Original Research Article

Prediction of Market Weight in Caribro-Dhanraja Broilers with Different Plumage Colour Using Growth Traits

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A B S T R A C T

Present study predicted 6th week body weight of Caribro-Dhanraja broilers (n=75) with different plumage colour through backward elimination regression from 2nd week growth traits (weight, weight gain, chick length, weight: length^2, shank length, toe length, breast length, breast girth, thigh length and wing length). Day old chicks were grouped into yellow, black and stripped colour groups based on plumage colour (25 chicks in each group) and traits were measured biweekly upto 6th week. Plumage colour significantly influenced shank, toe and thigh length, and breast girth at 2nd week; whereas, wing length at 4th week (P≤0.05). In yellow plumage group, weight, daily gain, weight: length^2, shank, breast and thigh length at 2nd week were positively associated with 6th week body weight (P≤0.05). In black plumage group, weight, daily gain and weight: length^2 of 2nd week were positively association with 6th week body weight, but thigh length was negatively associated (P≤0.05). Weight, daily gain and weight: length^2 at 2nd week were positively associated with 6th week body weight in stripped plumage group (P≤0.05). Backward elimination regression model for prediction of 6th week body weight from 2nd week variables revealed higher R^2 value (59.6%) in black plumage (predictor variables were weight, breast girth and thigh length). However, R^2 value was 36% for stripped colour (predictor variables were weight and breast girth), 25.3% for yellow plumage (predictor variable was wing length) and 41% for pooled data (predictor variables were growth and breast girth). The results indicated lower accuracy for prediction of 6th week body weight based on variables from 2nd week.

Introduction

Poultry meat is well accepted by people of all religions throughout the world. In the present scenario, poultry meat production of the world is dominated by white-feathered broilers because of their fast growth rate along with better feed efficiency (Yang and Jiang, 2005). Slow growing coloured broilers have great consumers' demand owing to better quality meat in terms of appearance, less fat and taste as well as better performance in tropical

climate than fast growing white feathered broilers (Yang and Jiang, 2005, Padhi, 2016). Further, coloured chickens fetch more price than the white feathered fast growing broilers (Bett *et al.,* 2011). Identification of broilers with better growth potential at an early age is most essential for better economic return as inferior birds can be culled early.

Chick quality traits, particularly weight of chick has been commonly used to assess growth performance at later age, but such effect is inconsistent and diminished well in advance before the market age (Jiang *et al.,* 2007; Molenaar *et al.,* 2008; Patbandha *et al.,* 2017). Moreover, others reported positive effect of body linear traits like chick body length on growth performance up to market age (Molenaar *et al.,* 2008; Mukhtar *et al.,* 2013; Patbandha *et al.,* 2017). Association of shank and toe length at early age with future growth performance was observed to be inconsistent up to market age in different studies (Wolanski *et al.,* 2006; Willemsen *et al.,* 2008; Patbandha *et al.,* 2017). However, information regarding association of traits like daily gain, body mass index (weight: length^2), toe length, breast length, breast girth, thigh length and wing length with market weight is scanty.

Further, significant effect of plumage colour on growth traits of chicks within a particular strain has been well established (Azahan, 1994; Rizzi *et al.,* 2013; Rizzi, 2017). Additionally, variable selection for regression model using backward elimination (where initially model includes all variables and later deleted one by one based on *F*-statistics) has been reported to be best among the all stepwise procedures (Sauerbrei *et al.,* 2007). Hence, the present study was designed to predict the market weight of Caribro-Dhanraja broiler chicken with different plumage colour using backward elimination regression model of different early growth traits.

