THE QUALITY OF PORK ROASTS AS INFLUENCED BY THE FEEDING OF ANTIBIOTICS TO HOGS

by

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INTRODUCTION

The feeding of antibiotics to swine is rapidly becoming a widespread practice. It has been demonstrated that such a practice increases the utilization of feed, promotes growth, and decreases the occurrence of disease. These factors result in certain advantages to the farmer such as lowering the cost of feed and decreasing the incidence of runt pigs.

Packers and retail dealers are interested in the effect of antibiotics in the ration of swine on the quality of the carcass as measured by dressing percentage, the proportion of fat to lean cuts, and the depth of the back fat. Consumers judge the quality of pork by its flavor, tenderness and juiciness, and the proportion of fat to lean. Nutritionists have questioned the effect of antibiotics consumed by growing-fattening pigs on the nutritive value of the meat.

The few studies in the literature relative to the quality of the carcass have been concerned with the factors that interest the packers and retail dealers. Although the weight lost during cooking and the palatability of the meat are the final tests of quality, no references were found which reported the effect of antibiotics in the ration of pigs on these factors. Microscopic examination of muscle tissue may give information which will supplement and help explain the results of cooking and palatability tests. Therefore, the present study was conducted to determine the effect of feeding two antibiotics, aureomycin hydrochloride and terramycin hydrochloride, on the

cooking losses, palatability, and histological structure of fresh pork.

REVIEW OF LITERATURE

The Use of Antibiotics in Hog Rations

Since 1950, many investigators have reported the use of antibiotics in the ration of hogs. The work in this country has been concentrated at state Agricultural Experiment Stations; in Canada, at the Ontario Agricultural College; and in England, at the University of Reading. Generally, an antibiotic was defined as a metabolic product, produced by a living organism which inhibits the growth of other organisms. Reasons that were given for the feeding of antibiotics are: (1) to stimulate growth, (2) to increase feed efficiency, and (3) to aid in the prevention of disease.

Stimulation of Growth. Several experiments were conducted to study the stimulation by antibiotics of the growth of pigs. According to Wallace, Ney, and Cunha (1951) the use of aureomycin and terramycin in the ration of growing-fattening pigs resulted in a significant stimulation of growth, but when chloromycetin was fed, pigs gained at a significantly slower rate than the pigs fed the other two antibiotics. The difference in the rate of growth between pigs fed aureomycin and terramycin was non-significant.

Luecke, Thorpe, Newland, and McMillan (1951) studied the effect of aureomycin, penicillin, streptomycin, and neomycin on

growth promotion in pigs. Aureomycin fed at 10 mg per pound of ration increased significantly the growth rate of pigs fed a B-vitamin fortified corn, soybean ration. Neomycin had a deleterious effect on the growth rate of pigs. Streptomycin and penicillin increased growth slightly, but the gains were non-significant.

Catron, Jensen, Homeyer, Maddock, and Ashton (1952) studied the effect of feeding aureomycin on the protein requirement of growing-fattening swine. The variations in the rations fed to 16 lots of pigs may be summarized as follows:

Rations		Percent protein at 3 stages of growth		
Without aureomycin	With aureomycin	Weaning to 75 lbs.	75 to 150 lbs.	150 lbs. to market wt.
I	Ia	20	17	14
II	IIa	18	15	12
III	IIIa	16	13	10
IV	IVa	14	11	8

Rations Ia, IIa, IIIa, and IVa contained 10 mg aureomycin per pound. Each of the above rations was fed to two lots of pigs. The results of the study showed that without aureomycin the 16-13-10 percent protein combination was sufficient to supply the pigs' need from weaning to market weight. Higher levels of protein were considered in excess of the pigs' requirement if the rations were balanced in respect to non-protein dietary factors. With aureomycin, the 14-11-8 percent protein combination produced gains equal to the higher levels of protein. Without the antibiotic, the rate of growth of pigs fed the 14-11-8 percent protein combination was less than that of pigs on the higher levels

of protein. Aureomycin was considered to have a protein "sparing-like" effect at the lower level of protein intake when fed at 10 mg per pound of ration.

Feed Efficiency. Some of the studies reported on feeding pigs stated that the use of antibiotics resulted in greater feed efficiency. Brown and Luther (1950) found that the effect of feeding terramycin, streptomycin, penicillin, and aureomycin to healthy growing-fattening pigs was an increase in feed efficiency. However, the efficiency of feed for pigs which had reached market weight was not improved by including these same antibiotics in the ration.

Barber, Braude, and Mitchell (1953) reported that the food utilization of castrated male pigs was improved when Aurofac 2A (aureomycin and vitamin B_{12}) was used to supplement a diet containing a thyroid active preparation and stilbesterol. This confirms an earlier report by Barber (1953) in which he stated that the addition of aureomycin to a basal diet containing protein of vegetable origin resulted in a marked improvement in the efficiency of food utilization.

Prevention of Disease. Along with the work on stimulation of growth and feed efficiency, it was found that antibiotics aid in the prevention of disease. Wallace, Ney, and Cunha (1951) stated that there was less incidence of scours in pigs fed aureomycin and terramycin than when pigs were on control rations. Catron (1952) in a summary of the recent developments in animal nutrition reported that the use of the "antibiotics of choice," aureomycin and terramycin, reduced the number of "runt" pigs

and the incidence of non-specific enteritis. He stated that the response to the antibiotics was directly proportional to the disease level in pigs, and that some healthy pigs have failed to respond with increased growth and feed utilization to the use of antibiotics.

Lepley, Catron, and Culbertson (1950) stated that either aureomycin or other nutritional factors present in the Animal Protein Factor helped control diarrhea or scours in pigs. Carpenter (1950) reported that with aureomycin added to a basal diet, there was no diarrhea in weaned pigs. He found that the "disease level" of intestinal flora, that is, the level of intestinal bacteria above which scours occurred, has an important bearing on the dietary requirements of vitamin B_{12}. Since aureomycin reduced the level of intestinal bacteria below the disease level, it had a sparing effect on the requirements for vitamin B_{12}.

Mechanism of Antibiotic Action

A symposium reported in Feed Age (Anonymous, 1951) summarized five theories that have been proposed to account for the results of including antibiotics in feeds. Most of these theories centered around the effect of antibiotics on the intestinal flora. The first theory was presented by Dr. James McGinnis of Washington University. He proposed that penicillin and terramycin promote growth by preventing enterotoxemia caused by clostridium perfringes. Dr. J. R. Groschke of Michigan State College was less specific in postulating that antibiotics suppress some unfavorable bacteria and allow the favorable bacteria

to develop with some production of unknown factors probable. Investigators at Ontario Agricultural College suggested that antibiotics increase the availability of ingested nutrients or perhaps stimulate intestinal synthesis of unknown factors. According to scientists at the University of Maryland, antibiotics suppress cecal bacteria that utilize nutrients at the expense of the host. The last theory presented at the symposium was that of Dr. J. R. Couch and his associates at Texas Agricultural and Mechanical College. They believe that there is a possible systemic effect from the use of antibiotics.

Catron (1952) grouped the five theories postulated above into what he called two logical theories; namely, the disease control and the nutritional theories. The first explanation given by Catron was that the antibiotic inhibits pathogenic and/or toxin forming microorganisms which are injurious to the pig. His nutritional theory was that the feeding of antibiotics resulted in increased accumulation of certain nutrients in the liver and in the blood. It may be that the feeding of antibiotics permits the microbial synthesis of and/or sparing of certain nutrients necessary for growth of the pig by increasing the quantity of "nutrient (s)" available for absorption.

