T H E S I S

C O L O R O F B E E F

As Influenced by the Ration

and

T H E V I T A M I N V A L U E O F B E E F

With Special Reference to the Vitamin A Content

Submitted by

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COLORADO AGRICULTURAL COLLEGE

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GRADUATE WORK

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY RONALD C. TOM

ENTITLED COLOR OF BEEF AS INFLUENCED BY THE RATION AND THE VITAMIN VALUE OF BEEF WITH SPECIAL REFERENCE TO THE VITAMIN A CONTENT.

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

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In Charge of Thesis

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Committee on Advanced Degrees

TABLE OF CONTENTS

C O L O R   O F   B E E F
AS INFLUENCED BY THE RATION
AND
T H E   V I T A M I N   V A L U E   O F   B E E F
WITH SPECIAL REFERENCE TO THE VITAMIN A CONTENT

INTRODUCTION

The object of this thesis is to make a study of the color of beef as influenced by the ration, and also a study of the value of beef as a source of the vitamins, stressing the relation of yellow color to vitamin A content.

A review of literature on work done on the vitamin content of beef is presented to show that, as far as investigators at the present time can determine, the discrimination of the buying public against yellow fat is not supported by tests made by experiment stations during the past several years. These tests have been made mostly since 1919.

REVIEW OF LITERATURE

Funk, in 1910, designated the term "vitamin" to indicate a group of indispensible nutritive complexes. A diet may have an appropriate chemical composition and yet be unsatisfactory for the nutrition of man. (1).

The term vitamin A was for some years used interchangeably with fat-soluble vitamin; but in recent years it has been shown that there are at least three fat-soluble substances belonging to the general category to which the term vitamin is commonly and conveniently applied, and so as the evidence has become adequate there have been differentiated from vitamin A first an anti-rachitic and then vitamin E, commonly called the antisterility vitamin, which is a misnomer. This is a vitamin which controls the proper functioning of the placenta.

In its present significance, therefore, the term vitamin A stands for a substance, or possibly a closely related group of substances which, independently of the two other fat-soluble substances just mentioned, is essential to growth and health.

The most common criteria of its absence are cessation of growth on a diet adequate in all other respects and a more or less characteristic susceptibility to eye disease. But this latter is only one phase of a widespread weakening of the body tissues and increased susceptibility to infections of several kinds including, lung, skin and bladder infections and, as more recently demonstrated, inflammation and formation of pus in the ears, the sinuses, and particularly in the glands near the base of the tongue. Hence, even after the complete differentation of the two other fat-soluble substances mentioned, vitamin A remains much more than merely an antiophthalmic substance. (2).

As the composition of a feed evidently affects the vitamin content of the finished product, whether beef, pork, or lamb, some observations on the probable relation between the fat-soluble vitamin and pigmentation of plants are given.

H. Steenbock (3) (1919) submits evidence from his own work and from that of other investigators from which the hypothesis is advanced that the fat-soluble vitamin is a plant pigment or a closely related compound. This work was done with white corn versus yellow corn to determine the probable relation between the fat-soluble vitamin and yellow pigments.

L. S. Palmer (4) 1919) cites a number of instances where the relationship between carotinoids and fat-soluble vitamin suggested by Steenbock apparently breaks down. It is admitted however that the similarity of certain of the properties of the two kinds of material offers a working basis for the ultimate isolation of the fat-soluble vitamin.

Steenbock and Boutwell (5) (1920), in continuation of the work to determine the relation between the fat-soluble vitamin and pigmentation, observed that yellow maize is superior to red or white varieties as a source of vitamin A. Yellow maize was found to furnish enough of the fat-soluble vitamin to allow growth at the normal rate to take place in the rat and to make possible reproduction but not rearing of the young. White maize under similar conditions produced absolute nutritional failure. Red maize with a white endosperm gave the same results as white maize and with a yellow endosperm the results approximate those of yellow maize.

Steenbock and Sell (6) (1922) present further data confirming the senior author's theory of association of vitamin A with yellow pigmentation. White sweet potatoes and white carrots were found to contain but little vitamin A. The tops of white carrots pigmented with chlorophyll were richer in vitamin A than the bottoms of the same roots containing less pigment. White cabbage leaves in the head contained only one-tenth as much yellow pigment as green cabbage leaves and a much lower content of vitamin A.

The Indiana Experiment Station (7) (1927) published results of an experiment from which they conclude that vitamin A in corn is found only in yellow kernel. Grains of corn with pure white endosperm, grains with pure yellow endosperm, and grains having the white plant characters but yellow endosperm were fed to albino rats. It was found that the vitamin A content of corn bears a definite relation to the yellow endosperm.

McCollum and Simmonds state that butterfat, egg yolk fats, and the leaves of certain plants contain vitamin A, necessary for growth and maintenance of health. This substance is not found in any fats or oils of vegetable origin. (1).

McCollum and Simmonds, in reference to the vitamin content, divide animal tissues into two classes as a source of the vitamins: (1) glandular organs, as the liver and kidney, (2) and specialized tissue, as muscle. The organs which are the seat of metabolic activity are more complete foods than the supporting and contractile tissues. (1).

Watson (1) (1906) found that rats fed on an exclusive diet of horse and beef muscles died young, and older ones were inferior in their ability to produce and rear young.

Osborne and Mendel (1) (1917-1918) showed that beef muscle is very deficient in vitamin A, B, and C. Meat extracts were also deficient in these respects.

They found (8) (1917) that a diet containing 20 percent dried ox muscle as the sole source of vitamins and proteins, and otherwise adequate, did not induce growth in young rats. Extracts of fresh beef gave the same results.

Cole (9) (1917) fed a dried meat powder prepared from lean meat of South American cattle to young rats, the meat amounting to 26.8 percent of the ration, and the sole source of vitamins and proteins. The rats made satisfactory growth during a fourteen day period and the author concludes that the product contains a good supply of the accessory food factors.

McCollum, Simmonds, and Parsons (10) (1921) investigated the nutritive value of ox muscle when fed to white rats in two lots. Twenty-five percent of dried raw muscle was fed in one lot, and twenty-five percent of cooked muscle was fed in the other. In both lots growth ceased at the end of about four weeks.

McCollum and Davis (1) (1915) examined the more liquid portion of beef fat and found it to contain vitamin A, whereas, the unfractionated, or remaining fat was very poor in it.

Drummond (1) (1921) confirms the view that vitamin A content of beef fat like that of lard depends on the diet of the animal.

McCollum and Simmonds give a summary of the work of several investigators in determining the properties of vitamin A. Certain of these experiments are summarized in the following pages.

McCollum and Davis (1) (1914), from work with eggs and butter reported that vitamin A is fairly stable at high temperatures, and also show that vitamin A is able to withstand saponification in aqueous solutions. Steenbock and Sell and Buell have seince found that vitamin A resists saponification in the cold by alcoholic potash.

Osborne and Mendel (1) (1915) stated that vitamin A will resist a 96 degree centigrade temperature for many hours, and is therefore stable at high temperatures. Steenbock, Boutwell and Kent (1918) stated that vitamin A is destroyed by 100 degrees centigrade for four hours, and is not stable to high temperatures.

The explanation of the difference of these works is afforded by Hopkins (1) (1920). This work shows that vitamin A is stable at high temperatures in the absence of oxygen, but not in the presence of oxygen.

Euler (1) (1922) used several preparations, in different combinations, in experiments with mice and obtained results which are interpreted as indicating that several different compounds of vitamin A are concerned with growth activity.

Steenbock (1) (1919) called attention to the fact that among the vegetable foods, the distribution of vitamin A appeared to be associated in a remarkable way with yellow pigmentation. Drummond (1919) sought to determine whether vitamin A is one of the yellow pigments of plants by bringing rats into a vitamin A deficiency and then feeding them pure and impure preparations of pigment carotin. The results indicated that carotin is not identical with vitamin A. Palmer (1914) observed that cottonseed oil is rich in carotinoids but is devoid of vitamin A. He also showed that the blood of certain amimals such as sheep and swine is free from carotinoids. This would seem to preclude the entrance of vitamin A into the tissues of these animals if it were one of the pigments.

Palmer and Kempster (1) (1919) showed that chickens may be hatched, grown and reproduced on a diet free from carotinoids, and be normal except for the absence of pigment in shanks, beaks and other parts.

Stephenson (1) (1920) stated that an impure preparation of carotin, which did not behave like a source of vitamin A when fed as such, acquired the properties of this substance when dissolved in palm-kernel oil previously tested and found ineffective for the stimulation of growth. This observation, if substantiated, would seem to indicate that vitamin A may not be absorbable and utilized unless it is carried by at least small amounts of fats. Stephenson reported also that butterfat can be decolorized of its yellow pigment by absorbing the carotin with charcoal without imparing its value in vitamin A.

Steenbock and Boutwell (1) (1920) had earlier stated that this vitamin is not carotin. In several later papers Steenbock presented data showing the remarkable association of this substance with the yellow pigment of plants.

Palmer and Kennedy (1) (1921) finally disposed of the question by showing there is no correlation between pigmentation of certain foods and their content of vitamin A. They succeeded in demonstrating that approximately a normal growth and reproduction can be secured in the rat, on rations free from carotinoids but rich in vitamin A. They also pointed out certain numerical relations between the carotin content and vitamin A efficiency of various foods. These varied within wide limits. Two diets were used, one containing about twenty-two hundred times as much pigment as the other. Both were found to contain practically the same amounts of vitamin A.

Ghose (1922) found vitamin A in buffalo "ghee" which is pure white. This agrees with observations of Drummond and Coward (11) (1920) who studied "the nutritive value of animal and vegetable oils and fats considered in relation to their color." They tested twenty-four samples of fats and oils, including beef fat, which were pigmented in varying degrees, and found no relation between vitamin content and color. They concluded that unless we assume the existence of a leuco form it does not appear that the vitamin A is a member of the lipochrome group of pigments. They believe the association of vitamin A with yellow pigment is accidental.

From these results it appears that further attempts to establish a relationship between yellow pigment and vitamin A are futile.

Hawk and Bergheim (12), in a discussion of the sources of the vitamins, give cod liver oil as the outstanding source of vitamin A. Other important sources are butter, cream, milk, eggs, spinach, carrots, lettuce and alfalfa. It has been clearly shown in the case of butter, cream and milk that their vitamin content depends on the diet of the cow. The leading source of vitamin B is yeast. Other sources are lettuse, prunes, spinach, beans, cabbage, milk, potato and the whole grains of the cereals. Vitamin C is derived chiefly from fresh fruits and vegetables; orange juice, tomatoes, cabbage, peas, lettuce, pineapple, raspberry and spinach. Vitamin D is found in milk, butter, eggs, lettuce, dandelion greens and bread made with milk. The chief sources of vitamin E are wheat germ and lettuce. Also, alfalfa, oats, corn, cottonseed oil, olive oil, peanut oil. The P-P factor is found in lean meat, milk, leafy vegetables, lettuce and yeast.

