UNIVERSITI PUTRA MALAYSIA

EFFECTS OF *Lactobacillus* PROBIOTIC ON GROWTH PERFORMANCE AND COCCIDIOSIS IN BROILER CHICKENS CHALLENGED WITH *Eimeria tenella*

WAN NUR FADHILAH BINTI SHAMSUDIN

IB 2019 25

EFFECTS OF *Lactobacillus* PROBIOTIC ON GROWTH PERFORMANCE AND COCCIDIOSIS IN BROILER CHICKENS CHALLENGED WITH *Eimeria tenella*

By

WAN NUR FADHILAH BINTI SHAMSUDIN

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

February 2019

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Master of Science

EFFECTS OF *Lactobacillus* PROBIOTIC ON GROWTH PERFORMANCE AND COCCIDIOSIS IN BROILER CHICKENS CHALLENGED WITH *Eimeria tenella*

By

WAN NUR FADHILAH BINTI SHAMSUDIN

February 2019

Chairman : Norhani binti Abdullah, PhD
Faculty : Institute of Bioscience

Avian coccidiosisis is an intestinal disease caused by several species of *Eimeria* (family Eimeriidae) of the phylum Apicomplexa. Probiotics had been evaluated as an alternative to anticoccidial drugs, and although the resistance of birds to coccidiosis was enhanced, but the protective effects were not always associated with an improved growth performance. Therefore, it was necessary to find probiotic species with anti-coccidiosis activity and at the same time improved broilers growth performance when challenged with *E. tenella*. Five out of 46 lactic acid bacteria (LAB) isolates from chicken intestine demonstrated good tolerance to acidic pH 3, 0.3% bile salts and of these, three isolates showed strong adhesion to Caco-2 cells. These three isolates also showed antagonistic activity against pathogenic *E. coli* (078:K80), *Salmonella enterica serovar Typhimurium*, *C. perfringens* (Type A), *Salmonella enterica serovar Enteritidis*, *E. faecium* (FM3), *E. faecalis* (E227). All three isolates had high inhibition zone (> 6mm) against *E. coli* 078:K80 and *Salmonella enterica serovar Typhimurium* and were susceptible to antibiotics gentamicin, kanamycin, streptomycin, tetracycline, erythromycin, clindamycin, chloramphenicol and ampicillin. These isolates were identified by using 16S rRNA sequencing technique and identified as two *L. salivarius* and one *L. reuteri* with accession number MH375403, MH375402 and MH375404, respectively. The LAB isolates were evaluated for their efficacy as anticoccidiosis alternatives in broilers challenged with *E tenella*. Four dietary treatments: untreated, unchallenged broilers fed basal diet (BD); treated with anti-coccidial drug (EimeriaX 12%) and challenged (ANTI); untreated and challenged (COCCID); and treated with probiotic (*Lactobacilli* mixture at $5x10^8$ CFU/kg) and challenged (PRO); were used in a feeding trial of 42 days with 40 chicks (Cobb 500) per treatment divided into 5 replicates. All groups, except BD, were challenged with $2x10^4$/mL of *E. tenella* oocysts on day 14 of broilers age. The results showed that broilers fed PRO diet had comparable body weight and feed conversion ratio (FCR) compared to BD and ANTI groups. Broilers of COCCID group had significantly lower ($P<0.05$) body weight and higher FCR. The lesion score was only detected in both infected chickens of PRO and COCCID groups at day 21 and was not detected at day 42. Oocyst count was significantly higher ($P<0.05$) in the COCCID group, compared to PRO

and ANTI groups. The population of *Lactobacillus* spp. and *Bifidobacterium* spp., as well as villus and crypt depth were significantly higher ($P<0.05$) in the PRO group, while the populations of *E. coli* and *C. perfringens* were lower. In conclusion, the isolated LAB probiotics could improve the growth performance and alleviate the effects of coccidiosis infection when challenged with *E. tenella*, comparable to broilers treated with anticoccidial drug.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

KESAN PROBIOTIK *Lactobacillus* TERHADAP PRESTASI PERTUMBUHAN DAN KOKSIDIOSIS DALAM AYAM PEDAGING YANG DI CABAR DENGAN *Eimeria tenella*

Oleh

WAN NUR FADHILAH BINTI SHAMSUDIN

Februari 2019

Pengerusi : Norhani binti Abdullah, PhD
Fakulti : Institut Biosains

Koksidiosis poltri ialah penyakit usus yang disebabkan oleh beberapa spesis *Eimeria* (keluarga Eimeriidae) filum Apikompleksa. *Eimeria tenella* adalah paling patogenik. Antikoksidiosis koksidiosid, koksidiostat dan ionofor digunakan untuk mengawal koksidiosis. Kesedaran mengenai keselamatan kesihatan pengguna yang dikaitkan dengan residu ubat di dalam rangkai makanan mencetuskan larangan dan penggantian ubatan sintetik kepada makanan tambahan seoerti probiotik. Sebagai alternatif kepada ubatan antikoksid, probiotik dapat meningkatkan rintangan burung kepada koksidiosis dengan berkesan, tetapi kesannya tidak sentiasa berkait dengan prestasi penumbuhan. Lantaran itu, adalah perlu untuk mengasingkan probiotik baru yang menunjukkan aktiviti antikoksidiosis dan berkeasn positif terhadap pertumbuhan ayam pedaging yang dijangkiti *E. tenella*. Lima daripada 46 isolat bakteria asid laktik yang diasingkan daripada usus ayam menunjukkan toleransi baik terhadap pH 3, 0.3% garam hempedu, dan tiga daripadanya menunjukkan lekatan tertinggi kepada sel Caco-2. Tiga isolat ini juga menunjukkan aktiviti antagonistik terhadap patogen *E. coli* (078:K80), *Salmonella enterica serovar Typhimurium, C. perfringens* (Type A), *Salmonella enterica serovar Enteritidis, E. faecium* (FM3), *E. faecalis* (E227). Semua ketiga isolat ini memberikan kesan perencatan yang tinggi (nilai>6mm) terhadap *E. coli* (078:K80) dan *Salmonella enterica serovar Typhimurium* juga rentan terhadap antibiotik gentamisin, kanamisin, streptomisin, tetrasiklin, eritromisin, klindamisin, kloramfenikol dan ampisilin. Isolat ini dikenalpsti melalui jujukan 16S rRNA sebagai dua *L. salivarius* dan satu *L. reuteri* dengan nombor kemasukan masing-masing MH375403, MH375402 dan MH375404. Bakteria asid laktik dinilai keberkesanan sebagai alternatif antikoksidiosis kepada ayam pedaging yang dicabar *E. tenella*. Empat rawatan pemakanan: ayam pedaging tidak dirawat atau dicabar (BD); dirawat dengan antikoksid (EimeriaX 12%) dan dicabar (ANTI); tidak dirawat dan dicabar (COCCID); dirawat dengan probiotik (campuran *Lactobacillus* isolat pada kadar $5x10^8$ CFU/kg) dan dicabar (PRO), digunakan dalam kajian selama 42 hari dengan 40 ekor anak (Cobb 500) setiap kumpulan dibahagi kepada 5 replikat. Setiap kumpulan, kecuali BD dicabar dengan $2x10^4$/mL oosis *E. tenella* pada umur 14 hari. Keputusan percubaan menunjukkan ayam yang diberi probiotik

mempunyai berat badan dan kadar penukaran makanan (FCR) yang tinggi berbanding kumpulan BD dan ANTI. Ayam kumpulan COCCID menunjukkan berat badan yang paling rendah dan FCR tertinggi. Skor luka hanya dikesan pada kedua-dua kumpulan PRO dan COCCID pada umur 21 hari tetapi tidak pada umur 42 hari. Kiraan oosis tinggi secara ketara ($P<0.05$) pada kumpulan COCCID dibandingkan dengan PRO dan ANTI. Populasi *Lactobacillus* spp. dan *Bifidobacterium* spp. vilus dan kedalaman *crypt* adalah tinggi secara ketara ($P<0.05$) pada kumpulan PRO manakala populasi *E. coli* dan *C. perfringens* rendah. Sebagai kesimpulan, probiotik bakteria asid laktik boleh menambahbaik prestasi pertumbuhan ayam pedaging dan mengurangkan kesan jangkitan koksidiosis apabila dicabar dengan *E. tenella* setanding dengan ayam pedaging yang diberi ubat antikoksid.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude and thanks to Professor Dr. Ho Yin Wan, my first main supervisor who had retired form UPM. She had given me valuable ideas and constructive suggestions to support my study.

I wish to record my deep appreciation and most sincere gratitude to the late Associate Professor Dr. Sieo Chin Chin, my second main supervisor, who passed away in October 2015. Her valuable guidance and support, for the experimental part of the study, will be always remembered. Her warm, engaging and friendly approach has boosted my confidence throughout the study.

I wish to thank my present Supervisory Committee, Dr. Norhani Abdullah, as the main supervisor and Associate Professor Dr. Wan Zuhainis Saad, as the co-supervisor for their encouragement and helpful suggestions in preparing the thesis.

"My life is so blessed with some of the most amazing people.
Thank you for being part of my journey……"

I am indebted to Agro-Biotechnology Institute, Malaysia (ABI) especially to Mr Loo Shu San, the project leader of this research grant, for his trust in me to be involved in the project. I am grateful to the Ministry of Science, Technology and Innovation (MOSTI) for the ScienceFund grant scheme under the project "Evaluation of probiotic formulation for the control of coccidiosis in broiler chickens" (02-05-19-SF007).

I also wish to express my sincere gratitude to Professor Dr. Wan Kiew Lian, (School of Bioscience and Technology, Universiti Kebangsaan Malaysia) for the hospitality, facility and guidance especially during the feeding trial experiments.

Words are not enough to describe my heartfelt appreciations to Mr. Khairul Kamar Bakri, Mr. Nagayah Muniandy, Madam Haw Ah Kam, Puan Noor Nadia Mohd Sohaili from The Probiotic and Prebiotic Technology Programme, Laboratory of Vaccine and Immunotherapeutics, for their invaluable assistance.

I am very glad to have my fellow lab mates and good friends to help me through this part of my life and always answered my silly little questions. My sincere thanks to all - Shirley, Helen, Shaufi, Lily, Sam, Wei Li, Zira, Irnada, Ninie, Wani, and Intan from Universiti Kebangsaan Malaysia.