Effects of Antibiotics on the Quality of the Carcass

Few studies were found in the literature concerning the effect of antibiotics on the quality of the carcass. Bray (1953) stated that one reason for this was that quality of the pork was not the primary purpose of most experiments, and was reported

incidentally if at all. In his paper, Bray (1953) reported work done in Ohio which seemed to indicate that the level of protein fed was far more effective in changing the lean to fat ratio than was the use of an antibiotic.

Wilson, Burnside, Grummer, and Bray (1953) measured the ratio of lean to fat in carcasses from hogs fed control rations containing high, intermediate, and low levels of protein. The percentage of protein in these rations were as follows:

	Percent protein at 3 stages of growth		
Control rations	Weaning to 75 lbs.	75 to 150 lbs.	150 to 200 lbs.
High protein	20	16	12
Intermediate protein	17	13	10
Low protein	14	11	9.5

These rations were supplemented with vitamin B_{12} and/or aureomycin. For this experiment, 96 pigs were placed in 12 lots. The 12 lots of pigs were further divided into three groups of four lots each, which were fed rations containing the three levels of protein. The four lots of pigs within each of the three groups were fed as follows: Lot 1, a control ration; Lot 2, the control ration supplemented with vitamin B_{12}; Lot 3, the control ration plus aureomycin; and Lot 4, the control ration plus vitamin B_{12} and aureomycin. Of the controls, the high protein rations produced carcasses which had the highest percent of lean cuts. When the intermediate and lower levels of protein were fed, the addition of vitamin B_{12} and aureomycin, separately or together, gave a significant increase in the percentage of lean cuts. With these levels of protein, the combination of vitamin B_{12} and

aureomycin gave the greatest proportion of lean meat. There was not a significant difference in the ratio of lean to fat between the lot fed vitamin B_{12} and aureomycin on the lower protein level and the lot fed the high protein control ration.

The paper in which Catron et al. (1952) reported the effect of aureomycin on protein requirements of growing-fattening swine also included data on the effect of aureomycin on carcass quality. They found no significant differences among the levels of protein fed or between antibiotic and non-antibiotic treatments in respect to depth of back fat, the length and depth of the body, or the percent of lean to fat measured on 24 representative carcasses.

Broquist (1954) reported that aureomycin fed in therapeutic amounts, that is, levels above 10 mg per pound of feed to combat disease, did not appear in muscle or glandular tissue after the animal was slaughtered. However, when aureomycin was fed at 200 g per ton of feed for six days, traces of the antibiotic were found in the muscle tissue. These traces of aureomycin disappeared after the meat was cooked. Withdrawal of the antibiotic from the feed two days before slaughter reduced the incidence of traces of aureomycin in muscle tissue when levels as high as 1,000 g per ton of feed were given.

The Quality of Pork Roasts

A description of good quality pork, both raw and cooked, is given by the Committee on Preparation Factors of the National Cooperative Meat Investigations (1942). This group stated that good quality raw pork is obtained from finished hogs which have a

comparatively small ratio of fat to lean and produce well-muscled hams and loins. Good quality cooked pork is described as uniformly brown with the outside crisp but not hard. The inside should be grayish-white without a tinge of pink, firm and tender, not dry or crumbly. The juice should be a yellowish brown with no pink tinge.

Factors that Affect the Quality of Cooked Meat. Since the eating quality is the final test of good meat, factors that affect this property are important. In a paper on factors that affect the quality of beef, Gaddis, Hankins, and Hiner (1950) stated that the quantity and quality of juice were among the factors that affect eating quality. According to Mackintosh, Hall, and Vail (1936) the desirability of any piece of meat is measured almost entirely by its flavor, juiciness, and tenderness. These authors pointed out that the tenderness of the meat was of prime importance. Although these studies were reported on beef, the same factors apply to pork.

The particular muscle cooked, and especially the portion of the muscle used, have been shown to be factors that affect the quality of cooked meat. Other factors are the temperature at which the meat is cooked and the flavor that is developed during cooking. Weir (1953) reported that both the organoleptic method and the Warner-Bratzler shearing apparatus indicated that the middle sections of the longissimus dorsi muscle of pork were less tender than the anterior or posterior portions.

Gaddis, Hankins, and Hiner (1950) suggested that if beef or lamb were cooked to a degree of doneness that involved no serious

loss of moisture, a cut with low intramuscular fat should yield more press fluid than one with a high fat content, chiefly because cooking resulted in removing the fat. Since fat tends to hold moisture, the loss of fat would mean that there was less moisture in the tissue to be expressed by mechanical means. This discussion was related to beef and lamb, but the same principle may explain why pork is not as juicy as some other meats. Pork must be cooked well-done; the long cooking period and subsequent dripping as well as volatile losses would tend to make the pork dry.

Since pork is from a fat young animal, there is an inherent tenderness in the meat due to the lack of connective tissue. Therefore, pork yields many cuts suitable for roasting. (Committee on Preparation Factors of the National Cooperative Meat Investigations, 1942). This same committee recommended an oven temperature of 350° F., and an internal temperature of 176° to 185° F. to insure thorough cooking of pork. Care should be taken that the thermometer bulb is well down into the center of the roast when the temperature is read, since the coagulation of meat proteins sometimes forces the bulb upward out of the meat. A roasting pan protects the lower part of the roast, the committee reported, and does not allow such rapid heat penetration as in the top of the roast.

Child and Satorius (1938) found that there was no difference in the volume of press fluid from the longissimus dorsi muscle of pork when it was roasted well done at temperatures of 100°, 125°, 175°, and 200° C. (212°, 257°, 347°, and 392° F.), but more pounds

of force were required to shear a core of meat cooked at 200° C. (392° F.) than were required to shear a core of meat cooked at 125° C. (257° F.).

Measuring the Quality of Cooked Meat. Meat may be measured for quality either subjectively, by a selected panel of experienced judges, or objectively by instruments developed for the measuring of given factors. Factors scored by the panel of judges are aroma, flavor of fat and lean, tenderness, and juiciness. Factors measured mechanically are juiciness, through fluids expressed from a given sized sample of meat, and tenderness, by force required to shear a core of meat.

Howe and Barbella (1937) discussed the flavor of meat and meat products in relation to evaluation by a taste panel. Flavor of meat should be recognized as a combination of variable factors that leave different impressions with different judges, no matter how experienced they are. Meat flavor, in its truest sense, consists of the stimuli given to the taste buds by inherent organic and inorganic substances such as water soluble extractives, lipids, small amounts of carbohydrates and salts of compounds produced by these products, and by proteins during cooking. Roasted or broiled meats have two zones of flavor, the outer portion subjected to browning, and the inner portion heated slowly, by induction, and not browned. To maintain a standard for the judges, it was recommended that the inner portion be the part submitted to the taste panel for judgment.

Crocker (1948) conducted a detailed study of meat flavors. He found that neither bones nor fat contribute to flavor. He

stated that cooked beef flavor is a complicated sensation due to volatile substances that are fragrant, moderately acidic, slightly burnt, distinctly goaty, and definitely sulfury. The flavor of pork was found to have a fundamentally meaty character like beef but with more sweetness of taste. A flavor described as "piggy" was noted as characteristic of the animal.

There are many reports in the literature that describe the factors which contribute to toughness of meat. Some of these reports compare the scores of the taste panel with the values obtained with the shearing apparatus. Mackintosh, Hall, and Vail (1936) stated that the palatability committee is a partial solution to the problem of testing for tenderness, but it is open to criticism because of the personal elements involved. In their work, the chief handicap to the shearing apparatus was the lack of means of securing a uniform sample. However, they found that a correlation did exist between shear values and the tenderness scores of a palatability committee.

