PREDICTION OF BODY WEIGHT OF BROILERS AT DIFFERENT AGES FROM SOME LINEAR BODY MEASUREMENTS

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ABSTRACT

The prediction of live body weight from six body measurements was studied using the Cobb broiler strain. A total of two hundred and sixty-four chicks comprising of one hundred and thirty-four at males and females were used. Mean body weights day-old, 3, 6, 9 and 12 weeks of age were 36.7g, 276.16g, 856.72, 1,334.1g and 1,762.5g respectively for the sexes combined. Males were generally more uniform in body weight and the body measurements than the females as indicated by the lower coefficient of variability (2.53% vs 3.38% for body weight at 3 weeks of age). The males were significantly ($P < 0.05$) heavier than the females at 9 and 12 weeks of age. Cumulative weight gain was more rapid between 3 and 6 weeks of age and decreased with age up to the 12th week.

The correlations, linear and stepwise regression equations reveal linear relationships between body weight and all body measurements (Body length, Body girth, Keel length, Shank length, Drumstick length and Shank thickness). Live body weight of bird was best predicted singly using keel length at 3 and 9 weeks of age and body girth and the 12th week. However, with a combination of two to four of the body measurements, the prediction efficiency was enhanced.

Key words: Broiler, Live body weight, Prediction, Body measurements.

INTRODUCTION

Broiler carcass conformation may be expressed in terms of body weight, breast width, keel length, body girth and other measurement standards. Geneticists have traditionally used these measurements as guides towards improving the market quality of breeding stocks.

Live body weight, body conformation and yield are important factors to broiler breeders and processors. Phenotypic correlations between live body weight and eviscerated yield is a measure of processing efficiency and is an important factor in marketing cost. Breeders are thus interested in the heritabilities of these traits

and in their genetic and phenotypic correlations. Of particular interest to breeders are the correlations of conformation and live body weight with eviscerated weight as information on the former two traits can be obtained without sacrificing the birds.

A number of external body parts are known to be positively correlated with body weight. Such body parts include shank length and diameter which are indicators of leg development and brisket width and length as indicators of breast development (Maciejowski and Zieba, 1982).

Broiler producers are interested in the relationship that exists between body weight and physical characteristics (body conformation) since this information would reflect on the feed efficiency and performance of broiler birds. Breeders need to establish the relationship that exists between these parameters and to organise the breeding programme so as to achieve an optimum combination of body weight and good conformation for maximum economic returns.

Establishment of such relationships makes the work of the breeder easier and faster as efforts can then be concentrated on traits that are easier to measure. It would also remove any setback that are to result from simultaneous selection of negatively correlated traits. Where it is difficult to quickly estimate live body weight of birds on farms, a knowledge of simple regression equations will prove a valuable asset.

The present study was designed to determine the relationships between body weight and live body measurements viz body length, body girth, keel length, shank length and thickness and drumstick length and to establish linear relationships through simple regression equations that can be used to rapidly estimate body weight on farms.

MATERIALS AND METHODS

Two hundred and sixty-four day-old Cobb broiler chicks obtained from a commercial hatchery were weighed and wing banded. The

TABLE 1. MEANS OF BODY WEIGHTS AND LINEAR MEASUREMENTS AT DIFFERENT AGES

Age Characters	3 weeks		6 weeks		9 weeks		12 weeks	
	Mean $\pm$ s.e.	C.O.V.	Mean $\pm$ s.e.	C.O.V.	Mean $\pm$ s.e.	C.O.V.	Mean $\pm$ s.e.	C.O.V.
body weight (g)	276.16 $\pm$ 5.68	2.06	856.72 $\pm$ 14.47	1.69	1,341.06 $\pm$ 25.89	1.93	1,762.50 $\pm$ 36.71	2.08
body length (cm)	20.70 $\pm$ 0.16	0.77	30.13 $\pm$ 0.18	0.60	37.75 $\pm$ 0.32	0.82	43.55 $\pm$ 0.35	0.80
body girth (cm)	16.19 $\pm$ 0.12	0.76	23.8 $\pm$ 0.18	0.76	28.23 $\pm$ 0.23	0.90	30.24 $\pm$ 0.22	0.71
keel length (cm)	5.08 $\pm$ 0.05	1.04	7.83 $\pm$ 0.07	0.85	9.76 $\pm$ 0.09	0.88	11.20 $\pm$ 0.12	0.95
shank length (cm)	4.28 $\pm$ 0.03	0.74	6.26 $\pm$ 0.06	0.83	8.60 $\pm$ 0.08	0.91	9.69 $\pm$ 0.09	0.94
drumstick length (cm)	6.94 $\pm$ 0.08	1.20	9.63 $\pm$ 0.09	0.96	12.80 $\pm$ 0.15	1.14	15.71 $\pm$ 0.13	0.83
shank thickness (cm)	1.26 $\pm$ 0.02	1.66	1.87 $\pm$ 0.02	1.33	2.31 $\pm$ 0.09	0.69	2.43 $\pm$ 0.01	0.4
s.e. = Standard error	C.O.V. = Coefficient of variation							

