THE EFFECT OF STRAIN, SEX AND RATION ON RATE OF GAIN, DRESSING PERCENTAGES AND MEAT YIELD OF CHICKEN BROILERS

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ABSTRACT

A study was made of the effects of strain, sex and Calorie:protein ratio of the diet on weight gains, feed efficiency, dressing percentages and meat yields of chicken broilers. In conjunction with this study an attempt was made to determine a simple and accurate method of estimating meat yield.

The experiment, conducted in a randomized complete block design with a factorial arrangement of treatments, involved three strains, two sexes, and four diets. Groups of twenty-five chicks were randomly assigned to pens in electrically heated battery brooders. Average weight gains and feed efficiencies were based on twenty-five birds per pen. Average dressing percentages were based on ten birds per pen, and average percentage meat yields were based on six birds per pen.

The results indicated that strain, sex and Calorie:protein ratio of the diet affected weight gain, feed efficiency and dressing percentages. Sex, and the Calorie:protein of the diet affected percentage meat yield.

The regression equations of total bone weight on femur weight and total bone weight on tibiotarsi weight, which were derived to estimate edible meat yield, were significantly affected by strain, sex and Calorie:protein ratio.

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CHAPTER I

INTRODUCTION

I PURPOSE OF THE STUDY

The production of chicken broilers is a major branch of Canada's poultry industry. During the past decade broiler production has developed from an incidental sideline of egg production to its present status representing slightly over fifty per cent of Canada's poultry meat supply. Table I indicates the growth of broiler marketings in Canada during the period 1953 to 1958 inclusive. Broiler chicken, as a percentage of total chicken marketed, increased from approximately forty-nine per cent in 1953 to eighty-six per cent in 1958. This phenomenal growth was associated with concomitant technological developments in nutrition, genetics, processing and merchandising.

Extensive research has been conducted on the effects of strain, sex, and Calorie:protein ratio on growth rate and feed efficiency. Limited research has been carried out to determine the independent effects of these factors on dressing percentages and meat yields. While the individual action of strain, sex, and Calorie:protein ratio has been investigated, the effects of the interactions between these factors has not been ascertained. The purpose of this study was to determine whether significant interactions exist between strain, sex, and Calorie:protein ratio. An attempt was also made to augment present

TABLE I TOTAL CHICKEN AND BROILER CHICKEN MARKETINGS IN CANADA FROM 1953 to 1958

(DRESSED WT BASIS)

YEAR	TOTAL CHICKEN MARKETED '000 LBS	BROILER CHICKEN MARKETED '000 LBS	BROILER CHICKEN AS % TOTAL CHICKEN
1953	60,779	30,049	49.4%
1954	80,535	49,883	61.9
1955	84,098	61,347	72.9
1956	132,976	103,677	77.9
1957	150,473	126,326	83.9
1958	205,455	176,645	86.0

knowledge of the independent effects of each of these factors on growth, feed efficiency, dressing percentage and percentage meat yield of broiler type stock.

In previous investigations several methods, many of which are time consuming and laborious, have been used to determine meat yield. A simple, accurate method of determining meat yield is required. Therefore, during this study an attempt was made to determine a method of accurately estimating the total bone weight and thus the meat yield of chicken broilers from the weight of the femurs and tibiotarsi of the skeletal system. Table II is a glossary of terms used throughout the thesis.

II GLOSSARY OF TERMS

Strain 1	-	Cobbs cross or (CbCb)
Strain 2	-	Cornish x Cobbs or (CoCb)
Strain 3	-	Vantress x Nichol or (VaNi)
Ration 1	-	low protein-high energy or (LPHE)
Ration 2	-	low protein-low energy or (LPLE)
Ration 3	-	high protein-high energy or (HPHE)
Ration 4	-	high protein-low energy or (HPLE)

CHAPTER II

REVIEW OF LITERATURE

The differences between strains and between sexes in growth rate and feed efficiency have not been studied extensively in recent years, but the results of earlier work on these two factors will be presented. Also, a summary of experiments conducted to determine the effect of the Calorie:protein ratio on growth rate and feed efficiency will be given.

Strain and sex have been shown by some researchers to have a significant effect on losses during dressing and evisceration and on the yield of edible meat from chicken broilers. Research has also shown that energy level can affect eviscerated yield. The following presentation will be limited mainly to research pertaining to the effects of strain and sex; limited information is available on the effects of energy and protein levels.