The following table adapted from Hawk and Bergheim (12) gives an indication of the distribution of the six vitamins in the feeds in which we are primarily interested in connection with this experiment:

Feed	Vitamin A	Vitamin B	Vitamin C	Vitamin D	Vitamin E	Vitamin P-P
Alfalfa	# # #	# #	X		#	
Corn (yellow)	#	# #	-	?	#	
Barley (whole)	#	# #	-	X	#[1]	
Cottonseed oil	?	-	-	?	#	
Meats	- to #	#	?	?	#	# #[2]
Margarin (animal fat)	- to #	-	-			

Excellent source of the vitamin

Good source of the vitamin

Vitamin present in a fair amount

- No appreciable amount of vitamin present

X Evidence lacking or insufficient

? Doubt as to presence or relative amount of vitamin

1 Present in sprouted barley

2 Fresh lean beef

H. C. Sherman (13) gives a table showing approximations to vitamin A content of foods. He gives aproximately two hundred and fifty units of vitamin A per pound in clear, raw, lean beef, and twenty-five hundred units per pound in beef fat. From a study in quantitive experiments upon vitamin B content of foods he gives about one hundred and sixty units of vitamin B per pound of clear, raw, lean beef.

Attempts have been made to isolate vitamin A, but as yet none have been successful. Takahashi in Japan (12) claims to have secured vitamin A in pure form and to have shown it to be an alcohol closely related to cholesterol. He calls it "biostearin," and claims that the presence of 0.0001 percent of this substance in the diet maintains the health and growth in the rat.

Following this general summary of earlier work done on the vitamins, especially vitamin A, and with some reference to the sources of the vitamins, properties of vitamin A, and relative amounts in certain feeds, is a more complete summary of work done by investigators in recent years. Being more directly interested in vitamin A, the former discussion was taken up first.

From a study of the nutritive value of animal and vegetable oils and fats considered in relation to their color, Drummond and Coward (11) (1920) concluded that no hard and fast line can be drawn between the animal and vegetable oils and fats when their value as a source of vitamin A is being considered.

Taken as a class the animal fats possess a growth promoting power superior to that of the vegetable oils, but one or two members of the later class (e. g. palm oil) may show considerable activity in that respect.

Unless we assume the existence of a leuco-form, it does not appear probable that the fat-soluble vitamin is a member of the lipochrome class of pigments. The frequent association of the growth factor with pigments of that type must therefore be regarded as accidental.

The nutritive value of an animal oil or fat would appear to be influenced considerably by the diet of the animal. (11). One preliminary experiment shows that the winter rations of cows may have the effect of lowering the food value of the milk unless considerable care is exercised in the selection of the animal's diet.

The nutritive value of both animal and vegetable oils and fats is probably influenced by the processes of preparation and refining which they may undergo.

Probably the most extensive work with the fat-soluble vitamin in beef has been done by Steenbock, Sell, and Buell. A study of "the fat-soluble vitamin and yellow pigmentation on animal fats with some observations on its stability to saponification" (14) was carried on during two years, 1919 to 1920. During work prior to 1919 with the oleo oils from beef fat, prepared in commerce for the manufacture of oleomargarine, they found that this substance, in some instances, was richer in vitamin A than many butters. They also became aware of the fact that the vitamin content seemed to vary directly with the intensity of pigmentation. This lead to the collection of additional data to determine whether this was a mere coincidence, or commonly true.

During 1919 the experiments were confined to an investigation of the perinethric fat of animals of the Jersey, Durham and Holstein breeds. A basal ration of casein 18, agar 2, wheat germ 6, salts (No. 32) 4, dextrin 70 was used. Results showed the Jersey fat to be very active, while the Durham fat gave no evidence of containing this vitamin. The same inactivity was shown by the Holstein fat. Both the Holstein and Durham fat were practically colorless; the Jersey fat, on the other hand, was fully as pigmented as a sample of June butter.

In 1920 these experiments were duplicated except that the samples were not taken from any particular breed but were selected promiscuously from slaughtered animals for color and intensity. The dark beef fat was fully equal in color to June butter, the medium beef fat was two-thirds as colored, and the light beef fat was only one-tenth as colored. The rats were fed a basal ration of white corn 40, casein 14, salts (No. 32) 3, salts (No. 35) 1, fat 5, dextrin 37. The results obtained were essentially of the same character as those obtained the year before - the fat-soluble vitamin content was roughly parallel to the pigmentation. In view of results with butterfat, it is not to be concluded that this is necessarily always the case. The rapidity of fat deposition, its mobilization, and the variation in the assimilation of pigment with different breeds and individuals, no doubt all operate to modify the primary determinative effect of the composition of the ration.

From the results of these experiments, Steenbock, Sell and Buell conclude that in beef fat the fat-soluble vitamin content does not run closely parallel to the yellow pigment; yet, in general, beef fat samples most highly pigmented are usually richest in their fat-soluble content.

From experiments carried on at the same time, Steenbock and co-workers found that the fat-soluble vitamin withstands severe methods of saponification. This indicates that it is not a fat and probably not an ester and makes possible the compounding of satisfactory fat-free synthetic rations for investigative purposes.

Hoagland and Snider (15) (1925) carried on experiments with vitamin A in beef, pork and lamb. In their work with vitamin A in beef, five lots of purified ox muscle were tested to determine their freedom from vitamin A. Eight groups of rats were used in the experiment, and most of them developed opthalmia. The experiment was usually discontinued a short time after the rats ceased to gain in weight, even tho opthalmia was not evident. As much as thirty percent beef in the ration failed to furnish enough vitamin A for normal growth. From fifty to ninety-five percent of beef in the ration furnished sufficient vitamin A for a normal growth in some cases, but not quite normal in others. The two groups that made some growth probably received a slight amount of vitamin A in the purified ox muscle fed to them. The slight growth obtained in the other three groups was probably due to the reserve store of vitamin A in the tissues of the young rats. Groups seven and eight, receiving fifty and ninety-five percent ox muscle respectively, made almost normal growth.

McCampbell, (16) Kansas Agricultural College, Manhattan, Kansas, published an article on "Color of Grass Fed Beef" in the Producer, May, 1927. In this article McCampbell discusses the question "To what extent is the belief that beef from grass-fattened animals is objectionably dark in color based on fact?"

A carload of steers from a range herd of well bred four-year-old steers, grazed during the summer of 1926 on bluestem grass near Manhattan, Kansas, was bought by the College and divided into three groups. These groups were fed on bluestem grass, corn and bluestem grass, and cottonseed cake and bluestem grass. When these steers were slaughtered it was found first, that none of the meat was objectionably dark, and second, that both lean and fat from animals of the three groups was almost exactly alike. The beef from steers short-fed on grass was somewhat firmer and a little less dry than the straight grass-fed beef. These tests proved the meat from steers fattened on straight grass to be "wholesome, nutritious, moderately tender, of good flavor, and fairly juicy". How far the dry weather of the 1926 season tended to influence the results is considered problematical.

From these tests, McCampbell draws the conclusion that "there could have been no serious objections to the color of the beef from cattle fattened on Kansas bluestem grass during the summer of 1926." He says that "the matter of size of cuts of grass-fattened aged steers is a more serious handicap to the sale of this class of beef than any other."

Richardson and Jacobs (17) (1929) carried on experiments to determine how "method of feeding affects quality and palatability of beef." Results obtained show that roasts cooked from beef fattened with either full feed of barley and alfalfa hay, or with fifty percent as much barley with alfalfa hay, were fine in texture, tender, juicy, rich, and had a desirable flavor and aroma. Roasts from beef fattened on alfalfa hay alone were coarse, tought, dry, lacking in richness, and somewhat lacking in flavor and aroma.

W. C. Powick (18) conducted three series of experiments (1925) to determine the inactivation of vitamin A by rancid fat. A comparison of the nutritive value of sweet and rancid fat was made. As far as could be judged by the limited number of experimental animals, the rancid lard proved inferior to the sweet lard chiefly thru causing the destruction of the vitamin A. Both sweet and rancid lard were fed mixed with egg yolk as the source of vitamin A, also the egg yolk was fed separate from the lard. When the rancid lard was mixed with the egg yolk, normal growth soon ceased. In the other cases growth was normal. The results suggested that the destruction of vitamin A by rancid fat is a gradual process. This is attributed to the oxidation of the vitamin by the organic peroxides of the rancid lard.

Steenbock, Boutwell and Kent (19) (1918) carried on experiments with "vitamins in oleo oils prepared from beef fats." They found that rats fed on a basal ration with five grams of oleo oil (beef) made slightly better gains than another group fed on basal ration with five grams of butterfat. In general, however, oleomargarines, on account of vitamin-poor fats used and methods of manufacture and storage, are not to be considered in the same class with good butterfat. Prime oleo oil was found to be inferior to "extra" and ungraded samples.

Hoagland and Snider (20) (1926) reported the results of a study of the vitamin A content of twenty-four samples of oleo oil, and eight samples of oleo stearin, collected from commercial meat packing plants in New York, Chicago, Kansas City, Denver and St. Paul.

In general, it was found that the yellow oleo oil was much the richest in vitamin A; that the number 2 and number 3 (medium yellow), and mutton (white) oleo oil had approximately the same value; and that the number 1 (white) oleo oil was the poorest in vitamin A.

In the oleo stearin each sample of yellow stearin was richer in vitamin A than the other grades, comparing with some samples of the number 1 oleo oil.

Although the yellow oleo oil was found to be richer in vitamin A than the other grades of oil, there appeared to be no constant relation between the color of an oil and its vitamin content. The mutton oleo oil, dead white in color, was approximately as rich as the medium yellow number 2 and number 3 oleo oils.

As compared with other commercial food fats and oils oleo ranks below butter but ahead of lard and the vegetable fats and oils as a source of vitamin A.

Earlier investigations by Osborne and Mendel (21)

(1915) showed that eighteen percent of beef fat, rendered in the laboratory, furnished nearly sufficient vitamin A for normal growth in rats. Beef oil, prepared by fractional crystalization of beef fat from alcohol, was found to be rich in vitamin A, but the crystaline fractions with high melting points proved to be inactive.

Halliburton and Drummond (22) found that a ration containing twenty percent of oleo oil was inadequate for normal growth in rats.

A short summary of some work done on the antineuritic properties of beef give us some indication of the vitamin B content of beef.

Cooper (23) (1912) appears to have been the first to study systematically the antineuritic properties of beef muscle. Five lots of pigeons were fed daily 2, 4, 6, 10 and 20 grams each for 50 days. Twenty grams of beef daily caused a slight increased in weight; but less than 20 grams was only sufficient to delay polyneuritis or to reduce its severity.

