UNIVERSITI PUTRA MALAYSIA

EFFECTS OF PREBIOTIC, PROBIOTIC AND SYNBIOTIC ON PERFORMANCE AND CECAL MICROBIOME OF LAYING HENS

SHIRLEY TANG GEE HOON

IB 2016 11

EFFECTS OF PREBIOTIC, PROBIOTIC AND SYNBIOTIC ON PERFORMANCE AND CECAL MICROBIOME OF LAYING HENS

By

SHIRLEY TANG GEE HOON

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

July 2016

DEDICATIONS

This thesis is dedicated to my lovely grandmother, mother, aunties, uncle, husband and my siblings for their love, endless support and encouragement

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Degree of Doctor of Philosophy

EFFECTS OF PREBIOTIC, PROBIOTIC AND SYNBIOTIC ON PERFORMANCE AND CECAL MICROBIOME OF LAYING HENS

By

SHIRLEY TANG GEE HOON

July 2016

Chairman : Associate Professor Wan Zuhainis Saad, PhD
Institute : Bioscience

The rampant use of antibiotics as growth promoters in poultry feed has led to development of antibiotic resistant bacteria and accumulation of antibiotic residues in poultry eggs and meat. Probiotic bacterial strains, prebiotic oligosaccharides and their combination as synbiotics (probiotics + prebiotics) have been considered as alternatives to antibiotic growth promoters (AGPs) in poultry production. A recent study showed that prebiotic isomaltooligosaccharide (IMO) significantly improved the performance and intestinal health of broiler chickens. The effects and role of IMO however, have not been explored on laying hens. Therefore, the present study was initiated to evaluate the *in vivo* effects of prebiotic IMO (PRE) and probiotic PrimaLac® (PRO), administered singly, and in combination as a synbiotic (SYN) (IMO + PrimaLac®), on performance, biochemical and hematological responses, egg quality and chemical compositions of egg yolks, and diversity and functional potential of cecal microbiome of laying hens. The layer feeding trial showed that the supplementation of PRE, PRO or SYN significantly ($P < 0.05$) improved the body weight gain, feed intake, feed conversion ratio (FCR), egg production, egg weight, egg mass and egg size of laying hens at 20-36, 37-52 and/or 20-52 weeks of age. PRE, PRO or SYN supplementation also significantly ($P < 0.05$) lowered the levels of serum total cholesterol, low-density-lipoprotein (LDL) cholesterol, alkaline phosphatase (ALP), alanine aminotransferase (ALT), heterophil (H) percentages and H/L ratio, and increased lymphocyte (L) percentages at 36 and 52 weeks of age. PRE, PRO or SYN supplementation resulted in significant ($P < 0.05$) decreases in the cholesterol (24 and 28 weeks of age) and saturated fatty acid (SFA; 28, 32 and 36 weeks of age), and increases in the unsaturated fatty acid (UFA; 28, 32 and 36 weeks of age) and polyunsaturated fatty acid (PUFA; 28 weeks of age), including linoleic and alpha-linolenic acids of eggs without affecting the egg quality (Haugh unit, relative weights of the albumen and yolk, specific gravity, shell thickness and yolk color) (20-36 weeks of age), and lipid, carotenoid and tocopherol contents of eggs (24, 28, 32 and 36 weeks of age). The quantification of the bacterial population using quantitative real-time PCR (qPCR) showed that PRE, PRO or SYN supplementation significantly ($P < 0.05$) increased the populations of cecal lactobacilli and

bifidobacteria at 36 and 52 weeks of age, but decreased the populations of total cecal Enterobacteriaceae and *Escherichia coli* at 36 weeks of age. The cecal volatile fatty acids (VFA; acetic, propionic and butyric acids) and non-VFA (lactic and succinic acids) were significantly ($P < 0.05$) increased whilst harmful microbial enzyme activities (β-glucosidase, β-glucuronidase and urease) significantly ($P < 0.05$) decreased after PRE, PRO or SYN supplementation at 36 and 52 weeks of age. The 16S rRNA deep-sequencing analysis revealed that the relative abundance of cecal lactobacilli was significantly ($P < 0.05$) increased in all supplemented hens (PRE, PRO or SYN) at 36 and 52 weeks of age. The relative abundance of cecal bifidobacteria was also increased significantly ($P < 0.05$) in PRE- or SYN-supplemented hens at 36 weeks of age, and in PRE-, PRO- or SYN-supplemented hens at 52 weeks of age. At 36 weeks of age, the relative abundance of cecal Enterobacteriaceae decreased significantly ($P < 0.05$) after PRE, PRO or SYN supplementation. The whole metagenome shotgun sequencing analysis indicated that the microbiome of PRE-, PRO- or SYN-fed hens were predicted to have higher percentages of genes involved in carbohydrate metabolism (gluconeogenesis/glycolysis, citrate cycle, butanoate and pyruvate metabolisms); xenobiotics biodegradation and metabolisms (dioxin, xylene and toluene degradation); lipid metabolism (arachidonic acid metabolism and fatty acid elongation); Adenosine Triphosphate (ATP)-binding cassette transporters (ABC transporters); signalling molecules and interaction; immune and digestive systems as compared to control hens at 36 weeks of age. In conclusion, the results of the present study showed that the supplementation of PRE, PRO or SYN could improve the hen performance, produce eggs with lower cholesterol and SFA, and promote the hen health by altering the microbial populations, diversity and functional potential of cecal microbiome without affecting the egg quality of laying hens.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

