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Food poisoning : poultry and poultry products as possible etiological agents

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FOOD POISONING. POULTRY AND POULTRY PRODUCTS AS POSSIBLE ETIOLOGIC AGENTS

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Statement of Problem

It is well recognized by the men of medicine as well as the lay public that vegetable and fruit processing has reached nearly perfection. It is rare these days to have a report of food poisoning because of improperly processed produce. The advent of the ordinary tin can with its protective lacquered or metalic lining, pasteurization, proper selection of those products not grossly contaminated or in process of decay, proper washing techniques, sanitary assembly lines, and the proper health program concerning employees and plants have all served to reduce the possibility of contamination of products by pathogenic organisms to a striking degree. Wide education of handlers and public as to the qualities of a bulging can has also made its contribution in the field of health. Therefore, it appears that in this particular field Public Health and medical personnel has only to continue surveillance for infractions of standards.

In the past twenty or thirty years there has been a swing to the commercial preparation of many of our meats of all kinds. Among those of the most recent has been that of processed poultry on a large

scale. Heretofore, a person visited his local produce market andpicked out the fowl best suited to his particular demands. This practice is rapidly becoming a thing of the past and even the small produce house has introduced facilities for the processing of the fowl for the customer. It has been estimated that not one bird in a hundred is seen alive by the ultimate consumer. This fact is probably the leading source of disease from a poultry consumption standpoint. However, this does not disregard those medium sized businesses which process poultry without proper sanitary control. These organizations described, much too often, are concerned with producing a clean looking product but disregard the sanitation aspects. These organizations most frequently have one or two tanks of water for cleansing bird as the evisceration process is carried out, thus mixing body of bird with intestine and thus exposing the meat of the bird to the intestinal contents. This injudicious mixing of entrails with finished product is the place where the greatest strides can be taken in preventing contamination. Fortunately, we do have a third organization, the large producers, who operate on a smaller margin, but make up the deficit in quantity and who strive to maintain

high sanitation standards. This is done for the most part by proper selection of birds to be dressed, separation of defeathering from the evisceration process, proper disposal of entrails and their separation from the body of the bird, large quantities of fresh, clean water along the flow line for washing, rapid and detached packaging, rapid cooling and freezing, proper distribution of product being careful to keep it frozen, and lastly, frequent and periodic health examinations on personnel and plant.

The foregoing accounts give but one impression--that of quick monetary return with a minimal investment in equipment for the smaller producers. Large concerns designed especially for poultry processing have to maintain high standards in order to claim the long term financial returns. Therefore, an expense at the beginning is an asset and insurance for future profits.

It is obvious from the preceding discussion that the responsibility for the contamination lies with smaller producers. The large companies are held to the responsiblity of instilling and maintaining high decontamination practices and health standards. The fault

however, does not lie with the small producer alone, but with the medical profession and health department in not educating these concerns as to the hazards involved in poor sanitation when dealing with two products--the finished eviscerated bird and the entrails.

In an average Nebraska town the local produce house also dresses poultry as a courtesy to their customers. Therefore, this aid is rapidly becoming a responsibility of the produce station and they are installing equipment to accommodate their newly found business. The equipment is of various degrees of cleanliness and efficiency and usually includes a rack on which to hang the bird to bleed it, a scald tank, and a washing and evisceration table or tank. Some include a cold water soaking tank to release the blood still in the tissues; the water may or may not be iced for cooling the warm carcass.

The writer has visited one establishment which does its processing during the holiday season. In this place there is a five gallon scald tank, a table for removingpin feathers and the same table is used for eviscer tion. There are also four to five large laundry tubs for cooling. The process is carried out in a re-conditioned hexagonal chicken house. The

building is as clean as one could imagine, but the mixing of flopping, dying birds with removal of pin feathers and evisceration processes is not desired. According to Hinshaw, McNeil and Taylor[1] found that the greatest concentration and variation of coliform bacteria were found in turkeys at a ratio of about 7;1 over chickens and 90:1 over ducks and geese.

Since the small organization described above does most of its work just prior to the holiday seasons, the rush of business makes contamin ion more likely. Their method of processing is obviously not to be desired and such practices should be discouraged.

In order to demonstrate some of the practices employed in all sizes of organizations the pictures below are submitted. Plates I to VII have been taken from a large scale poultry processing plant of approved design. Plates VIII to X are taken from a processing plant that does local processing of poultry and maintains retail outlets at various places in the city. Plate XI is taken in an establishment which does a small amount of restaurant work and serves also as a fairly good size retail outlet. Plate XII has been taken at a place of business, primarily a poultry receiving center and secondarily as a customer processor.

Plate I The apparatus is that of a multi-jet washer and multi-fingered rotating drums which are used for removal of feathers missed in the defeathering process and to wash off surface dirt. There is a marked decrease in the number of surface bacteria. After leaving the equipment, thus illustrating the effectiveness of using liberal amounts of water in washing.

Plate II The attendants at Station 5 have the task of first entering the body cavity by cutting around the vents. Care in their cutting here will prevent gross spillage of intestinal contents within the body cavity.

Plate III Evisceration of the fowl is accomplished at this point. The process uses the method of grasping all the intestines and the heart and removing them in one quick pull. The entrails are then allowed to fall free of the bird in order not to contaminate more than necessary. Even though this is good practice, contamination from ruptured intestines or vent leakage is carried on to the next bird.

Plate IV Handling of the intestines in removing the giblets is a definite source of contamination to the giblets supplementing the infection that is usually already present in them.

Plate V The inspector is a graduate veternarian who examines intestines and body cavity for evidence of pathological material. Diseased birds are discarded by him. However, his job requires the handling of all organs, inside of body cavity, and the outside of carcass. This procedure proceeds to seed the bird even better both inside and outside. This station is a very definite source of gross contamination.

Plate VI The "inside" washer is an attempt at forceful removal of discarded particles and intestinal contamination. It is only fair as a cleaning mechanism but is greatly supplemented by adding chlorine to the wash water.

Plate VII After the feet and legs are removed, one ore wash is maintained to clean of^ the skin of the bird. This is accomplished by means of a multi-jet spray designed to hit the skin from all angles. From this station the birds proceed to be graded, wrapped, and frozen for distribution.

Plate VIII Adequate surveillance of incoming poultry to use only disease-free birds is important to this organization. Also, they use controlled growing procedures to provide poultry in the off-season periods. This practice is to be lauded as long as no obviously diseased birds are used in the processing.

Plate IX The killing rack is an approved one, although killing and picking in the same room as evisceration takes place is definitely poor practice. Most contamination initially is from the feathers and dkin. Flopping chickens only serve to throw out a literal cloud of contamination and this process should be separated from evisceration procedures. The scald tank is a very definite source of contamination but the water should be changed frequently.

Plate X The rotary de-feathering equipment is the quickest and most satisfactory, but its location three feet from the evisceration talbe onlv contributes to droplet contamination of the evisceration table. Repeated use of the evisceration table with no separation from intestines further serves to increase contamination by fecal material. This situation is definitely not to be desired.

Plate XI There has been a honest attempt at separating killing from evisceration procedures. However, the picking machine is in droplet contact with evisceration tables shown at right of picture. The evisceration tables are poor in that no provision is made for either frequent washing or continuous rinsing. And still, as in Plate X, entrails are mixed with carcasses on the same table.