Materials and Methods

Experimental birds and general management

The experiment was conducted on Caribro-Dhanraja coloured broiler strain during June to August, 2017 at Instructional Livestock Farm Complex, Junagadh Agricultural University, Junagadh (Gujarat). Junagadh is located with a latitude of 21° 31' N and an altitude of 70° 36' E under South Saurashtra Agroclimatic zone. Day old, physically healthy straight run chicks (n=75 with 25 chicks from each yellow, black and stripped colour) were included for this study. The chicks were numbered individually using wing band at the start of the experiment. The chicks were reared under deep litter system of housing with uniform managemental conditions as per the farm standards. Lighting facilities were switched on before few hours of arrival of chicks to provide the required temperature for brooding and provided continuously during the study period for 24 hours. Experimental birds were vaccinated for poultry diseases (Marek's disease and New castle disease) as per the guidelines for commercial broilers. Birds were provided with commercial starter mash (23% CP and 2800 Kcal ME per kg) and finisher mash (20% CP and 2900 Kcal ME per kg diets) with *ad libitum* access to feed and water.

Measurement of growth traits

Growth traits of individual birds such as body weight, length of chick, shank, toe, breast, thigh, wing and girth of breast were measured at 2 weeks interval up to 6 weeks. All the traits were measured during morning before feeding and watering. Daily gain and body mass index (weight: length^2) were calculated. Chick length was defined as length from tip of beak to length of longest toe excluding its nail and measured by keeping the chick on a

platform on its ventral aspect in such a position by extending neck and toe to their maximum extent gently. Length from hock joint to bottom of foot pad was considered as shank length; whereas, length of longest toe upto insertion of nail was defined as toe length. Breast length and girth were defined as length between both vertices of the sternum and circumference of the breast region, respectively. Wing length was measured from scapula joints to the last digit of the wing and thigh length was measured from shinbone-femur joint to shinbone-tarsus joint.

Statistical analysis

The data of growth traits were collected and presented as mean with standard error estimates. The growth traits of broilers among the different plumage groups were compared by one-way analysis of variance and Duncan's multiple range tests was used as post hoc test to compare the pair wise mean differences. Correlation of different growth traits at 2nd, 4th and 6th week with body weight at 6th week was estimated by Pearson correlation. Backward elimination regression model (Chatterjee *et al.,* 2000) was used for prediction of 6th week body weight from variables recorded at 2nd week of age. The variables were removed one by one from the model when probability of '*F*' > 0.1. The statistical analysis was carried out using SPSS software package (Version 16.0, USA) and considered as significant when '*P*' ≤ 0.05.

Results and Discussion

Growth traits

Body weight and conformation traits of coloured broiler chicken are presented in table 1. The body weight of coloured broilers was observed to be 1717.75g at 6th week with feed conversion ratio (0-6 weeks) of 2.16. Plumage colour did not affect body weight, daily body

gain, chick length, weight: length^2 and breast length of broilers during the study period. There was significant effect of plumage colour on shank length ($P<0.05$), toe length ($P<0.001$), breast length ($P<0.05$) and thigh length ($P<0.05$) at 2nd week of age. However, at 4th week the wing length was significantly affected by the plumage colour in coloured broilers ($P<0.01$).

The live weight of CARIBRO-Dhanraja observed in this study is comparatively higher than the previous studies (Singh, 2008; Bhonsle, 2009; Tomar *et al.,* 2011; Anonymous, 2003, 2017), who reported 6th week body weight about 769-1580g. This variation might be attributed to different managerial practices as well as climatic alteration in different regions. Further, comparatively higher value of body confirmatory traits were observed in this study than the others (Singh, 2008; Singh and Jilani, 2008; Bhonsle, 2009) may be the reason of higher live weight of broilers as these parameters are positively associated with live weight.

Plumage colour did not influence body weight in Caribro-Dhanraja chickens which is in consonance with Azahan (1994), who observed similar weight in red and black-red native or Kampung chickens of Malaysia. In case of Padovana chickens of Italy, previous studies reported significant effect of plumage colour on daily growth (Rizzi *et al.,* 2013; Rizzi, 2017), such effect was not observed in Caribro-Dhanraja. The Padovana chicken has slow growth rate (<20g/day, Rizzi *et al.,* 2013); whereas, Caribro-Dhanraja has better growth rate of 23.43-49.24g/d, might be attributed to variation of results between the studies. Additionally, Rizzi (2017) observed the effect of plumage colour on daily growth rate up to the maturity age in Padovana chickens and beyond that such effect was nullified.