Hoagland (24) (1923), studied the vitamin B content of the voluntary muscle of the ox, sheep and hog. In studies with beef healthy mature pigeons of the homer type were used. Samples of both beef and veal, taken from different parts of the carcass, were fed in amounts varying from fifteen to twenty-five percent of the ration. There was very little difference in the average survival period of all pigeons fed on beef and veal. The average period was from twenty-six to twenty-eight days.

Damon (1) (1922) found that commercial beef extract did not contain vitamin B.

Hoagland (1) (1923) states that lean pork is rich in vitamin B. He says it compares favorably with the vitamin content of liver and kidney. Beef, he says, contains less vitamin B than pork, and mutton stands between these.

Wright (1) (1925) from a study of fresh beef, lard, pork and mutton, beef stored two years, lamb stored three years, and pork stored nine years were all comparable in their content of vitamin B. He concludes that storage of meat is without effect on the vitamin B content.

These experiments, with little variation in the general results, all seem to indicate that beef is a rather poor source of vitamin B.

In regard to the antiscorbutic vitamin there seems to be a wide variation of opinion. However, the majority of the experiments, especially those completed in recent years, indicate that beef is not a good source of vitamin C.

Stefansson (25) in observing three cases of scurvy on his polar expedition states that meat, and especially raw meat, prevented and cured scurvy.

This is not in agreement with the work of Click, Hume, and Shelton or Pitz (25) for the former were unable to prevent the onset of the disease (in guinea pigs) by the administration of meat juice while the latter made the same observation except that the administration of dry meat to the oats-milk diet delayed the onset of symptoms.

W. H. Wilcox (26) (1920) published a general report of a special study of scurvy and beriberi from their clinical aspects and from the point of view of prevention and treatment, the study being made from May, 1916, to January, 1919 during the Mesopotamia Campaign.

The report discusses first the rations of the Indian troops as the greatest incidence of scurvy and of the later rations of both Indian and British troops, showing the means taken to correct the deficiency, in the former, of antiscorbutic factors, and in the latter of the antiberiberi factors.

The striking value of raw meat juice as an antiscorbutic is noted. "It was owing to the adequate supply of fresh vegetables, fruit, and fresh meat that deficiency deseases were stamped out from the Mesopotamia Expeditionary Forces after March, 1917."

Ducher, Pierson and Beister (25) (1919) in a preliminary report on the antiscorbutic properties of raw, lean beef state that their work indicates, quite conclusively, that raw, lean beef does not possess antiscorbutic properties, so far as those properties can be tested by observations on guinea pigs.

A report of the completed experiment (27) (1920) confirmed the preliminary report. Guinea pigs were fed diets of oats, water, and an amount of milk sufficient to improve the diet but insufficient to prevent scurvy. These animals developed scurvy and died. When water extracts of raw lean beef were fed representing 5, 10, 15 and 20 grams of raw beef no difference could be noticed in the time of the onset of scurvy or in the length of life in the experimental animal. By feeding chopped meat with dry rolled oats it was shown that scurvy would develop in practically the same time as when the meat extract was fed. The excellent condition of animals on an orange juice-beef extract diet showed conclusively that the poor condition of the animals on the beef extract was due to the absence of the antiscorbutic vitamin rather than to any injurious property of the beef extract.

Rouse and MacLeod (28) (1928) tested fresh lean beef as a supplement to white bread. Rats on bread and meat diet were given bread ad libitum and five grams a day of fresh lean beef. They did not eat more than half the meat, and the amount was cut down. The animals grew quite well from three to five weeks, then usually remained stationary for two or three months, after which they declined gradually or grew very slowly.

This experiment showed beef to be deficient in vitamin B as all the animals presented marked evidence of acute rickets. In the whole period only about one-eight normal growth was obtained.

Goldberger, Wheeler, Lillie, Rogers (29) carried out a test to determine the preventative properties of beef in connection with pellagra. This test was carried out at the Georgia State Sanitarium over a period of one year, beginning December 17, 1924 and ending December 31, 1925. Twenty-four patients were treated for a period of ten to twelve months. The complete absence of any indication, or a recurrence of pellagra would seem to be conclusive evidence of the preventative action of the fresh lean beef.

Tho the beef prevented pellagra, the diet was evidently slightly deficient in the beriberi vitamin as five patients developed a slight evidence of this disease.

Lamb and Evvard (30) (1922) published a bulletin called "Vitamins On the Farm - Their Practical Relation to Livestock Raising" which gives some valuable points to be remembered about vitamins in practical farm feeding.

Vitamins are necessary for mature as well as for growing animals, to promote health, vigor and resistance to disease.

Growing animals show the lack of vitamins sooner than mature animals. Reproduction also demands a sufficient supply of vitamins in order to be successful.

The vitamin least widely distributed and most likely to be lacking in vitamin A, the principal known sources of which are butterfat, egg yolk, cod-liver oil, green leaves of plants, and in lesser amounts, certain seeds, for example, yellow corn and soybeans. It is also found in small amounts in the germs of practically all seeds. As far as is now known, it is the one vitamin most likely to be low in ordinary farm rations, especially where good pasture is not supplied.

SUMMER PASTURE EXPERIMENT 1930

The Colorado Agricultural Experiment Station conducted a summer pasture experiment with yearling steers during the summer of 1930. The author assisted in this work, and in this thesis studies the results with a view to determine, in as far as possible, the effect of a high protein content ration vs. a low protein content ration, also, the effect of dry lot vs. pasture on the color of beef.

The decision to conduct this experiment was caused by the results of the 1929 summer pasture experiment. In this experiment five lots of six steers each were fed. One lot received the grain mixture and alfalfa hay in dry lot. Three lots received the grain mixture on pastures, which were sweet clover, alfalfa and Morton's pasture grass mixture respectively. The fifth lot received the grain mixture on pasture, which was Morton's mixture supplemented by linseed oil meal, a high protein content concentrate. When the carcasses were graded in Denver, the carcasses of the steers fed in dry lot were all white; the three lots on pasture with the grain mixture, but no protein supplement, were all yellow; while the lot on pasture with the grain mixture and linseed oil meal showed two white and four yellow carcasses. These results indicated that linseed oil meal, a high protein supplement, in the ration might tend to offset the effect of the pasture, and to whiten the carcass. This indication of the effect of linseed oil meal in the ration lead to the question of whether any other, or all other, high protein content supplements might tend to whiten the carcass. Therefore, both linseed oil meal and cottonseed oil meal were used in the 1930 summer pasture experiment to determine, as far as possible, the effect of these widely used protein supplements.

Treatment of Steers Before Beginning of Experiment

The steer calves to be fattened during the summer pasture experiment were roughed through the winter on warming-up rations for 120 days, December 3, 1929, to April 2, 1930. There were two lots of 20 steers each. Lot 1 received a ration of 1.7 pounds barley, 9.6 pounds beet tops, 14.9 pounds wet beet pulp, .5 pound cottonseed cake and 5.0 pounds alfalfa hay. The steers in this lot made an average daily gain of 1.52 pounds. Lot 2 received a ration of 1.7 pounds ground barley, 9.3 pounds corn silage, 14.9 pounds wet beet pulp, .5 pounds cottonseed cake, 4.6 pounds alfalfa hay. They made an average daily gain of 1.78 pounds.

These steers were allotted on April 1, 1930. The factors of type, condition, breeding, origin, color of coat and weight were considered in the allotment, and were balanced to make the lots as nearly equal as possible for experimental purposes.

This allotment was cancelled becauseheavy rainfall over a period of several days made the pastures soft and boggy, and it was thought inadvisable to put cattle on the pastures while in this condition. The steers were than fed for a period of 32 days, April 2 - May 14, in two lots, 20 steers to each lot. The steers received ground corn, ground barley, cottonseed cake, corn silage, beet tops and alfalfa hay until May 14, 1930. During this 32 day period the grain ration fed to the steers was gradually increased until the steers were receiving a full grain ration when placed on experiment May 14, 1930.

On May 14 the calves were again allotted, this time into seven lots according to type, breeding, condition, origin, color of coat and weight, making the seven lots as nearly equal as possible for the summer pasture experiment to be conducted. After the allotment had been made the steers received the first feed P. M. May 14, 1930, The steers were weighed on May 12, 13 and 14 to obtain the average initial weight, and again every 30 days during the experiment.

Ration Fed

The following rations were fed to the steers on summer pasture experiment 1930:

Grain mixture - equal parts of ground barley and ground corn.

Salt self fed in all lots.

Lot No. 1. Grain mixture, alfalfa hay in dry lot.

Lot No. 2. Grain mixture, cottonseed meal, alfalfa hay in dry lot.

Lot No. 3. Grain mixture, alfalfa pasture.

Lot No. 4. Grain mixture, Morton's pasture

Lot No. 5. Grain mixture, cottonseed meal, Morton's pasture.

Lot No. 6. Grain mixture, linseed oil meal, Morton's pasture.

Lot No. 7. Cottonseed meal, Morton's pasture.

Management of Pastures During Experiment

The experiment was run for a period of 128 days, May 14, 1930, to September 19, 1930. Lots 1 and 2 were in dry lot during the 128-day feeding period. Lots 3, 4, 5 and 6, on pasture during this period, had access to two one acre plots, and lot 7 had access to unlimited pasture on Morton's pasture grass mixture. One acre only was available to each lot for grazing at one time. While the steers were grazing one acre, the other acre was irrigated and allowed to rest. The pastures were irrigated at 14 to 21 day intervals during the feeding period. By this method the steers were kept on practically fresh pasture all the time.

Lot 3 was on alfalfa pasture, while lots 4, 5, 6 and 7 were on Morton's pasture grass mixture. This grass is a mixture of awnless (western) brome grass Bromus inermis), orchard grass (Dactylis glomerata), timothy (Phleum pratense), meadow fescue (Festuca pratensis), and yellow blossom sweet clover (melilotus officinatis). There was, however, very little clover on the pasture in 1930 because most of it had been killed out by mowing in 1929.

Close of Experiment

The summer pasture experiment was closed at noon September 19, 1930, when the steers received the last feed at the regular morning feeding. The steers were weighed September 18, 19 and 20 to obtain the final average feed lot weight.

A summary of the results of the summer pasture experiment, 1930, is presented in Table I.