Plate XII This custom processor is only doing himself a favor, not the customer. He has poor sanitation procedures as the Plates show and there is no care used in cleaning the establishment otherwise. Stagnant water which the birds are subjected to is plainly visible on the evisceration table.

These on-the-spot photos taken while most busi-nesses were in operation helps to incriminate the smaller processor in using unsanitary procedures alone. Bacteriolgically, all plants leave a great deal to be desired; but the smaller producers need their attention brought to the situation. Education and standards of sanitation are, therefore, in strict need.

Plate I

Washer similar to Bloomomatic type washer (#12 on Flow Chart I). Washing of picked chicken and removal of feathers left from de-feathering process occurs here.

Plate II

Station #5 of Flow Chart I at which cutting around thighs and vent occurs.

Plate III

Evisceration of fowl. Note that entrails drop free from bird.

Plate IV

Processing of giblets. Person in upper right of picture removes giblets from intestines.

Plate V

Inspector. Examination of entrails and inside of body cavity occurs at this point.

Plate VI

Station #13. "Inside" washer using a jet spray on each bird.

Plate VII

"Outside" washer. Bird is considered a finished product at this point and proceeds to cooler and wrapping.

Plate VIII

Holding pen and controlled chicken growing.

Plate IX

Killing rack and scald tank.

Plate X

Right to Left
1. Picking process
2. Pin feathering
3. Evisceration table

Plate XI

Processing room of a smaller poultry processing establishment. Killing room is behind wall at right.

Plate XII

Processing room of a custom only poultry processing establishment. All birds to be dressed are selected by the patron.

The impetus for this project lies in the ever investigative field of bacteriology. Bacteriologists were called in initially to test the possible contamination of water by fecal products in a water supply. A few years ago typhoid fever was very prevalent and it required bacteriologists to ascertain where the sourc of contamination arose and what could be done to eliminate its possibility. The chain of events beg n full force at that point and eventually widened its scope to include beef, pork, fish, vegetables, and fruit. The pendulum is now swinging toward poultry, since we are entering a phase in w ich large scale poultry processing is a new element.

The initial work on this project was carried out by the members of the Bacteriology Department of the Nebraska College of Medicine upon inquiry of a business organization concerned with the building of mac' ines to do a more efficient job and employ a speedier method of poultry processing. This concern was interested in improving the effectiveness of their machines in rendering a bacteriologically safe poultry product. Many of the Department's recommendations have been incorporated in the newer models of poultry processing equipment.

During World War II the Quartermaster Corps found that foods containing chicken parts were unsatisfactory to use in many cases. They, ther fore, decided to invite the particip tion of bacteriology departments from several medical schools in order to ascertain if there were not some way to eliminate this spoilage. They felt that perhaps a few revisions in the processing line and better sterilization procedures could be determined. The Bacteriology Department of the Nebraska College of Medicine has compiled a large amount of work on the project and is continuing the research. Their findings and recommendations are to be evaluated concommitantly with the other investigators and the organizations preparing foodstuffs for armed service consumption will have to make revisions in their preparation to meet quartermaster standards.

Method and Materials

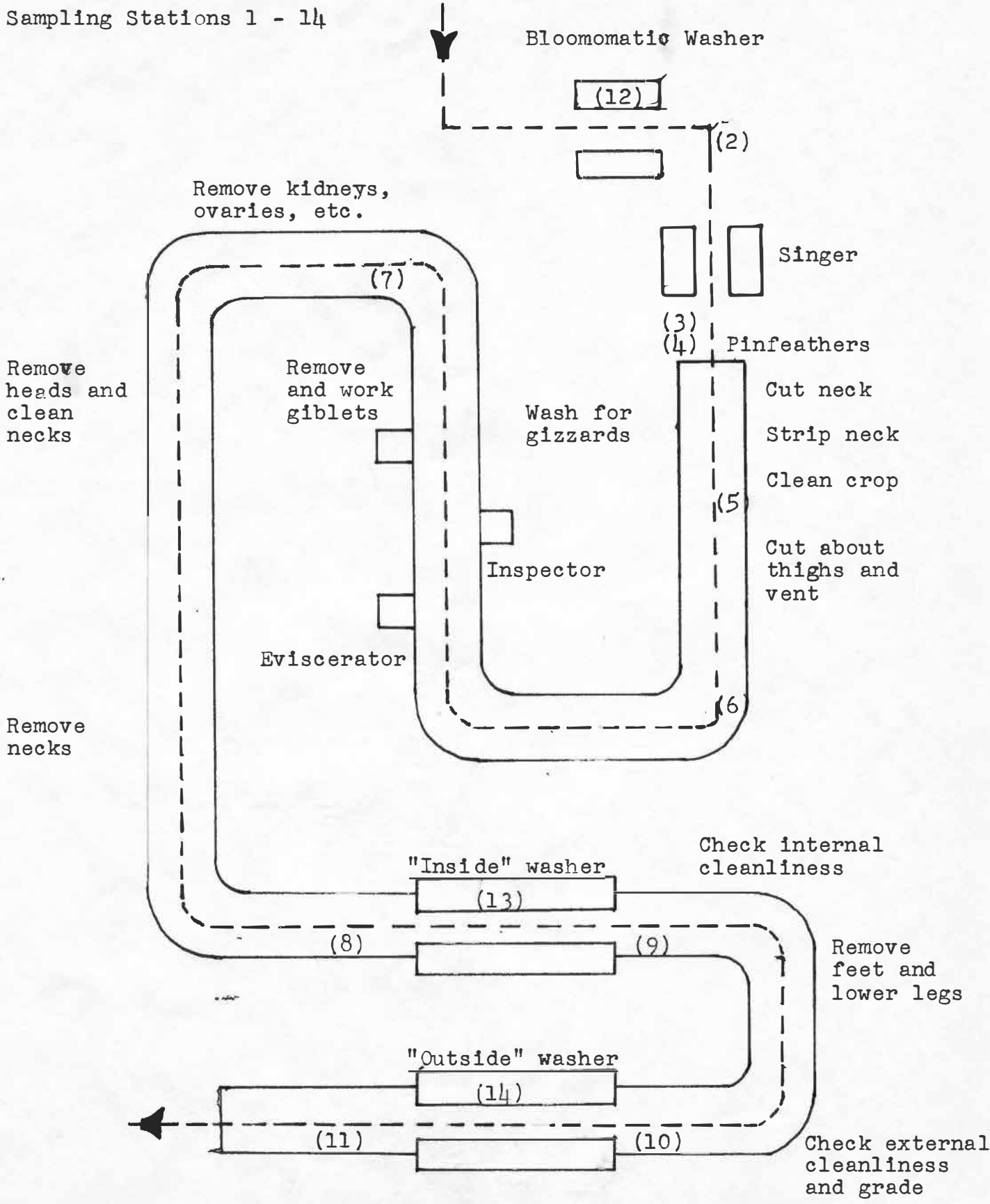
Chart I is a schematic representation of a flow line in one of our larger poultry processing establishments. It has been approved as the processing line most efficient in reducing bacterial counts on the finished packages product. The line has been designed in order to separate each individual process. It has been carefully determined that each process in its order prevents contamination of the bird to its greatest degree until just before the washingprocess.