Table.1 Body weight and conformation traits of coloured broiler chicken

Weeks	Yellow (n=25)	Black (n=25)	Stripped (n=25)	Overall (n=75)
Body weight (g)				
2nd week	368.84±6.53	375.32±8.57	372.60±6.31	372.25±4.12
4th week	1021.76±21.93	1043.40±22.82	1020.04±17.87	1028.40±12.01
6th week	1716.00±45.83	1728.44±43.41	1708.80±38.52	1717.75±24.33
Daily gain (g/day)				
0-2 week	23.18±0.44	23.69±0.59	23.41±0.44	23.43±0.28
2-4 week	46.64±1.27	47.72±1.19	46.25±0.99	46.87±0.66
4-6 week	49.59±1.84	48.93±1.80	49.20±1.67	49.24±1.01
Chick length (cm)				
2nd week	33.60±0.21	33.25±0.27	33.70±0.20	33.52±0.13
4th week	47.36±0.32	48.02±0.26	48.07±0.29	47.82±0.17
6th week	57.92±0.46	58.22±0.37	58.76±0.37	58.30±0.23
Weight: Length^2 (g/cm^2)				
2nd week	0.326±0.004	0.340±0.008	0.328±0.006	0.331±0.004
4th week	0.455±0.007	0.451±0.006	0.441±0.005	0.449±0.004
6th week	0.509±0.008	0.508±0.008	0.494±0.007	0.504±0.005
Shank length (cm)				
2nd week	5.65±0.07[ab]	5.50±0.09[a]	5.74±0.05[b]	5.63±0.04*
4th week	8.04±0.07	7.96±0.08	8.10±0.06	8.03±0.04
6th week	9.68±9.68	9.80±9.80	9.84±9.84	9.77±9.77
Toe length (cm)				
2nd week	4.24±0.05[a]	4.18±0.03[a]	4.54±0.07[b]	4.32±0.03***
4th week	5.76±0.05	5.84±0.08	5.72±0.05	5.77±0.03
6th week	6.80±0.08	6.83±0.07	6.72±0.06	6.78±0.04
Breast length (cm)				
2nd week	7.54±0.08	7.41±0.08	7.50±0.07	7.48±0.05
4th week	11.12±0.13	11.16±0.11	11.09±0.10	11.12±0.06
6th week	13.32±0.15	13.48±0.13	13.50±0.09	13.43±0.07
Breast girth (cm)				
2nd week	17.27±0.10[a]	16.81±0.15[b]	17.17±0.13[ab]	17.08±0.08*
4th week	24.17±0.19	24.64±0.21	24.16±0.16	24.32±0.11
6th week	29.24±0.40	29.69±0.39	29.02±0.25	29.32±0.21
Thigh length (cm)				
2nd week	7.51±0.07[a]	7.08±0.08[b]	7.61±0.07[a]	7.40±0.05*
4th week	10.48±0.08	10.33±0.11	10.56±0.06	10.45±0.05
6th week	12.75±0.13	12.89±0.13	12.88±0.10	12.84±0.07
Wing length (cm)				
2nd week	11.21±0.09	11.29±0.28	11.02±0.08	11.17±0.10
4th week	17.74±0.15[a]	17.10±0.20[b]	17.85±0.12[a]	17.57±0.10**
6th week	22.13±0.20	21.93±0.20	22.13±0.17	22.06±0.11
Means with different superscript within a row differed significantly (P≤0.05); * P≤0.05; * P≤0.01; * P≤0.001				

Table.2 Correlation of 2nd 4th and 6th week body weight and chick conformation with weight at 6th week in coloured broiler chicken