"The best things in life are the people you love, the places you've seen,
and the memories you've made along the way…"

Finally, and most importantly, to my beloved parents, brothers and sisters, for all their endless love, untiring patience, trust, support, and full confidence in me throughout this journey.

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

Norhani Abdullah, PhD
Professor
Institute of Tropical Agriculture and Food Security
Universiti Putra Malaysia
(Chairman)

Wan Zuhainis Saad, PhD
Associate Professor
Faculty of Biotechnology and Biomolecular Sciences
Universiti Putra Malaysia
(Member)

Wan Kiew Lian, PhD
Professor
School of Bioscience and Biotechnology
Universiti Kebangsaan Malaysia
(Member)

_____
ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: _____ Date: _____

Name and Matric No.: Wan Nur Fadhilah Binti Shamsudin, GS35330

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature:	
Name of Chairman of Supervisory Committee:	Professor Dr. Norhani Abdullah
Signature:	
Name of Member of Supervisory Committee:	Associate Professor Dr. Wan Zuhainis Saad
Signature:	
Name of Member of Supervisory Committee:	Professor Dr. Wan Kiew Lian

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS

AGP	Antibiotic Growth Promoter
AME	Apparent metabolisable energy
ATCC	American Type Culture Collection
AST	Aspartate Aminotransferase
BLAST	Basic Local Alignment Search Tool
bp	Base pair
BW	Body weight
BWG	Body weight gain
Ca	Calcium
$CaCl_2$	Calcium chloride
CFU	Colony forming unit
Cl	Chloride
cm	Centimeter
Co	Cobalt
Cu	Copper
DMEM	Dulbecco's Modified Eagle Medium
DVS	Department of Veterinary Services
dH_2O	Distilled water
DNA	Deoxyribonucleic acid
dNTP	Deoxyribonucleotide Triphosphate
EDTA	Ethylenediaminetetraacetic acid
EFSA	European Food Safety Authority
EU	European Union
FAO	Food and Agriculture Organization
FBAs	Free Bile Acids
FBS	Fetal bovine serum
Fe	Iron
FCR	Feed conversion ratio
FDA	Food and Drug Administration
g	Grams
GE	Gross energy
GIT	Gastrointestinal tract
h	Hour
Hb	Hemoglobin
H_2O	Water
HCl	Hydrogen chloride
HDL	High-density Lipoprotein
H:L	Heterophils:Lymphocytes
IDF	International Dairy Federation

IgA	Immunoglobulin A
ISO	International Organization for Standardization
IST	ISO-Sensitest
K	Potassium
Kcal	Kilocalories
KCl	Potassium chloride
kg	Kilogram
LAB	Lactic Acid Bacteria
LDL	Low-density Lipoprotein
LIVES	Laboratory Of Vaccines and Immunotherapeutics
LSM	Lactic Acid Bacteria Susceptibility Test Medium
MARDI	Malaysian Agricultural Research and Development Institute
MCHC	Mean Corpuscular Hemoglobin Concentration
MCV	Mean Corpuscular Volume
Mg	Magnesium
$MgSO_4$	Magnesium sulphate
MICs	Minimal Inhibitory Concentrations
MIU	Million international units
min	Minutes
mg	Milligram
mL	Milliliter
mm	Milimeter
Mn	Manganese
MRS	De Man, Rogosa and Sharpe
N	Nitrogen
Na	Sodium
NaCl	Sodium chloride
NaOH	Sodium hydrochloride
NCBI	National Center for Biotechnology Information
ND	No detected
NRC	National Research Council
nm	Nanometer
OD	Optical density
P	Phosphorus
PBS	Phosphate Buffered Saline
PCR	Polymerase chain reaction
PCV	Packed Cell Volume

PenStrep	Penicillin-Streptomycin
pH	Potential of Hydrogen
PKE	Palm Kernel Expeller
RBC	Red Blood Cell
rpm	Ram per minutes
RNA	Ribonucleic acid
rRNA	Ribosomal ribonucleic acid
s	Seconds
Se	Selenium
sp.	Species
SPSS	Statistical package for the Social Science
UPM	Universiti Putra Malaysia
USA	United State of America
UV	Ultraviolent
v/v	Volume per volume
WBC	White blood cell
WHO	World Health Organization
w/v	Weight per volume
vol	Volume
Zn	Zinc
µg	Microgram
µL	Microliter
x *g*	Gravity force

CHAPTER 1

INTRODUCTION

The demand for poultry meat and poultry products is increasing, due to the increase in population density and consumption of poultry products as the primary protein source (The Poultry Site, 2014). Malaysia is considered self-sufficient in poultry meat and eggs, where 90% of the production is in Peninsular Malaysia, and the rest in East Malaysia.

In poultry rearing, the high-density stocking rate requires proper management to alleviate problems related to the stressful conditions which may cause problems associated to infectious disease that may affect productivity (Baracho et al., 2006). Infectious disease can be caused by pathogens consisting of bacteria, viruses and protozoa (Elmusharaf and Beynen, 2007; Alexander et al., 2008; Ricke, 2014). Pathogenic *E. coli* causes a variety of diseases known as colibacillosis, which causes enteric disease and increases mortality rate in chickens, and results in economic losses in the poultry industry (Kumar et al., 2004). Salmonellae infections constitute a serious health, breeding and economic problem especially in poultry farms. Coccidiosis is another disease caused by protozoan parasite which infects the intestinal system of poultry (Tewari and Maharana, 2011). Current approaches to counter avian coccidiosis involve the use of anticoccidial chemicals, vaccines and natural products. Anticoccidial chemicals, coccidiocides, coccidiostats, and ionophores, have long been used as a thought strategy to manage avian coccidiosis in current poultry production (Chapman et al., 2010). However, *Eimeria* species have developed resistance to both chemical and ionophore drugs over time (Stringfellow et al., 2011). As such, the employment of live vaccines to manage coccidiosis has greatly raised. However, early and uniform administration of live oocysts as vaccine results in a low-level infection, necessary for immunity development, but it can cause an early reduction in growth and may increase the chick's susceptibility to secondary infections, such as necrotic enteritis.

The use of antibiotics is practised to ensure health and growth performance of the birds. The use of antibiotic as growth promoters and infection control in animal feed has been reported for about 50 years ago (Hao et al., 2014). In Malaysia specifically, the Department of Veterinary Services (DVS) produced specific guidelines on concentration of drugs or antibiotics that can be used by the local farmers (DVS, 2006). Although poultry production is well managed, but the concern about antibiotic residues in the poultry products as well as the emergence of antibiotic resistance genes in the pathogens have become a great concern worldwide (Castanon, 2007). There are reports showing that the residue of the antibiotic growth promoters in poultry products may cause harm to the consumers (Chapman et al., 2013; Reid et al., 2014). These phenomena have trigger serious efforts by researchers to find safe alternatives to avoid dependency on harmful drugs for enhancing poultry production (Floros et al., 2010).

The Food and Drug Administration (FDA) has projected a ban on using antibiotics at subtherapeutic levels in feed attributable to the potential for compromising the health of humans. However, a large phase of the regulated trade, as well as farmers and ranchers, has contended that in nearly thirty years of use, antibiotics at subtherapeutic levels in

animals haven't compromised human or animal health or influenced the medical aid of human sickness (Be'er et al., 2009). The first country to ban the use of nontherapeutic antibiotic was Sweeden in 1986 as requested by the Federation of Sweedish Farmers and continue to stop all prophylactic medication in 1988. Denmark restricts direct sale of therapeutic antimicrobials from veterinarians and limits veterinary profits from antimicrobial sales in 1994 and Germany bans the use of avoparcin in 1996. European Union (EU) strictly bans use of all antibiotic growth promoters in 2006 (Cogliani et al., 2011).

Coccidiosis, the most common parasitic disease in poultry, is known to develop through a combination of several different species of the parasites as each species has its own specific location in the intestine (Elmusharaf and Beynen, 2007). So far, nine *Eimeria* species, *E. acervulina*, *E. brunetti*, *E. maxima*, *E. necatrix*, *E. praecox*, *E. mitis*, *E. tenella*, *E. mivati*, and *E. hagani*, have been identified from chickens (Joyner and Long, 1974). The *E. tenella* is found to be one of the most pathogenic species as it can survive outside of the intestine and infect others in the same flock, thus spreading the disease (Tewari and Maharana, 2011). To date, the occurrence of coccidiosis has resulted in great losses in poultry production (Giannenas et al., 2012).

The increasing demand by customers for drug residue free poultry and poultry products has led to the event of other ways for the treatment and management of avian diseases. There is a number of options for minimising or substituting antimicrobials use, such as, vaccination, feed additives like enzymes, prebiotic, probiotic, acidifiers, plant extracts, essential oils and yeast (FAO 2010) . Natural products are emerging as an attractive way to combat coccidiosis. Antioxidant rich essential oils have been evaluated to alleviate the damage caused by oxidative stress during coccidiosis. However, results are very divergent and often not as satisfactory as expected (Idris et al., 2017). Several challenges in the anticoccidial use of natural products such as anticoccidial efficacy, identification of active compounds, mechanism, safety, and cost-effectiveness of plant extracts and compounds need to be overcome prior to large scale applications (Muthamilselvan et al., 2016).

Probiotics have long been considered as alternatives to the antibiotics (Menconi et al., 2014). Probiotics are "live organisms which when administered in adequate amounts confer a health benefit on the host" (FAO/WHO, 2001). They have been reported to improve health of the host animal by enhancing the beneficial microflora, improving the host resistance to pathogenic microorganisms, and increasing the level of immunomodulation of the host (Jin et al., 1998). Most common bacterial probiotics species in poultry belong to *Lactobacillus*, *Streptococcus*, *Bacillus*, *Bifidobacterium*, *Enterococcus*, *Aspergillus*, *Candida*, and *Saccharomyces* (Kabir, 2009). Some of the important criteria for a probiotic bacterial species are it must be a normal inhabitant of the gut, able to adhere to intestinal epithelium, to survive at low pH and exposure to bile salt, to compete with other microorganisms in the gastrointestinal tract, to increase immune response, and to maintain high viability rate in normal storage condition (Walker and Gilliland, 1993).

