	-	-	-	-	-	-
Soybean oil meal	16.1	4.9	13.9	4.1	17.3	4.5	17.3	4.5	13.9	2.6
Ground limestone	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Iodized salt	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Dry vitamin D_3*	5.7 grams	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Dry vitamin A**	33.2 grams	33.2	33.2	33.2	-	-	-	-	-	-

* 24,800 I.U. per gram
** 5,000 I.U. per gram

Continued...

Experiment II

Table 2.
Continued...

Treatments	F		G		H		I		J	
Calculated % protein	18	14	18	14	18	14	18	14	18	14
Ingredients										
Barley	54.0	64.0	46.0	58.5	46.0	58.5	36.0	43.5	36.0	43.5
Oats	16.0	21.0	16.0	19.0	16.0	19.0	12.0	15.0	12.0	15.0
Dehydrated cereal grass meal	10.0	10.0	-	-	20.0	20.0	-	-	40.0	40.0
Dehydrated alfalfa meal	-	-	20.0	20.0	-	-	40.0	40.0	-	-
Linseed oil meal	4.6	4.6	4.2	0.3	4.2	0.3	2.6	-	2.6	-
Meat meal	-	-	-	-	-	-	-	-	-	-
Soybean oil meal	13.9	13.0	12.3	0.7	12.3	0.7	7.9	-	7.9	-
Ground limestone	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Iodized salt	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Dry vitamin D_3* 5.7 grams	5.7		5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Dry vitamin A**	-	-	-	-	-	-	-	-	-	-

* 24,800 I. U. per gram
** 5,000 I. U. per gram

Experiment III

A third trial was undertaken in the winter of 1954-55 to determine the comparative nutritional value of alfalfa and cereal grass in finishing rations for swine. This trial involved 60 pigs of similar breeding to those in Experiments I and II. The procedure for managing, feeding, recording feed consumption, marketing, grading and scoring was the same as outlined for Experiment I with the following exceptions: Upon weaning all the pigs were fed a basal ration consisting of two parts barley and one part oats, a protein supplement of three parts soybean oil meal and one part meat meal, supplemented with iodized salt, ground limestone, dry vitamin D_3 and dry vitamin A. The pigs were allotted to 10 lots of six pigs each, on the basis of total weight per lot, sex, and breeding, at approximately 105 pounds, which can be considered the beginning of the finishing period. In this trial all the treatments received a protein supplement of three parts soybean oil meal one part meat meal with the exception of treatment J/which contained a protein supplement of soybean oil meal alone. The rations fed are presented in Table 3. It should be noted that the rations containing 1.5% of forages in Experiment I were replaced by rations containing 5% alfalfa and cereal grass. It was thought that this was a more practical level to use, especially considering carotene supplementation.

Table 3.

Experiment III
Composition on Meal Mixtures

Treatments	A	B	C	D	E	F	G	H	I	J
Calculated % protein	14	14	14	14	14	14	14	14	14	14
Ingredients										
Barley	43.50	43.50	58.00	58.00	62.00	62.00	66.00	66.00	70.00	69.00
Oats	15.00	15.00	19.00	19.00	20.00	20.00	22.00	22.00	23.00	23.00
Dehydrated cereal grass meal	-	40.00	-	20.00	-	10.00	-	5.00	-	-
Dehydrated alfalfa meal	40.00	-	20.00	-	10.00	-	5.00	-	-	-
Meat meal	-	-	0.30	0.30	1.30	1.30	1.50	1.50	1.50	-
Soybean oil meal	-	-	1.20	1.20	3.70	3.70	4.00	4.00	4.00	6.5
Ground limestone	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Iodized salt	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Dry vitamin D_3*	5.7 grams	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Dry vitamin A**	-	-	-	-	-	-	-	-	33.2 grams	33.2 grams

* 24,800 I. U. per gram
** 5,000 I. U. per gram

CHAPTER IV

RESULTS

Experiment I

The data of Experiment I on rate of gain, feed efficiency, and carcass quality are presented in Tables 4 and 5.

The rates of gain and feed efficiency for this trial could not be considered satisfactory due to a sporadic incidence of parakeratosis. Because of this outbreak all of the pigs on ration D, three pigs on ration E, and one pig each from rations F, G, and H were removed from the trial. Appropriate calculations were made to adjust for feed consumptions in affected lots. Differences in numbers slaughtered per lot is explained by the fact that one or two gilts from some of the lots were retained for a study of the effect of cereal grass and alfalfa upon reproduction. This did not interfere with the analysis of rate of gain, or feed efficiency but did reduce the numbers of carcasses studied.

The data pertaining to statistical analysis of Experiment I are found in Appendix I. Because of the variation in initial weights of the test pigs, the data on the rates of gain were analyzed by the covariance technique. However, the rates of gain were also subjected to an analysis of variance so that a least significant difference could be calculated for the mean rates of gain for the treatments. Analysis of variance was applied to carcass measurements on the basis of sex, treatment, and interaction of sex and treatment. Since feed consumption was recorded on a per pen basis these data indicate only average feed efficiency within lots.

The analysis of covariance technique, which adjusted for differences

Experiment I

Table 4. Summary of Effects on Pig Gains and Feed Efficiency

Treatment	A	B	C	D	E	F	G	H	I
Description									
Number of pigs	8	8	8	8	5	7	7	7	8
Average initial weight, pounds	39.3	40.0	40.3	38.4	50.6	46.0	45.4	47.0	45.3
Average final weight, pounds	194.9	192.4	195.1	196.9	196.2	195.6	195.7	195.1	195.4
Average days on test	140.0	127.7	114.6	148.7	107.8	109.0	115.0	121.0	117.3
Average daily gains, pounds	1.11	1.19	1.35	1.07	1.35	1.36	1.31	1.22	1.28
Average pounds feed per 100 pounds gain	479	454	398	425	473	451	394	419	397
Average daily feed, pounds	5.33	5.42	5.37	4.53	6.39	6.12	5.15	5.12	5.09

Table 5. Experiment I

Summary of Effects on Hog Carcass Quality

Treatment	A	B	C	D	E	F	G	H	I
Description									
Average length of side, inches	30.58	30.83	30.40	30.10	30.43	30.60	30.45	29.75	29.92
Average depth shoulder fat, inches	1.72	1.72	1.88	1.80	1.90	1.88	1.98	1.93	1.92
Average depth back fat, inches	.88	.97	1.02	1.00	1.03	.97	1.17	1.08	1.06
Average depth loin fat	1.22	1.27	1.40	1.28	1.50	1.23	1.38	1.42	1.30
Area, eye of lean, square inches	3.78	4.19	3.62	4.86	3.72	3.61	3.56	3.57	4.20
Average carcass score	78.0	78.8	74.6	76.2	69.7	76.0	58.2	57.8	64.6
Carcass Grades	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C	A B C
	4 2 0	3 3 0	3 2 0	4 2 0	2 1 1	2 4 0	1 4 1	2 3 1	3 3 0

in initial weights, revealed significant differences for treatments, sex, and interaction of sex and treatments. Considering all treatments the barrows average0.03 pounds per day greater rate of gain. Treatments had a significant effect on rate of gain when subjected to an analysis of variance. The calculated least significant difference was approximately 0.15 pounds per day for the mean rates of gain per treatment. Because of parakeratosis rates of gain for some of the treatments were not considered as indicative of the value of the ration received. This was especially true of treatment D which had an abnormally low rate of gain which was not thought to be related to the ration. Feed efficiency varied from 394 to 479 pounds of feed per hundred pounds of gain, with treatment G the most efficient, and treatment A the least efficient.

A simple t-test on rates of gain for the lots receiving alfalfa at 1.5%, 5, 10 and 20% levels, and lots receiving cereal grass at the same levels, revealed no significant differences.