KESAN PREBIOTIK, PROBIOTIK DAN SINBIOTIK TERHADAP PRESTASI DAN MIKROBIOM SEKUM AYAM PENELUR

Oleh

SHIRLEY TANG GEE HOON

Julai 2016

Pengerusi : Profesor Madya Wan Zuhainis Saad, PhD
Institut : Biosains

Penggunaan antibiotik sebagai penggalak pertumbuhan dalam makanan poltri secara berleluasa telah menyebabkan perkembangan bakteria rintangan antibiotik dan pengumpulan sisa antibiotik dalam telur dan daging poltri. Strain bakteria probiotik, oligosakarida prebiotik dan kombinasi mereka sebagai sinbiotik (probiotik + prebiotik) telah dipertimbangan sebagai alternatif kepada antibiotik penggalak pertumbuhan dalam pengeluran poltri. Baru-baru ini, satu kajian menunjukkan bahawa prebiotik isomaltooligosakarida (IMO) dapat mempertingkatkan prestasi dan kesihatan usus ayam pedaging dengan signifikannya. Walau bagaimanapun, kesan dan peranan IMO terhadap ayam penelur masih belum dikaji. Oleh demikian, kajian ini dijalankan untuk menilai kesan-kesan *in vivo* prebiotik IMO (PRE), probiotik PrimaLac® (PRO), yang diberikan secara individu, dan secara kombinasi sebagai sinbiotik (SYN) (IMO + PrimaLac®) terhadap prestasi, respon biokimia dan hematologi, kualiti telur dan komposisi kimia kuning telur, serta diversiti dan fungsian potensi mikrobiom sekum ayam penelur. Hasil kajian *in vivo* menunjukkan bahawa suplementasi PRE, PRO atau SYN menambah baik penambahan berat badan, pengambilan makanan, kadar penukaran makanan (FCR), produksi telur, berat telur, jisim telur dan saiz telur ayam penelur secara signifikan ($P < 0.05$) pada umur 20-36, 37-52 dan/atau 20-52 minggu. Suplementasi PRE, PRO atau SYN juga menurunkan paras jumlah serum kolesterol dan kolesterol LDL, ALP, ALT, peratusan heterofil (H) dan nisbah H/L, dan meningkatkan peratusan limfosit (L) dengan signifikannya ($P < 0.05$) pada umur 36 dan 52 minggu. Suplementasi PRE, PRO atau SYN telah mengurangkan kolesterol (pada umur 24 dan 28 minggu) dan asid lemak tepu (SFA; pada umur 28, 32 dan 36 minggu), dan meningkatkan asid lemak tak tepu (UFA; pada usia 28, 32 dan 36 minggu) dan asid lemak politaktepu (PUFA; pada umur 28 minggu), termasuk asid linoleik dan alfa linolenik dalam telur dengan signifikannya ($P < 0.05$) tanpa memberi kesan kepada kualiti telur (Unit Haugh, berat relatif albumen dan kuning telur, graviti spesifik, ketebalan kulit telur dan warna kuning telur) (dari umur 20-36 minggu), dan lemak, karotenoid dan kandungan tokoferol telur (pada umur 24, 28, 32 dan 36 minggu). Kuantifikasi populasi bakteria dengan menggunakan kuantitatif PCR (qPCR) menunjukkan bahawa suplementasi PRE, PRO atau SYN meningkatkan populasi sekal laktobasili

