FACTORS AFFECTING THE INCIDENCE OF BREAST BLISTERS IN YOUNG MARKET TURKEYS

by

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INTRODUCTION

Regulations governing the inspection of poultry and poultry products in interstate or foreign commerce became mandatory on January 1, 1959. Article 81.84 of these regulations states, in part: "Any organ or part of a carcass which is affected by an inflamatory process shall be condemned."

By virtue of this article the inspector on the processing line is directed to remove all callouses, true breast blisters, scaly skin, or skin that is thicker than normal. When the inspector removes abnormal tissue it usually involves cutting away enough skin to cause a turkey to be downgraded to Grade C. Since the producer receives a reduced price for downgraded turkeys, a flock with a high percentage of turkeys with abnormal tissue would result in serious economic loss. In the 1960 Kansas State University Random Sample Turkey Test over fifty percent of the male turkeys in a pen of six hundred turkeys were downgraded for breast blisters. Some commercial growers reported high incidence of breast blisters in the same growing season.

When the problem of breast blisters was first investigated in the early 1940's only fluid filled blisters were considered. In view of modern inspection practices the term "breast blister" has evolved to mean any abnormal tissue on the breast area that, when cut off, will cause downgrading of the bird. Therefore, the term now includes the true breast blister, calouses, injuries, rough infected skin, and skin that has become thicker than normal. When these conditions are taken into consideration many more birds are classified as having breast blisters. The term "breast blister" may not be morphologically correct, but from the standpoint of downgrading this is not important.

Considering the expanded meaning of the term "breast blister", it was felt that an investigation into some of the causes of breast blisters was needed. Therefore, a study was conducted in an effort to accomplish the following objectives: 1. To find a causative organism for breast blisters, 2. To determine the effect of roost height on incidence of breast blisters, 3. To determine the effect of body conformation on incidence of breast blisters, and 4. To determine if the incidence of breast blisters was different between strains.

REVIEW OF LITERATURE

Very little information concerning breast blisters in turkeys can be found in the literature. There are, however, some reports regarding the same problem in chicken broilers. Since it might be reasoned that the cause of breast blisters is the same in both chickens and turkeys, this review of literature contains information concerning both species of poultry.

Hodgson and Gutteridge (1941), working with Barred Plymouth Rock chickens, found definite breed and sex differences in the development of breast blisters. The males exhibited a much higher incidence than females, and Mediterranean breeds were less likely to have the condition than American breeds. The age of the bird when blisters developed was also investigated and it was found that the blisters began developing between the eighth and thirteenth week, and were still appearing at the twenty-first week. The experiment was terminated at the twenty-second week. The greatest increase in blister formation took place between the eighteenth and twentieth weeks.

O'Neil (1943) studied the morphology of the breast blister and described it as a cystic formation varying in size from that of a small bean up to 2.5 inches long by .75 inch wide. Inside the cyst he found a node-like structure that contained a cavity full of sterile brownish to red fluid. The color was due to recent hemorrhage.

Under the microscope three kinds of tissue were observed: mesenchyme (immature connective tissue), white fibrous connective tissue, and fibrous cartilage. The lining of the cavity was comparable to synovial membrane.

The blister was caused, according to O'Neil, by pressure on the skin from above, and was a protection for the skin or keel bone or both. The cause was definitely not infectious or parasitic in origin. Bacteriological determinations showed the fluid in the blister to be sterile. The possibility of breast blisters being a form of leukosis was investigated and found to be negative.

Body depth relative to weight of the chicken was given by Bird (1944) as cause of breast blisters. He explained that the deeper bodied birds exerted more pressure on the breast while roosting, thus creating more irritation resulting in a breast blister. In observations concerning genetic resistance to blisters, Bird explained that some strains, instead of developing a specific insensitivity in their connective tissue toward breast blisters, have inherited a shallow body conformation of the type that does not need breast blisters for protection.

Records were kept over a five year period on the percentage of chickens studied that had blisters and the amount of rainfall during the months of May through September. It was concluded that weather conditions would be important only so far as rearing conditions were affected. A high rate of precipitation may affect an increase in percent of blisters, thereby explaining fluctuations from year to year where body depth does not change.

O'Neil (1944) in a controlled experiment involving two hatches of Barred Plymouth Rock and New Hampshire cockerels found a slight but consistent relationship between rate of growth and development of breast blisters. The faster the birds grew, the more apt they were to have blisters. Time of hatch also had an effect on incidence of blisters. Late hatched birds grew more slowly, had plumper breasts, and fewer cysts.

It has been pointed out by many authors that the breast blister gives the bird a measure of protection. Kondra and Cavers (1947) noticed that the incidence of breast blisters was lower among chickens selected for early feathering than among late feathering birds. In later experiments they found when chickens were deprived, through breeding or by physical removal, of the protection afforded by early breast feathering, breast blisters increased significantly both in number and size regardless of sex, breed, or body conformation.

Funk and Savage (1956) also studied the problem of breast blisters in broilers as affected by breast feathering. In a broiler strain of White Rocks they experimented by plucking the breast of every other bird selected at random and leaving them in 10 by 12 foot pens with non-plucked birds of the same hatch as controls. There was built-up litter in the pens. Observations were made two weeks after plucking. Twenty-three (74.2%) of 31 birds plucked showed breast blisters, but of 35 birds not plucked in the same pen only 17.1 percent showed any blisters.

They also observed that in a pen of damp litter, breasts that were bare from plucking showed irritation and blistering of the skin.

Gyles, Gilbreath, and Smith (1957) found that differences in incidence of breast blisters within and between groups were influenced by body weight, sex, and breast feathering. Growth rate for birds with blisters was higher than for birds without blisters within age, sex, and breeding groups. These workers also found less feather protection for birds with blisters as compared to birds without blisters. Males were more prone to the condition than females.

Smith (1956) working with broilers found that birds raised on whole corn cob litter had a higher incidence of breast blisters than those raised on a litter of shavings, sawdust or ground corn cobs. Increased dampness of any litter was found to increase the number of blisters. Increased irritation was given as the reason for increased numbers of blisters.

Stephenson, Bezanson, and Hall (1960) in their study of several factors that influence incidence of breast blisters found no significant differences in blister incidence when birds were fed chlorotetracycline, oxytetracycline, proccaine penicillin, bacitracin, or furizolidone at the rate of 100 gms per ton of feed. In another experiment they found that of three different types of litter, wood shavings, oat straw, and rice hulls, with a servall (canepomace) control, there were no statistically significant differences between type or depth of litter.