Carcass quality was evaluated by length, depth of shoulder, loin, and back fat, and area of loin muscle. The depth of shoulder fat differed significantly due to sex but not for treatment or interaction of sex and treatment. The barrows averaged 0.2 inches more depth of shoulder fat than the females. There were significant differences in depth of loin and back fat due to sex, with the barrows averaging 0.2 inches more loin fat and 0.1 inches more back fat than the females. Loin area differed significantly due to sex and treatment, but not to the interaction of sex and treatment. The females averaged 0.61 square inches more area of loin muscle than the barrows. Treatment I averaged 0.67 square inches more area of loin muscle than treatment H, with these two treatments producing

the extremes. No significant differences in carcass length due to treatments, sex, or interaction of sex and treatment were found.

Treatments B, D, F, and H, the cereal grass treatments, produced 11 grade A's, 12 grade B's, and 1 grade C, while treatments A, C, E, and F, the alfalfa treatments, produced 10 grade A's, 9 grade B's, and 2 grade C's. Carcass scores differed significantly due to treatment and sex, but not to the interaction of sex and treatment. The cereal grass treatments had an average carcass score of 71 compared to 69 for the alfalfa treatments. Treatment C (20% cereal grass) had the highest average carcass score (80) while treatment B (1.5% alfalfa) had the lowest carcass score (55).

Experiment II

Rate of gain, feed efficiency, and carcass quality data for Experiment II are presented in Tables 6 and 7.

The parakeratosis condition encountered in Experiment II necessitated the removal of one pig from treatment J. Appropriate calculations were made to adjust for feed consumption. The rates of gain could be considered as nearly average, with the rates of gain and feed efficiency decreasing as the level of forages increased in the ration. In this trial the basal portion of the ration was two parts barley and one part oats. Carcass data were not complete for all lots inasmuch as one gilt was retained from each lot for reproduction studies with these forage products. However, this did not interfere with statistical analysis other than reduce the amount of carcass data.

Statistical analyses for this trial are found in Appendix II. The analysis of covariance technique revealed significant differences in rates of gain due to treatment and to sex but not to the interaction of sex and treatment. In this trial the barrows gained an average of 0.11 pounds per day more than the females. The analysis of variance technique revealed differences in rate of gain due to treatment but not to sex or interaction of sex and treatment. The calculated least significant difference for the mean rates of gain for each treatment was approximately 0.15 pounds per day. Feed efficiency varied from 372 to 534 pounds of feed per hundred pounds of gain, with treatment B (basal) the most efficient, and treatment I (40% alfalfa) the least efficient.

The criteria for analysis of carcass quality are the same as described for Experiment I. The depth of shoulder fat was significantly

Experiment II

Table 6. Summary of Effects on Pig Gains and Feed Efficiency

Treatment	A	B	C	D	E	F	G	H	I	J
Description										
Number of pigs	6	6	6	6	6	6	6	6	5	6
Average initial weight, pounds	60.2	59.7	59.8	60.3	60.0	59.3	41.8	42.0	66.4	66.5
Average final weight, pounds	199.0	193.3	192.5	196.5	196.3	193.5	191.7	195.5	194.0	200.8
Average days on test	91.0	91.0	95.7	92.2	101.5	93.3	126.0	116.7	120.4	113.2
Average daily gain, pounds	1.53	1.47	1.39	1.48	1.34	1.48	1.19	1.32	1.06	1.19
Average pounds feed per 100 pounds gain	403	472	412	443	469	413	513	443	534	514
Average daily feed, pounds	6.15	5.46	5.72	6.54	6.30	5.93	6.10	5.83	5.66	6.11

Table 7. Experiment II
Summary of Effects on Hog Carcass Quality

Treatment	A	B	C	D	E	F	G	H	I	J
Description										
Average length of side, inches	31.10	30.84	30.70	30.88	30.60	31.22	29.73	30.80	29.92	30.56
Average depth of shoulder fat, inches	1.68	1.76	1.78	1.73	1.78	1.70	1.63	1.68	1.78	1.74
Average depth back fat, inches	.90	.94	.93	.83	.92	.87	.88	.90	.90	.92
Average depth loin fat, inches	1.16	1.18	1.28	1.33	1.28	1.10	1.25	1.33	1.34	1.32
Area, eye of lean, square inches	3.65	3.76	3.65	3.74	3.50	3.94	4.24	3.95	3.98	4.38
Average carcass score	84.2	82.4	80.2	81.8	75.8	83.7	72.3	81.8	73.0	77.4
Carcass Grade	A B	A B	A B	A B	A B	A B	A B	A B	A B	A B
	4 1	4 2	4 2	3 3	4 1	5 1	4 2	5 1	2 3	3 2

greater (0.1 inch) for barrows than for gilts. This was true also for loin and back fat which averaged 0.1 inches and 0.2 inches greater in depth respectively, for barrows than for females. The loin area was not significantly different as a result of treatment but was significantly greater (0.38 square inches) for the female. Carcass length differed significantly due to sex and to treatment but not to the interaction of sex and treatment. The females produced carcasses averaging 0.5 inches longer than the barrows. A simple t-test on carcass length for those lots receiving alfalfa and for those lots receiving cereal grass revealed a significant difference with those on cereal grass averaging approximately 0.7 inches longer. The pigs on rations containing 1.5, 10, 20 and 40% levels of alfalfa produced 14 grade A and 8 grade B carcasses while pigs on rations containing 1.5, 10, 20 and 40% levels of cereal grass produced 16 grade A and 7 grade B carcasses. An analysis of variance of carcass score showed no significant differences due to treatments, or sex, or interaction of sex and treatments. However, a simple t-test on carcass score for the lots receiving alfalfa and the lots receiving cereal grass revealed that the cereal grass treatments had significantly higher scores.

Experiment III

Rates of gain, feed efficiency, and carcass quality data are presented in Tables 8 and 9. Rates of gain for the trial were considered as nearly average. However, feed efficiency was not considered satisfactory. The basal portion of the ration in this trial was 2 parts barley and one part oats. Carcass analysis was made on the basis of 5 per lot as one gilt was retained from each of the lots for reproduction studies. This did not interfere with the statistical analysis other than reduce the amount of carcass data.

Statistical analysis of this trial is found in Appendix III. The analysis of covariance technique revealed significant differences in rate of gain due to treatments. This was also true for the analysis of variance. The calculated least significant difference for the mean rates of gain for each treatment was 0.21 pounds per day. Feed efficiency varied from 671 to 478 pounds of feed per hundred pounds of gain with the treatment J (basal) the most efficient and treatment A (40% alfalfa) the least efficient.

Treatments had no significant effect on depth of shoulder fat, depth of back fat, carcass length, and carcass score. However, the loin area and depth of loin fat differed significantly due to treatments. Treatment D (20% cereal grass) had the largest loin area and treatment I (basal) the smallest. Treatment C (20% alfalfa) had the greatest depth of loin fat and treatment B (40% cereal grass) the least. The pigs on rations containing 5, 10, 20, and 40% levels of alfalfa and the same levels of cereal grass both produced 13 grade A and 8 grade B_1 carcasses.

Experiment III

Table 8. Summary of Effects on Pig Gains and Feed Efficiency

Treatment	A	B	C	D	E	F	G	H	I	J
Number of pigs	6	6	6	6	6	6	6	6	6	6
Average initial weight, pounds	108.9	110.7	102.2	104.2	104.8	103.7	104.8	108.0	107.7	106.7
Average final weight, pounds	196.8	199.5	198.7	195.5	196.7	195.0	197.0	195.3	195.5	194.0
Average days on test	89.5	72.3	75.8	71.3	59.8	62.3	61.3	61.0	60.3	58.7
Average daily gains, pounds	0.98	1.23	1.27	1.28	1.53	1.47	1.50	1.43	1.45	1.49
Average pounds feed per 100 pounds gain	671	609	604	560	540	556	515	527	498	478
Average daily feed, pounds	6.60	7.49	7.68	7.17	8.29	8.14	7.74	7.53	7.25	7.12

Table 9.

