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Force feeding as a Stress Factor on Muscovy Ducks

Ahmed A.A. Mohammed, Mootaz A.M. Abdel-Rahman*, Madeha H.A. Darwish

Department of Animal Hygiene, Faculty of Veterinary Medicine, Assiut University, Egypt

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Abstract

The experiment was done to determine the effects of force feeding on drinking, panting behaviors, feed consumption, weight gain, feed conversion ratio, live body weight, slaughter weight, carcass weight and dressing percentage, serum corticosterone, triiodothyronine (T3) and tetraiodothyronine (T4) of Muscovy ducks. Two groups were used; the first one was the control group, which fed on basal diet only and the second group was force fed by grabbing the neck, and a metal or plastic tube 8 to 12 inches long was inserted down the esophagus. Ducklings were forced to ingest a greater amount of food than what they would eat voluntarily. The previous parameters were recorded daily or weekly during the experiment or after slaughtering. Blood samples for separation of serum were collected after slaughtering. The results explained that, there was an insignificant increase in drinking behavior. However, there was a significant increase in feed consumption, live body weight, feed conversion, weight gain, dressing percentage, panting behavior, liver weight and serum corticosterone level while there was a significant decrease in T3 and T4 level. It could be concluded that, force feeding at the end of the fattening period of ducks had adverse effect on some duck behaviors and some blood parameters but led to improvement in performance parameters and carcass characters.

Keywords: Force feeding; Behavior; Performance; Blood hormones; Muscovy ducks

Introduction

Over the past years a considerable amount of scientific research has focused on animal welfare (Broom, 1991; Sandøe *et al*., 2003). Performance records, behavioral, physiological and clinical parameters are considered as good indicators for assessing animal welfare (Broom, 1996). As the demand for animal protein has increased, people begin to use Muscovy ducks as a source of meat. The Muscovy or Barbary duck is good for meat production. It is important to know that the Muscovy male is twice the size of the female, hence its use in the production of foie gras - bigger bird, bigger liver (Pingel, 2004).

European regulations in the past ten years have tried to take into account the welfare of domestic animals, and various points are being or have been discussed concerning ducks, including overfeeding with the use of individual cages restraining duck movement during this period, stocking density and group size, the use of slatted-floors in relation to leg problems, practices that reduce feather pecking such as reduced light intensity and beak trimming, and possible access to an outdoor run and to open water for drinking, bathing and swimming (Rodenburg *et al*., 2005).

Evidence of acute or chronic stress when measuring physiological responses to manipulation, intubation and overfeeding was reported by Guémené *et al*. (2001). Mule ducks exhibited less fear towards the caretaker than to an unknown person during the overfeeding period, suggesting that ducks do not learn to treat their regular feeder as an aversive stimulus (Faure *et al*., 2001). Pekin and mule ducks are more reactive to stressful reactions and more often express fear reactions than Muscovy ducks (Faure *et al*., 2003).

Force fed ducks significantly increased the body weight, body weight gain and improved feed conversion ratio (SCAHAW, 1998). Also, beneficial effects on force fed duck performance and increased their respiration rate and body temperature compared with control (Meulen and Dikken, 2004).

*Corresponding author: Mootaz A.M. Abdel-Rahman

E-mail address: mootazabdelrahman@yahoo.com

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Force feeding had a positive effect on water intake (Beck, 1996) and dressing percentage (Fournier *et al*., 2008).

Ducks exposed to severe stress in accompany to force feeding (Beck, 1996; Servière *et al*., 2002). Various painful injuries to the esophagus, including hemorrhagic inflammation and perforations of the esophagus, which can be compounded by the subsequent growth of opportunistic germs and fungal growth were resulted from force feeding (Banon, 1989)

Structural problems degeneration, sclerosis, vascular problems and necrosis directly affect the anatomy of the liver and its quality as a result of the process of force feeding in ducks (Beck, 1996; Davail *et al*., 2003). Approximately 2% to 4% of force-fed birds were died during the force-feeding period, compared with only 0.2% of comparable non-force fed birds of about the same age (SCAHAW, 1998; CIFOG, 2002).

