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Effect of Beak Color on Growth Performance and Carcass Characteristics of Pekin Ducks

M.A. Alsaffar[1], A. Makram[2], G.N. Rayan[1,3], A. Zein EL-Dien[3], W. Shehata[4], A.H. ELAttar[3] 10.18805/IJAR.BF-1581

ABSTRACT

Background: Pekin ducks are broadly raised over the world, particularly in Asia continent, moreover, they are famous for the delightful taste of Beijing roast duck around the world. The aim of this study was to explore the effect of beak color on growth performance, carcass traits and sexual dimorphism of Pekin ducks.

Methods: A total of 250 one-day-old Pekin ducks were separated according to beak color into two groups, yellow beak (YB) and blue beak (BB). Body weight and body weight gain were recorded from the first week to the marketing age (6 wks). Carcass traits were taken at the marketing age (20 ducks /each phenotype). Sexual dimorphism was calculated for live body weight and carcass traits at marketing age.

Result: show that YB ducks have significantly heavier body weight at 1 and 5 wks of age compared to BB, however the body weight of BB ducks was higher at 3 and 4 wks of age. At marketing age, the differences in body weight between two phenotypes were not significant. Generally, BB ducks have significantly higher body weight gain and growth rate compared to YB ducks. The mortality and defect ratio were affecting beak color, the blue beak ducks recorded higher relative mortality rate and lower defect ratio compared to yellow beak ducks. There was no effect of beak color on carcass traits. However, the sexual dimorphism was significantly higher for the YB ducks for most traits compared to BB. In conclusion, we concluded has a significant effect beak color on growth performance and sexual dimorphism of Pekin ducks.

Key words: Beak color, Carcass, Pekin ducks, Performance.

INTRODUCTION

Ducks are one of the famous and common birds in Egypt, as it is the second type of poultry raised in Egypt; numbers of ducks produced in Egypt are 100 to 150 million domestic ducks. Therefore; there are many species of ducks in Egypt, divided into two categories; commercial and local ducks. Commercial ducks raising in the farm as French Muscovy ducks, Pekin Star ducks and Mule ducks, local strain of ducks are essential for economic rural (Pingel, 2004; FAO, 2014; Kilany *et al*., 2016).

Pekin ducks are broadly raised over the world, particularly in Asia continent, moreover, they are famous for the delightful taste of Beijing roast duck around the world, which needs a high skin/fat proportion or body fat proportion and these large birds have white feathers with orange legs, feet and bill (Makram, 2016; Zhu *et al*., 2020).

Nowadays in Egypt, companies have produced new strains of Pekin duck (Pekin Star), which grow rapidly, but inside these, the birds have two colors in the beak, orange and blue. The blue color is new in Pekin ducks. Earlier, some researchers reported that colorations are regularly the result of a blend of pigment. Beak and skin as often as possible contain combinations of carotene and xanthophyll. Carotenoids; in oil beads and melanocytes are the leading cause of an olive-green color within the beaks of mallards (Anas). Another; black melanins and yellow carotenoids juxtaposed are frequently the main cause of olive-green in feathers. In any case, the blue color could be an additional auxiliary color in fowls. Usually, Tyndall scrambling create blue coloring. No studies that confirm a relationship between beak color and the productive performance in poultry. However, More studies confirm that there is a relationship between feather color and economic traits, as a result obtained by Rizzi (2018), who found a relationship between the colorful plumage and bodyweight of Padovana chickens. Houndonougbo *et al.* (2017), found an effect of feather color

[1]Department of Animal and Fish Production, College of Agricultural and Food Sciences, King Faisal University, Al-Ahsa 31982, Saudi Arabia.
[2]Poultry Production Department, Faculty of Agriculture, Fayoum University, Egypt.
[3]Department of Poultry Production, Faculty of Agriculture, Ain Shams University, Hadayek Shoubra 11241, Cairo, Egypt.
[4]Department of Agricultural Biotechnology, College of Agricultural and Food Sciences, King Faisal University, Al-Ahsa 31982, Saudi Arabia.

