THE EFFECT OF VARIOUS FEEDS

ON THE

COLOR OF LEAN BEEF

THE EFFECT OF VARIOUS FEEDS ON THE COLOR OF LEAN BEEF

By

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INTRODUCTION

The production and fattening of meat animals are done primarily for the flesh which is used for human food. Of course there are various glands such as the liver which have a very high nutritive value in special cases of nutritional disturbances and many other glands are made into expensive thereapeutic preparations, but since these glands are small and are expensive to process the net return of these as compared to the entire carcass is relatively small. The entire offal from the killing floor is also processed into many types of articles, but these too are by-products of the meat industry.

Since the lean is the principal source of income the beef sold to the retailers and housewives should be as appealing in quality and color as possible. If the color of the lean is dark, there is an objection from the psychological standpoint even though there seems to be no objection after this dark beef is cooked. There seems to be no difference in the amount of nutritive values such as protein, minerals, and fats as compared to the more desirable colored beef. Other tests such as palatability and tenderness show very little discrimination against the "black-cutters."

The "black-cutting" carcasses in highly finished young cattle should not be confused with the dark color found in the carcasses of old cows and especially the dairy breeds. The color and sticky appearance are very typical in these good cattle because the color ranges from a dark-red to a deep purplish red. The consistency of the lean is more or less sticky as though a muscilaginous substance had been spread over the cut surface of the beef. This condition cannot be detected by any known means in the live animals, and seldom is it visible until after the carcass is quartered.

When a beef carcass is quartered it is first split down the back and each half is cut between the twelfth and thirteenth ribs. The large muscle, the longissimus dorsi, next to the back bone that is transversed between the twelfth and thirteenth ribs, is usually the place where color readings are made.

This problem of "black-cutting" beef has been known to the packing industry for many years, and is very widely spread throughout our country; in fact these black-cutting carcasses are found in all sections of the United States. No statistics are available as to the approximate number of these cattle, but several hundred thousand dollars is a reasonable estimate for the economic loss incurred each year by the livestock and meat industry. LaVoi (6) found about 3% of these dark-cutters in the highly finished 4-H club calves shown at the International Livestock Exposition in Chicago, Illinois in 1938. However, the average kill at the various packing houses will probably not produce as high a percent of these off-colored cattle as was found in the 4-H club group at Chicago for the one year.

Because of the great financial losses from this dark cutting meat the National Livestock and Meat Board with the cooperation of the national, state, and local 4-H club leaders and members; vocational agricultural teachers and students; State Agricultural Colleges and Experiment Stations; International Live Stock Exposition management; Live Stock Marketing Agencies; the Union Stock Yards Company of Chicago; the American Meat Institute and member packers have set up a research committee to direct the experiments and studies of this subject.

This technical committee has compiled all the available work, and they have found that many theories have been advanced for the causes of

dark beef, and other factors related to it. In their compilations they have discarded many of the earlier theories about the causes of this condition in well finished young beef, such as age of calf, tendency to go off feed, loss in weight while on exhibit, times fed daily, number of calves fed together, exercise, confinement of animals, method of delivery, type of water, sickness, age and method of castration, size of rib-eye, and degree of finish. Some of the theories need further research to determine whether or not they are actually related to the color of beef. Delayed bleeding for ten minutes has been thought to cause some carcasses to cut dark, but others have cut with an excellent color of the meat. Some of the "black-cutters" were very nervous animals, and this may have been thought to be one cause. Nevertheless, many of the western fed cattle are probably as nervous as any of the cattle slaughtered at the packing companies; yet, a very high percentage of these cattle will have an excellent color reading. Probably one of the hardest theories to prove is that of inheritance. During the early history of breed improvement in England some of the Shorthorn cattle were said to be less desirable for meat than some other Shorthorns and other breeds because of the dark flesh they produced. Today some of all breeds may cut dark, but it may be due to use of these dark fleshed Shorthorns in cross breeding during the days of early improvement of the other breeds. Some of the management problems such as feed before project started, age calf first received grain, forced feeding, length of time on feed, mineral content of water, and drugs used are thought to cause dark beef. However, no work so far has proved that any of these management practices will produce dark beef. Many feeds and ration ratios also are thought to affect the color of meat. These are ratio of roughage to grain, ratio of protein supplement to grain, high sugar ration, high fat ration,

kind of roughage, new corn, frozen grass, pasture, lack of milk, soybeans, and minerals. It would seem logical that of the many thousands of cattle fed annually, all of these various rations would be fed to many groups, and that if these feeds caused black beef most those fed the same ration in one group would cut dark, although this does not seem to be the case. Other characteristics which may tie up with some of the carcasses and meat are diameter of muscle fibers, lactic acid content of muscle, respiratory enzymes, and moisture content of muscle. Very little is known about these factors.