Table 1

SUMMER FATTENING EXPERIMEN

Colorado Agricultural Experiment Station, Fo lins, Col do

Final Period May 14, 1930 to Sept. 19, - 128 Days
(Table based on one average c

Lot No.	1	2	3	4	5	6	7
No. of steers per lot	6	6	8	6	6	6	2
Ration Fed Grain mix.-equal parts of ground corn and ground barley Salt self-fed in all lots	Grain Mixture Alfalfa Hay	Grain Mixture C.S. Meal Alf. Hay	Grain Mixtu Alfal Pastu	Grain Mixture Morton's Pasture	Grain mix. C.S. meal Morton's Pasture	Grain mix. L.O. meal Morton's Pasture	C.S. Meal Morton's Pasture
Weight at start	641.1	653.1	637.7	653.9	663.6	648.1	638.3
Final Market Weight	862.1	879.8	831.2	836.9	861.3	814.6	792.1
T otal gain at Market	221.0	226.8	193.5	183.0	197.7	166.6	153.8
Daily Gain at Market	1.73	1.77	1.5	1.43	1.54	1.30	1.20
Shrink to Market	2.86	3.55	2.1	2.62	3.59	3.72	3.01
Average Daily Feed							
Ground Corn	5.23	3.99	4.9	5.51	4.11	4.11	
Ground Barley	5.23	3.99	4.9	5.51	4.11	4.11	
Cottonseed Meal		2.83			2.83		5.21
Linseed Oil Meal						2.83	
Alfalfa Hay	6.96	9.84					
Alfalfa Pasture (acres)			.0020				
Morton's Pasture (acres)				.0026	.0026	.0026	unlimited
Salt	.02	.01	.0	.07	.06	.06	.08
Feed required per cwt. mkt. gain							
Ground corn	302.7	225.0	328.1	385.0	266.3	316.2	
Ground Barley	302.7	225.0	328.1	385.0	266.3	316.2	
Cottonseed Meal		159.6			183.5		433.4
Linseed Oil Meal						217.5	
Alfalfa Hay	402.9	555.6					
Alfalfa Pasture (acres)			.1				
Morton's Pasture (acres)				.18	.17	.20	unlimited
Salt	1.2	.3	4.0	4.9	3.9	4.7	6.4
Feed Cost per cwt. mkt. gain	11.51	14.24	11.	13.66	14.75	18.35	11.33*
Cost per Steer at Feedlot @$12.00 CWT.	76.93	78.37	76.	78.47	79.63	77.77	76.60
T otal cost of feed	25.44	32.29	22.0	25.00	29.15	30.57	17.42*
Est. fixed costs	7.16	7.40	7.0	7.19	7.34	7.33	6.92
Selling Expense	3.13	3.23	3.0	3.09	3.19	2.99	2.87
Total cost at market	112.66	121.29	108.	113.75	119.31	118.66	103.81
Selling price cwt.	11.75	11.75	11.	11.35	11.56	11.75	10.50
Gross return	101.30	103.38	94.0	94.99	99.56	95.72	83.17
Loss per steer	11.36	17.91	14.	18.76	19.75	22.94	20.64**

Feed costs: Ground corn $33.00 Ton; Ground barley 27.00 Ton; Cottonseed Meal 52.00 Ton; Linsee Meal $60.00 Ton; Alfal 12.00 Ton; Alfal ure 11 51 Acre; Morton's Pasture 11.51; Salt 18.00 Ton

*These costs do not include the unlimited amount of pasture availa steers in Lot 7

**This loss does not include unlimited pasture received by Lot 7.

DISCUSSION OF RESULTS

Only two steers were fed in lot 7, and were put into the experiment only to obtain a lead with regard as to the effect on color of beef of cottonseed meal fed as a sole concentrate on pasture. Lot 7 should not be compared with the other lots as to rate of gains, economy of gains or loss per head. The cost per hundred weight of gains and the loss per head, shown in Table I for lot 7, are not accurate because these figures do not include the cost of the unlimited pasture available to the steers in lot 7.

The results of the summer pasture experiment 1930, Table I, are based on market gains. The largest total gain, 226.8 pounds, and largest average daily gain, 1.77 pounds, was produced on the grain mixture, cottonseed meal and alfalfa hay fed in dry lot by lot 2. These gains were only slightly larger than the gains made by lot 1, fed the grain mixture and alfalfa hay in dry lot, but were considerably more expensive, costing $14.24 per hundred weight. The steers in lot 1 made a total gain of 221.0 pounds during the 128-day feeding period, an average daily gain of 1.73 pounds, at a cost of $11.51 per hundred weight. This was the second largest and second cheapest gain in the experiment. When the steers were sold they showed the smallest loss per head, $11.36. The steers in lots 1, 2 and 6 sold for the highest average price per hundred weight, $11.75.

Lot 3, receiving the grain mixture on alfalfa pasture, made the cheapest gains and the fourth largest gains made in the experiment. These steers gained a total of 193.5 pounds, or 1.51 pounds per day, at a cost of $11.39 per hundred weight. When marketed they showed a loss of $14.63 per head. The loss per head was larger than than of lot 1 because three steers in this lot sold as cut outs,[1] lowering the average selling price per hundred weight for this lot. These steers showed the least shrink to market, 2.16 percent.

The grain mixture on Morton's pasture, fed in lot 4, produced a total gain of 183.0 pounds, or 1.43 pounds daily gain at a cost of $13.66 per hundred weight, but lost $18.76 per hundred weight when marketed. This was the third cheapest gain and the lot ranked fourth from the standpoint of least loss per head. Two steers from this lot sold as cut outs.

Adding cottonseed meal to the grain mixture on Morton's pasture, in lot 5, increased the gain 1.54 pounds per day, the third largest gain. It also in-

1. When a number of cattle are marketed they are usually sold for a stated price per hundred weight with a few head of the least desirable cut out and sold at a lower price per hundred weight. When the summer pasture steers were sold they brought $11.75 per hundred weight with eight head cut out and sold for $10.50 per hundred weight. These steers are call "outs" or "cut outs."

creased the feed cost per hundred weight to $14.75. When the steers were sold they showed a loss of $19.75 per head, one steer selling as a cut out.

Lot 6, fed the grain mixture and linseed oil meal on Morton's pasture grass mixture, made the lowest gain in the experiment, 1.30 pounds per day. These gains cost the most per hundred weight, $18.35, and the steers lost $22.94 per head when marketed, the largest loss per head. This lot also showed the largest shrink to market, 3.72 percent.

Cottonseed meal alone on Morton's mixture, fed to lot 7, showed a feed cost per hundred weight gain of $11.33. However, this cost is not accurate because it does not include the unlimited amount of pasture available to these steers. Lot 7 showed the smallest gain 1.20 pounds per day, or 153.8 pounds total market gain, and when the steers were sold they showed the greatest loss per head, when the unlimited pasture to these steers was considered. These steers were extremely nervous in temperament, and were sold as cut outs, showing that cottonseed meal alone on pasture is not a satisfactory ration, either from the standpoint of rate of gains, or economy of gains.

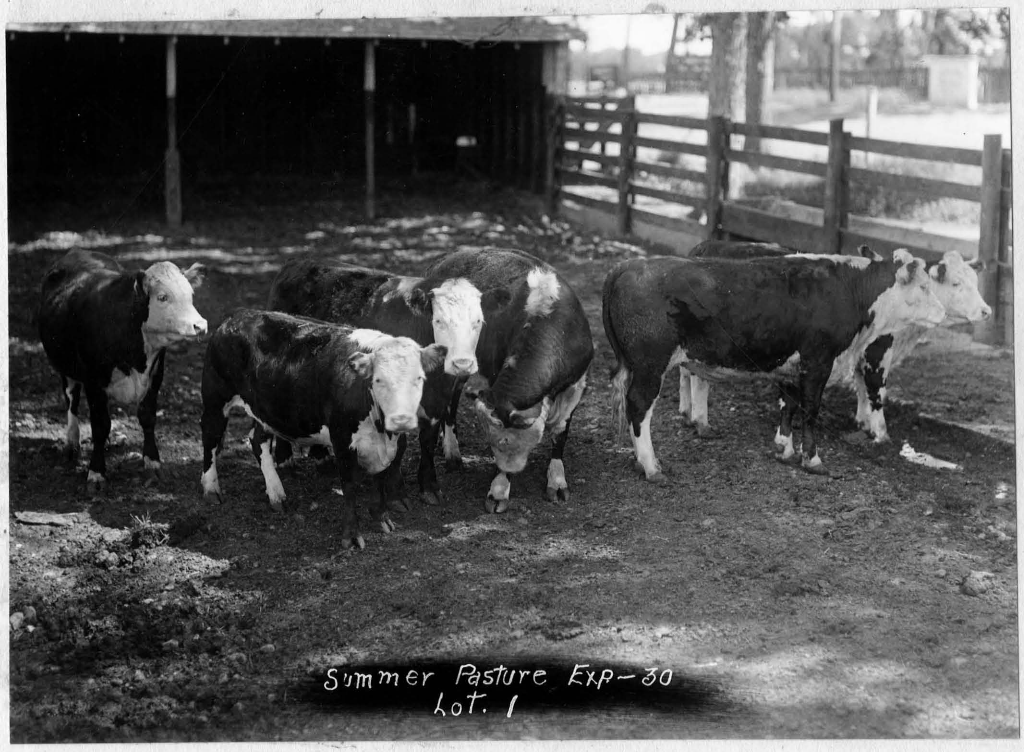
These results, based on market gains, show that dry lot, both with and without a high protein supplement, is superior to pasture from the standpoint of rate of gains when the steers have been carried through the winter on a warming-up ration and prepared to start the experiment on a full grain ration. The grain mixture, cottonseed meal and alfalfa hay in dry lot, lot 2, produced the largest gains, but was considerably more expensive than the grain mixture and alfalfa hay in dry lot 1. Lot 1 made very satisfactory gains, from the standpoint of rate and economy of gains. The steers in this lot all sold as tops and made the smallest loss per head.

The grain mixture on alfalfa pasture, lot 3, produced the cheapest gains and made the second smallest loss per head, but was not so satisfactory when rate of gain and selling price per hundred weight was considered.

Both lots 3 and 4, receiving the grain mixture on alfalfa pasture and on Morton's pasture respectively, but receiving no protein supplement, made cheaper gains than lots 5 and 6, receiving the grain mixture with a high protein supplement on Morton's pasture. Lots 3 and 4 showed larger gains than lot 6, receiving the grain mixture and linseed oil meal on Morton's pasture, but smaller gains than lot 5, receiving the grain mixture and cottonseed meal on Morton's pasture.