A number of studies have been conducted to evaluate the efficacy of probiotics to alleviate the effects of coccidiosis in poultry. Ritzi et al. (2016) reported that the combination of probiotics and coccidiosis vaccines (*Eimeria* oocysts) could enhance

performance and provide protective effect against a mixed Eimeria challenged. Similarly, Bozkurt et al. (2014) also observed that probiotics and prebiotics supplementation to chickens exposed to experimental coccidiosis alleviated the influence of the disease and lessen the depression in growth. In another study, Lee et al. (2007) also observed that *Pediococcus*-based probiotic effectively enhanced the resistance of birds but partially alleviated the negative growth effects associated with coccidiosis. On the other hand, Abu-Akkada and Awad, (2015) reported that multispecies probiotic mix (Lacto G®) supplementation to broilers prevented mortality, reduced oocyst output and the severity of *E. tenella* lesions, but the protective effects were not associated with an improved growth performance. Abdelrahman et al. (2014) also reported that broilers that received the several-species host-specific probiotic (PoultryStar) in their diet performed hugely same as to broilers that received salinomycin in terms of overall feed conversion ratio, oocyst shedding, mortality, and intestinal lesions. However, body weights of broilers in the probiotic group at d 42 were significantly lower than the salinomycin or unchallenged group. Similarly, Lee et al. (2007b) reported that MitoGrow (as a probiotic) administered to *E. tenella*-infected birds, did not improve weight gains or oocyst output.

These findings clearly demonstrated the positive effects of probiotics in enhancing resistance of birds towards coccidiosis, but the positive effects on growth performance of birds challenged with *Eimeria* infection were not apparent.

Problem statement

Several probiotics have been shown to protect broiler chickens against coccidiosis, but the protective effects were not always associated with an improved broilers growth performance. Therefore, it was imperative to find probiotics species which possess anti-coccidiosis activity and at the same time capable of improving broilers growth performance when challenged with *E. tenella*.

Objective

The main objective of the study was to isolate and screen beneficial bacteria with probiotic properties and anti- coccidial activity as feed additive for broiler chicken.
The specific objectives were:

i. To isolate and characterize beneficial *Lactobacillus* spp. from broiler chicken intestine with probiotic properties.

ii. To evaluate the efficacy of isolated probiotics in the performance of broiler chickens challenged with *Eimeria tenella.*

REFERENCES

Abbas Hilmi, H. T., Surakka, A., Apajalahti, J., and Saris, P. E. J. (2007). Identification of the most abundant *Lactobacillus* species in the crop of 1- and 5-week-old broiler chickens. *Applied and Environmental Microbiology*. 73(24): 7867–7873.

Abdel-Hafeez, H. M., Saleh, E. S. E., Tawfeek, S. S., Youssef, I. M. I., and Abdel-Daim, A. S. A. (2017). Effects of probiotic, prebiotic, and synbiotic with and without feed restriction on performance, hematological indices and carcass characteristics of broiler chickens. *Asian Journal of Poultry Science*. 30(5): 672–682.

Abdelrahman, W., Mohnl, M., Teichmann, K., Doupovec, B., Schatzmayr, G., Lumpkins, B., and Mathis, G. (2014). Comparative evaluation of probiotic and salinomycin effects on performance and coccidiosis control in broiler chickens. *Poultry Science*. 93(12): 3002–3008.

Abu Akkada, S.,S. and Awad, A., M. (2015). Protective Effects of Probiotics and Prebiotics on *Eimeria tenella*-Infected Broiler Chickens. *Pakistan Veterinary Journal*. 35(4): 446-450.

Adil, S., Banday, T., Bhat, G. A., Salahuddin, M., Raquib, M., and Shanaz, S. (2011). Response of broiler chicken to dietary supplementation of organic acids. *Journal of Central European Agriculture*. 12(3): 498–508.

Aguilar-Toalá, J. E., Garcia-Varela, R., Garcia, H. S., Mata-Haro, V., González-Córdova, A. F., Vallejo-Cordoba, B., and Hernández-Mendoza, A. (2018). Postbiotics: An evolving term within the functional foods field. *Trends in Food Science and Technology*. *75*: 105–114.

Ahmad, T. A., Tawfik, D. M., Sheweita, S. A., Haroun, M., and El-Sayed, L. H. (2016). Development of immunization trials against *Acinetobacter baumannii*. *Trials in Vaccinology*. 5: 53–60.

Aka-gbezo, S., Konan, A. G., Cho, M. N., Achi, P., Koffi-nevry, R., Koussemon-camara, M., and Bonfoh, B. (2017). Screening of antimicrobial activity of lactic acid bacteria isolated from anango baca slurry , a spontaneously fermented maize product used in Côte d'Ivoire. *International Journal of Biological and Chemical Sciences*. 11(6): 2616–2629.

Al-Gawad, A. A., Mahdy, O. A., El-Massry, A. A. N., and Al-Aziz, M. S. A. (2012). Studies on coccidia of Egyptian balady breed chickens. *Life Science Journal*. 9(3): 568–576.

Al-Saadoon, Z. M., and Al-Rubaie, H. M. A. (2013). Effects immunization with oocyst of *Eimeria tenella* sonicate on some blood parameters of broiler chickens. *Al-Anbar Journal of Veterinary Science*. 6(2): 1–7.

Alagawany, M., Abd El-Hack, M. E., Farag, M. R., Sachan, S., Karthik, K., and Dhama, K. (2018). The use of probiotics as eco-friendly alternatives for antibiotics in

poultry nutrition. *Environmental Science and Pollution Research*. 25(11): 10611–10618.

Alexander, J., Atli Auðunsson, G., Benford, D., Cockburn, A., Cravedi, J.P., Dogliotti, E., and Verger, P. (2008). Cross-contamination of non-target feedingstuffs by salinomycin authorised for use as a feed additive. *The EFSA Journal*. 591: 1–38.

Allen, P. C., and Fetterer, R. H. (2002). *Recent Advances in Biology and Immunobiology of. Cytokine*. 15(1): 58–65.

Amerah, A. M., Romero, L. F., Awati, A., and Ravindran, V. (2017). Effect of exogenous xylanase , amylase , and protease as single or combined activities on nutrient digestibility and growth performance of broilers fed corn/soy diets. *Poultry Science*. 96(4): 807–816.

Amit-Romach, E., Sklan, D., and Uni, Z. (2004). Microflora ecology of the chicken intestine using 16S ribosomal DNA primers. *Poultry Science*. 83(7): 1093–1098.

Andrabi, S. T., Bhat, B., Gupta, M., and Bajaj, B. K. (2016). Phytase-producing potential and other functional attributes of lactic acid bacteria isolates for prospective probiotic applications. *Probiotics and Antimicrobial Proteins*. 8(3): 121–129.

Apata, D. (2008). Growth performance, nutrient digestibility and immune response of broiler chicks fed diets supplemented with aculture of *Lactobacillus bulgaricus*. *Journal of the Science Of Food and Agriculture*. 88: 125–135.

Awad, W. A., Ghareeb, K., Abdel-Raheem, S., and Böhm, J. (2009). Effects of dietary inclusion of probiotic and synbiotic on growth performance, organ weights, and intestinal histomorphology of broiler chickens. *Poultry Science*. 88(1): 49–55.

Bannister, L. H. and Mitchell, G. H. (1989). The fine-structure of secretion by Plasmodium knowlesi merozoites during red-cell invasion *Journal of Protozoology*. 36: 362-367.

Baracho, M., Camargo, G., Lima, A., Mentem, J., Moura, D., Moreira, J., and Nääs, I. (2006). Variables impacting poultry meat quality from production to pre-slaughter: a review. *Brazilian Journal of Poultry Science*. 8(4): 201–212.

Baurhoo, B., Phillip, L., and Ruiz-Feria, C. A. (2007). Effects of purified lignin and mannan oligosaccharides on intestinal integrity and microbial populations in the ceca and litter of broiler chickens. *Poultry Science*. 86(6): 1070–1078.

Be'er, A., Zhang, H. P., Florin, E.-L., Payne, S. M., Ben-Jacob, E., and Swinney, H. L. (2009). Deadly competition between sibling bacterial colonies. *Proceedings of the National Academy of Sciences*. 106(2): 428–433.

Bedford, M. (2000). Removal of antibiotic growth promoters from poultry diets: implications and strategies to minimise subsequent problems. *World's Poultry Science Journal*. 56(04): 347–365.

Bernama. (2016). Malaysia targets antibiotics-free chicken by 2020. March 2016. Retrieved from http://www.malaysiakini.com/news/333981.

Bernet, M. F., Brassart, D., Neeser, J. R., and Servin, A. L. (1994). *Lactobacillus acidophilus* LA 1 binds to cultured human intestinal cell lines and inhibits cell attachment and cell invasion by enterovirulent bacteria. *Gut*. 35(4): 483–489.

Beski, S. S., and Al-Sardary, S. Y. T. (2015). Effects of Dietary Supplementation of Probiotic and Synbiotic on Broiler Chickens Hematology and Intestinal Integrity. *International Journal of Poultry Science*. 14(1): 31–36.

Besteiro, S., Michelin, A., Poncet, J., Dubremetz, J. F., and Lebrun, M. (2009). Export of a *Toxoplasma gondii* rhoptry neck protein complex at the host cell membrane to form the moving junction during invasion. *PLoS Pathogens*. 5(2): 1-14.

Binder, H.J., B., Filburn, and M., Floch. (1975). Bile acid inhibition of intestinal anaerobic organisms. *The American Journal of Clinical Nutrition*. 28(2): 119–125.

Black, J.G. (2008). Microbiology. John Wiley and Sons (Asia) Pte. Ltd. Seventh Edition.

Booth, C., and Shea, J. a O. (2002). *Isolation and Culture of Intestinal Epithelial Cells. Culture.* 8: 303-335.

Bozkurt, M., Aysul, N., Küçükyilmaz, K., Aypak, S., Ege, G., Çatli, A. U., and Cinar, M. (2014). Efficacy of in-feed preparations of an anticoccidial, multienzyme, prebiotic, probiotic, and herbal essential oil mixture in healthy and *Eimeria* spp.-infected broilers. *Poultry Science*. 93(2): 389–399.

