EFFECT OF USING CARROT (*Daucus carota*) POWDER IN BROILER RATION AS A GROWTH PROMOTER TO PRODUCE SAFE MEAT

ESAM BIN WADUD

DEPARTMENT OF POULTRY SCIENCE

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA-1207

DECEMBER, 2020

EFFECT OF USING CARROT (*Daucus carota*) POWDER IN BROILER RATION AS A GROWTH PROMOTER TO PRODUCE SAFE MEAT

BY

ESAM BIN WADUD

REGISTRATION NO. 18-09311

A Thesis
Submitted to the Department of Poultry Science
Sher-e-Bangla Agricultural University, Dhaka
In Partial Fulfillment of the Requirements for the degree of

MASTER OF SCIENCE (MS)

IN

POULTRY SCIENCE

SEMESTER: Jul-Dec/2020

APPROVED BY

Prof. Dr. Md. Anwarul Haque Beg
Supervisor
Department of Poultry Science
Sher-e-Bangla Agricultural University

Assist. Prof. Dr. Amina Khatun
Co-Supervisor
Department of Pathology
Sher-e-Bangla Agricultural University

Prof. Dr. Md. Anwarul Haque Beg
Chairman
Department of Poultry Science
Sher-e-Bangla Agricultural University

Dr. Md. Anwarul Haque Beg

Professor
Department of Poultry Science
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh
Mobile No: +8801718026200
E-mail: mahbegsau@yahoo.com

CERTIFICATE

*This is to certify that the thesis entitled "**EFFECT OF USING CARROT (Daucus carota) POWDER IN BROILER RATION AS A GROWTH PROMOTER TO PRODUCE SAFE MEAT**" submitted to the Faculty of Animal Science & Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of Master of Science in Poultry Science, embodies the result of a piece of bona fide research work carried out by **ESAM BIN WADUD**, Registration No. **18-09311** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

Dated: December, 2020
Place: Dhaka, Bangladesh

Prof. Dr. Md. Anwarul Haque Beg
Supervisor
Department of Poultry Science
Sher-e-Bangla Agricultural University

DEDICATED TO

MY BELOVED PARENTS,

TEACHERS AND FRIENDS

ACKNOWLEDGEMENT

At the beginning, the author bows the grace and mercy of the "Almighty Allah", the omnipresent, omnipotent and omniscient, who enabled him to complete this thesis.

The author with a sense of respect expresses his heartfelt gratitude to his Supervisor Professor Dr. Md. Anwarul Haque Beg, Chairman, Department of Poultry Science, Sher-e-Bangla Agricultural University, Dhaka for his untiring and painstaking guidance, invaluable suggestions, continuous supervision, timely instructions, inspirations and constructive criticism throughout the tenure of research work.

Heartfelt gratitude and profound respect are due to his Co-supervisor Assistant Professor Dr. Amina Khatun, Department of Pathology, Sher-e-Bangla Agricultural University, Dhaka for his co-operation, constructive criticism, and valuable suggestions for the modification and improvement of the research work.

The author is deeply grateful to Dr. Maksuda Begum and Md. Aftabuzzaman, Assistant Professor, Department of Poultry Science, Sher-e-Bangla Agricultural University, Dhaka for their advice and sincere co-operation in the completion of the study. The author is grateful to Professor Dr. Md. Elias Uddin, Bangladesh Agricultural University and Dr. Sonia Tabasum Ahmed, Adjacent faculty, Department of Poultry Science for their kind help, advice and co-operation in the completion of the study.

The author is specially grateful to Md. Zahir Uddin Rubel, Lecturer, Department of Poultry Science, Sher-e-Bangla Agricultural University and Mst. Mayeeda Parvin, Researcher. The author is also grateful to all the staffs of the Department of Poultry Science, Sher-e-Bangla Agricultural University, Dhaka for their co-operation. The author deeply owes his whole hearted thanks to all the relatives, friends, well-wishers specially Md. Monirul Haque, Md. Torikul Islam, Ratan Karmakar, Nawshin Angum, Sadik Ahmed for their help and inspiration during the period of the study.

The author takes the opportunity to express his indebtedness and profound to his beloved father Abdul Wadud, mother Payara Begum, sister Afroza Akhter, Brother Md. Moniruzzaman and grandparents for their love, blessings, prayers, sacrifices, moral support and encouragement for his study which can never be forgotten.

The Author

LIST OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

Abbreviation	Full meaning
A.M	Ante meridiem
ACF	Aberrant crypt foci
AGPs	Antibiotic growth promoters
ANOVA	Analysis of Variance
AOM	Azoxymethane
AR	Antibiotic resistance
BANSDOC	Bangladesh National Scientific and Technical Documentation Center
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BLRI	Bangladesh Livestock Research Institute
BSH	Bile salt hydrolase
BWG	Body weight gain
CF	Crude fiber
CHD	Coronary heart disease
CHO	Chinese hamster ovary
Cm	Centimeter
cm^2	Square centimeter
CONTD.	Continued
CP	Crude protein
DM	Dry matter
DP	Dressing Percentage
e.g.	For example
EDTA	Ethylene diamine tetraacetic acid

Abbreviation	Full meaning
et al.	And others/Associates
Etc.	And the other things
EU	European Union
FC	Feed consumption
FCR	Feed conversion ratio
G	Gram
GI	glycemic index
Hb	Hemoglobin
i.e.	That is
IBD	Infectious bursal disease
Kcal	Kilo –calorie
Kg	Kilogram
L	Liter
M.S.	Master of Science
Ml	Milliliter
Mm	Millimeter
m.mole	Millimoles
NS	Non-significant
PI	Production Index
P.M	Post meridiem
Ppm	Parts per million
SAU	Sher-e-Bangla Agricultural University
SE	Standard error

Abbreviation	Full meaning
SPSS	Statistical package for social sciences
TT	*Tribulus terrestris*
USA	United States of America
viz.	Such as
Vs	Versus
WHO	World Health Organization

LIST OF SYMBOLS

Symbols	Full meaning
@	At the rate of
+	Plus
<	Less than
>	Greater than
°C	Degree Celsius
%	Percentage
&	And
*	5% level of significance
/	Per

EFFECT OF USING CARROT (*Daucus carota*) POWDER IN BROILER RATION AS A GROWTH PROMOTER TO PRODUCE SAFE MEAT

ABSTRACT

A feeding trial was conducted on 150-day-old Lohman meat broiler chicks for a period of 28 days in the Poultry Farm of Sher-e-Bangla Agricultural University, Dhaka. The aim of the study was to assess the efficiency of dietary carrot powder supplementation on the production index and health status of commercial broiler chicken. The chicks were assigned randomly to five treatment groups comprising of T_1 (Control), T_2 (Antibiotic), T_3 (0.5% Carrot Powder), T_4 (1% Carrot Powder) and T_5 (1.5% Carrot Powder) randomly. Treatments were replicated thrice with 10 chicks per replicate. The results showed that dietary supplementation of carrot powder had no significant ($P>0.05$) difference on feed consumption, body weight gain and final live weight of broiler compared to control group. Higher feed consumption found in T_2 (2546.80±23.09g) group compared to other groups. However, superior final live weight (1859.50±34.83g) obtained in T_4 group where birds fed with 1% carrot powder compared to those of antibiotic and control group. Improved FCR value (1.36±0.03) found in both T_3 and T_5 group which is statistically non-significant ($P>0.05$) with the values of other groups. Dietary supplementation of carrot powder had significant ($P<0.05$) effect on the dressing percentage of broiler compared to control group. Highest dressing percentage (75.23±0.76) obtained in 1% carrot powder (T_4) supplementation group. Dietary supplementation of carrot powder had significant ($P<0.05$) effect on the relative weight of spleen but had no significant ($P>0.05$) effect on relative weight of bursa in different groups. Birds supplemented with 1% carrot powder showed significantly ($P<0.05$) higher spleen weight (2.66± 0.16g) and 0.5% carrot powder (T_3) showed insignificantly ($P>0.05$) higher bursa weight (3.08±0.79g). The relative weight of liver and heart of different groups showed that there was no significant ($P>0.05$) difference but relative weight of gizzard showed significant ($P<0.05$) difference among the groups. The superior weight of liver was 48.92±2.71g in T_5 (1.5% carrot powder), gizzard and heart were 48.92±0.51g and 12.17±1.52g in T_4 (1% carrot powder) respectively. The glucose, cholesterol and hemoglobin concentration had no significant ($P>0.05$) difference among all groups but comparatively lower glucose (16.03±0.27m.mole/L) in T_5, lower cholesterol (4.90±0.40m.mole/L) & hemoglobin (6.60±0.13m.mole/L) level was found in T_4 group. It is evident from this trial that birds fed with 1% carrot powder supplemented diet achieved superior result because of superior final body weight, FCR, dressing percentage and internal organ weight compared to control and antibiotic groups. So carrot powder can be use as natural feed additive for the replacement of antibiotic in broiler production.

CHAPTER 1

INTRODUCTION

Poultry meat production is one of the most important and first growing industry of agriculture in Bangladesh to meet up the requirement of protein and nutrition. In 1995 the poultry industry started in an organized manner in Bangladesh. Poultry plays an important role in the economic development of the country. Bangladesh provides a very fertile field for the development of broiler industries. Broiler production has become a profitable and most popular income generating activity at present time for the people of the country. The broiler industry in Bangladesh is developing rapidly and its success depends on how rapidly a bird attains maximum marketable weight. The principle of poultry production is to achieve high level of performance through efficient utilization of feed keeping survivability as maximum as possible. Poultry meat contains protein and is essential for human health as dietary minerals, vitamins and amino acids deficiency can be reduced by the contribution of poultry products rich in all essential nutrients (Cherian *et al.*, 2005). It also minimizes the risk of developing cardiovascular diseases and their risk factors, overweight, insulin resistance and tumors. The poultry production systems have led to marked increase in the production of poultry meat and eggs throughout the world.

Broiler meat plays an important role in diet as it contributes macro and micro nutrients required for the growth and maintenance of human health. High cost of meat is a major stumbling block for consumers who would like to relish highly nutritious, tastier meat products regularly. Recent trend in meat industry is development of value added meat products to reduce the cost and improve the yield and product quality due to unabated upward price trend of broiler chicken (Ahlawat *et al.*, 2012).

Intensive poultry production in developing countries could be further enhanced through feeding strategies that promote feed utilization in relation to bird performances. A variety of synthetic feed additives including antibiotic growth promoters (AGPs) have been used in poultry feeds to maximize the efficiency of production, product quality and to control diseases. Before July 1999 in the European Union, the inclusion of antibiotics as growth promoters in animal feed was widely adopted and better growth stimulation, uniformity was observed (Bedford, 2000). Antibiotics have the ability to

decrease feed usage per production unit with concomitant increase in production performance (Falçao-e-Cunha *et al.,* 2007). Beside these advantages, antibiotic exerts several fatal hazards which compromise human and animal health (Diarra *et al.,* 2010).

The administration of antibiotic in animal feed results in the emergence and spread of antimicrobial resistant bacteria, which is a cause of worldwide concern (Garcia-Migura *et al.,* 2014). Scientific evidence suggests that the unregulated massive use of antibiotic has led to increased problem of antibiotic resistance (Diarra *et al.,* 2007; Furtula *et al.,* 2010; Forgetta *et al.,* 2012) which causes spread of resistant microbes and presence of antibiotics residues in feed and environment (Carvalho and Santos, 2016; Gonzalez Ronquillo *et al.,* 2017).

Strong evidence that the antibiotics use in animals and humans leads to the selection of resistant organisms that may cause treatment failure and the human costs, including death and prolonged illness, associated with such failures. This concern has led to the banning of certain antibiotic growth promoters (AGPs) in European Union countries by April 1997. Consumer pressure in other countries, such as USA, is pushing the poultry business to rear animals without using AGPs (Dibner and Richards, 2005; Castanon, 2007). The removal of AGP's authorization resulted in substantial increase in infection in poultry (Knarreborg *et al.,* 2002; Casewell, 2003). Poultry business has needed to find alternatives to AGPs in order to stem the spike in infection rates. These alternatives are required to be environmental friendly and safe for both animal and humans who consume animal products (Cabuk *et al.,* 2006).

Natural medicinal product from herbs and spices has also been introduced as feed additives in poultry diets. Feed additives of "natural" origin are establishing their credibility as 2 feasible alternative. In Indian sub-continent, herbal plants or oil are traditionally used for therapeutic treatment for centuries. Since, Bangladesh is very rich in herbal and medicinal plants, inclusion of herbal plants and products such as carrot (*Daucus carota*) in poultry diet could be a good approach to find out alternatives of antibiotic growth promoters (AGPs) and other growth promoters, hormones or enzymes those are commonly used to enhance the growth performance of commercial broilers.

The carrot (*Daucus carota*) is an annual or biennial herb, usually orange in color. It contains beta carotene and high level of fiber that is very useful for digestive system and it improves bowel performance in the absorption of nutrients. It also rich in biotin,

calcium, magnesium, phosphorus, organic sodium and vitamin C, D, E and K. Carrot has several phytonutrients like lycopene, lutein and zeaxanthin. Feeding carrot to birds influenced the development of the gastrointestinal tract and composition of the micro-flora thus improve production performance of broiler.

A rapid rise in the popularity of orange carrots was observed with the recognition of its high pro vitamin A content (Simon, 2000). Carotenoids and anthocyanins are the major antioxidant pigments found in carrots. Cultivar differences in carrots rely in the type of pigments present. Carotenoids are the yellow, orange, or red colored phytochemicals found in most yellow and orange fleshed cultivars. The widely used orange carrot is high in α- and β-carotene and is a rich source of pro vitamin A. Yellow carrot color is due to lutein which plays an important role in prevention of macular degeneration (Dias, 2012).

Carrots have also a unique combination of three flavonoids: kaempferol, quercetin and luteolin (Ching and Mohamed, 2001; Lila, 2004; Horbowicz *et al.,* 2008). They are also rich in other phenols, including chlorogenic, caffeic and p-hydroxybenzoic acids along with numerous cinnamic acid derivates. Among hydroxycinnamic acid and its derivates, chlorogenic acid represents 42.2% to 61.8% of total phenolic compounds detected in different carrot tissues (Zhang and Hamauzu, 2004; Gonçalves *et al.,* 2010). Bioactive polyacetylenes, such as falcarinol (synonymous with panaxynol), and falcarindiol are found in carrots. The concentration of falcarinol in fresh carrots depends on carrot tissue cultivar and water stress (Lund and White, 1990). Falcarinol is the most bioactive phytochemical of the carrot polyacetylenes. It is though that this compound may stimulate cancer-fighting mechanisms in the body. The mode of action behind the favorable effect of falcarinol may be due to its hydrophobicity and its ability to form an extremely stable carbocation with the loss of water thereby acting as a very reactive alkylating agent toward proteins and other biomolecules (Hansen *et al.,* 1986). Besides other sesquiterpenes, which presence has also been found in various biochemical analyses, daucuside and daucuso are sesquiterpenoids recently isolated from carrot seeds and that have cytotoxic effect against gastric cell lines (Ahmed *et al.,* 2005; Fu *et al.,* 2010).

Carrot is a good source of dietary fiber and of the trace mineral molybdenum, rarely found in many vegetables. Molybdenum aids in metabolism of fats and carbohydrates

and is important for absorption of iron. It is also a good source of magnesium and manganese. Magnesium is needed for bone, protein, making new cells, activating B vitamins, relaxing nerves and muscles, clotting blood, and in energy production (Guerrera *et al.,* 2009). Insulin secretion and function also require magnesium (Kim *et al.*, 2010; Bartlett and Eperjesi, 2008). Manganese is helpful in carbohydrate metabolism, in coordination with enzymes in the body (Dias, 2012). Manganese is used by the body as a co-factor for the antioxidant enzyme, superoxide dismutase. Potassium and magnesium in carrots help in functioning of muscles.

So, we are again concentrating on the use of our ancient medicinal system to find beneficial herbs and plants, which can be safely used to increase poultry production. Keeping this view in mind, the research was conducted to investigate the effect of feeding carrot (*Daucus carota*) powder on the growth performances and carcass characteristics of commercial broilers.

Objectives

1. To evaluate the effect of carrot powder on the growth performance and some internal organ characteristics of broiler chicken in comparison with antibiotic and basal diet.
2. To determine the effect of dietary supplementation of carrot powder on serum biochemical parameters of broiler chicken.

CHAPTER 2

REVIEW OF LITERATURE

Sources of literature

A good number of literatures were reviewed to make out the background, drawbacks and prospects of research, understand previous findings and to answer the research status of this field. Among them half were full article, some were abstracts and the others were miscellaneous. A brief account is given below depending on seven main headlines viz, Effect of antibiotic growth promoters (AGPs) on poultry, Antibiotic resistance in poultry, Restrictions of antibiotic growth promoters (AGPs), Alternatives to antibiotic growth promoters such as Carrot, Nutritional benefits of carrot, Health benefits of carrot, Effect of carrot on poultry.

Poultry production is one of necessary animal practices not only for fulfilling necessary food requirements of people but also for contributing to improving economy of the countries throughout the world. Among the animal products, broiler meat is one of the inexpensive protein sources for all consumers and its quality. Feed cost accounts for up to 80% of the total worth of production and is a very important element in determining the extent of poultry survivality and profitability. Feed is a major component affecting net return from the poultry expedition. Various strategies like feed supplements and additives are used to confirm more net return and to minimize expenditure on feed. Lucrative broiler production largely depends on optimum utilization of feed, improved body weight, prevention of diseases and reduced mortality rate. Use of chemical feed additives as growth promoters have criticism due to harmful effects on consumer health and there is increasing demand for organic meat and eggs. In view of this, herbal and plant derivatives would be a valuable substitute to promote growth and health in poultry as there is no residual toxicity.

2.1 Effect of antibiotic growth promoters (AGPs) on poultry

Supplementation of antibiotics as subtherapeutics promotes bird feed efficiency and maintain the gut health, growth and development (Rosen, 1995 and Danzeisenet *et al.*, 2011). Inclusion of antibiotics in poultry diet can also lessen the prevalence of enteric pathogens. A variety of antimicrobials contributed to infectious diseases control,

prevention and treatment efforts in animals since the 1940s. A low level and subtherapeutic dose of antimicrobials raises the efficiency of animal growth through improving feed efficiency, preventing and controlling diseases (Niewold, 2007), improving the digestibility of nutrients (Dibner and Richards, 2005), improving the structure of intestinal flora (Norin, 1997), mitigating the transmission of zoonotic pathogens (Elder *et al.,* 2002; Doyle and Erickson, 2006), and improving the environment (Kobayashi, 2010).