The ideal arrangement manifests itself first by the separation of the killing and de-feathering process from the eviscer tion process. This is accomplished in two different rooms with an endless belt using a wire rack for hanging the bird by its feet. After being killed the birds are scalded in a tank, or more preferably by a spray process, with the water between 140° to 150° Fahrenheit. Although the temperature of this water is not lethal to all organisms[2], frequent changing of the water serves adequately to prevent too great a bacterial popul tion to accumulate. A higher temperature is more desirable, but above 150° the skin of the bird is easily torn.

From the de-feathering room the bird goes to (1) on the chart and into the Bloomomatic washer (12) where multi le rubber fingers on two opposite drums slap the bird and knock off any remaining feathers. A hard water spray from all angles combined with the rubber fingers helps greatly to reduce the number of skin bacteria. The fowl then continues to (2) and into the gas flame singer for removal of small feathers, hair, and to dry the skin. At this point there is a small reduction in skin bacteria from the direct flame. At stations (3) and (4) are employees who remove pin feathers only and inspect the bird for skin lesions, eliminating those carcasses undesirable for processing. At this point the bacterial count reaches its low point and from here, various cutting processes, especially removing the entrails, serves to contaminate the skin surface. Station (5) is the point at which fecal contamin tion is most likely to occur first since this is the point where the vent and intestines are exposed. The lower intestine is frequently and accidentally ruptured and bowel contents spilled into the body cavity. Between stations (6) and (7) is a veternarian who inspects the body cavity and the organs for obvious signs of pathology. He eliminates pathologic birds at this point. Station (7)

Chart I
Flow Sketch Evisceration
Diagrammatic

Sampling Stations 1 - 14



is the point where contamination of the body by S. pullorum occurs when the employee handles infected ovaries.[3] Also the liver, heart, and unabsorbed egg yolk act as the reservoirs for Salmonellas other than S. pullorum and S. gallinarum.[4] Beyond station (7) the bird is handled only on the outside and the contamination is spread by contact. Station (13) is the place where the use of a good hand stream of water does most to reduce the bacterial population. At this point is an employee with a nozzled hose who sprays inside and outside of each bird at least two times. This forced spray is effective in reducing the total number of organisms; but, of course, does not render a bird sterile bacteriologically. Two final inspections complete the line at station (9) and (10) with inspection of the body cavity and the outside of the bird. The fowl then goes through a final spraying from all directions and emerges as a relatively clean bird bacteriologically.

One final person still handles each bird at the end of the line and he grades and weighs birds dividing them into roasters, baking chickens, and fryers. He puts the carcass into a tank filled with clean, chipped ice for chilling until further disposition can be carried out.

Packaging of the bird is the next procedure with roasters and bakingchickens wrapped whole in a cellophane bag and immediately placed in a sharp freeze for storage. The fryers are cut into various pieces and wrapped in a cellophane protected carbon and subjected to the same freezing process. It is here that the greatest increase in bacterial contamination occurs as each piece of chicken is laid on a wood cutting block. These wooden cutting blocks used repeatedly for this operation are the source of the contamination.[4]

The materials used for the isolation techniques are of the routine variety. Nutrient agar in the form of Tryptone-Glucose Extract agar and selective media for coliform organisms in the form of Violet-Red Bile agar was used for the culturing. Glasware included Petri dishes, 150 ml. Erlenmeyer dilution flasks, 20 ml. pyrex test tubes, and 1 ml. graduated pipettes.

The culturing was carried out in an incubator at approximately 37.5° Centigrade for 24 hours. All culturing was carried out under strict aseptic bacteriological met ods.

Collection of the specimen was made on a spot plate containing sterile nutrient agar (12 ml.) and applied to the breast of the bird just anterior to the legs. This same spot was used in each plating and

eleven samples were taken on each bird according to the first eleven stations on Chart I. Stations (12), (13), and (14) were wash water samples taken in a sterile 200 ml. sealed jar. All samples were then placed in a portable cooler and taken to the laboratory where plating was carried out not later than four hours.

The spot plate samples were homogenized for two minutes in a Waring blendor with 108 ml. of sterile saline in order to make a 1:10 dilution. Serial dilutions were then made in sterile water with dilutions of 1:100, 1:1,000; 1:10,000, and 1:100,000 obtained. Each sample was then plated in duplicate with 1 ml. of sample in each diluting solution on Bacto-Tryptone-Glucose Extract agar and Bacto-Violet-Red Bile agar. The latter, because of its selectivity was plated only to a dilution of 1:1,000. After the twenty-four hour incubation period, each plate was counted under a counting chamber and results recorded and averaged.

All materials were sterilized in an autoclave at 120° F. and 18 pounds pressure for a period of twenty minutes before taking samples andplating. The Waring blendors were sterilized under similar conditions. The diluting solutions were composed of sterile normal saline and water.

Using the average total counts obtained from a series of independent sampling procedures, Chart II was plotted in order to graphically illustrate the effectiveness of the various working techniques. The graph also indicates at what points in the assembly line contamination increases and those points requiring special consideration for reducing the counts. It must be understood that the evisceration process exposes the carcasses necessarily and that under any circumstances, a similar graphic pattern would be obtained. Of course, a flat abscissa is the desired condition, but necessarily an impossible situation.

Chlorine in one form or another is recognized for its bacteriostatic properties and it was suggested that perhaps using its gaseous state would be desirable if there were no serious side reactions. Chart II was compiled to illustrate the relative effectiveness of plain water and gaseous chlorine injected into the water in the concentrations of 10 and 20 parts per million. Each bar of the graph represents an average of multiple samplings from the assembly line. The solid bar represents plain tap water with no chlorine added; the broken line graph represents tap water with 10 parts per million of gaseous chlorine added; the alternating dot-dash graph represents tap water with 20 parts per million of gaseous chlorine added.

