



UNIVERSITI PUTRA MALAYSIA

***EFFECTS OF ENVIRONMENTAL ENRICHMENT ON GROWTH
PERFORMANCE, PHYSIOLOGICAL STRESS RESPONSE AND
BEHAVIOUR IN BROILER CHICKENS***

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By

NURHAFIZAH BINTI MOHD TAMAGI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfillment of the Requirements for the Degree of Master of Science**

November 2019

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Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Master of Science

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November 2019

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Chickens are constantly responding to environmental stimulation. These stimuli can be perceived as threatening or otherwise by birds. In view of this, environmental enrichment has been used as a tool to improve the welfare of intensively-raised farm animals.

Experiment 1 was conducted to investigate the effects of auditory enrichment by means of classical music and Quran recitation, and regular human contact by means placing one hand inside the cage on growth performance, tonic immobility as an indicator of fear response and serum level of corticosterone (CORT) and ceruloplasmin (CPN) as physiological stress indicators in broiler chickens. A total of 768 day-old broiler chicks were subjected to the following treatments from day 1 to day 35 (i) no sound enrichment and without regular human contact, as control, (ii) no sound enrichment with regular human contact (HC), (iii) sound enrichment by classical music (Vivaldi's Four Season) and without regular human contact (CM), (iv) sound enrichment by classical music with regular human contact (CMH), (v) sound enrichment by holy Quran recital (Yaseen chapter) without regular human contact (QR) and (vi) sound enrichment by holy Quran recital with regular human contact (QRH). Both sound stimuli were applied 3 hours a day intermittently. The regular human contact was conducted twice daily for 30 min between 10:30 h to 11:00 h, and 16:30 h to 17:00 h. For the regular human contact treatment, the experimenter entered the room gently with minimal noise and placed her right hand into the cage. There were no significant sound enrichment x human contact interactions for body weight (BW), feed intake (FI) and feed conversion ratio (FCR). The CM birds had significantly greater BW on days 7 and 14 and higher FI on day 7 than control birds. Regular human contact had no effect on BW, FI or FCR of birds. Both CM and QR birds had significantly lower CORT on day 7 and day 11, and also lower CPN on day 35 when compared to controls. Sound enrichment had a negligible effect on tonic immobility duration. These findings suggest that sound enrichment may improve early growth performance and reduce stress in broilers.

Experiment 2 was conducted to determine the effect of mirrors as enrichment on the welfare of broilers stocked at different densities. A total of 208 day-old Cobb chicks were randomly assigned to a 2×2 factorial arrangement, with or without mirrors and stocked at low or high densities. Implementation of mirrors in birds' cage had no significant effect on growth performance and there was no interaction between stocking density and enrichment for BW, FI and FCR. However, the body weight and feed intake of birds stocked at high density (HD) was significantly lower than birds stocked at low density (LD) during day 35 of age. There were significant stocking density x enrichment interactions for CORT and CPN. While the presence of mirror panels in the cages of HD birds had no effect on CORT, it increased the CORT in LD birds. However, both HD and LD birds had lower CPN when mirror panel was present in their cages. Unlike the birds without mirrors, HD had no effect on CORT and CPN of the birds reared in cages with mirror enrichment. Stocking density and mirror enrichment only affected resting behaviour of birds. It is concluded that mirror panels are beneficial to reduce stress in chickens stocked at higher densities. Provision of mirrors did not give any negative effects on growth performance and behaviour of the chickens. In conclusion, environmental enrichment is more effective in reducing stress response rather than improving growth performance in broilers.

Abstrak thesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

KESAN-KESAN PENGAYAAN PERSEKITARAN TERHADAP PRESTASI PERTUMBUHAN, FISIOLOGI STRES DAN KELAKUAN AYAM PEDAGING

Oleh

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Ayam sentiasa memberi tindak balas yang konsisten terhadap rangsangan persekitaran. Rangsangan ini boleh diterima oleh burung sebagai sesuatu yang mengancam atau sebaliknya.