Other investigators have found a close correlation between tenderness scores of a taste panel and shear values of meat. Ramsbottom, Strandine, and Koonz (1945) found a high correlation between the shear values of beef muscle and the organoleptic rating. They stated that factors other than fat and connective tissue have profound effects on tenderness. These factors include the amount of denaturation and coagulation of muscle protein, and the degree of hardening or shrinking of the fibers.

Deatherage and Garnatz (1952) found no close relationship between the tenderness determinations by a sensory panel and by

shear strength measurements on the longissimus dorsi muscle of beef. In view of the poor correlation between the taste panel and shear machine scores, it was presumed that shear strength and tenderness are not the same property of meat. Therefore, the use of "shear strength" and "tenderness" as synonyms should be avoided, these investigators believe. They stated that for fundamental investigations of tenderness as a consumer quality attribute of meat, the sensory panel appeared to be the preferred method for guiding research.

Hardy and Noble (1945) found that judgments of juiciness in meat varied greatly. The judges who scored the longissimus dorsi muscle of pork in several test periods, separated by at least a week, had varied scores from period to period, but maintained a standard for scoring within each test. The authors stated that this indicated the judges were scoring a real factor; not the amount of juice alone, but a combination of the quantity of juice and other factors. Seimers and Hanning (1953) reported that physiological factors such as the greater flow of saliva in the presence of fat may be involved in testing meat for juiciness by organoleptic methods.

The results of studies concerned with the correlation of judges' scores for juiciness and press fluid yields are varied. Some of these differences may be attributed to the two types of apparatus generally used for measuring press fluid. However, this does not account for all of the differences that have been reported. The pressometer, employed by Childs and Moyer (1938), requires a sample of approximately two grams, and a pressure of

250 pounds per square inch applied for five minutes. The press fluid is calculated on the difference in the weight of the sample before and after pressing, and is expressed in percent.

The Carver Laboratory Press described by Hay (1952) is another type of apparatus used to determine press fluids. This instrument takes samples of ground meat ranging from 25 to 45 g. A pressure of 4,000 pounds per square inch is gradually built up over a period of 15 minutes. The press fluid is measured in a graduated centrifuge tube and is expressed as milliliters per gram of sample. The 25 to 45-gram sample used with this instrument has three advantages over the sample used in the pressometer. With the larger sample there is less chance for error than with the 2-gram sample. Also, there is opportunity for obtaining more representative sampling with the 25 to 45-gram sample than with the 2-gram sample. Then, too, when the expressed fluid is collected in graduated centrifuge tubes, the ratio of fat to serum in the fluid may be determined.

Satorius and Child (1938) compared panel scores for juiciness and the press fluid values as determined with the pressometer, for the longissimus dorsi muscle of beef and pork. They found a positive, but nonsignificant correlation of 0.31 between juiciness scores and the percentage of press fluid. Hardy and Noble (1945) used the same apparatus for measuring the press fluid of pork loin roasts, and obtained a highly significant correlation (from 0.32 to 0.51) between juiciness scores and percentage of press fluid. It is interesting to note that although these correlation coefficients were highly significant, the authors considered them too low to be of importance. A large number of degrees of

freedom was the explanation given for the highly significant correlations.

Although statistical correlations were not given, there were other studies where both subjective and objective methods of measuring the juiciness of meat were used in which there was a positive relationship between judges' scores and press fluid yields. For example, Harrison, Lowe, McClurg, and Shearer (1949) found that press fluid values followed the same pattern as juiciness scores when they studied the effect of aging in beef. The press fluid yields for this study were found by means of the pressometer. Hay, Harrison, and Vail (1953), on the other hand, found in a study of the use of a tenderizer on beef that significant differences in scores for juiciness of top round steaks were not accompanied by significant differences in press fluid yields as determined by the Carver Laboratory Press.

Histological Studies

General Characteristics of Muscle. Lowe (1943) described beef muscle in some detail, and stated that pork muscle is very similar, except that the fibers are narrower and there is less connective tissue. Muscle is made up of fibers held together by connective tissue and surrounded by a sheath of heavier connective tissue. Fibers are grouped in bundles called fasciculi. The size of the bundles varies in different muscles. Connective tissue, which varies in thickness, surrounds the fasciculi. Any of the connective tissue may contain small globules of fat. Muscle fibers are described as elongated, cylindrical, multinucleated cells. Each fiber is enclosed in a sacrolemma which

is a thin, colorless, elastic membrane, about 1 millimicron thick. Each fiber has longitudinal and cross striations, with the cross striations usually more distinct. The fat cells are spherical unless packed together so closely that the shape is changed to polyhedral. The amount of fat and the size of the fat cells vary with the nutritional state of the animal and with its age.

Effect of Cooking. Ramsbottom, Strandine, and Koonz (1945) found that cooking beef muscle produced a pronounced change in collagenous connective tissue but very little change in elastic connective tissue. Cooked muscle fibers were more compact than uncooked fibers and had indistinct and irregular borders.

Wang, Rasch, Bates, Beard, Pierce, and Hankins (1954) found that the nature of the adipose tissue in meat changed on cooking. They studied cooked samples of longissimus dorsi and semitendinosus muscle from beef. Fat movement from fat cells to perimysial spaces with changes in the physical form of the fat were observed. The escape of the fat from the fat cells took place in individual endomysial fat cells as well as in larger fat islands in the perimysia. The walls of the fat cells were intact, indicating that the fat had diffused out of the cell without structural damage. The fat was found to undergo progressive dispersion from the source, spreading as it proceeded, and often resulting in a trail of considerable size.

EXPERIMENTAL PROCEDURE

Meat Used

Preslaughter Treatment. The meat for this experiment was taken from hogs raised by the Department of Animal Husbandry as part of a longer experiment planned by the Agricultural Experiment Station. Weanling pigs were fed the following rations: (1) a basal ration adequate for growth, (2) the basal ration plus 10 mg aureomycin hydrochloride per pound of feed, and (3) the basal ration plus terramycin hydrochloride in the same amount. The basal ration consisted of yellow corn, soybean oil meal (solvent), alfalfa meal, tankage, salt, steam bone meal, and vitamin D_2 (Table 7, Appendix). This ration was mixed with three levels of protein. At the beginning of the experiment the ration contained 18 percent of protein. After the pigs were on the experiment for 45 days, the protein was reduced to 15 percent. Seven days after the animals reached a weight of approximately 100 pounds, the protein was further reduced to 12 percent. The pigs were kept on this ration until they reached a weight of 225 pounds, and then they were slaughtered.

The experiment was divided into two parts. In the first part, four pigs were fed each ration, and were slaughtered in February and March; in the second part, five pigs were fed each ration, and were slaughtered in August and September.

Postslaughter Treatment. After slaughtering, the carcasses hung in the Animal Husbandry cooler at a temperature of 36° F. until the internal temperature of the hams reached 36° F. Ribs

9 through 13, taken from the left loin of each carcass, were wrapped loosely in cellophane and stored in a household refrigerator over night. The meat was roasted to an internal temperature of 185° F. in a rotary oven maintained at 350° F.

Methods of Measuring the Quality of the Pork

Palatability Tests. Slices of lean meat approximately one-eighth inch thick and cut across the grain of the longissimus dorsi muscle were scored by a panel of six experienced judges for aroma, flavor of lean, juiciness, and tenderness (Plate I). Also, samples from the inside fat layer covering the longissimus dorsi muscle were scored for flavor. The score card had a range of 7 points, with 7 being the highest score possible for each factor (Form I, Appendix). The scores for each palatability factor were averaged and analyzed statistically.