dan bifidobakteria dengan signifikannya ($P < 0.05$) pada umur 36 dan 52 minggu, tetapi, mengurangkan populasi jumlah sekal Enterobacteriaceae dan *Escherichia coli* pada umur 36 minggu. Asid lemak meruap (VFA; asid asetik, propionik dan butyrik) dan bukan VFA (asid laktik dan suksinik) dalam sekum ayam penelur meningkat secara signifikan ($P < 0.05$), dan aktiviti enzim mikrob berbahaya ("β-glukosidase", "β-glukuronidase" dan "urease") menurun secara signifikan ($P < 0.05$) selepas suplementasi dengan PRE, PRO atau SYN pada umur 36 dan 52 minggu. Analisis penjujukan 16S rRNA menunjukkan bahawa kelebihan relatif laktobasili telah ditingkatkan secara signifikan ($P < 0.05$) dalam sekum ayam penelur yang disuplementasi dengan PRE, PRO atau SYN pada umur 36 dan 52 minggu. Kelebihan relatif bifidobakteria juga ditingkatkan dengan signifikannya ($P < 0.05$) dalam sekum ayam penelur yang disuplementasi dengan diet PRE atau SYN pada umur 36 minggu, dan diet PRE, PRO atau SYN pada umur 52 minggu. Pada umur 36 minggu, kelebihan relatif sekal Enterobacteriaceae diturunkan dengan signifikannya ($P < 0.05$) selepas suplementasi PRE, PRO atau SYN. Analisis penjujukan metagenomik "shotgun" menunjukkan bahawa mikrobiom ayam penelur yang diberi diet PRE, PRO atau SYN dijangka mempunyai peratusan gen yang lebih tinggi dalam metabolisme karbohidrat (glukoneogenesis/glikolisis, kitaran sitrat, metabolisme butanoate dan piruvat); xenobiotik biodegradasi dan metabolisme (degradasi dioksin, xilena dan toluena); metabolisme lemak (metabolisme asid arakidonik dan pemanjangan asid lemak); pengangkut "ATP-binding cassette" (pengangkut ABC); pengisyaratan molekul dan interaksi; sistem imun dan pencernaan, jika berbanding dengan ayam penelur kawalan pada umur 36 minggu. Kesimpulannya, hasil-hasil kajian tersebut menunjukkan suplementasi PRE, PRO atau SYN dapat menambah baik prestasi, menghasilkan telur dengan paras kolesterol dan SFA yang rendah, serta meningkatkan kesihatan ayam penelur dengan memanipulasikan populasi, diversiti dan fungsian potensi mikrobiom sekum tanpa mempengaruhi kualiti telur ayam penelur.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my deepest gratitude to my ex-supervisor, Professor Dr. Ho Yin Wan, for her attentive guidance, endless patience and encouragement throughout the course of my study. Moreover, I have obtained valuable insights through her advices that have helped me grow not only academically but also build my character, resilience and grit. I am grateful and honored for being given the opportunity to pursue my doctoral degree under her supervision. I wish her the very best of health and happiness in her retirement.

I wish to express my deep appreciation and most sincere gratitude to the late Associate Professor Dr. Sieo Chin Chin (who was chairperson of my supervisory committee till she passed away in October 2015), for her invaluable guidance, support and encouragement in completing this research work. Her warm, engaging and friendly approach has boosted my confidence throughout this study.

My heartfelt appreciations are extended to the chairperson of my supervisory committee, Associate Professor Dr. Wan Zuhainis Saad, for her kind assistance, support and advice that nurtured my passion for research.

I wish to extend my sincere thanks to my co-supervisor, Associate Professor Dr. Kalavathy Ramasamy, for her assistance and constant encouragement throughout the course of my work and in the preparation of the thesis. Special appreciation goes to Mr Wong Hee Kum, ex-Deputy Director of Strategic Livestock Research Centre, MARDI, for sharing his expertise in layer management and feed formulation.

I am indebted and thankful to Madam Haw Ah Kam, Mr Nagayah Muniandy, Mr. Khairul Kamar Bakri, Cik Nadia, staffs of the Probiotic and Prebiotic Technology Programme, Laboratory of Vaccine and Immunotherapeutics, Institute of Bioscience, for their technical support and kind assistance throughout my study.

I sincerely thank the Department of Higher Education, Ministry of Education, for the PhD funding and the Ministry of Science, Technology and Innovation (MOSTI) for the research project funding.

I appreciate the friendship, motivation and support from my labmates and friends, Wei Li, Su Ting, Fadhilah, Helen Tang, Ling Lit, Saminathan, Shaufi, Soo Ning, Ying Ying, Ying Jie and Mei Chee. I would like to thank them for their help, moral support, active co-operation and invaluable support. I have enjoyed the time that I spent with them throughout my studies.

I am truly blessed and fortunate to have my beloved husband Pin Jern, who has selflessly supported my decision to pursue my PhD. I thank him for always being there, at every step of all my endeavours, and for helping me overcome my fears and failures. I truthfully appreciate his courage, understanding and trust which have been the pillars in our relationship.

To my beloved grandmother, mother, father-in-law, mother-in-law, uncle, aunties, sisters, brother, brother-in-laws, sister-in-laws and cousins, your support, both morally and financially, have enabled me to complete my study with confidence and without having to fear and worry.