A reduction in the effectiveness of AGP in the last 30 years were suggested by Laxminarayan *et al.* (2015), which may be linked to optimization of production conditions, enhancing in the baseline weight gain of animals, increasing level of resistance, and potential switch in the type of molecules used. Different mechanisms of action have been proposed and various studies have been carried out to interpret AGP function: a growth-promoting effect may be associated to modification of some intestinal characteristics in the first week of life of broilers, as deeper crypts in the ileum, indicating faster tissue development (Miles *et al.,* 2006). In addition, the studies show the capability of AGP to lessen normal early microbial proliferation, and hence competition for nutrients during the gut maturation, which takes approximately 6 to 9 days in chicks (Geyra *et al.,* 2001). These switches is related to better nutrient absorption, resulting in lower feed intake and superior weight gain when compared to chickens that do not receive AGP in the Initial phase. Nutrient absorption is not the intestines' sole function, as they perform an immunological role as well (Round *et al.,* 2010). The close and intermittent contact of the gastrointestinal mucosa with the enteric microbiota results in a constant state of inflammation (Biancone *et al.,* 2002) and can influence macromolecular intestinal permeability (MacDonald and Monteleone, 2005). AGP amasses in inflammatory cells and increases the intracellular killing of bacteria, inhibiting the innate immune response (Labro, 2000). Therefore, the use of AGPs reduces the catabolic costs of maintaining an immune response by allowing more resources to be dedicated to anabolic processes (Niewold, 2007). The first days of life of a broiler can be envisaged stressful, since it happens the vaccination management, transportation, setting in new place, and microbial outpours resulting from living on litter, as well as the proposition of a diet with anti-nutritional factors (Willis and Reid, 2008; Yassin *et al.,* 2009). Considering the hypothesis of a non-antibiotic action of AGP, which results in a minimized intestinal inflammatory response (Niewold, 2007),

this may be an explanation why AGP results in positive effects on the primary phase. On the other hand, broilers in Final phase are much more capable to cope with stressors, because the first contact with microorganisms has already occurred and it outcomes in a lower level of immune response, and there is a reduction on total stress, since the adaptation of the animal to the environment already happened. Also suggested that AGP growth-promoting effect does coincide with a reduction in bile salt hydrolase (BSH) activity in the gut (Knarreborg *et al.*, 2004; Guban *et al.*, 2006; Lin, 2013). The lactobacilli are present in the crop and in the digestive tract, and this genus is accountable for BSH production, active in the small intestine, impairing the emulsification and absorption of dietary lipid. AGP is a common dietary intervention to modulate the gut microflora (Dibner and Richards, 2005) and the activity of the intestinal microbiota, along with both pathogenic and commensal bacteria (Lin *et al.*, 2013). Some differences in the spectrum of activities, differing gut microbiota effects could be expected between various AGP, and this has been demonstrated in some researches (Neumann and Suen, 2015; Costa *et al.*, 2017). As an example, Zinc bacitracin enhanced the diversity of the cecal microbiota of broilers, with increases in Faecalibacterium and Ruminococcus torques phylotype, and reductions in Lactobacillus salivarius phylotype and Eubacterium (Crisol-Martínez *et al.*, 2017). All of these mechanisms acting as interrelated multi factors may set out the best results observed in the Total period of rearing.

2.2 Antibiotic resistance in poultry

Antimicrobials use in animal production dates as far back as the 1910 when due to scarecity of meat products, workers carried out protests across America (Ogle, 2013). Scientists at that time started looking for means of producing more broiler meat at relatively cheaper costs; resulting in the use of antibiotics and other antimicrobial agents (Dibner and Richards, 2005). With the global threat of antibiotic resistance and enhancing treatment failures, the non-therapeutic use of antibiotics in animal production has been banned in various countries (Cogliani *et al.*, 2011; Choct, 2001).

Antibiotic resistance (AR) which is defined as the ability of an organism to resist the killing effects of an antibiotic to which it was normally susceptible and become an issue of worldwide interest. This microbial resistance is not a new phenomenon since all microorganisms have an inherent capability to resist some antibiotics. However, the

rapid surge in the development and spread of AR is the main concern (Aarestrup *et al.*, 2008). In recent years, enough evidence highlighting a link between over use of antimicrobials and antimicrobial resistance from animals as a contributing factor to the overall burden of AR has emerged (Marshall and Levy, 2011). The extent of exercise is expected to increase markedly over upcoming years due to intensification of farming practices in most of the developing countries (Van Boeckel *et al.*, 2015). The main reasons for the practice of antibiotics in food-producing animals include prevention of infections, treatment of infections, promotion of growth and improvement in production in the farm animals (Castanon, 2007).

Poultry production is one of the most widespread food industries worldwide. Chicken is the most commonly farmed species. A large diversity of antimicrobials, are used to raise poultry in most of the countries (Boamah *et al.*, 2016). A huge number of such antimicrobials are considered very much important in human medicine. The indiscriminate use of such essential antimicrobials in production is likely to accelerate the development of AR in pathogens, as well as in commensal organisms. This result in treatment failures, economic losses and could act as origin of gene pool for transmission to humans. In addition, there are also human health concerns about the presence of antimicrobial residues in meat, eggs and other essential animal products (Mehdizadeh *et al.*, 2010). Generally, when antibiotics used in any setting, it eliminates the susceptible bacterial strains leaving behind those with traits that can resist the drug. These resistant bacteria then multiply and become a dominating population and as such, are able to transfer (both horizontally and vertically) the genes responsible for their resistance to many other bacteria (Laxminarayan *et al.*, 2013). Resistant bacteria can transferred from poultry products to humans via eating or handling meat contaminated with pathogens. Once these pathogens are in the human body system, they could colonize in the intestines and the resistant genes could shared or transferred to the endogenous intestinal flora, jeopardizing further treatments of infections caused by such organisms.

Bacteria counteract the actions of antibiotics by four mechanisms, namely; enzyme modification, alteration in target binding sites, efflux activity and reduced permeability of bacterial membrane. This expression of resistance towards antibiotics by bacteria could either be intrinsic or be acquired. Intrinsic resistance is due to inherent properties within the bacteria chromosome such as mutations in genes of bacteria and

chromosomally inducible enzyme production, whereas acquired resistance could be due to the transmission of resistance genes from the environment and/or horizontally transfer from other bacteria (McDermott *et al.,* 2003).

The use of antibiotics in poultry production is favorable to farmers and the economy because it has generally improved poultry performance effectively and economically. But at the same time, the likely dissemination of antibiotic resistant strains of pathogenic and non-pathogenic organisms into the environment and their further transmission to humans could also lead to serious consequences on public health.

2.3 Restriction & ban of antibiotic growth promoters (AGPs)

The pressure for decreasing the use of antibiotic growth promoters (AGP) is a growing and irreversible process, and several countries are adhering to the restrictions and ban on AGP usage. Sweden, the first country, which changed the laws of AGP usage in 2006, the EU imposed a whole ban of all AGP. The USA is not only limiting AGP usage but also moving towards a significant reduction of antibiotics usage in industrial food animal production (Salim *et al.,* 2018). The most recent effort toward AGP restriction in Brazil and China was banning the use of antibiotic named Colistin in 2016 (Walsh and Wu, 2016; Davies and Walsh, 2018). In the same year, Vietnam announced the ban of AGP by 2020 (USDA, 2016). India has introduced drug withdrawal time for livestock production (Kahn, 2017). And also Bangladesh, Bhutan, Indonesia, Myanmar, Nepal, Sri Lanka, and Thailand have announced AGP restrictions (Goutard *et al.,* 2017).It was observed that the increasing pressure to prohibit the use of these additives is based on the possibility of induction of cross-resistance of pathogenic bacterial strains in people (Tang *et al.,* 2017).

Van Boeckel *et al.* (2015) stated that in broiler production, there is an estimated annual use of 148 mg/kg of AGP with the objective of obtaining better results of weight gain and feed conversion. However, considerable variability in performance response to AGP have been observed, contingent on genetic potential, phase of rearing, as well as hygiene and managements. Many of the studies have shown no weight gain difference in broilers fed an AGP diet in the absence of health problems (Denev, 2006; El-Faham *et al.,* 2015; Naveenkumar *et al.,* 2017). However, Zhang *et al.* (2005) have reported the efficiency of AGP, with positive effects on broilers weight gain and feed conversion. It is clear that AGP restrictions in the production of animal food are

expanding and therefore its consequences should be studied, including its effect on broiler performance and the expected economic results of such restriction.

2.4 Replacement of antibiotic growth promoters (AGPs) in broiler ration

In recent years, use of antibiotic growth promoters in poultry nutrition has not been given permission as a result serious health problems encountered in the people. Instead of the detrimental promoters, more interest is growing for utilizing extracts or powder of vegetative parts of medicinal plants, some agricultural plants as alternative feeding supplements in terms of probiotics, organic acids, prebiotics, and essential oils (Kahraman, 2009). Herbs, aromatic and medicinal plants are alternative chiefly to growth promoter as antibiotics, but today they are researched inadequately. In this regard, natural plants and agro-industrial by products may submit a better potential to poultry nutritionists. Some earlier studies have already demonstrated the potential effects of alternative feed supplements in poultry feeding. Among them, Sahin and Duru (2010) studied the effect of *Tribulus terrestris* (TT) extract on digestive system and growth performance of broiler chicks. Duru and Sahin (2012) evaluated the potential effect of applying dietary puncture vine (*Tribulus terrestris*) powder together with various carriers on blood parameters, growth performance, and carcass characteristics of broilers. Duru and Sahin (2015) focused on the effect of dietary puncture vine (*Tribulus terrestris*) powder with differential carriers on production and egg quality in Super Nick white laying hens. Kaya and Yildirim (2011) studied the effect of dried sweet potato vines powder on several egg production parameters and egg yolk color in hybrid layers (Super Nick). Duru (2013) examined the influence of strawberry leaf powder as a supplement on production, quality and yolk cholesterol in Lohmann Brown laying hens. To produce the best results in poultry feeding, researchers are still investigating new alternative feeding sources, such as lemon, olive, orange, strawberry, endemic plant species or agro-industrial by products of the plants cultivated for food supply (Duru, 2013). For instance, carrot (*Daucus carota*) can possibly be a new feeding supplement in agroindustrial by-product (Hammershøj *et al.*, 2010).

2.5 Carrot

Carrot (*Daucus carota*) is the most important crop of Apiaceae family. It is a root vegetable, which has worldwide distribution. Carrots were first used for medicinal purposes and gradually as food. There are written records in Europe, indicated that

carrots were cultivated prior to the tenth century. The colors of the carrot root flesh may be white, yellow, orange, red, purple, or very dark purple. The first cultivated carrots were yellow and purple fleshed. Orange carrots, today more popular, were developed in the 15th and 16th centuries in Central Europe. A rapid rise in the popularity of orange carrots observed with the recognition of its high provitamin-A content.

The production amount of carrots and turnips was 44.762 tons in the year 2019 in the World (FAO Stat, 2019). Carrot cultivated all over the world is a root vegetable which is biochemically rich source of minerals, fiber, carbohydrates, antioxidant flavonoids, most of essential micronutrients, and especially beta-carotene (Sharma *et al.,* 2012).

2.5.1 Nutritional benefits of carrot meal

There is a long tradition of feeding carrots to livestock and poultry but their use in animal feeding is marginal nowadays. Carrots used as animal feed are usually cull (grade out) or surplus carrots obtained during periods of overproduction. They typically fed fresh and are available whole or chopped, unwashed or washed. Carrots can also be ensiled. Dehydrated carrots are popular treats for horses and pets. Other carrot products that are occasionally fed to livestock and poultry include the tops, resulting from harvesting, and various by-products of carrot processing (juice, aromas etc). Fresh carrot roots have higher water content (about 88%) and are, therefore, a refreshing feed. However, animals consuming huge amounts of carrots may consume less dry matter, resulting in reduced nutrient and energy intakes. The dry matter contains up to 60% sugars, mostly sucrose, which make carrots both digestible and palatable. Because of their huge carbohydrate content, carrots considered as an energy feed. Protein content is low (4-12% DM) and they contain moderate amounts of fiber. Like many other roots and tubers, they may contain high levels of mineral matter (more than 10%) due to residual dirt and it is, therefore, preferable to wash them before feeding animals.

An important benefit of carrot roots is their high level of carotenoid content, and particularly ß-carotene, a precursor of vitamin A (retinol), involved in eye function, reproduction, growth and maintenance of skin and mucous membranes. Hammershøj *et al.* (2010) stated that carotene content depends on carrot variety: orange types contain mostly α- and ß-carotene but purple, red and yellow carrots have a different carotenoid composition. Raw orange carrots contain 200-1000 mg/kg DM of ß-carotene. ß-carotene is located in the chromoplasts as crystals and stabilized by lipoproteins, and

its stability is rather high (Hammershøj *et al.*, 2010). However, processes like ensiling and drying can significantly reduce the ß-carotene content (Frias *et al.*, 2010). Autocatalytic oxidation of ß-carotene may caused by the reduction of moisture content during the dehydration process. According to Frias *et al.* (2010) certain drying processes (e.g. shade drying) are less destructive than others. For herbivores, the ß-carotene content of carrots makes them particularly valuable when hay and straw are the only other feeds (Fuller, 2004). Frias *et al.* (2010) stated that carrots have also been tested as a natural source of pigments in animal and poultry productions where product color is important, such as poultry egg production, fish and crustaceans. Carrots are rich in vitamin C (ascorbic acid) and containing about 300-700 mg/kg DM of this vitamin. However, as vitamin C is very much highly heat labile, it is very much susceptible to dehydration (Frias *et al.*, 2010). Carrot tops contain about 11-12% crude protein in the DM, 17 % of crude fiber and up to 18% of ash, depending on the amount of residual dirt. Carrot juice residue has a relatively much low protein content (7.7% DM) and a high amount of fiber (Enishi *et al.*, 2004).

Table 1. Nutritional composition of carrot

Nutrient Component	Amount
Moisture	88.8%
Protein	0.7%
Fat	0.5%
Carbohydrate	6%
Sugars	5.6%
Crude fiber	2.4%
Ash	1.1%
β-carotene	8285 µg/ 100 g
Calcium	34 mg/ 100 g
Iron	0.4 mg/100 g
Phosphorous	25 mg/100 g
Sodium	40 mg/ 100 g
Potassium	240 mg/100 g
Magnesium	9 mg/100 g
Copper	0.02 mg/ 100 g
Zinc	0.2 mg/100 g
Carotenes	5.33 mg/100 g
Thiamine	0.04 mg/100 g
Riboflavin	0.02 mg/100 g
Niacin	0.2 mg/100 g
Vitamin C	4 mg/100 g
Energy value	126 kJ/100 g

(Source: Holland *et al.*, 1991)

2.5.2 Health benefits of carrots

2.5.2.1 Antioxidant, anticarcinogen, and immunoenhancer benefits

Like many other colored vegetables, carrot is also a gold mine of antioxidants. Carotenoids, polyphenols and vitamins present in carrot act as antioxidants, anticarcinogens, and immune enhancers. Carotenoids are very widely distributed in orange carrots are potent antioxidants which can neutralize the outcome of free radicals. They have been shown to have inhibition mutagenesis activity contributing to reduce risk of some cancers (Dias, 2012). Zhang and Hamauzuet (2004) reported that flavonoids and phenolic derivates, present in carrot roots play also an essential role as antioxidants. They also exert anticarcinogenic activities, decrease inflammatory insult, and modulate immune response (Dias, 2012). Zaini *et al.*, (2011) stated the anti-carcinogenic effect of carrot extracts on myeloid and lymphoid leukemia cell lines. In vitro analysis was done on 72 hours incubation of carrot in leukemia cell lines and in non-tumor control cells. It showed that carrot possessed the ability to induce apoptosis and cause cell cycle arrest in leukemia cell lines. The outcome was less prominent in myeloid and hematopoietic stem cells. Those investigators considered that β-carotene and falcarinol present in the carrot may have been responsible for this beneficial effect of "kill" leukemia cells and inhibit their progression. Anti-clastogenic activity of carrot on Chinese hamster ovary cells and human lymphocytes. Fresh carrot juice was observed to attenuate the increase in the frequencies of sister-chromatid exchanges induced by cyclophosphamide in wild type and mutant CHO cells. Larsen *et al.*, (2005) reported the impact of carrot and its constituent falcarinol against development of azoxymethane (AOM)-induced colon preneoplastic lesions in colon. Rats were assorted, treated with AOM, and fed with carrot and falcarinol isolated from carrot. The results stated that there was a significant reduction in tumors and aberrant crypt foci (ACF) fed with carrot and falcarinol. The researchers concluded that this evidence indicates that dietary treatment with carrot and falcarinol has the potential to delay or retard the progress of large ACF and colon tumors. Extracts of carrot, which contain various amounts of falcarinol, falcarindiol, and falcarindiol 3-acetate, had significant inhibithory effects on both normal and cancer cell proliferation. The aliphatic C17-polyacetylenes are the potential anti-cancer principles of carrots and that the synergistic interaction between bioactive polyacetylenes may be important for bioactivity.

Other reports have reported that falcarinol exerts cytotoxic activity against several human tumor cell lines in vitro, destroying pre-cancerous cells in the tumors. Ekam *et al.* (2006) stated the immunomodulatory effect of carrot-extracted carotenoid. The percentage variation in lymphocytes, eosinophils, monocytes and platelet count were evaluated. Interestingly, carotenoid administered animals showed a significant enhance in lymphocytes, eosinophils, monocytes and platelet concentration. The beneficial effect was due to carrot's α- and β-carotenoids. A deficiency in vitamin A can cause eye's photoreceptors to deteriorate, which leads to a great vision problems. B-carotene (the carotenoid with the most provitamin-A activity) in carrots helps to enhance vision, especially night vision and also provides protection against macular degeneration and development of senile cataract. Eating carrots rich in β-carotene may restore vision. The curative effect of carotenoids and antioxidant polyphenols, and dietary fibers against bladder cancer and other carcinomas has also been reported. Brazionis *et al.* (2009) reported that Carotenoids of carrots which have no vitamin A activity may shrink also a diabetic's risk of developing diabetic retinopathy since as observed recently type 2 diabetics who had lower levels of no vitamin A activity carotenoids, lycopene, lutein and zeaxanthin, had corresponding higher levels of retinopathy. Besides cartloads of β-carotene and other carotenoids, carrots contain vitamins like vitamin C and K, thiamin (B1), riboflavin (B2), pyridoxine (B6) and folates (B9), necessary for metabolism of carbohydrates, proteins and healthy productive performance. Vitamin C promotes the absorption of non-heme iron and is required for reducing infections and vitamin K helps preventing bleeding. Thiamin (B1) has highly useful effects on our nervous system and mental attitude; riboflavin is essential for cell respiration, and red blood cell formation; pyridoxine inhibits the formation of homocysteine and decreases the risk of heart disease; and folates may decrease the risk of heart attack by lowering homocysteine levels. High levels of homocysteine has been found to be associated with an enhanced risk of hardening of arteries due to the accumulation of fatty plaques.