Broz, J., and Paulus, C. (2016). Eubiotics: Definition and different concepts. DSM 1-3. Retrieved from : https://www.dsm.com/anh/en/feedtalks/eubiotics-definition-and-different-concepts.html (Last accessed: 15 August 2018)

Buck, B. L., Altermann, E., Svingerud, T., and Klaenhammer, T. R. (2005). Functional Analysis of Putative Adhesion Factors in *Lactobacillus acidophilus* NCFM Functional Analysis of Putative Adhesion Factors in *Lactobacillus acidophilus* NCFM. *Applied and Environmental Microbiology*. 71(12): 8344–8351.

Bujnakova, D., Strakova, E., and Kmet, V. (2014). *In vitro* evaluation of the safety and probiotic properties of *Lactobacilli* isolated from chicken and calves. *Anaerobe.* 29: 118–127.

Butaye, P., Devriese, L. A., and Haesebrouck, F. (2003). Antimicrobial growth promoters used in animal feed : effects of less well known antibiotics on gram-positive bacteria. *Clinical Microbiology Reviews.*16(2): 175–188.

Cao, G. T., Zeng, X. F., Chen, A. G., Zhou, L., Zhang, L., Xiao, Y. P., and Yang, C. M. (2013). Effects of a probiotic, *Enterococcus faecium*, on growth performance, intestinal morphology, immune response, and cecal microflora in broiler chickens challenged with *Escherichia coli* K88. *Poultry Science*. 92(11): 2949–2955.

Carasi, P., Díaz, M., Racedo, S. M., Antoni, G. De, Urdaci, M. C., and Serradell, M. de los A. (2014). Safety characterization and antimicrobial properties of kefir-isolated *Lactobacillus kefiri*. *BioMed Research International*. 2014: 1–7.

Carter, A., Adams, M., La Ragione, R. M., and Woodward, M. J. (2017). Colonisation of poultry by *Salmonella Enteritidis* S1400 is reduced by combined administration of *Lactobacillus salivarius* 59 and *Enterococcus faecium* PXN-33. *Veterinary Microbiology*. 199: 100–107.

Castanon, J. I. R. (2007). History of the use of antibiotic as growth promoters. *Poultry Science*. 86(11): 2466–2471.

Chandok, H., Shah, P., Akare, U. R., Hindala, M., Bhadoriya, S. S., Ravi, G. V., and Nayarisseri, A. (2014). Screening, isolation and identification of probiotic producing *Lactobacillus acidophilus* Strains EMBS081 and EMBS082 by 16S rRNA Gene Sequencing. *Interdisciplinary Sciences: Computational Life Sciences*. 7(3): 242–248.

Chapman, H. D., Barta, J. R., Blake, D., Gruber, A., Jenkins, M., Smith, N. C., and Tomley, F. M. (2013). A Selective Review of Advances in Coccidiosis Research . *Advances in Parasitology*. 83: 93-171.

Chapman, H. D., Jeffers, T. K., and Williams, R. B. (2010). Forty years of monensin for the control of coccidiosis in poultry. *Poultry Science*. 89(9): 1788–1801.

Chen, Y.-C., Travers, R. L., Walhin, J.-P., Gonzalez, J. T., Koumanov, F., Betts, J. A., and Thompson, D. (2017). Feeding influences adipose tissue responses to exercise in overweight men. *American Journal of Physiology - Endocrinology And Metabolism*. 313(1): E84–E93.

Choct, M. (2006). Enzymes for the feed industry: past, present and future. *World's Poultry Science Journal*. 62(01): 5–16.

Cogliani, C., Goossens, H., and Greko, C. (2011). Restricting Antimicrobial Use in Food Animals: Lessons from Europe. *Microbe*. 6(6): 274–279.

Conway, D. P., and McKenzie, M. E. (2007). Poultry coccidiosis: diagnostic and testing procedures. Poultry coccidiosis. Blackwell Publishing. Third Edition.

Costa, E., Uwiera, R. R., Kastelic, J. P., Selinger, L. B., and Inglis, G. D. (2011). Non-therapeutic administration of a model antimicrobial growth promoter modulates intestinal immune responses. *Gut Pathogens*. 3(1): 1–15.

Cotter, P. D., and Hill, C. (2003). Antimicrobial activity - The most important property of probiotic and starter lactic acid bacteria. *Food Technology and Biotechnology*. 67(3): 429–453.

Dalloul, R. a, Lillehoj, H. S., Shellem, T. a, and Doerr, J. a. (2003). Enhanced mucosal immunity against *Eimeria acervulina* in broilers fed a *Lactobacillus*-based probiotic. *Poultry Science*. 82(1): 62–66.

Damayanti, E., Julendra, H., Sofyan, A., and Hayati, S. N. (2016). Bile salt and acid tolerant of lactic acid bacteria isolated from proventriculus of broiler chicken. *Media Pertenakan*. 37(2): 80-86.

Das, O., Savsani, H. H., Padodara, R. J., Garg, D. D., Marandi, S., and Barad, N. (2016). Effect of dietary prebiotics, probiotics and synbiotics as feed additives on blood. *International Journal of Science, Environment and Technology*. 5(5): 3546–3552.

Dec, M., Puchalski, A., Urban-Chmiel, R., and Wernicki, A. (2014). Screening of *Lactobacillus* strains of domestic goose origin against bacterial poultry pathogens for use as probiotics. *Poultry Science*. 93(10): 2464–2472.

Dibner, J. J., and Richards, J. D. (2005). Antibiotic growth promoters in agriculture : history and mode of action. *Poultry Science*. 84(4): 634–643.

Duary, R. K., Rajput, Y. S., Batish, V. K., and Grover, S. (2011). Assessing the adhesion of putative indigenous probiotic lactobacilli to human colonic epithelial cells. *Indian Journal of Medical Research*. 134(11): 664–671.

Dubremetz, J. F., Garcia-Réguet, N., Conseil, V., and Fourmaux, M. N. (1998). Apical organelles and host-cell invasion by Apicomplexa. *International Journal for Parasitology*. 28(7): 1007–1013.

Dunshea, F. R., D'Souza, D. N., Jensen, B. B., and Engberg, R. M. (2014). Meat, Animal, Poultry And Fish Production And Management Antibiotic Growth Promotants. *Encyclopedia of Meat Sciences*. Elsevier Ltd. 2: 172-176.

DVS (2006). Guide to Poultry Meat Production, Poultry Unit, Department of Veterinary Services, Putrajaya. Jun 2006: 1- 45.

Eckert, C. G., Kalisz, S., Geber, M. A., Sargent, R., Elle, E., Cheptou, P. O., and Winn, A. A. (2010). Plant mating systems in a changing world. *Trends in Ecology and Evolution*. 25(1): 35–43.

Ehrmann, M. a., Kurzak, P., Bauer, J., and Vogel, R. F. (2002). Characterization of lactobacilli towards their use as probiotic adjuncts in poultry. *Journal of Applied Microbiology*. 92(5): 966–975.

El-Ghany, W. A. A. (2010). Comparative evaluation on the effect of coccidiostate and symbiotic preparations on prevention of *Clostridium perfringens* in broiler chickens. *Global Veterinaria*. 5(6): 324–333.

El-Kholy, A. M., El-Shinawy, S. H., Meshref, A. M. S. M. S., and Korny, A. M. M. (2014). Screening of antagonistic activity of probiotic bacteria against some food-borne pathogens. *Journal of Applied and Environmental Microbiology*. 2(2): 53–60.

El-sissi, A. F., and Mohamed, S. H. (2011). Impact of Symbiotic on the Immune Response of Broiler Chickens Against NDV and IBV Vaccines. *Global Journal of Biotechnology and Biochemistry*. 6(4): 186–191.

Elmusharaf, M. A., and Beynen, A. C. (2007). Coccidiosis in poultry with emphasis on alternative anticoccidial treatments. *Annals of the World Association on Animal Pathology*. 9–44.

Erdoĝan, Z., Erdoĝan, S., Aslantaş, Ö., and Çelik, S. (2010). Effects of dietary supplementation of synbiotics and phytobiotics on performance, caecal coliform population and some oxidant/antioxidant parameters of broilers. *Journal of Animal Physiology and Animal Nutrition*. 94(5): e40-e48.

Fair, R. J., and Tor, Y. (2014). Perspectives in medicinal chemistry antibiotics and bacterial resistance in the 21st century. *Perspectives in Medicinal Chemistry*. 25–64.

FAO. (2010). Poultry Meat and Eggs, Food and Agriculture Organization of the United Nations. Agribusiness hand book.

FAO/WHO (Food and Agriculture Organization/World Health Organization) (2001). Health and Nutritional Properties of Probiotics in Food including Powder Milk with Live Lactic Acid Bacteria.Report of a Joint FAO/WHO expert consultation on evaluation of healt and nutritional properties of probiotics in food including powder milk with lactic acid bacteria. 1-34.

Feighner, S. D., and Dashkevicz, M. P. (1987). Subtherapeutic levels of antibiotics in poultry feeds and their effects on weight gain, feed efficiency, and bacterial cholyltaurine hydrolase activity. *Applied and Environmental Microbiology*. 53(2): 331–336.

Feng, J., Wang, L., Zhou, L., Yang, X., and Zhao, X. (2016). Using in vitro immunomodulatory properties of lactic acid bacteria for selection of probiotics against salmonella infection in broiler chicks. *PLoS ONE*. 11(1): 1–14.

Filho, P. R. A. C., Díaz, S. J. A., Fernando, F. S., Chang, Y. F., Andreatti Filho, R. L., and Berchieri Junior, A. (2015). Immunomodulatory activity and control of *Salmonella Enteritidis* colonization in the intestinal tract of chickens by *Lactobacillus* based probiotic. *Veterinary Immunology and Immunopathology*. 167(1–2): 64–69.

Filho, P.R.A.C., Almeida, A. M. Monstassier, H.J., Jr, A.B. (2017). Chemotaxis of CCL4 on monocytes and neutrophils in vitro and recruitment of macrophages and CD8 T cells in the intestinal mucosa: effects on *Salmonella* Typhimurium control. Retrieved from : https://www.conference-service.com/ICIS2017/documents /agenda/data/abstracts/en/abstract_0423.html. (Last accesed: August 2018).

Floros, J. D., Newsome, R., Fisher, W., Barbosa-Cánovas, G. V., Chen, H., Dunne, C. P., and Ziegler, G. R. (2010). Feeding the world today and tomorrow: The importance of food science and technology. *Comprehensive Reviews in Food Science and Food Safety*. 9(5): 572–599.