Objective Tests. Five objective tests were used to measure the quality of the roasts. These included the cooking time; volatile, dripping, and total cooking losses; shear values; press fluid yields; and certain histological characteristics. The cooking time was figured in minutes per pound and the cooking losses in percent.

To obtain shear values, one sample was taken from the center of the longissimus dorsi muscle of each roast (Plate I). A core of cooked meat one inch in diameter and parallel to the fiber axis was removed with a sharp-edged metal cylinder and sheared on the Warner-Bratzler shearing apparatus. This instrument measures the force, in pounds, required to shear a one-inch core

EXPLANATION OF PLATE I

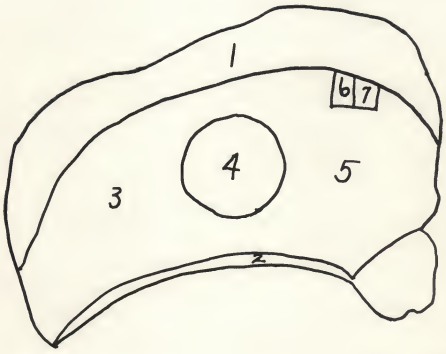
Cooked Roast

1. Fat.
2. Bone.

Sampling of the longissimus dorsi muscle

3. Slices for palatability.
4. Core for shearing.
5. Samples for press fluids.
6. Cooked sample for histological studies.
7. Raw sample for histological studies.

PLATE I



of meat. Four shears were made on each core; the values were averaged and analyzed statistically.

The cooked meat sampled for press fluid yields was taken from the longissimus dorsi muscle (Plate I). The fat and muscle sheath were trimmed from the meat, which was then ground in a Universal home grinder and mixed well. A 25-gram sample of the ground meat was packed in the 2.25-inch metal cylinder of the Carver Laboratory Press in the following manner. A double layer of cheese cloth was used to line the cylinder. A circle of 5.5 centimeter filter paper was placed on the cheese cloth in the bottom of the cylinder. The meat was added in three layers with a layer of filter paper separating each layer of meat. Another piece of filter paper was placed on top, the cheese cloth folded over this, and the whole covered by a leather disk. The metal plunger was placed in the cylinder, the cylinder put on a shallow metal pan, and the entire assembly placed in the Carver Laboratory Press. The schedule for applying the pressure over a 15 minute period was:

Time in minutes	Pressure* in pounds
1.0	5,000
2.0	7,500
3.0	10,000
5.0	10,000
7.5	12,500
10.0	15,000
11.0	16,000
15.0	16,000

* The pressure in the schedule refers to the load on the 1.25 inch ram of the test cylinder. The maximum load on the meat was 4,000 pounds per square inch.

The expressed fluids were collected in the shallow pan, and any fluid clinging to the cylinder was coaxed into the pan with the aid of a rubber policeman. The fluid was poured into a graduated centrifuge tube and stored in a refrigerator overnight. The amount of total fluids, serum, and fat were recorded the following morning. Two press fluid determinations were made on aliquots of the ground meat, the results averaged, and the data for the total volume of press fluid analyzed statistically.

For histological studies, adjacent raw and cooked samples, cut parallel to the long axis of the fibers, were taken from each loin and placed in physiological salt and formalin solution. Immediately prior to sectioning, each sample was trimmed into a block about 6 mm square and placed in tap water until cut on the freezing microtome. The sections were sliced 25 microns thick, and stained with Harris's Hematoxalin and Sudan IV. The sections were then washed in tap water and mounted on slides in glycerine jelly. This treatment resulted in fat stained red, and the muscle blue with the nuclei a darker blue. Specific sectioning, staining, and mounting procedures are given in the Appendix.

The following arbitrary numerical evaluations published by Ramsbottom, Strandine, and Koonz (1945) for estimating connective tissue were used to estimate the amount of fat present in the samples.

Relative amount of fat	Numerical value
none	1
small	3
medium	5
large	7

The number of fibers in a microscopic field obtained with a 10x eyepiece and a 43x objective were counted. This procedure gave the relative width of the fibers in the longissimus dorsi muscle.

RESULTS AND DISCUSSION

The experiment was divided into two parts; part I being carried out in February and March, and part II in August and September. In each part of the experiment, the pigs used were divided into three lots. One lot was fed a control ration; the second, the control ration plus aureomycin; and the third, the control ration supplemented with terramycin.

Data were obtained to measure the effect of these rations on the quality of rib roasts. The data for the roasts from each lot of pigs were averaged for each part of the experiment. Also, average values were determined for the two parts of the experiment. Separate analyses of variance were run on the data from parts I and II.

Cooking Time and Cooking Losses

The average cooking times for the roasts in the two parts of the experiment were nearly the same. The roasts from pigs fed the aureomycin ration required the longest cooking time, an

average of 45.6 minutes per pound, while those in the control and terramycin groups required 43.2 and 41.8 minutes per pound, respectively (Table 1).

In part I of the experiment, there were little differences in the average cooking time for roasts from the three groups. However, there were large differences in cooking time among the roasts from each lot of pigs. In the control group, for example, there was a range from 37.2 to 50.6 minutes per pound (Table 2). The extremes in cooking time for roasts in the aureomycin group were 39.4 and 51.0 minutes per pound, whereas in the terramycin group, they were 37.1 and 47.7 minutes per pound.

Like part I, data from part II showed practically no difference in cooking time among the three groups of roasts. Also there was a great deal of variation in cooking time within each group of roasts, but at the most, the averages differed only two minutes per pound (Table 3).

Average cooking losses for the entire experiment are given in Table 1, and those for each roast in Table 2. Differences in cooking losses due to treatment were insignificant (Table 4). The variation in the average total cooking losses for the roasts from the different groups was small (Table 2). As might be expected, roasts which required the longest cooking time, that is, the aureomycin group, also lost the most weight during cooking, an average of 24.7 percent (Table 1). The slightly shorter cooking times necessary for the control and the terramycin roasts were reflected in smaller cooking losses, 22.3 and 20.9 percent, respectively (Table 1). Generally, variations in cooking losses

Table 1. Average cooking time, cooking losses, palatability scores, shear force values, and press fluid yields of pork roasts.

Treatment	Cooking time	Cooking losses			Aroma	Flavor score		Tenderness		Juiciness	
		Vol.	Drip.	Total					Shear		P/fluid
	min./lb.	%	%	%	scores	Lean	Fat	Score	lbs.	Score	ml/25 g
Control Ration											
Part I	43.1	9.5	11.8	21.4	5.7	6.0	5.8	5.9	12.8	5.9	9.4
Part II	43.3	11.0	12.2	23.1	6.7	6.6	6.3	5.8	13.2	5.5	7.2
Average	43.2	10.3	12.0	22.3	6.2	6.3	6.1	5.9	13.0	5.7	8.3
Aureomycin Ration											
Part I	45.8	12.7	13.4	26.2	5.6	6.0	5.5	5.2	15.4	5.1	7.9
Part II	45.4	11.6	11.7	23.2	6.5	6.5	6.2	5.5	13.0	5.3	7.5
Average	45.6	12.2	12.5	24.7	6.0	6.3	5.8	5.3	14.2	5.2	7.7
Terramycin											
Part I	41.5	8.8	11.6	20.5	5.5	5.9	5.7	5.4	13.2	5.3	8.5
Part II	42.2	10.1	10.9	21.3	6.4	6.0	5.9	5.6	13.5	5.2	7.7
Average	41.8	9.4	11.2	20.9	5.9	5.9	5.8	5.5	13.3	5.2	8.1

Table 2. Cooking time, cooking losses, palatability scores, shear force values, and press fluid yields of pork roasts. Part I.