Experiment III
Summary of Effects on Carcass Quality

Treatment	A	B	C	D	E	F	G	H	I	J
Average length of side, inches	30.80	30.87	30.30	29.98	30.27	29.66	30.08	30.20	30.25	30.72
Average depth of shoulder fat, inches	1.70	1.77	1.85	1.82	1.94	1.98	2.02	1.92	1.98	1.88
Average depth of back fat, inches	0.88	0.87	1.02	1.02	1.08	1.12	1.08	0.96	1.12	1.00
Average depth of loin fat	1.30	1.18	1.72	1.34	1.46	1.46	1.48	1.50	1.62	1.47
Area, eye of loin, square inches	3.88	4.06	4.31	4.69	3.92	4.45	4.02	4.09	3.72	4.19
Average carcass score	79.0	84.2	72.2	76.0	73.4	62.4	69.4	65.4	61.0	72.5
Grade A	4	6	4	4	2	1	3	2	2	2
Grade B	1	-	2	1	3	4	2	3	3	4

CHAPTER V

DISCUSSION

The adequacy of a ration for growing-fattening swine is usually measured by rate of gain, feed efficiency, and carcass quality. Rate of gain is the average daily increase in live weight during the feeding period. Feed efficiency is the number of pounds of total ration required to produce 100 pounds liveweight gain. Carcass quality is determined by the standards referred to in the procedure for Experiment I. These three criteria were used in this investigation for the evaluation of cereal grass and alfalfa in growing-fattening rations and finishing rations.

It should be noted at this point that Experiments I and II involved rations for both the growing and finishing period while Experiment III was concerned with the finishing period. As a result of the sporadic parakeratosis condition the data of Experiment I could not be considered representative of either the rations or the pigs. While the conditions affected some of the lots in Experiment III the effect was much less pronounced.

The higher levels of forages (i.e. 20 and 40% levels) in the rations reduced rate of gain and feed efficiency in all three experiments. However, ration D (10% cereal grass) produced the lowest rate of gain in Experiment I and this appeared to be due largely to the effects of parakeratosis which very severely affected the growth and development of the affected pigs. As fibre levels in the growing-fattening rations were increased above the normal range of six to eight per cent feed efficiency decreased. The 20 and 40% levels of forages increased the fibre content to the extent that it decreased efficient utilization of the ration. These

results are in accord with the work of Crampton et al (1954) who found that increased levels of fibre usually decreased rate of gain. With the exception of ration D (10% cereal grass) in Experiment I levels of forages up to 10% did not significantly affect rate of gain in the three experiments. Although differences in rate of gain due to alfalfa and cereal grass treatments were not discernable in Experiment III, there was a definite trend established in Experiment II. The cereal grass treatments in all cases were superior to alfalfa in this trial.

The growing period is the most critical of the pig's life and hence its requirements of protein, vitamins and minerals are more exacting. Cereal grass supplemented rations were superior to those supplemented with alfalfa meal in the growing period. There may be two possible explanations for this result. Cereal grass may possibly be a better source of protein, B complex vitamins and minerals. Alfalfa is known to contain a growth depressant and this factor (s) may be involved here (Cooney et al, 1948). This might explain the results in Experiment III (finishing rations) where no differences in rate of gain between cereal grass or alfalfa treatments were noted at levels up to 20%. At the higher levels of inclusion (especially the 40% level) cereal grass was superior to alfalfa with respect to rate of gain. Palatability may have been an influencing factor in this instance as the pigs did not consume as much per day on the 40% alfalfa ration. The growth depressant factor (s) in alfalfa may have reached a level where it was definitely deleterious. The differences could not be attributed to either fibre or protein levels as randomly selected samples were analysed and found to compare very closely with the calculated levels.

Hanson et al (1955) reported that a trend towards fatter carcasses

was associated with the rate of gain. This trend was also observed in these investigations as indicated by carcass score. However, when considering alfalfa and cereal grass treatments on a comparative basis this did not occur in Experiment II. The pigs on cereal grass treatments gained faster and produced higher quality carcasses. This was also observed in Experiment I at the 5 and 10 and 20% levels of cereal grass. In Experiment III the pigs on the 20 and 40% levels of cereal grass produced higher carcass scores and gained somewhat faster (especially the 40% level) than the pigs on the corresponding alfalfa treatments.

All of the treatments containing forages regardless of level, were less efficient than any of the basal rations. The difference in feed efficiencies was not large for the rations containing small amounts of forages but was quite pronounced for the 20 and 40% percent levels. Feed efficiencies in Experiment I and III were considerably higher than average; parakeratosis undoubtedly was a contributing factor. In Experiment III the cereal grass treatments resulted in superior feed efficiency only at the 20 and 40% levels. These results were expected as there is a high correlation between feed efficiency and rate of gain. It was observed that at the 20 and 40% levels of alfalfa the pigs had a tendency to sort the feed but little wastage resulted. However, palatability of alfalfa may be a factor in producing poorer results at these high levels. In these Experiments the increased levels of fibre decreased feed efficiency. Crampton et al (1954) did not in all cases find decreased feed efficiency with an increase in fibre content. Where a marked decrease in feed efficiency did occur in this investigation, the levels of fibre were higher than those used in Crampton's investigation.

For all experiments the cereal grass treatments tended to produce higher quality carcasses. According to McMeeken (1940), Crampton et al (1954), and Hanson et al (1955), carcass fatness is associated in most cases with rate of gain and feed consumption. This investigation bears out these findings although on a comparative basis cereal grass did produce a greater rate of gain and higher carcass quality than alfalfa in Experiment II. The 40% percent levels of forages in Experiment II, however, tended to produce carcasses of slightly lower quality. This might be attributed to the slightly lower dressing percentage of these pigs. The high fibre in these rations would of necessity cause the pig to consume more feed to obtain the same nutrients as in a low fibre ration. Bohman et al (1953) reported a marked enlargement of the stomach and the intestines with hogs receiving 30 and 50% alfalfa in rations but no significant differences in dressing percentages or carcass quality were observed. The 40% level of forages in Experiment III produced higher quality carcasses than those receiving the lower levels. Since only the finishing period was involved in Experiment III, these results are in agreement with Crampton et al (1954) whose investigation of fibre in rations for the finishing period produced similar results. In the light of these and other investigations fibre would seem to exert a deleterious effect on carcass quality when fed at very high levels in growing-fattening rations.

The affects of sex on rate of gain and carcass quality as indicated by Experiment I and II are in keeping with the results of Crampton et al (1946) and Fredeen (1953). Sex had a significant effect on rate of gain, back-fat measurements, and loin area. The barrows gained faster but were

inferior in carcass quality because of a greater depth of shoulder, back, and loin fat, and smaller eye of lean (longissimus dorsi muscle). The number of gilts in Experiment III was too small to permit an analysis of the sex effect.

Under the conditions of these experiments levels of alfalfa and cereal grass up to 10% of the total ration did not appreciably affect rate of gain or feed efficiency. Levels in excess of 10% depressed growth and feed efficiency but generally increased carcass quality. From an economic viewpoint the inclusion of these forages in rations depends on their cost in relation to other swine feeds. In order to insure an adequate supply of carotene (vitamin A) the inclusion of these meals in rations from 1.5 to 5% would be practical. If alfalfa and cereal grass are comparable in cost the use of cereal grass would be preferred especially in growing-fattening rations since cereal grass did produce a greater rate of gain, superior feed efficiency, and higher carcass quality than alfalfa treatments.