Foltz, K. L., Ritzi, M. M., Barrett, N. W., Evans, N. P., Collins, D., Sriranganathan, N., and Persia, M. E. (2017). Efficacy of *Lactobacillus plantarum* supplementation in

broilers challenged with avian pathogenic *Escherichia coli* and *Salmonella* Typhimurium. *The Journal of Applied Poultry Research*. 26 (3): 316-324.

Fontana, L., Bermudez-Brito, M., Plaza-Diaz, J., And, S. M.-Q., and Gil, A. (2013). Sources , isolation , characterisation and evaluation of probiotics. *British Journal of Nutrition*. 109: S35–S50.

Frece, J., Kos, B., Svetec, I. K., Zgaga, Z., Mrša, V., and Šušković, J. (2005). Importance of S-layer proteins in probiotic activity of *Lactobacillus acidophilus* M92. *Journal of Applied Microbiology*. 98(2): 285–292.

Fuller, R. (1989). Probiotics in man and animals. *The Journal of Applied Bacteriology*. 66(5): 365–378.

Ghadban, G. S. (2002). Probiotics in broiler production - A review. *Archiv Fur Geflugelkunde*. 66(2): 49–58.

Ghareeb, K., Awad, W. a., Mohnl, M., Porta, R., Biarnes, M., Bohm, J., and Schatzmayr, G. (2012). Evaluating the efficacy of an avian-specific probiotic to reduce the colonization of *Campylobacter jejuni* in broiler chickens. *Poultry Science*. 91(March): 1825–1832.

Ghasemi HA, Shivazad M, Mir zapour-Rezaei, SS and Karimi-Torshizi,MA. (2016). Effect of synbiotic supplementation and dietary fat sources on broiler performance, serum lipids, muscle fatty acid profile and meatquality. *British Poultry Science*. 57: 71–83.

Giannenas, I., Papadopoulos, E., Tsalie, E., Triantafillou, E., Henikl, S., Teichmann, K., and Tontis, D. (2012). Assessment of dietary supplementation with probiotics on performance, intestinal morphology and microflora of chickens infected with *Eimeria tenella*. *Veterinary Parasitology*. 188(1–2): 31–40.

Giannenas, I., Tsalie, E., Triantafillou, E., Hessenberger, S., Teichmann, K., Mohnl, M., and Tontis, D. (2014). Assessment of probiotics supplementation via feed or water on the growth performance, intestinal morphology and microflora of chickens after experimental infection with *Eimeria acervulina*, *Eimeria maxima* and *Eimeria tenella*. *Avian Pathology*. 43(3): 209–216.

Gibson, G. L. E. Y. Y. R., and Roberfroid, M. B. (1995). Dietary modulation of the human colonie microbiota : introducing the concept of prebiotics. *The Journal of Nutrition*. 125(6): 1401–1412.

Gourbeyre, P., Denery, S., and Bodinier, M. (2011). Probiotics, prebiotics, and synbiotics: impact on the gut immune system and allergic reactions. *Journal of Leukocyte Biology*. 89(5): 685–695.

Grimwood, J., and Smith, J. E. (1996). *Toxoplasma gondii*: The role of parasite surface and secreted proteins in host cell invasion. *International Journal for Parasitology*. 26(2): 169–173.

Guglielmetti, S., Tamagnini, I., Mora, D., Minuzzo, M., Scarafoni, A., Arioli, S., and Parini, C. (2008). Implication of an outer surface lipoprotein in adhesion of *Bifidobacterium bifidum* to Caco-2 cells. *Applied and Environmental Microbiology*. 74(15): 4695–4702.

Gupta, A., Dixit, A. K., Dixit, P., and Mahajan, C. (2012). Prevalence of gastrointestinal parasites in cattle and buffaloes in and around Jabalpur, Madhya Pradesh. *Journal of Veterinary Parasitology*. 26(2): 186–188.

Gussem, M. D. (2007). Coccidiosis in poultry : review on diagnosis, control, prevention and interaction with overall gut health. *16th European Symposium on Poultry Nutrition*, 253–261.

Hao, H., Cheng, G., Iqbal, Z., Ai, X., Hussain, H. I., Huang, L., and Yuan, Z. (2014). Benefits and risks of antimicrobial use in food-producing animals. *Frontiers in Microbiology*. 5(JUN): 1–11.

Hassanzadazar, H., Ehsani, A., Mardani, K., and Hesari, J. (2012). Investigation of antibacterial , acid and bile tolerance properties of lactobacilli isolated from Koozeh cheese. *Veterinary Research Forum*. 3(3): 181–185.

Heravi, R.,M., Kermanshahi, H., Sankian,M., Nassiri,M.,R., Moussavi.,A.,H., Nsiraii,L.,R., Varasteh.,A.,R. (2011). Screening of lactobacilli bacteria isolated from gastrointestinal tract of broiler chickens for their use as probiotic. *African Journal of Microbiology Research*. 5(14): 1858-1868.

Higgins, J. P., Higgins, S. E., Wolfenden, a D., Henderson, S. N., Torres-Rodriguez, A., Vicente, J. L., and Tellez, G. (2007). Effect of lactic acid bacteria probiotic culture treatment timing on S*almonella Enteritidis* in neonatal broilers. *Poultry Science*. 89(2): 243–247.

Hofmann A. F. (1994). Bile acids: chemistry, pathochemistry, biology, pathobiology, and therapeutics. C*ellular and Molecular Life Sciences* 65(16): 677–718.

Holscher, H. D. (2017). Dietary fiber and prebiotics and the gastrointestinal microbiota. *Gut Microbes*. 8(2): 172–184.

Hughes, P., and Heritage, J. (2015). Antibiotic growth - promoters in food animals, (1993). *Assessing quality and safety of animal feeds*. 129-252.

Huycke, M. M., Sahm, D. F., and Gilmore, M. S. (1998). Multiple-drug resistant enterococci: The nature of the problem and an agenda for the future. *Emerging Infectious Diseases*. 4(2): 239–249.

Hynönen, U., B, W.-W., Palva, A., Korhonen, T. K., Westerlund-Wikström, B., Palva, A., and Korhonen, T. K. (2002). Identification by flagellum display of an epithelial cell-and fibronectin-binding function in the SlpA surface protein of *Lactobacillus brevis*. *Journal of Bacteriology*. 184(12): 3360–3367.

Idris, M., Abbas, R. Z., Masood, S., Rehman, T., Farooq, U., Babar, W., and Riaz, U. (2017). The potential of antioxidant rich essential oils against avian coccidiosis. *World's Poultry Science Journal*. 73(1): 89–104.

Idris, K. and S.N. Rahim (2010). Issues and challenges of livestock industry in Malaysia. In: *Proceedings of the 31st Malaysian Society of Animal Production Annual Conference*. 6-8 June 2010, Kota Bharu Kelantan. 1-9.

Isroli, I., Yudiarti, T., Widiastuti, E., and Sugiharto, S. (2017). Probiotic bacillus plus vitamins and minerals enhanced haemoglobin values and relative weight of ileum and improved feed conversion ratio of broilers during brooding period. *Livestock Research for Rural Development*. 29(11): 6–11.

Jahromi, M. F., Liang, J. B., Abdullah, N., Goh, Y. M., Ebrahimi, R., and Shokryazdan, P. (2016). Extraction and characterization of oligosaccharides from palm kernel cake as prebiotic. *BioResources*. 11(1): 674–695.

Jatau, I. D., Odika, A. N., Thlama, M., Talba, A. M., Bisalla, M., and Musa, I. W. (2014). Response of 2 breeds of broiler chicks to experimental infection with low dose of E*imeria tenella* sporulated oocysts. *Turkish Journal of Veterinary and Animal Sciences*. 38(4): 398–404.

Jeong, J. S., and Kim, I. H. (2014). Effect of *Bacillus subtilis* C-3102 spores as a probiotic feed supplement on growth performance, noxious gas emission, and intestinal microflora in broilers. *Poultry Science*. 93(12): 3097–3103.

Jiang, M., Zhang, F., Wan, C., Xiong, Y., Shah, N. P., Wei, H., and Tao, X. (2016). Evaluation of probiotic properties of *Lactobacillus plantarum* WLPL04 isolated from human breast milk. *Journal of Dairy Science*. 99(3): 1736–1746.

Jin, L. Z., Ho, Y. W., Abdullah, N., and Jalaludin, S. (2000). Digestive and bacterial enzyme activities in broilers fed diets supplemented with *Lactobacillus* cultures. *Poultry Science*, *79*(6), 886–891.

Jin, L. Z., Ho, Y. W., Abdullah, N., and Jalaludin, S. (1998a). Acid and bile tolerance of *Lactobacillus* isolated from chicken intestine. *Letters in Applied Microbiology*. 27(3): 183–185.

Jin, L. Z., Ho, Y. W., Abdullah, N., and Jalaludin, S. (1998b). Growth performance, intestinal microbial populations, and serum cholesterol of broilers fed diets containing *Lactobacillus* cultures. *Poultry Science*. 77(9): 1259–1265

Jin, L. Z., Ho, Y. W., Abdullah, N., and Jalaludin, S. (1996). Influence of dried *Bacillus subtilis* and lactobacilli cultures on intestinal microflora and performance in broilers. *Asian-Australasian Journal of Animal Sciences*. 9(4): 397-404.

Johnson, J., and Reid, W. M. (1970). Anticoccidial drugs: lesion scoring techniques in battery and floor-pen experiments with chickens. *Experimental Parasitology*. 28(1): 30–36.

Jordan, A., Caldwell, D. J., Klein, J., Coppedge, J., Pohl, S., Fitz-Coy, S., and Lee, J. T. (2011). *Eimeria tenella* oocyst shedding and output in cecal or fecal contents following experimental challenge in broilers. *Poultry Science*. 90(5): 990–995.

Joyner, L. P., and Long, P. L. (1974). The specific characters of the Eimeria, with special reference to the coccidia of the fowl. *Avian Pathology*. 3(3): 145–157.

Jukes, T. H., E. L. R. Stokstad, R. R. Taylor, T. J. Combs, H. M. Edwards and G. B. Meadows. 1950. Growth promoting effect of aureomycin on pigs. *Arch. Biochem*. 26: 324–330.