Treatment and Roast No.[a]	Cooking time min./lb.	Cooking losses: Vol. %	Drip. %	Total %	Aroma scores[b]	Flavor score: Lean[b]	Fat	Tenderness: Score[b]	Shear lbs.	Juiciness: Score	P/fluid ml/25 g
Control Ration 67A'	44.0	9.5	11.6	21.1	5.7	6.6	5.0	5.6	12.4	5.8	9.8
68A'	37.2	7.9	7.8	15.7	5.5	5.8	6.2	6.0	14.0	6.2	9.6
69A'	40.7	10.8	11.7	22.5	5.7	5.5	6.2	6.3	9.8	5.8	9.5
70A'	50.6	9.9	16.4	26.3	6.1	6.3	6.1	5.8	15.0	5.8	9.0
Average	43.1	9.5	11.8	21.4	5.7	6.0	5.8	5.9	12.8	5.9	9.4
Aureo-mycin Ration[c] 71A'	51.0	16.0	14.0	30.0	6.8	6.6	6.0	5.3	16.9	5.5	6.2
73A'	39.4	9.7	10.8	20.5	5.4	5.8	5.0	5.3	16.6	4.8	7.6
74A'	48.4	12.5	15.0	27.5	4.8	5.5	6.0	5.4	15.5	5.0	7.7
75A'	44.6	12.6	13.9	26.5	5.5	6.3	5.2	4.8	13.8	5.2	10.2
Average	45.8	12.7	13.4	26.2	5.6	6.0	5.5	5.2	15.4	5.1	7.9
Terra-mycin Ration[c] 76A'	43.6	10.9	12.9	23.8	5.0	5.4	5.8	5.4	12.2	4.8	7.2
78A'	47.7	9.5	13.1	22.6	5.6	6.4	5.0	6.0	11.5	5.6	8.7
79A'	37.1	7.3	9.9	17.2	6.0	5.8	6.3	4.5	17.5	5.8	7.8
80A'	37.5	7.7	10.8	18.5	5.5	6.2	5.5	5.5	11.7	5.3	10.2
Average	41.5	8.8	11.6	20.5	5.5	5.9	5.7	5.4	13.2	5.3	8.5

[a] Ribs 9 through 13 from the carcass of the given animal number; ' after the number indicates the left side of the carcass.

[b] Maximum score possible, 7.0.

[c] 10 mg/lb. of ration.

Table 3. Cooking time, cooking losses, palatability scores, shear force values, and press fluid yields of pork roasts. Part II.

Treatment and Roast No.[a]	Cooking time min./lb.	Cooking losses: Vol. %	Drip. %	Total %	Flavor score: Aroma scores	Lean[b]	Fat	Tenderness: Score[b]	Shear lbs.	Juiciness: Score	P/fluid ml/25 g
Control Ration 1A'	44.8	13.1	13.0	25.4	6.8	6.6	6.6	6.0	16.0	5.3	6.1
2A'	37.6	10.1	12.0	22.1	6.5	6.5	6.0	6.0	9.4	5.0	8.8
3A'	42.2	9.2	9.6	19.0	6.6	6.6	6.2	5.8	11.0	5.6	6.8
4A'	48.5	12.4	13.8	25.5	6.6	6.5	6.0	5.8	17.8	6.0	5.7
5A'	43.5	10.2	12.8	23.2	6.8	6.8	6.5	5.8	11.8	5.6	8.9
Average	43.3	11.0	12.2	23.1	6.7	6.6	6.3	5.8	13.2	5.5	7.2
Aureo- mycin Ration[c] 6A'	39.1	10.8	11.8	22.1	6.5	6.5	6.3	6.0	13.6	5.3	8.7
7A'	48.1	11.0	13.0	24.0	6.6	6.4	6.0	5.4	10.5	5.4	7.1
8A'	54.1	14.7	11.6	26.3	6.8	6.6	6.6	5.8	12.9	5.3	6.2
9A'	40.2	9.7	9.6	18.2	6.4	6.4	6.1	4.9	14.0	5.1	7.8
10A'	45.4	11.8	13.5	25.5	6.4	6.6	6.0	5.6	13.8	5.2	7.6
Average	45.4	11.6	11.7	23.2	6.5	6.5	6.2	5.5	13.0	5.3	7.5
Terra- mycin Ration[c] 11A'	41.1	11.4	10.3	21.8	6.5	6.3	6.3	5.5	10.3	5.2	9.0
12A'	37.2	9.9	10.1	20.1	6.3	6.3	6.4	5.6	11.4	4.9	7.5
13A'	40.2	8.0	9.2	17.4	6.2	5.0	5.2	5.2	16.6	5.2	9.0
14A'	44.1	10.3	11.1	21.8	6.6	6.8	6.3	5.5	16.5	5.6	5.4
15A'	48.3	11.0	13.9	25.2	6.2	5.8	5.4	6.0	12.5	5.0	7.6
Average	42.2	10.1	10.9	21.3	6.4	6.0	5.9	5.6	13.5	5.2	7.7

[a] Ribs 9 through 13 from the carcass of the given animal number; ' after the number indicates the left side of the carcass.

[b] Maximum score possible, 7.0.

[c] 10 mg/lb. of ration.

Table 4. F-values for analyses of variance of cooking losses, palatability factors, shear values, and press fluid yields.

Part	Total cooking losses	Aroma	Flavor: Fat	Flavor: Lean	Tenderness: Score	Tenderness: Shear	Juiciness: Score	Juiciness: Press fluid
I	2.2 ns.	0.16 ns.	0.34 ns.	0.04 ns.	3.2 ns.	1.5 ns.	5.6 *	0.14 ns.
II	0.69 ns.	1.2 ns.	0.81 ns.	2.0 ns.	1.7 ns.	0.0038 ns.	0.17 ns.	0.11 ns.

ns. Non-significant
* Significant at the 5 percent level.

among individual roasts followed the variation in cooking time (Tables 2 and 3). Total cooking losses were composed of approximately the same percentage of volatile and dripping losses.

Palatability Factors

Aroma and Flavor. Since aroma and flavor are so closely related, these two palatability factors are discussed together. The average aroma and flavor scores for each group of roasts are given in Table 1, and those for the individual roasts in Tables 2 and 3. There was no significant difference among the three groups of roasts in the aroma and flavor scores for either part of the experiment, nor was there much variation in the scores within a treatment. In each part of the experiment, the roasts in the terramycin group scored the lowest number of points, while the control group scored the highest (Table 1). However, the scores were close enough that the low terramycin flavor score might be attributable to a personal rather than a flavor factor.

Tenderness. The tenderness of the meat was measured by judges' scores and shear values. Tenderness scores for individual roasts in each part of the experiment are given in Tables 2 and 3. Statistical analyses showed no significant difference in the tenderness scores or the shear values of the three groups of roasts in either part of the experiment. The average scores, as given in Table 1, varied only 0.5 of a point from the lowest score, for aureomycin roasts, to the highest, for the control roasts. Similar to the tenderness scores, the shear values for all three groups of roasts were much the same. A high score and low shear value indicate tenderness, and the shear values as well as tenderness scores rated the control roasts as most tender and those in the aureomycin group, the least tender. There was practically no difference in tenderness of the control and terramycin roasts. In both parts I and II there was some variation in the scores of individual roasts within a group. In part I, the greatest difference amounted to 1.5 points, and occurred in the terramycin roasts. The shear values for these same roasts varied in similar fashion; the most tender roast as judged by the palatability panel having a shear value of 11.5, and the least tender roast having a shear value of 17.5. Thus, a positive relationship between palatability scores for tenderness and shear values was demonstrated.