Corresponding Author: G.N. Rayan, Department of Animal and Fish Production, College of Agricultural and Food Sciences, King Faisal University, Al-Ahsa 31982, Saudi Arabia.
Email: gahmed@kfu.edu.sa

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on body weight of the native Guinea Fowl breeding in West Africa. Also, (Yakan *et al*., 2012; Sarıca *et al*., 2015), showed there is the relationship between feather color and carcass traits of geese. Another; study by Ismoyowati *et al.* (2018), found an effected of feather color in live body weight in Muscovy duck. Color form is a complex processes affected by genes and physiological processes (Ismoyowati *et al*., 2018; Makarova *et al*., 2019). Current research aims to investigate the effect of beak color on some economic traits (growth performance, carcass traits and sexual dimorphism) in Pekin ducks.

MATERIALS AND METHODS

Housing and management

Two- hundred- and fifty of one-day Pekin ducks, at first weeks of age they were divided into two groups according to beak color, the yellow beak (YB) and blue beak (BB) (Fig 1). Their distribution ratios were 61.7% and 38.3% for YB and BB, respectively. All; ducklings were brooded in floor pens. Brooding temperature was 33°C for the first three days and then reduced until it reached 26°C, at two weeks of age. The birds exposed to a continuous light during the first three days, then a light schedule of 16 L: 8 D until the end of the fattening period (6 wks of age). The sixteen lighting hours included 11 to 12 hours of natural daylight and then the artificial light applied. The water and feed provided *ad libitum*. Table 1 shows the calculated Analysis and structure of the diet. Besides, the commercial diet, birds in the group 3 given free access for raising (free-range system) in the pasture for 6 hours daily from six to ten am and from four to six pm from the 7th day of age, after they have been trained to grazing in the pasture from the 2nd day. There are many grasses and tree leaves in the field, as recorded in Table 2. The field or pasture itself divided into two parts; where ducks go to the field at one day and the alternative day go the second part of the pasture. Dimensions of the field were 1400 m^2 (56 × 25) and 1410 m^2 (47 × 30) for part 1 and 2, respectively. Birds reared together without pens with the identical diets and the field or pasture.



Fig 1: Types of beak in pekin ducks yellow beak (left) and blue beak (right).

Bodyweight and body weight gain

The live body weight recorded at 1, 2, 3, 4, 5 and 6 wks of age, growth rate and weight gain were calculated.

Mortality and defects

The mortality rate recorded during the experimental period. In addition, the defects recorded for the birds who did not die, but had some imperfections like a defect in legs, dwarfism and neck.

Carcass traits

When the ducklings attained marketing age, 20 ducks from every phenotypic were randomly taken and weighing, then killed for carcass evaluation. Birds eviscerated by removing the viscera. The giblets (gizzard, liver and heart) cleaned. The every parts expressed as a ratio of live body weight. Dressing percentage and edible meat parts percentage calculated.

Sexual dimorphism

$$\text{Sexual dimorphism} = \frac{\text{Male value-Female value}}{\text{Female}} \times 100$$

or

$$\frac{\text{Male value}}{\text{Female value}} \text{-}1 \times 100$$

Thus, this gives the percentage by which males differ from females so that positive values (>0) mean that male is greater than the female for that trait, a zero value means males and females are equal and negative values (<0) mean that female is greater than the male for that trait.

Statistical analysis

The data was analysed by a one-way analysis of variance by using the General Linear Model (GLM) procedure of SAS (2003) according to the following model:

$$Y_{ij} = \mu + B_i + e_{ij}$$

Where:
Y_{ij}= jth observations of the ith treatment.
μ= Overall means.
B_i= Beak color effect.
e_{ij}= Experimental error.

Data related to carcass traits analysed by two-way analysis of variance with beak color effect and the sex with interaction by GLM procedure of SAS (2003) as the next model (II):

$$Y_{ij} = \mu + B_i + S_j + [B \times S]_{ij} + e_{ijk}$$

Where:
Y_{ij}= Trait measured.
μ= Overall mean.
B_i= Beak color effect.

S_j= Sex effect (j=1 and 2).
$[B \times S]_{ij}$= Interaction between beak color and sex.
e_{ijk}= Experimental error.

Duncan's multiple range tests were used to detected differences among treatment means.

RESULTS AND DISCUSSION

Growth performance

Data presented in Table 3 show the effect of beak color on body weight, weight gain and growth rate of Pekin duck. The results revealed that the Yellow beak (YB) ducks have significantly heavier body weight at 1 and 5 wks of age than Blue beak (BB) however, the bodyweight of BB ducks was higher at 3 and 4 wks of age. The differences in bodyweight between the two phenotypes were not significant at marketing age. Generally Blue beak ducks have significantly higher body weight gain and growth rate compared to Yellow beak ducks.