Jung, S. J., Houde, R., Baurhoo, B., Zhao, X., and Lee, B. H. (2008). Effects of galacto-oligosaccharides and a Bifidobacteria lactis-based probiotic strain on the growth performance and fecal microflora of broiler chickens. *Poultry Science*. 87(9): 1694–1699.

Kabir, S. M. L. (2009). The role of probiotics in the poultry industry. *International Journal of Molecular Sciences*. 10(8): 3531–3546.

Kalia, S., Bharti, V. K., Gogoi, D., Giri, A., and Kumar, B. (2017). Studies on the growth performance of different broiler strains at high altitude and evaluation of probiotic effect on their survivability. *Scientific Reports*. 7(April): 1–8.

Kareem, K. Y., Loh, T. C., Foo, H. L., Asmara, S. A., and Akit, H. (2017). Influence of postbiotic RG14 and inulin combination on cecal microbiota, organic acid concentration, and cytokine expression in broiler chickens. *Poultry Science*, 96(4): 966–975.

Kareem, K. Y., Loh, T. C., Foo, H. L., Akit, H., and Samsudin, A. A. (2016). Effects of dietary postbiotic and inulin on growth performance, IGF1 and GHR mRNA expression, faecal microbiota and volatile fatty acids in broilers. *BMC Veterinary Research*. 12(1): 8–17.

Kareem, K. Y., Loh, T. C., Foo, H. L., Asmara, S. A., Akit, H., Abdulla, N. R., and Foong, Ooi, M. (2015). Carcass, meat and bone quality of broiler chickens fed with postbiotic and prebiotic combinations. *International Journal of Probiotics and Prebiotics*. 10(1): 23–30.

Karthikeyan, V., and Santosh, S. W. (2009). Isolation and partial characterization of bacteriocin produced from *Lactobacillus plantarum. African Journal of Microbiology Research*. 3(5): 233–239.

Kathirvelan, C., Janani, S. R., Ramesh, J., and Purushothaman, M. R. (2015). Significance of usage of phytase in poultry nutrition. *International Journal of Science Enviroment*. 4(4): 1214–1217.

Kei, H. M. (2015). Supply and utilization accounts selected agricultural commodities, Malaysia. The Office Statistician Malaysia. 1–4.

Khan, S. H., and Iqbal, J. (2016). Recent advances in the role of organic acids in poultry nutrition. *Journal of Applied Animal Research*. 44(1): 359–369.

Kos, B., Šušković, J., Vuković, S., Šimpraga, M., Frece, J., and Matošić, S. (2003). Adhesion and aggregation ability of probiotic strain *Lactobacillus acidophilus* M92. *Journal of Applied Microbiology*. 94(6): 981–987.

Kumar, A., Jindal, N., Shukla, C. L., Asrani, R. K., Ledoux, D. R., and Rottinghaus, G. E. (2004). Pathological changes in broiler chickens fed ochratoxin A and inoculated with *Escherichia coli*. *Avian Pathology*. 33(4): 413–417.

Kumar, S., P.K.Singh, Prasad, A., and Chanramoni. (2009). Effect of graded level of dietary energy and protien on the growth performance of cockerels. *Indian Journal of Animal Nutrition.* 26(1): 86–89.

Lambert, J. M., Bongers, R. S., De Vos, W. M., and Kleerebezem, M. (2008). Functional analysis of four bile salt hydrolase and penicillin acylase family members in *Lactobacillus plantarum* WCFS1. *Applied and Environmental Microbiology*. 74(15): 4719–4726.

Lan, G., Abdullah, N., Jalaludin, S., and Ho, Y. W. (2012). Effects of freeze-dried *Mitsuokella jalaludinii* culture and Natuphos®phytase supplementation on the performance and nutrient utilisation of broiler chickens. *Journal of the Science of Food and Agriculture*. 92(2): 266–273.

Lee, S. H., Lillehoj, H. S., Dalloul, R. a, Park, D. W., Hong, Y. H., and Lin, J. J. (2007a). Influence of *Pediococcus*-based probiotic on coccidiosis in broiler chickens. *Poultry Science*. 86(1): 63–66.

Lee, S., Lillehoj, H. S., Park, D. W., Hong, Y. H., and Lin, J. J. (2007b). Effects of Pediococcus and Saccharomyces-based probiotic (MitoMax) on coccidiosis in broiler chickens. *Poultry Science*. 30: 261–268.

Lee, H., and Kim, H. Y. (2011). Lantibiotics, Class I Bacteriocins from the Genus Bacillus. *Journal of Microbiology and Biotechnology*. 21(3): 229–235.

Lee, Y. K., and Salminen, S. (1995). The coming of age of probiotics. *Trends in Food Science and Technology*. 6(7): 241–245.

Lelis, G. R., Albino, L. F. T., Calderano, A. A., Tavernari, F. de C., Rostagno, H. S., de Araújo Campos, A. M., and Ribeiro Junior, V. (2012). Diet supplementation with phytase on performance of broiler chickens. *Revista Brasileira de Zootecnia*, 41(4): 929–933.

Levkut, M., Pistl, J., Lauková, A., Revajová, V., Herich, R., Evčíková, Z., and Kokinčáková, T. (2009). Antimicrobial activity of *Enterococcus faecium* EF 55 against S*almonella Enteritidis* in chicks. *Acta Veterinaria Hungarica*. 57(1): 13–24.

Loh, T. C. (2004). Livestock production and the feed industry in Malaysia. *Animal Science*. 329–339.

Loh, T. C., Choe, D. W., Foo, H. L., Sazili, A. Q., and Bejo, M. H. (2014). Effects of feeding different postbiotic metabolite combinations produced by *Lactobacillus plantarum* strains on egg quality and production performance, faecal parameters and plasma cholesterol in laying hens. *BMC Veterinary Research*. 10: 1–9.

Lückstädt, C., and Mellor, S. (2011). The use of organic acids in swine nutrition , with special focus on dietary potassium diformate. *Recent Advances in Animal Nutrition - Australia*. 18: 123–130.

Mallo, J. J., Gracia, M. I., 2, J. S., Honrubia, P., and Puyalto, M. (2016). Effect of partially protected sodium butyrate on performance, digestive organs, intestinal villi and *E. coli* development in broilers chickens. *International Journal of Poultry Science*. 13(7): 390–396.

Markovic, R., Sefer, D., Krsti, M., and Petrujki, B. (2009). Effect of different growth promoters on broiler performance and gut morphology. *Archivos de Medicina Veterinaria*. 41: 163–169.

Markowiak, P., and Śliżewska, K. (2018). The role of probiotics, prebiotics and synbiotics in animal nutrition. *Gut Pathogens*. 10(1): 21.

Maron, D., Smith, T. J., and Nachman, K. E. (2013). Restrictions on antimicrobial use in food animal production: an international regulatory and economic survey. *Globalization and Health*. 9(1): 48.

Menconi, A., Bielke, L. R., Hargis, B. M., and Tellez, G. (2014). Immuno-modulation and anti-inflammatory effects of antibiotic growth promoters versus probiotics in the intestinal tract. *Journal of Microbiology Research and Reviews*. 2(7): 62–67.

Moal, V. L.-L., and Servin, A. L. (2006). The front line of eneteric host defense against unwelcome intrusion of harmful microorgansims: mucins, antimicrobial peptides and microbiota. *Clinical Microbiology Reviews*. 19(2): 315–337.

Mona A. E., F., Mohamed H. K., and Abd- El Alim. (2016). Effect of phytobiotics, probiotics and toltrazuril on chicken coccidiosis. *Zagazig Veterinary Journal*, 44(December): 214–223.

Mookiah, S., Sieo, C. C., Ramasamy, K., Abdullah, N., and Ho, Y. W. (2014). Effects of dietary prebiotics, probiotic and synbiotics on performance, caecal bacterial populations and caecal fermentation concentrations of broiler chickens. *Journal of the Science of Food and Agriculture*. 94(2) 341–348.

Moore, R. J. (2016). Necrotic enteritis predisposing factors in broiler chickens. *Avian Pathology*. *45*(3): 275–281.

Moore, P. R., Evenson, A., Luckey, T. D., E.McCoy, C.A.Elvehjem, and E.BHart. (1946). Use of sulfasuxidine, streptothricin, and streptomycin in nutritional studies with the chick. *The Journal of Biochemedical Chemistryy*. 165: 437–441.

Mountzouris, K. C., Tsirtsikos, P., Kalamara, E., Nitsch, S., Schatzmayr, G., and Fegeros, K. (2007). Evaluation of the efficacy of a probiotic containing *Lactobacillus*,

Bifidobacterium, *Enterococcus*, and *Pediococcus* strains in promoting broiler performance and modulating cecal microflora composition and metabolic activities. *Poultry Science*. 86(2): 309–317.

Mountzouris, K. C., Tsitrsikos, P., Palamidi, I., Arvaniti, a, Mohnl, M., Schatzmayr, G., and Fegeros, K. (2010). Effects of probiotic inclusion levels in broiler nutrition on growth performance, nutrient digestibility, plasma immunoglobulins, and cecal microflora composition. *Poultry Science*. 89(1): 58–67.

Munyaka, P. M., Tactacan, G., Jing, M., O, K., House, J. D., and Rodriguez-Lecompte, J. C. (2012). Immunomodulation in young laying hens by dietary folic acid and acute immune responses after challenge with *Escherichia coli* lipopolysaccharide. *Poultry Science*. 91(10: 2454–2463.

Murate, L. S., Paião, F. G., Almeida, A. M. de, Berchieri Jr., A., and Shimokomaki, M. (2015). Efficacy of prebiotics, probiotics, and synbiotics on laying hens and broilers challenged with *Salmonella Enteritidis*. *The Journal of Poultry Science*. 52(1): 52–56.

Muthamilselvan, T., Kuo, T., Wu, Y., and Yang, W. (2016). Herbal remedies for coccidiosis control: a review of plants, compounds, and anticoccidial actions. *Evidence-Based Complementary and Alternative Medicine*.2016: 1-19.

Nguyen, A. T. V., Nguyen, D. V., Tran, M. T., Nguyen, L. T., Nguyen, A. H., and Phan, T. N. (2015). Isolation and characterization of *Bacillus subtilis* CH16 strain from chicken gastrointestinal tracts for use as a feed supplement to promote weight gain in broilers. *Letters in Applied Microbiology*. 60(6). 580–588.