Juiciness. Judges' scores for juiciness did not show as definite a positive relationship to press fluid yields as the palatability scores did to shear values. Average juiciness scores by the palatability committee and average press fluid

yields for both parts of the experiment are given in Table 1. Average figures show that the control group had the highest juiciness scores and press fluid yields. The average juiciness scores for aureomycin and terramycin are the same, but the terramycin group had a higher average press fluid yield than the aureomycin roasts. The explanation for this disagreement is probably that the palatability panel and the Carver Laboratory Press do not measure exactly the same factors. There are a variety of factors that enter into the judgment of juiciness by a panel (Seimers and Hanning, 1953). These include psychological factors as well as the amount of fat present in the meat and the temperature of the sample.

Average juiciness scores for individual roasts are given in Tables 2 and 3. In part I, but not in part II, there was a significant difference in the juiciness scores for the roasts from the three groups of pigs. There was no significant difference among treatments for press fluid yields in either part of the experiment (Table 4).

As in the over-all averages, the roasts in the control group of the first part of the experiment had the highest juiciness scores and press fluid yields. The lowest juiciness score was 5.1 for the aureomycin roasts. Variations within groups in part I were not large; the most, 1.0, was found in the terramycin group of roasts. Press fluid yields varied to a greater extent than juiciness scores within groups. The greatest variation was in the aureomycin group of part I. The press fluid yields for these roasts varied from 6.2 to 10.2 ml/25 g of meat. In part

II, the highest juiciness score was that of the control roasts, but the terramycin group of roasts had the highest press fluid yields. Conversely, the lowest juiciness score, 5.2 points, was that of the terramycin roasts while the lowest press fluid yields were those of the control group. Variations similar to those in part I occurred in the terramycin roasts of part II.

Gaddis, Hankins, and Hiner (1950) stated that fat loss in cooking would cause moisture loss in the meat, since fat tends to hold water. This would indicate that juiciness scores and press fluid determinations should be related in the amount of fat present in the total press fluids. This was not true in the experiment presented here. Higher juiciness scores were given roasts in which a smaller amount of fat was found in the press fluid than those with a larger amount of fat. In part I, for example, the average amount of fat in the press fluid from the terramycin group of roasts ranged between 1.5 ml/25 g of meat to 0.9 ml/25 g sample. Juiciness scores for that group were the reverse, the highest score, 5.8 points, given the same roast as had the least amount of fat, 0.9 ml/25 g.

The average palatability scores given in Table 1 showed that the roasts in the control group of both parts of the experiment generally were rated highest. The control group also had the lowest shear value, an indication of more tender meat, and the highest press fluid yield in part I. Although the differences in the average figures were small, this showed a general trend of highest scores to the control group of roasts. However, the differences were not great enough to be statistically significant,

and would probably not make much difference in the consumer's choice of meat. The roasts in the aureomycin group scored the next highest in most of the palatability factors, and those in the terramycin group had the lowest average scores.

Histological Characteristics

The histological characteristics of the meat in this experiment were determined on a small sample taken from the longissimus dorsi muscle of each roast (Plate I). It is possible that other variations than those reported in this discussion occurred in the meat in other parts of the animals involved in the study. However, since the samples were taken from the same general area of the longissimus dorsi muscle of each roast, it was believed that comparisons could be drawn on that basis.

The width of the fibers of the longissimus dorsi muscle, and the amount and deposition of fat are the two histological characteristics reported here. The number of fibers in a microscopic field obtained with a 10x eyepiece and a 43x objective was used as a basis for the determination of the relative width of the fibers. Since the width of the fibers found in meat is believed to be related to the tenderness of the meat, with the most tender meat having the finest fibers, these figures are of interest. Fat deposits are important also, since well-marbled meat is usually judged more tender and juicy than meat with little fat. Generally, when fat was found on the slides in large amounts, most of it was in lacy connective tissue in large clumps of many cells (Plates II and IV). Some was deposited between fibers as

EXPLANATION OF PLATE II

There is a large amount of fat shown in the slide made from a roast in the aureomycin group. The fat is distributed throughout the tissue, partly in large clumps as in the top of the photomicrograph, and in smaller amounts between the fibers. Some empty fat cells with intact walls may be seen in the tissue at the top of the picture.

PLATE II

EXPLANATION OF PLATE III

A moderate amount of fat found as most typical in roasts from the terramycin group is shown in this photomicrograph. The fat is distributed throughout the tissue, sometimes in moderate sized clumps as seen near the top of the picture, and sometimes between fibers as in the lower part of this picture.

PLATE III

EXPLANATION OF PLATE IV

The large amount of fat in this photomicrograph of a slide made from a roast in the control group is similar in distribution and amount to that in Plate II. Large clumps of fat may be seen near the top of the picture in lacy connective tissue, with smaller clumps in the center and lower parts of the picture. A small amount of fat may be seen between the muscle fibers throughout the tissue.

PLATE IV

single cells in a row, similar to a string of beads as in Plate II. In the cases where there was a moderate amount of fat, it was distributed mostly as clumps of cells in connective tissue with some individual cells between fibers (Plate III).

Averages of the mean number of muscle fibers found in the samples from roasts in parts I and II are given in Table 5.

Table 5. Average of the mean number of muscle fibers and fat scores for parts I and II.

Ration	Muscle fibers			Fat score*		
	Cooked	Raw	Average	Cooked	Raw	Average
Control						
Part I	6.1	6.4	6.2	5.5	5.1	5.3
Part II	6.9	6.4	6.7	5.9	5.5	5.7
Average	6.5	6.4	6.4	5.7	5.3	5.5
Aureomycin						
Part I	6.1	5.8	5.9	4.1	4.9	4.5
Part II	6.6	6.3	6.4	6.2	6.8	6.5
Average	6.8	6.0	6.1	5.1	5.8	5.5
Terramycin						
Part I	6.2	5.6	5.9	5.4	5.6	5.5
Part II	6.9	6.1	6.5	5.2	5.2	5.2
Average	6.5	5.8	6.2	5.3	5.4	5.3

* Scale for estimating amount of fat:

1 - none
3 - small
5 - moderate
7 - large

The slight difference in these numbers shows that there was little variation in the width of muscle fibers from pigs given the three treatments. The highest average for cooked and raw tissues was

6.4, indicating the narrowest fibers occurred in the muscle from the control group. This was only 0.3 of a point higher than the lowest number which was found in the muscle from pigs fed aureomycin. Even though these differences were small, there is agreement with the tenderness scores and shear values which shows that the roasts from the control group were the most tender and those from the aureomycin group, the least tender. Terramycin groups averaged 6.2 muscle fibers for cooked and raw tissue in the microscopic field used.

The average scores for number of fibers from muscles of the individual roasts in part I of the experiment are given in Table 6. Five slides made from raw and five from cooked samples of each roast were averaged to obtain these figures, except for 78A' raw where the fibers were too broken and torn to count. The average did not vary greatly among treatments. Following the over-all average (Table 5), the largest average number of fibers from raw and cooked samples, 6.2, were found in muscle from the control group, with aureomycin and terramycin having the same average number, 5.9. The average number of fibers in the muscle from one group of samples varied to a greater extent than the average of the mean number of fibers among treatments. The average number of fibers in the muscle from groups in part I ranged from 5.8 to 7.1 for the controls; 5.5 to 6.6 for aureomycin; and 5.4 to 6.6 for terramycin treatments.