Some work has been done to show a relationship between dark colored beef and various management practices such as fatigue, chilling, and withholding of feed and chilling prior to slaughter. There seems to be a tendency for some animals to cut dark when feed is withheld and the animals chilled before they are slaughtered. Some other characteristic relationships that seem to be tied up with black beef are sugar content of the muscle, pH and oxygen uptake of the tissues, slightly yellow fat, and slightly soft lean.

REVIEW OF LITERATURE

In 1938 The National Livestock and Meat Board in cooperation with various other interested parties of the meat industry began a very extensive program hoping to find the cause of "black-cutting" beef.

LaVoi (5) gave a report of the 308 4-H club calves shown at The International Livestock Exposition. He collected data on each live calf by sending to each 4-H club member a questionnaire asking for the breeding; feeding—time the project was started and amount and kind of feed; disposition—whether nervous or docile; vaccinations, sickness, and drugs used, if any; management practices—housing, exercise, water, and times fed daily; and exhibiting or show circuit. The carcass data after the calves were slaughtered included dressing percentage, characteristics in determining commercial grades, and color of rib-eye muscle using the Munsell (15) color system approved by the United States Department of Agriculture.

He found that the greatest number of off-colored carcasses were obtained where the cattle were exposed to cold weather in outdoor pens and the calves were without food from the time of purchase until slaughtered. This report shows that 2.6% black, 5.8% dark, and 9.4% shady-cutting carcasses were encountered. Random samples of the dark and bright meat were used for chemical studies. It was found that the dark beef showed a higher pH value, thus indicating a lower acid content. Also the muscles of the dark cutters contained less sugar, probably in the form of glucose with the average sugar content of dark samples being 0.03%, of shady samples 0.11%, and of light cutting samples 0.18%. Also it was

found the oxygen uptake of the dark samples were less than the lighter-cutting samples. Some of the carcasses were dropped from one to four grades just because of the color alone. There were 88.2 percent of the carcasses graded prime before ribbing and 67 percent after ribbing. This was a loss of 11.2 percent for the one factor of color of lean.

After finding a difference in the sugar content of the muscles, an experiment (16) where the administration of insulin to 12 cattle to determine whether dark beef could be produced experimentally was conducted. He found that by administering sufficient amounts of insulin, dark beef may be produced experimentally. The amount of insulin must be large enough to deplete the muscle of its water extractable sugars. The data obtained by chemical analysis of the muscle tissues paralleled those found in other experiments.

Another experiment (17) was used to check the results of the insulin experiment. Since insulin depletes muscle tissue of sugar, and the hormone adrenaline raises the sugar content of blood and tissues, it was decided to see if cattle, which were given adrenaline, would yield a lighter color lean than a control group which was given glucose. The results showed that adrenaline would cause the meat to be lighter in color, but a very undesirable factor in the form of hemmorrhagic spots appeared in the meat. Oxygen uptake capacity experiments and pH values were also run on this group of carcasses, but the findings seemed to contradict those of the 1938 4-H club calves. The oxygen uptake capacity of dark-cutting muscle (pH 6.8) was greater than that of a light-cutting muscle (pH 5.6), but the water extractable reducing sugars and the color of muscle showed a corelation thus confirming previous investigations.

In 1939 there were 426 4-H club calves shown at the International

Livestock Exposition. (18) Similar questionnaires were sent to the club feeders, and data were collected the same as the previous year. This group showed a reduction from the previous year in off color carcasses. There were 1.87% black, 3.52% dark and 8.21% shady-cutters. It was found that the blood sugar before and after slaughter had no effect on the color of the rib-eye muscle. Other tests that were made checked very closely with the findings of previous years. It is known that the pancreas secretes insulin, so histological studies were made of this organ; however, due to the many factors which are involved with its function, no information was obtained from this study.

In 1940 (19) a group of 122 4-H club calves from The International Livestock Exposition were divided into three groups to determine whether with-holding feed would produce more dark-cutters than the ones well fed and warmly housed. It was found that the well treated animals produced no dark-cutters, but in the groups where feed was withheld in addition to chilling, dark cutters were produced.