Plasma corticosterone concentrations of force-fed ducks were below those of ACTH-challenged ducks and not reliably above observed baseline concentrations although it has not been demonstrated that this experiment's protocol for assessing stress is sensitive to environmental stressors (Guémené *et al*., 2001) as ducks are highly stressed by the presence of unfamiliar handlers during the process of force feeding (Faure *et al*., 2001). Foie gras production induce a significant reduction in circulating T3 and T4 concentration (Gyirffy, 2008).

This might explain why a force-fed duck may initially show little fear of the person performing the force-feeding. Bronchial obstruction, fibrosis of the liver, enterotoxemia, and enteritis are afflictions that can threat en force-fed birds, according to a French industry manual (Zayan, 2001; ITAVI, 2004).

Materials and methods

Twenty four one month old Muscovy ducklings in a completely randomized design test with two groups (Two replicates per each), each replicate included six birds. The two groups were the control group and the force feeding group.

Control group

Where the duckling reared under normal environmental, feeding and housing conditions.

Force feeding group

Where the ducklings reared under all the above treatment in addition to force feeding during which, the duck was grabbed by the neck, and a metal or plastic tube 8 to 12 inches long was inserted down the esophagus. Ducklings were forced to ingest a greater amount of food than what they would eat voluntarily (Beck *et al*., 1996).

Management and cleaning

Day to day management was carried out for keeping the facility clean. After daily cleaning, cleaned feeders and drinkers were dried and filled with food and water. Also, the contaminated wastes and dead birds were hygienically disposed by incineration.

Lighting

Continuous lighting program (23 hours lightning: 1 hour darkness) was used, 60 watt bulb was suspended 2.20 m at head height of the birds (Coates *et al*., 2000).

Temperature and relative humidity

The temperature was set initially at average between 85 and 90 Fahrenheit. Birds were observed if they were huddled that mean temperature too low, if they were panted or stayed away that mean temperature was too high and gradually reduced by one degree a day by slightly raising heat lamp at a rate of 3 /week (Coates *et al*., 2000).

Diet and feeding

The basal diets were formulated using Central Poultry Developmental Organization (1999) guidelines. It contained 21% protein (starter type from 1 –6 weeks) and 23% (grower type from 6 – 8 days) with 3200 kcal/kg. Feed was offered daily and residual feed was measured weekly.

Birds' identifications

Bird identifications carried by wing band which changed every week.

Medication and vaccination

Medication was given to the experimented ducklings according to the design shown in Table 1. The chicks were vaccinated in drinking water against duck cholera and duck plague.

Behavioral Observations

Behavioral observation was started from 37 days old and extended up to 70 days old using both video tape and eye observation. Duckling's behavior was observed to directly throughout the study using scanning technique according to Fraser and Broom (1990). Three birds in each replicate were observed three times a day for three days / week as follows: At early morning (8.0: 9.0 am), at late morning (12:1 pm) and at late afternoon (4: 5 pm). So each group was observed 30 minutes daily for recording the percent of ducklings performing the following behaviors: 1) Drinking behavior: obtaining water at the drinkers. 2) Panting (respiration rate): measured by counting birds which have rapid movement of body wall or opening it mouth during respiration.

Duckling Performance

Live body weight (LBW)

Ducklings were individually weighed at the end of the experimental period (37 to 70 days of age) using Sartorius balance produced by Sartorius Universal, Germany. Individual live body weights was totaled and divided by the number of experimented ducklings to obtain the average live body weight (LBW). All birds were weighted to nearest 0.1g.

Body weight gain (BWG)

The average live body weight gain was calculated every week by subtracting the individual initial live weight from the final one. Individual live weight gains were totaled and divided by the number of experimented ducklings to obtain average live body weight gain (BWG).