These workers found significant differences between breeds and strains in males but not in females. Marketing time was found to make a difference in number of blisters with older birds having the highest incidence.

Dietary fat was also studied but no significant difference resulted from this treatment.

Although some authors maintain that microorganisms are not the cause of breast blisters, others contend that, through injury to the skin over the breast, organisms are introduced and do cause the formation of a blister.

Marsden and Martin (1955) say that blisters are caused by turkeys bumping themselves, or roosting on sharp objects. These injuries permit pus-forming organisms such as staphylococci to enter. Swollen hock joints (Synovitis) and breast blisters, according to these authors, are caused by the same organism and often appear at the same time.

Van Ness (1946) reported that a particular broiler producer lost several two month old birds in which the causative agent was *Staphylococcus citreus*. The organism was isolated in pure culture from breast blisters and livers of dying birds. All sick birds showed breast blisters and arthritis. It was believed that the organisms gained initial entry at the position of the breast blister. It was further reported that these birds were housed on wire that had many protruding jagged points. Losses were reduced when these wire points were covered.

Hinshaw and McNeil (1952), working with Synovitis in turkeys found that, of 33 one month old turkey poults inoculated intravenously with .5 cc. of Micrococcus pyogenes var aureus, eight had sternal abscesses in 12 days. In other experiments they found that birds given intravenous inoculations often developed sternal abscesses. However, these abscesses developed after the inoculation and not before as some authors have suggested. Therefore, the sternal abscesses are probably not the natural portal of entry for Synovitis causing organisms. In the acute stage the Synovitis causing organism can be isolated from any tissue of the body.

Fahey (1954) found no sternal abscesses in a flock of turkeys with a natural infection of Synovitis. He also found that terramycin in conjunction with other antibiotics would control the Synovitis infection.

In discussing the natural portal of entry for the Synovitis causing bacteria, Hole and Purchase (1931) showed that the incidence of infection in young pheasants was greater when they were in a field of thistles. Hinshaw and McNeil (1952) noticed that the disease occurred when young turkeys were put in fields containing thorns of various kinds. Mosquitoes were also believed to have an effect similar to that of the thorns.

MATERIALS AND METHODS

The turkeys used in this experiment were those hatched for the Fourth Central Kansas Random Sample Turkey Meat Production Test. From 12 strains represented there were 1326 turkeys hatched; of this total 1150 were on official test and could not have tests or treatments performed on them. The remaining 176 turkeys were available for the various treatments. The strains, varieties, and locations at which the eggs were sampled are given in Table 1. Henceforth these strains will be referred to only by number.

Table 1. Varieties and strains of turkeys entered in the Fourth Kansas Random Sample Turkey Meat Production Test.

Strain number	Strain and variety	Eggs sampled at	Strain number	Strain and variety	Eggs sampled at
1	Schmidt (bronze)	Kansas	7	Meadowbrook (bronze)	Kansas
2	Segar (white)	Kansas	8	Nicholas (white)	Kansas
3	Kimber (bronze)	California	9	Browning (bronze)	Kentucky
4	Wilford (white)	Kansas	10	Wrolstad[1] (white)	Kansas
5	Nicholas strain cross (bronze)	California	11	Rose-A-linda (bronze)	Kansas
6	Keithly (white)	Kansas	12	Waite's (bronze)	Missouri

[1] Strain 10 was a medium weight bird; the other eleven were heavy strains.

The turkeys, hatched at the Kansas State University Poultry Farm, were sexed, debeaked and toe marked by strain and sex on the day they were hatched. The first two weeks the turkeys were kept in batteries in the turkey rearing house at the Kansas State University Turkey Rearing Farm. After two weeks the poults were wingbanded and transferred to two 30 x 60 foot floor pens in the turkey rearing house, where they remained for six weeks. At eight weeks of age the birds were weighed, examined for breast blisters, and put on range. The turkeys were then weighed and examined for breast blisters each month thereafter. The examination for breast blisters consisted of observing the birds, "feeling" the keel area and noting any callouses, abscesses, or injuries. Any abnormal growth that was thought to be serious enough to be cut off the breast by the inspector at processing time and cause downgrading of the turkey was recorded as a breast blister.

On range the turkeys were divided into 15 separate pens. Each of the pens 1 through 12 were 30 by 110 feet with one strain and 50 turkeys per pen, 25 males and 25 females. In some pens there were not exactly 25 males and 25 females due to sexing error; however, no pen had a ratio greater than 23 to 27 except in pen 2 there were 18 males and 27 females.

There were 550 turkeys in pen number 14 which was 180 feet wide and 400 feet long. Eleven strains of turkeys, a maximum of 25 males and 25 females from each strain were represented in this composite pen. There were no turkeys from strain 2 in the composite pen. The excess 176 turkeys with strains 1, 4, 7, 11 and 12 represented were divided equally between pens 13 and 15. These two pens were both 110 feet wide and 180 feet long.

While the turkeys on official test were not available for treatment the composite pen, pen 14, had a different type roost than the 12 small pens and these were analyzed as two separate roost treatments. There were two shelters in pen 14, each 12 by 20 feet, with the roosts under the shelter six inches from ground level. Also, there were roosts on top the sloping wooden roof of the shelter. The lowest roof roost was 3 feet 6 inches from the ground, and the highest was 6 feet 7 inches off the ground. Walks were provided so the birds could walk up on the roof (Plate I).

In the 12 small pens the shelters were all the same, 10 by 10 feet with roosts 16 inches from the ground under a sloping corrugated iron roof (Plate II).

Pen 13 had a shelter 12 feet by 24 feet with a sloping corrugated iron roof and the roosts were 26 inches off the ground (Plate III). There was

EXPLANATION OF PLATE I

Shelter with roof roosts in pen 14.

PLATE I

EXPLANATION OF PLATE II

Feeders, waterers, and shelter of the type used in pens 1 through 12.

PLATE II

EXPLANATION OF PLATE III

The shelter used in pen 13.