In addition to the previously mentioned 122 calves, there were 438 4-H club calves graded and studies made as in previous years. All owners were sent questionnaires similar to those in 1938 and 1939 as to feeding, breeding, and management.

This group was better fed and housed before slaughter than those of 1938 and 1939. Also feeding and management seemed to be improved as indicated by the questionnaires. Consequently, as was expected, the color was much brighter with only 0.45% cutting black and 4.5% off in color. Data collected on various tests paralleled those of previous years.

Since commercial cattle, that is cattle produced and fed by experienced feeders for the purpose of meat, is the source of supply for the packing industry, a group of these cattle (20) was subjected to severe treatment,

chilling and with-holding feed, to determine the color of the lean. The data obtained paralleled that of other experiments indicating that the more severe the treatment the darker the color of beef.

As has been indicated, with-holding feed and chilling may affect the color of lean meat. An exploratory experiment with cats was conducted during the summer of 1940. (21). The cats were chilled and not fed before being killed. The results were that the muscle of the cats was darker in color, lower in extractable sugars, and higher in pH than the flesh from the control cats.

Packers for a number of years have criticized grass beef because they thought it contributed to dark lean beef. Longwell (7) took spectrophotometric color reading on about 100 experimental cattle. These cattle received various rations such as pasture and grain, pasture alone followed by grain and hay. He found no evidence of dark beef in pasture fed cattle with an equal degree of finish to the dry lot cattle.

In a later report Longwell (8) states that no dark cutters were obtained from 220 experimental cattle fed on pasture; pasture and grain; and grain alone. He concluded that the more highly finished carcasses would cut a lighter lean. An occasional dark-colored carcass would be found in a group of steers regardless of the kind of feed.

A report by Longwell (9) shows that color readings were made on beef samples of finished yearlings, two-year-olds, and three-year-old cattle. All these cattle were highly finished and fed grain the latter part of the experiment. After slaughtering, samples for the color reading were taken mostly from the right side near the twelfth rib. The two-year-old steers fed at Morgantown showed very little difference in brightness, and none of these steers were dark enough to be objectionable. There were one or two dark carcasses in each lot of the Lewisburg cattle in 1929, but it

was thought that the feed was not the cause. In 1930 all cattle from Lewisburg killed bright. In 1931 it seemed that two lots cut somewhat brighter than others. One of the lots received grass alone 84 days, then grain on grass for 112 days, and the other lot received grass alone 140 days and grain on grass 56 days. The difference was measurable, but was so slight that he considered it negligible.

Bull (3) also did some work with cattle on pasture and dry-lot feeding. The steers were put on sweet clover, alfalfa, and brome grass pastures for this experiment. They were started on pasture May 6 and taken off September 23. On September 23, one steer from each lot was slaughtered to study the effects of the different pastures on the color of the meat. The cattle were then put in a dry lot and fed 35 more days when a second steer was slaughtered from each pen and 65 days later a third steer was slaughtered from each lot. Records were taken on the carcasses including color of lean. Results of this experiment showed that pastures did not produce dark lean in beef, but it did cause the fat to be yellow.

Bull (1) has found that delayed bleeding will cause dark beef. In this experiment he used twenty steers. Ten of these were stunned and bled immediately, five were stunned and bled five minutes later, and five were killed by the kosher method. He found that the steers in the first and third lots were very good in color for that age of beef, while three steers from the second lot had a very poor color. The hemoglobin content of the meat was 0.291, 0.293, and 0.316 per cent in the respective lots.

In 1934 in another experiment Bull (4) used fourteen Hereford steer calves which were of similar age and breeding, and which were fed a ration consisting of corn, soybean oil meal, silage, and alfalfa hay. Eight steers were stunned and bled immediately while the other six were killed

and bled ten minutes later. The average brightness for the first group was 12.7 percent, an excellent degree of brightness for beef of this age and grade. The delayed bleeding group showed a brightness of 10.5 percent which is a low degree of brightness. There seemed to be no overlapping between the low groups, but there was a definite relationship between the color of lean and time of bleeding when a spectrophotometer was used for reading color.

In another group he had thirteen steer and heifer calves of similar age, breeding, and feeding records. In this group three were bled immediately and ten were killed and bled ten minutes later. Two heifer calves were very wild and "mad" when slaughtered. The results of this group showed that all calves, except the two that were "mad" at the time of slaughter, killed bright. These were typical black-cutters. Since there were some dark cutters in one group of cattle these experiments could indicate that delayed bleeding may cause meat to cut less desirable in color. However these findings contradict the conclusions of the adrenaline experiment (17) because excessive excitement increases the natural flow of adrenaline.