TABLE 2. EFFECT OF SEX ON SOME GROWTH CRITERIA IN A BROILER STRAIN

Characters	3 weeks		6 weeks		9 weeks		12 weeks	
	Male	Female	Male	Female	Male	Female	Male	Female
Body weight (g)	276.71 ^a	275.53 ^a	856.18 ^a	857.33 ^a	1,397.94 ^a	1,283.0 ^b	1,859.0 ^a	1,663.33 ^b
Body length (cm)	20.8 ^a	20.6 ^a	30.13 ^a	30.12 ^a	38.5 ^a	37.19 ^a	44.45 ^a	42.54 ^b
Body girth (cm)	16.10 ^a	16.19 ^a	23.26 ^a	23.08 ^a	28.45 ^a	27.98 ^a	32.02 ^a	30.46 ^b
Keel length (cm)	5.06 ^a	5.20 ^a	7.84 ^a	7.82 ^a	9.91 ^a	9.60 ^a	12.41 ^a	11.80 ^b
Shank length	4.32 ^a	4.24 ^a	6.36 ^a	6.15 ^a	8.76 ^a	8.41 ^b	10.10 ^a	9.22 ^b
Drumstick length (cm)	6.97 ^a	6.89 ^a	9.61 ^a	9.66 ^a	13.40 ^a	12.55 ^b	15.12 ^a	15.25 ^b
Shank thickness (cm)	1.23 ^a	1.23 ^a	1.86 ^a	1.87 ^a	2.36 ^a	2.26 ^b	2.46 ^a	2.39 ^b

Mean having different letter superscripts differed significantly ($P \leq 0.05$)

C.O.V. = coefficient of variation.

birds were reared on deep litter throughout the experimental period and were electrically floor brooded from day-old up to three weeks of age. The birds were fed *ad libitum* with the normal broiler diets (23% crude protein broiler starter and 19.5% crude protein broiler finisher diets). Water was also made available free choice.

Body weight and all body measurements were taken on the birds at an interval of 3 weeks (3, 6, 9 and 12 weeks) early in the morning before feeding the birds. All measurements of the legs were taken on the right leg of each bird. Body weight of individual birds was taken with a top loading scale in grams to two places of decimal. Body length and body girth were measured in centimeters using a tape rule while keel length, drumstick length and shank thickness were

TABLE 3: SIMPLE CORRELATION BETWEEN BODY WEIGHT AND THE BODY MEASUREMENTS

Characters	Body Weight/Age			
	3 weeks	6 weeks	9 weeks	12 wks
Body Length	0.69**	0.53**	0.69**	0.61**
Body Girth	0.73**	0.65**	0.67**	0.78**
Keel Length	0.72**	0.69**	0.71**	0.78**
Shank Length	0.66**	0.49**	0.60**	0.62**
Drumstick Length	0.51**	0.40**	0.54**	0.46**
Shank Thickness	0.33**	0.36**	0.47**	0.27*