PLATE III

1 by 2 inch welded wire under the roosts and around the shelter to keep the turkeys from getting under the roosts. The 12 by 16 foot shelter in pen 15 was constructed by fastening 2 by 6 inch boards to four posts, placing 2 by 4 inch cross pieces between the 2 by 6's, and placing woven wire over the frame, then laying construction plastic over the woven wire to form a roof with only sufficient slope to cause water to run off. The roosts donsisted of five logs placed on the ground under the shelter. The logs were about 8 inches in diameter and 12 feet long (Plate IV). With the exception of pen 15 all roosts were 18 inches apart and made of 2 by 2 inch lumber.

The feeders in pens 1 through 12 were the same with two per pen; all were 150 pound capacity, round, metal self-feeders that could be raised by adjustable legs as the turkeys grew (Plate II). The self-feeders in pens 13, 14 and 15 were of wooden construction, 8 feet long, 4 feet wide and 4 feet high (Plate V). The waterers were 55 gallon oil drums connected to two float controlled drinking cups all mounted as a single unit on 4 by 4 inch skids (Plate II). The drinking cups were 10 inches from the top to ground level. Aside from the differences in roosts and feeders, all other management conditions were as near constant as possible from pen to pen.

The ration for the first eight weeks was a standard commercial ration obtained from the Quaker Oats Company. From eight weeks to the termination of the experiment the rations were supplied by Kansas State University (Appendix Table 1) and were mixed by the Department of Flour and Feed Milling Industries at the University.

To determine the role of microorganisms in turkey breast blisters isolations were made from blisters on fourteen month old breeding males and one twelve week old male, all from commercial flocks. The isolations were made by opening the blister with a sterile scalpel, placing a sterile swab inside the

EXPLANATION OF PLATE IV

Shelter used in pen 15.

PLATE IV

EXPLANATION OF PLATE V

Self feeders of the type used in pens 13, 14 and 15.

PLATE V

blister then placing the swab in physiological saline. Streak plates were made from the saline solution. The isolations were made on Difco nutrient agar, turkey blood agar, and in Difco nutrient broth. The plates and tubes were incubated at 37°C. under aerobic and anaerobic conditions. The turkey blood agar was prepared by mixing 5 ml. of sterile defibrinated turkey blood in 95 ml. of Difco nutrient agar at 45°C.

There were four different organisms isolated in pure culture from the primary isolations, and were designated as organisms A, B, C, and D. Organism A was a gram negative, motile rod .5 micron wide and 1 micron long that produced acid from glucose, and had an optimum temperature of 33°C. Organism B was a motile gram negative rod .3 micron wide and .7 micron long; it produced acid and gas from glucose; the optimum temperature was 23°C. Organism C was a non-motile gram positive coccus .6 micron in diameter, produced acid from glucose, and had an optimum temperature of 23°C. Organism D was a gram negative motile rod .4 micron wide and .8 micron long, produced acid from glucose, and had an optimum temperature of 23°C. These were prepared for inoculation into host turkeys as follows: the organisms were transferred from pure culture nutrient agar slants into 6 ml. of Difco nutrient broth in 15 ml. centrifuge tubes equipped with aluminum foil caps, and incubated 48 hours at 37°C. The cells were then washed by centrifuging for 12 minutes at 2000 R.P.M., decanting the broth, and resuspending the cells in 6 ml. of sterile water. After the cells were washed twice they were resuspended in 6 ml. of sterile water in the centrifuge tubes equipped with rubber syringe stoppers. These were taken immediately to the turkey rearing range where the inoculations were carried out by injecting 1 ml. of the suspended cells into each host turkey. Disposable 2 ml. syringes with 22 gauge needle attached were used to make injections. The injections were made subdermally about one inch posterior to the point of the keel bone and directly over the keel. Sterile equipment and aseptic techniques were used at all times. Alcohol was used to clean the breast area where injections were made.

Thirty male and female turkeys were selected at random at 15 weeks of age, fifteen from pen 13 and fifteen from pen 15, to receive six treatments, five birds for each treatment. Treatments A, B, C, and D were the four different organisms; treatment E was a sterile water control handled exactly as the four suspensions of organisms. Treatment F was an irritation treatment accomplished by forcing thorns from hedge trees (Maclura pompifera) into the keel area and breaking them off beneath the skin. The thorns were used to simulate thistles or sandburs that, according to Hole and Purchase (1931), Hinshaw and McNeil (1952), may increase the incidence of breast blisters. The thorns, about three-eighths inch long, were cleaned with alcohol before being put in place. The area where the skin was broken was also cleaned with alcohol.

The thirty treated turkeys were examined for breast blisters at market time, and examinations made for microorganisms in any treated turkeys that had fluid filled breast blisters. The methods employed for making isolations of the organisms were the same as those described above except 2 ml. sterile disposable syringes were used to take the samples.

The turkeys were all processed at the same USDA approved commercial processing plant, inspected by the same inspector, and were graded by a USDA grader. The turkeys were hauled live from the K.S.U. turkey farm 120 miles to the processing plant. The hens were marketed at 22 weeks of age, the males four weeks later at 26 weeks of age.

Bird (1944) indicated that body conformation may be a contributing factor to incidence of breast blisters. In this experiment three body conformation measurements, keel length, body depth and breast width, were taken on the eviscerated birds at time of processing. The measurements were taken on the processing line with the birds hanging by the legs from the shackles and measurements were made to the nearest one-tenth inch by using sliding calipers. The keel length was measured from the anterior to the posterior points of the sternum. Body depth was measured through the deepest part of the body from a point slightly posterior of the point of the keel to the anterior of the ilium. Breast width was measured through the widest part of the breast which was near the anterior point of the sternum.

The measurements on the males of the 12 strains and their live weights at market time were analyzed statistically by use of the discriminant function (Goulden, 1952). The discriminant function was used in this experiment to determine if there were physical observations that could be made which might be used to predict whether or not a turkey would develop a breast blister.