Bull and others (4) did some work on the effect of age, sex, and length of feeding period on the quality of baby beef. The first group which was run in 1926-27 consisted of twelve steer calves and twelve heifer calves which were full-fed a ration of shelled corn, cotton seed meal, corn silage, and alfalfa hay. Steers and heifers were slaughtered at various intervals throughout the experiment. They found no difference in rate of gain between the steers and heifers on the same ration. The next year, 1927-28, they used twenty high grade Hereford calves on the same ration as the previous year. The results of both experiments were recorded together when they found that sex had no effect on color, but that calves with a higher degree of finish also showed a more dominant wave length

(a redder hue) than those not so well finished. Included in this report are the color reports on two veal calves, two four-year-old steers, and four hard bone cows. The color of the two veal calves was light with the wave length in the orange-yellow band. Due to age the two four-year-old steers and the hard boned cows all cut quite dark and all the hues were a reddish purple. In the entire experiment on young beef they found six calves that were typical black cutters, all of them being in the purple part of the spectrum.

It was concluded that age, finish, and ration have some influence on the color of beef, but other factors affect the color to a more considerable extent.

EXPERIMENTAL

Object of the experiment:

The purpose of this experiment was to record the effect of various feeds upon the color of young high quality beef. Various other factors such as degree of finish, fat color, desirability of kidney fat, and commercial grade were also recorded.

Procedure:

This experiment was made on 36 high grade Hereford steers which were divided into 4 lots with 9 steers in each lot, and fed 174 days.

The feeds used in each lot were:

Lot I---Ground shelled corn, cottonseed cake, silage, and ground limestone.

Lot II--Ground oats 87 days, ground shelled corn 87 days, cottonseed cake, silage, and ground limestone.

Lot III-Ground shelled corn and ground oats, half and half; silage and ground limestone; cottonseed cake.

Lot IV--Ground kafir heads 60 days, ground kafir 114 days, cottonseed cake, silage and ground limestone.

The steers were fed grain twice daily, and after the 56th day of trial, the grain was increased to such amounts that the feed was not quite cleaned up by the next feed. The silage was fed three times daily for the first 69 days and at noon and night daily thereafter.

Each steer was weighed individually for three consecutive days and the average of these three weights taken as the average initial weight. Individual weights were taken every twenty-eight days during the experiment, and the final weight was the average of the weights for the last three consecutive days of the experiment.

The steers were taken to the Oklahoma City Stockyards and sold through the regular marketing channels, Armour & Company and Wilson & Company each purchasing two lots. Each company slaughtered the steers and shrouded the carcasses without bias.

The carcasses were hung in the coolers for approximately forty-eight

hours before being "ribbed down" for inspection of the rib-eye muscle. The Munsell (15) color discs were used for reading results of the color of the lean rib-eye muscles.

Results:

The following table I shows the weights at the beginning and end of the experiment, the percentage of shrink from the final weights at the end of the experiment, and dressing percentage.

Table I

Ration, Weights, Market Shrink, and Dressing percent of Cattle on Feeding Experiment at Oklahoma A and M College 1941-1942

	Ration	Original weight	Final weights	Pounds Shrink	Dressing percent
Lot 1	Corn	509	893	19#	60.6%
Lot II	Oats ½, Corn ½	508	897	25#	60.1%
Lot III	Oats ½, Corn ½	510	896	27#	60.3%
Lot IV	Ground Kafir	508	844	36#	60.0%

Before the carcasses were ribbed, they were graded by J. A. Beall, Associate Professor, Animal Husbandry Department, Oklahoma A. and M. College, for exterior carcass color, conformation, degree of finish, amount of kidney fat, and commercial grade. The following tables II, III, and IV give the composite of each lot.

Table II

Exterior Carcass Color[1] and Conformation[2] of Carcasses of Cattle on Feeding Experiment at Oklahoma A. and M. College 1941-1942.

	Exterior Carcass Color		Conformation	
Lot 1	No. Carcasses	9	No. Carcasses	9
0*				
1	5		3	
2	4		2	
3			4	
4				
Lot 2		9		9
0*				
1	2		1	
2	6		3	
3	1		4	
4			1	
Lot 3		9		9
0*	9			
1			2	
2			4	
3			3	
4				
Lot 4		9		9
0*	9			
1			2	
2			5	
3			2	
4				

1. The numbering used for exterior carcass color was 0-2 white, 3-5 light yellow, and 6-9 yellow.

2. The numbering on conformation was 0-2 blocky, 3-5 medium rangy, and 6-9 rangy.

* Numbers arbitrary standards sent out by the National Livestock and Meat Board Scoring Chart.