Feed intake (FI)

Ducklings in each replicate were provided with a certain amount of feed every week.
The residuals were obtained at the end of the same week and the amount of feed consumed was calculated from differences. The following equation was applied to obtain the average amount of feed consumed.
Feed intake (g/bird) = Amount of feed consumed / Number of ducklings

Feed conversion (FC)

Feed conversion (feed required to produce a unit of gain) was calculated for each age interval by dividing the average feed consumption per duckling per week on the average body weight gain per duckling per week.

Carcass traits

At the ends of the growing period (70 days old), 5 birds from each treatment were taken randomly. Birds were individually weighed to the nearest gram and slaughtered by severing the carotid artery and jugular veins. After four minutes of bleeding, each bird was dipped in a water bath for two minutes and feathers were removed by hand. After the removal of the head, carcasses were manually eviscerated to determine some carcass traits, including dressing % (eviscerated carcass without head, neck and legs) and giblets % (gizzard, liver, spleen, proventriculus and heart). Cold carcass weights were calculated after they were kept at 4°C for 18 hours.
Dressing % was calculated as follows:
Dressing % = Eviscerated carcass weight + giblets (heart, empty gizzard and liver) weight x 100

Table 1. Medication was given to the experimented ducklings

Name of drugs	Age	Does of drugs	Route of Administration
Enroflox 10%	1-3 days of age	0.5 ml/liter	Drinking water
Royal Colistin	1-3 days of age	1g/6liter	Drinking water
Vitamins AD_3E	3 days/week	1ml/liter	Drinking water
Liquid minerals	3 days/week	1ml/liter	Drinking water
Neotermycin	4-10 days of age	3g/liter	Drinking water

Live body weight at slaughter

Heart, empty gizzard, spleen, proventriculus and liver weights were expressed as relative weight proportionate to pre-slaughter live body weight.

Blood parameters

Blood parameters were estimated in the laboratory of microbiology (Department of Microbiology and Immunity, Faculty of Medicine, Assiut University, Egypt).

At 70 days old, 5 birds were randomly taken from each treatment, weighed and slaughtered. During the bird-sanguinary blood samples were collected as follows

Three ml of blood from each bird were collected in a test tube without anticoagulant to determine the chemical blood parameters and hormones. The tubes were kept at the room temperature for 30 minutes, then they were stored in the refrigerator for 60-90 minutes and then centrifuged at 3000 r.p.m for 10 minutes and the separated serum was transferred to another Epindoorf`s tube using micropipette. The sera were kept at –20ºC, until analysis using commercial kits according to the procedure outlined by the manufacturer.

Triodothyronine (T3)

Serum triiodothyronine (T3) was assayed by a solid phase enzyme immunoassay using Bio Tina GmbH Total T3 commercial ELISA kits (Code#Bio-ET3/96;Bio-ET3/48) manufactured by Bio Tina GmbH, Bugweg 53, 58119 Hagen, Germany.

Thyroxin (T4)

Serum Thyroxin (T4) was assayed by a solid phase enzyme immunoassay using Bio Tina GmbH Total T4 commercial ELISA kits (Code#Bio-ET3/96; Bio-ET3/ 48) manufactured by Bio Tina GmbH, Bugweg 53, 58119 Hagen, Germany.

Serum corticosterone analysis

Serum corticosterone was determined by Assay Max corticosterone ELISA kits, obtained from ASSAYPRO (Cataloge number (EC3001-1).

Statistical analysis

The results in both experiments were expressed as the mean ± SE. Differences between group means was assessed by a one-way analysis of variance (ANOVA) and post-hoc Duncan test using SPSS 11.0 statistical software (Spss, Inc, Chicago, IL, 2001).

Results

Behavioral observation

The data was tabulated in Table 2, claimed the effect of force feeding on drinking and panting behavior. Analysis of variance of these results illustrated that, there was a significant increase of panting behavior in the force feeding group compared with the control group. However, there was an insignificant increase of drinking behavior in the force feeding group in comparison with the control one.

Performance characters

There was a significant increase of feed intake, average final body weights and average body weight gain as a result of these force feeding. On the other hand, there was a significant decrease in force feeding group in comparison with the control one (Tables 3, 4).

