EFFECT OF DIFFERENT MECHANICAL VIBRATION ON BLOOD PARAMETERS OF ONE DAY OLD BROILER CHICKEN

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ABSTRACT

Mechanical vibrations are congenital to any system of transportation. In poultry industry, the higher or lower intensity of this agent during the transportation of eggs and chickens can increase the production losses and decrease the efficiency of the system as a whole. This study was carried out to investigate the effects of mechanical vibration (MV) generated by mechanized equipment on eggs, chickens mortality and levels of some blood biochemicals (triglyceride, glucose, cholesterol, calcium, phosphorus, urea) were analyzed in one days chickens. The data showed that the glucose and urea concentrations in blood of one day old chicks and their mortality increased with increasing vibration levels but calcium, cholesterol and triglyceride levels decreased. Levels of vibration seemed not to affect all of parameters. Mechanical vibrations may be responsible for the incidence of cracks, in addition to promoting the agitation of internal constituents (yolk and albumen), which could potentially compromise the quality of birth and hatchlings. The mechanical vibration are related to stress, discomfort and depreciation of the welfare of the birds, changed in glucose and corticosteroids levels and thus affect other factors as well as the quality of the meat.

Keywords: Glucose, Cholesterol, Triglyceride, Calcium, Phosphorus, Urea, Mortality, Broiler chick, Mechanical vibration

INTRODUCTION

Higher meat consumption necessitates increased number of broiler farms. Due to the development of the industry and livestock technology, traditional small-scale facilities have changed to large-scale mechanized units. Egg transport is an essential component in current system integration of poultry production; it is responsible for loading of fertilized eggs from stock plants to hatcheries, day-old chicks from hatcheries to farms and disposal poultry for slaughterhouses. However, this process still receives little attention and many aspects related to it may impose stress on the eggs and day old chicks, resulting in a higher incidence of productive losses. The vibration studies, affecting livestock productivity directly or indirectly, have been conducted (Graul *et al.,* 1976; Warriors *et al.,* 1997; Stephen *et al.,* 1998; Yun, 1998; Baek *et al.,* 2002; Lee *et al.,* 2003; Lee *et al.,* 2004; Campo *et al.,* 2005; Kim *et al.,* 2012). All the results referenced above, were related to the effects of noise and vibration generated in poultry industry. Studies on the effects of mechanical vibration on egg incubation and productivity of broilers production are limited.

Stress could have considerable effect on animal behavior. Stress decrease growth and development. It has negative effect on embryo development. Stress impairs haemostasis (Fuchs

et al., 2001). At any stage of pregnancy, stress could affect embryo development, especially the brain development (Nishio *et al.,* 2005). Hypothalamo-hypophysis axis is disordered in embryo by stress (Reul *et al.,* 2000). In stress both hormone ACTH and cortisol increase in blood. Mechanical vibration is one type of stress. The effects of stress during transportation and other mechanical vibrations have been studied during egg production (Carter *et al.,* 1970). Shaking of the eggs should be reduced to a minimum because it has detrimental effect on egg quality (Walker *et al.,* 1972). Important damage during transportation occurs in egg shell and internal egg quality which could affect the egg characteristics. Transportation stress is one of the reasons recently noticed to affect eggs hatching, the development poultry industry, food consumption pattern and thus the Iranian economy. The negative effects of mechanical vibration on incubation are widely known. It is a common and years old belief that poor transportation of eggs may seriously decrease their hatchability (Saint-Hilaire, 1836; Dareste, 1877; Landauer and Baumann, 1943). Saint-Hilaire produced malformed chick embryos by subjecting eggs to various environmental conditions, including physical trauma and toxins (Saint-Hilaire, 1836).

There are data on the effects of vibration on egg development. Potter and Bassett (2001) studied the effects of different levels of vibration on egg hatchability, by examining the effects of transportation-induced jarring on embryo development and hatchability, and concluded that jarring did not increase physical abnormalities or defects in the development of hatched chicks.

Interpretation effect of transportation is difficult because the location of the pallet and the eggs in the truck has a large effect on egg characteristics. Effect of transportation with the help of vibrating table (electro-dynamic shaker) was investigated (Berardinelli *et al.,* 2003). This idea guided the use of a device for modeling the transport effects on egg hatchability and blood parameters of one day chicken broilers in small scale farms. The aim of this experiment was to investigate the effects of different vibration frequencies and levels on egg hatchability and blood parameters of one day chicken broilers.