Chart II

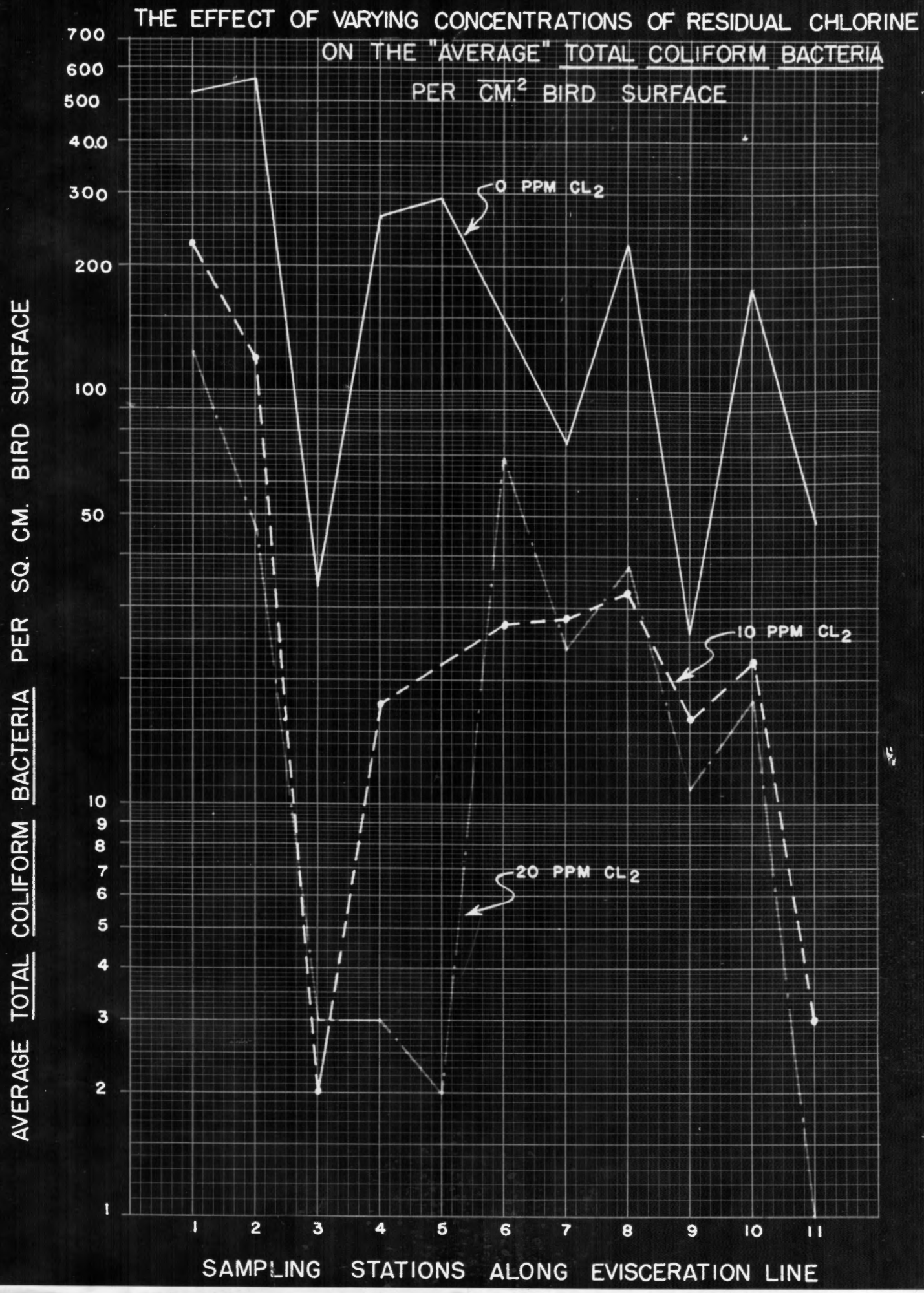

THE EFFECT OF VARYING CONCENTRATIONS OF RESIDUAL CHLORINE ON THE "AVERAGE" TOTAL COLIFORM BACTERIA PER CM.² BIRD SURFACE
AVERAGE TOTAL COLIFORM BACTERIA PER SQ. CM. BIRD SURFACE
700
600
500
400
300
200
100
50
10
9
8
7
6
5
4
3
2
1
0 PPM CL2
10 PPM CL2
20 PPM CL2
1 2 3 4 5 6 7 8 9 10 11
SAMPLING STATIONS ALONG EVISCERATION LINE

Chart III

THE EFFECT OF VARYING CONCENTRATIONS OF RESIDUAL CHLORINE ON THE "AVERAGE" TOTAL VIABLE BACTERIA PER $\overline{CM}^2$ BIRD SURFACE

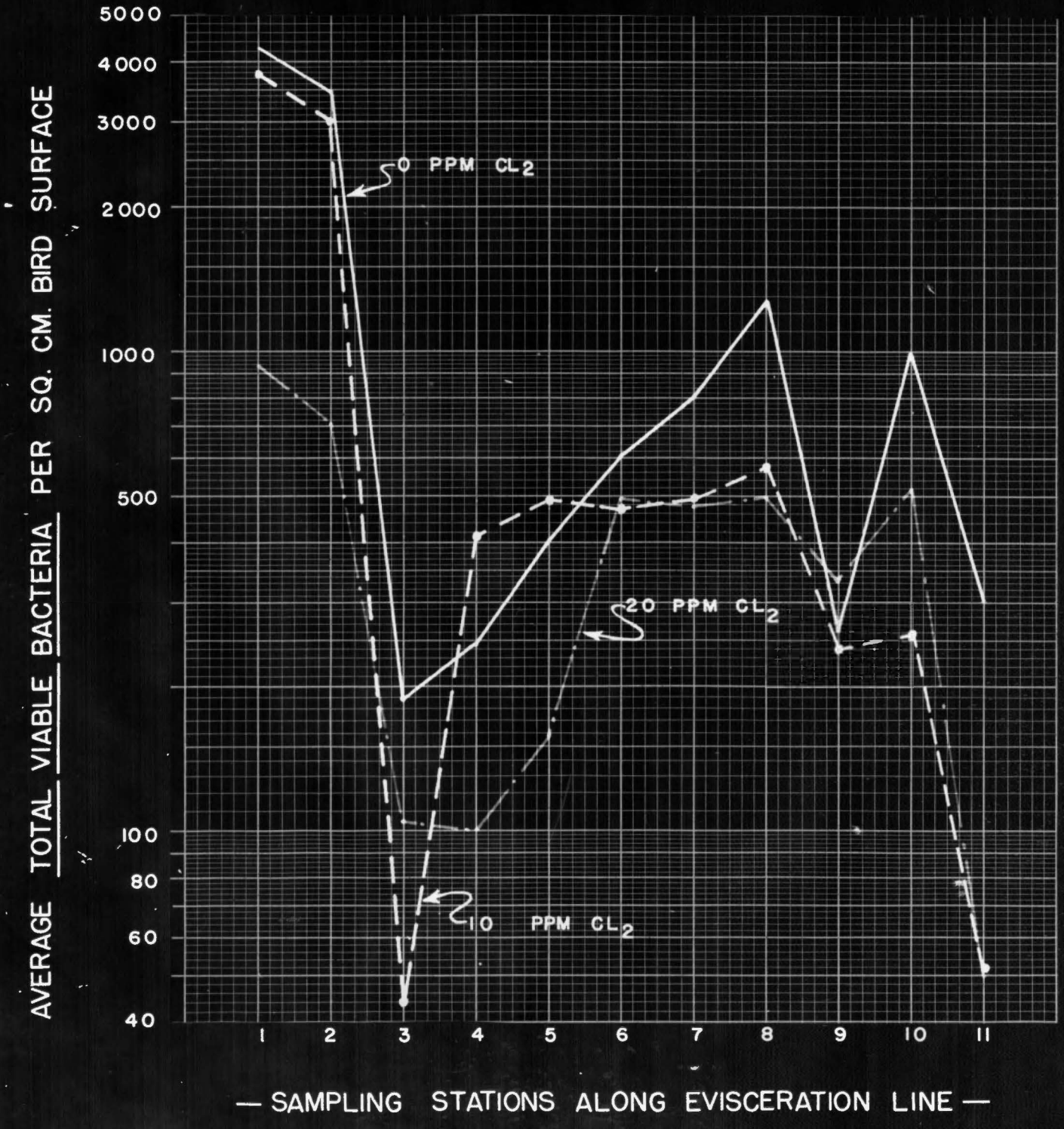
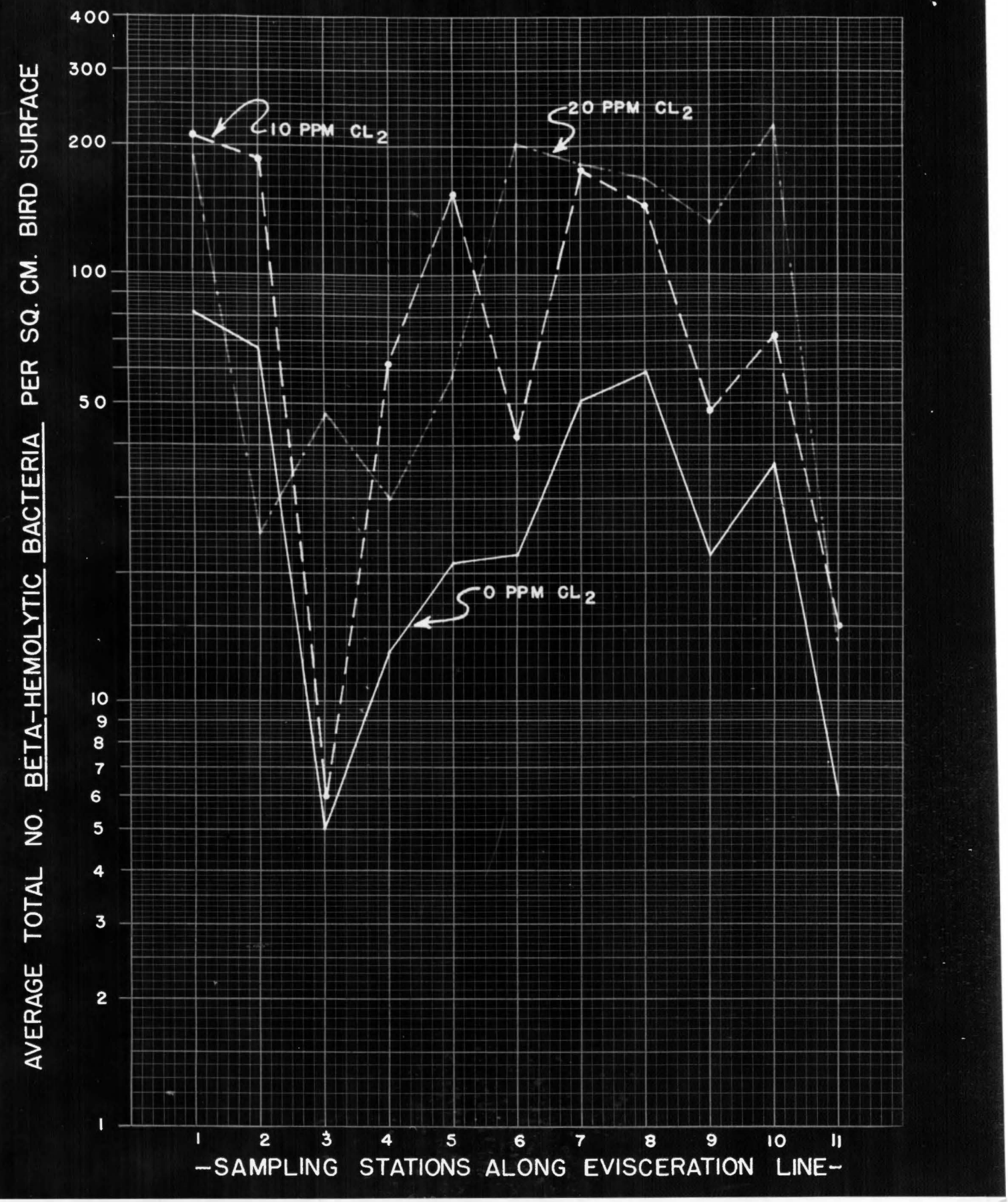