The beak color was significantly affected growth performance. It could say there was an effect of beak color on live body weight, body weight gain and growth rate. Some research has studied the possibility of linking qualitative and productive traits (Lowe *et al*., 1965). Some earlier studies reported no association; other studies found a white gene (the dominant) decrease the live body weight. Faruque *et al.* (2010) study the correlation between qualities and quantities traits in three phenotypes of native chicken, they found the live body weight was different among the three phenotypes.

Duguma (2006); Gwaza *et al.* (2018) reported that the white skin color result from white skin alleles (W*W)' thereby producing white skin. However, the yellow skin is caused by a recessive allele (W*Y), which allow deposition of carotenoids in the skin. From our results, we found a relationship between the beak color and body weight, body weight gain and growth rate.

Mortality and defects

Mortality and defect of Pekin duck as affected by beak color shown in Fig 2. Blue beak ducks recorded a higher relative mortality rate (4.12%) compared to yellow beak ducks (0.65%). Conversely, Yellow beak ducks recorded a higher defects rate (3.27%) compared to Blue beak ducks (1.03%) throughout the experimental period.

In another meaning, we can say the blue beak ducks recorded a higher mortality rate (4.12%) and lower defect ratio (1.03%) compared to yellow beak ducks (0.65% and 3.27%, respectively). Few studies compared among different phenotypes for mortality, (Al-Qamashoui *et al*., 2014) found significant differences for mortality ratio among six phenotypes of local chicken in Omani. Also other studies confirm that the higher mortality found in the brown laying chicken (Häne *et al*., 2000; Berg, 2002; Blokhuis *et al*., 2007). The present results confirm an effect of beak color on the defect and mortality ratio.

Table 1: Diets distribution and chemical analysis of experimental diets.

Ingredient	Diets distribution		
	0-2 wks	2-4 wks	4-6wks
	Starter	Grower	Finisher
Yellow corn	58.74	67.00	73.44
Soybean meal 44%	30.40	24.00	16.00
Corn gluten meal 60%	7.50	6.04	7.60
Wheat bran	0.00	0.00	0.00
Limestone	0.65	0.55	0.55
Die calcium phosphate	1.50	1.20	1.20
Salt	0.3	0.30	0.3
Vit.-Min. Mex*	0.50	0.50	0.50
Methionine	0.01	0.01	0.01
Dry Yeast	0.1	0.10	0.10
Dry mulases	0.1	0.10	0.10
Trigonella	0.1	0.10	0.10
Chamomile	0.1	0.10	0.10
Total	100	100	100
		Calculated chemical analysis	
Crude protein, %	23.07	20.04	18.00
ME, kcal/kg	2972.50	3006.60	3100.10
Calcium, %	0.75	0.62	0.60
Avail.phosphorus, %	0.41	0.34	0.33
Methionine, %	0.42	0.37	0.35
Lysine, %	1.05	0. 88	0.70
Fiber, %	3.53	3.23	2.83

Carcass characteristics

Data presented in Table (4) clarifies the effect of beak color on relative carcass traits of Pekin duck. The Yellow beak ducks recorded a significantly heavier body weight compared to blue beaks. As expected, males were significantly heavier body weight (3135 g) compared to females (2867 g). No significant difference between the interaction between beak color and sex observed. Generally; no significant differences between the studied phenotypes as regards carcass characteristics (Table 4).

Our results agree with (Saatci *et al*., 2009; Kırmızıbayrak and Boğa, 2018), which the did not found an effect for plumage color on carcass traits in geese. However, (Sarıca *et al*., 2015) confirm that effect of different feather colors of geese on slaughter traits such as, head, feet weight, abdominal fat weight, but they did not find an effect of feather color on blood, liver, hot and cold carcass weight. Another study done by (Yakan *et al*., 2012) pointed there was no significant effect of feather color on geese carcass traits. The economic traits such as carcass traits and growth performance are substantial in duck production, these traits are controlled by sets of candidate genes (Hassan *et al*., 2018). The present results did not find an effect of beak color on carcass traits.

Table 2: Types of the grasses in pasture.