2.5.2.2 Glucose, cholesterol and cardiovascular disease lowering and anti-hypertensive benefits

Nutritionist generally recommend consuming carrots in moderation because they contain more sugar than any other vegetable. This recommendation was based on the first journal article ever published on the carrot glycemic index (GI), in 1981, reported

that we quickly digest the carbohydrates in carrots. That study observed the carrots had a GI of 92 (where glucose = 100). A later study that showed the carrots had a GI of 39 ± 7 and the carrot juice of 45 ± 4 (Cael not pub). Recent research shows a significant association between vitamin A-rich carotenoids and diabetes status. According to these researchers higher blood glucose levels, as well as higher fasting levels of insulin, observed in study participants with lower level of carotenoids. Carotenoid levels also reduced as the severity of glucose intolerance enhanced. Suggestion of these findings is that carrot and vitamin A-rich carotenoids might help lower glucose level to manage their condition. Chau *et al.* (2004) comparing the characteristics, properties and in vitro hypoglycemic outcome of various carrot water insoluble fiber-rich fractions, showed that dietary fiber-rich fractions, which contained not only water insoluble dietary fiber but also alcohol and water insoluble solids, isolated from carrot pomace exhibited glucose-adsorption capacity and amylase inhibition activity. Dietary fiber transports also a significant amount of polyphenols and carotenoids linked to the fiber matrix though the gut. Chau *et al.* (2004) also included that the enhanced glucose absorbance capacity and reduction of amylase activity of dietary fiber of carrot might help control post-prandial serum glucose level. This report confirmed the strong relationship between dietary fiber intake and lower risk of higher glucose level (Dias, 2012). More recently, Poudyal *et al.* (2010) showed the efficacy of purple carrot juice against metabolic syndrome. Purple carrot diet supplemented in a high-carbohydrate, high-fat diet-fed rat model. Interestingly, there was a decrease in impaired glucose tolerance, endothelial function and abdominal fat deposits. The purple carrot juice was rich in anthocyanin and low in carotenoids. Authors concluded that the anthocyanins of the carrot juice were responsible for the beneficial outcome. Nicolle *et al.* (2003) stated that carrot showed cholesterol absorption mitigating effects in experimental carrot feed. Regulation in bile acid secretion and antioxidant status also reported. These investigators also showed a significant decrease in liver cholesterol and triglyceride levels. Moreover, carrot consumption enhanced the vitamin E level in plasma and increased the ferric reducing ability of plasma. In another research work, these authors administered lyophilized carrot enriched diet. Carrot ingestion reduce lipoma and improved antioxidant status. In addition, it enhanced the level of vitamin E and myocardial cells. The suggestion of this result is that carrot intake may exert a protective effect against cardiovascular disease linked to atherosclerosis. The outcome may be due to the synergistic action of dietary fiber and antioxidant polyphenols in

carrot (Nicolle *et al.*, 2003). The consumption of carrots has also been associated with lower risk of heart attacks. In a recent study, Griep *et al.* (2011) reported the associations between fruit and vegetables of different colors and their subgroups and 10-year coronary heart disease (CHD) incidence. Consuming more deep-orange-colored fruits and vegetables is associated with a lower risk of CHD. In particular, carrots (their largest contributor to total orange fruit and vegetables consumption with 60 %), were associated with a 32% lower risk of CHD. They concluded, "A higher intake of deep orange fruit and vegetables, and especially carrots, may protect against CHD".

Gilani *et al.* (2000) reported he anti-hypertensive effect of two cumarin glycosides (DC-2 and DC-3) from carrots. Dose dependent intravenous administration of these glycoside compounds caused a reduction in arterial blood pressure. Moreover, in vitro studies by the same investigators stated that the glycoside compounds caused inhibitory effects on spontaneously beating guinea pig atria, as well as on the kt-induced contractions of rabbit aorta. The decreased blood pressure observed in in vitro studies may be due to the calcium channel blocking action of cumarin glycosides (DC-2 and DC-3) from carrots.

2.5.2.3 Hepatoprotective, and renoprotective benefits

Carrot help to protect liver from acute injury by the toxic effects of environmental chemicals. The effect of carrot on carbon tetrachloride (CC14)-induced acute liver damage in mouse investigated. The increased serum enzyme levels by CC14-induction significantly lowered due to pre-treatment with the carrot. Carrot also reduced the elevated serum bilirubin and urea content due to CC14 administration. Enhanced activities of hepatic 5'-nucleotidase, acid phosphatase, acid ribonuclease and lowered levels of succinic dehydrogenase, glucose-6-phosphatase and cytochrome P-450 produced by CCl4 were reversed by the carrot in a dose-responsive way. Mills *et al.* (2008) studied the possible effects of bioactive compounds in 4 bio fortified carrot cultivars (purple/orange, purple/orange/red, orange/red, and orange) on the provitamin-A bio efficacy and antioxidant potential on the liver. Mital *et al.* (2011) reported the Reno protective activity of carrot root extract on renal ischemia reperfusion acute injury in rats. Rats with renal reperfusion injury showed significantly reduced activity of superoxide dismutase, catalase and glutathione, and a significant increase in

malondialdehyde level. The study showed that carrot extract exerts Reno protective activity against ischemia reperfusion induced kidney acute injury, by decreasing free radical scavenging activity one of the mechanisms behind ischemia reperfusion damage of kidneys.

2.5.2.4 Wound healing benefits

Patil *et al.* (2012) studied that animals treated with topical cream of ethanoic extract of carrot, formulated at different concentrations, showed significant reduction in wound area, epithelization period and scar width when compared to control group animals in an excision wound model. Meanwhile, rate of wound contraction significantly enhanced. Moreover, there were also significant increases in wound tensile strength, hydroxyproline content and protein content in animals treated with the topical cream formulation of ethanoic extract of carrot. The antioxidant and anti-microbial activities of ethanoic extract of carrot, mainly flavonoids and phenolic derivate, may be involved in this enhanced curative property. Wound healing outcomes may also be due to regulation of collagen expression and inhibition of elevated levels of lipid peroxides.

2.5.2.5 Anti-bacterial and anti-fungal benefits

Rossi *et al.* (2007) studied the essential oil obtained from aerial parts of the wild carrot showed inhibitory action against the enteropathogen Campylobacter jejuni. Also phenylpropanoids, such as methylisoeugenol and elemicin, from essential oil also exerted antimicrobial effect against Campylobacter coli and C. lari strains. These authors observed that an aromatic ring and a double bond on the side chain of both methylisoeugenol and elemicim might be the responsible for the anti-microbial effects. Misiaka *et al.* (2004) stated that carrot seed oil extracts exhibited moderate inhibitory outcomes on mycelia growth of alternaria alternate (one of the most popular phytotoxic fungi infesting the carrot plant), isolated from the surface of carrot seeds cultivar Perfekcja. Experiments, namely with the chemical compounds, carotol, β-caryophyllene, and daucol were carried out to find out whether the observed activity was derived from the action of carotol alone or from a synergistic action. Carotol significantly shuttered the growth of the fungi and decreased the colony radial size. Meanwhile, the inhibitory effect produced by daucol was comparatively less than carotol. No effect was exerted by β-caryophyllene. The suggestion of this result is that carotol is the main agent responsible for the anti-fungal activity of carrot. Growth of

Staphylococcus aureus and Escherichia coli were inhibited by both luteolin and its 4'-O-glucoside. Moreover, in the 2.2-diphenyl-1-picrylhydrazyl assay luteolin showed greater radical scavenging activity.

2.5.2.6 Anti-inflammatory and analgesic benefits

The anti-inflammatory and analgesic effects of carrot seed extract reported experimentally. Vasudevan *et al.* (2006) reported that carrot possess anti-inflammatory effect. In their study paw, edema was induced in rats using carrageenan histamine, and serotonin; and arthritis was induced using formaldehyde. Surprisingly, the disease condition reduced in rats fed with a high dose of carrot. Furthermore, in order to assess the carrot's analgesic activity, writing effect was induced by intra-peritoneal injection. There was a significant decrease in writhing effect after the administration of carrot. Carrot has anti-inflammatory properties due to the inhibition of cyclooxygenase enzymes and provide anti-inflammatory benefits. That were significant even when compared to anti-inflammatory drugs like Aspirin, Ibuprofen, Naproxen and Celebrex.

2.5.3 Effect of carrot on poultry

2.5.3.1 Effect of carrot meal supplementation on productivity of chickens

There is very much limited information on the use of carrots in poultry feeding. Carrot roots and tops can provide carotenoids to laying hens. In Denmark, carrots have become common as forage in organic egg production practice. In organic laying hens fed a diet supplemented with 70 g/d of orange, yellow or purple carrots, a reduction in certain performance parameters (egg and yolk weight for all carrot colors, egg mass for orange carrots) but enhanced yolk color parameters and carotenoid content were noted. Purple carrots were beneficial for egg laying rate and egg and yolk mass (Hammershøj and Kidmose, 2006; Hammershøj *et al.*, 2010). Giving egg-laying hens' access to maize silage, barley-pea silage and carrots as foraging materials reduced pecking behavior, thus improving animal welfare (Steenfeldt *et al.*, 2007).

Steenfeldt *et al.* (2007) and La´zaro *et al.* (2003) studied that carrot fed hens had a higher final body weight, suggesting that large amounts of easily fermented components like sugars and soluble non-starch polysaccharides contributed energy to the hens. Similarly, feeding carrot to birds influenced the development of the gastrointestinal tract and composition of the micro-flora and reduced feed intake for

egg laying hens (Steenfeldt *et al.*, 2007). Carrot tops fed at 5% to laying hens improved the ß-carotene content and the color score of egg yolk. This increase was obtained at 5% inclusion rate and did not affect egg weight, Hough unit, egg-shape index and strength and thickness of egg shell very much (Ishikawa *et al.*, 2001).

Rizal *et al.* (2010) in the study on the utilization of carrot juice wastes as corn replacement in the broiler chicken diet, stated that the feed consumption of broilers was improved by the treatments. They attributed this to the increase in the palatability of diets. The authors further studied that daily gain of broiler chickens was highly improved by treatments. Enhance in the juice wastes mixture in diets increased the average daily gain of broiler chickens. In the same study, increase in the level of juice wastes mixture in diets improved the feed conversion ratio or the efficiency of feed utilization of broiler chickens. Their results indicated that enhance in the average daily gain was not in the same proportion with the enhance in the feed consumption. More daily gain obtained from every unit of feed consumption. The authors concluded with that carrot and fruit juice waste mixtures could be used up to 20% for broiler diets effectively replace 40% corn in the diet. High crude fiber content in juice waste mixture reduces its utilization in the broiler diets.

2.5.3.2 Effect of carrot meal supplementation on carcass characteristics of chickens

Sacks (2002) reported that high fat pads in broiler chickens result in high levels of cholesterol in broiler meat. Abdominal and subcutaneous fat are regarded as the main sources of waste in slaughterhouses (Ibrahim, 2000). Poultry use carotenoids for pigmentation, and they are involved in growth metabolism and fertility. Ponte *et al.* (2004) studied that carotenoids and xanthophylls give poultry carcasses their desirable yellow color. Inclusion level of carrot tops in the diet of growing rabbits up to 60% of the DM decreased carcass characteristics. Ibrahim (2000) reported that carrot tops replacing 67 to 100% of clover hay in the diet of growing rabbits was detrimental to carcass characteristics. Contrary to the reports, Mona and Hanan (2002) stated that carrot tops could also substitute for up to 75% of soybean meal in commercial diets for does and bucks without any negative outcomes on carcass characteristics. Also, feeding carrot leaf meal to growing rabbits, the live weight and dressing carcass weight numerically superior to the controls (Ngoshe *et al.*, 2013). In another report, Abdu *et*

al. (2012) said that carrot meal inclusion in the diets of rabbits significantly influenced the live and carcass weights. Prolonged use of carrots in the feeding of beef cattle may give a yellow color to the carcass fat (Fuller, 2004).

Research work on the effect of carrot meal on broiler chicken's carcass is limited. For decades, carotenoids a major component of carrots have attracted attention for improving health and skin coloration, improved sexual behavior, vitamin-A precursors and antioxidant. The fact observed that broiler chicken carcass skin and meat color affect the consumer's final judgment on the quality and value of poultry products. Broiler chickens with a yellow skin color observed to be a considered desirable by consumers while chickens with less desirable coloring have a lower market value, and purchased less often by consumers (Tarique *et al.*, 2013).

CHAPTER 3

MATERIALS AND METHODS

3.1 Statement of the experiment

The research work was conducted in the experimental trial shed at **Sher-e-Bangla Agricultural University Poultry Farm, Dhaka,** includes 150 day-old straight run (Lohmann meat) commercial broiler chicks from a single hatch for a period of 28 days from **13th October to 10th November, 2019** to assess the feasibility of using carrot powder in commercial broiler diet on growth performance, meat yield characteristics and hematological status of broiler chickens. This research also may help to make a conclusion about carrot powder as the alternative of antibiotic.

3.2 Collection of experimental broiler chickens

A total of 150 day-old Lohmann meat commercial broiler chicks were collected from Kazi hatchery, Savar, Dhaka.

3.3 Experimental materials

The collected chicks were carried to the university poultry farm at early morning. They were kept in electric brooders equally for 7 days by maintaining standard brooding protocol. During brooding time only basal diet was given. Treatments were not used at that period. After 7 days chicks were selected from brooders and distributed randomly in five (5) dietary treatment groups. 30 chicks were distributed randomly in one group for control and other 30 chicks for antibiotic group. The rest 90 chicks were distributed randomly in three (3) groups treated with carrot powder.

Each treatment had three (3) replications with 10 birds per replication. The total numbers of treatments were five (5) and their replications were 15 (Table 2).

3.4 Experimental treatments

T1 = Basal diets (control)

T2 = Basal diets + Antibiotics (Powder Doxivet, Dose: 1gm/2L water)

T3 = 0.5% Carrot Powder (500 gm of Carrot Powder/100 kg of the feeds)

T4 = 1% Carrot Powder (1 kg of Carrot Powder/100 kg of the feeds)

T5 = 1.5% Carrot Powder (1.5 kg Carrot Powder/100 kg of the feeds)

Table 2. Layout of the experiment

Treatments with Replications (10 birds/replication)			No. of birds
T_1R_1(N=10)	T_5R_2(N=10)	T_4R_3(N=10)	30
T_3R_3(N=10)	T_2R_2(N=10)	T_5R_1(N=10)	30
T_4R_1(N=10)	T_5R_3(N=10)	T_2R_1(N=10)	30
T_3R_1(N=10)	T_4R_2(N=10)	T_1R_3(N=10)	30
T_2R_3(N=10)	T_1R_2(N=10)	T_3R_2(N=10)	30
Total			150

3.5 Preparation of experimental house

Proper cleaning and washing of the experimental house was performed by using clean tap water. Ceiling, walls and floor were thoroughly cleaned and disinfected by spraying diluted Iodophor disinfectant solution (3 ml/liter water). After proper drying, the house was divided into 15 pens of equal size using wood materials and wire net. The height of wire net was 36 cm. A group of 10 birds were randomly allocated to each pen (replication) of the 5 (five) treatments. The stocking density was 1 m^2/10 birds.

3.6 Experimental diets

The chicks were supplemented with starter and grower commercial Kazi broiler feed which were purchased from the market.

Table 3. Broiler starter and grower ration with nutrient composition (As per manufacturers feedbag labeling)

Name of nutrient content in Starter ration	Minimum percentage present
Protein	21.0 %
Fat	6.0%
Fiber	5.0%
Ash	8.0%
Lysine	1.20%
Methionine	0.49%
Cysteine	0.40%
Threonine	0.79%
Arginine	1.26%
Name of nutrient content in Grower ration	**Minimum percentage present**
Protein	19.0 %
Fat	6.0%
fiber	5.0%
Ash	8.0%
Lysine	1.10%
Methionine	0.47%
Cysteine	0.39%
Tryptophan	0.18%
Threonine	0.75%
Arginine	1.18%

Feed were supplied 4 times daily by following Lohmann Meat Manual and ad libitum drinking water supplied 2 times daily.

3.6.1 Collection of carrot powder

Carrot powder was mixed in commercial basal diets according to treatment level. Good quality carrots were collected from the local market. After collection, carrots were washed properly with fresh water and chopped in small pieces. Then air dried properly under shed for 7 days. Then dried carrots were crushed in wooden mortar and pestle. The ingredients were contained in air tight container until used.