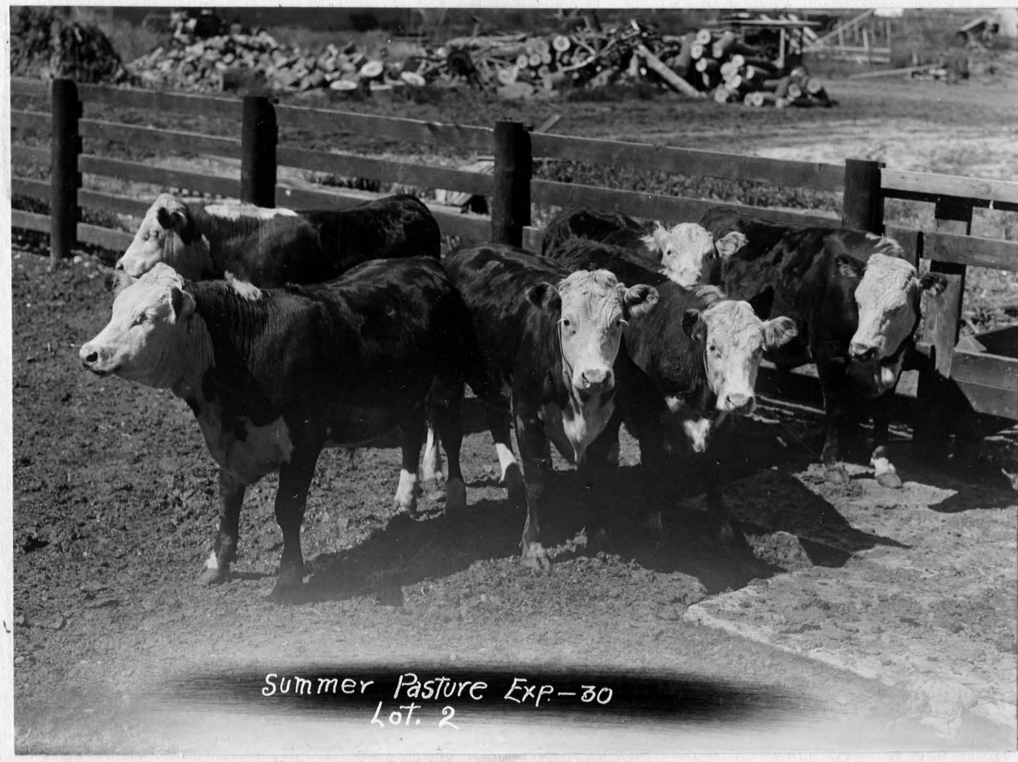
The grain mixture and linseed oil meal on Morton's pasture was unsatisfactory from the standpoint of rate and economy of gains, but the steers sold for the same price per hundred weight, $11.75, as the steers fed in dry lot.

Cottonseed meal alone on Morton's pasture was the least satisfactory ration fed in the experiment, from the standpoint of rate of gains, selling price per hundred weight and loss per head when the unlimited pasture available to them is considered.



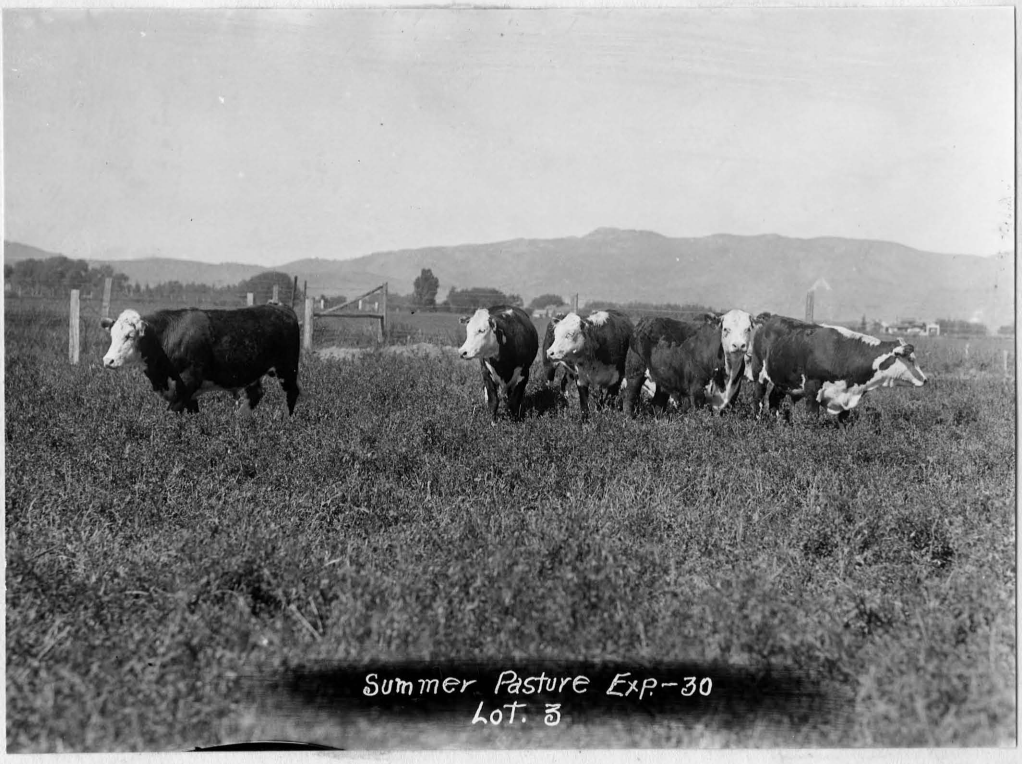
Lot No. 1. Grain mixture alfalfa hay in dry lot.

Average slaughter steer grade U.S.D.A. 84.68



Lot No. 2. Grain mixture, cottonseed meal, alfalfa hay in dry lot.

Average slaughter steer grade U.S.D.A. 85.65

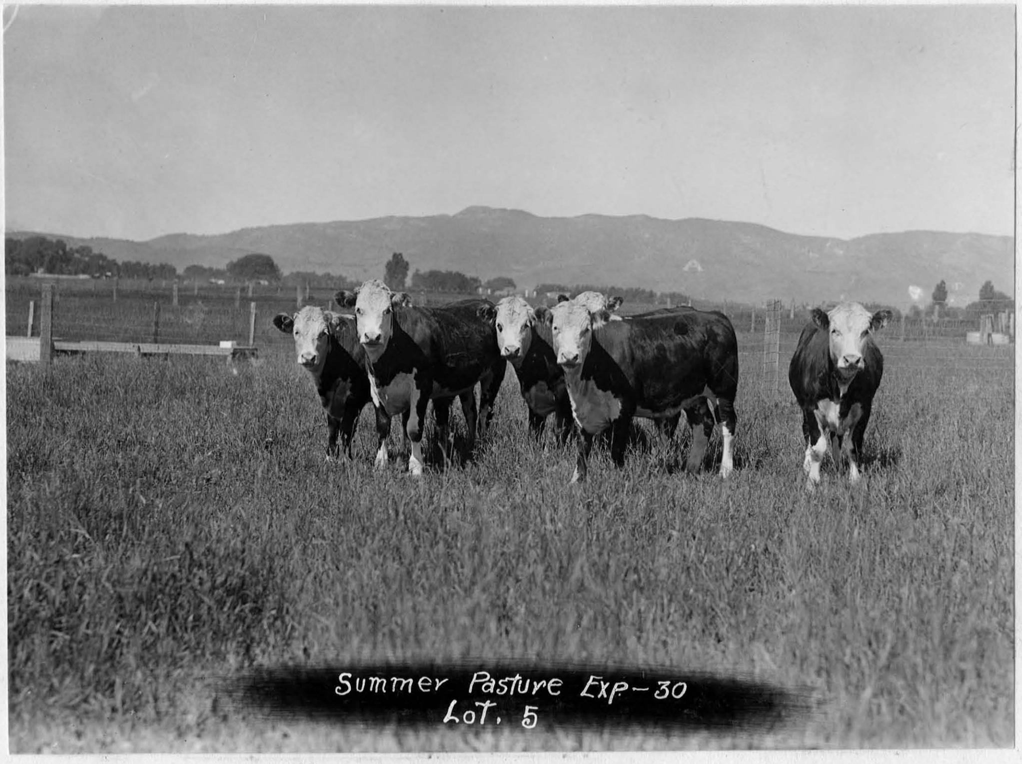


Lot No. 3. Grain mixture, alfalfa pasture.

Average slaughter steer grade U.S.D.A. 78.27

Lot No. 4. Grain mixture, Morton's pasture.

Average slaughter steer grade U.S.D.A. 79.93



Lot No. 5. Grain mixture, cottonseed meal, Morton's pasture.

Average slaughter steer grade U.S.D.A. 82.93

Lot No. 6. Grain mixture, linseed oil meal, Morton's pasture.

Average slaughter steer grade U.S.D.A. 81.61

Lot No. 7. Cottonseed meal alone on Morton's pasture.

Average slaughter steer grade U.S.D.A. 72.57

TREATMENT OF STEERS FROM CLOSE OF EXPERIMENT UNTIL SHIPPING

After the close of the experiment, September 19, 1930, lots 3 to 7 inclusive were taken off pasture and placed in dry lot for 12 days until the steers were shipped, September 30, 1930. The rations remained the same during this 12 day period for all lots except lots 3 to 7 inclusive. These lots received alfalfa hay instead of pasture.

SLAUGHTER STEER GRADING

On September 29, the day before the steers were shipped, they were graded as slaughter steers by L. B. Burk and D. J. Slater, United States Department of Agriculture, and H. B. Osland, Colorado Agricultural College. The grading charts were interpreted by the writer, and these figures sent to the Department of Animal Industry, Washington, D. C., where the average slaughter cattle grades were calculated. These grades are presented in Table III.

SHIPPING AND SALUGHTER OF STEERS

The steers were fed the last grain feed in the morning September 30, 1930. Those having indistinct brands were branded with white paint soaked into waste wool. This method was a success, saving much trouble when the brands were read in Denver. After noon the steers were driven three miles to the loading point, and loaded on the cars at 4 P. M., September 30. The cars were bedded with four bales of straw each. Departure was made immediately after loading, and the steers arrived in Denver after a direct run of about eight hours.

Swift and Company bought the steers October 1, 1930. They were in good shape and had an excellent fill. Fed was withheld for 24 hours before slaughtering, and the steers were killed and hung in the cooler October 2, 1930. E. J. Maynard, H. B. Osland, L. B. Burk, and the writer read brands and marked the number or brand of the steer on each front shank bone, and on ribs of each half carcass with indelible pencil. By this method of marking, the carcasses were easily identified the next day when color readings and carcass grades were taken.

CARCASS GRADING AND COLOR READINGS.

The carcasses were graded and color readings made in the cooler October 3, 1930. A. A. Anderson, of Swift and Company, made an ocular color reading of both fat and lean, and also graded the carcasses and stamped them with the packer grade. All the carcasses were to be packed as "Swift Select." E. J. Maynard, Colorado Agricultural College, and Clyde Hinderlider, Swift and Company, made color readings on the carcasses with a color reading machine. L. B. Burk, D. J. Slater, United States Department of Agriculture, and the writer prepared carcass grading charts. These charts were later interpreted by the writer and the interpretations sent to the Department of Animal Industry, Washington, D. C., where the average carcass grade was calculated. The carcass grades are presented in Table III, and the color readings are presented in Table IV.