Noriega, L., Cuevas, I., Margolles, A., and de los Reyes-Gavilán, C. G. (2006). Deconjugation and bile salts hydrolase activity by Bifidobacterium strains with acquired resistance to bile. *International Dairy Journal*. 16(8): 850–855.

Noriega, L., Gueimonde, M., Sánchez, B., Margolles, A., and De Los Reyes-Gavilán, C. G. (2004). Effect of the adaptation to high bile salts concentrations on glycosidic activity, survival at low PH and cross-resistance to bile salts in Bifidobacterium. *International Journal of Food Microbiology*. 94(1): 79–86.

Nurmi, E., and Rantala, M. (1973). New aspects of *Salmonella* Infection in broiler production. *Nature*. 241(5386): 210–211.

Olnood, C. G., Beski, S. S. M., Choct, M., and Iji, P. A. (2015). Novel probiotics: Their effects on growth performance, gut development, microbial community and activity of broiler chickens. *Animal Nutrition*. 1(3): 184–191.

Ouled-Haddar, H., Idoui, T., Sifour, M., Guezira, M., and Bouthabet, M. (2012). Isolation, characterization and microencapsulation of probiotic *Lactobacillus curvatus* G7 from chicken crop. *The Online Journal of Science and Technology*. 2(1)1-6.

Owosibo, A. O., Odetola, O. M., Odunsi, O. O., Lawrence-Azua, O. O. (2013). Growth , haematology and serum biochemistry of broilers fed probiotics based diets. *African Journal of Agriculture*. 8(41): 5076–5081.

Patel, R. M., and Denning, P. W. (2013). Therapeutic use of prebiotics, probiotics, 869 and postbiotics to prevent necrotizing enterocolitis: what is the current evidence? *Clinics in Perinatology*, 40(1), 11–25.

Patterson, J. A, and Burkholder, K. M. (2003). Application of prebiotics and probiotics in poultry production. *Poultry Science*. 82(4): 627–631.

Pfeiler, E. A., and Klaenhammer, T. R. (2009). Role of transporter proteins in bile tolerance of *Lactobacillus acidophilus*. *Applied and Environmental Microbiology*. 75(18): 6013–6016.

Pourakbari, M., Seidavi, A., Asadpour, L., and Martínez, A. (2016). Probiotic level effects on growth performance, carcass traits, blood parameters, cecal microbiota, and immune response of broilers. *Anais Da Academia Brasileira de Ciencias*. 88(2): 1011–1021.

Prescott, J. F., Parreira, V. R., Mehdizadeh Gohari, I., Lepp, D., and Gong, J. (2016). The pathogenesis of necrotic enteritis in chickens: what we know and what we need to know: A review. *Avian Pathology*. 45(3): 288–294.

Price, C. E., Reid, S. J., Driessen, A. J. M., and Abratt, V. R. (2006). B*ifidobacterium longum*. *Society*. 72(1): 923–926.

Proellocks, N. I., Coppel, R. L., and Waller, K. L. (2010). Dissecting the apicomplexan rhoptry neck proteins. *Trends in Parasitology*. 26(6): 297–304.

Quinto, E. J., Jiménez, P., Caro, I., Tejero, J., Mateo, J., and Girbés, T. (2014). Probiotic lactic acid bacteria: a review. *Food and Nutrition Sciences*. 5(18): 1765–1775.

Rajoka, M. S. R., Hayat, H. F., Sarwar, S., Mehwish, H. M., Ahmad, F., Hussain, N.,Shi, J. (2018). Isolation and evaluation of probiotic potential of lactic acid bacteria isolated from poultry intestine. *Microbiology (Russian Federation)*. 87(1): 116–126.

Raman, M., Banu, S. S., Gomathinayagam, S., and Raj, G. D. (2011). Lesion scoring technique for assessing the virulence and pathogenicity of Indian fi eld isolates of avian Eimeria species. *Vetrinarski Arhiv*, *81*(2), 259–271.

Ravi Mangal Patel, P. W. D. (2013). Therapeutic Use of Prebiotics, Probiotics, and Postbiotics to Prevent Necrotizing Enterocolitis: What is the Current Evidence? *Clinical Perinatol*. 40(1): 11–25.

Ravindran, V., Cabahug, S., Ravindran, G., and Bryden, W. L. (1995). Influence of microbial phytase on apparent ileal amino acid digestibility of feedstuffs for broilers. *Poultry Science*. 78(5): 699–706.

Reid, A. J., Blake, D. P., Ansari, H. R., Billington, K., Browne, H. P., Bryant, J., and Pain, A. (2014). Genomic analysis of the causative agents of coccidiosis in domestic chickens. *Genome Research*. 24(10): 1676–1685.

Rezaei, S., Jahromi, M. F., Liang, J. B., Zulkifli, I., Farjam, S., Laudadio, V., and Tufarelli, V. (2013). Effect of oligosaccharides extract from palm kernel expeller on growth performance , gut microbiota and immune response in broiler chickens *Poultry Science*.94(10): 2414–2420.

Ricke, S. C. (2014). Application of Molecular Approaches for Understanding Foodborne *Salmonella* Establishment in Poultry Production. *Advances in Biology*, 2014: 1–25.

Ritzi, M. M., Abdelrahman, W., Van-Heerden, K., Mohnl, M., Barrett, N. W.,and Dalloul, R. A. (2016). Combination of probiotics and coccidiosis vaccine enhances protection against an Eimeria challenge.*Veterinary Research*.47(1):1-8.

Roberts, T., Wilson, J., Guthrie, A., Cookson, K., Vancraeynest, D., Schaeffer, J., Moody, R., Clark, S. (2015). New issues and science in broiler chicken intestinal health intestinal microbial composition shifts and impacts.pdf. *World's Poultry Science Journal*. 71: 259–270.

Ruiz, L., Margolles, A., and Sánchez, B. (2013). Bile resistance mechanisms in *Lactobacillus* and *Bifidobacterium*. 4(December): 1–8.

Saitou, N., and Nei, S. (1987). The neighbor-joining method: a new method for reconstructing phylogenetic trees. *Mol. Biol. Evol.* 4(4):406-425.

Salma, U., Miah, A. G., Maki, T., Nishimura, M., and Tsujii, H. (2007). Effect of dietary *Rhodobacter capsulatus* on cholesterol concentration and fatty acid composition in broiler meat. *Poultry Science.* 86(9): 1920–1926.

Sanhueza, E., Paredes-osses, E., González, C. L., and García, A. (2015). Electronic journal of biotechnology effect of pH in the survival of *Lactobacillus salivarius* strain UCO _ 979C wild type and the pH acid acclimated variant. *Electronic Journal of Biotechnology.* 18(5): 343–346.

Sarangi, N. R., Babu, L. K., Kumar, A., Pradhan, C. R., Pati, P. K., and Mishra, J. P. (2016). Effect of dietary supplementation of prebiotic, probiotic, and synbiotic on growth performance and carcass characteristics of broiler chickens. *Veterinary World*. 9(3): 313–319.

Sharman, P. A., Smith, N. C., Wallach, M. G., and Katrib, M. (2010). Chasing the golden egg: Vaccination against poultry coccidiosis. *Parasite Immunology*. 32(8): 590–598.

Shewale, R. N., Sawale, P. D., Khedkar, C., and Singh, A. (2014). Selection Criteria for Probiotics. *International Journal of Probiotics and Prebiotics*. 9(January 2014): 1–6.

Shokryazdan, P., Faseleh Jahromi, M., Navidshad, B., and Liang, J. B. (2017). Effects of prebiotics on immune system and cytokine expression. *Medical Microbiology and Immunology*. 206(1). 1–9.

Shokryazdan, P., Sieo, C. C., Kalavathy, R., Liang, J. B., Alitheen, N. B., Faseleh Jahromi, M., and Ho, Y. W. (2014). Probiotic potential of *Lactobacillus* strains with antimicrobial activity against some human pathogenic strains. *BioMed Research International*. 2014: 1-16.

Silva, M., Jacobus, N. V., Deneke, C., and Gorbach, S. L. (1987). Antimicrobial substance from a human Lactobacillus strain. *Antimicrobial Agents and Chemotherapy*. 31(8): 1231–1233.

Šlapeta, J. and V. Morin-Adeline. 2011. Apicomplexa Levine 1970. Sporozoa Leucart 1879. Version 18 May 2011.

Soccol, C. R., Porto, L., Vandenberghe, D. S., Spier, M. R., Bianchi, A., Medeiros, P., and Yamaguishi, C. T. (2013). The Potential of Probiotics : A Review. *Food Technology Biotechnology*. 48(4: 413–434.

Stavric, S. (1987). Microbial colonization control of chicken intestine using defined cultures. F*ood technology (USA)*.

Stringfellow, K., Caldwell, D., Lee, J., Mohnl, M., Beltran, R., Schatzmayr, G., and Farnell, M. (2011). Evaluation of probiotic administration on the immune response of coccidiosis-vaccinated broilers. *Poultry Science*. 90(8): 1652–1658.

Sundar, S. B., J, H. T., Ravi, L. B., G, S., and Senthil, K. T. M. A. (2017). Anticoccidial drug resistance in chicken coccidiosis and promising solutions : A review. *Journal of Entomology and Zoology Studies*. 5(4): 1526–1529.

Taherpour, K., Moravej, H., Reza Taheri, H., and Shivazad, M. (2012). Effect of dietary inclusion of probiotic, prebiotic and butyric acid glycerides on resistance against coccidiosis in broiler chickens. *The Journal of Poultry Science*. 49(1): 57-61.

Tapsir S., Mokhdzir H.L., Nor Rahim, S. and Jalil, N. (2011). Issue and Impact in Broiler Contract Farming in Peninsular Malaysia. *Economic and Technology Management Review*. 6: 33-57.

Tewari, A. K., and Maharana, B. R. (2011). Control of poultry coccidiosis: Changing trends. *Journal of Parasitic Diseases*. 35(1): 10–17.

Thakur, N., Angad, G., Veterinary, D., Rokana, N., Panwar, H., Angad, G., and Veterinary, D. (2016). Probiotics: Selection criteria, safety and role in health and disease, *Journal of Innovative Biology*. 3(1): 259-270.