The two groups to discriminate were designated as group A, with breast blisters, group B without breast blisters. The data were set up in the following form:

	Group A <u>with blisters</u>				Group B <u>without blisters</u>			
	X_1	X_2	X_3	X_4	X_1	X_2	X_3	X_4
	°	°	°	°	°	°	°	°
	°	°	°	°	°	°	°	°
	°	°	°	°	°	°	°	°
	°	°	°	°	°	°	°	°
	°	°	°	°	°	°	°	°
	°	°	°	°	°	°	°	°
mean	$\bar{X}_{a_1}$	$\bar{X}_{a_2}$	$\bar{X}_{a_3}$	$\bar{X}_{a_4}$	$\bar{X}_{b_1}$	$\bar{X}_{b_2}$	$\bar{X}_{b_3}$	$\bar{X}_{b_4}$

where X_1 = keel length, X_2 = body depth, X_3 = breast width, and X_4 = body weight. Then a function of the form: $Z = \ _1X_1 + \ _2X_2 + \ _3X_3 + \ _4X_4$

was found where the λ 's are the weights assigned to the X variables. The weights were computed by solving the following set of simultaneous equations:

$$\lambda_1\sum(x_1^2) + \lambda_2\sum(x_1x_2) + \lambda_3\sum(x_1x_3) + \lambda_4\sum(x_1x_4) = d_1$$
$$\lambda_1\sum(x_1x_2) + \lambda_2\sum(x_2^2) + \lambda_3\sum(x_2x_3) + \lambda_4\sum(x_2x_4) = d_2$$
$$\lambda_1\sum(x_1x_3) + \lambda_2\sum(x_2x_3) + \lambda_3\sum(x_3^2) + \lambda_4\sum(x_3x_4) = d_3$$
$$\lambda_1\sum(x_1x_4) + \lambda_2\sum(x_2x_4) + \lambda_3\sum(x_3x_4) + \lambda_4\sum(x_4^2) = d_4$$

where x_1, x_2, x_3, x_4 are deviations from the means $\bar{x}_a - \bar{x}_b$ and $d_1 = \bar{x}_{a_1}-\bar{x}_{b_1} \ldots d_4 = \bar{x}_{a_4}-\bar{x}_{b_4}$.

From this information the analysis of variance of Z (Table 5) was made, such that the ratio of the variance between group A and B to that within groups was maximum.

The sum of squares and degrees of freedom were:

Source	d.f.	s.s
Between groups	k	$(n_an_b/n_a+n_b)D^2$
Within groups	n_a+n_b-k-1	D

where $D = \lambda_1d_1 + \lambda_2d_2 + \lambda_3d_3 + \lambda_4d_4$, k = 4 = number of variables studied, n_a = number with breast blisters, and n_b = number without breast blisters. The F test was made using the within group mean square as the error term.

A significant F would indicate that turkeys could be placed in group A or group B on the basis of body conformation. If the F were significant the sum of squares between groups was partitioned by use of the following formula: $(n_an_b/n_a+n_b)(d_p^2/\sum x_p^2)^2$ where p = 1, 2, ..4. The partitioning was done to determine whether or not all four variables were needed to be able to place turkeys in group A or group B.

Misclassification of turkeys, putting them in the wrong group, would occur when the group mean is over half the group difference (Mather, 1947). The group difference in Z is equal to the error sum of squares which is equal to D; therefore, a deviation from D of D/2 would cause misclassification provided the difference is in the right direction.

To find the estimated percent that would be misclassified, the estimated standard deviation z(error mean square) was divided into D/2. This result gave the number of times the standard deviation of Z was exceeded. When this result, with appropriate degrees of freedom, is found in the "t" table, the percent misclassified can be read directly. The percent was then divided by 2 since misclassification can occur in only one direction.

The roost height data were analyzed by use of the chi-square test of independence (Goulden, 1952). Since it has been well established in the literature that females of the species seldom develop breast blisters (Hodgson and Gutteridge, 1941; Gyles et al., 1957; and Stephenson et al., 1960) and reaffirmed in this work, only males are included in the statistical analysis. Females were used only where treatments A,B,C,D,E, and F were employed.

The analysis of the roost height data includes only males from strains 1, 4,7,11 and 12 since those were the only strains represented in pens 13 and 15. The males that had received injections were not included in the roost height analysis.

RESULTS AND DISCUSSION

The time of development of breast blisters is presented in Table 2 where the incidence of blisters is reported at 16, 20, 22, 24, and 26 weeks of age. Also included in Table 2 is a report of the downgrading at the processing plant which, compared to the field observations at the 26 week period, gives an indication of the accuracy of the field observations in predicting whether or not the turkey would be downgraded.

Table 2. Age of turkeys and development of breast blisters.[1]

Strain	16th week	20th week	22nd week	24th week	26th week	Number downgraded[2]
1	0	5	5	4	5	4
2	0	3	4	5	3	6
3	0	3	4	3	3	4
4	0	0	1	1	1	1
5	0	1	1	0	0	0
6	0	4	5	4	3	6
7	0	2	2	2	2	6
8	0	4	3	3	4	4
9	0	6	6	6	5	4
10	0	3	3	3	3	10
11	0	7	6	4	5	3
12	0	1	1	1	1	3
Total	0	40	41	36	35	51

[1] These data are from the 12 small pens only; each pen contained approximately 25 males. Values refer to the number of birds in each pen that were recorded as having breast blisters.

[2] The number of turkeys downgraded for breast blisters at the processing plant.

It can be seen that the development of breast blisters starts some time between weeks sixteen and twenty, which agrees with observations on chickens by Hodgson and Gutteridge (1941). Also, it appears that after the twentieth week there is little change in the number of breast blisters. The difference in total number of blisters between the twenty-second and twenty-sixth weeks is probably due either to differences in observations of the two persons examining for breast blisters, or in some cases callouses may have come off in the periods between observations.

Table 2 shows that 51 turkeys from pens 1 through 12 were downgraded for breast blisters. Observations in the field showed 35 turkeys were believed to have breast blisters. However, of the 35 indicated as having breast blisters, only 18 were actually downgraded at the processing plant. Therefore, the field observations were accurate in eighteen out of 51 cases, or 35 percent of the time. However, much of the error in blister determinations was in strain 10. These turkeys, being in a medium weight class, matured earlier than the other strains and at market time had developed thick folds of rough skin over the breast area. In many cases the skin was cut off during processing, but the thickened skin condition had not been considered a breast blister during field observations.

The accuracy of field determinations is also affected by some of the callouses coming off in the scalding and picking process, or the inspector on the line trimming off the callous but not cutting the skin. The latter situation can be observed in Plate VI, which shows a turkey that had been recorded as having a blister but after processing was graded A Grade. Also, three males from pens 1 through 12 were condemned that had been designated as having breast blisters, which caused a decrease in the accuracy. All of the birds designated in the field as having fluid filled blisters were downgraded at the processing plant. Plate VII shows such a turkey live, during processing, and after packaging. This was a C Grade turkey.