The prediction of the weight of edible meat from live, dressed or eviscerated weights has been studied and the results of these studies will be presented.

I THE EFFECT OF STRAIN, SEX AND CALORIE:PROTEIN RATIO ON WEIGHT GAINS AND FEED EFFICIENCY

Several workers have established that differences exist between strains in growth rate and feed efficiency. Asmundson and Lerner (1933), Schnetzler (1936), Jaap and Morris (1937), and Waters and

Bywaters (1943) have shown that strains within a breed often exhibit inherent differences in rates of growth.

That males exhibit a greater and more rapid gain in body weight than females has been reported by Kempster (1921) and Carver and Hougan (1935).

The effects of dietary protein and energy levels on growth rate and feed efficiency have been investigated by several workers. One of the earliest papers on this subject by Hill and Dansky (1950) revealed that growth was reduced by a high energy-low protein ration; when the energy level was reduced, growth was normal.

Peterson et al (1954) and Hill and Dansky (1954) suggested that feed consumption is determined primarily by the energy content of the diet. They also reported that feed intake varied inversely with the energy content of the diet.

Combs and Romoser (1955), Leong et al (1955) and Matterson et al (1955) reported that as the energy content of a ration was increased, the protein requirement for optimum growth increased.

Donaldson, Combs and Romoser (1956) working with productive energy levels of approximately 972, 1087 and 1200 productive Cals./ pound, found that at each energy level, average weight gain and feed conversion improved with an increase in the protein level until an adequate level was supplied.

Mraz et al (1958) corroborated previous findings that at specified energy levels, the growth of male chicks increased as the protein level increased. In their work productive energy levels ranged from 450 to 900 Cals./pound and protein levels from 7.5 to 30 per cent. Feed efficiency also improved as the protein level increased at each energy level. Furthermore, diets with Calorie:protein ratios over 45:1 were inferior to diets with Calorie:protein ratios of 45:1 or less in promoting growth of ten week old broilers.

Sunde (1956) reported that in chicks a high protein-low energy diet caused a reduction in both growth rate and feed efficiency when compared to a low protein-low energy diet. Increasing the energy level of the diet by the addition of fat increased the weight of chicks and improved feed efficiency at both four and ten weeks of age. These results indicate that when the per cent protein is high, the energy level must also be high. Sunde also suggested that a change in the protein level causes the optimum Calorie:protein ratio to change.

Vondell and Ringrose (1958) found that when protein levels ranged from 16.5 per cent to 22.5 per cent the relative effects on growth rate of increasing the Calorie:protein ratio from 36:1 to 53:1 were not different at the various protein levels. In direct contrast to Sunde (1956), they suggested that the above Calorie:protein ratios would produce similar effects throughout a wider range of protein levels than was considered in their study, provided that other nutrients were in balance. Furthermore they concluded that the choice of a specific Calorie:protein ratio should lie between 45:1 and 53:1

and that this ratio would be effective in promoting optimum growth irrespective of the level of dietary protein.

Shutze and associates (1958) compared sexes and two methods of rearing (battery and floor) to determine the effects of varying levels of energy and protein on growth and feed efficiency. They reported differences between sexes and between methods of rearing. Their results also indicated that with battery reared birds at four weeks of age there were differences between sexes in growth and feed efficiency response to increased energy levels. In contrast at eight weeks of age both sexes responded similarly to increased energy levels. These workers also reported that males showed improved growth and feed efficiency when protein level was increased but females generally showed no significant response, regardless of the energy level in the ration. It was concluded that when reared in batteries, male and female birds may have different requirements for protein, independent of the energy level.

II THE EFFECT OF STRAIN, SEX AND CALORIE:PROTEIN RATIO ON DRESSING PERCENTAGE AND MEAT YIELD

Renard (1949) found considerable variation among breeds and crosses in percentage losses during both dressing and evisceration.

Jaap and associates (1950) working with forty-four strains and crosses of varied ancestry concluded that rapid growth (weight) was the major factor increasing both the percentage dressed and percentage eviscerated yields at twelve weeks of age. However, these workers found that strain differences were evident after the effect of weight had been removed. This prompted the authors to suggest that there were heritable factors other than weight which affected percentage dressed and percentage eviscerated yields. In addition it was concluded that the percentage dressed and eviscerated yields of females were lower than males because of their (females) lower body weight.

Hathaway et al (1953) using both broiler and non broiler strains found significant differences between strains in eviscerated yields and edible meat yields. They also reported, that, in most cases, females tended to yield a greater percentage of edible meat. No significant sex differences were noted in percentage loss from live to dressed weight.