MATERIAL AND METHODS

Vibration Simulator: The vibration simulator device was designed in Agriculture College of Lorestan University, Iran (Figure 1). This equipment has vertical movement (jarring simulator) and the vibrations calibrated for different frequencies. The simulator is a vibration machine with a two dimensional vibration plate moved by a motor.

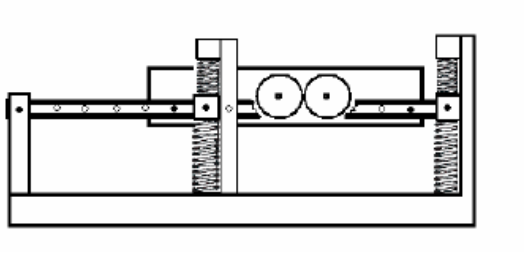

Figure 1: Vibration simulation device

The machine can be set to different levels of vibration between 6 – 15 Hz. The vibration simulator was provided with fixed amplitudes and frequencies covering the range measured on trucks. Similar device have been described by Guillou and O'Brien (1969), Ogut *et al.* (1999) and Vursavus and Ozguven (2004). The vibration simulator consist of a table of soft springs and attached to it an actuating system that include adjustable weights on two counter rotating shafts (counterweights) revolving in opposite directions and about the gravity center of the table and its load, providing vertical vibration only. Counterweights were powered by an electric motor (3.0 kW and 3,000 rpm).

The speed of the electric motor was adjusted by means of a speed control unit (inverter), which had a 4.0 kW power. The magnitude and angular velocity of the rotating masses can be changed. Because the frequency of the vibration simulator table is directly related to the rotation number of the counterweights, the frequency of the table was obtained based on the number of revolutions of the electric motor. Therefore, the speed of the electric motor was measured by means of the speed control unit and the number of the revolutions of electric motor measured in revolution per minute (rpm) was divided by 60 seconds and the frequency of the vibration simulator table was obtained in Hz. The acceleration of the vibration simulator table was directly measured using an

Table 1: Effect of different frequency of vibration on blood parameters and age mortality

Parameter	Frequency 1 [5 Hz]	Frequency 2 [7.5 Hz]	Frequency 3 [10 Hz]	Frequency 4 [12.5 Hz]
Urea (mg/dl)	25.83 ± 7.40^{a}	26.05 ± 5.93^{b}	30.30 ± 10.20^{c}	34.60 ± 4.79^{d}
Glucose (mmol/l)	153.70 ± 34.20^{c}	161.36 ± 9.80^{d}	129.94 ± 53.10^{a}	139.16 ± 29.50^{b}
Triglyceride (mmol/l)	429.83 ± 7.80^{d}	404.00 ± 90.00^{c}	386.15 ± 18.40^{b}	357.88 ± 9.70^{a}
Cholesterol (mmol/l)	84.88 ± 50.40^{c}	51.79 ± 42.80^{b}	52.72 ± 26.10^{b}	49.73 ± 31.00^{a}
Calcium (mmol/l)	7.98 ± 1.20^{d}	6.50 ± 0.40^{a}	6.85 ± 0.80^{cd}	6.73 ± 0.90^{b}
Phosphorus (mg/dl)	5.46 ± 1.20^{c}	5.47 ± 0.90^{c}	5.29 ± 1.20^{b}	4.46 ± 0.80^{a}
Age morality (days)	15.59 ± 3.90^{d}	11.03 ± 7.70^{c}	9.10 ± 7.00^{b}	7.58 ± 6.90^{a}

Means with similar superscripts on a row are not significantly different and means with different superscripts on a row are significantly different

Table 2: Effect of different levels of vibration on blood parameters and age mortality

Parameter	Level 1 [48 cm]	Level 2 [78 cm]	Level 3 [115 cm]
Urea (mg/dl)	27.33 ± 4.74^{a}	30.50 ± 5.80^{a}	29.88 ± 9.20^{a}
Glucose (mmol/l)	159.32 ± 27.70^{a}	179.30 ± 27.70^{a}	161.23 ± 39.52^{a}
Triglyceride (mmol/l)	34.03 ± 14.46^{a}	71.66 ± 11.02^{a}	73.67 ± 8.11^{a}
Cholesterol (mmol/l)	409.04 ± 51.68^{a}	388.08 ± 25.70^{a}	386.28 ± 35.19^{a}
Calcium (mmol/l)	7.50 ± 0.60^{a}	6.50 ± 0.70^{a}	6.95 ± 1.04^{a}
Phosphorus (mg/dl)	5.75 ± 1.70^{a}	4.93 ± 0.58^{a}	4.80 ± 1.30^{a}
Age morality (days)	10.60 ± 6.50^{a}	10.01 ± 6.20^{a}	11.84 ± 6.40^{a}