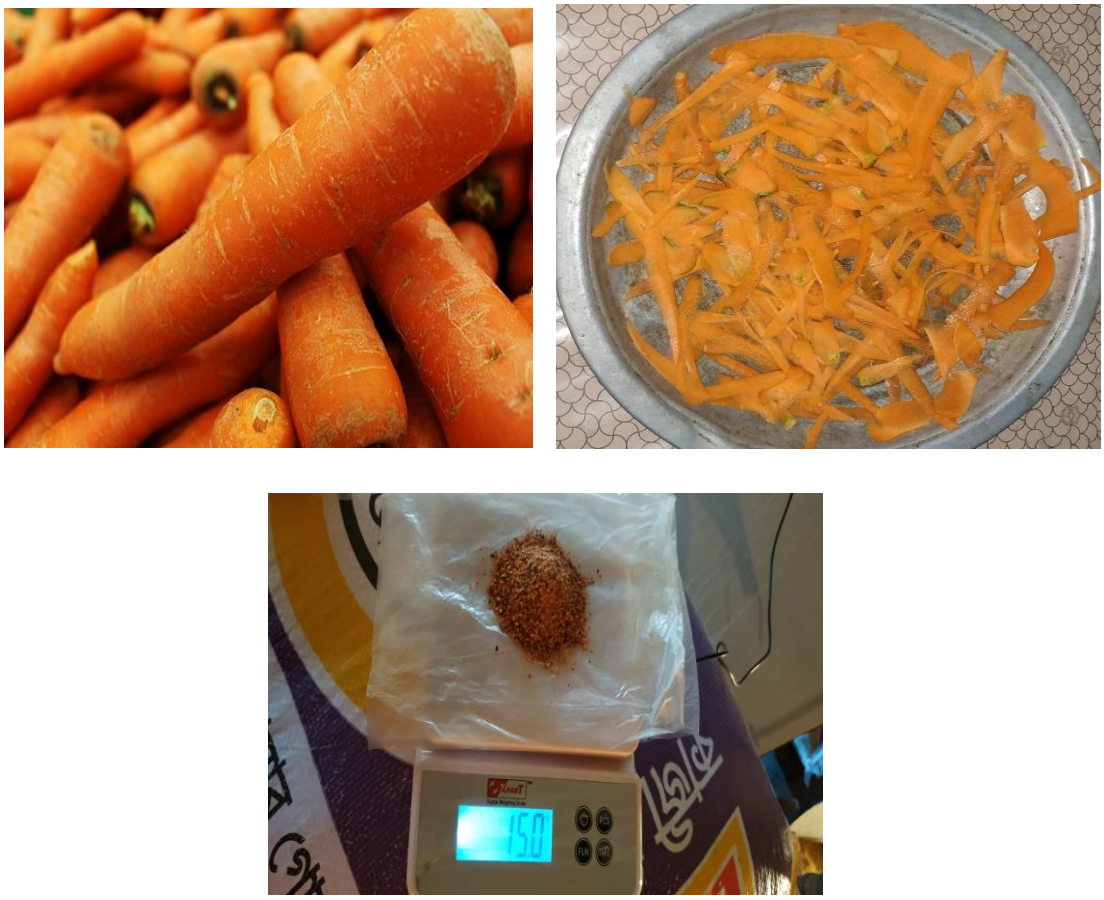


Plate 1: Raw, chopped and powder form of carrot

3.7 Management procedures

Feed intake and body weight were recorded every week and survivability was recorded for each replication up to 28 days of age. The following management procedures were followed during the whole experiment period.

3.7.1 Brooding management of baby chicks

The experiment was conducted during **13th October to 10th November, 2019**. The average temperature was near about 29ºC and the RH was 73% in the poultry house. Common brooding was done for seven days. After seven days the chicks were distributed in the pen randomly. There were 10 chicks in each pen and the pen space was $1m^2$. Due to cold climate brooding temperature was maintained as per requirement. Brooding temperature was adjusted (below 35ºC) with house temperature. When the environmental temperature was above the recommendation, then no extra heat was provided. At day time only few electric bulb was used to stimulate the chicks to eat and drink. In brooding extra heat was not provided at day time except mid night to morning. Electric fans were used as per necessity to save the birds from the heat stress and its harmful effects.

3.7.2 Room temperature and relative humidity

Daily room temperature (ºC) and humidity (%) were recorded every six hours with a thermometer and a wet and dry bulb thermometer respectively. Averages of room temperature and percent relative humidity for the experimental period were recorded and presented in Appendix 1 & 2.

3.7.3 Litter management

Litter was provided at a depth of 6 cm by using rice husk as litter material. At the end of each day, litter was stirred to prevent accumulation of harmful gases and to reduce parasite infestation. At 3 weeks of age, droppings on the upper layer of the litter were cleaned and for necessity fresh litter was added.

3.7.4 Feeding and watering

The birds were offered with ad libitum feed and clean fresh water. One large feeder and one big round drinker were provided in each pen for 10 birds. Feeders were cleaned at

the end of each week and drinkers were washed daily in the morning before supplying water. Feces and dirt contamination in the feeder and drinker were avoided by raising the feeder and drinker at a manageable height by using brick.

3.7.5 Lighting

There was provision of light in the broiler farm to stimulate feed intake and body growth at night. For first 2 weeks 24 hours lighting schedule was used. Thereafter 23 hours light and 1 hour dark was scheduled up to 28 days.

3.7.6 Bio security measures

Biosecurity components were properly maintained during the experimental period. Entry of wild birds and animals were prohibited. Footbath was used in front of the shed door to avoid the risk of pathogen transmission. To prevent diseases in the farm, chicks were vaccinated as per standard vaccination schedule. Proper hygienic and sanitation program was undertaken in the farm and its premises. Several vitamins like Vitamin B-Complex, Vitamin-ADEK, Vitamin-C, Calcium and electrolytes were supplied to the birds.

3.7.7 Vaccination

The vaccines were collected from medicine shop (Ceva Company) and administered to the experimental birds according to the standard vaccination schedule. The vaccination schedule is shown in Table 4.

Table 4. Vaccination schedule

Age of birds	Name of Disease	Name of vaccine	Route of administration
3 days	IB + ND	MA-5 + Clone-30	One drop in each eye
9 days	Gumboro	G-228E (inactivated)	Drinking Water
17 days	Gumboro	G-228E (inactivated) booster dose	Drinking Water
21 days	IB + ND	MA-5 + Clone-30 D	Drinking Water

3.7.8 Proper ventilation

The experimental shed was south facing and open-sided. Due to wire net cross ventilation, it was easy to remove polluted gases from the farm. Beside ventilation was regulated as per requirement by folding polythene screen.

3.7.9 Sanitation

Strict sanitary measures were taken during the experimental period. Disinfectant (Virkon) was used to disinfect the feeders and drinkers and the house also.

3.8 Study parameters

3.8.1 Recorded parameters

Data was recorded on weekly live weight, weekly feed consumption and death of chicks to calculate mortality percent. FCR was calculated from final live weight and total feed consumption per bird in each replication. After slaughter gizzard, liver, spleen, heart and bursa weight were measured from each broiler chicken. Dressing yield was calculated for each replication to find out dressing percentage. Blood sample was

collected and analysis from each replication to measure glucose, cholesterol and hemoglobin level.

3.9 Data collection

3.9.1 Live weight:

The initial day-old live weight and weekly live weight of each replication was kept to get final live weight record per bird.

3.9.2 Dressing yield:

Dressing yield = Live weight - (blood + feathers + head + shank+ digestive system + Liver+ Heart) weight.

$$\text{Dressing percentage} = \frac{\text{Dressing yield}}{\text{Live weight}} \times 100$$

3.9.3 Feed consumption:

Daily feed consumption record of each replication was kept to get weekly and total feed consumption record per bird.

3.9.4 Mortality of chicks:

Daily death record for each replication was counted up to 28 days of age to calculate mortality.

3.9.5 Dressing procedures of broiler chicken:

Two birds were picked up randomly from each replicate at the 28th day of age and sacrificed in halal method to estimate dressing percentage of broiler chicken. All birds to be slaughtered were weighed and fasted for overnight (12 hours) but drinking water was provided ad-libitum during fasting to facilitate proper bleeding. All the live birds were weighed again prior to slaughter. Birds were slaughtered by severing jugular vein, carotid artery and the trachea by a single incision with a sharp knife and allowed to complete bleed out at least for 2 minutes. Outer skin was removed by sharp scissor and hand. Then the carcasses were washed manually to remove loose singed feathers and other foreign materials from the surface of the carcass. Afterward the carcasses were eviscerated and dissected according to the methods by Jones (1982). Heart and liver

were separated from the remaining viscera by cutting them loose and then the gall bladder was removed from the liver. Cutting it loose in front of the proventriculus and then cutting with both incoming and outgoing tracts to remove the gizzard content. Dressing yield was found by subtracting blood, feathers, head, shank, liver, heart and digestive system weight from live weight.

3.9.6 Blood sample analysis

Blood samples (1 ml/bird) were collected into ethylenediamine tetraacetic acid (EDTA) tubes from the wing veins. Samples was calculated by Easy Touch meter for glucose, hemoglobin and cholesterol.

3.10 Calculations

3.10.1 Live weight gain:

The average body weight gain of each replication was calculated by deducting initial body weight from the final body weight of the birds.

Body weight gain = Final weight – Initial weight

3.10.2 Feed intake:

Feed intake was calculated as the total feed consumption in a replication divided by number of birds in each replication.

$$\text{Feed intake (g/bird)} = \frac{\text{Feed intake in a replication}}{\text{Number of birds in a replication}}$$

3.10.3 Feed conversion ratio:

Feed conversion ratio (FCR) was calculated as the total feed consumption divided by weight gain in each replication.

$$\text{FCR} = \frac{\text{Feed intake (gm)}}{\text{Weight gain (gm)}}$$

3.11 Statistical analysis

The data was subjected to statistical analysis by applying one way ANOVA using statistical package for social sciences (SPSS) version 16. Differences between means were tested using Duncan‟s Multiple Comparison Test and significance was set at $P<0.05$.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Dietary effect on production index of broiler chicken

Calculation of Production Index (PI) is one the major parameter to assess the successfulness of broiler chicken production which compare broiler results from different flocks, region and treatment groups. The performance of broiler chickens is measured through five factors. These factors are:

- The level of feed consumption
- The achievement of body weight
- Feed Conversion Ratio
- Dressing Percentage
- Survivability rate

Measurement and assessment of the five factors reflect the quality of maintenance and performance maintenance of broiler chickens.

4.1.1 Weekly Feed Consumption (FC)

The mean weekly feed consumption (g) of broiler chicks at the end of 4th week in the dietary group T_1, T_2, T_3, T_4 and T_5 were 1039.13±6.20, 1054.13±19.80, 1023.17±3.58, 1006.23±4.00, 1042.00±5.03 respectively. The overall mean feed consumption of different groups showed significantly different ($P<0.05$) among control (T_1), antibiotic (T_2), 0.5% Carrot powder (T_3), 1% Carrot powder (T_4) and 1.5% Carrot powder (T_5) supplementation group in 1st, 2nd and 4th week. Also 3rd week result shows no significant difference. 1st week FC has no effect among various treatments, 2nd and 4th week highest values are 549.70±1.51 in T_4 and 1054.13±19.80 in T_2 group respectively. Also 2nd and 4th week lowest values are 532.97±3.29 in T_5 and 1006.23±4.00 in T_4 group respectively.

These results are in agreement with the findings of Hammershøj *et al.* (2010) reported that dietary Carrot powder incorporation respectively had significant ($P< 0.05$) effect on weekly feed consumption in layer at different inclusion level compared to control

group. These results also agreed with the findings of Ng'ambi *et al.* (2019) mentioned that broiler diet supplemented with Carrot powder was significantly (P< 0.05) decreased feed intake of the birds.

Table 5. Effects of feeding different level of carrot powder and antibiotic on feed consumption (g/bird) of broiler chickens at different week

Treatment	1st week FC (gm/bird)	2nd week FC (gm/bird)	3rd week FC (gm/bird)	4th week FC (gm/bird)
T_1	165.67^{a}±0.33	537.87^{ab}±4.67	792.97±7.77	1039.13^{a}±6.20
T_2	165.00^{a}±1.52	535.23^{ab}±0.92	792.43±16.03	1054.13^{a}±19.80
T_3	163.33^{a}±1.20	539.53^{ab}±8.92	788.47±10.14	1023.17^{ab}±3.58
T_4	156.67^{b}±0.33	549.70^{a}±1.51	814.73±1.98	1006.23^{b}±4.00
T_5	157.33^{b}±2.02	532.97^{b}±3.29	793.13±11.28	1042.00^{a}±5.03
Mean ± SE	161.60*±1.13	539.06*±2.38	796.35^{NS}±4.69	1032.93*±5.79

Here, T_1=(Control), T_2=(Antibiotic), T_3=(0.5% Carrot powder), T_4=(1% Carrot powder) and T_5=(1.5% Carrot powder). Values are Mean ± S.E (n=15) one way ANOVA (SPSS, Duncan method).

- Mean with different superscripts at the same column are significantly different (P<0.05)
- Mean within same superscripts don't differ (P>0.05) significantly
- SE= Standard Error
- *means significant at 5% level of significance (p<0.05)
- NS= Non significant

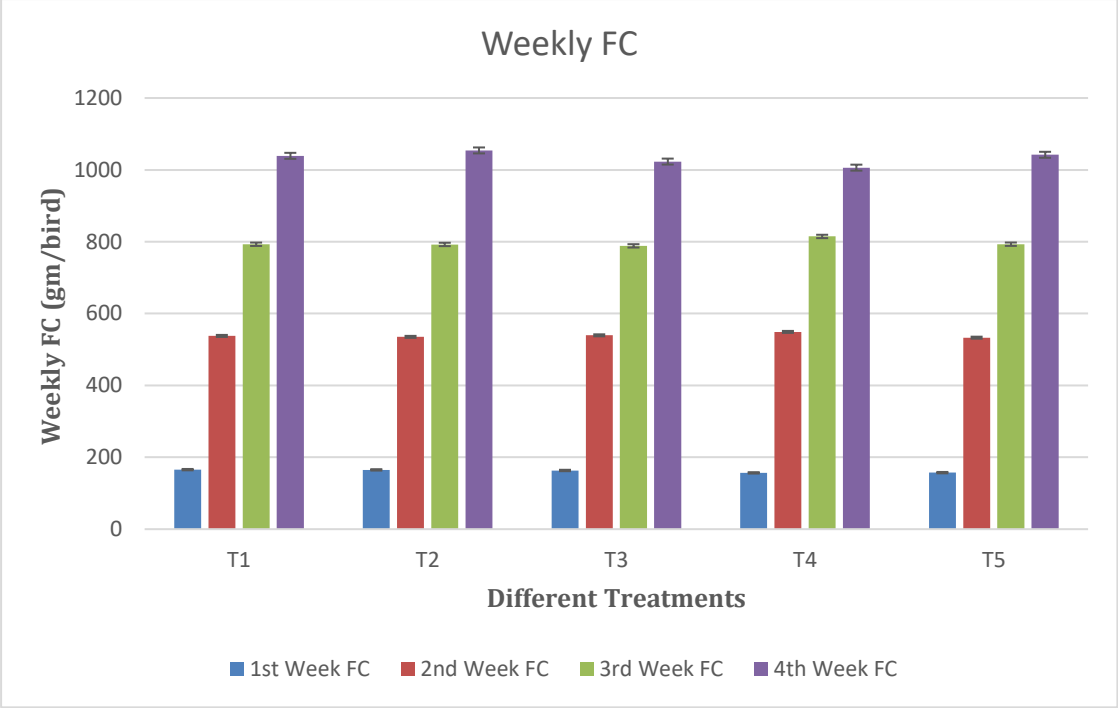


Figure 1. Effects of dietary supplementation of carrot powder and antibiotic on feed consumption (g/bird) of broiler chickens at different week

4.1.2 Weekly body weight gains

The mean body weight gains (g) of broiler chicken at the end of 4th week in different groups were 688.33±4.41, 693.33±26.67, 683.33±26.03, 629.00±29.51, 724.67±51.07 respectively. The overall mean body weight gain of different groups showed that there was no significant (P>0.05) difference in groups T_3, T_4 and T_5 compared to control (T_1) and antibiotic (T_2) group (Table 6 and Figure 2).

The highest body weight gain obtained at the end of 4th week in 1.5% Carrot powder supplementation (T_5) and the lowest body weight gain obtained in 1% Carrot powder supplementation (T_4) group.

These results are in agreement with those findings which showed that dietary supplementation of Carrot meal had no significant effect (P>0.05) on growth rate of unsexed Arbor acre broiler chickens (Ng'ambi *et al.*, 2019). But on the other hand these results are contradictory with the findings of Ewuola and Odefemi (2019) reported that rabbits fed with 1 ml Carrot extract had significantly (P<0.05) higher body weight gain than compared to control group.

Table 6. Effects of feeding different level of carrot powder and antibiotic on body weight gain (BWG) (g/bird) of broiler chickens at different week

Treatment	1st week BWG (gm/bird)	2nd week BWG (gm/bird)	3rd week BWG (gm/bird)	4th week BWG (gm/bird)
T_1	150.33±6.36	367.00±12.66	617.33±16.38	688.33±4.41
T_2	149.00±2.65	387.00±1.53	627.00±11.37	693.33±26.67
T_3	153.00±2.89	373.67±10.35	643.00±20.11	683.33±26.03
T_4	153.33±5.78	368.33±2.85	664.67±15.93	629.00±29.51
T_5	161.33±1.20	380.67±6.33	597.67±34.93	724.67±51.07
Mean ± SE	153.40^{NS}±1.98	375.33^{NS}±3.63	629.93^{NS}±10.09	683.73^{NS}±14.42

Here, T_1=(Control), T_2=(Antibiotic), T_3=(0.5% Carrot powder), T_4=(1% Carrot powder) and T_5=(1.5% Carrot powder). Values are Mean ± S.E (n=15) one way ANOVA (SPSS, Duncan method).

- Mean with different superscripts at the same column are significantly different ($P<0.05$)
- Mean within same superscripts don't differ ($P>0.05$) significantly
- SE= Standard Error
- NS= Non significant

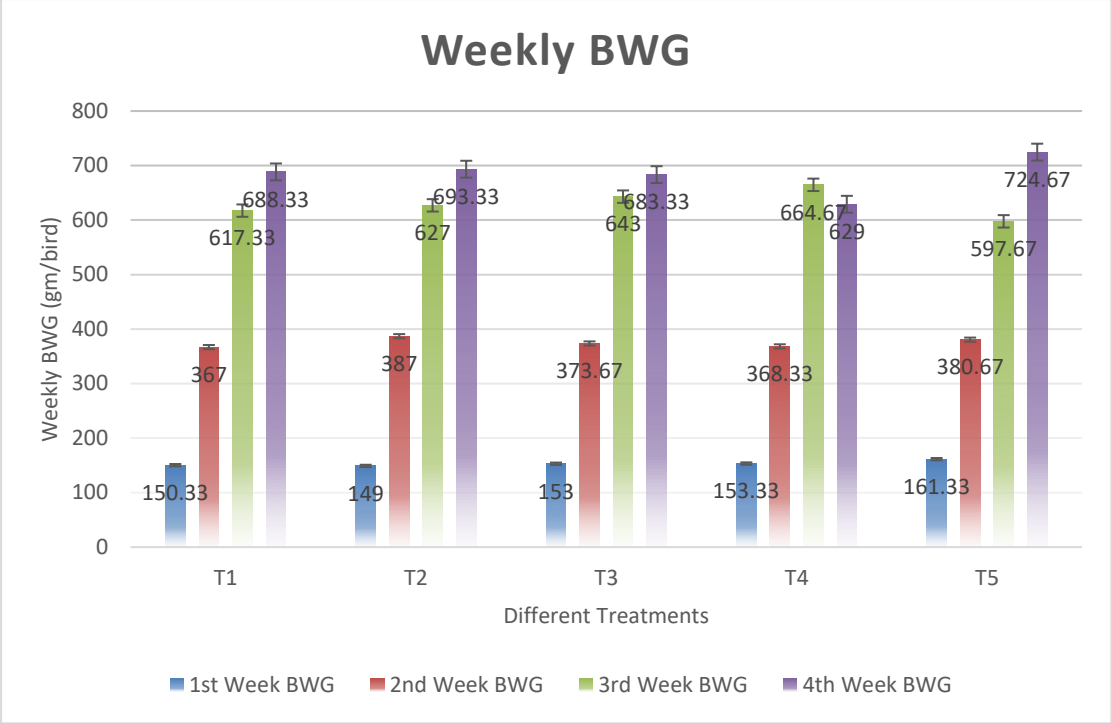


Figure 2. Effects of dietary supplementation of carrot powder and antibiotic on body weight gain (g/bird) of broiler chickens at different week

4.1.3 Weekly Feed Conversion Ratio (FCR)

The mean weekly FCR of broiler chicks at the end of 4th week in different groups were 1.51±0.01, 1.46±0.06, 1.52±0.07, 1.68±0.09, 1.42±0.11 respectively. The overall mean FCR of different groups showed that there was no significant (P>0.05) increase among the treatment groups (Table 7 and Figure 3).