Weeks	Body weight	Daily gain	Chick length	Weight: Length^2	Shank length	Toe length	Breast length	Breast girth	Thigh length	Wing length
Yellow										
X_2. WT_6	0.593 (0.002)	0.606 (0.001)	0.241 (0.246)	0.586 (0.002)	0.419 (0.037)	0.289 (0.161)	0.498 (0.011)	0.340 (0.096)	0.399 (0.048)	0.261 (0.208)
X_4. WT_6	0.954 (0.000)	0.957 (0.000)	0.593 (0.002)	0.785 (0.000)	0.833 (0.000)	0.523 (0.007)	0.762 (0.000)	0.703 (0.000)	0.674 (0.000)	0.576 (0.003)
X_6. WT_6	-	0.967 (0.000)	0.836 (0.000)	0.847 (0.000)	0.851 (0.000)	0.744 (0.000)	0.818 (0.000)	0.821 (0.000)	0.697 (0.000)	0.670 (0.000)
Black										
X_2. WT_6	0.575 (0.003)	0.564 (0.003)	-0.019 (0.926)	0.585 (0.002)	0.236 (0.256)	0.0453 (0.830)	0.256 (0.217)	0.021 (0.922)	-0.424 (0.034)	0.199 (0.339)
X_4. WT_6	0.894 (0.000)	0.928 (0.000)	0.726 (0.000)	0.853 (0.000)	0.759 (0.000)	0.671 (0.000)	0.653 (0.000)	0.542 (0.005)	0.495 (0.011)	0.311 (0.130)
X_6. WT_6	-	0.914 (0.000)	0.807 (0.000)	0.889 (0.000)	0.797 (0.000)	0.765 (0.000)	0.739 (0.000)	0.414 (0.039)	0.755 (0.000)	0.726 (0.000)
Stripped										
X_2. WT_6	0.592 (0.001)	0.599 (0.001)	0.196 (0.347)	0.445 (0.025)	0.160 (0.445)	0.120 (0.566)	0.371 (0.067)	0.256 (0.216)	0.0446 (0.833)	0.207 (0.320)
X_4. WT_6	0.912 (0.000)	0.902 (0.000)	0.758 (0.000)	0.514 (0.008)	0.688 (0.000)	0.665 (0.000)	0.515 (0.008)	0.600 (0.001)	0.612 (0.001)	0.592 (0.001)
X_6. WT_6	-	0.950 (0.000)	0.761 (0.000)	0.828 (0.000)	0.527 (0.006)	0.756 (0.000)	0.521 (0.007)	0.628 (0.000)	0.862 (0.000)	0.658 (0.000)
Pooled data										
X_2. WT_6	0.579 (0.000)	0.581 (0.000)	0.115 (0.325)	0.521 (0.000)	0.259 (0.025)	0.112 (0.338)	0.371 (0.001)	0.164 (0.160)	-0.016 (0.886)	0.186 (0.110)
X_4. WT_6	0.918 (0.000)	0.930 (0.000)	0.664 (0.000)	0.727 (0.000)	0.748 (0.000)	0.609 (0.000)	0.660 (0.000)	0.605 (0.000)	0.541 (0.000)	0.404 (0.000)
X_6. WT_6	-	0.941 (0.000)	0.788 (0.000)	0.847 (0.000)	0.707 (0.000)	0.751 (0.000)	0.714 (0.000)	0.618 (0.000)	0.755 (0.000)	0.679 (0.000)

X_2. WT_6 = Correlation of traits of 2nd week with 6th week body weight; X_4. WT_6 = Correlation of traits of 4th week with 6th week body weight; X_6. WT_6 = Correlation of traits of 6th week with 6th week body weight. Figures in parenthesis indicate '*P*' value.

Table.3 Backward elimination regression model for prediction of 6th week body weight from variables recorded at 2nd week of age

Intercept with predictors in final model	Regression coefficients	'P' - Value of Regression coefficient	R^2 (%)	'P' - Value of model
Yellow				
Constant	-21.571	0.407	25.3	0.010
Wing Length	218.012	0.010		
Black				
Constant	192.906	0.000	59.6	0.000
Body weight	0.173	0.001		
Breast Girth	-9.452	0.001		
Thigh Length	-7.073	0.057		
Stripped				
Constant	82.477	0.023	36.0	0.007
Body weight	0.287	0.002		
Breast Girth	-8.143	0.018		
Constant	1972.644	0.000	41.0	0.000
Pooled				
Growth	69.61	0.000		
Breast Girth	-110.39	0.004		

R^2 = Coefficient of determination of regression model

Though certain conformation traits (shank, toe, thigh and wing length and breast girth) showed significant variation among the different plumage groups of Caribro-Dhanraja chickens, the results were not consistent. The FCR of Caribro-Dhanraja chickens observed in this study is more or less comparable with Anonymous (2003) and Bhonsle (2009), but higher than Tomar *et al.,* (2011). Moreover, annual report of ICAR cited wide variation of FCR (1.65-2.15) at different centers (Anonymous, 2003).