In part II of the experiment, the diameter of the fibers appeared to be about the same as in part I. The largest average number of muscle fibers from raw and cooked samples, 6.7, were

Table 6. Average number* of muscle fibers and fat score for individual roasts, parts I and II.

Ration	Muscle fibers: Cooked	Raw	Average	Fat score**: Cooked	Raw	Average
			Part I			
Control						
67A'	6.2	6.0	6.1	5.5	4.0	4.7
68A'	5.8	6.1	5.9	5.3	3.3	4.3
69A'	6.0	5.7	5.8	4.8	7.0	5.9
70A'	6.5	7.8	7.1	6.3	6.3	6.3
Average	6.1	6.4	6.2	5.5	5.1	5.3
Aureomycin						
71A'	5.6	5.9	5.7	4.0	5.0	4.5
73A'	5.6	5.4	5.5	2.5	4.0	3.2
74A'	6.6	5.5	6.0	4.0	4.6	4.3
75A'	6.8	6.5	6.6	6.0	6.0	6.0
Average	6.1	5.8	5.9	4.1	4.9	4.5
Terramycin						
76A'	7.2	6.1	6.6	6.0	6.5	6.3
78A'	6.1	--	6.1	6.0	4.5	5.2
79A'	6.0	5.5	5.7	6.5	6.0	6.3
80A'	5.5	5.4	5.4	3.0	5.3	4.1
Average	6.2	5.6	5.9	5.4	5.6	5.5
			Part II			
Control						
1A'	7.1	5.8	6.4	3.0	5.3	4.1
2A'	6.5	7.1	6.8	5.5	5.0	5.3
3A'	6.6	6.2	6.4	7.0	5.0	6.0
4A'	7.5	6.5	7.0	7.0	6.0	6.5
5A'	6.8	6.5	6.6	7.0	6.0	6.5
Average	6.9	6.4	6.7	5.9	5.5	5.7

* Average number in microscopic field with 10x eyepiece, 43x objective.

** Scale for estimating amount of fat:

1 - none
3 - small
5 - moderate
7 - large

Table 6 (concl.).

Ration	Muscle fibers			Fat score		
	Cooked	Raw	Average	Cooked	Raw	Average
Aureomycin						
6A'	6.0	6.0	6.0	6.0	7.0	6.5
7A'	6.1	6.5	6.3	7.0	7.0	7.0
8A'	7.3	7.3	7.3	5.0	7.0	6.0
9A'	6.6	5.1	5.8	7.0	6.0	6.5
10A'	7.0	6.6	6.8	6.0	7.0	6.5
Average	6.6	6.3	6.4	6.2	6.8	6.5
Terramycin						
11A'	7.0	5.6	6.3	5.0	5.0	5.0
12A'	7.0	6.0	6.5	5.0	4.0	4.5
13A'	7.1	6.6	6.8	7.0	7.0	7.0
14A'	6.6	6.5	6.5	5.0	6.0	5.5
15A'	6.9	5.8	6.3	4.0	4.3	4.2
Average	6.9	6.1	6.5	5.2	5.2	5.2

counted for the control group. However, in the terramycin group, the average number of muscle fibers was slightly higher, 6.5, than in the aureomycin group which averaged 6.4. There was some variation within treatments with ranges of 5.9 to 7.0 in the control group; 5.8 to 7.3 in the aureomycin group; and 6.3 to 6.8 in the terramycin group.

Average fat scores for muscle tissue from pigs fed the three rations in part I are similar (Table 6). The highest average fat score of 5.5 for both raw and cooked samples was given the roasts from the terramycin group with the average scores for the control group the next highest, 5.3, and aureomycin the lowest, 4.5. Fat scores varied within the treatments, and individual slides showed much variation. This difference could be attributed to a fat

deposit in the samples sectioned which did not appear in every slide for the roast.

In part II of the experiment, the fat scores varied more than in part I. The highest average fat score for the raw and cooked samples was 6.5, a large amount, in the aureomycin group. This was 1.3 points higher than the lowest scores 5.2, a moderate amount, for the terramycin group. There was also wide variation in the amount and distribution of fat within the sections from one group of roasts, especially in the roasts of the terramycin treatment where the range of scores was 4.2 to 7.0.

No definite conclusions can be drawn from the over-all picture, that is, the average of mean fat scores, because there was so much variation in the amount and distribution of fat in the individual slides made from sections of the same roasts and from samples of the roasts within any one group.

SUMMARY

The experiment was divided into two parts: part I was carried out in February and March, and part II in August and September. In each part of the experiment three lots of pigs were fed the following rations: (1) a control ration, (2) the control ration plus aureomycin hydrochloride, and (3) the control ration plus terramycin hydrochloride. The pigs were slaughtered as each of them reached a weight of 225 pounds, and roasts consisting of ribs 9 through 13 from the left side of each carcass were cooked at 350° F. to an internal temperature of 185° F.

Cooking time, in minutes per pound; and volatile, dripping,

and total cooking losses, in percent, were determined for each roast. A committee of seven judges scored the meat for aroma, flavor of lean and fat, tenderness, and juiciness. Samples of the cooked meat were sheared on the Warner-Bratzler shearing apparatus as an objective means for measuring tenderness, and pressed in the Carver Laboratory press to determine the fluids present in the meat. Histological sections of both raw and cooked meat were examined for the amount and distribution of fat and the width of the muscle fibers.

The data from this study indicate that the antibiotics in the rations of pigs had little, if any, effect on the cooking quality and palatability of the rib roasts. The average time required to cook the roasts was approximately the same for all three groups. However, there was a wide variation in the time necessary to cook the individual roasts within a group.

Analyses of variance showed that the three groups of roasts did not vary significantly in the following factors: total cooking losses, aroma, flavor of lean and fat, and tenderness as measured by a palatability panel and the Warner-Bratzler shearing apparatus. There were no significant differences in the juiciness scores for the three groups of roasts in part II, nor in the press fluid yields of the roasts in parts I and II. However, analysis of the juiciness scores for roasts in part I indicated a significant difference in juiciness which was due to treatment.

The histological characteristics differed widely among roasts and among slides of sections from the same roasts. The average number of fibers in a given field showed that the muscle

from the roasts in the control group had the narrowest fibers, although there were only slight differences in the average number of fibers in all three groups of roasts. The slides from the roasts of the control group and the aureomycin group had the highest scores for fat, and those from the terramycin group the lowest.

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APPENDIX

Table 7. Composition of basal ration.*

Ingredients	Percent protein in ration		
	18	15	12
Yellow corn	73.5	80.5	87.5
Soybean oil meal	11.0	7.0	5.0
Tankage	10.0	7.0	4.0
Alfalfa meal	3.0	3.0	2.0
Vitamin D	1.0	1.0	--
Steamed bone meal	0.5	0.5	0.5
Ground limestone	0.5	0.5	0.5
Salt	0.5	0.5	0.5

* Robinson, 1954.