These results are coincided with the findings of Sherif (2018) who concluded that dietary Carrot meal supplementation respectively had non-significant (P>0.05) effect on weekly feed conversion ratio (FCR) on New Zealand White rabbits. On the other hand, Salisu *et al.* (2012) observed that supplementation carrot meal in rabbit had significantly (P<0.05) increased body weight and the treatment group caused better improvement in the feed conversion ratio as compared to that of control group.

Table 7. Effects of feeding different level of carrot powder and antibiotic on FCR of broiler chickens at different week

Treatment	1st week FCR	2nd week FCR	3rd week FCR	4th week FCR
T_1	1.05±0.03	1.45±0.04	1.28±0.02	1.51±0.01
T_2	1.05±0.02	1.42±0.01	1.30±0.02	1.46±0.06
T_3	1.08±0.02	1.44±0.03	1.23±0.03	1.52±0.07
T_4	1.08±0.05	1.45±0.01	1.19±0.05	1.68±0.09
T_5	1.01±0.00	1.41±0.03	1.33±0.09	1.42±0.11
Mean ± SE	1.06^{NS}±0.01	1.43^{NS}±0.01	1.26^{NS}±0.02	1.52^{NS}±0.04

Here, T_1=(Control), T_2=(Antibiotic), T_3=(0.5% Carrot powder), T_4=(1% Carrot powder) and T_5=(1.5% Carrot powder). Values are Mean ± S.E (n=15) one way ANOVA (SPSS, Duncan method).

- Mean with different superscripts at the same column are significantly different ($P<0.05$)
- Mean within same superscripts don't differ ($P>0.05$) significantly
- SE= Standard Error
- NS= Non significant

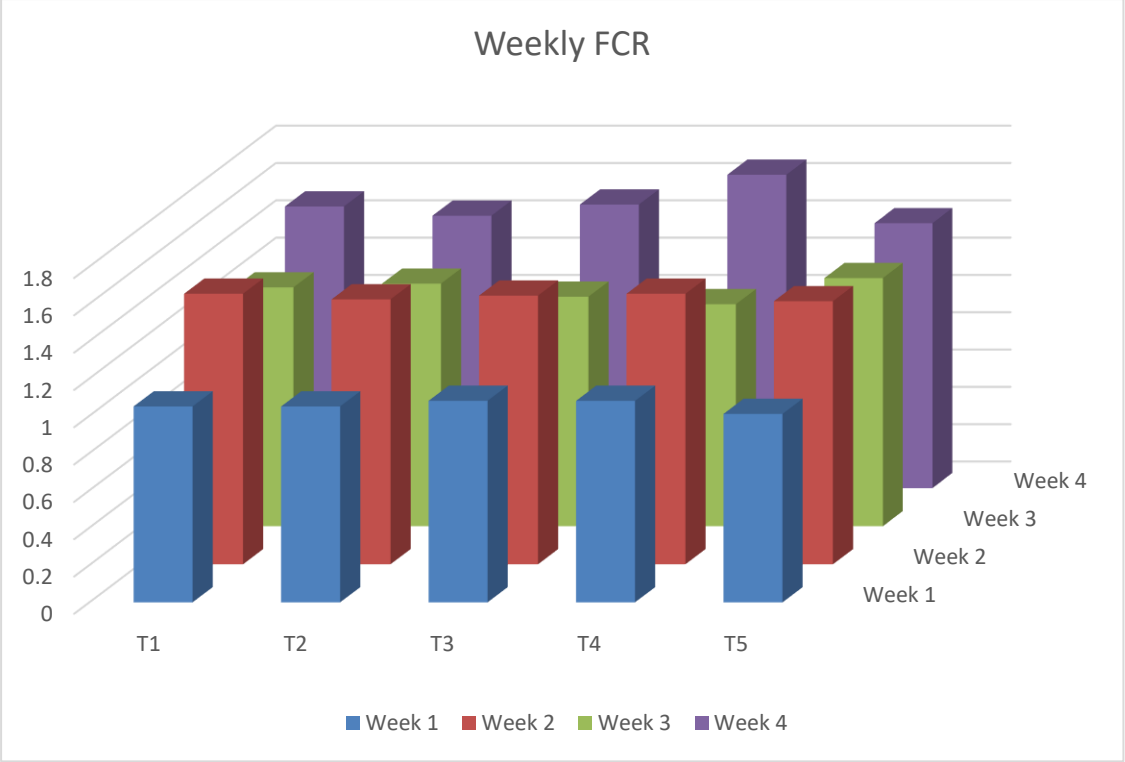


Figure 3. Effects of dietary supplementation of carrot powder and antibiotic on FCR of broiler chickens at different week

4.1.4 Feed Consumption (FC)

Different treatment groups (Table 8 and Figure 4) showed no significant (P>0.05) differences in feed consumption (g) of broiler chicken. Antibiotic group consumed higher amount of feed (2546.80±23.09) and 0.5% carrot powder (T_3) treated group consumed lower amount of feed (2514.50±8.67).

These results are also in agreement with the findings of El-Medany *et al.* (2008) who reported that dietary supplementation of dried carrot processing waste in growing rabbit diets had no significant effect (P>0.05) on feed intake. Ng'ambi *et al.* (2019) also mentioned that supplementation of carrot in broiler diets had non-significant (P>0.05) differences on feed consumption of broiler chicken. In contrast, other researcher Rizal *et al.* (2010) concluded that dietary carrot and other fruits juice supplementation to broilers had higher significant (P<0.05) feed consumption value than control group.

Table 8. Effects of feeding carrot powder and antibiotic on different production index level of broiler chickens under different treatment

Treatment	Final Live Weight (g/Broiler)	FC (g)	FCR	DP% (Skinless)	Survivability (%)
T_1	1832.67± 20.41	2535.63± 2.23	1.39±0.01	72.74^{ab}±0.80	100±0.00
T_2	1770.83± 69.58	2546.80± 23.09	1.38±0.01	74.10^{ab}±1.56	100±0.00
T_3	1846.33± 40.09	2514.50± 8.67	1.36±0.03	71.74^{b}±1.07	100±0.00
T_4	1859.50± 34.83	2527.33± 0.33	1.39±0.02	75.23^{a}±0.76	96.67±3.33
T_5	1820.67± 17.89	2525.43± 6.29	1.36±0.03	71.18^{b}±0.43	93.33±3.33
Mean ± SE	1826.00^{NS}±17. 51	2529.94^{NS}± 5.19	1.37^{NS}± 0.01	73.00^{*}± 0.55	98.00^{NS}±.1.07

Here, T_1=(Control), T_2=(Antibiotic), T_3=(0.5% Carrot powder), T_4=(1% Carrot powder) and T_5=(1.5% Carrot powder). Values are Mean ± S.E (n=15) one way ANOVA (SPSS, Duncan method).

- Mean with different superscripts at the same column are significantly different (P<0.05)
- Mean within same superscripts don't differ (P>0.05) significantly
- SE= Standard Error
- *means significant at 5% level of significance (p<0.05)
- NS= Non significant

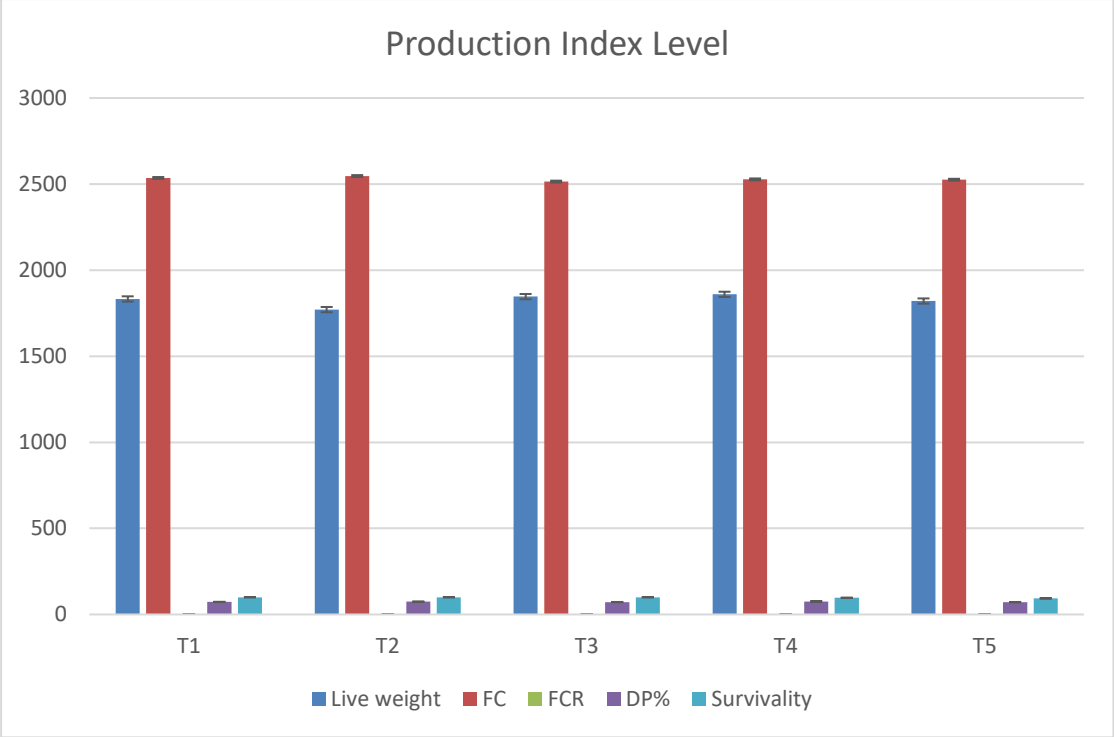


Figure 4. Effects of dietary supplementation of carrot powder and antibiotic on different production index level of broiler chickens under different treatment

4.1.5 Final Body Weight

Data presented in (Table 8 and Figure 4) showed that the effect of treatments on final live weight (gram per broiler chicken) was not significant (P>0.05). The relative final live weight (g) of broiler chickens in the dietary group T_1, T_2, T_3, T_4 and T_5 were 1832.67±20.41, 1770.83±69.58, 1846.33±40.09, 1859.50±34.83 and 1820.67±17.89 respectively. The highest result was found in T_4 (1859.50±34.83) and lowest result was in T_2 (1770.83±69.58) group. However, Final live weight of broiler fed with carrot powder diet increased but there were no differences (P>0.05) compared to that of the control and antibiotic treated groups. The final live weight of T_3 and T_4 group was also higher than the control group (T_1).

Simmilar results also obtained by Ewuola and Odefemi (2019) who found that there was no significant difference (P>0.05) of dietary carrot supplementation on average final body weight of rabbit but the weight performance was numerically increased as the inclusion levels of carrot meal increased.

4.1.6 Feed Conversion Ratio (FCR)

Data presented in (Table 8 and Figure 4) showed that the effect of treatments on feed conversion ratio (FCR) was not significant (P>0.05) in broiler chicken. The lower FCR (1.36±0.03) found in birds supplemented with 0.5% carrot powder (T_3) and 1.5% carrot powder (T_5), higher FCR (1.39±0.01) in the control group (T_1). However, Feed conversion ratio of T_3 (1.36±0.03) and T_5 (1.36±0.03) was lower than the control group.

These results are coincided with the findings of Ng'ambi *et al.* (2019) who concluded that dietary carrot supplementation respectively had non-significant (P>0.05) effect on weekly feed conversion ratio (FCR). Contradictory result found in the research of Rizal *et al.* (2010), who showed significant (P<0.05) decrease in feed conversion ratio in carrot extract to broilers treatment groups than control group.

4.1.7 Dressing Percentage (DP)

The dressing percentage of broiler chicks at 28^{th} days presented in (Table 8 and Figure 4) were significantly (P<0.05) differ in T_1 (control), T_2 (antibiotic), T_3, T_4 and T_5 group. Broiler supplemented with 1% carrot powder (T_4) had a greater (P<0.05) dressing percentage (75.23±0.76) compared with the control (72.74±0.80) group. Dressing percentage of antibiotic group T_2 was 74.10±1.56, 0.5% carrot powder supplemented group T_3 was 71.74±1.07, and 1.5% carrot powder supplemented group T_5 was 71.18±0.43.

Similar result showed by Forwood et al. (2020), who found that carrot-fed lambs had significantly (P<0.05) 2.7% higher cold dressing percentage while consuming less than control lambs.

4.1.8 Survivability

The survivability rate showed on (Table 8 and Figure 4) different group was not significant (P>0.05). The survivability rate of different treatment groups T_1, T_2, T_3, T_4 and T_5 were 100±0.00, 100±0.00, 100±0.00, 96.67±3.33 and 93.33±3.33 respectively. Treatment had no significant (P>0.05) effect on survivability rate.

4.2 Serum biochemical parameters

4.2.1 Glucose

Effects of dietary supplementation of carrot powder on concentration of glucose of broiler chickens presented in Table 9 and Figure 5. Dietary incorporation of carrot powder had no significant (P>0.05) difference among the treatment group. The lowest amount (16.03±0.27) of plasma glucose found in T_5 (1.5% carrot powder) and highest amount (17.32±0.41) of plasma glucose found in T_3. But there was no statistical difference among the present values.

These results are in agreement with those obtained by Li *et al.* (2014) who found that there was no significant difference (P>0.05) of dietary carrot supplementation on serum glucose level of rat but lower glucose level found in carrot treatment groups than control group.

On the other hand, Louis *et al.* (2018) found contrary results and concluded that blood glucose levels were significantly (P<0.05) lower in carrot supplemented diabetic rats when compared with non-treated diabetic rats.

4.2.2 Cholesterol

Total cholesterol concentration (m.mole/L) in the serum of different groups ranged from 4.90±0.40 to 5.83±0.86. Statistical analysis revealed that insignificant (P>0.05) difference among the groups (Table 9 and Figure 5). The lower amount (4.90±0.40) of cholesterol found in 1% carrot powder supplementation group (T_4) comparable to antibiotic and control group but there was no statistical difference.

These results are in agreement with Nicolle *et al.* (2003) reported that carrot supplementation decrease serum cholesterol level in hypercholesterolemic rats and diabetic rats.

4.2.3 Hemoglobin

The effects of dietary carrot powder supplementation on concentration of Hemoglobin of broiler chickens presented in Table 9 and Figure 5. Feeding dietary carrot powder had no significant (P>0.05) difference among the treatment. Although the highest

amount (7.10±0.55) of Hemoglobin are found in T_3 (0.5% carrot powder) than antibiotic, control and other groups.

However, contradictory result showed by Ngoshe *et al.* (2013) reported that dietary supplementation of carrot in rabbit meal had significant (P<0.05) effect on blood hemoglobin level and gradual increase of hemoglobin level in carrot supplementation group than control and antibiotic.

Table 9. Effects of feeding carrot powder and antibiotic on serum biochemical level of broiler chickens under different treatment

Treatment	Glucose (m. mole/L)	Cholesterol (m. mole/L)	Hemoglobin (m. mole/L)
T_1	16.08±0.78	4.93±0.67	6.98±0.45
T_2	17.12±0.29	5.37±0.04	6.72±0.41
T_3	17.32±0.41	4.98±0.55	7.10±0.55
T_4	17.22±0.08	4.90±0.40	6.60±0.13
T_5	16.03±0.27	5.83±0.86	7.00±0.16
Mean ± SE	16.91^{NS}±0.20	5.20^{NS}±0.24	6.88^{NS}±0.15

Here, T_1=(Control), T_2=(Antibiotic), T_3=(0.5% Carrot powder), T_4=(1% Carrot powder) and T_5=(1.5% Carrot powder). Values are Mean ± S.E (n=15) one way ANOVA (SPSS, Duncan method).