Carcass characters

There was a significant increase in live body weights at slaughtering time, slaughter and Carcass weight, dressing percentage and liver weight per-

Table 2. Effect of Force Feeding on ingestive behavior (% of birds/10 minutes) of Muscovy ducks.

Behavioural Pattern / Group	Panting and drinking behavior	
	Panting behavior	Water intake
Control	1.51 ± 0.33^b	12.96 ± 0.74
Force Feeding	7.77 ± 0.64^a	15.92 ± 0.71

centage in the force feeding group compared with the control one (Tables 5, 6).

Effect of force feeding on serum hormones

There was a significant decrease in serum T3 and serum T4 in the force feeding group in comparison with the control one. However, there was a non-significant decrease in serum T3/T4 ratio and significant increase in serum corticosterone level in the force feeding group compared with the control group (Table 7).

Table 3. Effect of Force Feeding on body weight (g) at slaughtering time of Muscovy ducks.

Birds \ Group	Control	Force feeding
Over all mean	$4749{\pm}227.2^{b}$	$5508{\pm}189.6^{a}$

Overall means for each item with different superscripts in the same raw significantly differ (p<0.05).

Table 4. Effect of Force Feeding on Feed intake (g), weight gain (g) and feed conversion ratio of Muscovy ducks.

Performance parameter	Feed intake		Body weight gain		Feed conversion ratio	
	Control	Force feeding	Control	Force feeding	Control	Force feeding
8^{th} week	$1857{\pm}1.6^{b}$	$2080{\pm}1.4^{a}$	$400{\pm}0.4^{b}$	$800{\pm}0.6^{a}$	$4.64{\pm}0.6^{a}$	$2.60{\pm}0.4^{b}$
9^{th} week	$2025{\pm}1.5^{b}$	$2370{\pm}1.6^{a}$	$390{\pm}0.6^{b}$	$820{\pm}0.5^{a}$	$5.19{\pm}0.7^{a}$	$2.89{\pm}0.6^{b}$

Overall means for each item with different superscripts in the same raw significantly differ (p<0.05).

Table 5. Effect of Force Feeding on Eviscerated weight (g) and Dressing % of Muscovy Ducks.

Group \ Carcass traits	Eviscerated weight and dressing	
	Eviscerated weight (g)	Dressing (%)
Control	4583 ± 116.4^{b}	89.30 ± 5.69^{b}
Force Feeding	5175 ± 146^{a}	96.12 ± 2.93^{a}

Table 6. Effect of Force Feeding on liver weight (g) of Muscovy Ducks.

Bird \ Parameter	Edible Giblets	
	Liver	
	Control	Force feeding
Over all mean	$60.75{\pm}1.7^{b}$	103.50 ± 3.2^{a}

Overall means for each item with different superscripts in the same raw significantly differ (p<0.05).

Table 7. Effect of force feeding on serum Tri-iodothyronine (T3), Thyroxine (T4)(nmol/l), T3/T4 ratio and Corticosterone (ng/ml).

Bird \ Group	T3		T4		T3:T4 ratio	Corticosterone		
	Control	Force Feeding	Control	Force Feeding	Control	Force Feeding	Control	Force Feeding
Over all mean	$1.88{\pm}0.19^{a}$	$1.16{\pm}0.18^{b}$	$23.36{\pm}0.28^{a}$	$16.80{\pm}0.13^{b}$	$0.08{\pm}0.07$	$0.06{\pm}0.01$	$10.12{\pm}0.21^{b}$	$23.28{\pm}0.92^{a}$

Overall means for each item with different superscripts in the same raw significantly differ (p<0.05).

Discussion

Findings reported by Beck (1996) and SCAHAW (1998); Molner (2004) were inconsistent with the results and it can be explained by the finding of Molner (2004), who stated that, increased the amount of food during the force feeding leads to increase the drinking behavior to help the deglutition of food.