CAROTENE*

In conjunction with the study of the effect of alfalfa and cereal grass on rate of gain, feed efficiency and carcass quality, the effect of storage on carotene content of these products was investigated. It was felt that a study of this kind would provide valuable data on these products as sources of carotene since length and conditions of storage have a marked influence on carotene content and also because alfalfa and cereal grass are sold on a guaranteed carotene content basis.

The study divided itself into two phases: 1. The monthly loss of carotene in alfalfa and cereal grass after a twelve month storage period. These samples were then analyzed at six consecutive monthly intervals. 2. The rate of carotene destruction in freshly processed samples of alfalfa and cereal grass. Three samples were obtained from early, medium and late season crops, respectively, and were analyzed 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 carotenoid pigments, which were not absorbed, were then collected and their transmit-

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* This portion of the investigation was a combined project with Mr. N. C. Young, Graduate Assistant, Division of Poultry Science, University of Manitoba.

** Methods of Vitamin Assay, Prepared and Edited by the Association of Vitamin Chemists, Inc. 2nd Ed. Revised and Supplemented 1951. Interscience Publishing, Inc., New York.

tancy measured in a spectrophotometer and compared with that of a standard.

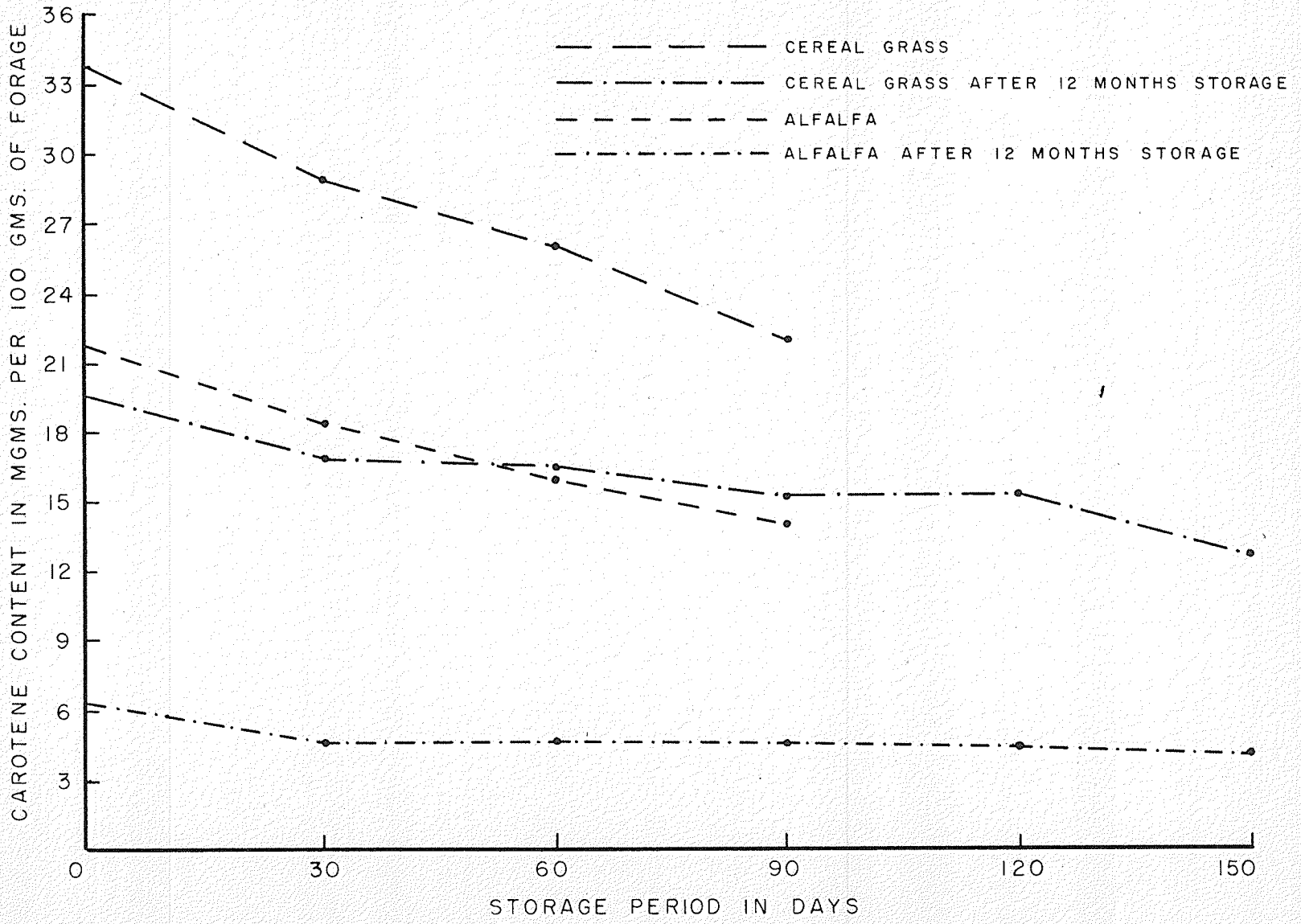
The carotene content of cereal grass and alfalfa dropped from 33 and 21 milligrams of carotene to 19 and 6 milligrams of carotene per 100 grams, respectively, during the 12 month storage period. While the loss in carotene value was 44% for cereal grass, the alfalfa meal lost almost 73%. These samples 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 this period.

Three different shipments of the two meals were analyzed and found to be very similar in carotene content and rate of destruction. Samples of the forages were analyzed at the time of arrival and at four monthly (30 day) intervals. The analyses showed a fairly consistent rate of destruction The average of the analyses were used in the preparation of Graph I. The cereal grass dropped from 33 to 22 milligrams of carotene per 100 grams and alfalfa from 21 to 14 milligrams of carotene per 100 grams in this period. This represents a loss of 35and 36%, respectively, 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. This finding is in agreement with that of other investigators, notably Halverson and Hart (1947). From the graph it may be noted that cereal grass very nearly paralleled the alfalfa in rate of carotene destruction.

Graph 1.

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



From the practical standpoint cereal grass and alfalfa can be stored rather successfully in sealed paper sacks under unheated, relatively dry and dark conditions for short periods. As recommended carotene levels* must be maintained in a swine ration, higher levels of these meals would have to be added if they had been stored for a prolonged period. Generally, one milligram of carotene per pound of total ration is sufficient for normal physiological processes. On this basis cereal grass should be added at 0.75 pounds to 100 pounds of total ration at the beginning of the period and slightly more than 1 pound after 12 months storage. The alfalfa should be added at the rate of 1 pound per 100 pounds of total ration at the beginning of the period and at 4 pounds at the end of the storage period (12 months).

If the alfalfa and cereal grass is fresh, and is stored for short periods only (2-6 months) an increase in level of meals in rations would not be necessary since the loss in that period would not be large.

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* Recommended Nutrient Allowances for Swine. Revised August 1950. A Report of the Committee on Animal Nutrition. National Research Council. 2101 Constitution Ave. N. W. Washington 25, D. C., U. S. A.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The comparative nutritional value of dehydrated alfalfa meal and dehydrated cereal grass meal in rations for growing-fattening swine was investigated. The pigs were fed in dry -lot on a barley, oats, soybean oil meal basal ration with graded levels of the forage products. The main criteria used for the comparisons were rate of gain, feed efficiency and carcass quality.

Under the conditions of these investigations the following conclusions were drawn:-

1. The addition of either dehydrated alfalfa meal or cereal grass meal up to and including 10% of the total ration did not significantly affect the rate of gain.