Chart IV

THE EFFECT OF VARYING CONCENTRATIONS OF RESIDUAL CHLORINE ON THE "AVERAGE" TOTAL BETA-HEMOLYTIC BACTERIA PER $\overline{CM}^2$ BIRD SURFACE



It is impressive to note the degree of effectiveness that liberal quantities of water has in reducing the surface co nt initially. Of interest too, the progression of the graph shows that even with contamination of numerous handlers and exposure to the intestinal flora, the count at no time reaches the levels found at the first two stations. Just this evidence is sufficient to prove the value of liberal quantities of water at frequent points in the processing line. From comparison of the three curves it would seem that the water with 10 ppn. of chlorine was more effective in reducing bacterial count. This is true, but also the factor of natural bacterial inhibition comes into play at this level. According to Ch rt III, the higher concentration of chlorine shows a more complete elimination of coliform organisms as comp red to the lesser concentration. However, this is relative to coliform organisms which are more sensitive to chlorine inhibition. Chart IV shows that use of chlorine is actually of little value in reducing streptococcal counts. This is not due completely to the use of chlorine however. First of all, the streptacoccus is more resistant to chlorine inhibition than the coliform organisms. Since the coliforms are very sensitive to chlo ine, the rapid reduction of coliforms

with a consequent rapid depletion of the natural competitive inhibition between coliforms and streptacocci increases the total streptacoccal count. These factors account for the apparent ambiguity in the results depicted in the three graphs.

Nevertheless, Chart III shows a very marked reduction in the total number of coliform organisms which is the aim of the experiment. Also the aim of the experiment is to show the most effective method of reducing the number of causative agents of infectious diarrheas and systemic manifestations in humans. This same chart very definitely illustrates and proves the inestimatiable value of in-plant chlorination procedures. The concentrations, apparently, are not too important as the curves almost completely reproduce each other and that actually the presence of chlorine at some point around 10 ppm. will be considered an effective range. Goresline[5] and his group have produced results with the use of chlorine that is astounding. They first proved the value of liberal quantities of plain water in working the carcasses with a reduction of bacterial counts ranging up to 80%. Using chickens on the line washed with chlorinated water, they found that contamination was reduced 90% in most cases with

some reductions up to 99%. These facts go a long way in proving Gunderson's[6] statement that,

> "Controlled experiments have shown that a chicken almost free from intestinal bacteria can be produced."

The preceding discussion has shown that there is considerable that can be done in producing bacteriologically safe eviscerated poultry. Attention is now shifted to consider the increase or decrease in bacteria after reaching the freezing state. For this phase of the experiment, one portion of the chicken was used throughout in order to maintain consistent results. Chicken livers were used for two reasons, first being that this portion was known to harbor many bacteria and which would have high counts. Secondly, because each package would be mixed with livers from many chickens, the effect of this mixing would be hown.