Stotts and Darrow (1953) found that in tests designed to compare Cornish crossbreds, non Cornish crossbreds and purebreds, the Cornish crossbreds gave consistently higher meat yields (as a percentage of eviscerated weight) in both males and females. Meat yield was determined by the "cooked in stockinette" method. Cornish crossbreds also had a significantly higher meat to bone ratio than non Cornish crossbreds or purebreds. Females from all stocks studied produced higher yields of edible meat (as a percentage of eviscerated weight) than males; however the differences were small and non significant.

Morrison et al (1954) compared eight broiler crosses on the basis of eviscerated and edible meat yield. They reported no significant differences between crosses in eviscerated yield (as a percentage of dressed weight) or edible meat yield (as a percentage of eviscerated weight). To separate the meat from the bones in order to determine edible meat yield, each bird was cooked for twenty minutes at fifteen pounds pressure.

Orr (1955) compared strains, rations (one ration contained no fat while the other contained five per cent stabilized animal fat) and sexes on the basis of dressed yield, eviscerated yield and cooked edible meat yield. Strain, sex and ration had no significant effect on chilled dressed weight expressed as a percentage of live weight. However, significant strain and sex differences were observed when eviscerated weight was expressed as a percentage of live weight. Cooked edible meat yield was found to differ significantly among strains on the basis of chilled dressed weight and live weight but such differences were not significant when cooked edible meat yield was expressed as a percentage of eviscerated weight. Sex and ration had no significant effect on cooked edible meat yield.

Harms _et al_ (1957) using rations with productive energy levels of 731, 881 and 978 Cals./pound and Calorie:protein ratios of 36:1, 40:1 and 44:1 respectively, reported that as the energy level of the diet increased (thus increasing the Calorie:protein ratio) eviscerated yield, as a percentage of live weight, increased significantly.

McNally and Spicknall (1949) using Rhode Island Red males ranging in live weight from one and a half to six pounds derived regression equations to be used for the prediction of edible meat yield from live, dressed or eviscerated weight. Standard errors of estimate ranging from 17.40 gms (regression of weight of edible meat on eviscerated weight) to 49.86 gms (regression of weight of edible meat with giblets on live weight) were presented in conjunction with the regression equations.

CHAPTER III

EXPERIMENTAL PROCEDURE

I WEIGHT GAINS AND FEED EFFICIENCY

To obtain data on the effects of strain, sex and Calorie:protein ratio on weight gain and feed efficiency an experiment involving two sexes, three strains and four diets was conducted.

Six hundred broiler chicks (300 males, 300 females), obtained from several commercial hatcheries in Winnipeg were individually weighed, wingbanded and distributed into groups of twenty-five which were randomly assigned to pens in electrically heated battery brooders. Feed and water were supplied ad libitum. The birds were vaccinated at one week of age with infectious bronchitis water soluble vaccine. Individual chick weights to the nearest gram and feed consumption per pen to the nearest tenth of a pound were recorded for a period of eight weeks. This experiment was replicated upon completion.

The four diets shown in Table II were formulated so that each contained a different combination of two energy and two protein levels, and all diets were adequately balanced for other known essential nutrients.

II DRESSED, EVISCERATED AND EDIBLE MEAT YIELDS

Ten birds from each of the forty-eight pens (twenty-four pens in each replicate) were randomly selected and sacrificed at eight and one half weeks of age. All birds were dispatched by inserting a