Eksperimen 1 telah dijalankan untuk menyiasat kesan pengayaan pendengaran iaitu muzik klasik dan pembacaan al-Quran dan pengendalian biasa manusia dengan memasukkan satu tangan di dalam sangkar terhadap prestasi pertumbuhan, 'tonik immobility' sebagai penunjuk respon ketakutan dan paras serum 'corticosterone' (CORT) dan 'ceruloplasmmin' (CPN) sebagai petunjuk tekanan dalam ayam pedaging. Sebanyak 768 ekor anak ayam Cobb berumur sehari tertakluk kepada rawatan berikut dari hari pertama hingga ke hari 35 (i) tiada pengayaan bunyi dan tanpa hubungan biasa manusia sebagai kawalan, (ii) tiada pengayaan bunyi dengan hubungan biasa manusia (HC), (iii) pengayaan bunyi oleh muzik klasik (Vivaldi's Four Season) dan tanpa hubungan biasa manusia (CM), (iv) pengayaan bunyi oleh muzik klasik dengan hubungan biasa manusia (CMH), (v) pengayaan bunyi oleh bacaan ayat suci Al-Quran (surah Yaseen) tanpa hubungan biasa manusia (QR) dan (vi) pengayaan bunyi dengan bacaan ayat suci Al-Quran dengan hubungan biasa manusia (QRH). Kedua-dua rangsangan bunyi dipasang selama 3 jam sehari secara berselang-seli. Perhubungan biasa antara manusia dan ayam dijalankan dua kali sehari selama 30 minit antara jam 10:30 hingga jam 11:00, dan 16:30 hingga jam 17:00. Untuk rawatan hubungan biasa manusia, pengkaji memasuki kawasan kajian secara lembut dengan minimal bunyi dan meletakkan tangan kanannya ke dalam sangkar. Tiada interaksi di antara pengayaan bunyi dan hubungan manusia yang signifikan bagi parameter untuk berat badan (BW), jumlah makanan yang diambil (FI) dan nisbah penukaran makanan (FCR). BW bagi ayam dalam kumpulan CM jauh lebih besar pada hari ke-7 dan ke-14 dan FI lebih tinggi pada hari ke-7 daripada ayam dalam kumpulan kawalan. Hubungan manusia biasa tidak memberi kesan kepada BW, FI atau FCR burung. Kedua-dua kumpulan ayam ini (CM dan QR) mencatatkan paras CORT yang lebih rendah pada hari ke 35, dan juga paras CPN yang

lebih pada hari ke-35 apabila dibandingkan dengan kumpulan kawalan. Pengayaan bunyi tidak memberi apa-apa kesan buruk ke atas tempoh 'tonic immobility'. Penemuan ini menunjukkan bahawa pengayaan bunyi boleh meningkatkan prestasi pertumbuhan awal dan mengurangkan tekanan dalam ayam pedaging.

Eksperimen kedua dijalankan untuk menentukan kesan cermin sebagai alat pengayaan terhadap kebajikan ayam pedaging yang ditebar pada kepadatan yang berlainan. Sejumlah 208 ekor anak ayam Cobb berumur sehari diletakkan secara rawak ke susunan faktorial 2×2 , dengan atau tanpa cermin dan ditebar pada kepadatan rendah atau tinggi. Pelaksanaan cermin dalam sangkar burung tidak mempunyai kesan yang signifikan terhadap prestasi pertumbuhan dan tidak ada interaksi antara ketumpatan stok dan pengayaan untuk BW, FI dan FCR ayam. Walau bagaimanapun, berat badan dan jumlah pengambilan makanan ayam yang diletakkan dalam ketumpatan tinggi (HD) jauh lebih rendah berbanding ayam yang diletakkan pada kepadatan rendah (LD) pada hari ke 35. Terdapat interaksi antara ketumpatan stok dan pengayaan untuk CORT dan CPN. Walaupun, kehadiran panel cermin dalam sangkar burung HD tidak memberi kesan kepada CORT, ia meningkatkan CORT dalam burung LD. Namun, kedua-dua kumpulan ayam, HD dan LD mempunyai CPN yang lebih rendah ketika panel cermin diletakkan dalam sangkar mereka. Tidak seperti ayam tanpa cermin, ketumpatan stok lebih tinggi (LD) tidak mempunyai kesan terhadap CORT dan CPN ayam yang ditenak dalam sangkar dengan pengayaan cermin. Selain itu, ketumpatan stok dan pengayaan cermin hanya mempengaruhi perilaku rehat ayam. Sebagai kesimpulan, pelaksanaan panel cermin dalam ketumpatan stok ayam pedaging yang berlainan seolah-olah mempunyai kelebihan dari segi kebajikan ayam pedaging, terutamanya dengan mengurangkan tekanan kepada ayam yang ditebar pada kepadatan tinggi. Penggunaan cermin juga tidak memberi sebarang kesan negatif kepada prestasi pertumbuhan dan kelakuan ayam. Sebagai kesimpulan, pengayaan persekitaran lebih berkesan dalam mengurangkan tindak balas tekanan dan bukannya meningkatkan prestasi pertumbuhan dalam ayam pedaging.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The member of the Supervisory Committee was as follows:

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LIST OF ABBREVIATIONS

ACTH	Adrenocorticotrophic hormone
ANOVA	Analysis of variance
APP	Acute phase protein
BW	Body weight
CM	Auditory enrichment by classical music and no regular human contact
CMH	Auditory enrichment by classical music and subjected to regular human contact
CORT	Serum level of corticosterone
CPN	Serum level of ceruloplasmin
CRH	Cortitropin releasing-hormone
D	Hour of dark
dB	Decibel
FCR	Feed conversion ratio
FI	Feed intake
g	Gram
HC	No auditory enrichment and subjected to regular human contact
HD	High density
HLR	Heterophil to lymphocyte ratios
HPA	Hypothalamo-pituitary-adrenal
kcal	Kilocalorie
kg	Kilogram
L	Hour of light
LD	Low density

m	Metre
ME	Metabolizable energy
mL	Mililiter
nm	Nanometer
QR	Auditory enrichment Quran recitation and subjected to regular human contact
QRH	Auditory enrichment by Quran recitation and no regular human contact
s	Seconds
SAS	Statistical analytical system
SD	Stocking density
SE	Standard error
TI	tonic immobility
μ L	microliter

CHAPTER 1

INTRODUCTION

The poultry industry has evolved from a cottage, small scale industry to a large scale industry, and from a traditional operation to a modern operation. Before World War 1, people used to rear poultry - only to provide meat and eggs for their own consumption. Over the past few decades, however, there has been a huge expansion in the livestock industry to meet the increasing demand for livestock products. This growth has been long led by poultry sub-sector (Narrod *et al.*, 2008). According to the Food and Agriculture Organization (FAO, 2016), about 116 million tonnes of chicken meat were produced in 2016 with over 70% of the broiler chickens raised in modern and environmentally controlled houses.

Despite the huge impact of modern production systems on the poultry industry and food security, the systems have been associated with many welfare issues. The poultry industry's incessant drive for efficiency and cost reductions has resulted in numerous social and ethical concerns that may diminish its exceptional achievements. These include disruption of social attachments, a lack of stimulation in a barren environment, restriction of movement or activity and stressful human-animal interaction (Duncan, 2002). Awareness on animal welfare issues among consumers is on the rise and they expect meat, eggs and milk are produced from welfare-friendly farms (Blokhuys *et al.*, 2003).

Animal welfare is defined as an animal's state in coping with the conditions in which an animal lives, and relies on the ability of the animal to sustain fitness and avoid suffering (Broom, 1986). The 'Five Freedoms' principle by the UK Welfare Codes is the basic philosophy to assess the strength or weakness of any husbandry system in the aspect of animal welfare as it addresses both physical fitness and mental suffering. These five freedoms are freedom from hunger and thirst, freedom from discomfort, freedom from pain, injury, and disease, freedom to express normal behaviour and freedom from fear and distress (Webster, 1994).

In broiler chicken production, adequate supply of balanced diets and clean water, proper housing, professional veterinary attention and proper handling are essential. However, progressive scientific research on farm animals suggests that the needs of poultry extend far beyond these physical resources (Dawkins, 1990). Poultry and other farm animals have a wide range of needs that are a consequence of the many functional systems required in order to live as physically and psychologically healthy individuals. Intensively raised poultry are often raised in a barren environment that may lead to frustration, boredom and harmful abnormal behaviour (Petherick and Rushen, 1997). Environmental enrichment may enhance behavioural repertoire, increase the ability to cope with challenges, and the addition of biologically relevant features to animals' environment. It is classified into five elements, which are social enrichment, occupational enrichment, physical enrichment, sensory enrichment and nutritional

enrichment (Bloomsith *et al.*, 1991). The provision of environmental enrichment can improve poultry welfare as chickens' preferred enriched environment (Jones, 2002). Social enrichment involves direct or indirect (visual, olfactory and auditory) contact with conspecific (other individual or human) whereas occupational enrichment encompasses both psychological and enrichment that encourage exercise (Bloomsith *et al.*, 1991). Physical enrichment involves altering the complexity of animal enclosure or adding accessories in an animal enclosure. Sensory enrichment includes any stimuli that are visual such as television, auditory such as music, or other modalities such as tactile and taste. Furthermore, nutritional enrichment includes presenting varied or a novel feed type, or changing the method of delivering feed to animals. The goals of environmental enrichment in farm animals are 1) to enhance behavioural diversity; 2) reduce abnormal behaviour; 3) increase positive utilization of the environment and; 4) increase the ability to cope with challenges in a more normal way (Chamova and Moodie, 1990).