Table 111

SLAUGHTER STEER AND CARCASS

Slaughter Steer Grades, Fort Collins. 29, 1930

Carcass Grades, Denver, Oct930

	1	2	3			6	7
Ration Fed	Grain Mix. Alfalfa	Grain Mix. Cs. meal Alfalfa	Grain Mix. Alfalfa Pasture	G r. Mor Past	Grain Mix. Cs. meal Morton's Pasture	Grain Mix. L. O. meal Morton's Pasture	Cs. Meal Morton's Pasture
Slaughter Steer Grade U.S.D.A.	82.38 83.27 83.10 89.36 81.46 88.49	86.57 87.22 88.00 88.00 81.84 80.29	71.05 69.80 76.81 84.00 77.96 81.34 79.36 85.81	79 84 75 85 83 71	81.35 74.69 85.40 84.45 84.85 86.81	81.03 83.59 83.67 84.73 79.20 77.42	71.11 74.02
Average	84.68	85.65	78.27	79	82.93	81.61	72.57
Carcass Grade U.S.D.A.	85.73 77.85 84.36 85.08 80.13 85.52	85.21 81.66 83.01 83.58 78.89 70.39	69.72 75.58 72.76 77.36 83.48 71.55 76.49 81.82	71 78 70 83 73 71	78.92 69.45 81.93 81.07 79.20 80.05	81.68 78.43 75.74 79.27 74.19 70.39	67.48 72.73
Average	83.11	80.46	76.10	74	78.44	76.62	70.11
Carcass Grade Packer	Choice Med. A Med. A Good Med. A Choice	Good Med. A Choice Good Med. A Med. B	Med. B Med. A Med. A Med. A Good Med. B Med. A Med. A	Med. Med. Med. Good Med. Med.	Med. A Med. B Good Med. A Med. A Med. A	Med. A Med. A Med. A Med. A Med. A Med. B	Med. B Med. B
Average	Good	Good	Med. A	Med.	Med. A	Med. A	Med. B
Numerical Average	12.2	12.5	13.1	13	13.0	13.2	14.0

DISCUSSION OF TABLE III

Slaughter steer grade, U. S. D. A., and carcass grade, U. S. D. A., and carcass grade, Packer, show a very close relationship. They give a good indication of the effects of the different rations fed on the grade of the steer and of the carcass.

The packer grades, Table III, are in divisions, and the averages of these grades are not as finely divided as the U. S. D. A. slaughter steer grades, figured in percent. Therefore, the writer placed the numerical average of the carcass grades, packer, of each lot in Table III to show more clearly the differences in the average carcass grades, packer. These numerical averages are taken from Table II. Both the slaughter steer grades and the carcass grades, U. S. D. A., and the carcass grades, packer, indicate that dry lots, lots 1 and 2 are superior to pasture for finishing warmed-up cattle for market; and that the grain mixture on pasture without a high protein supplement, lots 3 and 4, or the grain mixture on pasture with a high protein supplement, lots 5 and 6, is better than cottonseed meal alone on Morton's pasture, lot 7. Comparison of the grades of lot 7 with the grades of the other lots show that this is an unsatisfactory ration from the standpoint of the effect of the ration on both slaughter steer grade and grade of carcass.

Lots 1 and 2 fed the grain mixture and alfalfa hay, and the grain mixture, cottonseed meal and alfalfa hay respectively, in dry lot, grade higher than the pasture lots, showing that dry lot may be expected to produce a better and a more desirable carcass than pasture. Lot 2, receiving a high protein concentrate, graded slightly higher as slaughter steers than lot 1, not receiving high protein supplement. However, when the carcasses were graded, both the U.S.D.A. and packer grades showed lot 1 to be the best carcasses in the experiment.

The grain mixture on Morton's pasture with either cottonseed meal, lot 5, or linseed oil meal, lot 6, produced better slaughter steers and more desirable carcasses, U. S. D. A. grades, than the grain mixture on either alfalfa pasture, lot 3, or Morton's pasture, lot 4, without a high protein supplement.

A comparison of lots 5 and 6 shows cottonseed meal to be superior to linseed oil meal as a high protein concentrate, when fed with the grain mixture on Morton's pasture, from the standpoint of slaughter steer grade and quality of carcass.

Both slaughter steer grades, U. S. D. A., and carcass grades, packer, show that the grain mixture on Morton's pasture, lot 4, is superior to the grain mixture on alfalfa pasture. Though the carcass grade

U. S. D. A., for lot 3 is higher than for lot 4, both slaughter steer grades, U. S. D. A., and carcass grades, packer, being high for lot 4 indicates that Morton's pasture is superior to alfalfa pasture as a pasture crop from the standpoint of slaughter steer and carcass produced.

From a study of Table III it may be said that, in general, dry lot is superior to pasture in its effect on both slaughter steer grade and grade of carcass, and that cottonseed meal alone on pasture is an unsatisfactory ration.

Table lV

COLOR OF BEEF

As Influenced by the Rati[illegible]

U. S. D. A. and Packer Grades, Denv[illegible]. 3, 1930

Lot No.	1	2	3	[illegible]	5	6	7
Ration Fed	Grain mix. Alfalfa	Grain mix. Cs. Meal Alfalfa	Grain mix. Alfalfa Pasture	Gr[illegible]x. Mo[illegible] P[illegible]	Grain mix. Cs. meal Morton's Pasture	Grain mix. L. O. meal Morton's Pasture	Cs. meal Morton's Pasture
Color	W. SF	SY	Y		SY SF	Y	Y
of Fat	SY SF	W	Y		Y	SY SF	Y
Color	W	SY	W SF		W	SY	
Chart	W	W	SY SF		SY F	W	
Readings	W	W	SY SF		Y SF	SY SF	
Packer	W	SY SF	Y		SY	Y	
			W F				
			Y				
Average	W 10.2	VSY 11.0	SY VSF 12.0	[illegible].7	SY VSF 12.0	SY 12.0	Y 13.0
Color	W	W	SY		Y F	W	Y F
of Fat	W	W	Y		SY	SY F	SY F
Ocular	W	W	SY F		W	W	
Readings	W	W	SY		SY F	SY	
Packer	W	W	SY		SY F	SY F	
	W	SY F	SY		SY	SY	
			SY				
			SY				
Average	W 10.0	W. 10.2	SY 12.3	[illegible] 12.0	SY SF 12.0	SY VSF 11.3	SY F 12.5
Color	11 Choice	11 Choice	15 Black	12[illegible]	12 Good	12 Good	14 Dark
of lean	11 Choice	11 Choice	12 Good	12[illegible]	14 Dark	13 Fair	13 Fair
Ocular	12 Good	12 Good	13 Fair	15[illegible]	13 Fair	12 Good	
Readings	14 Dark	12 Good	12 Good	11[illegible]e	13 Fair	12 Good	
Packer	12 Good	14 Dark	12 Good	13[illegible]	13 Fair	13 Fair	
	12 Good	13 Fair	11 Choice	12[illegible]	13 Fair	12 Good	
			12 Good				
			11 Choice				
Average	12.0 Good	12.2 Good-	12.3 Good-	12[illegible]d-	13.0 Fair	12.3 Good-	13.5 Fair

DISCUSSION OF TABLE IV.

The carcasses of the steers in the summer pasture experiment were graded by both color chart readings and by ocular readings of fat and lean by the packer. These grades on color of fat, color chart and ocular, and color of lean, ocular, are very closely related and give a good indication of the effect of the ration on the color of beef.

The most nearly ideal carcasses, from the standpoint of color, were produced in dry lot, lots 1 and 2. Pasture with the grain mixture, both with and without a high protein supplement, produced carcasses of a more desirable color than did cottonseed meal alone on pasture, lot 7. This was an undesirable ration from the standpoint of the effect of the ration on color of fat and lean. These general results correspond very closely to the results shown in Table III, slaughter steer and carcass grades.

The grain mixture and alfalfa hay in dry lot, lot 1, produced the most desirable color of carcass, both fat and lean. Color of fat in this lot graded "white," and color of lean graded "good".

Lot 2, dry lot, fed the grain mixture with a high protein supplement, graded only slightly lower than lot 1, dry lot. The average color chart grade for lot 2 was "very slightly yellow"; and the ocular grade "white" for color of fat. Color of lean graded slightly less than "good".

The four lots receiving the grain mixture on pasture, lots 3, 4 5 and 6, graded so closely that individual carcass grades must be considered, and some reference made to Table II, Master Table, pages 69 and 70 for the color chart readings to enable accurate placing of these lots.

From this study it may be seen that the grain mixture supplemented by linseed oil meal on Morton's pasture, lot 6, produced the most desirably colored carcasses of the lots on pasture. The color chart readings for lot 6 show one "white", one "slightly yellow," two "slightly yellow, slightly fiery", and two "yellow". The ocular color readings for this lot show two "slightly yellow, fiery", two "slightly yellow" and two "white" carcasses, averaging "slightly yellow, very slightly fiery". Lot 6 shows more "white" carcasses than lot 3 and 5, and no "very yellow" carcass, as in lot 4. The color of lean in lot 6 is better than lots 4 and 5, and more uniform than lot 3. The grades are two "fair" and four "good", averaging slightly less than "good".

Lot 5, receiving the grain mixture with cotton-seed meal on Morton's pasture, graded "slightly yellow, very slightly fiery", color chart reading ; and "slightly fiery", ocular reading. Color of lean was "fair", Lot 4, receiving the grain mixture without a high protein supplement on Morton's mixture, graded "slightly yellow", color chart reading; and "slightly yellow, very slightly fiery", ocular reading. Color of lean graded a little less than "good". Table II shows, however, that the average color chart reading for lot 5 is a little lower than for lot 4 in units of yellow and red color persent. Table IV shows that lot 4 has a slightly higher average, when interpreted numerically, than does lot 5 in both color of fat and color of lean readings. This indicates that, as in dry lot, cottonseed meal has a slightly undesirable effect on color of beef

Steers receiving the grain mixture on Morton's pasture, lot 4, dressed out slightly more desirable carcasses than steers receiving the grain mixture on alfalfa pasture, lot 3. Table II shows an average of 38.0 units of yellow and 28.5 units of red color for lot 4; and an average of 40.5 units of yellow and 29.0 units of red color for lot 3. Ocular color readings, lot 4, show one "white", one "very slightly yellow, fiery", two "slightly yellow", and one "yellow, fiery", and one "very yellow" carcas, the lot averaging "slightly yellow". In lot 3, there are five "slightly yellow", one "slightly yellow, fiery"and two "yellow" carcasses, the lot averaging "slightly yellow". The grades on color of lean show an average of slightly less than "good" for lots 3 and 4, with one "black" [1] carcass in each lot. More "white" carcasses and a slightly higher average color chart reading for lot 4 indicates that Morton's mixture has a slightly more desirable effect on color of beef than alfalfa pasture.