Of the thirty turkeys selected from pens 13 and 15 to receive treatments A through F, eleven were females and nineteen were males. None of the eleven treated females were downgraded for breast blisters. One of the downgraded males was from pen 15 and four were from pen 13. The turkey in pen 15 had received treatment C, but the downgrading was due to a callous so no bacteriological determinations were made. Since the callous was exposed to outside contamination, bacteriological isolations would be meaningless so far as a causative organism is concerned. In pen 13 three of the treated turkeys were downgraded for callouses and one had a large fluid filled blister, (Plate VII). The turkey with the fluid blisters had received treatment A, a gram negative rod. Cultures from the fluid of the blister showed only a gram positive

EXPLANATION OF PLATE VI

Fig. 1. The turkey as it appeared under field conditions.

Fig. 2. The turkey as it appeared after picking and scalding and before inspection.

Fig. 3. After inspection, the callous has been trimmed off.

Fig. 4. Finished product. The bird was saved.

PLATE VI

Fig. 1

Fig. 2

Fig. 3

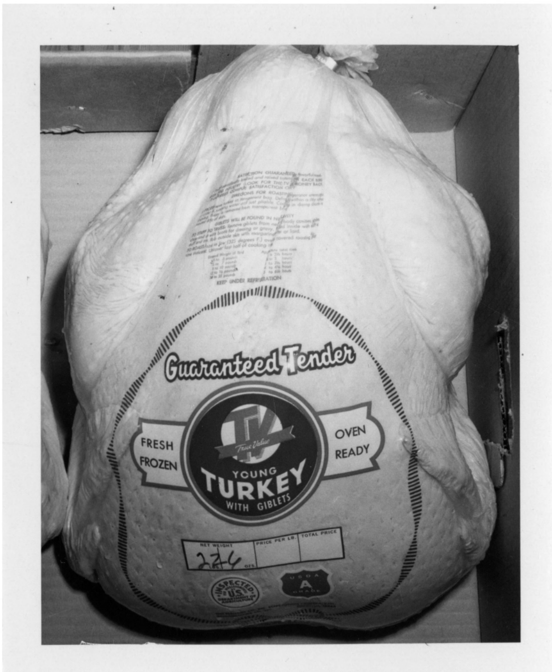

Fig. 4

EXPLANATION OF PLATE VII

Fig. 1. Fluid filled breast blister as it appeared on the live turkey.

Fig. 2. Same turkey as in Fig. 1 before inspection.

Fig. 3. Fluid filled blister being removed.

Fig. 4. Final product. Grade C turkey.

PLATE VII

Fig. 1

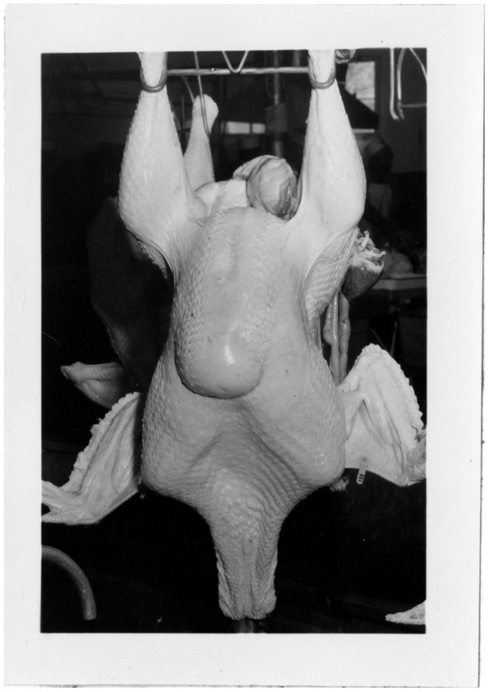

Fig. 2

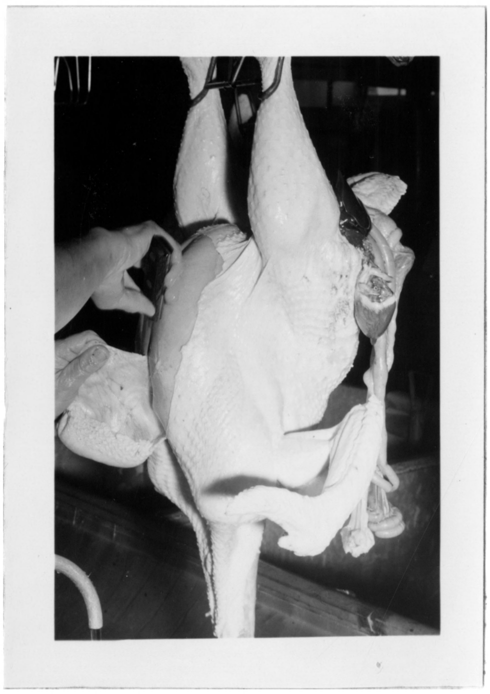

Fig. 3

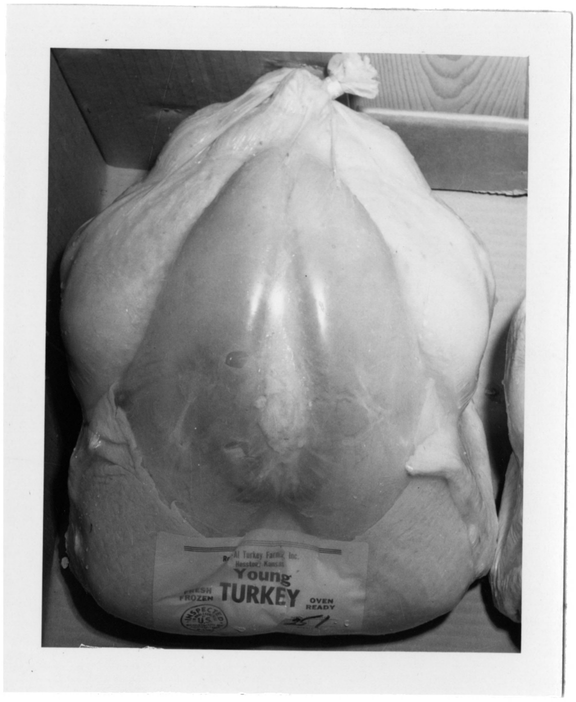

Fig. 4

coccus. The fluid in the blister was brownish in color, watery, and had no detectable odor. Two other turkeys in pen 13 that had received no treatments also had fluid filled blisters similar to that of the treated turkey.