*, ** Significant at $P < 0.05$ and $P < 0.01$, respectively

TABLE 4: SIMPLE REGRESSION EQUATIONS FOR PREDICTING BODY WEIGHT AT DIFFERENT AGES

Parameter	Age	Intercept (a)	Regre. Coeff. (b)	Coefficient of determination (R)
Body Length	3	-233.1	24.59	0.477
	6	-411.72	42.11	0.279
	9	-762.75	55.81	0.482
	12	1047.93	64.53	0.372
Body Girth	3	-267.37	33.57	0.531
	6	-380.49	53.38	0.480
	9	-591.34	68.55	0.451
	12	2275.94	129.07	0.615
Keel Length	3	-120.31	78.05	0.524
	6	-321.14	150.38	0.480
	9	-732.94	212.72	0.498
	12	-610.96	195.75	0.378
Shank Length	3	2232.72	118.78	0.440
	6	0.44	136.78	0.239
	9	-363.65	198.68	0.359
	12	649.02	248.89	0.378
Drumstick Length	3	34.93	34.77	0.258
	6	253.67	62.60	0.160
	9	98.71	62.60	0.290
	12	300.80	131.30	0.216
Shank Thickness	3	164.73	88.37	0.106
	6	466.39	209.22	0.129
	9	-412.62	760.17	0.219
	12	315.01	855.05	0.072

measured in centimeters with a pair of vernier callipers.

Statistical Analysis

Data collected were subjected to one way analysis of variance by the completely randomised design (Steel and Torrie, 1980). Correlation, linear and step wise regression analyses between body weight and the various parameters were also determined. A linear regression equation of the type $Y = a + bx$ was used where:

Y = body weight the dependent variable

a = constant in the regression equation

b = regression coefficient

x = various body measurements.

RESULTS AND DISCUSSION

The means for body weight, body length, body girth, keel length, shank length, shank thickness and drumstick length at the ages of 3, 6, 9 and 12 weeks are presented in Table 1. The data give a numerical conception of the average growth progression for the different body measurements. The coefficient of variation is presented to give an estimate of the relative variation in data.

Body development in relation to age

Analysis of the results shows no significant ($P < 0.05$) sex difference in body weight and all body measurements at 3 weeks (Table 3). However, significant ($P < 0.05$) sex difference was recorded for body weight of birds at 9 and 12 weeks of age (1,397.94g versus 1,283.0g and 1,850.0g versus 1,663.3g for the males and females, respectively, for the two ages). Similar results were reported by Gilbreath and Upp (1952), Hathaway et al (1953) and Wahid et al (1974), in other broiler strains. The generally low values of coefficient of variability for all parameters indicate that these traits varied less within the strain and between sexes (Tables 1 and 2). However, the coefficient was greatest at the third week of age for females in almost all the parameters. According to Gilbreath and Upp (1952), the coefficient attains its greatest variability for males and not females in the Dark Cornish fowl at the same age. This report indicates that there is probably strain differences in terms of variability in body weight at 3 weeks of age.

The overall mean body weight at day-old for the chicks used in this experiment was 36.7g.

Thus, the cumulative weight gains from 0 to 3 weeks of age was 239.46g 580.56g from 3 to 6 weeks, 487.34g from 6 to 9 weeks and 418.44g from 9 to 12 weeks of age. The overall cumulative weight gain was 1,725.8g from 0 to 12 weeks of age. This growth progression indicates that rapid development takes place within the 3rd - 6th weeks of age and that the rate of gain subsequently decreased with age up to 12 weeks. It appears therefore that this broiler strain combines an initial faster growth with a latter slower rate.

Relation of body measurement to weight

High positive correlations were computed for body weight and almost all body measurements at the four ages under consideration (Table 3). Johnson and Asmundson (1957) observed similar results for the Broad Breasted Bronze turkey.

The high positive correlation coefficient for body weight-shank length relationship (0.62 at 12 weeks) obtained in this study was comparable to the report of Lerner et al (1947) in 12 weeks old New Hampshire and in 20 weeks old layer type chicken described by Tierce and Nordskog (1985).

Although shank thickness was also positively correlated with body weight, the correlations were very low. Values of 0.33, 0.36, 0.47 and 0.27 were observed for the relationship at the ages of 3, 6, 9 and 12 weeks respectively. This tends to suggest that shank thickness may not be a good indicator of body conformation. This is contrary to the conclusion of Maciejowski and Zieba (1982) that shank length and thickness were good indicators of leg development. However, it can be deduced from this study that the rate of development of the thickness of shank, though linear, was not in proportion to the increase in length of shank. This implies that a longer shank does not indicate plumpness.