Among many types of enrichment, auditory enrichment is one of the enrichments that has become increasingly popular in a variety of species in recent years including poultry (Davila *et al.*, 2011). Application of music or sound stimuli on poultry has shown wide-ranging outcomes in terms of growth performance, behavioural and physiological effects of chickens (Christensen and Knight, 1975; Campo *et al.*, 2005). It has been suggested that classical music able to improve the well-being of chickens (Gvanyahu *et al.*, 1989; Nicol, 1992) while exposure to slaughterhouse sounds (Chloupek *et al.*, 2009) or vehicle sounds (Campo *et al.*, 2005) resulted in an increase of stress level of hens. Apart from that, Christensen and Knight (1975), failed to find any significant effect of dinner music and rock and roll genre of music on the growth performance of broiler chickens. The recognition of the variation effect of sound stimuli depending on their types generate interest in investigating the effect of various sound stimuli include Quran recitation on poultry. For example, a study by Ghazali *et al.*, (2015) has been reported that application of Quran recitation on broiler chickens showed an improvement of the growth rate of broilers and has a significant physiological effect on broilers meat (Tahrir *et al.*, 2017).

Besides, application of visual stimulation on chickens seem to be practical and appropriate in the commercial flock. Like most avian species, chickens are particularly sensitive to visual contact with a human. The study by Barnett *et al.* (1994) and Jones, (1995) found that exposure birds to a frequent daily basis to close visual contact resulted in less fear to human. In placing more emphasis, Zulkifli *et al.* (2002) reported that regular human contact not only can reduce the fear of chickens toward handling and crating but also can improve antibody of the birds. On the other hand, visual stimulation through a mirror image also been studied in many species of animals. Implementation of a mirror in animals' cage or pen resulted in an increase in exploratory pecking and decrease in vocalization in chicks (Montevchhi and Noel, 1978), reduced heart rate of isolated heifers and reduced stereotypic weaving in horses (Mills and Davenport, 2002). Moreover, jungle crows were reported to attack a mirror image (Kusayama and Watanabe, 2000), flamingos do a marching show in front of a mirror (Pickering and Duverge, 1992) and rabbits preferred to be in the presence of mirror over isolation (Dalle Zotte *et al.*, 2009). These findings suggest that animals recognize self-mirror images as conspecific and recommend the potential use of mirrors as a tool for social enrichment (Mills and Cooper, 2002; Watanabe, 2016).

Although there are considerable studies of the effect of auditory and visual stimulation in animals include poultry, information are still lacking in the previous study that required further study on these enrichments. Firstly, despite the growing attention of study on the effect of the auditory stimulation on chickens, limited studies of the effect of classical music and Quran recitation as auditory stimulation remain. Secondly, to the best of our knowledge, no previous study has explored the influence of such sensory enrichment on growth performance during the entire grow out period of broiler chickens. Thirdly, the relationship between environmental enrichment and corticosterone and ceruloplasmin level (reliable indicator stress in poultry, Zulkifli *et al.*, 2014) was less thoroughly investigated. Also, there is a lack of study between the relationship of environmental enrichment and fear response of chickens as indicates by tonic immobility and fear behaviour. Other than that, most studies of the mirror application on animals have concentrated on the effect of the mirror on laboratory or socially isolated animals. Less study was conducted on the effect of the mirror's application in different stocking density of animals in a cage or house.

These studies were carried out to elucidate the effects of auditory enrichment (in terms of classical music and Quran recitation) and regular human contact (visual stimulation) as environmental enrichment in the barren environment of chickens' cages. The influence of providing mirror as an enrichment to broilers stocked at various densities were also determined. The present studies may provide important information on the selection of effective enrichment tools in chickens. It is hypothesized that chickens reared in an enriched environment will have improved growth performance and reduced fear and stress responses.

Objectives

The objectives of this study were:

- 1) To investigate the effects of auditory enrichment and regular human contact on growth performance, tonic immobility, and serum levels of corticosterone (CORT) and ceruloplasmin (CPN) in broiler chickens.
- 2) To determine the effect of mirror-enrichment on growth performance, behaviour, CORT and CPN in broiler chickens stocked at different densities.

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