None of the five turkeys that received treatment B were downgraded. There was one turkey downgraded for each of the other five treatments, and in no case were two turkeys downgraded for the same treatment.

Four out of ten, or forty percent, of the treated turkeys in pen 13 and one out of nine, or eleven percent, in pen 15 were downgraded. These percentages compare very favorably with the figures for the pens when all male turkeys are considered (Table 3). Therefore, it would be reasonable to conclude that the six treatments had little or no effect on the incidence of breast blisters for the turkeys in pens 13 and 15.

Table 3. Chi-square analysis of roost height.

Roost height	With blisters O[1]	With blisters E[2]	Without blisters O	Without blisters E	Total[2]	$(O-E)^2/E$	Percent with breast blisters
8 inches	4	6	21	19	25	.876	16
16 "	27	32	102	97	129	1.036	21
26 "	13	7	15	21	28	6.856	46
42-79 "	31	29	86	88	117	.182	26
Total	75		224		299	8.95*[3]	25

[1] "O" is the observed frequency of blisters, "E" the expected frequency of blisters computed from the border totals.

[2] Total number per treatment observed.

[3] Significant at .05 level.

The contingency chi-square analysis of the roost height data presented in Table 3 shows a statistically significant effect between pens with different height and type roosts. The hypothesis that the higher the roost the higher the incidence of breast blisters was accepted. This would indicate that pen 14 with roosts on the shelter roof as high as seventy nine inches from the ground level should show a significant increase in turkeys with breast blisters. However, when the pens with different roost heights were analyzed separately, using 25 percent as the expected frequency of blisters, pen 13, with roosts twenty-six inches high, was the only one that showed significance ($\chi^2 = 6.856$, $P < .01$).

The shelter in pen 13 was the only one that had new roosts or wire under the roosts. These two factors may have been the cause of the turkeys injuring themselves, resulting in the high incidence of breast blisters (46%). These conclusions agree with those of O'Neil (1943) and in part with those of Marsden and Martin (1955) that blister development is caused by the birds bumping themselves or roosting on sharp objects.

The analyses of variance of the discriminating functions presented in Table 5 show the function (Table 4) to be significant in strains 2, 10, 11 and for all strains combined. Table 6 shows the partitioned between groups sum of squares for strains 2, 10, 11 and when all strains are combined. It can be seen in the combined group, and also in strains 2 and 10, that each variable taken independently is not in itself powerful enough to be used to place turkeys in group A or B. Therefore, all variables must be considered before the turkeys can be separated. In strain 11 body depth was significant, indicating that body depth could be used in this particular strain to separate the turkeys into the proper groups.

Misclassification would occur if the deviation from D (within group sum of squares) was greater than .02041639 in strain 2, .01212677 in strain 10, .06117712 in strain 11, or .00096451 when all strains are combined. Using this information, in strain 11 ten percent would be misclassified and over 30 percent

Table 4. The values of Z for twelve strains of turkeys.

Strain	Z equation
1	$Z = +29.102X_1$[2] $+ 40.104X_2 + 14.742X_3 - X_4$
2	$Z = +1.221X_1 - 2.186X_2 - 7.271X_3 - X_4$
3	$Z = +17.777X_1 + 190.537X_2 + 12.767X_3 - X_4$
4	$Z = -X_1 + 22.589X_2 + 18.396X_3 - 5.594X_4$
5	$Z = +14.511X_1 - X_2 + 4.836X_3 - 2.328X_4$
6	$Z = -2.311X_1 - 1.634X_2 - 2.329X_3 - X_4$
7	$Z = +8.164X_1 - 4.209X_2 + 4.481X_3 - X_4$
8	$Z = +3.598X_1 + 4.317X_2 + 1.054X_3 - X_4$
9	$Z = +43.747X_1 - 32.618X_2 + 28.249X_3 - X_4$
10	$Z = -13.423X_1 + 9.630X_2 + 6.466X_3 - X_4$
11	$Z = -3.832X_1 - 19.837X_2 + 3.574X_3 - X_4$
12	$Z = +22.659X_1 - 2.691X_2 + 5.837X_3 - X_4$
All strains combined	$Z = +9.6017X_1 + 11.9664X_2 + 83.1741X_3 - X_4$

[1] For simplicity the smallest weight, [illegible] , is divided into each of the other weights in the equation.

[2] X_1 = Keel length, X_2 = Body depth, X_3 = Breast width, X_4 = Body weight.

Table 5. Analysis of variance of Z[1] for body conformation for 12 strains of male turkeys.

Strain	Source of variation	d.f.	Mean square	F
1	Between groups	4	.00011893	.79
	Within groups	49	.00015039	
2	Between groups	4	.01667320	5.31**[2]
	Within groups	13	.00314098	
3	Between groups	4	.00002846	.30
	Within groups	39	.00009524	
4	Between groups	4	.00004959	.26
	Within groups	39	.00018959	
5	Between groups	4	.00202303	1.36
	Within groups	32	.00148831	
6	Between groups	4	.00112638	1.40
	Within groups	32	.00080334	
7	Between groups	4	.00010746	.80
	Within groups	46	.00013388	
8	Between groups	4	.00014581	.52
	Within groups	38	.00027969	
9	Between groups	4	.00161687	1.86
	Within groups	35	.00087001	
10	Between groups	4	.00161475	3.06*
	Within groups	46	.00052724	
11	Between groups	4	.01958913	6.72**
	Within groups	42	.00291319	
12	Between groups	4	.00021367	.84
	Within groups	40	.00025353	
All strains combined	Between groups	4	.00008023	21.11**
	Within groups	505	.00000380	

[1] The "Z" equations are presented in Table 4.