- Mean with different superscripts at the same column are significantly different (P<0.05)
- Mean within same superscripts don't differ (P>0.05) significantly
- SE= Standard Error
- NS= Non significant

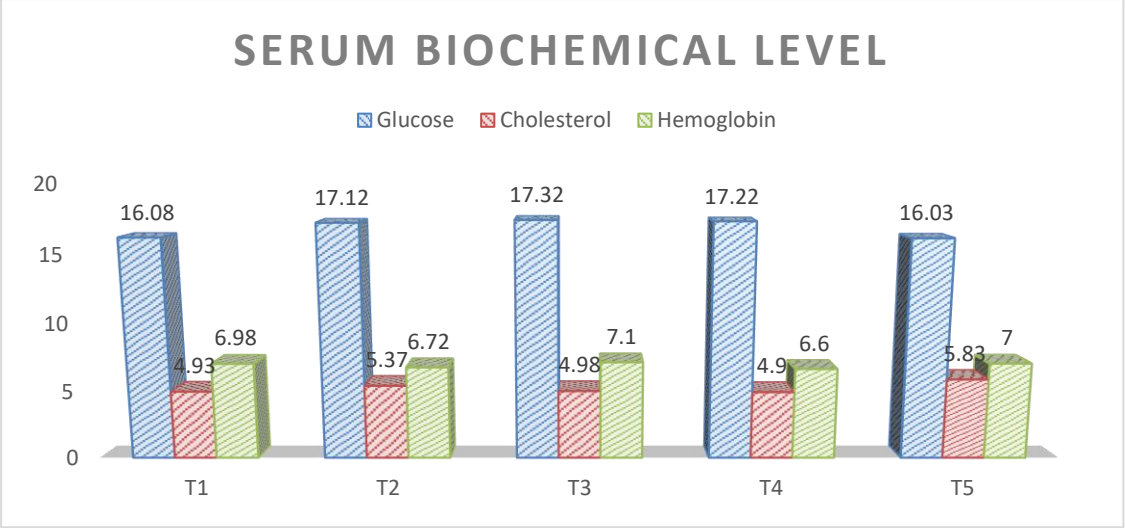


Figure 5. Effects of dietary supplementation of carrot powder and antibiotic on serum biochemical level of broiler chickens under different treatment

4.3 Internal organs

The relative weight of liver (g) of broiler chicks in dietary group T_1, T_2, T_3, T_4 and T_5 were, 42.67±2.17, 43.35±4.98, 41.17±3.12, 40.67±3.49 and 48.92±2.71 respectively. The highest result was obtained in T_5 (1.5% carrot powder) and lowest was in T_4 (1% carrot powder) group. However, there was no significant ($P>0.05$) difference in the relative weight of liver among the groups (Table 10 and Figure 6).

The comparative weight of gizzard (g) presented in Table 10 and Figure 6 showed significant ($P<0.05$) difference among all treatment group. The relative weight of gizzard of broiler chicks in dietary group T_1, T_2, T_3, T_4 and T_5 were 38.25±0.87, 40.92±2.44, 40.58±1.84, 48.92±0.51 and 44.33±2.48 respectively. The highest result (48.92±0.51) was obtained in T_4 (1% carrot powder) and lowest was in T_1 (control) group.

The relative weight of heart (g) of broiler chicken in the dietary groups were T_1 (11.33±1.02), T_2 (11.17±0.93), T_3 (10.75±0.50), T_4 (12.17±1.52) and T_5 (10.58±0.30). The results shows that there was no significant ($P>0.05$) difference of values among groups. The highest result (12.17±1.52) was obtained in T_4 (1% carrot powder) and lowest was in T_5 (1.5% carrot powder) group (Table 10 and Figure 6).

In case of liver and heart weight, these results are in agreement with the findings of Rizal *et al.* (2010) who concluded that broiler chicken supplemented with carrot extract

had non-significant (P>0.05) effect on liver, gizzard and heart weight. But contradictory to results of gizzard weight. Similar results also found in the research of Ewuola and Odefemi (2019) who reported that carrot fruit extract had no significant (P>0.05) differences on liver and heart weight in rabbits compared to control group.

Table 10. Effects of feeding carrot powder and antibiotic on internal organs of broiler chickens under different treatment

Treatment	Liver (g)	Gizzard (g)	Heart (g)	Spleen weight (g)	Bursa weight (g)
T_1	42.67±2.17	38.25^{b}±0.87	11.33±1.02	2.25^{ab}± 0.28	2.92± 0.22
T_2	43.35±4.98	40.92^{b}±2.44	11.17±0.93	1.83^{b}± 0.16	2.42± 0.54
T_3	41.17±3.12	40.58^{b}±1.84	10.75±0.50	1.92^{b}± 0.22	3.08± 0.79
T_4	40.67±3.49	48.92^{a}±0.51	12.17±1.52	2.66^{a}± 0.16	2.92± 0.30
T_5	48.92±2.71	44.33^{ab}±2.48	10.58±0.30	2.17^{ab}± 0.08	2.83± 0.22
Mean ± SE	43.35^{NS}±1.52	42.60*±1.21	11.20^{NS}±0.39	2.16^{*}±0.11	2.83^{NS}±0.18

Here, T_1=(Control), T_2=(Antibiotic), T_3=(0.5% Carrot powder), T_4=(1% Carrot powder) and T_5=(1.5% Carrot powder). Values are Mean ± S.E (n=15) one way ANOVA (SPSS, Duncan method).

- Mean with different superscripts at the same column are significantly different (P<0.05)
- Mean within same superscripts don't differ (P>0.05) significantly
- SE= Standard Error
- *means significant at 5% level of significance (p<0.05)
- NS= Non significant

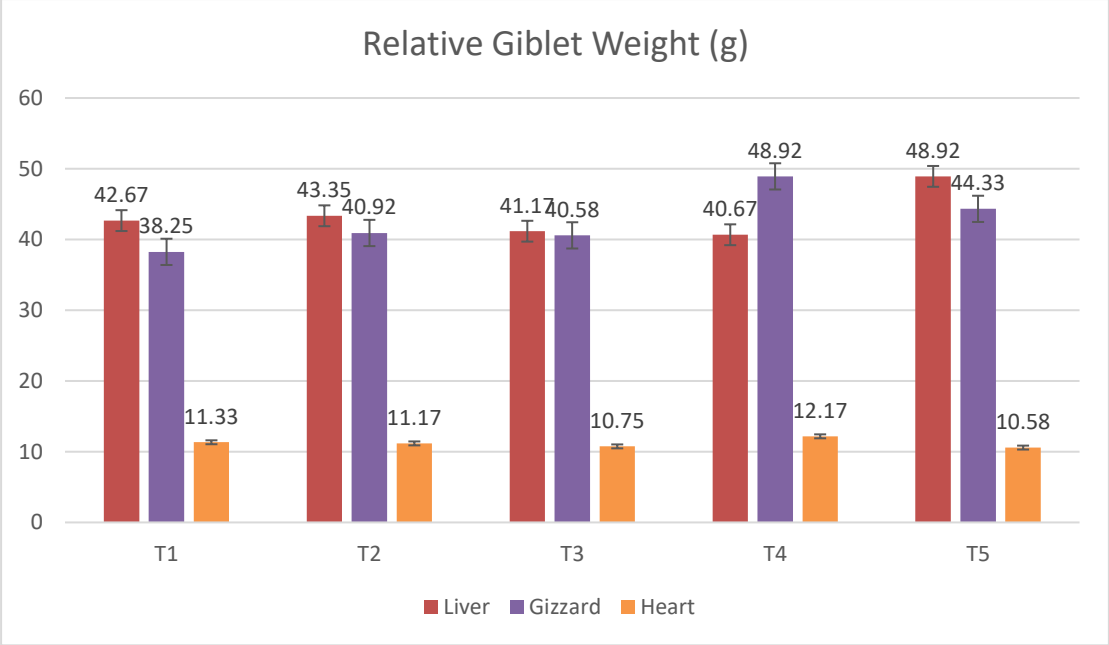


Figure 6. Effects of dietary supplementation of carrot powder and antibiotic on relative giblet weight of broiler chickens under different treatment

Data presented in Table (10) and Figure (7) shows the effect of dietary carrot powder supplementation on immune organs of Lohman meat broiler during the period from day 0 to 28 days of age. The comparative weight of spleen (g) of broiler chicks in the dietary groups were T_1 (2.25±0.28), T_2 (1.83±0.16), T_3 (1.92±0.22), T_4 (2.66±0.16) and T_5 (2.17±0.08). The highest value was found in T_4 (2.66±0.16) and lowest value was in T_2 (1.83±0.16). The relative weight of spleen of different groups showed that there were significant ($P<0.05$) difference among the treatments compared with control group. These results reveal that supplementation of carrot powder in broiler ration improved the weight of spleen compared with the control and antibiotic group.

The present study shows that dietary supplementation of carrot powder in broiler ration had no significant ($P>0.05$) difference on bursa weight of broiler chicken (Table 10 and Figure 7). The highest bursa weight (3.08±0.79) found in the 0.5% carrot powder supplementation (T_3) group and lowest (2.42±0.54) in the antibiotic (T_2) group.

Present results are similar to the findings of Ewuola and Odefemi (2019) who showed that dietary supplementation of carrot fruit extracts had significant ($P<0.05$) differences in immune organ weight in case of rabbits.

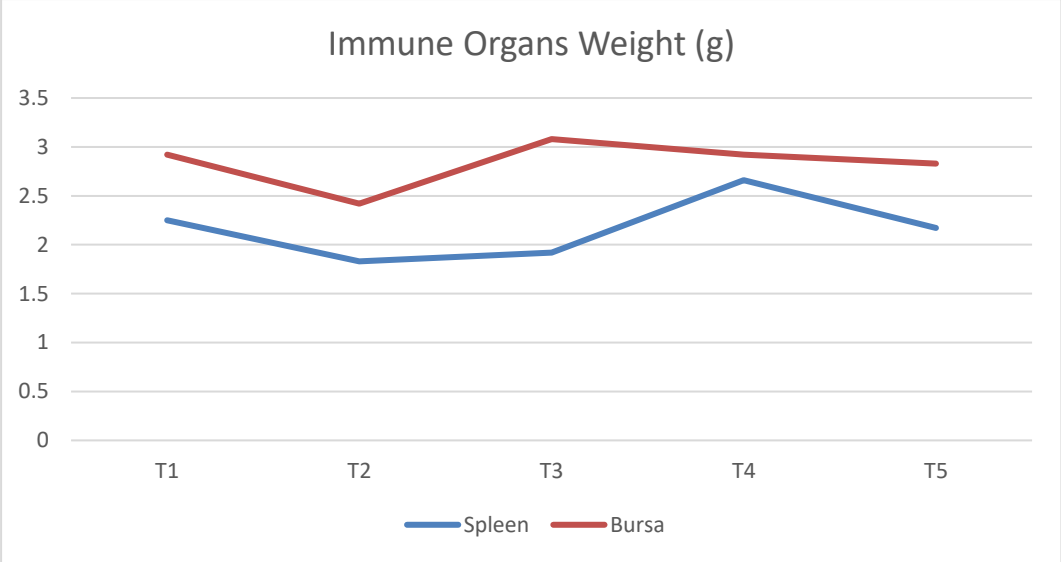


Figure 7. Effects of dietary supplementation of carrot powder and antibiotic on immune organs of broiler chickens under different treatment

CHAPTER 5

SUMMARY AND CONCLUSION

A study was conducted with broilers to investigate the effects of natural feed additives as alternative to an antibiotic growth promoter. The study was planned to determine the comparative efficacy of carrot powder on the productive performance, hematology and health status of commercial broilers. A total 150 day-old Lohman meat broiler chicks were reared for a period of 28 days in the Poultry Farm of Sher-e-Bangla Agricultural University, Dhaka. The chicks were assigned to five treatment groups comprising of T_1 (Control), T_2 (Antibiotic), T_3 (0.5% Carrot Powder), T_4 (1% Carrot Powder) and T_5 (1.5% Carrot Powder) randomly. Treatments were replicated thrice with 10 chicks per replicate.

At 28 days of age, 30 broilers were sacrificed in halal method to evaluate the efficacy of dietary carrot powder and antibiotic supplementation. The production indexes viz. feed consumption, body weight, body weight gain, FCR, dressed weight, dressing percentage, relative internal organs weight, relative immune organs weight; blood biochemical parameters and survivability of broiler on different replication of different treatments was recorded and compared. All collected data were subjected to one-way analysis of variance using statistical package for social science (SPSS) version 16 and differences in compare means using Duncan method.

There was no significant ($P>0.05$) difference on the live body weight among different treatment groups. The higher body weight found in T_4 (1% carrot powder) treatment group compared to other groups and values were followed in a descending order in T_3, T_1, T_5 and T_2 group. The weekly feed consumption showed significant ($P<0.05$) difference among all treatment groups, but final feed consumption were insignificantly ($P>0.05$) different among all treatment groups. Weight gain and FCR showed no significant ($P>0.05$) difference among all treatment groups. The better FCR found in birds fed diets with both 0.5% carrot powder and 1.5% carrot powder supplementation compared to that of control group. The dressing percentage showed significant ($P<0.05$) difference among carrot powder treated groups as well as compared to control & antibiotic groups. The highest dressing percentage found in 1% carrot powder supplementation group (T_4) compared to that of control group. The relative weight of

liver and heart did not show any significant (P>0.05) difference among the treatment groups but gizzard weight showed significant (P<0.05) difference among carrot powder treated groups, antibiotic and control group. The highest gizzard weight found in 1% carrot powder and the lowest gizzard weight in control group.

The serum biochemical parameters viz. glucose, cholesterol and hemoglobin concentration were measured. The result showed that there was no significant (P>0.05) difference in the level of glucose, cholesterol & hemoglobin among all treatment groups. Although the glucose level are insignificantly (P>0.05) lowest in 1.5% carrot powder and the cholesterol and hemoglobin level are insignificantly (P>0.05) lowest in 1% carrot powder compared to control & antibiotic groups. The relative weight of spleen had significant (P<0.05) difference due to carrot powder supplementation. The highest spleen weight found in T_4 (1% carrot powder) group compared to the control & antibiotic groups. The relative weight of bursa had no significant (P>0.05) difference among carrot powder treated groups and control group. Although the highest bursa weight found in 0.5% carrot powder treated group compared to the control & antibiotic groups.

On basis of this analysis of the above mentioned research findings, it can be concluded that carrot powder supplementation had very effective impact on production performance, serum biochemical parameters, immune stimulation of broiler chicken. Birds fed 1% carrot powder supplemented diet achieved superior result. So, carrot powder can be use as natural feed additive and a growth promoter in broiler production. Therefore, the present study recommends that implementation of this feeding supplement in the field aspect for commercial broiler production, which is safe, sound, and economically viable and environmentally suitable for our country. However, further more experimental trial are required to assess the impact of carrot on the better quality of broiler meat production to ensure the safety of human consumption.

REFERENCES

Aarestrup, F. M., Wegener, H. C. and Collignon, P. (2008). Resistance in bacteria of the food chain: epidemiology and control strategies. *Expert review of anti-infective therapy*, **6** (5): 733-750.

Abdu, S.B., Jokthan, G.E., Hassan, M.R., Adamu, H.Y., Yashim, S.M. and Ikani, E. (2012). Effects of inclusion levels of carrot leaf meal on performance of growing rabbits. *World J. L. Sci. and Med. R.*, **2** (2): 65-70.

Ahlawat, S. S., Sharma, D. P., & Khanna, N. (2012). Development of low cost chicken cutlets using different extenders. *J. Dairying, Foods Home Sci.*, **31**(3): 199-202.

Ahmed, A. A., Bishr, M. M., El-Shanawany, M. A., Attia, E. Z., Ross, S. A., & Paré, P. W. (2005). Rare trisubstituted sesquiterpenes daucanes from the wild *Daucus carota*. *Phytochem.*, **66** (14): 1680-1684.

Bartlett, H. E., & Eperjesi, F. (2008). Nutritional supplementation for type 2 diabetes: a systematic review. *Ophthal. Physiol. Opt.*, **28** (6): 503-523.

Bedford, M. (2000). Removal of antibiotic growth promoters from poultry diets: implications and strategies to minimise subsequent problems. *World's Poult. Sci. J.*, **56** (4): 347-365.

Biancone, L., Monteleone, I., Blanco, G. D. V., Vavassori, P., & Pallone, F. (2002). Resident bacterial flora and immune system. *Digestive and Liver Disease*, **34**: 37-43.

Boamah, V. E., Agyare, C., Odoi, H., & Dalsgaard, A. (2016). Practices and factors influencing the use of antibiotics in selected poultry farms in Ghana. *Int. J. Antimicrob. Agents*, **2**: 120.

Brazionis, L., Rowley, K., Itsiopoulos, C., & O'Dea, K. (2009). Plasma carotenoids and diabetic retinopathy. *British J. Nutr.*, **101** (2): 270-277.

Cabuk, M., Bozkurt, M., Alcicek, A. H. M. E. T., Akbaþ, Y., & Küçükyýlmaz, K. (2006). Effect of a herbal essential oil mixture on growth and internal organ weight of broilers from young and old breeder flocks. *S. Afr. J. Anim. Sci.*, **36** (2): 135-141.

Carvalho, I. T., & Santos, L. (2016). Antibiotics in the aquatic environments: a review of the European scenario. *Environ. Inter.*, **94**: 736-757.

Casewell, M., Friis, C., Marco, E., McMullin, P., & Phillips, I. (2003). The European ban on growth-promoting antibiotics and emerging consequences for human and animal health. *J. antimicrob. Chemother.*, **52** (2): 159-161.

Castanon, J. I. R. (2007). History of the use of antibiotic as growth promoters in European poultry feeds. *Poult. Sci.*, **86** (11): 2466-2471.

Chau, C. F., Chen, C. H., & Lee, M. H. (2004). Comparison of the characteristics, functional properties, and in vitro hypoglycemic effects of various carrot insoluble fiber-rich fractions. *LWT-Food Sci. tech.*, **37** (2): 155-160.

Cherian, A., Seena, S., Bullock, R. K., & Antony, A. C. (2005). Incidence of neural tube defects in the least-developed area of India: a population-based study. *The Lancet*, **366** (9489): 930-931.

Ching, L. S., & Mohamed, S. (2001). Alpha-tocopherol content in 62 edible tropical plants. *J. Agri. food Chem.*, **49** (6): 3101-3105.

Choct, M. (2001). Alternatives to in-feed antibiotics in monogastric animal industry. *ASA Tech. Bul.*, **30**: 1-6.

Cogliani, C., Goossens, H., & Greko, C. (2011). Restricting antimicrobial use in food animals: lessons from Europe. *Microbe*, **6** (6): 274-279.

Costa, M. C., Bessegatto, J. A., Alfieri, A. A., Weese, J. S., Filho, J. A., & Oba, A. (2017). Different antibiotic growth promoters induce specific changes in the cecal microbiota membership of broiler chicken. *PLoS One*, **12** (2): 0171642.

Crisol-Martínez, E., Stanley, D., Geier, M. S., Hughes, R. J., & Moore, R. J. (2017). Understanding the mechanisms of zinc bacitracin and avilamycin on animal production: linking gut microbiota and growth performance in chickens. *Appl. Microbio. Biotec.*, **101** (11): 4547-4559.

Danzeisen, J. L., Kim, H. B., Isaacson, R. E., Tu, Z. J., & Johnson, T. J. (2011). Modulations of the chicken cecal microbiome and metagenome in response to anticoccidial and growth promoter treatment. *PloS one*, **6** (11): 27949.

Davies, M., & Walsh, T. R. (2018). A colistin crisis in India. *The Lancet. Infect. Dis.*, **18** (3): 256-257.