Means with similar superscripts on a row are not significantly different and means with different superscripts on a row are significantly different

acceleration measurement device and a piezoelectric accelerometer. Treated eggs were placed on three trays (the same type of fiber trays used in the field for transportation) then placed onto the simulator. Four thousand, three hundred and twenty (4320) fertilized eggs from Dorbar Industry (Iran – Brujerd) were allocated in three levels 48, 78 and 115 cm. Frequency of experimental treatments were 5, 7.5, 10 and 12.5 Hz with three replications each. Each replicate had 360 eggs. After fixed time of vibration, fertilized eggs were disinfected and incubated into setter for a period of 18 days. From the 18th day, eggs were transferred to hatching unit (incubator BKF, USA) and left until the 21 day. The number of hatched eggs was calculated. From the un-hatched eggs in each replicate, two un-hatched eggs were selected and broken. Age of the fetus was estimated. After hatching two chickens were selected randomly and the blood serum sampled with the help of centrifuge at 6500 rpm for 15 minutes. Serums were assayed for glucose, cholesterol, triglyceride, urea, calcium and phosphorus.

Data Analysis: Data collected were analyzed for their central tendencies, variances and significant difference ($p<0.05$) using SAS 9.2 software.

RESULTS

Eggs treated with different vibrations had no congenital defects. High-frequency vibration produced statistically significant changes such as (i) decrease of triglyceride, phosphorus, calcium and cholesterol level in blood and (ii) increase of urea, glucose level in blood in the day old chick (Table 1).

In Treatment 3 and 4, the treated eggs had a lower hatchability. A higher level of dead embryos and cracks/shell problems was observed between treatment 1 and 4 significantly ($p<0.05$). In trial 4, the treated eggs had a lower hatchability, higher level of dead embryos, more cracks/shell. In the treatment 1 which received 5 Hz, significantly low mortality was observed when compared with other treatments, while between treatments 2, 3 and 4 were not significantly different.

The frequency had significant ($p<0.05$) effect on glucose level. Glucose concentration in treatment 5 Hz was significantly higher than those in treatment 12.5 Hz. In this experiment, different levels of vibration had no effect on whole parameters (Table 2). Variations of different parameters were shown in Figures 2 and 3.

DISCUSSION

Vibration stress is a known kind of stress in poultry industry. The objective of the present study was to investigate the effects of different vibration frequencies and levels on egg hatchability and blood parameters of one day chicken broilers. Factors associated with chicken embryo mortality and blood parameters were vibration frequency and level related.

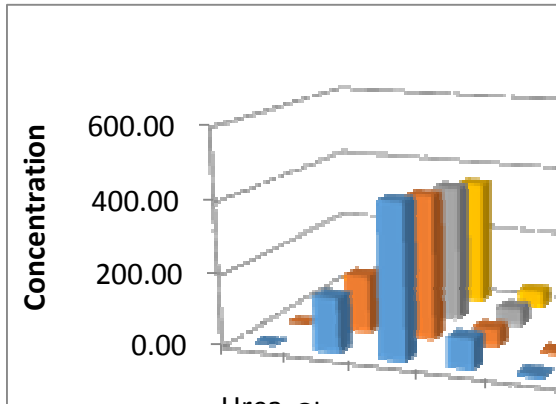

Figure 2: Different frequency on blood parameters, urea, glucose, triglyceride, cholesterol, calcium, phosphorous and age mortality

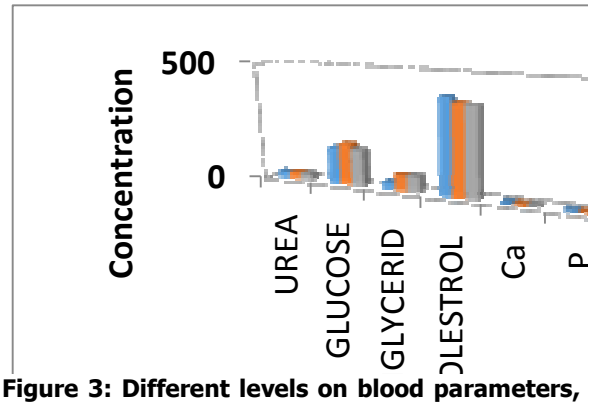

Figure 3: Different levels on blood parameters, urea, glucose, triglyceride, cholesterol, calcium, phosphorous and age mortality

As the magnitude of the frequency increased, mortality increased. The use of different vibration levels on eggs had no effect on all the experimental parameters.