2. Rates of gain and feed efficiency tended to decrease with increasing levels of forages in the ration.

3. Dehydrated cereal grass meal was superior at all levels to dehydrated alfalfa meal in growing-fattening rations with respect to rate of gain, feed efficiency and carcass quality.

4. Dehydrated cereal grass meal and dehydrated alfalfa meal were comparable in value in finishing rations at levels up to 20% of the total ration with respect to rate of gain, feed efficiency and carcass quality.

5. Dehydrated cereal grass meal was superior to dehydrated alfalfa meal with respect to rate of gain, feed efficiency, and carcass quality in all trials at the 40% level of inclusion.

6. When compared to the barley, oats, soybean oil meal basal ration in no cases did the inclusion of dehydrated alfalfa meal or dehydrated cereal grass meal result in an improvement in rate of gain or feed efficiency.

7. Gilts produced carcasses of higher quality than did the barrows.

8. Carcass quality improved with the increase in level of forages up to 20% of the total ration.

CHAPTER VII

APPENDIX I

DATA OF EXPERIMENT I

Table 1.

Rates of Gain

	A	B	C	D	E	F	G	H	I
M	1.28	1.47	1.48	1.01	1.52	1.16	1.48	1.37	1.45
	.99	1.05	1.48	1.16	1.58	1.39	1.09	1.06	1.27
	1.11	.89	1.39	1.06	-	1.31	1.34	1.45	1.29
	-	-	-	1.21	-	1.44	1.36	-	-
	-	-	-	.94	-	1.48	-	-	-
F	1.10	1.19	1.33	1.03	1.23	1.39	1.50	1.43	1.33
	1.12	1.16	1.47	1.12	1.49	1.40	1.29	1.29	1.42
	1.33	1.31	1.26	1.03	1.11	-	1.23	1.14	1.33
	1.16	1.44	1.32	-	-	-	-	1.03	1.01
	.94	1.34	1.16	-	-	-	-	-	1.28

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	8	.7181	.0898	4.23**
Sex	1	.0123	.0123	.58
Interaction	8	.1777	.0222	1.05
Error	48	1.0173	.0212	
Total	65	1.9254		

** Significant at 1%

Table 2. Mean Rates of Gain

A	B	C	D	E	F	G	H	I
1.28	1.47	1.48	1.01	1.52	1.16	1.48	1.37	1.45
.99	1.05	1.48	1.16	1.58	1.39	1.09	1.06	1.27
1.11	.89	1.39	1.06	1.23	1.31	1.34	1.45	1.29
1.10	1.19	1.33	1.21	1.49	1.44	1.36	1.43	1.33
1.12	1.16	1.47	.94	1.11	1.48	1.50	1.29	1.42
1.33	1.31	1.26	1.03	-	1.39	1.29	1.14	1.33
1.16	1.44	1.32	1.12	-	1.40	1.23	1.03	1.01
.94	1.34	1.16	1.03	-	-	-	-	1.28
$\bar{X}$ =1.13	1.23	1.36	1.07	1.39	1.37	1.33	1.25	1.30

L. S. D. = .149

Table 3.

Initial Weights and Daily Gains

	A		B		C		D		E		F		G		H		I	
Treatment	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y
M	49	1.28	48	1.47	51	1.48	39	1.01	49	1.52	41	1.16	53	1.48	55	1.37	53	1.45
	34	.99	34	1.05	38	1.48	32	1.16	61	1.58	50	1.39	34	1.09	42	1.06	40	1.27
	40	1.11	30	.89	29	1.39	43	1.06	-	-	53	1.31	36	1.34	59	1.45	40	1.29
	-	-	-	-	-	-	26	1.21	-	-	39	1.44	44	1.36	-	-	-	-
	-	-	-	-	-	-	38	.94	-	-	41	1.48	-	-	-	-	-	-
F	33	1.10	36	1.19	34	1.33	46	1.03	48	1.23	53	1.39	65	1.50	46	1.43	41	1.33
	41	1.12	32	1.16	41	1.47	40	1.12	54	1.49	45	1.40	36	1.29	48	1.29	53	1.42
	53	1.33	47	1.31	42	1.26	43	1.03	41	1.11	-	-	50	1.23	42	1.14	62	1.33
	33	1.16	51	1.44	46	1.32	-	-	-	-	-	-	-	-	37	1.03	36	1.01
	31	.94	42	1.34	41	1.16	-	-	-	-	-	-	-	-	-	-	37	1.28

M - Males
F - Females

x - initial weights
y - daily rate of gain

Table 4. Analysis of Covariance

Source	DF	x^2	xy	y^2	SS	DF	MS	Calculated F Values
Treatment	8	959.7880	18.0694	.7181				
Sex	1	15.3224	- .4425	.0123				
Interaction	8	491.5335	4.8837	.1777				
Error	48	3224.4334	34.3244	1.0173	.3654	47	.0078	
Total	65	4691.0773	56.8350	1.9254				
Treatment and error difference	56	4184.2214	52.3938	1.7354	1.0793 .7139	8	.0892	11.43**
Sex and error difference	49	3239.7558	33.8819	1.0296	.6753 .3099	1	.3099	39.73**
Interaction and error difference	56	3715.9669	39.2081	1.1950	.7813 .4159	8	.0520	6.67**

** Significant at 1% level

Table 5. Simple "t-test" on Mean Rates of Gain for Alfalfa and Cereal Grass Treatments

Alfalfa	Cereal Grass
1.28	1.47
.99	1.05
1.11	.89
1.10	1.19
1.12	1.16
1.33	1.31
1.16	1.44
.94	1.34
1.48	1.01
1.48	1.16
1.39	1.06
1.33	1.21
1.47	.94
1.26	1.03
1.32	1.12
1.16	1.03
1.52	1.16
1.58	1.39
1.23	1.31
1.49	1.44
1.11	1.48
1.48	1.39
1.09	1.40
1.34	1.37
1.36	1.06
1.50	1.45
1.29	1.43
1.23	1.29
	1.14
	1.03

Calculated $t = 1.18$

$t_{.975} = 2.02$

Table 6. Simple "t-test" on Carcass Score for Cereal Grasses and Alfalfa Treatments

Alfalfa	Cereal Grass
82	93
78	90
85	68
81	63
61	74
81	85
63	72
86	69
78	76
52	90
94	78
92	72
64	98
53	78
88	73
60	49
30	75
70	83
58	80
43	94
	61
	25
	53
	34

Calculated $t = < 1$

$t_{.975} = 2.02$

Table 7. Carcass Score

	A	B	C	D	E	F	G	H	I
M	61	95	94	69	64	78	30	25	70
	81	74	52	76	53	73	70	53	72
	81	63	78	90	-	49	58	34	-
	-	-	-	78	-	75	42	-	-
	-	-	-	72	-	83	-	-	-
F	78	93	63	72	92	98	60	80	74
	82	90	86	-	-	-	88	94	75
	85	76	-	-	-	-	-	61	76

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	8	3246.5558	405.8195	2.44*
Sex	1	2298.8961	2298.8961	13.82**
S x T	8	2668.4738	333.5592	2.00
Error	31	5158.1968	166.3934	-
Total	48	13372.1225	-	-

* Significant at 5%
** Significant at 1%

Table 8. Length of Carcass

	A	B	C	D	E	F	G	H	I
M	30.5	30.6	30.9	30.1	30.2	31.5	29.7	29.1	30.1
	30.7	29.5	29.2	29.8	30.9	29.9	29.5	28.6	30.5
	29.8	29.9	31.9	31.0	-	30.7	31.2	20.5	-
	-	-	-	30.3	-	29.7	29.6	-	-
	-	-	-	28.9	-	31.4	-	-	-
F	31.9	31.9	29.8	30.5	30.2	30.4	30.8	31.3	29.4
	29.8	31.7	30.2	-	-	-	31.9	30.9	29.6
	30.8	31.4	-	-	-	-	-	29.1	29.7