Denev, S. A. (2006). Effect of different growth promoters on the cecal microflora and performance of broiler chickens. *Bulgarian J. Agri. Sci.*, **12** (3): 461.

Diarra, M. S., Rempel, H., Champagne, J., Masson, L., Pritchard, J., & Topp, E. (2010). Distribution of antimicrobial resistance and virulence genes in Enterococcus spp. and characterization of isolates from broiler chickens. *Appl. Environ. Microbial.*, **76** (24): 8033-8043.

Diarra, M. S., Silversides, F. G., Diarrassouba, F., Pritchard, J., Masson, L., Brousseau, R., & Topp, E. (2007). Impact of feed supplementation with antimicrobial agents on growth performance of broiler chickens, Clostridium perfringens and enterococcus counts, and antibiotic resistance phenotypes and distribution of antimicrobial resistance determinants in Escherichia coli isolates. *Appl. Environ. Microbial.*, **73** (20): 6566-6576.

Dias, J. S. (2012). Major classes of phytonutriceuticals in vegetables and health benefits: A review. *J. Nutr. Ther.*, **1** (1): 31-62.

Dias, J. S. (2012). Nutritional quality and health benefits of vegetables: A review. *Food Nut. Sci.*, **3** (10): 1354-1374.

Dibner, J. J., & Richards, J. D. (2005). Antibiotic growth promoters in agriculture: history and mode of action. *Poult. Sci.*, **84** (4): 634-643.

Doyle, M. P., & Erickson, M. C. (2006). Reducing the carriage of foodborne pathogens in livestock and poultry. *Poult. Sci.*, **85** (6): 960-973.

Duru, M. (2013). Effects of dietary strawberry (Fragaria x ananassa Duch.) leaf powder on egg yield, quality and egg yolk cholesterol in laying hens. *J. Food, Agri. Environ.*, **11**: 477-480.

Duru, M., & Şahin, A. (2012). Effects of dietary puncture vine (*tribulus terrestris*) powder in different carriers on growth performance, carcass characteristics and blood parameters of broiler chicks. *Kafkas Univ. Vet. Fak. Derg.*, **18**: 359-365.

Duru, M., and Sahin, A. (2015). Effects of dietary *Tribulus terrestris* with different carriers on performance and egg quality of laying hens. *J. Fd. Hlth. Sci.,* **1**: 84-93.

Ekam, V.S., Udosen, E.O. and Chighu, A.E. (2006). Comparative Effect of Carotenoid Complex from Goldenneo-Life Dynamite and Carrot Extracted Carotenoids on Immune Parameters in Albino Wistar Rats. *Nigerian J. Physio. Sci.*, **21**: 1-4.

Elder, R. O., Keen, J. E., Wittum, T. E., Callaway, T. R., Edrington, T. S., Anderson, R. C., & Nisbet, D. J. (2002). Intervention to reduce fecal shedding of enterohemorrhagic *Escherichia coli* O157: H7 in naturally infected cattle using neomycin sulfate. *J. Anim. Sci.*, **80**: 15.

El-Faham, A. I., Ahmed, A. M. H., & El-Sanhoury, M. H. S. (2015). Thyme leaves or its extracted oil for enhancing productive and physiological status of broiler chickens. *Egyptian Poult. Sci. J.*, **35**: 215–236.

El-Medany, N. M., Hashem, N. A., & Abdl-Azeem, F. (2008). Effect of incorporating dried carrot processing waste in growing rabbit diets. *Egyptian J. Nutrition and Feeds*, **11**(1): 25-37.

Enishi, O., Yoshioka, T., Nakashima, K., Saeki, M., & Kawashima, T. (2004). Analysis of in situ ruminal digestive characteristics and nutritive value of pumpkin and carrot juice residue for ruminant feeds. *J. Japanese Soci. Grassland Sci. (Japan)*, **50** (4): 360-365.

Ewuola, E. O., & Odefemi, T. R. (2019). Growth response, organ morphometry, sperm production and reserve in rabbit bucks administered carrot fruit extracts. *Nigerian J. ani. Pro.*, **46** (1): 30-36.

Falcão-e-Cunha, L., Castro-Solla, L., Maertens, L., Marounek, M., Pinheiro, V., Freire, J. and Mourão, J.L. (2007). Alternatives to Antibiotic Growth Promoters in Rabbit feeding: A Review. *World Rabbit Sci.*, **15**: 127–140.

Forgetta, V., Rempel, H., Malouin, F., Vaillancourt, R. Jr., Topp, E., Dewar, K. (2012). Pathogenic and multidrug-resistant Escherichia fergusonii from broiler chicken. Poult Sci, **91**: 512-525.

Forwood, D. L., Holman, B. W., Hopkins, D. L., Smyth, H. E., Hoffman, L. C., Chaves, A. V., & Meale, S. J. (2020). Feeding unsaleable carrots to lambs increased performance and carcass characteristics while maintaining meat quality. *Meat Sci.*, **173**: 108402.

Frias, J., Peñas, E., Ullate, M., & Vidal-Valverde, C. (2010). Influence of drying by convective air dryer or power ultrasound on the vitamin C and β-carotene content of carrots. *J. agri. food chem.*, **58** (19): 10539-10544.

Fu, H.W., Zhang, L., Yi, T., Feng, Y.L. and Tian, J. (2010). Two New Guaniane-Type Sesquiterpenoids from the Fruits of *Daucus carota* L. *Fitoterapia*, **81**: 443-446.

Fuller, M.F. (2004). The Encyclopedia of Farm Animal Nutrition. *CABI Publishing Series*, 606.

Furtula, V., Farrell, E.G., Diarrassouba, F., Rempel, H., Pritchard, J. and Diarra, M.S. (2010). Veterinary pharmaceuticals and antibiotic resistance of *Escherichia Coli* isolates in poultry litter from commercial farms and controlled feeding trials. *Poult. Sci.*, **89**: 180-188.

Garcia-Migura, L., Hendriksen, R. S., Fraile, L. and Aarestrup F. M. (2014). Antimicrobial resistance of zoonotic and commensal bacteria in Europe: The missing link between consumption and resistance in veterinary medicine. *Vet. Microbiol.*, **170**: 1–9.

Geyra, A., Uni, Z., & Sklan, D. (2001). The effect of fasting at different ages on growth and tissue dynamics in the small intestine of the young chick. *British J. Nutrition*, **86**(1): 53-61.

Gilani, A. H., Shaheen, F., Saeed, S. A., Bibi, S., Sadiq, M., & Faizi, S. (2000). Hypotensive action of coumarin glycosides from *Daucus carota*. *Phytomedicine*, **7**(5): 423-426.

Gonçalves, E. M., Pinheiro, J., Abreu, M., Brandão, T. R. S., & Silva, C. L. M. (2010). Carrot (*Daucus carota* L.) peroxidase inactivation, phenolic content and physical changes kinetics due to blanching. *J. Food Engineering*, **97** (4): 574-581.

Gonzalez, R. M., & Angeles H. J. C. (2017). Antibiotic and synthetic growth promoters in animal diets: review of impact and analytical methods. *Food Control*, **72**: 255-267.

Goutard, F. L., Bordier, M., Calba, C., Erlacher-Vindel, E., Góchez, D., de Balogh, K. & Vong, S. (2017). Antimicrobial policy interventions in food animal production in South East Asia. *bmj*, **358**: 3544.

Griep, L.M., Verschuren, W.M., Kromhout, D., Ocké, M.C. and Geleijnse, J.M. (2011) Colors of Fruit and Vegetables and 10-Year Incidence of CHD. *British J. Nutrition*, **106**: 1562-1569.

Guban, J., Korver, D. R., Allison, G. E., & Tannock, G. W. (2006). Relationship of dietary antimicrobial drug administration with broiler performance, decreased population levels of *Lactobacillus salivarius*, and reduced bile salt deconjugation in the ileum of broiler chickens. *Poult. sci.*, **85** (12): 2186-2194.

Guerrera, M. P., Volpe, S. L. and Mao, J. J. (2009). Therapeutic Uses of Magnesium. *American Family Phys.*, **80**: 157-162.

Hammershøj, M. and Kidmose, U. (2006). Coloured carrot varieties as forage material for egg layers. *EPC 2006 - 12th European Poultry Conference, Verona, Italy*, 10-14 September, 2006, 114.

Hammershøj, M., Kidmose, U. and Steenfeldt, S. (2010). Deposition of carotenoids in egg yolk by short-term supplement of coloured carrot (*Daucus carota*) varieties as forage material for egg-laying hens. *J. Sci. Fd. Agric.*, **90**: 1163-1171.

Hansen, L., Hammershoy, O. and Boll, P.M. (1986). Allergic Contact Dermatitis from Falcarinol Isolated from Schaffera arboricola. Contact Dermatitis, **14**: 91-93.

Holland, B., Unwin, J. D. and Buss, D. H. (1991). Vegetables, herbs and spices: Fifth supplement to McCance and Widdowson's, London.

Horbowicz, M., Kosson, R., Grzesiuk, A. and Bski, H.D. (2008). Anthocyanins of Fruits and Vegetables—Their Occurrence Analysis and Role in Human Nutrition. *Vegetable Crops Res. Bul.*, **68**: 5-22.

Ibrahim, M. R. M. (2000). Efficiency of using peanut hay and carrot- tops hay for feeding growing rabbits. *Egyptian J. Rabbit Poult. Sci.,* **10** (1): 147-156.

Ishikawa, S., Tachikawa, M. and Hayakawa, H. (2001). Effect of carrot leaf supplementation on egg yolk beta-carotene content and egg quality (Part 2). *Japan Poult. Sci.*, **38** (6): 167-176.

Kahn, L. H. (2017). Antimicrobial resistance: a One Health perspective. Trans. R. Soc. Trop. Med. Hyg. **111**: 255–260.

Kahraman, Z. (2009). Herbal Feed Additive and Their Usage in Laying Hen Diets. *Tavukçuluk Araş Derg.,* **8**: 34-41.

Kaya, S., and Yıldırım, H. (2011). The effect of dried sweet potato (Ipomea batatas) vines on egg yolk color and some egg yield parameters. *Int. J. Agric. Biol.,* **15**: 766–770.

Kim, D.J., Xun, P., Liu, K., Loria, C., Yokota, K., Jacobs Jr., D.R. and He, K. (2010). Magnesium Intake in Relation to System Inflammation, Insulin Resistance, and the Incidence of Diabetes. *Diabetes Care*, **33**: 2604-2610.

Knarreborg, A., Lauridsen, C., Engberg, R. M., & Jensen, S. K. (2004). Dietary antibiotic growth promoters enhance the bioavailability of α-tocopheryl acetate in broilers by altering lipid absorption. *J. nutr.*, **134** (6): 1487-1492.

Knarreborg, A., Simon, M. A., Engberg, R. M., Jensen, B. B. and Tannock, G. W. (2002). Effects of dietary fat source and subtherapeutic levels of antibiotic on the bacterial community in the ileum of broiler chickens at various ages. *Appl. Environ. Microbiol.*, **68** (12): 5918–5924.

Kobayashi, Y. (2010). Abatement of methane production from ruminants: trends in the manipulation of rumen fermentation. *Asian Aust. J. Anim. Sci.*, **23**: 410–416.

Labro, M. T. (2000). Interference of antibacterial agents with phagocyte functions: immunomodulation or "immuno-fairy tales"? *Clin. Microbiol. Rev.*, **13**: 615–650.

Larsen, M. K., Christensen, L. P., Vach, W., Hoitinga, R. J. and Brant, K. (2005). Inhibitory Effects of Feeding with Carrots or (−)-Falcarinol on Development of

Azoxymethame-Induced Preneoplastic Lesions in the Rat Colon. *J. Agri. Food Chem.*, **53**: 1823-1827.

Laxminarayan, R., Duse, A., Wattal, C., Zaidi, A. K., Wertheim, H. F., Sumpradit, N., ... & Cars, O. (2013). Antibiotic resistance—the need for global solutions. *The Lancet infectious diseases*, **13** (12): 1057-1098.

Laxminarayan, R., Van Boeckel, T., & Teillant, A. (2015). The economic costs of withdrawing antimicrobial growth promoters from the livestock sector.

Lázaro, R., García, M., Aranibar, M. J., & Mateos, G. G. (2003). Effect of enzyme addition to wheat-, barley-and rye-based diets on nutrient digestibility and performance of laying hens. *British poult. Sci.*, **44** (2): 256-265.

Li, C., Ding, Q., Nie, S. P., Zhang, Y. S., Xiong, T. and Xie, M. Y. (2014). Carrot juice fermented with Lactobacillus plantarum NCU116 ameliorates type 2 diabetes in rats. *Journal Agri. Food Chem.*, **62** (49): 11884-11891.

Lila, M. A. (2004) Anthocyanins and Human Health: An in Vitro Investigative Approach. *J. Biomed. Biotec.*, **5**: 306-313.

Lin, J., Hunkapiller, A. A., Layton, A. C., Chang, Y. J. and Robbins, K. R. (2013). Response of intestinal microbiota to antibiotic growth promoters in chickens. *Foodborne pathogens and disease*, **10** (4): 331-337.

Louis, X. L., Raj, P., McClinton, K. J., Yu, L., Suh, M. and Netticadan, T. (2018). Supplementation of type 1 diabetic rats with carrot powder lowers blood glucose without improving cardiac structure and function. *Prev. nutrition and food sci.*, **23** (2): 115.

Lund, E. D. and White, J. M. (1990). Polyacetylenes in Normal and Waterstressed "Orlando Gold" Carrots (*Daucus carota*). *Jour. Sci. Food and Agri.*, **51**: 507-516.

MacDonald, T. T. and Monteleone, G. (2005). Immunity, inflammation, and allergy in the gut. *Science*, **307**: 1920–1925.

Marshall, B. M. and Levy, S. B. (2011). Food animals and antimicrobials: Impacts on human health. *Clinic. Micro. Rev.*, **24**: 718-733.

Mc Dermott, P. F., Walker, R. D. and White, D. G. (2003). Antimicrobials: modes of action and mechanisms of resistance. *Int. j. toxic.*, **22** (2): 135-143.

Mehdizadeh, S., Kazerani, H. R. and Jamshidi, A. (2010). Screening of chloramphenicol residues in broiler chickens slaughtered in an industrial poultry abattoir in Mashhad, Iran. *Iranian J. Vet. Sci. Tec.*, **2**: 25-32.

Miles, R. D., Butcher, G. D., Henry, P. R. and Littell, R. C. (2006). Effect of antibiotic growth promoters on broiler performance, intestinal growth parameters, and quantitative morphology. *Poult. Sci.*, **85** (3): 476-485.

Mills, J. P., Simon, P. W. and Tanumihardjo, S. A. (2008). Biofortified Carrot Intake Enhances Liver Antioxidant Capacity and Vitamin A Status in Mongolian Gerbils. *J. Nutrition*, **138**: 1692-1698.

Misiaka, I. J., Lipoka, J., Nowakowska, E. M., Wieczoreka, P. P., Mlynarz, P. and Kafarski, P. (2004). Antifungal Activity of Carrot Seed Oil and Its Major Sesquiterpene Compounds. *Zeitschrift für Naturforschung*, **59**: 791-796.

Mital, P. R., Laxman, P. J. and Rameshvar, P. K. (2011). Protective Effect of *Daucus carota* Root Extract against Ischemia Reperfusion Injury in Rats. *Pharm.*, **1**: 432-439.

Mona, S. R. and Hanan, A. H. (2002). Effect of using dried Egyptian clover and orange peels as natural feed additives on egg production, egg quality and immune response of laying hens. *Fayoum Jour. Agri. Res. Dev.*, **21**: 188-205.

Naveenkumar, S., Karthikeyan, N., Babu, R. N., Veeramani, P. and Sivaramakrishnan, S. (2017). Effect of organic acid salts as an alternative to antibiotic growth promoters on the production performance of commercial broiler chicken. *Int. J. Curr. Microbiol. App. Sci*, **6** (9): 3470-3480.

Neumann, A. and Suen, G. (2015). Differences in major bacterial populations in the intestines of mature broilers after feeding virginiamycin or bacitracin methylene disalicylate. *J. Appl. Microb.*, **119**: 1515–1526.

Ng'ambi, J. W., Mokgope, P. K., Brown, D. and Manyelo, T. G. (2019). Effect of dietary carrot meal supplementation on productivity and carcass characteristics

of arbor acre broiler chickens aged 22 to 42 days. *Appl. Eco. Enviro. Res.*, **17** (5): 12337-12346.

Ngoshe, A. A., Igwebuike, J. U. and Adamu, S. B. (2013). Effects of feeding carrot (*Daucus carota* L.) leaf meal on haematology, blood chemistry and carcass characteristics of growing rabbits in a semi-arid environment of Borno State of Nigeria. *Pakistan J. Nutrition*, **12** (1): 12-19.

Nicolle, C., Cardinault, N., Aprikian, O., Busserolles, J., Grolier, P., Rock, E., Demigné, C., Mazur, A., Scalbert, A., Amouroux, P. and Rémésy, C. (2003). Effect of Carrot Intake on Cholesterol Metabolism and on Antioxidant Status in Cholesterol-Fed Rat. *European J. Nutrition*, **42** (5): 254-261.

Niewold, T. (2007). The nonantibiotic anti-inflammatory effect of antimicrobial growth promoters, the real mode of action? A hypothesis. *Poult. Sci.*, **86**: 605–609.

Norin, K. E. (1997). Influence of antibiotics on some intestinal microflora associated characteristics. *Anaerobe.*, **3**: 145–148.

Ogle, M. (2013). In meat we trust: An unexpected history of carnivore America. *Houghton Mifflin Harcourt*, 384.

Patil, M. V., Kandhare, A. D. and Bhise, S. D. (2012). Pharmacological Evaluation of Ethanolic Extract of *Daucus carota* Linn Root Formulated Cream on Wound Healing Using Excision and Incision Wound Model. *Asian Paci. J. Trop. Biomed.*, **2**: 646-655.

Ponte, P. I., Prates, J. A., Crespo, J. P., Crespo, D. G., Mourãoj, L., Alves, S. P., Bessa, R. J. B., Chaveiro-soares, M. A., Ferreira, L. M. and Fontes, C. M. (2008). Improving the lipid nutritive value of poultry meat through the incorporation of dehydrated leguminous-based forage in the diet for broiler chicks. *Poult. Sci.*, **87**: 1587-1594.

Poudyal, H., Panchal, S. and Brown, L. (2010) Comparison of Purple Carrot Juice and β-Carotene in a High-Carbohydrate, High-Fat Diet-Fed Rat Model of the Metabolic Syndrome. *British J. Nutrition*, **104**: 1322-1332.