Form I

MEAT COOKING RECORD

Grading Chart for Cooked Meat

Judge_____ Sample No._____ Kind_____ Date_____

FACTOR	PHASE	7	6	5	4	3	2	1	1	2	3	4	5
Aroma	Intensity	very pro.	pro.	m. pro.	s. pro.	per.	s. per.	imper.					
	Desirability	very des.	des.	m. des.	s. des.	neu- tral	undes.	undes.					
Flavor of Lean	Intensity	very pro.	pro.	m. pro.	s. pro.	per.	s. pro.	imper.					
	Desirability	very des.	des.	m. des.	s. des.	neu- tral	s. undes.	undes.					
Tenderness	Intensity	very tender	tender	m. tender	s. tough	tough	very tough	ext. tough					
Juiciness	Quantity of Juice	very juicy	juicy	m. juicy	s. dry	dry	very dry	ext. dry					
	Quality of Juice	very rich	rich	m. rich	s. rich	per.	s. per.	imper.					
Flavor of Fat	Intensity	very pro.	pro.	m. pro.	s. pro.	per.	s. per.	imper.					
	Desirability	very des.	des.	m. des.	s. des.	neu- tral	s. undes.	undes.					

Key to Abbreviations

pro. - pronounced
m. - moderately
s. - slightly
imper. - imperceptible
des. - desirable
undes. - undesirable
ext. - extremely
per. - perceptible

Comments:

SECTIONING, STAINING, AND MOUNTING PROCEDURE

Sectioning

The tissue to be sectioned was removed from the preservative, blotted on a paper towel, and cut to a block about 6 mm square. It was then placed in tap water. By means of a glass rod, a few drops of gum arabic were put on the corrugated surface of the freezing plate of the microtome. The block of tissue was laid on the gum arabic with forceps, and covered with gum arabic dropped from the glass rod. Only enough gum arabic was used to cover the tissue. The height of the freezing chamber was adjusted so that the upper edge of the tissue was level with the blade of the microtome knife. The automatic feed mechanism was set to cut sections 25 microns thick.

A small dish of tap water in which a wire basket was placed, was used to receive the sections as they were cut. The sections were removed from the microtome knife by means of a camel's-hair brush and transferred to the basket in the dish of tap water. The brush was wiped between transferring sections to help prevent excess moisture accumulating on the knife blade which would cause thawing of the frozen block.

Two difficulties in sectioning often arose. These and the reasons for them were: (1) too hard tissue caused the section to splinter and (2) too soft tissue caused tearing of the section. To correct the first difficulty, the tissue was allowed to thaw a few moments, or was rubbed lightly with the finger. The second difficulty was corrected by refreezing the tissue by turning the

valve to the freezing chamber on and off a few times.

Staining

The wire basket was lifted from the tap water with forceps and passed through reagents in the following manner for staining:

1. Dip for 1 minute in 30% alcohol
   50% alcohol
   70% alcohol.
2. Stain in the scarlet red solution 3 minutes
3. Wash 1 minute in 70% alcohol
   50% alcohol
   30% alcohol.
4. Wash in distilled water 1 minute.
5. Stain in hematoxylin 35 seconds (time depends on tissue and freshness of stain. Be careful not to overstain.).
6. Wash thoroughly in tap water, through at least 2 baths.

Mounting

The washed sections were lifted by means of a camel's-hair brush from the wire basket into a small dish of tap water. A clean microscope slide was held at a sharp angle with one end resting on the bottom of the dish. The sections were teased up on the slide with a needle. Two sections were mounted on each slide. The water was allowed to run off as the slide was lifted slowly from the water so that the tissue laid flat without folds or wrinkles. Excess water was wiped off with a lint-free cloth. A drop of warm glycerine jelly was put at one end of the tissue.

The cover glass was passed through a flame to warm it, then set at the same end as the drop of glycerine jelly so that the glycerine flowed along the edge of the glass. The glass was then lowered slowly enough over the sections to allow air bubbles to escape, and the glycerine jelly to run smoothly under the glass. These slides may be kept for over a year. However, the colors gradually fade, especially from the muscle fibers.

The results of the treatment were that the muscle fibers were stained blue with the nuclei a darker blue; the fat, orange to red; and the connective tissue, unstained.

Solutions

Scarlet Red

Make up a saturated solution of dye in equal parts of 70% alcohol and acetone. Keep in a tightly stoppered bottle.

0.5 g scarlet red (Sudan IV)
25.0 ml 70% alcohol
25.0 ml acetone

Filter before using.

Alum Hematoxylin

1.0 g hematoxylin
10.0 ml absolute alcohol
20.0 g alum
200.0 ml water
0.5 g mercuric oxide
0.4% acetic acid

Dissolve hematoxylin in alcohol. Add to warm solution of alum and water. Bring to boil and add mercuric oxide. The solution will bubble vigorously when this addition is made. Boil one minute longer, plunge flask into cold water and cool rapidly under the faucet. Add acetic acid just before using. The mercuric oxide ripens the stain.
Filter before using.

Freezing Gum Arabic

3 g gum arabic
5 ml water

Mix with glass rod. This should be mixed in small quantities as it molds readily.

Alcohols

70% alcohol

70.0 ml 95% alcohol
25.0 ml water

50% alcohol

50.0 ml 95% alcohol
45.0 ml water

30% alcohol

25.0 ml 95% alcohol
70.0 ml water

THE QUALITY OF PORK ROASTS AS INFLUENCED BY THE FEEDING OF ANTIBIOTICS TO HOGS

by

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AN ABSTRACT OF A THESIS

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INTRODUCTION

Reports on the feeding of antibiotics to swine have stated that this practice increases the utilization of feed, promotes growth, and decreases the occurrence of disease. However, few studies were found in the literature relative to the quality of the meat from pigs fed antibiotics. Therefore, this study was conducted to determine the effect of feeding two antibiotics, aureomycin hydrochloride and terramycin hydrochloride, on the cooking losses, palatability, and certain histological characteristics of fresh pork.

PROCEDURE

The experiment was divided into two parts; part I was carried out in February and March, and part II in August and September. In each part of the experiment three lots of pigs were fed the following rations: (1) a control ration, (2) the control ration plus aureomycin hydrochloride, and (3) the control ration plus terramycin hydrochloride. The pigs were slaughtered as each of them reached a weight of 225 pounds, and roasts consisting of ribs 9 through 13 from the left side of each carcass were cooked at 350° F. to an internal temperature of 185° F.

Cooking time, in minutes per pound; and volatile, dripping, and total cooking losses, in percent, were determined for each roast. A committee of seven judges scored the meat for aroma, flavor of lean and fat, tenderness, and juiciness. Samples of the cooked meat were sheared on the Warner-Bratzler shearing

apparatus as an objective means for measuring tenderness, and pressed in the Carver Laboratory press to determine the fluids present in the meat. Histological sections of both raw and cooked meat were examined for the amount and distribution of fat and the width of the muscle fibers.

RESULTS

The data from this study indicate that the antibiotics in the rations of pigs had little, if any, effect on the cooking quality and palatability of the rib roasts. The average time required to cook the roasts was approximately the same for all three groups. However, there was a wide variation in the time necessary to cook the individual roasts within a group.

Analyses of variance showed that the three groups of roasts did not vary significantly in the following factors: total cooking losses, aroma, flavor of lean and fat, and tenderness as measured by a palatability panel and the Warner-Bratzler shearing apparatus. There were no significant differences in the juiciness scores for the three groups of roasts in part II, nor in the press fluid yields of the roasts in parts I and II. However, analysis of the juiciness scores for roasts in part I indicated a significant difference in juiciness which was attributed to the ration.

The histological characteristics differed widely among roasts and among slides of sections from the same roasts. The average number of fibers in a given field showed that the sections made from the roasts in the control group had the narrowest fibers, although there were only slight differences in the

average number of fibers in all three groups of roasts. The slides from the roasts of the control group, and from the aureomycin group had the higher scores for fat, those from the terramycin group the lowest.