Correlation of growth traits with market weight

Correlation of different growth traits at 2nd, 4th and 6th week with 6th week body weight is depicted in Table 2. Growth traits at 2nd week and above age were positively and significantly correlated with live weight at 6th week in all the three groups (yellow, black and stripped) as well as in pooled data; however, the degree of association differed among the groups. On the other hand, association of growth traits at 2nd week with 6th week varied among the different plumage groups. In yellow plumage group, the body weight, daily gain, weight: length^2, shank length, breast length and thigh length at 2nd week was positively associated with body weight at 6th week. In black plumage group, body weight, daily gain and weight: length^2 of 2nd week was positively associated with 6th week weight, but the association between thigh length of 2nd week and body weight of 6th week was negative. Similar to yellow and black plumage, body weight, daily gain and weight: length^2 at 2nd week was positively associated with 6th week weight in stripped plumage group. In pooled data, there was positive and significant association of 2nd week body weight, daily gain, weight: length^2, shank length and breast length with 6th week body weight. Previous studies reported positive association of growth traits with body weight at 6th or 7th week of age in Caribro-Dhanraja broiler chicken carried out by different authors at different parts of India (Singh, 2008; Singh and Jilani, 2008; Bhonsle, 2009; Tomar *et al.,* 2011) and similar results were observed in this study. The degree of association of growth traits at 2nd, 4th and 6th week with body weight at 6th week increases with increase in age which is inconsonance with Singh (2008). Significant variation of correlation coefficient values among different plumage groups may be due to in consistent effect of plumage colour on growth. Positive association of early growth traits with market weight indicates that market weight could be predicted from early growth traits in Caribro-Dhanraja broiler chicken.

Prediction of market weight

The outputs of final backward elimination regression model for prediction of 6th week body weight based on growth traits at 2nd week are presented in Table 3. The regression model revealed higher accuracy (R^2=59.6%, *P*<0.001) in black plumage group and the predictor variables were body weight, breast girth and thigh length. However, in yellow and stripped plumage groups the R^2 values for prediction of 6th week body weight using variables at 2nd week were very small (R^2 = 25.3%, *P*=0.01 and R^2 = 36.0%, *P*=0.007, respectively). Moreover, regression analysis of pooled data resulted R^2 value 41% and predictor variables were daily growth and breast girth. The results indicated marked effect of plumage colour on prediction of 6th week body weight using variables at 2nd week might be attributed to variation of different traits among the different plumage groups. Previous studies used different linear conformation traits for prediction of live weight and observed comparatively higher value of coefficient of determination of regression model (Latshaw and Bishop, 2001;

Amao *et al.,* 2011; Sanda *et al.,* 2014). The predicted and explanatory variables of same age were regressed by the previous authors (Latshaw and Bishop, 2001; Amao *et al.,* 2011; Sanda *et al.,* 2014), but in this study 6th week body weight was predicted using variables at 2nd week. This may be reason of lower value of coefficient of determination of regression in Caribro- Dhanraja broiler chicken. Further, the linear traits for the final model also varied among the studies. This may be the reason of lower value of coefficient of determination of regression model in Caribro- Dhanraja broiler chicken. The results of this study indicated inconsistent effect of plumage on growth traits in Caribro-Dhanraja coloured broilers. Growth traits showed positive association with live body weight. Sixth week body weight could be predicted with higher accuracy from variables recorded at 2nd week of age in black plumage group and the predictor variables were body weight, breast girth and thigh length. However, there was very less accuracy for prediction of 6th week weight based on variable at 2nd week for other plumage groups (yellow and stripped) and even for pooled data.

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