Lot 7, receiving cottonseed meal alone on Morton's pasture, graded "yellow" on color chart readings and "slightly yellow and fiery", packer. The packer grade showed too much red or "fiery" coloring in the fat, which is objectionable. The color of lean, packer grade, was slightly under "fair". These grades were the lowest received on color, both fat and lean. Lot 7 also graded low on slaughter steer and carcass grades. This indicates that cottonseed meal alone on pasture is not a satisfactory ration from the standpoint of the effectof the ration on color of beef and on slaughter steer grade and carcass grade.

This study of the color grading of carcasses, TableIV, indicates that steers fattened in dry lot will dress out a carcass whiter and more desirably colored than those fed on pasture. These results duplicate those obtained in the summer pasture experiment 1929.

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1. A carcass graded "black" means one that has a very dark color of lean.

This 1929 work indicated, however, that linseed oil meal might tend to whiten the carcasses of steers fed grain on pasture. The 1930 experiment does not indicate, however, that cottonseed meal has that effect.

This year's results, 1930, comparing lots 1 and 4, receiving the grain mixture without protein supplement, in dry lot and on Morton's pasture, respectively, with lots 2 and 5, receiving the grain mixture supplemented by cottonseed meal in dry lot and on Morton's pasture, respectively, indicate that cottonseed meal may have a slightly undesirable effect on the color of beef.

Both the 1929 and 1930 experiments show that Morton's pasture, lot 4, has a more desirable effect on the color of beef than does alfalfa pasture, lot 3.

SUMMARY

Rate and Economy of Gain and Sale Value

The results of the summer pasture experiment, 1930, in which warmed-up cattle were finished for market, indicate that dry lot, lots 1 and 2, is superior to pasture from the standpoint of rate of gain; while the grain mixture on alfalfa pasture, lot 3, produced slightly more economical gains than the grain mixture and alfalfa hay, fed in dry lot, lot 1. This dry lot ration, however, produced steers that sold for a higher price per hundred than those fattened on the grain mixture and alfalfa pasture, and lost less per head than those fed on any other ration in the experiment. The addition of cottonseed meal to the grain mixture fed in dry lot, lot 2, increased the rate of gain, but was too expensive to be economical in this experiment because of the high amount fed per day.

Steers fed the grain mixture on pasture, both Morton's mixture, lot 4, and alfalfa pasture, lot 3, without a high protein supplement, made more economical gains, and lost less per head than those fed grain mixture with a high protein supplement, either cottonseed meal, lot 5, or linseed oil meal, lot 6, on Morton's pasture.

Finish of Steers and Carcass Grades

The slaughter steer and carcass grades, U. S. D. A., and carcass grades, packer, of the steer fed on summer pasture, 1930, indicate that a better slaughter steer and a more desirable carcass may be produced in the dry lot than on pasture.

Slaughter steers fed the grain mixture, cottonseed meal and alfalfa hay in dry lot, lot 2, graded higher than steers fed the grain mixture, without a high protein supplement, and alfalfa hay in dry lot, lot 1. However, when the carcasses were graded in the cooler, it was found that the carcasses produced on the grain mixture and alfalfa hay without protein supplement graded the higher.

The grain mixture with cottonseed meal, lot 5, or with linseed oil meal, lot 6, on Morton's pasture produced slaughter steers and carcasses that graded, according to U. S. D. A. grades, higher than those produced on the grain mixture and alfalfa pasture, lot 3, or the grain mixture and Morton's pasture, without protein supplement, lot 4. Both U. S. D. A. and packer grades indicate that cottonseed meal, lot 5, is superior to linseed oil meal, lot 6, from the standpoint of slaughter steer and carcass grades. Packer grades on the carcasses indicate, however, that the grain mixture without a high protein supplement, lot 4, or with cottonseed meal, lot 5, on Morton's pasture is superior to the grain mixture on alfalfa pasture, lot 3, which in turn graded higher than the grain mixture with linseed oil meal on Morton's pasture, lot 6.

As both slaughter steer and carcass grades, U. S. D. A., agree, and the grading was done by a committee, the writer considers this a good indication that the grain mixture on Morton's pasture with either cottonseed meal, lot 5, or linseed oil meal, lot 6, may be expected to produce a better slaughter steer and a more desirable carcass than grain mixture on either Morton's pasture, lot 4, or alfalfa pasture, lot 3, without a high protein supplement.

The slaughter steer and carcass grades indicate that cottonseed meal alone on Morton's pasture, lot 7, will not produce a good slaughter steer or a desirable carcass, and is not a satisfactory ration from that standpoint.

Slaughter steers and carcass grades, U. S. D. A., and carcass grades, packer, indicate that, in general, a better slaughter steer and a more desirable carcass may be produced in dry lot than on pasture. Also, that the addition of a high protein supplement to the grain mixture, particularly cottonseed meal, will improve the ration fed on Morton's pasture. Although the grades are close, they indicate that on Morton's pasture as compared with alfalfa pasture there may be produced on the former pasture a better slaughter steer and a carcass equally as good.

Color of Beef

Color enters into the carcass grades discuseed above, and the discussion which follows is a discussion of color as an effect of ration with carcasses described from a commercial standpoint. "Yellow", "fiery" and "black" carcasses are undesirable in the degree to which they are colored.

The effects of the various rations fed in the 1930 summer pasture experiment on the color of beef are shown by the color of fat, color chart readings; color of fat, ocular readings, made by the packer; and color of lean, ocular readings, made by the packer.

These readings indicate that a whiter and more desirably colored carcass may be produced in the dry lot than on pasture, and that cottonseed meal alone on Morton's pasture is not a satisfactory ration from the standpoint of its effect on the color of beef.

The grain mixture with linseed oil meal on Morton's pasture, lot 6, had the most desirable effect on the color of beef of any ration fed on pasture. These results agree with those obtained in the previous year's work, and indicate that linseed oil meal may tend to have a slightly desirable effect on the color of beef.

This is not true, however, of cottonseed meal. The grain mixture and alfalfa hay in dry lot, lot 1, produced a whiter color of fat and a more desirable color of lean than did the grain mixture with cottonseed meal, a high protein supplement, and alfalfa hay in dry lot, lot 2. The grain mixture on Morton's pasture, lot 4, produced carcasses that graded slightly higher, color readings of fat and lean, then the grain mixture with cottonseed meal on Morton's pasture, lot 5. When cottonseed meal was added to the grain mixture on Morton's pasture the color of fat showed slightly more yellow color and a little more "fire", and the color of lean graded slightly darker than that produced on the grain mixture and Morton's pasture without protein supplement. These results, as those obtained from the dry lots, lots 1 and 2, indicate that cottonseed meal may have a slightly undesirable effect on the color of beef.

The grain mixture on Morton's pasture, both with and without a high protein supplement, shows a higher grade on the color of fat than does the grain mixture on alfalfa pasture; although the color of lean grades a little lower. However, the average of the fat and the lean color grades for the entire carcasses finished on the grain mixture and Morton's pasture, lot 4, is slightly higher than that for the grain mixture on alfalfa pasture, lot 3, and indicates that Morton's mixture is slightly more desirable than alfalfa pasture pasture in its effect on the color of beef.

CONCLUSIONS

1. Dry lot is superior to pasture for finishing warmed-up steers for market.

2. Cottonseed meal fed as a high protein exclusive supplement in large amounts, in dry lot and on pasture, is not economical, although it does increase rate of gain.

3. Cottonseed meal added to the grain mixture on Morton's pasture may produce a better slaughter steer and more desirable carcass with the exception of color, then the grain mixture without protein supplement on Morton's pasture.

4. Cottonseed meal may tend to have a slightly undesirable effect on the color of beef, both in dry lot and on Morton's pasture.

5. Linseed oil meal seems to whiten the carcass and to improve the color of the entire carcass when fed with the grain mixture on Morton's pasture.

6. Morton's pasture without protein supplement may produce a better slaughter steer and a more desirable carcass, and have a more desirable effect on the color of beef than alfalfa pasture.

7. The grain mixture and alfalfa hay fed in dry lot seem to have a more desirable effect on the color of beef than any other ration fed in the experiment.

8. The grain mixture, cottonseed meal and alfalfa hay fed in dry lot seem to have a more desirable effect on the color of the carcass than the rations fed on pasture in this experiment.

9. Cottonseed meal alone on Morton's pasture is not a satisfactory ration from the standpoint of its effect on the color of beef.

APPENDIX
MASTER TABLE

Slaughter steer grades U. S. D. A.; carcass grades U. S. D. A., and packer; color chart readings, packer; ocular color readings, packer; and color of lean, packer, are presented in a Master Table, Table II, and the numerical value and interpretations of color chart readings, packer; carcass grades, packer; and color of lean, packer, in such a way as to show how the interpretations and averages presented in later tables were obtained.

The slaughter steers were graded at the Colorado Agricultural Experiment Station, September 19, 1930, by a committee composed of L. B. Burk and D. J. Slater, Washington, D. C., and H. B. Osland, Colorado Agricultural College. The carcasses were graded in the cooler October 3, by L. B. Burk, D. J. Slater and the writer. These grades were interpreted by the writer, and the interpretations sent to the Department of Animal Industry, Washington, D. C., where the average slaughter steer and the average carcass grades, U. S. D. A. were calculated. These grades are presented in Table II and Table III.

The carcasses were graded in the cooler by A. A. Andrews, packer representative, October 3, 1930. This packer grade was stamped on each carcass, and was determined by Mr. Andrews according to the system used by Swift and Company, Denver. In this system numbers from ten to nineteen inclusive are used to denote a certain carcass grade: 10, prime; 11, choice; 12, good; 13, medium A; 14, medium B; 15, fair; 16, plain; 17, common, 18, cutter; 19, canner. These grades are made considering color of fat, color of lean and quality of carcass. The carcass grades, packer, are presented in Table II and Table III.

Mr. Andrews also graded the carcasses according to color of fat and color of lean by ocular readings. Color of fat grades used by the packer were: W, white; VSY, very slightly yellow; SY, slightly yellow; Y, yellow; VY, very yellow; according to the degree of yellow color of the fat. The amount of red coloring or "fire" in the fat is denoted, according to degree of excess, by: VSF, very slightly fiery; SF, slightly fiery; F, fiery; and VF, very fiery. The amount of yellow coloring and the amount of red coloring in the fat determine the color grade of the fat, as: W "white"; SY SF, "slightly yellow, slightly fiery." Color of lean grade was determined by the degree of red pigment in the lean, as: Prime, choice, good, fair, dark, black. The writer interpreted these grades into numbers so as to secure a more accurate color of lean grade. The color of fat and the color of lean grades, ocular readings, packer, are presented in Table II and Table IV.