[2] *.05 level of significance; ** .01 level of significance

Table 6. Partitioned sum of squares.[1]

Strain	Source	d.f.		S.S.	M.S.	F
2	Between groups	4		.0666928	.01667320	5.31**[2]
	Due to X_1 alone		1	.0003264		1.0
	Due to X_2 alone		1	.0007444		1.0
	Due to X_3 alone		1	.0009140		1.0
	Due to X_4 alone		1	.0000010		1.0
	Within groups	13		.0408328	.00314098	
10	Between groups	4		.00645900	.00161475	3.06*
	Due to X_1 alone		1	.00001526		1.0
	Due to X_2 alone		1	.00000057		1.0
	Due to X_3 alone		1	.00041414		1.0
	Due to X_4 alone		1	.00000000		1.0
	Within groups	46		.02425345	.00052724	
11	Between groups	4		.07835655	.01958913	6.72**
	Due to X_2 alone		1	.06457829		22.17**
	Due to others		3	.01377826	.00459275	1.57
	Within groups	42		.12235425	.00291319	
All strains combined	Between groups	4		.00032094	.00008023	21.11**
	Due to X_1 alone		1	.00000009		1.0
	Due to X_2 alone		1	.00000000		1.0
	Due to X_3 alone		1	.00000000		1.0
	Due to X_4 alone		1	.00000000		1.0
	Within groups	505		.00192903	.00000380	

[1] The partitioned sum of squares do not equal the "Between group" sum of squares because the variables are correlated (Appendix Table 4).

[2] * .05 level of significance ** .01 level of significance

would be misclassified in strains 2, 10, and when all strains are combined.

In strain 11 body conformation could be used to determine which turkeys would be most likely to have breast blisters. The table of means (Appendix Tables 2 and 3) shows strain 11 to have a very broad breast. The means also show that turkeys in strain 11 with breast blisters had the lowest mean body depth in the heavy strains while turkeys in strain 11 without breast blisters had higher than average body depth. In the analysis of Z (Table 5), it is shown that body depth alone in strain 11 is sufficient to determine which turkeys would have breast blisters. In the discriminant function equation (Table 4) for strain 11, the most weight is placed on breast width. Therefore, it may be concluded that turkeys with wide breasts and shallow bodies are more prone to have breast blisters than those with wide breast and deep bodies. This is in direct contradiction to the conclusions of Bird (1944). Strain 5 had the widest breast of all strains considered and deeper body than the average of all strains. The analysis of variance of Z was nonsignificant in strain 5.

In strain 10 there were a large number of birds downgraded for breast blisters due to the late marketing of these birds. This was probably the reason for this strain having a significant discriminant function. Large variability of body weight within group A was no doubt responsible for the significant Z in strain 2.

Since, when all twelve strains were combined, the analysis of variance of Z was significant but none of the measurements considered alone were significant, it appears that overall body conformation in turkeys has an effect on the incidence of breast blisters.

The indications here are that through reduction in variability among strains, and proper genetic selection a body conformation could be selected for that would be less prone to the breast blister condition.

SUMMARY

The incidence of breast blisters in young market turkeys was investigated. Microorganisms, different roost heights and types, and body conformation were studied as possible causes for breast blisters. A breast blister was defined as any abnormal tissue on the breast that would be removed at processing time and cause the bird to be downgraded.

The conclusions were: 1. Microorganisms had little, if any, effect on incidence of breast blisters in the turkeys injected with four different organisms. 2. Roost differences were found to cause a statistically significant increase in breast blister incidence. The increase was attributed to roost type rather than roost height. 3. Broad breasted, shallow bodied turkeys were shown to have a significantly higher incidence of breast blisters than turkeys with other body types. When data for all twelve strains were combined and analyzed, body conformation appeared to have an effect on the incidence of breast blisters, indicating that a body conformation could be selected for that would be less prone to the blistering condition.

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APPENDIX

Table 1. Random Sample turkey rations from eight weeks of age to market time.

KSU 20% protein complete turkey grower (granules)
Fed from 8 to 16 weeks of age

Ingredients	Amt./100 lbs.
Corn, ground yellow	27.0 lbs.
Sorghum grain, ground	27.0 "
Oats, ground	10.0 "
Dried grain fermentation sol. feed supplement	2.0 "
Soybean oil meal, 44% prot. solvent extracted	20.0 "
Fish meal, 60% prot.	2.0 "
Meat and bone meal, 50% prot.	3.0 "
Alfalfa meal 17% prot. dehyd.	5.0 "
Steamed bone meal	2.0 "
Calcium carbonate	1.5 "
Salt	0.5 "
Total	100.0 lbs.

Added per mix of:	Amt./100 lbs.
Vitamin A (10,000 I.U./gm.)	20 gms.
Vitamin D_3 (3,000 I.C.U./gm.)	15 "
58-A-Merck(R) (B-complex)	113 "
Aurofac (1.8-1.8) (R) or equivalent antibiotic-B_{12}	230 "
"CCC" 244 (R)	23 "
Bifuran (R) (1 lb./ton)	23 "

KSU 16% protein complete turkey finisher (granules)
Fed from 16 weeks of age to market time

Ingredients	Amt./100 lbs.
Corn, ground yellow	32.0 lbs.
Sorghum grain, ground	31.0 "
Alfalfa meal, 17% protein, dehy.	5.0 "
Wheat middlings (shorts)	12.0 "
Meat and bone scraps	4.0 "
Dried fermentation grains or sol.	2.5 "
Ground limestone	2.0 "
Steamed bone meal	1.0 "
Salt	0.5 "
Soybean oil meal, 44% protein, solvent extracted	10.0 "
Total	100.0 lbs.

Added per mix of:	Amt./100 lbs.
"CCC" 244 (R) (Trace mineral mix)	23 gms.
Vitamin A (10,000 U.S.P. units/gm)	20 "
Vitamin D_3 (3,000 I.C.U. per gram)	15 "
58 A-Merck(R) (B-complex vit. mix.)	46 "
nf-180 (R) (Furazolidone)	23 "
Aurofac 1.8-1.8 (R) or equivalent antibiotic-B_{12} suppl.	230 "

(R) = Registered trade-mark.

Table 2. Means and standard deviations of three body conformation measurements and live body weight of male turkeys without breast blisters.

	Keel length		Body depth		Breast width		Body weight	
Strain	Mean	Std.dev.	Mean	Std.dev.	Mean	Std.dev.	Mean	Std.dev.
1	7.62	.28	8.74	.30	5.02	.56	29.88	2.45
2	7.45	.81	8.67	.77	4.67	.50	28.45	4.65
3	7.98	.35	8.89	.28	5.06	.48	32.30	2.58
4	7.41	.34	8.42	.24	4.97	.51	27.32	2.91
5	7.58	.35	8.86	.44	5.42	.58	30.19	2.30
6	7.41	.31	8.76	.38	4.73	.38	28.03	2.38
7	7.97	.45	8.85	.29	4.70	.41	30.26	3.28
8	7.71	.42	8.92	.37	4.73	.47	29.53	2.82
9	8.20	.33	9.13	.27	4.48	.39	31.40	4.23
10	6.45	.38	7.80	.43	4.40	.37	21.41	1.86
11	7.76	.36	8.87	.30	5.37	.54	31.45	2.64
12	8.28	.28	9.45	.30	4.16	.41	31.87	3.20
Combined analysis	7.66	.58	8.78	.51	4.82	.60	29.40	3.99

Table 3. Means and standard deviation of three body conformation measurements and live body weight of male turkeys with breast blisters.