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	8	5.9235	.7404	1.25
Sex	1	2.0657	2.0657	3.48
S x T	8	9.2080	1.1510	1.94
Error	31	18.3767	.5929	-
Total	48	35.5739	-	-

Table 9. Shoulder Fat

	A	B	C	D	E	F	G	H	I
M	2.0	1.9	1.8	1.8	2.0	1.9	2.3	2.3	2.0
	1.7	1.9	2.1	1.8	2.1	1.6	1.8	1.9	2.1
	1.8	1.9	1.7	1.8	-	2.5	2.0	1.8	-
	-	-	-	1.6	-	2.0	2.4	-	-
	-	-	-	1.7	-	1.7	-	-	-
F	1.5	1.5	2.0	2.1	1.6	1.6	2.0	2.0	1.7
	1.9	1.5	1.8	-	-	-	1.4	1.8	1.8
	1.4	1.6	-	-	-	-	-	1.8	2.0

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	8	.4185	.0523	1.11
Sex	1	.4340	.4340	9.25**
S x T	8	.5139	.0642	1.37
Error	31	1.4548	.0469	-
Total	48	2.8212	-	-

** Significant at 1%

Table 10. Back Fat

	A	B	C	D	E	F	G	H	I
M	1.3	1.0	1.0	1.0	1.1	1.2	1.4	1.4	1.2
	.8	1.0	1.2	1.2	1.1	.9	1.1	1.0	.9
	.9	1.0	.8	1.0	-	1.0	1.2	1.1	-
	-	-	-	1.1	-	1.2	1.2	-	-
	-	-	-	.8	-	.8	-	-	-
F	.6	.9	1.1	.9	.9	.7	1.3	1.0	1.1
	.8	.8	1.0	-	-	-	.8	1.1	1.0
	.9	1.1	-	-	-	-	-	.9	1.1

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	8	.3101	.0388	1.39
Sex	1	.1564	..1564	5.61*
S x T	8	.1418	.0177	0.64
Error	31	.8652	.0279	-
Total	48	1.4735	-	-

* Significant at 5%

Table 11. Loin Fat

	A	B	C	D	E	F	G	H	I
M	1.4	1.3	1.2	1.5	1.6	1.4	1.9	2.1	1.4
	1.1	1.3	1.6	1.1	1.7	1.0	1.2	1.2	1.4
	1.2	1.5	1.4	1.4	-	1.4	1.4	1.7	-
	-	-	-	1.1	-	1.3	1.4	-	-
	-	-	-	1.2	-	1.3	-	-	-
F	1.2	1.0	1.5	1.4	1.2	1.0	1.5	1.4	1.2
	1.0	1.1	1.3	-	-	-	.9	1.2	1.4
	1.4	1.4	-	-	-	-	-	.9	1.1

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Square	Mean Square	Calculated F Value
Treatment	8	.3470	.0434	<1
Sex	1	.3530	.3530	7.59**
S x T	8	.6028	.0753	1.62
Error	31	1.4427	.0465	-
Total	48	2.7455		

** Significant at 1%

Table 12. Loin Area (Square inches)

	A	B	C	D	E	F	G	H	I
M	2.98	3.25	3.61	3.78	3.93	3.48	3.57	3.11	3.55
	3.79	3.94	3.26	3.94	2.93	3.18	3.93	3.31	4.92
	3.57	3.79	3.45	4.35	-	3.14	3.22	2.76	-
	-	-	-	4.00	-	3.70	3.60	-	-
	-	-	-	3.88	-	3.62	-	-	-
F	4.43	5.08	3.52	4.92	4.31	4.55	3.32	3.52	4.36
	4.10	5.30	4.28	-	-	-	3.71	4.23	3.98
	3.81	3.75	-	-	-	-	-	4.28	4.20

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	8	3.5510	.4439	2.56*
Sex	1	4.2923	4.2923	24.80**
S x T	8	1.9387	.2423	1.40
Error	31	5.3661	.1731	-
Total	48	15.1481	-	-

*Significant at 5% level
**Significant at 1% level

CHAPTER VIII

APPENDIX II

DATA OF EXPERIMENT II

Table 1. Rate of Gain

	A	B	C	D	E	F	G	H	I	J
M	1.52	1.35	1.46	1.34	1.29	1.38	1.28	1.22	1.00	1.18
	1.74	1.48	1.42	1.61	1.48	1.40	1.45	1.15	-	1.17
	1.49	1.74	1.69	1.64	1.39	1.52	-	1.55	-	-
F	1.47	1.49	1.48	1.67	1.24	1.44	1.01	1.54	1.01	1.22
	1.43	1.53	1.35	1.29	1.36	1.38	1.18	1.49	1.08	1.12
	1.55	1.32	1.11	1.44	1.30	1.50	1.17	1.13	1.13	1.17
	-	-	-	-	-	-	1.12	-	1.10	1.27

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	1.2119	.1347	7.90**
Sex	1	.0394	.0394	2.26
Interaction	9	.1632	.0181	1.04
Error	39	.6775	.0174	
Total	58	2.0920		

** Significant at 1%

Table 2. Mean Rates of Gain

A	B	C	D	E	F	G	H	I	J
1.52	1.35	1.46	1.34	1.29	1.38	1.28	1.22	1.00	1.18
1.74	1.48	1.42	1.61	1.48	1.40	1.45	1.15	1.01	1.17
1.49	1.74	1.69	1.64	1.39	1.52	1.01	1.55	1.08	1.22
1.47	1.49	1.48	1.67	1.24	1.44	1.18	1.54	1.13	1.12
1.43	1.53	1.35	1.29	1.36	1.38	1.17	1.49	1.10	1.17
1.55	1.32	1.11	1.44	1.30	1.50	1.12	1.13	-	1.27
X= 1.53	1.49	1.42	1.50	1.34	1.44	1.20	1.35	1.06	1.19

L. S. D. = .154

Table 3. Simple "t-test" on Mean Rates of Gain for for Alfalfa and Cereal Grass Treatments

Alfalfa	Cereal Grass
1.46	1.34
1.42	1.61
1.69	1.64
1.48	1.67
1.35	1.29
1.11	1.44
1.29	1.38
1.48	1.40
1.39	1.52
1.24	1.44
1.36	1.38
1.30	1.50
1.28	1.22
1.45	1.15
1.01	1.55
1.18	1.54
1.17	1.49
1.12	1.13
1.00	1.18
1.01	1.17
1.08	1.22
1.13	1.12
1.10	1.17
	1.27

Calculated $t = 1.96$

$t_{.975} = 2.02$

Table 4. Initial Weights and Daily Gains

Treatment	A		B		C		D		E	
	x	y	x	y	x	y	x	y	x	y
M	50	1.52	54	1.35	61	1.46	60	1.34	60	1.29
	67	1.74	58	1.48	53	1.42	58	1.61	52	1.48
	72	1.49	70	1.74	63	1.69	54	1.64	49	1.39
F	69	1.47	61	1.49	76	1.48	78	1.67	76	1.24
	43	1.43	64	1.53	59	1.35	52	1.29	66	1.36
	60	1.55	51	1.32	47	1.11	60	1.44	57	1.30

Treatment	F		G		H		I		J	
	x	y	x	y	x	y	x	y	x	y
M	50	1.38	32	1.28	34	1.22	58	1.00	70	1.18
	73	1.40	49	1.45	33	1.15	-	-	58	1.17
	55	1.52	-	-	41	1.55	-	-	-	-
F	59	1.44	49	1.01	51	1.54	67	1.01	67	1.22
	67	1.38	42	1.18	54	1.49	60	1.08	67	1.12
	52	1.50	42	1.17	39	1.13	70	1.13	77	1.17
	-	-	37	1.12	-	-	77	1.10	60	1.27