Common name	Binomial name	
Type of grasses		
Field bindweed	*Convulvulus arvensis L*	
Jungle rice	*Echinochloa colonum*	
Bermuda grass	*Cynodon dactylon*	
Nutsedge	*Cyperus longus L*	
Annual sowthistle	*Sonchus oleraceus L*	
Common purslane	*Portulaca oleracea*	
Type of trees		
Common name	Binomial name	No. of Trees
Date palm	*Phoenix dactylifera*	5
Berry	*Morus rubra*	2
Guava	*Psidium guajava*	2
Mango	*þMangiferaindica*	2
Fig	*Ficus carica*	9
Drumstick tree	*Moringa oleifera*	3
Grapes	*Vitis vinifera,*	3
Lemon	*Citrus aurantifolia*	1
Orange	*Citrus × sinensis*	6
Zapota	*Manilkarazapota*	3
Ficus	*Ficus retusa*	2

Sexual dimorphism

Data presented in Table 5 show sexual dimorphism of body weight and carcass traits of Pekin duck. A significant difference between studied phenotypes detected for sexual dimorphism. The Yellow beak ducks recorded a significantly higher sexual dimorphism compared to blue beak ducks for most traits.

Table 3: Effect of beak color on body weight, weight gain and growth rate of Pekin duck.

Age (week)	Beak color		Level of significant
	Blue	Yellow	
Body weight			
1	232.22^{b} ±3.65	241.04^{a}±2.33	0.04
2	639.23±10.01	649.79±5.96	NS
3	1175.11^{a}±14.81	1127.27^{b}±9.58	0.006
4	1787.88^{a}±28.87	1643.04^{b}±14.30	0.0001
5	2250.0^{b}±28.50	2329.64^{a}±23.93	0.05
6	2720.7±80.84	2631.14±21.75	NS
Body weight gain			
1-2	399.16±2.93	408.25±4.11	NS
2-3	552.61^{a}±12.76	454.91^{b}±3.35	0.0001
3-4	660.46^{a}±14.19	495.19^{b}±4.43	0.0001
4-5	466.15^{b}±5.81	686.67^{a}±10.87	0.0001
5-6	681.40^{a}±28.87	266.40^{b}±6.12	0.0001
1-6	2576.13^{a}±54.92	2287.54^{b}±16.09	0.0001
Growth rate			
1-2	23.22±0.13	22.95±0.09	NS
2-3	15.0^{a}±0.12	13.03^{b}±0.06	0.0001
3-4	11.11^{a}±0.18	9.02^{b}±0.04	0.0001
4-5	5.87^{b}±0.13	8.58^{a}±0.07	0.0001
5-6	6.39^{a}±0.30	2.83^{a}±0.07	0.0001

a and b Means within the same row with different letters are significantly differed .

Average weight at 1 day old was 52.7 gm.

Our results confirm there is an effect of beak color on sexual dimorphism; which, the sexual dimorphism was lower in Blue color ducks; this indicated that the homogeneity is higher in blue beak ducks. Lower sexual dimorphism or, the higher homogeneity ratio is due to the increase in female weight of Blue beak ducks compared to the female of yellow beak ducks, opposite trend was found to males, which, the male of blue beak ducks were lower in weight compared to the male of yellow beak duck. Burley *et al.* (1992); Negro *et al.* (1998) reported that changes of beak color were diverse in females and males and this may reflect sexual contrasts in hormonal activity or costs of reproduction

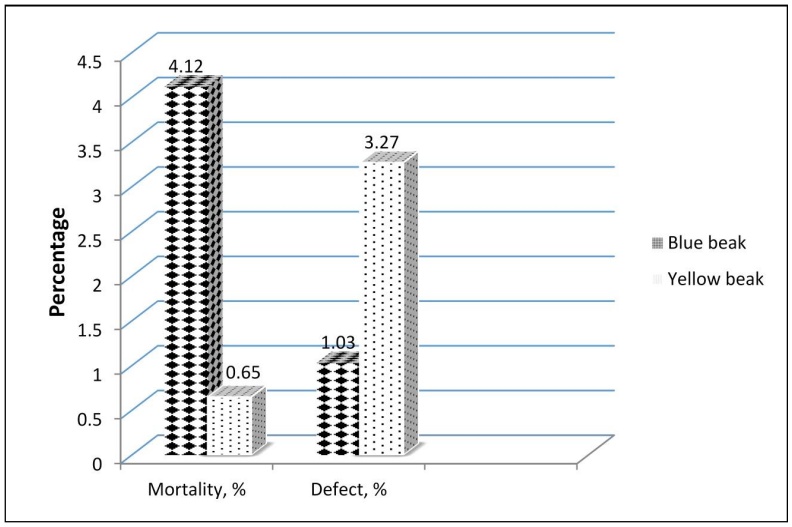


Fig 2: Mortality and defect percentages of pekin duck as affected by beak color.