Blood glucose is a sensitive, reliable indicator of environmental stress in chicken. Blood glucose was decreased in F4 as compared to control (F1). Glucose concentration was elevated by cadmium stress on chicken (Abdo and Abdulla, 2013). Cadmium induced hyperglycemia with decreased in liver glycogen in catfish *Heteropneustes fossilis* (Sastry and Subhadra, 1985). Soengas *et al.* (1996) reported that hyperglycemia that occurred in Atlantic salmon (*Salmo salar*) after toxicity with cadmium may be due to changes in liver carbohydrate metabolism (activation of liver glycogenolysis and glycolysis) as well as increased levels of plasma glucose.

Bone is a dynamic tissue influenced by physiological, nutritional and physical factors such as mechanical and physical activities (Rath *et al.,* 2014). It is formed and destroyed continually under the control of hormones and physical factors. This constant activity allows the modeling process, i.e., modification of the bone architecture to meet physical stresses (Stevens and Lowe, 1992).

Most bones have a large marrow cavity in the center; this may contain yellow marrow, which is mostly fat, or red marrow, the connective tissue in which red and some white blood cells are made (Villee *et al.,* 1989). No significant different between all treatments was observed.

The calcium : phosphorus ratio decreased significantly as compared to control. In their study clearly indicated that, there is an altered calcium and phosphorous metabolism. As calcium and phosphorous are important constituent of bone, ultimately, bone metabolism is altered, as reported by many workers (Oelzner *et al.,* 1998; Walwadkar *et al.,* 2006). Negative correlation between calcium/phosphorus ratio and lipid peroxide ($r = -0.76$) suggested that the generation of reactive oxygen species in excess may be particularly important in the bone resorption that occurs in association with inflammatory diseases (Garrett *et al.,* 1990). Decrease in calcium level may contribute to a negative calcium balance and acceleration of immunomodulatory effects (Kroger *et al.,* 1993; Oelzner *et al.,* 1998). Significant positive

correlations between vitamin E and calcium (r = + 0.67), suggested that vitamin E may also be an important for immunity of an organism along with calcium (Kroger *et al.,* 1993).

The effects of mechanical vibration on serum triglyceride concentrations in incubated eggs are depicted in Figure 2. Serum triglyceride concentrations in incubated eggs were significantly lower in treatment F4 ($p<0.05$) than control (F1). These findings are consistent with the reported of Moraes *et al.* (2003) in broiler chicks subjected to thermal stress. Applying of high vibration may exert an important effect on triglyceride absorption. Compared to the control group, chicks received 12.5 Hz had significantly lower concentrations of blood cholesterol. Lowering of cholesterol levels may be mediated by the stimulation of hepatic cholesterol -7-hydroxylase activity (Babu and Srinivasan, 1997; Asai *et al.,* 1999).

As a measure of renal function status, serum uric acid, urea and creatinine levels are often regarded as reliable markers (Oelzner *et al.,* 1998; Walwadkar *et al.,* 2006). Urea is the detoxification product of the ammonia derived from deamination of amino acids, thus urea considered to be the end product of protein catabolism (Kroger *et al.,* 1993).

The catabolism of the purines (adenine and guanine) produces uric acid using xanthine oxidase. Thus, increased in the serum concentrations of these components is indicative of renal injury simply because the kidneys excrete them. Mortality of embryos was increased significantly at 12.5 Hz in treatment 4. It is possible to verify that the mechanical vibration in poultry production produces negative effects.

Conclusion: The result of the current study confirmed that mechanical vibrations resulted in stress that increased production losses especially hatchability. However, the transport process is inevitable, there is no way not to carry eggs or birds and it is hard to control the quality of roads and trucks. Thus, strategies should be employed that reduces vibration based on new scientific investigations that address engineering concepts for the development of new vehicles; boxes, trucks and hatching trays with reduced vibrations. High vibration is harmful to the developing chicken embryo.

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