The Poultry Site. (2016). Global Poultry Trends: Poultry to Boost Global Meat Market Share Above 36 Per Cent. July 2016. Retrieved from: http://www.thepoultrysite.com/articles/3645/global-poultry-trends-poultry-to-boost-global-meat-market-share-above-36-per-cent/. (Last accessed: 13 Agust 2018).

The Poultry Site. (2014). Global poultry trends 2014: Poultry Set to Become No.1 Meat in Asia. September 2014. Retrieved from: http://www.thepoultrysite.com/articles/3230/global-poultry-trends-2014-poultry-set-to-become-no1-meat-in-asia/. (Last accessed: 13 August 2018).

Thompson, S.W. and Hunt, R.D. (1966). Selected histochemical and histopathological methods. CC Thomas Springfield.

Tierney, J., Gowing, H., Van Sinderen, D., Flynn, S., Stanley, L., McHardy, N., and Mulcahy, G. (2004). In vitro inhibition of *Eimeria tenella* invasion by indigenous chicken *Lactobacillus* species. *Veterinary Parasitology*. 122(3): 171–182.

Timmerman, H. M., Koning, C. J. M., Mulder, L., Rombouts, F. M., and Beynen, A. C. (2004). Monostrain, multistrain and multispecies probiotics - A comparison of functionality and efficacy. *International Journal of Food Microbiology*. 96(3): 219–233.

Toghyani, M., Mosavi, S. kazem, Modaresi, M., and Landy, N. (2015). Evaluation of kefir as a potential probiotic on growth performance, serum biochemistry and immune responses in broiler chicks. *Animal Nutrition*. 1(4): 305–309.

Uttley, A.H., C.H.Collins, J.Naidoo,and R.C.George.(1988).Vancomycin resistant enterococci. *Lancet*: 57–58.

Vazquez, A. P. (2016). Bacillus species are superior probiotic feed-additives for poultry. *Journal of Bacteriology and Mycology: Open Access*. 2(3): 23–25.

Walker, D. K., and Gilliland, S. E. (1993). Relationship among bile tolerance, bile salt deconjugation, and assimilation of cholesterol by *Lactobacillus acidophilus*. *Journal of Dairy Science*. 76(4): 956–961.

Wang, J. P., Yoo, J. S., Lee, J. H., Zhou, T. X., Jang, H. D., Kim, H. J., and Kim, I. H. (2009). Effects of phenyllactic acid on production performance, egg quality parameters, and blood characteristics in laying hens. *Journal of Applied Poultry Research*. 18(2): 203–209.

Wang, Z., Wang, L., Chen, Z., Ma, X., Yang, X., Zhang, J., and Jiang, Z. (2016). *In vitro* evaluation of swine-derived *Lactobacillus reuteri*: Probiotic properties and effects on intestinal porcine epithelial cells challenged with enterotoxigenic *Escherichia coli* K88. *Journal of Microbiology and Biotechnology*. 26(6): 1018–1025.

Wegener, H. C. (2003). Ending the use of antimicrobial growth promoters is making a difference. *ASM News*. 69(9): 443–448

Yang, C. M., Cao, G. T., Ferket, P. R., Liu, T. T., Zhou, L., Zhang, L.,Chen, A. G. (2012). Effects of probiotic, *Clostridium butyricum*, on growth performance, immune function, and cecal microflora in broiler chickens. *Poultry Science.* 91(9): 2121–2129.

You, M. J. (2014). Suppression of *Eimeria tenella* sporulation by disinfectants. *Korean Journal of Parasitology*. 52(4): 435–438.

Zacharof, M. P., and Lovitt, R. W. (2010). Development of an optimised growth strategy for intensive propagation, lactic acid and bacteriocin production of selected strains of lactobacilli genus. *International Journal of Chemical Engineering and Applications*. 1(1): 55–62.

Zhang, Z. F., and Kim, I. H. (2014). Effects of probiotic supplementation in different energy and nutrient density diets on performance, egg quality, excreta microflora, excreta noxious gas emission, and serum cholesterol concentrations in laying hens. *Journal of Animal Science*. 91(10): 4781–4787.

Zhou, Q., Zhang, Y., Yang, D., Demirkaya, E., Takeuchi, M., Tsai, W. L., and Mullikin, J. C. (2016). Loss-of-function mutations in TNFAIP3 leading to A20 haploinsufficiency cause an early onset autoinflammatory syndrome. 48(1): 67–73.

Zommiti, M., Connil, N., Hamida, J. Ben, and Ferchichi, M. (2017). Probiotic Characteristics of Lactobacillus curvatus DN317, a Strain Isolated from Chicken Ceca. *Probiotics and Antimicrobial Proteins*. 9(4): 415–424.

Zorriehzahra, M. J., Delshad, S. T., Adel, M., Tiwari, R., Karthik, K., Dhama, K., and Lazado, C. C. (2016). Probiotics as beneficial microbes in aquaculture: an update on their multiple modes of action: a review. *Veterinary Quarterly*. 36(4): 228–241.

BIODATA OF STUDENT

The author, Wan Nur Fadhilah Binti Shamsudin was born in 1986 (27th April) in Klang, Selangor. She did her Diploma in Science in 2008 at Universiti Teknologi MARA (UiTM) Jengka, Pahang. She was then conferred her Bachelor in Science (Hons) degree (Biomolecular Science) in 2012 by Universiti Teknologi MARA (UiTM) Shah Alam. Upon graduation, she started her career as a research officer at the Agro-Biotechnology Institute, Malaysia (ABI), Serdang. At the same time, she enrolled as a Master of Science student in Applied Microbiology at the Institute of Bioscience, Universiti Putra Malaysia under the supervision of Prof. Dr. Ho Yin Wan (until she retired in 2015), followed by the late Assoc. Prof. Dr. Sieo Chin Chin (until October 2015) and then under Prof. Dr. Norhani Abdullah. She was involved in a research project funded by the Ministry of Science under ScienceFund in a project titled "Evaluation of Probiotic Formulations for The Control of Coccidiosis in Broiler Chickens". The author was actively involved as facilitator and committee member in several workshops and seminars: (i) Organizing Committee for Facility Handover on Plant Tissue Culture Project in Kampung Lapasan, Tuaran, Sabah ln June 2017; (ii) Facilitator for plant tissue culture in Tuaran, Sabah, under Science Technology and Innovation event in May, 2017 (iii) Committee Member for organizing the Workshop on Plant Tissue Culture Technology under MOSTI Social Innovation Fund in Kota Kinabalu, Sabah, ion December 2016; (iv) Committee Member for National Institutes of Biotechnology Malaysia (NIBM) Convention, at MGI, Bangi in October 2016; (v) Organizing Committee in the Workshop on Bacteriophage Propagation and Purification (BPP) 2014 at Laboratory of Vaccines and Immunetherapeutics (LIVES), Institute of Bioscience, UPM. During her study, she had published her scientific findings in several conferences locally.

LIST OF PUBLICATIONS

Proceedings of paper presented in conferences and seminar:

Shamsudin.W.N.F., Ho,Y.W., Sieo,C.C., Wan,K.L., Azizi,A.A., Shanmugavelu.S., and Loo,S.S. Effects of *Lactobacillus* Isolated from Broiler Chickens on Growth Performance and Coccidiosis Infection Towards Broiler Chickens. International Conference on Life Sciences Revolution: Past, Present, Future and Beyond. Shah Alam 24-25th November 2015. Page: 149-151.

Shamsudin.W.N.F., Loo,S.,S., Sieo,C.,C., Wan,K.,L., Ho,Y.,W. 2014. Screening of *Lactobacillus* Isolated from Broiler Chickens for Probiotic Characteristics. International Agricultural Congress 2014. Page: 83.

Shamsudin.W.N.F., Loo,S.,S., Sieo, C.,C.,Kalavathy,R., Lim,S.,M., Lai,K.,S., Ho,Y.,W. 2014. *In Vitro* Screening for *Lactobacillus* with Adherence Property from Broiler Chicken Intestines. National Postgraduate Seminar 2014. Page: 75.

Shamsudin.W.N.F., Loo,S.,S., Sieo,C.,C., Wan,K.,L., Ho,Y.,W. 2014. Acid and Bile Tolerance Test of Lactobacillus Isolated from Broiler Chicken Intestine as Probiotic. 18th Biological Science Graduate Congress 2014. Page: 156.

Shamsudin.W.N.F., Loo,S.,S., Sieo,C.,C., Wan,K.,L., and Ho,Y.,W. 2013. Preliminary Screening of Probiotic Characteristic of Lactobacillus isolated from Broiler Chickens. International Congress of The Malaysian Society for Microbiology 2013. Page:103.

UNIVERSITI PUTRA MALAYSIA

STATUS CONFIRMATION FOR THESIS / PROJECT REPORT AND COPYRIGHT

ACADEMIC SESSION : First Semester 2019/2020

TITLE OF THESIS / PROJECT REPORT :

EFFECTS OF *Lactobacillus* PROBIOTIC ON GROWTH PERFORMANCE AND COCCIDIOSIS IN BROILER CHICKENS CHALLENGED WITH *Eimeria tenella*

NAME OF STUDENT : WAN NUR FADHILAH BINTI SHAMSUDIN

I acknowledge that the copyright and other intellectual property in the thesis/project report belonged to Universiti Putra Malaysia and I agree to allow this thesis/project report to be placed at the library under the following terms:

1. This thesis/project report is the property of Universiti Putra Malaysia.
2. The library of Universiti Putra Malaysia has the right to make copies for educational purposes only.
3. The library of Universiti Putra Malaysia is allowed to make copies of this thesis for academic exchange.

I declare that this thesis is classified as :

*Please tick (√)

☐	**CONFIDENTIAL**	(Contain confidential information under Official Secret Act 1972).
☐	**RESTRICTED**	(Contains restricted information as specified by the organization/institution where research was done).
☐	**OPEN ACCESS**	I agree that my thesis/project report to be published as hard copy or online open access.

This thesis is submitted for :

☐ **PATENT** Embargo from _____ until _____
(date) (date)

Approved by:

_____ _____

(Signature of Student)
New IC No/ Passport No.:

Date :

(Signature of Chairman of Supervisory Committee)
Name:

Date :

[Note : If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization/institution with period and reasons for confidentially or restricted.]