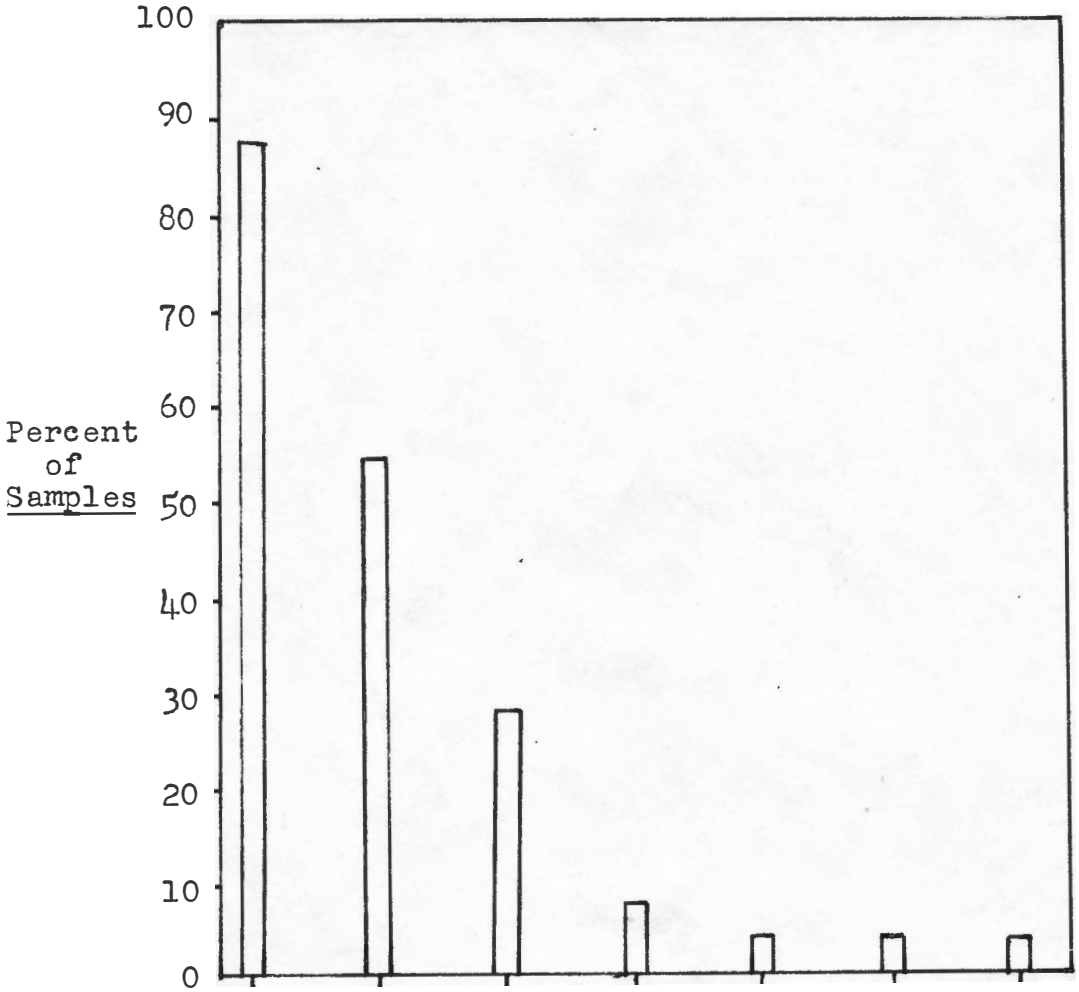
Similar aseptic precautions were maintained and the process was carried with results expressed in count per gram of material. All species previously isolated were isolated again from the frozen state with the time of refrigeration being indeterminate. It was found previous to freezing that isolation of Salmonella species was accomplished in 18% of the samples made on frozen chicken livers. The most startling result obtained was that of a 90% incidence of Escherichia species. This would certainly indicate that there had been fecal

contamination at some point in the processing line. It is strange that rigorous standards are designed for the purity of water supplies using Escherichia species as an index of fecal contamination, and yet, here in chickens showing a high coliform count, we have no standards to control this food processing. Some individuals will claim that freezing and cooking will destroy any of the coliform bacteria. It is true that freezing does reduce the number of bacteria, but Gunderson and McFadden[7] showed that both E. coli and S. pullorum can be maintained up to 48 weeks at temperatures between a -4° F. and -11° F. and still have significant numbers of bacteria viable. They demonstrated that there was a prompt initial decrease in bacterial count followed by a slower storage decline. The literature is replete with articles demonstrating this longevity under conditions that were formerly thought to be adequate for sterilization.

The second claim, that of cooking to destroy bacteria, is valid up to a point. The public still has two characteristics that contribute to potential food poisoning: impatience in cooking and the taste for rare meat. Incomplete cooking, of course, is a large factor in the preparation of exatoxigenic organisms.

TABLE V

PERCENT SAMPLES FROZEN PACKAGED CHICKEN LIVERS CONTAINING VARIOUS SPECIES OF BACTERIA *



* Courtesy Bacteriology Department, University of Nebraska College of Medicine.

The author feels that at least a portion of the outbreaks of food poisoning dervied from group dinners were due to incomplete cooking and further incubation of organisms on a steam serving table.

Table V shows that none of the samples taken from the frozen livers were sterile bacteriologically. Of course, natural air contaminants are present which would be there at any time; but, there is definite evidence of fecal contamination that must be reduced by further investigation on the evisceration line.

Caution toward aseptic technique and accuracy was maintained throughout experiments, but the sources of error are listed as follows:

1. Inadequate sterilization of spot plates and Petri dishes prior to sampling.
2. Contamination of spot plates before sampling or manual handling of spot plates.
3. Prolonged time between collection of sample and time of actual plating.
4. Contamination in the homogenization process either from transfer loop, diluting solutions, or Waring blendor.
5. Inaccurate measuring of diluting solutions.
6. Inadequate dry-heat sterilization of pipettes.
7. Inaccurate measuring of 1 ml. of sample in pipette.
8. Overall errors in counting colonies.
9. Inaccuracy in compiling statistics.

It is believed that with strict attention to these sources on the part of the technicians and their adherence to bacteriological methods, few of these sources actually entered into the results. Too, it is generally accepted that if the same group of workers carry out

the experiment, the same errors will be commited and yet the final results will be valid when the errors are taken into account.

With the relatively high incidence of infectious diarrheas in the United States today, attention has been shifted to what acts as a reservoir for these infections. Numerous investigators have implicated fowl in general harbor the infectious agent, whether or not it actually produces a disease in the fowl. In 1939 the statement was made thatpoultry contributed the greatest reservoir of paratyphoid infections among domestic animals in the United States.[8] Barnes[9] reported that fowl are by far the main animal reservoir of organisms affecting man, a point which cannot be over emphasized, since it may often aid in solving the origin of an outbreak of Salmonellosis. The agreement of these investigators is gratifying and illustrates the need for some type of edible fowl inspection.

Considerable work has been carried out to determine what organisms are present in poultry and what their infectivity toward humans comprises. One group of investigators[10] have determined at least 49 types of Salmonellaas natural and accidental infections in

fowl. Of these, approximately 40 have been isolated from humans both in the carrier stage and in the clinical stage with evidence of infection. Another group[11] isolated 35 species of Salmonella from chickens and found that all but S. pullorum, a natural chicken intestinal inhabitant, were found in the visceral organs other than the gastro-intestinal tract. The investigative crew headed by Gunderson[12], in a large series, found species other than Salmonella; but showed that there existed an overall incidence of poultry Salmonellosis of 4.4%. Most investigators agree that with fairly exhaustive research, they have not identified yet all the organisms present, which under suitable conditions, will produce clinical manifestations in humans.