Increasing of panting behavior was inconsistent with the general trend of Faure *et al*. (2000); Guémené *et al*. (2001); Molee *et al*. (2005); Comiti (2006) and Guémené *et al*. (2006), and may be related to thermoregulatory and respiratory disorders. It has been shown that, force-fed ducks sometimes exhibit open-beak breathing to thermo regulate as birds have no sudoriferous glands and their capacity to eliminate extra heat through contact with the air is limited by the insulating properties of their plumage. Thus, they open their beaks and pant to eliminate the latent heat associated with water losses. Ducks pant intensely to vent the excess heat generated by their forced over-consumption of food (Guy *et al*., 1998; Molee *et al*., 2005; Comiti, 2006; Guémené *et al*., 2006).

Furthermore, increasing the body weight, body weight gain, feed intake and feed conversion ratio could be explained as the result of excessive amounts of ingested feed during the finishing period of force feeding. Under this special nutritional state, it was found that the length of small intestine markedly increased in association with increase of body weight (Yamani *et al*., 1973). It was also shown that digestibility and absorption were almost normal in ducks force-fed twice the amount of ad libitum intake (Zahou *et al*., 1990). These functions suggest that force-feeding probably modify the gastrointestinal function.

Moreover, these results of carcass traits were in agreement with those obtained by Blum (1990); Gabarrou *et al*. (1996); Guy *et al*. (1998) and SCAHAW(1998); Food and Agriculture Organization of the United Nations (2002); Hermier *et al*. (2002); Guémené and Guy (2004); Molee *et al*. (2005) and Scientific Committee on Animal Health and Animal Welfare. (2013).

The results can be attributed to increased feed intake during the force feeding process which resulted in increased body weight and so the eviscerated body weight as well as dressing percentage (Guy *et al*., 1998; Hermier *et al*., 2002).

Concerning the results of liver, Force-feeding causes a rapid increase in the size of birds' livers. Estimates of this change in size vary between six and greater than ten times its original, healthy weight (Gabarrou *et al*., 1996; SCAHAW, 1998; Food and Agriculture Organization of the United Nations, 2002).it could be attributed to the presence of abnormally large quantities of fat within the hepatic cells. The concentration of fat gives foie gras its distinctive taste. The liver of a healthy duck is approximately 5% fat, while the liver of a force-fed bird is approximately 50-60% fat (Gabarrou *et al*., 1996; SCAHAW, 1998; Molee *et al*., 2005).

However, decreasing of serum thyroid hormones was in accordance with Faure *et al*. (1996); Guémené *et al*. (2001); ITAVI (2004) and Scientific Committee on Animal Health and Animal Welfare (2013) and could be due to the fact that force feeding stimulates the hypothalamus to lower level of thyroid releasing hormone secretion and affects the thyroid gland to decrease thyroid secretion (Guémené *et al*., 2001; ITAVI, 2004)

Different stresses indicators such as changes in corticosterone have been used to investigate acute and chronic stress related to force-feeding and have reinforced our knowledge regarding duck and goose physiology. It has been reported that neither the first episode of force-feeding nor subsequent episodes induce any significant increase in plasma corticosterone levels. On the other hand, significantly higher corticosterone levels were measured after handling during the rearing period of birds (Faure *et al*., 1996; Guémené *et al*., 1998, 2001).

In the reverse opinion, Clinical experimentation has shown that force-feeding does not induce any significant increase in plasma corticosterone levels in ducks kept in individual cages. In addition, additional experiments have demonstrated that the corticotrope system remains fully functional during the force-feeding period. The ducks were still able to secrete corticosterone after a physical stress, such as 15 minutes constrained in a net, demonstrating that the physiological status induced by overfeeding did not result in a blunted responsiveness of the alarm system (Guémené *et al*., 1998; 2001; Hermier 2002; ITAVI, 2004).

Conclusion

Force feeding at the end of the fattening period of ducks had adverse effect on some duck behaviors and some blood parameters but led to improvement in performance parameters and carcass characters. Therefore, it is advisable to prevent the force feeding in Egypt due to its adverse effect on the duck welfare.

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