Table III

Degree of External Finish and Desirability of Kidney Fat of Carcasses of Cattle on Feeding Experiment at Oklahoma A and M College 1941-1942

	Degree of Finish	Kidney Fat
Lot 1	9	9
Under Amount*	7	3
Desirable	2	5
Over Amount		1
Lot 2	9	9
Under Amount*	4	1
Desirable	4	4
Over Amount	1	4
Lot 3	9	9
Under Amount*	3	
Desirable	6	5
Over Amount		4
Lot 4	9	9
Under Amount*	5	
Desirable	4	6
Over Amount		3

* Those graded under amount varied somewhat, but all recorded in one group.

Table IV

Commercial grades of Carcasses of Cattle on Feeding Experiment at Oklahoma A and M College 1941-1942.

Lot 1	9
Good	3
Low Good	2
Medium	4
Lot 2	9
Good	2
Low Good	3
Medium	4
Lot 3	9
Good	4
Low Good	3
Medium	2
Lot 4	9
Good	4
Under Good	5
Medium	

The carcasses were then ribbed between the twelfth and thirteenth ribs which is usually the standard cut made quartering beef in the packing houses. Color readings were taken immediately after ribbing, and again 30 minutes later with Munsell (15) color discs.

None of the carcasses in the whole group were undesirable in color even though a few were graded as low as 6 after standing exposed to the air for 30 minutes.

The following Table V summarizes the color readings immediately after ribbing, and again 30 minutes later.

Table V

Color Readings of the Longissimus Dorsi Between Twelth and Thirteenth Ribs of Carcasses of Cattle on Feeding Experiment at Oklahoma A and M College 1941-1942.

	First Reading	Second Reading
Lot 1	9	9
A-4		
A-5		
A-6	*	*
A-7		
Lot 2	9	9
A-4		4
A-5		4
A-6	2	1
A-7	7	
Lot 3	9	9
A-4		4
A-5		4
A-6	8	1
A-7	1	
Lot 4	9	9
A-4		6
A-5	1	3
A-6	7	
A-7	1	

* Lot 1 was not ribbed because they had not been sold by the packing company, but correspondence from them later stated that all carcasses had color reading of A-5 or above.

1. Color standard reading A-1 - A-4 bright, A-5 - A-6 shady, A-7 - A-8 dark, and A-9 - A-10 black.

Various other factors were recorded about the carcasses after ribbing. Probably the greatest variation was in the marbling of the rib eye. About one-half of the carcasses were well marbled, and the rest varied from pratically no marbling to a desirable amount of inter-

muscular fat.

The texture of the lean of the rib-eye muscle varied within each group from fine to medium, and all groups were very similar in the texture of lean.

Only two carcasses were considered to have subnormal rib-eye muscles as to size, and one of these had an excessive amount of fat covering over that point. The other was considered to have insufficient fat covering. These two carcasses were in Lot 2, and one carcass in each Lot 3 and Lot 4 were also insufficiently covered over the twelfth and thirteenth ribs.

Discussion:

This group of cattle was fed on some of the most common fattening feeds used in this section of the country.

It will be noted that all lots had color readings that were very similar with the majority reading A-6 and A-7 immediately after ribbing. The readings thirty minutes later were mostly A-4 and A-5. This brightening effect is due to the normal oxygen uptake of the muscle tissue which is quite rapid for the first thirty minutes, and continues at a slower rate for about two more hours. Had time permitted a third reading two hours later it was assumed that all carcasses would have cut one color brighter than the 30 minute reading because of the normal oxygen uptake of the muscle at a reduced rate. This would have made all of the carcasses cut A-4 except the two that were read A-6 on the second reading.

However, if no brightening effect had occurred over the second reading the color of the carcasses was quite desirable and would have not been discriminated against by retailers or house wives. Any beef reading A-5 or A-6, even though it is considered a shady cutter, will be passed on to the consumer without any objection.

SUMMARY

A group of 36 high grade Hereford steers were fed rations of corn, oats, and kafir to determine whether or not any of these feeds would effect the color of lean in beef. It was found that there was little or no effect, that color of the lean was bright in all carcasses, with the exception of two which were slightly shady, yet all carcasses were considered quite desirable.

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