A list of the organisms encountered is long, but most authors agree on a few. They are presented below:

S. meleagridus	S. pullorum
S. anatum	S. montevideo
S. gallinarum	S. aertyke
S. paratyphi A and B	S. enteriditis
S. typhimurium	S. derby
S. cholerae suis	S. seftenberg
S. newington	Escherichia coli
Aerobacter aerogenes	Paracolobactrum
Bacillus spp.	Yeasts and molds

All of these species listed are quite capable of producing disease in humans. The presence of E. coli is not surprising but indicates that some place the fowl received fecal contamination.

It is interesting to note that Mallman[12] and his co-workers, working with strains isolated from chicken intestines, published a paper in 1942 in which they said th t,

> "none of the Salmonellas from chicken intestinal contents showed any pathogenicity for the Rhesus macus monkey when fed in excessive doses."

McCullough and Eisele[13] performed some work which proved the antithesis of Mallman's group. They were able to obtain a group of human volunteers who were in a closely regulated institution and under strict dietary management. Three strains of two species, S. meleagridus and S. anatum, originally isolated from market samples of spray-dried whole egg powder were fed to the volunteers. All six strains produced human illness with 32 of the men developing clinical disease. They also felt that the number of organisms received by each man was a number which, in all instances, was within the range which might conceivably be encountered. Many cases of asymptomatic carriers were produced, some persisting

for many weeks. Rubenstein, Feemster, and Smith[14] listed 356 cases of human Salmonellosis, most of these cases arising as a result of group dinners and institutional food programs. They indicate that most of the infections were probably a result of dissemination by carriers with subclinical cases, but that many of the organisms were encountered in poultry. These men also noted that the chronicity is maintained most probably in the gall bladder. In a bulletin of the Public Health Service[15], a survey of the statistics in 1948 showed th t out of 9,962 cases in 327 outbreaks, 2,492 cases in 61 outbreaks were attributed to poultry and poultry products. It is believed that these figures are only a fraction of the total number of infections resulting from incomplete reporting of the outbreaks by physicians. Rhodes[16] reports a case of infection with clinical symptoms of vomiting and diarrhea due to the Paracolon group of organisms.

Not only are the consumers to be considered in pathogencity of organisms in fowl, but those employees handling the birds are likewise susceptible. Irons[17] and is fellow investigators report an outbreak of Psittacosis in plant employees. In one plant which at that particular time was processing turkeys, 22

employees out of 78 total emplyees contracted the disease and required hospitilization. There were, to be sure, other asymtomatic cases not reported. Seventeen of the 22 employees were those involved in the defeathering and the removing of pin feathers. This proves that the scald tank is not lethal to all organisms and that after scalding, notonly are some of the organisms alive, but they are also infectious through droplet contamination.

McFadden and Gunderson[18] in their discussion of infectious diarrheas list the etiologic agents in part as due to Shigella, Salmonella, Amoeba, parasites, tuberculosis, cholera, paracolon, Proteus, Pseudomonas, streptococci, and others. Since many of these have been isolated from poultry, efficient control of possible sources of contamination of poultry is mandatory.

Discussion

In order to achieve standards compatible with production of bacteriologically safe poultry products, all concerns will have to be educated to follow a few b sic steps. The author has attempted to organize the material to fall in order with events along the processing line up to the delivery to the consumer.

Of paramount importance is the accomplishment of the selection of those birds which are not diseased and the elimination of diseased poultry. It is only reasonable that the incorporating of obviously diseased poultry, which more than likely would be placed with healthy birds, would be a very gross and obvious source of contamination. It wouldbe desirable, therefore, to have all birds culled prior to killing by an experienced individual. Each bird can be very quickly inspected and declared usable or unusable as the case may be. A good plan is the use of a holding pen in which new shipments of poultry from the poultry farmer could be detained for a desired length of time At the end of the specified period of time the diseased birds would be discarded. This is an extra expense which is bulky and re uires more handling, but is

obviously more thorough. Another method is the use of specialized poultry growers who would raise the poultry under good regulation and discard each diseased bird before sale. Most processors would be willing to pay a small premium per pound in order to obtain consistently high grade live poultry and thus initiating an incentive for the poultry growers to produce this high grade poultry. Lastly, the person who culls the birds which have been subject to moulting and cannabalistic pecking by other fowl. Many of these injured birds have small abscesses which are concentrations of bacteria seeded over the rest of the skin.

The largest share of contamination is from the surface of the bird; therefore, the provision of a washing station between the picking and drawing serves to diminish the gross contamination involved when the same person handles the bird throughout the complete dressing process. It has been proved that plain water does a respectible job of reducing the bacterial count. This count reduction is supplemented when in-plant chlorination procedures are used. This single addition is very efficient in raising processed chicken qualities and providing the consumer with a bacteriologically safe foodstuff. Also, this separation of picking and evisceration procedures eliminates the possibility of

droplet contamination of the evisceration trays or tables by flopping fowl on the kill rack.

Frequent washing along the whole processing line serves two purposes. First, washing aids in eliminating bacteria imposed by the employee who, prior to this, may have been handling a grossly diseased bird and seeded the next one in line. Secondly, it cleans the bird after the body cavity has been opened whether or not the intestine has been ruptured. Of course, the use of chlorinated water has its beneficial effects as depicted in the charts previously. Special care should be paid to those birds in which a viscus has been ruptured. After rupturing a viscus washing of the handler's hand after contact with such a contaminated bird should be initiated and the birds marked for identification. Fortunately the addition of chlorine has not been shown to decrease the quality of the bird and does not taste when cooked, thus creating a very desirable meat product.

With the completion of the whole evisceration process, the birds should be immediately cooled by some method; that is, snow, freezer cooling, or chipped ice. The chickens shouldbe wrapped in clean, sealed containers and immediately placed in a freezer for quick freezing. Since there is a definite decrease

in bacterial populations by freezing, combining the freezing with previous care in processing will serve to more efficiently reduce counts to a point below a critical infectious level. At no time should the cartons of frozen poultry be allowed to thaw. This only permits the cold-resistant organisms to incubate. Whatever the conditions, all processed meats must be cooled below normal incubation temperatures in order to prevent any further growth of bacteria present on the surface after processing.

The only index the retail outlet has for determing the shelf-life of the processed meat is the color. Sales resistance toward discolored meat has made it unprofitable to order large amounts of packaged frozen meats. This is as it should be, since large quantities cannot be stockpiled and the consumer is assured fresh products. The shelf-life is difficult to determine, but it has been shown by Gunderson[19] that cultures taken on alternating days showed only a small decrease from sample to sample. At the end of eleven sampling days there were still significant numbers of viable bacteria, some capable of producing an infection.

Recommendations

To the small processor:

1. Thorough inspection of each bird prior to killing in order to use only disease free poultry.
2. Separation of the killing and scalding from the evisceration process in different rooms. This can be easily accomplished by the building of a small room for evisceration.
3. Frequent change of scald water. Every half hour is an adequate change period.
4. Frequent cleansing of evisceration table either by scrubbing or using a continuous flow of water over the table.
5. Keep the equipment clean w ich comes into contact with the finishedproduct. Using the butcher shop practices of clean paper under the bird, the sale then gives a professional appearance.
6. The incorporation of chlorine is desired, but until less expensive equipment is designed, care in handling bird will give satisfa tory results.