Table 4: Effect of beak color on relative carcass traits of Pekin duck.

Traits	Sex (Sx)	Beak color (Bc)		Overall	Level of significant		
		Blue	Yellow		Bc	Sx	Bc*Sx
LBW, g	Male	3040±113.72	3230±114.07	3135.0[a]			
	Female	2930±120.9	2805±117.49	2867.5[b]			
	Overall	2985[b]	3017.5[a]		0.05	0.03	NS
Dressing, %	Male	71.92±0.77	71.22±0.71	71.57			
	Female	73.32±0.55	72.1±1.17	72.71			
	Overall	72.62	71.66		NS	NS	NS
Liver, %	Male	2.71±0.08	2.87±0.14	2.79			
	Female	2.4±0.19	2.65±0.16	2.57			
	Overall	2.60	2.76		NS	NS	NS
Gizzard, %	Male	2.89±0.13	2.93±0.1	2.91			
	Female	2.82±0.12	2.99±0.14	2.90			
	Overall	2.86	2.96		NS	NS	NS
Heart, %	Male	0.65±0.03	0.63±0.03	0.67			
	Female	0.67±0.05	0.72±0.05	0.70			
	Overall	0.66	0.67		NS	NS	NS
Giblets, %	Male	6.44±0.20	6.44±0.19	6.44			
	Female	5.91±0.17	6.40±0.21	6.15			
	Overall	6.18	6.42		NS	NS	NS
Head, %	Male	4.03±0.09	3.92±0.1	3.98			
	Female	3.85±0.2	3.9±0.14	3.88			
	Overall	3.94	3.91		NS	NS	NS
Edible meat parts, %	Male	78.36±0.81	77.66±0.64	78.01			
	Female	79.23±0.44	78.50±1.13	78.86			
	Overall	78.80	78.08		NS	NS	NS

[a and b]: Means within the same row with different letters are significantly differed.

Table 5: Sexual dimorphism of body weight and carcass traits of pekin duck.

Traits (g)	Blue		Yellow	
	Male	Female	Male	Female
LBW	3040±113.72	2930.0±120.92	3230.0±114.07	2805.0±117.49
Head	122.50±5.01	111.0 ±2.33	126.50±5.11	108.50±3.73
Dressed	2184.0±76.71	2152.0±98.07	2306.0±98.34	2028.0±102.17
Liver	89.0±6.86	70.0±4.35	92.50±4.43	76.0±6.70
Gizzard	87.50±4.36	83.50±5.74	94.50±4.44	83.50±4.72
Heart	19.50±0.90	19.50±1.17	20.0±0.75	20.0±1.67
Giblets	196.0±10.02	172.50±7.43	207.0±0.51	179.50±9.70
Edible meat parts	2380.0±84.52	2324.50±103.49	2513.0±102.31	2207.50±109.23
Traits (%)	**Blue**		**Yellow**	**Sig.**
LBW	3.96^{b}±1.137		15. 59^{a}±2.22	0.0002
Head	9.98^{b}±2.48		16.41^{a}±1.26	0.03
Dressed	2.08^{b}±2.16		14.38^{a}±2.86	0.003
Liver	26.79±3.54		26.95±7.39	NS
Gizzard	6.86±3.46		13.93±2.77	NS
Heart	1.33±4.07		4.33±6.85	NS
Giblets	0.94^{b}±4.53		13.21^{a}±4.0	0.05
Edible meat parts	3.87^{b}±5.25		14.50^{a}±2.61	0.05

^{a} and ^{b} Means within the same row with different letters are significantly differed.

(feeding exertion, incubation, egg-laying, *etc*.) during the season and ectoparasitism (Ewen *et al*., 2009). Anyway; the anticipated reduction in carotenoids concentration only happened in females, whereas vitamin A increased from mating to hatching within the two sexes. Therefore; sexual mismatches between changes in beak color and carotenoid levels may recommend that support of such physiologically critical chemicals in the integument (*i.e*., beak) after pairing is no longer adaptive for feeding males, but for females attempting to influence the feeding effort of their mates (*i.e*., beak color as a postmating sexually chosen signals that control investment in a reproduction of her male).

CONCLUSION

It could concluded that has a significant effect beak color on growth performance and sexual dimorphism of Pekin ducks.

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Conflicts of interest

There is no conflict of interests among authors and organizations.

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