Strain	Keel length		Body depth		Breast width		Body weight	
	Mean	Std.dev.	Mean	Std.dev.	Mean	Std.dev.	Mean	Std.dev.
1	7.69	.25	8.85	.33	5.10	.63	30.20	3.31
2	7.58	.19	8.90	.30	4.39	.59	28.96	2.22
3	7.90	.40	8.78	.33	5.04	.37	31.90	2.35
4	7.30	.29	8.38	.25	4.93	.50	26.05	3.50
5	7.78	.29	8.78	.41	5.33	.37	29.25	.49
6	7.59	.33	8.87	.26	4.71	.35	29.64	2.50
7	7.84	.36	8.92	.24	4.61	.49	30.18	3.13
8	7.60	.26	8.85	.49	4.83	.30	30.17	3.53
9	8.03	.30	9.10	.29	4.73	.48	32.58	2.31
10	6.36	.26	7.67	.26	4.59	.31	21.53	1.56
11	7.37	.29	8.15	.45	5.33	.59	26.92	5.22
12	8.08	.46	9.37	.43	4.18	.46	31.45	3.47
Combined analysis	7.55	.65	8.69	.61	4.77	.53	28.89	4.50

Table 4. Correlations between body conformation measurements.

	With blisters				Without blisters			
		X_2	X_3	X_4		X_2	X_3	X_4
Strain 1	X_1	.16	.63	.48	X_1	.48	-.12	.35
	X_2		.22	.39	X_2		-.37	.30
	X_3			.95	X_3			.43
Strain 2	X_1	.03	-.07	-.10	X_1	.94	.59	.94
	X_2		-.44	-.09	X_2		.64	.95
	X_3			.66	X_3			.74
Strain 3	X_1	.59	-.09	.68	X_1	.41	.32	.50
	X_2		-.39	.46	X_2		.07	.26
	X_3			.45	X_3			.53
Strain 4	X_1	.59	.25	.66	X_1	.50	.42	.70
	X_2		-.63	.02	X_2		.21	.64
	X_3			.57	X_3			.67
Strain 5	X_1	-.49	.10	.34	X_1	.49	-.21	.54
	X_2		-.90	.53	X_2		.53	.14
	X_3			-.63	X_3			.49
Strain 6	X_1	.31	.57	.57	X_1	.51	.03	.46
	X_2		.49	.09	X_2		-.07	.65
	X_3			.55	X_3			.35
Strain 7	X_1	-.18	.24	.49	X_1	.34	.37	.75
	X_2		-.20	-.13	X_2		-.07	.35
	X_3			.66	X_3			.68
Strain 8	X_1	.94	-.03	.79	X_1	.75	-.05	.65
	X_2		-.01	.86	X_2		-.10	.73
	X_3			.06	X_3			.34

Table 4. (Continued)

	With blisters				Without blisters			
Strain 9		X_2	X_3	X_4		X_2	X_3	X_4
	X_1	-.36	.36	.33	X_1	.53	.17	.39
	X_2		-.76	.01	X_2		-.33	.25
	X_3			.39	X_3			.22
Strain 10		X_2	X_3	X_4		X_2	X_3	X_4
	X_1	.65	.20	.74	X_1	.68	-.42	.60
	X_2		-.20	.60	X_2		.21	.63
	X_3			.48	X_3			.14
Strain 11		X_2	X_3	X_4		X_2	X_3	X_4
	X_1	.43	.45	.47	X_1	.25	.30	.57
	X_2		.85	.80	X_2		-.20	.35
	X_3			.87	X_3			.58
Strain 12		X_2	X_3	X_4		X_2	X_3	X_4
	X_1	.69	.17	.73	X_1	.58	.01	.54
	X_2		.10	.57	X_2		.04	.62
	X_3			.62	X_3			.50
All strains combined		X_2	X_3	X_4		X_2	X_3	X_4
	X_1	.81	.14	.84	X_1	.77	.03	.77
	X_2		-.07	.77	X_2		-.11	.68
	X_3			.35	X_3			.37

FACTORS AFFECTING THE INCIDENCE OF BREAST BLISTERS IN YOUNG MARKET TURKEYS

by

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A study was conducted to investigate the causes of breast blisters in young market turkeys. Microorganisms, roost height, and body conformation were studied as possible causes of breast blisters. Breast blisters were defined as any abnormal tissue on the breast area that would be cut off during processing and cause the bird to be downgraded. This included true blisters, callouses, and rough, dry skin. The turkeys used for the experiment were those hatched for the Fourth Kansas Central Random Sample Turkey Meat Production Test. Twelve different commercial strains of turkeys were represented in the test.

Twenty turkeys that were in excess of the official test turkeys were injected with four organisms previously isolated from breast blisters. Five turkeys were given a sterile water injection as a control, and five had thorns placed under the skin as an irritation treatment. All turkeys were selected at random. One turkey that had been injected with an organism developed a fluid blister, but the injected organism could not be recovered. It was concluded that microorganisms had little, if any, effect on the incidence of breast blisters in this experiment.

Four different roost heights and types were tested in the experiment. Statistically significant differences in incidence of breast blisters were found between pens with different roosts. It was concluded that roost type influenced an increase in blister incidence.

Body conformation measurements, keel length, body depth, and breast width were taken as the eviscerated birds moved along the processing line. These measurements along with live body weight at processing time were analyzed statistically to determine if any relationship existed between body conformation and increased incidence of breast blisters. One broad breasted strain appeared to be more prone to breast blisters if the body depth was less than

the average for the strain. When all strains were combined and analyzed the effects of body conformation were significant, therefore, it was concluded that body conformation had an effect on the incidence of breast blisters, indicating that a body conformation could be selected for that was less prone to breast blisters.