Rizal, Y., Mahata, M. E., Andriani, M. and Wu, G. (2010). Utilization of juice wastes as corn replacement in the broiler diet. *Int. J. Poult. Sci*, **9**(9): 886-889.

Rosen, G.D. (1995). Antibacterials in poultry and pig nutrition. *Biotech. Anim. feeds anim. feeding*, **12**: 172-178.

Rossi, P.G., Bao, L., Luciani, A., Panighi, J., Desjobert, J.M., Costa, J., Casanova, J., Bolla, J.M. and Berti, L. (2007). (E)-Methylisoeugenol and Elemicin: Antibacterial Components of *Daucus carota* L. Essential Oils against Campylobacter jejuni. *J. Agri. Food Chem.*, **55**: 7332-7336.

Round, J. L., O'Connell, R. M., & Mazmanian, S. K. (2010). Coordination of tolerogenic immune responses by the commensal microbiota. *J. autoimmunity*, **34** (3): 220-225.

Sacks, F.M. (2002). The role of high density lipoprotein (HDL) cholesterol in the prevention and treatment of coronary heart disease. *Int. J. Cardiol.*, **15**: 139-143.

Sahin, A. and Duru, M., (2010). Effects of *Tribulus terrestris* (Puncture vine) supplementation on performance and digestive system of broiler chicks. *Tar. Bil. Der.*, **16**: 271-277.

Salim, H. M., Huque, K. S., Kamaruddin, K. M. and Haque Beg, A. (2018). Global restriction of using antibiotic growth promoters and alternative strategies in poultry production. *Sci. pro.*, **101** (1): 52-75.

Salisu, B. A., Jokthan, G. E., Hassan, M. R., Adamu, H. Y., Yashim, S. M. and Ikani, E. (2012). Effects of inclusion levels of carrot (*Daucus carota*) leaf meal on performance of growing rabbits. *World J. Life Sci. Med. Res.*, **2** (2): 65.

Sharma, K. D., Karki, S., Thakur, N. S. and Attri, S., (2012). Chemical composition, functional properties and processing of carrot-a review. *J. Fd. Sci. Technol.*, **49**: 22-32.

Sherif, K., Rabie, M. H. and Bedair, A. I. (2018). Effect of Feeding Graded Levels of Carrot Tops Hay on Growth Performance of New Zealand White Rabbits. *J. Anim. Poult. Prod.*, **9**(7): 331-336.

Simon, P. W. (2000). Domestication, Historical Development and Modern Breeding of Carrot. *Plant Breeding Reviews*, **19**: 157-190.

Steenfeldt, S., Kjaer, J. B. and Engberg, R. M. (2007). Effect of feeding silages or carrots as supplements to laying hens on production performance, nutrient digestibility, gut structure, gut microflora and feather pecking behavior. *British Poult. Sci.*, **48**: 454-468.

Tang, K. L., Caffrey, N. P., Nóbrega, D. B., Cork, S. C., Ronksley, P. E., Barkema, H. W., ... & Ghali, W. A. (2017). Restricting the use of antibiotics in food-producing animals and its associations with antibiotic resistance in food-producing animals and human beings: a systematic review and meta-analysis. *The Lancet Planet. Heal.*, **1** (8): 316-327.

Tarique, T. M., Yang, S., Mohsina, Z., Qui, J., Zhao, J., Gang, C. and Ailiang C. (2013). Role of carotenoids in poultry industry in China. *J. Natural Sci. Res.*, **9**: 112-118.

Van Boeckel, T.P., Brower, C., Gilbert, M., Grenfell, B.T., Levin, S.A., Robinson, T.P., Teillant, A. and Laxminarayan, R. (2015). Global trends in antimicrobial use in food animals. *Proc. Nat. Acad. Sci.*, **112**: 5649-5654.

Vasudevan, M., Gunnam, K.K. and Parle, M. (2006). Anticonceptive and Anti-Inflammatory Properties of *Daucus carota* Seeds Extract. *Jour. Heal. Sci.*, **52**: 598-606.

Walsh, T. R. and Wu, Y. (2016). China bans colistin as a feed additive for animals. *Lancet Infect. Dis.,* **16**: 1102–1103.

Willis, W. L. and Reid, L. (2008). Investigating the effects of dietary probiotic feeding regimens on broiler chicken production and Campylobacter jejuni presence. *Poult. Sci.*, **87**: 606–611.

Yassin, H., Velthuis, A. G., Boerjan, M. and van Riel, J. (2009). Field study on broilers' first-week mortality. *Poult. Sci.*, **88** (4): 798-804.

Zaini, R., Clench, M. R. and Maitre, C. L. (2011). Bioactive Chemicals from Carrot (*Daucus carota*) Juice Extracts for the Treatment of Leukemia. *J. Med. Food*, **14**: 1303-1312.

Zhang, D. and Hamauzu, Y. (2004). Phenolic Compounds and Their Antioxidant Properties in Different Tissues of Carrots (*Daucus carota* L.). *J. Food Agri. Env. (JFAE)*, **2**: 95-100.

Zhang, K. Y., Yan, F., Keen, C. A. and Waldroup, P. W. (2005). Evaluation of microencapsulated essential oils and organic acids in diets for broiler chickens. *Int. J. Poult. Sci.*, **4**(9): 612-619.

APPENDICES

Appendix 1. Recorded temperature (ºC) during experiment

Weeks	Room temperature (ºC)						Average
	Period	7 A.M.	11 A.M.	3 P.M.	7 P.M.	11 P.M.	
1st	14.10.2019-20.10.2019	29.2	30.5	31.2	30.8	28.3	30.02
2nd	21.10.2019-27.10.2019	28.3	28.5	32.1	28.6	27.6	29.02
3rd	28.10.2019-03.11.2019	27.0	27.2	30.8	27.2	27.1	27.86
4th	04.11.2019-10.11.2019	28.2	30.2	30.0	28.6	26.8	28.76

Appendix 2. Recorded relative humidity (%) during experiment

Weeks	Relative humidity (%)						Average
	Period	7 A.M.	11 A.M.	3 P.M.	7 P.M.	11 P.M.	
1st	14.10.2019-20.10.2019	82	82	73	74	75	77.2
2nd	21.10.2019-27.10.2019	85	83	71	72	77	77.6
3rd	28.10.2019-03.11.2019	86	85	74	75	82	80.4
4th	04.11.2019-10.11.2019	87	86	83	77	81	82.8

Appendix 3. Feed consumption (g/bird) of 1st, 2nd, 3rd and 4th week under different treatment groups.

Treatment	Replication	1st week (g/bird)	2nd week (g/bird)	3rd week (g/bird)	4th week (g/bird)	Cumulative FC/bird (g)
T_1	R1	166	547.2	779.8	1043.5	2536.5
	R2	165	532.8	806.7	1026.9	2531.4
	R3	166	533.6	792.4	1047	2539
T_2	R1	167	534.8	802.2	1088	2592
	R2	162	537	814	1019.4	2532.4
	R3	166	533.9	761.1	1055	2516
T_3	R1	161	523.1	797.9	1027	2509
	R2	164	541.7	799.3	1026.5	2531.5
	R3	165	553.8	768.2	1016	2503
T_4	R1	157	550.8	814.2	1005	2527
	R2	156	546.7	811.6	1013.7	2528
	R3	157	551.6	818.4	1000	2527
T_5	R1	154	535.9	775.1	1048	2513
	R2	161	526.4	813.9	1032	2533.3
	R3	157	536.6	790.4	1046	2530

Appendix 4. Body weight (g/bird) of DOC, 1st, 2nd, 3rd and 4th week under different treatment groups.

Treatment	Replication	Weight of DOC (g/bird)	1st week (g/bird)	2nd week (g/bird)	3rd week (g/bird)	4th week (g/bird)
T_1	R1	47	190	573	1185	1880
	R2	47	210	552	1200	1890
	R3	47	192	568	1160	1840
T_2	R1	47	197	581	1230	1870
	R2	47	200	589	1210	1930
	R3	47	191	579	1190	1910
T_3	R1	47	200	585	1200	1880
	R2	47	205	558	1240	1970
	R3	47	195	578	1210	1850
T_4	R1	47	201	566	1220	1877
	R2	47	210	576	1220	1880
	R3	47	190	564	1260	1830
T_5	R1	47	206	583	1220	1844
	R2	47	209	602	1130	1890
	R3	47	210	582	1210	2000

Appendix 5. Average Live Weight, Eviscerated Weight and Dressing Percentage of broiler chicken of different replication under different treatment groups.

Treatment	Replication	Live Weight (g)	Eviscerated Weight (g)	Dressing Percentage (%)
T_1	R1	1820.5	1351	74.21038
	R2	1872.5	1359	72.57677
	R3	1805	1289.5	71.44044
T_2	R1	1791	1308	73.03183
	R2	1641.5	1183.5	72.09869
	R3	1880	1451	77.18085
T_3	R1	1925	1421	73.81818
	R2	1820.5	1295	71.1343
	R3	1793.5	1260.5	70.28157
T_4	R1	1898.5	1400.5	73.75897
	R2	1890	1443	76.34921
	R3	1790	1353	75.82402
T_5	R1	1836	1312.5	71.48693
	R2	1841	1320.5	71.72732
	R3	1785	1255.5	70.33613

Appendix 6. Weight of internal organs (g/bird) of broiler chicken under different treatment groups.

Treatment	Replication	Liver Weight (g)	Gizzard Weight (g)	Heart Weight (g)	Spleen Weight (g)	Bursa Weight (g)
T_1	R1(1)	44	40	10	3.5	4.5
	R1(2)	37	33	12	2	1.5
	R2(1)	38	47	14	2.5	3
	R2(2)	43	31	12.5	2	2
	R3(1)	52	44.5	9.5	1.5	3
	R3(2)	42	34	10	2	3.5
T_2	R1(1)	38.5	33.5	10	1.5	2.5
	R1(2)	39	39	11	1.5	1
	R2(1)	35	44	10.5	1.5	2
	R2(2)	41	45	9.5	2.5	2
	R3(1)	59	36	12	2	3.5
	R3(2)	48	48	14	2	3.5
T_3	R1(1)	54	49	11	2.5	4.5
	R1(2)	38.5	39.5	11.5	2	3.5
	R2(1)	43.5	42.5	13	1.5	1.5
	R2(2)	40	34.5	9.5	1.5	1.5
	R3(1)	36	36	10.5	2	3
	R3(2)	35	42	9	2	4.5
T_4	R1(1)	38	46	11	2.5	2.5
	R1(2)	39	52	13.5	3.5	4.5
	R2(1)	47	44.5	14.5	2	3
	R2(2)	48	55	15	3	2.5
	R3(1)	36	47	10	2.5	2
	R3(2)	36	49	9	2.5	3

Appendix 6 (Cont'd)

Treatment	Replication	Liver Weight (g)	Gizzard Weight (g)	Heart Weight (g)	Spleen Weight (g)	Bursa Weight (g)
T_5	R1(1)	51.5	37	10.5	2	2.5
	R1(2)	52	44	11.5	2	2.5
	R2(1)	61	39	9	1.5	3
	R2(2)	42	48	13	3	3.5
	R3(1)	46	51	11	2.5	2.5
	R3(2)	41	47	10.5	2	3

Appendix 7. Serum biochemical data in different treatment groups.

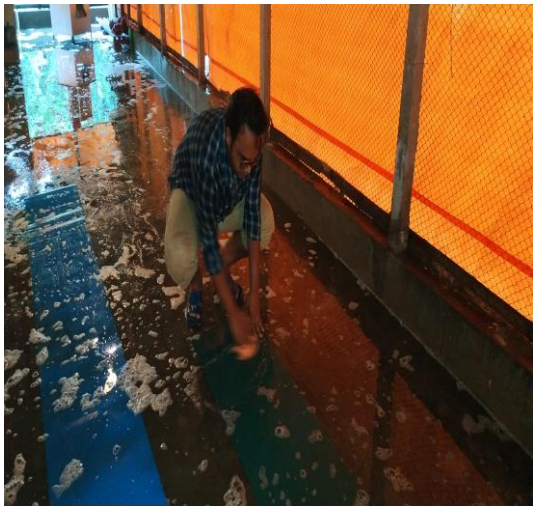
Treatment	Replication	Glucose (m. mole/L)	Cholesterol (m. mole/L)	Hemoglobin (m. mole/L)
T_1	R1(1)	15.4	4.9	7.6
	R1(2)	15.2	5.1	7.8
	R2(1)	18.3	5.6	7.1
	R2(2)	17	6.5	7.1
	R3(1)	15.5	3.7	6.2
	R3(2)	15.1	3.8	6.1
T_2	R1(1)	16.6	5.9	7.9
	R1(2)	17	4.7	6.8
	R2(1)	15.5	4.7	5.7
	R2(2)	18.4	6	6.2
	R3(1)	19.1	5.9	6.9
	R3(2)	16.3	5	6.8
T_3	R1(1)	17	4.5	8.3
	R1(2)	18.1	6.4	7.2
	R2(1)	16	5.6	5.9
	R2(2)	17	5.7	6.1
	R3(1)	17.9	3.7	8.3
	R3(2)	17.3	4.1	6.8
T_4	R1(1)	17.5	3.7	6.9
	R1(2)	17.1	4.5	6.2
	R2(1)	17.8	5	6.7
	R2(2)	16.3	5.5	6.1
	R3(1)	17.1	5.1	6.3
	R3(2)	17.5	5.6	6.8

Appendix 7 (Cont'd)

Treatment	Replication	Glucose (m. mole/L)	Cholesterol (m. mole/L)	Hemoglobin (m. mole/L)
	R1(1)	17	9.6	7.3
	R1(2)	15.6	5.5	6.6
T_5	R2(1)	16.5	4.7	6
	R2(2)	17.5	5.2	7.4
	R3(1)	17.4	4.7	7.4
	R3(2)	17	5.3	7.1

Appendix 8. Some photographs during the period of experiment conducted at SAU poultry farm.






Activities performed before and after arrival of day old broiler chicks

Appendix 8. Cont'd





Situations of broilers in farm during research period

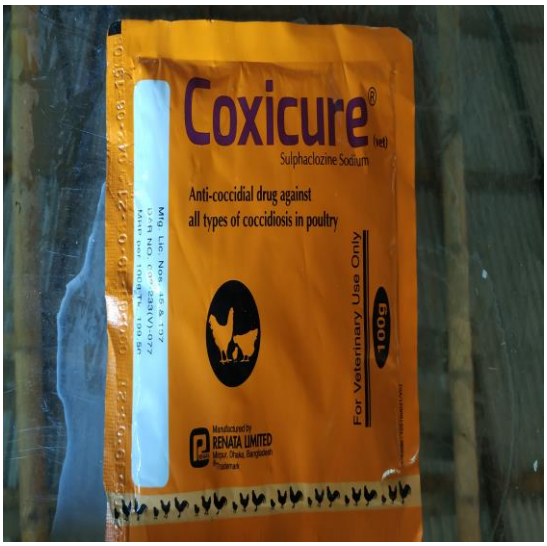
Appendix 8. Cont'd





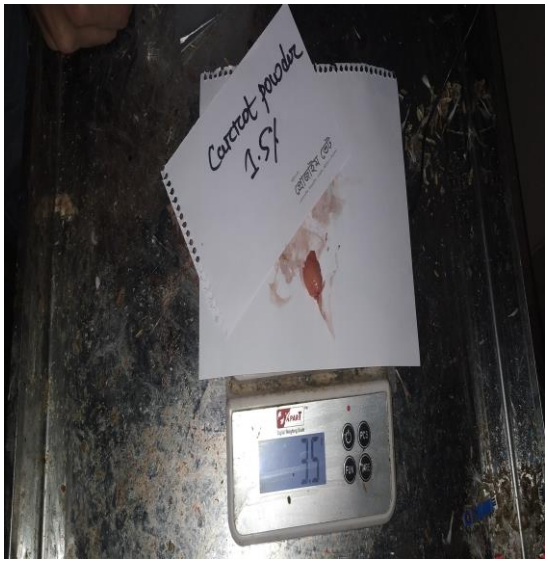

Vaccination, weight measurement and blood collection of birds

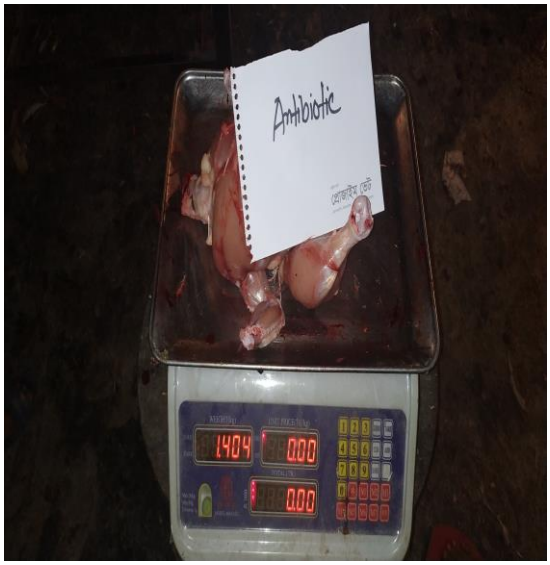
Appendix 8. Cont'd

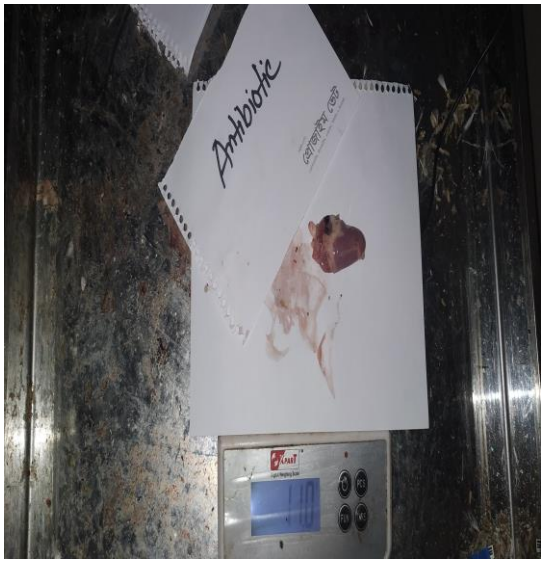


Different types of medication and vaccine used in the experiment

Appendix 8. Cont'd







Monitoring and weighing of internal organs and dressed broiler chicken