To the large producer:

1. Proper selection of fowl eligible for processing without using birds with obvious diseases.
2. Frequent change of scalding water or the use of a scalding spray will help eliminate the spread of accumulating bacteria in the scald water.
3. Use of separate employees for each process and the establishment of an approved flow line.
4. Frequent washing machines designed to attack contamination that potentially occurs at the various stations. The use of in-plant chlorination is urged.
5. Rapid cooling and packing with subsequent freezing to prevent any incubation can be carried out easily. In the case where fryers are cut into pieces, the use of cutting boards which are washed after cutting u three fryers is a good practice.
6. Provision of a first-aid room with attention to minor injuries of personnel will aid greatly in reducing morbidity of employees. Also, eac employee s ould undergo frequent physical examinations.

7. The use of chlorine will reduce the formation of slime-forming bacteria with the result that odors in the plant will be dissipated and workers will have a more agreeable attitude toward their working conditions.

To the Public Health Department:

1. Standards should be drawn up on a state basis for the production of poultry and poultry products similar to those used in beef, pork, vegetables, and fruits. Reference is made to Helvig and Hart's article on Poultry Sanitation Standards, Proce dings of the 47th Annual Conference of the State and Territorial Health Officers[20], and an article by the Production and Marketing Administrations[21], for the evidence of poor sanitation legislation in the United St tes and some of the practices that should be carried out.
2. There s ould be provision of a law prohibiting the use of "green struck" poultry in c icken products. Since they cannot be sold whole, the c nsum r s o ld not be forced to eat it just because he can not see the deterior ted bird before it has been used for other chicken dishes.

3. Routine inspections by Health Department officers should be made similar to those in other meat processing industries.

To the distributor:

1. Only enough frozen products should be bought to supply him for a week or ten days.
2. Refuse frozen products that are soft and show evidence of having been thawed. Also, any discolored meat should be refused.
3. Break up packages of poultry that have been accidentally opened and the parts placed for quick sale.
4. Keep all products frozen at all times.

To the consumer:

1. Acceptance of only clean looking products and the refusal to accept discolored meat will help to protect the consumer.
2. Acceptance of only securely sealed packages should be made.
3. The bird should be kept from thawing until ready for use; then thaw, wash, and cook thoroughly.
4. Patronize only businesses in which there is a license for the processing of poultry.

Conclusion

This paper has attempted to show there is a definite need for connective procedures in the processing of poultry. High levels of bacterial counts are definite evidence of contamination and the presence of coliform bacteria is, obviously, creating a potential health hazard. Evidence is offered to show that there are still many cases of food poisoning in the United States and a large percentage of these have arisen from poultry and poultry products. Therefore, it is apparent that there is a need for some standards in legislation to control this source of infection because of improper processing tec niques.

An attempt has been made to inform the consumer of the potential hazards in the processed poultry products. Therefore, caution in purchasing these pro ucts and thorough care in cooking will prevent the possibility of food poisoning.

Summary

The advent of large scale poultry processing has created new sources of food poisoning. Other processed foods have reached a point of satisfactory control in their contamination. It is thought that one of the sources of food poisoning arises from the small processor who has not yet been educated to realize the possibilities of poor techniques in processing contributing to infections.

Methods of isolation of various bacteria is discussed with emphasis on the points in an assembly line where contamination mostlikely occurs.

Graphic illustration is made of the use of liberal quantities of water and chlorinated water and the relative sensitivity of different types of bacteria. Errors in bacteriological techniques are suggested. Organisms encountered are listed and the possibility of human infections considered.

The various phases of the processing line are discussed, pointing out proper practices at those points and some of the fallacies.

Recommendations are made to the several businesses concerned with the production and sale of poultry. Precautions and approved procedures are listed.

BIBLIOGRAPHY

1. Hinshaw, W. R., McNeil, E., Taylor, T. J., "Avian Salmonellosis. Types of Salmonella Isolated and Their Relation to Public Health," Am. J. Hyg., 40:264, 1944.

2. Gunderson, M. F., Rose, K. D., Schwartz, P., "Bacteriology of Eviscerated Poultry," Quartermaster Reports, July 1, 1945.

3. Gunderson, M. F., Schneider, M. D., "Bacteriology of Eviscerated Poultry," Quartermaster Reports, August 16, 1944.

4. Mallman, W. L., Ryff, J. F., and Mathews, E., "Studies on Salmonella Groups. Met ods of Isolation and Pathogenicity of Strains Occuring in Intestines of Chickens," J. Inf. Dis., 70:253-262, 1942.

5. Goresline, H. E., Howe, M. A., Baush, E. R., and Gunderson, M. F., "In-Plant Chlorination Does a 3-Way Job," U. S. Egg and Poul. Mag., Vol. 57, April 1951.

6. Gunderson, J. F., "Do the Job Right When You're Eviscerating Poultry," U. S. Egg and Poul. Mag., July 1946.

7. Gunderson, M. F., McFadden, H. W., "Bacteriological Aspects of Precooked Frozen Foods," Quartermaster Reports, July 1, 1947.

8. Edwards, P. R., "Incidence of Salmonella Types in Fowls in the United States," Proc. World's Poult. Cong., p. 271-274, 1939.

9. Barnes, L. A., "Pathogenic Enteric Bacilli," U. S. Nav. Bull. 43:939-949.

10. Hinshaw, W. R., McNeil, E., and Taylor, T. J., "Avian Salmonellasis. Types of Salmonella Isolated and Their Relation to Public Health," Am. J. Hyg., 40:264-278, 1944.

11. Darbly, C. W. and Stafseth, H. J., "Salmonella Infections Common to Man, Animals, and Birds," Prac. U. S. Live Stock San. Assc., pp. 189-202, 1942.

12. Mallman, W. L., Ryff, J. F., and Mathews, E., "Studies on Salmonella Groups. Methods of Isolation and Pathogenicity of Strains Occurring in Intestines of Chickens," J. Inf. Dis., 70:253-262, 1942.

13. McCullough, N. B. and Eisele, C. W., "Experimental Human Salmonellosis," J. Inf. Dis. 88:278-289, May-June 1951.

14. Rubenstein, A. D., Feemster, R. F., and Smith, H. N., "Salmonellosis as a Public Health Problem in Wartime," Amer. J. Pub. Health, 34:841-853, 1944.

15. "Disease Outbreaks Conveyed through Foods Other than Milk and Milk Products in the United States in 1948 as Reported by State and Territorial Health Authorities," Milk and Food Branch, Division of Sanitation, Public Health Service, Federal Security Agency.

16. Rhodes, A. J., "A Small Outbreak of Diarrhea Associated with the Paracolon Bacellus," J. Hyg., 42:99-102, 1942.

17. Irons, J. V., Sullivan, T. D., and Rowen, J., "Outbreak of Prittacasis from Working with Turkeys or Chickens," Am. J. Pub. Health,

18. McFadden, H. W., and Gunderson, M. F., "Infectious Diarrheas," Nebr. St. Med. J., Vol. 36, March, April and May, 1951.

19. Gunderson, M. F., Kyle, T. S., Unpublished Reports.

20. Proceedings of the 47th Annual Conference of State and Territorial Health Officers, Nov. 1948.

21. "Regulations Governing the Grading and Inspection of Poultry and Domestic Rabbits and Edible Products thereof and U. S. Specifications for Classes, Standards, and Grades with Respect thereto," Poultry Branch, Production and Marketing Administration, U. S. Dept. Ag., Jan. 1, 1950.