TABLE II COMPOSITION OF RATIONS

INGREDIENT	Ration 1 (LPHE)	Ration 2 (LPLE)	Ration 3 (HPHE)	Ration 4 (HPLE)
	POUNDS			
Corn	30.00	-	150.00	-
Wheat	127.50	172.00	119.00	125.00
Oats	17.50	81.00	70.00	75.00
Oat Groats	215.00	100.00	30.00	100.00
Oat Hulls	27.50	-	9.00	-
Wheat Middlings	-	50.00	-	62.50
Wheat Bran	-	-	-	7.00
Soybean Meal	7.50	41.00	10.00	50.00
Fish Meal	17.50	6.00	72.50	17.50
Meat Meal	30.00	17.50	12.50	37.50
Yeast	10.00	10.00	10.00	10.00
Whey	10.00	10.00	10.00	10.00
Limestone	3.50	3.00	3.50	1.50
Dicalcium Phosphate	-	5.00	-	-
Salt	2.50	2.50	2.50	2.50
Aurofac "10"	0.25	0.25	0.25	0.25
Nicarbazin	0.125	0.125	0.125	0.125
Methionine	0.55	0.85	-	0.5
	GRAMS			
Dry D3	3.25	3.25	3.25	3.25
Choline	50.00	50.00	50.00	50.00
Riboflavin "77"	25.00	25.00	25.00	25.00
Manganese	25.00	25.00	25.00	25.00
Vitamin A Oil	113.00	113.00	113.00	113.00
Total	500.00 LBS	500.00 LBS	500.00 LBS	500.00 LBS
	CALCULATED ANALYSIS			
Productive Energy	966 Cals./LB	868 Cals./LB	968 Cals./LB	846 Cals./LB
Protein	18.20%	18.10%	22.20%	22.20%
Fibre	4.60%	5.00%	4.20%	4.90%
Calcium	1.03%	0.97%	1.01%	1.06%
Phosphorus	0.74%	0.83%	0.73%	0.91%

knife under the skin of the neck and severing the carotid arteries. The primary and secondary wing feathers and the main tail feathers were removed by a mechanical quill puller immediately prior to hot scald treatment (138 - 140°F). The remaining feathers were removed on a single drum rougher and by hand plucking. Live weight immediately prior to killing, weight after bleeding and warm dressed weight were recorded.

The dressed birds were hung on racks, sprayed with water and held for twenty-four hours in a walk-in cooler at a temperature of 35°F. They were then removed, dipped in water, placed in large polyethylene bags in lots of ten and held for another twenty-four hours at 35°F. Following this treatment, the birds were removed, weighed (chilled dressed weight) and eviscerated. Legs were removed at the hock joint, and the head removed by cutting between the first cervical vertebra and the occipital bone. Each bird was wiped with a dry cloth to remove excess moisture and eviscerated weight with and without giblets was recorded. The birds were then bagged and frozen at 0°F.

Six birds were selected at random from each group of ten that was killed, and used to calculate meat yield. The "cooked in stockinette" method described by Stotts and Darrow (1953) was used. The birds were removed from the freezer as required, individually wrapped in stockinette and placed in boiling water for a period of from two to two and one quarter hours. Upon removal of a bird from the water, the bones were separated from the muscle and cartilage and placed in a small polyethylene bag which was immediately sealed. Circumstances prevented the immediate weighing of the bones, but the weights of femurs, tibiotarsi and total bone to the nearest tenth of a gram were recorded for each bird as soon as possible after deboning. The weight of edible meat for each bird was obtained by calculating the difference between the total bone weight and the weight of the eviscerated carcass.

III STATISTICAL METHODS

The analysis of variance and analysis of covariance techniques were employed on four and eight week weight gains with feed consumption as the concomitant variable for the covariance analysis. Pen means were considered as experimental units with each mean based on the number of birds alive at eight weeks of age. Because of variable mortality each pen mean was not based on the same number of birds. Mortality ranged from zero to five birds per pen and the pen means were therefore calculated from twenty to twenty-five birds.

Before the analysis of variance was performed on feed conversion, feed consumption per pen was adjusted for the birds that died during the experiment. This adjustment was made by calculating the grams of feed consumed per gram of gain for the appropriate pen at the week closest to the date of death of the bird involved. From this figure and the body weight of the bird the feed consumption of the dead bird was estimated and subtracted from the pen total. No adjustment was made for birds which died before attaining the age of one week.

Dressed weight and eviscerated weight were each expressed as a percentage of live weight. Eviscerated weight was also expressed as a percentage of dressed weight. Edible meat weight was expressed as a percentage of live weight, dressed weight, and eviscerated weight. From these percentages (calculated for each of six birds per pen) pen means (in per cent) were calculated, transformed by the arcsin transformation (Snedecor, 1946) and considered as experimental units for analysis of variance.

Tukey's method, described by Snedecor (1946), was used for comparisons of means within a treatment.

The data pertaining to the total bone weight of an individual bird as related to the weight of its femurs and the weight of its tibiotarsi was analyzed by a method described by Ostle (1956). By the use of this method, regression equations and correlation coefficients for total bone weight and femur weight and total bone weight and tibiotarsi weight were calculated for each strain, sex and ration. As part of the analysis, F-tests were performed to determine if the Y-intercepts (α) and if the slopes (β) of the regression lines were significantly different within each of the above three categories (strain, sex and ration).