M - Males
F - Females

x - Initial weights
y - Daily rate of gain

Table 5. Analysis of Covariance

Source	DF	x^2	xy	y^2	SS	DF	MS	Calculated F Value
Treatment	9	3937.6441	1.8329	1.2119				
Sex	1	246.7139	- 6.8885	.0394				
Interaction	9	502.3694	6.7855	.1632				
Error	39	3099.9167	19.8367	.6775	.5506	38	.0145	
Total	58	7786.6441	21.5666	2.0920				
Treatment and error difference	48	7037.5608	21.6696	1.8894	1.8227 1.2721	47 9	.1413	9.74**
Sex and error difference	40	3346.6306	12.9482	.7169	.6668 .1162	39 1	.1162	8.01**
Interaction and error difference	48	3602.2861	26.6222	.8407	.6440 .0934	47 9	.0104	.72

**Significant at 1% level

Table 6. Shoulder Fat

	A	B	C	D	E	F	G	H	I	J
M	1.9	1.9	1.6	1.8	1.7	1.8	2.0	1.7	2.1	1.7
	1.3	1.6	1.9	1.6	1.7	1.6	1.8	1.7	-	2.0
	1.8	-	2.0	1.7	2.3	1.9	-	1.8	-	-
F	1.8	1.9	2.0	1.7	1.5	1.6	1.4	1.8	1.6	1.9
	1.6	1.7	1.6	1.8	1.7	1.3	1.5	1.7	1.7	1.4
	-	1.7	1.6	1.8	-	2.0	1.5	1.4	1.8	1.7
	-	-	-	-	-	-	1.6	-	1.7	-

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	.1331	.0148	.37
Sex	1	.2281	.2281	5.72*
S x T	9	.3265	.0363	.91
Error	35	1.3967	.0399	-
Total	54	2.0844	-	-

* Significant at 5%

Table 7. Back Fat

	A	B	C	D	E	F	G	H	I	J
M	.8	1.2	1.0	.9	1.0	.8	1.2	.9	1.2	1.1
	.7	.9	.9	.9	.8	.9	1.0	1.1	-	1.0
	1.1	-	1.0	.9	1.4	1.0	-	.9	-	-
F	1.1	1.0	1.0	.8	.6	.8	.7	1.0	.8	1.0
	.8	.7	.7	.8	.8	.7	.7	.8	.8	.6
	-	.9	1.0	.9	-	1.0	.8	.7	1.0	.9
	-	-	-	-	-	-	.9	-	.7	-

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	.0335	.0037	0.15
Sex	1	.3095	.3095	12.68**
S x T	9	.2318	.0257	1.05
Error	35	.8550	.0244	-
Total	54	1.4298	-	-

** Significant at 1%

Table 8. Loin Fat

	A	B	C	D	E	F	G	H	I	J
M	1.2	1.4	1.2	1.2	1.3	1.4	1.4	1.3	1.5	1.4
	1.0	1.2	1.4	1.5	1.1	1.1	1.4	1.4	-	1.6
	1.2	-	1.2	1.2	1.6	1.1	-	1.4	-	-
F	1.1	1.1	1.4	1.4	1.2	.9	1.1	1.5	1.4	1.3
	1.3	1.0	1.3	1.4	1.2	.8	1.0	1.2	1.4	1.1
	-	1.2	1.2	1.3	-	1.3	1.2	1.2	1.2	1.2
	-	-	-	-	-	-	1.4	-	1.2	-

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	.3558	.0395	1.82
Sex	1	.1137	.1137	5.24*
S x T	9	.2435	.0271	1.25
Error	35	.7608	.0217	
Total	54	1.4738		

* Significant at 5%

Table 9. Loin Area (Square inches)

	A	B	C	D	E	F	G	H	I	J
M	3.65	2.98	3.51	3.41	3.11	3.53	3.85	3.90	3.94	4.20
	4.00	3.85	3.19	3.70	3.71	3.77	3.90	4.10	-	3.81
	3.17	-	3.83	3.56	3.44	3.76	-	3.89	-	-
F	3.89	4.38	3.12	4.04	3.59	3.95	4.21	3.36	4.05	4.19
	3.55	4.26	3.65	4.28	3.64	5.02	4.89	3.42	4.31	4.11
	-	3.32	4.59	3.45	-	3.61	3.78	5.02	3.95	5.58
	-	-	-	-	-	-	4.80	-	3.64	-

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	3.6117	.4013	1.60
Sex	1	2.0170	2.0170	8.05**
T x S	9	.0006	.0001	-
Error	35	8.7732	.2507	-
Total	54	14.4025	-	-

** Significant at 1% level

Table 10. Carcass Score

	A	B	C	D	E	F	G	H	I	J
M	86	58	79	85	76	71	63	91	67	67
	93	92	80	62	88	95	67	71	-	71
	70	-	72	82	54	87	-	85	-	-
F	86	91	66	89	74	87	83	74	65	84
	86	87	88	87	87	86	80	84	77	71
	-	88	96	86	-	76	71	86	72	94
	-	-	-	-	-	-	70	-	84	-

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	960.4333	106.7148	1.02
Sex	1	390.7933	390.7933	3.75
S x T	9	605.1401	67.2378	<1
Error	35	3648.8333	104.2524	-
Total	54	5605.2000	-	-

Table 11. Simple "t-test" on Carcass Score for Cereal Grass and Alfalfa Treatments

Alfalfa	Cereal Grass
66	89
88	87
96	86
79	85
80	62
72	82
74	87
87	86
76	76
88	71
54	95
83	87
80	74
71	84
70	86
63	91
67	71
65	85
77	84
72	71
84	94
67	67
	71

$C_a$lculated t = 2.10*

$t_{.975}$ = 2.02

* Significant at 5% level

Table 12. Carcass Length

	A	B	C	D	E	F	G	H	I	J
M	30.9	29.0	30.9	31.3	30.8	30.0	29.2	30.9	29.9	29.9
	31.1	30.4	30.0	30.2	31.6	32.0	29.2	29.6	-	30.2
	30.8	-	31.1	29.6	29.6	30.4	-	31.0	-	-
F	30.7	30.8	30.3	32.2	31.0	32.4	29.9	30.7	29.3	30.9
	32.0	32.0	30.8	30.5	30.1	32.3	30.1	31.6	30.1	31.1
	-	32.0	31.1	31.5	-	30.2	29.9	31.0	29.8	30.7
	-	-	-	-	-	-	30.0	-	30.5	-

M - Males
F - Females

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Squares	Calculated F Value
Treatment	9	11.3420	1.2602	2.58*
Sex	1	2.9106	2.9106	5.95*
S x T	9	6.4044	.7116	1.45
Error	35	17.1150	.4890	
Total	54	37.7720		

* Significant at 5%

Table 13. Simple "t-test" on Carcass Length for Cereal Grass and Alfalfa Treatments

Alfalfa	Cereal Grasses
30.9	31.3
30.0	30.2
31.1	29.6
30.3	32.2
30.8	30.5
31.1	31.5
30.8	30.0
31.6	32.0
29.6	30.4
31.0	32.4
30.1	32.3
29.2	30.2
29.3	30.9
29.9	29.6
30.1	31.0
29.9	30.7
30.0	31.6
29.9	31.0
29.3	29.9
30.1	30.2
29.8	30.9
30.5	31.1
	30.7