The regression coefficients in Table 4 and 5 (taken as growth coefficients) give estimates of the order of growth of physical characteristics measured. The magnitude of the coefficient of determination (r^2) for each parameter in the regression equations shows the relative contribution of each body measurement to the body weight of bird at that particular age. For instance, 53.1% of body weight can be explained by body girth alone at 3 weeks of age while just 10.6% could be attributed to shank thickness at that age for the linear regression equations. For the stepwise regression equations, the reliability of r^2 increased with increasing number of body

TABLE 5. STEPWISE REGRESSION EQUATIONS FOR ESTIMATING BODY WEIGHT AT DIFFERENT AGES

Age	Step	Parameter	Intercept	Regression	Partial	Model
			(a)	Coeff. (b)	R ²	R ²
3	1	Keel length	-117.13	77.10	0.5383	0.5383
	2	Body girth	-291.39	19.47	-	-
		Keel length	-	49.38	0.1197	0.6580
	3	Body girth	-397.41	16.68	-	-
		Keel length	-	32.27	-	-
		Shank length	-	49.61	0.5250	0.7105
	4	Body girth	-383.30	14.21	-	-
		Keel length	-	32.27	-	-
		Shank length	-	40.63	-	-
		Drumstick length	-	13.01	0.233	0.7338
	1	Body length	-461.27	42.27	0.2833	0.2833
	2	Body length	-516.61	35.23	-	-
6		Body girth	-	13.63	0.0903	0.3736
	3	Body length	-1021.76	23.71	-	-
		Body girth	-	35.63	-	-
		Keel length	-	43.21	0.2067	0.5803
	4	Body length	-1069.47	18.83	-	-
		Body girth	-	36.32	-	-
		Keel length	-	47.77	-	-
		Drumstick length	-	15.13	0.0336	0.6140
	1	Keel length	-749.57	214.34	0.4983	0.4983
	2	Body length	-1536.50	37.95	-	-
		Keel length	-	148.21	0.1723	0.6706
	3	Body length	-1817.43	28.44	-	-
9		Body girth	-	31.80	-	-
		Keel length	-	121.32	0.0647	0.7353
	4	Body length	-2304.98	27.73	-	-
		Body girth	-	24.61	-	-
		Keel length	-	118.65	-	-
		Shank thickness	-	323.74	-	-
	1	Body girth	-2283.20	129.31	0.6151	0.6151
	2	Body length	-2752.52	27.54	-	-
		Body girth	-	105.96	0.0477	0.6628
	3	Body length	-2819.56	24.12	-	-
		Body girth	-	92.19	-	-
		Shank length	-	66.80	0.0163	0.6791

measurements combined. For instance, 76.8% of body weight are attributable to body length, body girth, keel length and shank thickness at 9 weeks of age.

The results indicate that with this strain of broilers, producers can easily predict weight of birds from any given value of the six body measurements. Simple tape rule/meter rule can be used to take body length, body girth, keel length, shank length and drumstick length of the bird. Substitution of the values in the regression equations for the different ages gives a close value of the body weight of bird at that particular age.

REFERENCES

- GILBREATH, Jr., J. C. and UPP C. W. 1952. The growth pattern of the Cornish Fowl, *Poul. Sci.* 30: 418 - 427.
- HATHAWAY, H. E., CHAMPAGNE, G. B., WATTS A. B. and UPP, C. W. 1953. Meat yields of broilers of different breeds strains and crosses. *Poultry Sci.* 32: 968 - 977.
- JOHNSON, A. S. and ASMUNDSON U. S. 1957. Genetic and environmental factors affecting size of body and body parts of turkeys. 1. The heritability and interrelationships of body weight and live body measurements. *Poultry Sci.* 36: 296 - 301.
- LERNER, I. M., ASMUNDSON V. S. and CRUDEN D. M. 1947. The improvement of New Hampshire fryers. *Poultry Sci.* 26: 515 - 524.
- MACIEJOWSKI, J. and ZIEBA, T. 1982. *Genetic and Animal Breeding. Part B. Stock improvement methods.* Elsevier Scientific Publishing Company, Amsterdam.
- STEEL, R.G.D. and TORRIE, J. H. 1980. *Principles and Procedures of Statistics. A Biometrical Approach.* 2nd Ed. McGraw-Hill Book Company, New York.
- TIERCE, J. F. and NORDSKOG, A. W. 1985. Performance of layer-type chickens as related to body conformation and composition. 1. A static analysis of shank length and body weight at 20 weeks of age. *Poultry Sci.* 64: 605 - 609.
- WAHID, A., MUKHERJEE T. K and JALALUDINS. 1974. Influence of breed and sex on live weight, performance, dressing and yield of meat from 12 week old broilers. *Poultry Sci.* 53: 1511 - 1519.