The color chart readings, packer, were made in the cooler October 3, 1930, by Mr. Andrews and Mr. E. J. Maynard, Colorado Agricultural College. The carcass to be graded was hung under a strong white light, and readings made by a color determining machine. This machine was a small electric motor which rotated four small colored discs rapidly. These discs were white, red,yellow and black, and were arranged in such a manner that any desired amount of the certain color could be made to show on the rotating disc at one time. When the rotating disc showed the same color as the color of fat, the machine was stopped and the amount of each color present was read by means of a circular scale marked off in 100 equal units. In this manner the exact number of units of each color present in the fat could be determined.

The numerical readings were recorded and later interpreted by the writer according to the system of relative grading used at that time by Swift and Company. By this system the carcasses in Lot 1, all of which graded "white", ocular reading, were used as a standard by which the other carcasses were graded. The numerical color chart readings for lot 1 were averaged. This average showed 41.0 units white, 27.5 units of red, 30.0 units of yellow and 1.5 units of black color. This average was used as a base for grading the other carcasses, and their color determined by the relative amount of yellow and red color present. The color of the carcass to be graded was determined by comparing the units of red and yellow color present with the average number of units present in lot 1. An excess of 4 to 12 units yellow color graded "slightly yellow"; an excess of 12 to 20 units of yellow color graded "yellow"; while an excess of more than 20 units of yellow color graded "very yellow". The red or "fiery" color of the fat was graded in the same manner as the yellow, and the two combined to give the color of fat. Both the color chart readings and the interpretations are presented in Table II, while only the interpretations are presented in Table IV. The writer placed a numerical interpretation on the average color chart readings in Table IV to show very slight differences in the average color grades of the different lots.

Table 11

MASTER TABLE

Slaughter Steer Grade U. S. D. A.; Carcass Grade D. A., and Packer; Color Chart Readings, Packer; Ocular Color gs, Packer and Color of Lean, Packer

Steer No.	Slaughter Steer Grade U.S.D.A.	Carcass Grade U.S.D.A.	Carcass Grade Packer	Colct Readings, Packer W	Y	B	Packer Intrɔd.	Ocular Color Reading	Color of Lean Packer
Lot No. 1 - Grain Mixture, alfalfa hay in dry lot									
39	82.38	85.73	11 Choice	38.5	27.0	2.0	W SF	W	Choice 11
58	83.27	77.85	13 Med. A	29.0	35.5	2.5	SY SF	W	Choice 11
90	83.10	84.36	13 Med. A	42.0	28.0	2.0	W	W	Good 12
93	89.36	85.08	12 Good	45.0	29.5	1.0	W	W	Dark 14
98	81.46	80.13	13 Med. A	45.0	29.5	1.5	W	W	Good 12
170	88.49	85.52	11 Choice	47.5	29.0	1.0	W	W	Good 12
Average	84.68	83.11	12.2 Good-	41.0	30.0	1.5	W 10.2	W 10.0	Good 12.0
Lot No. 2 - Grain mixture, cottonseed meal, alfalfa hay in dry lot									
66	86.57	85.21	12 Good	32.5	38.5	1.5	SY	W	Choice 11
69	87.22	81.66	13 Med. A	44.0	25.0	1.0	W	W	Choice 11
77	88.00	83.01	11 Choice	38.5	35.0	1.5	SY	W	Good 12
83	88.00	83.58	12 Good	38.0	28.5	1.5	W	W	Good 12
86	81.84	78.89	13 Med. A	40.5	28.5	1.0	W	W	Dark 14
92	80.29	70.39	14 Med. B	36.5	36.5	1.5	SY SF	SY F	Fair 13
Average	85.65	80.46	12.5 Good-	38.5	32.0	1.5	VSY 11.0	W 10.2	Good- 12.2
Lot No. 3 - Grain mixture, alfalfa pasture									
23	71.05	69.72	13 Med. A	27.5	49.0	2.0	Y	SY	Black 15
47	69.80	75.58	14 Med. B	22.0	47.5	4.0	Y	Y	Good 12
62	76.81	72.76	13 Med. A	28.0	32.5	1.0	W SF	Y	Fair 13
68	84.00	77.36	13 Med. A	30.0	37.0	2.0	SY SF	SY F	Good 12
73	77.96	85.48	12 Good	36.5	37.0	1.5	SY SF	SY	Good 12
78	81.34	71.55	14 Med. B	30.0	42.5	2.0	Y	SY	Choice 11
94	79.36	76.49	13 Med. A	24.5	30.0	1.5	W F	SY	Good 12
97	85.81	81.82	13 Med. A	29.0	48.0	1.5	Y	SY	Choice 11
Average	78.27	76.10	13.1 Med. A-	28.5	40.5	2.0	SYVSF 12.0	SY 12.3	Good- 12.3

Table ll Conti

MASTER TABI

Steer No.	Slaughter Steer Grade U.S.D.A.	Carcass Grade U.S.D.A.	Carcass Grade Packer	Color Readings, Packer W	Y	B	Intrpd.	Ocular Color Reading	Color of Lean Packer	
Lot No. 4 - Grain mixture, Morton's pasture grass mixture										
52	79.17	71.82	13 Med. A	15.5	55.0	2.0	VY	SY	Good	12
63	84.61	78.27	13 Med. A	32.5	40.0	2.0	SY	Y F	Good	12
74	75.64	70.79	14 Med. B	41.0	26.5	2.0	W	VY	Black	15
80	85.21	83.50	12 Good	31.5	35.5	2.0	S7	W	Choice	11
82	83.03	73.03	13 Med. A	38.0	31.0	1.5	W	VSY F	Fair	13
115	71.89	71.85	13 Med. A	33.0	38.5	1.0	SY	SY	Good	12
Average	79.93	74.88	13.0 Med. A	32.0	38.0	1.5	SY 11.7	SY VSF 12.0	Good-	12.5
Lot No. 5 - Grain mixture, Cottonseed meal, Morton's Pasture grass										
43	81.35	78.92	13 Med. A	25.5	41.0	1.5	SY SF	Y F	Good	12
64	74.69	69.45	14 Med. B	33.5	45.0	2.5	Y	SY	Dark	14
67	85.40	81.93	12 Good	43.5	28.5	1.5	W	W	Fair	13
71	84.45	81.07	13 Med. A	19.0	34.5	2.5	SY F	SY F	Fair	13
91	84.85	79.20	13 Med. A	21.0	43.0	2.0	Y SF	SY F	Fair	13
318	86.81	80.05	13 Med. A	31.0	40.5	1.0	SY	SY	Fair	13
Average	82.93	78.44	13.0 Med. A	29.0	39.0	2.0	SY VSF 12.0	SY SF 12.0	Fair	13.0
Lot No. 6 - Grain mixture, linseed oil meal, Morton's Pasture grase										
1	81.03	81.68	13 Med. A	33.5	46.0	1.5	Y	W	Good	12
15	83.59	78.43	13 Med. A	31.0	35.5	2.0	SY SF	SY F	Fair	13
56	83.67	75.74	13 Med. A	40.0	34.0	1.0	SY	W	Good	12
87	84.73	79.27	13 Med. A	43.5	27.0	1.0	W	SY	Good	12
100	79.20	74.19	13 Med. A	23.5	41.0	2.0	SY SF	SY F	Fair	13
186	77.42	70.39	14 Med. B	28.5	47.0	.5	Y	SY	Good	12
Average	81.61	76.62	13.2 Med. A-	33.5	38.5	1.5	SY 12.0	SY VSF 11.3	Good-	12.3
Lot No. 7 - Cottonseed meal, Morton's pasture grass mixture										
72	71.11	67.48	14 Med. B.	27.0	47.0	1.0	Y	Y F	Dark	14
89	74.02	72.73	14 Med. B	27.0	45.0	2.5	Y	SY F	Fair	13
Average	72.57	70.11	14.0 Med. B	27.0	46.0	2.0	Y 13.0	SY F 12.5	Fair-	13.5

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SUMMARY

The object of this thesis is to make a study of the color of beef as influenced by the ration, and also a study of the value of beef as a source of the vitamins, stressing the relation of yellow color to vitamin A content.

A study of the value of beef as a source of the vitamins was made by the writer by reviewing certain literature on work done on the vitamin content of beef. In this review of literature the relation of yellow color to vitamin A was stressed.

The Colorado Agricultural Experiment Station conducted a summer pasture experiment with yearling steers during the summer of 1930. The author assisted in this work, and in this thesis studies the results with a view to determine, in as far as possible, the effect of a high protein content ration vs. a low protein content ration, also, the effect of dry lot vs. pasture on the color of beef.

A summary of the study of the results obtained, showing the effect of the ration on rate and economy of gain and sale value, finish of steers and carcass grades, and color of beef is presented in the following pages.

Rate and Economy of Gain and Sale Value

The results of the summer pasture experiment, 1930, in which warmed-up cattle were finished for market, indicate that dry lot, lots 1 and 2, is superior to pasture from the standpoint of rate of gain; while the grain mixture on alfalfa pasture, lot 3, produced slightly more economical gains than the grain mixture and alfalfa hay, fed in dry lot, lot 1. This dry lot ration, however, produced steers that sold for a higher price per hundred than those fattened on the grain mixture and alfalfa pasture, and lost less per head than those fed on any other ration in the experiment. The addition of cottonseed meal to the grain mixture fed in dry lot, lot 2, increased the rate of gain, but was too expensive to be economical in this experiment because of the high amount fed per day.

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Conclusions

1. Dry lot is superior to pasture for finishing warmed-up steers for market.

2. Cottonseed meal fed as a high protein exclusive supplement in large amounts, in dry lot and on pasture, is not economical, although it does increase rate of gain.

3. Cottonseed meal added to the grain mixture on Morton's pasture may produce a better slaughter steer and more desirable carcass, with the exception of color, than the grain mixture without protein supplement on Morton's pasture.

4. Cottonseed meal may tend to have a slightly undesirable effect on the color of beef, both in dry lot and on Morton's pasture.

5. Linseed oil meal seems to whiten the carcass and to improve the color of the entire carcass when fed with the grain mixture on Morton's pasture.

6. Morton's pasture without protein supplement may produce a better slaughter steer and a more desirable carcass, and have a more desirable effect on the color of beef than alfalfa pasture.

7. The grain mixture and alfalfa hay fed in dry lot seem to have a more desirable effect on the color of beef than any other ration fed in the experiment.

8. The grain mixture, cottonseed meal and alfalfa hay fed in dry lot seem to have a more desirable effect on the color of the carcass than the rations fed on pasture in this experiment.

9. Cottonseed meal alone on Morton's pasture is not a satisfactory ration from the standpoint of its effect on the color of beef.