Calculated $t = 2.81^{**}$

$t_{.995} = 2.70$

**Significant at 1% level

CHAPTER IX
APPENDIX III
DATA FOR EXPERIMENT III

Table 1. Rate of Gain

A	B	C	D	E	F	G	H	I	J
1.21	1.25	1.17	1.38	1.76	1.54	1.50	1.83	1.54	1.50
.94	1.43	1.11	1.00	1.65	1.36	1.65	1.10	1.59	1.34
.98	1.27	1.43	1.65	1.71	1.27	1.67	1.43	1.50	1.70
.79	1.07	1.21	1.44	1.46	1.66	1.07	1.54	1.26	1.45
.93	1.28	1.40	1.13	1.40	1.43	1.64	1.48	1.40	1.47
1.21	1.18	1.40	1.23	1.31	1.63	1.75	1.46	1.46	1.53

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	1.5841	.1760	5.55**
Error	50	1.5848	.0317	-
Total	59	3.1689	-	-

** Significant at 1%

Table 2. Mean Rates of Gain

A	B	C	D	E	F	G	H	I	J
1.21	1.25	1.17	1.38	1.76	1.54	1.50	1.83	1.54	1.50
.94	1.43	1.11	1.00	1.65	1.36	1.65	1.10	1.59	1.34
.98	1.27	1.43	1.65	1.71	1.27	1.67	1.43	1.50	1.70
.79	1.07	1.21	1.44	1.46	1.66	1.07	1.54	1.26	1.45
.93	1.28	1.40	1.13	1.40	1.43	1.64	1.48	1.40	1.47
1.21	1.18	1.40	1.23	1.31	1.63	1.75	1.46	1.46	1.53
$\bar{X}$ = 1.01	1.25	1.29	1.31	1.55	1.48	1.55	1.47	1.46	1.50

L. S. D. = .208

Table 3. Initial Weights and Daily Gains

Treatment	A		B		C		D		E	
	x	y	x	y	x	y	x	y	x	y
	124	1.21	100	1.25	100	1.17	104	1.38	105	1.76
	100	.94	124	1.43	98	1.11	103	1.00	103	1.65
	120	.98	100	1.27	109	1.43	100	1.65	102	1.71
	103	.79	128	1.07	101	1.21	105	1.44	106	1.46
	102	.93	117	1.28	102	1.40	110	1.13	109	1.40
	104	1.21	95	1.18	103	1.40	103	1.23	104	1.31

Treatment	F		G		H		I		J	
	x	y	x	y	x	y	x	y	x	y
	101	1.54	100	1.50	117	1.83	102	1.54	108	1.50
	103	1.36	118	1.65	100	1.10	104	1.59	97	1.34
	101	1.27	114	1.67	103	1.43	115	1.50	112	1.70
	101	1.66	98	1.07	113	1.54	119	1.26	113	1.45
	112	1.43	104	1.64	100	1.48	106	1.40	100	1.47
	104	1.63	95	1.75	115	1.46	100	1.46	110	1.53

x - Initial weight
y - Daily rate of gain

Table 4.

Analysis of Covariance

Source	DF	x^2	xy	y^2	SS	DF	MS	Calculated F Value
Total	59	13195.65	5.0505	3.1689				
Treatment	9	139.07	- 8.4928	1.5841				
Error	50	13056.58	13.5433	1.5848	1.5708	49	.0321	
Treatment and error difference	59	13195.65	5.0505	3.1689	3.1670 1.5962	58 9	.1773	5.52**

** Significant at 1% level

Table 5. Carcass Score

A	B	C	D	E	F	G	H	I	J
92	70	83	66	63	43	57	56	32	69
92	92	65	88	64	80	60	77	86	65
64	83	81	75	79	57	91	76	73	56
67	71	76	88	88	66	48	53	53	75
80	94	65	63	73	66	91	65	61	94
-	87	63	-	-	-	-	-	-	76

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	2540.1466	282.2385	1.54
Error	43	7857.9667	182.7434	-
Total	52	10398.1133	-	-

Table 6. Carcass Length

A	B	C	D	E	F	G	H	I	J
30.7	29.3	31.4	29.1	30.2	29.2	29.0	30.2	29.6	31.4
31.4	30.5	29.6	30.6	29.8	29.9	29.6	30.0	30.8	29.8
31.4	31.8	30.7	29.9	30.8	30.0	31.8	31.1	30.2	29.8
30.1	30.1	31.5	30.8	30.3	29.8	28.8	29.5	30.4	30.2
30.4	31.2	29.8	29.5	30.3	29.4	31.2	30.2	30.2	31.7
-	32.3	28.8	-	-	-	-	-	-	31.4

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	7.0258	.7806	1.13
Error	43	29.6297	.6891	-
Total	52	36.6555	-	-

Table 7. Shoulder Fat

A	B	C	D	E	F	G	H	I	J
1.6	1.9	1.7	1.8	2.0	1.9	2.1	2.3	2.1	2.2
1.6	1.8	1.9	1.8	1.9	1.7	2.1	1.7	1.9	1.8
1.5	1.9	1.7	1.8	2.0	2.2	1.7	1.6	2.1	2.1
1 1.8	1.9	1.9	1.6	1.9	2.1	2.2	2.1	1.8	1.7
2.0	1.5	2.1	2.1	1.9	2.0	2.0	1.9	2.0	1.7
-	1.6	1.8	-	-	-	-	-	-	1.8

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	.4860	.0540	1.56
Error	43	1.4887	.0346	-
Total	52	1.9747		

Table 8. Back Fat

A	B	C	D	E	F	G	H	I	J
.8	1.0	1.0	1.1	1.1	1.3	1.1	1.1	1.3	1.0
.8	.9	.9	1.0	1.1	.9	1.3	.9	.9	1.0
1.0	.8	.9	.9	1.1	1.2	.8	.7	1.1	1.2
.9	.9	1.1	.8	1.0	1.1	1.2	1.1	1.2	1.0
.9	.8	1.1	1.3	1.1	1.1	1.0	1.0	1.1	.8
-	.8	1.1	-	-	-	-	-	-	1.0

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	.3915	.0435	.53
Error	43	.7817	.0818	-
Total	52	1.1732	-	-

Table 9. Loin Fat

A	B	C	D	E	F	G	H	I	J
1.2	1.3	1.4	1.3	1.5	1.7	1.5	1.8	1.9	1.4
1.2	1.3	1.4	1.4	1.5	1.2	1.7	1.2	1.4	1.5
1.4	1.1	1.3	1.4	1.5	1.5	1.2	1.4	1.5	1.6
1.3	1.2	1.6	1.0	1.3	1.5	1.6	1.6	1.7	1.5
1.4	1.1	1.5	1.6	1.5	1.4	1.4	1.5	1.6	1.2
-	1.1	1.4	-	-	-	-	-	-	1.6

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	.7202	.0800	3.11**
Error	43	1.1070	.0257	-
Total	52	1.8272		

** Significant at 1%

Table 10. Loin Area

A	B	C	D	E	F	G	H	I	J
4.05	4.08	4.52	4.41	3.21	3.52	4.51	3.81	3.20	3.55
4.60	3.95	4.05	4.45	3.82	5.37	3.69	4.00	4.08	4.00
3.25	3.63	3.05	3.98	4.10	4.08	3.61	4.85	4.41	3.73
3.89	4.59	4.39	5.89	4.55	4.90	4.25	3.70	3.20	4.61
3.62	3.62	4.21	4.20	3.92	4.36	4.04	4.09	3.72	4.88
-	4.51	5.65	-	-	-	-	-	-	4.40

Analysis of Variance

Source	Degrees of Freedom	Sum of Squares	Mean Square	Calculated F Value
Treatment	9	3.7214	4.1349	12.17**
Error	43	14.6166	.3399	-
Total	52	18.3380	-	-

** Significant at 1% level

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