I certify that a Thesis Examination Committee has met on 14 July 2016 to conduct the final examination of Shirley Tang Gee Hoon on her thesis entitled "Effects of Prebiotic, Probiotic and Synbiotic on Performance and Cecal Microbiome of Laying Hens" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Thesis Examination Committee were as follows:

Janna Ong binti Abdullah, PhD
Associate Professor
Faculty of Biotechnology and Biomolecular Sciences
Universiti Putra Malaysia
(Chairman)

Muhajir bin Hamid, PhD
Associate Professor
Faculty of Biotechnology and Biomolecular Sciences
Universiti Putra Malaysia
(Internal Examiner)

Shuhaimi bin Mustafa, PhD
Professor
Halal Products Research Institute
Universiti Putra Malaysia
(Internal Examiner)

Ming-Ju Chen, PhD
Professor
National Taiwan University
Taiwan
(External Examiner)

ZULKARNAIN ZAINAL, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 23 August 2016

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

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

Kalavathy Ramasamy, PhD
Associate Professor
Faculty of Pharmacy
Universiti Teknologi Mara
(Member)

BUJANG BIN KIM HUAT, 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 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.: Shirley Tang Gee Hoon, GS 33224

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) were adhered to.

Signature: _____
Name of Chairman of Supervisory Committee: Associate Professor Dr. Wan Zuhainis Saad

Signature: _____
Name of Member of Supervisory Committee: Associate Professor Dr. Kalavathy Ramasamy

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AA	Arachidonic acid
ACE	Abundance-based Coverage Estimators
AGPs	Antibiotic growth promoters
ALA	Alpha-linolenic acid
ALP	Alkaline phosphatase
ALT	Alanine aminotransferase
AST	Aspartate aminotransferase
ATCC	American Type Culture Collection
BCFA	Branched chain fatty acid
bp	Basepair
BSM	Bifidus Selective Medium
BSH	Bile salt hydrolase
C	Coverage
Ca	Calcium
cm	Centimeter
cfu	Colony-forming unit
CH_4	Methane
CK	Creatinine kinase
Cl	Chloride
Cq	Quantitative cycle
DGGE	Denaturing gradient gel electrophoresis
DHA	Docosahexaenoic acid
DNA	Deoxyribonucleic acid
DP	Degree of polymerization
E	Amplification efficiency
EC	Enzyme Commission
EDTA	Ethylene diamine tetraacetate
EFAs	Essential fatty acids
EMP	Embden Meyerhof Parnas
EPA	Eicosapentaenoic acid
FAMEs	Fatty acid methyl esters
FAO	Food and Agriculture Organization
FCR	Feed conversion ratio
FID	Flame ionization detector
FISH	Fluorescence *in situ* hydridization
fL	Femtoliter
FOS	Fructooligosaccharide
g	Gram
g	Gravity
GB	Gigabyte
GC	Gas chromatography
GGT	Gamma-glutamyl transpeptidase
GOS	Galactooligosaccharide
H	Heterophil

h	Hour
H/L	Heterophil/Lymphocyte ratio
H_2S	Hydrogen sulphide
Hb	Hemoglobin
HCN	Hydrocyanic acid
HDL	High-density lipoprotein
HMG CoA	Hydroxymethylglutaryl coenzyme A
HPLC	High performance liquid chromatography
HT-NGS	High-throughput next generation sequencing
HU	Haugh unit
IDBA-UD	De Bruijn Graph De Novo Assembler for Short Reads Sequencing data with Highly Uneven Sequencing Depth
IL	Interleukine
IMO	Isomaltooligosaccharide
IU	International units
K	Potassium
k	Kilo
K_2EDTA	Potassium enthylenediaminetetraacetate
KEGG	Kyoto Encyclopedia of Genes and Genomes
kg	Kilogram
L	Lymphocyte
L	Large
L	Liter
LAB	Lactic acid bacteria
LDL	Low-density lipoprotein
M	Medium
m	Meter
MCHC	Mean corpuscular hemoglobin concentration
MCV	Mean corpuscular volume
MEGAN	MetaGenome Analyzer
mg	Milligram
min	Minute
MJ	Millijoules
ml	Milliliter
mm	Millimeter
mM	Millimolar
mmol	Millimole
mol	Mole
MOS	Mannanoligosaccharide
MRS	de Man, Rogosa and Sharpe
MTBE	Methyl-tert-butyl ether
MUFA	Monounsaturated fatty acid

N50	Average length of a set of sequences
Na	Sodium
NaCl	Sodium chloride
NaClO	Alkaline hypochlorite
NaOH	Sodium hydroxide
NCBI	National Center for Biotechnology Information
NDOs	Non-digestible oligosaccharides
NGS	Next generation sequencing
NH_3	Ammonia
NH_4Cl	Ammonium chloride
$(NH_4)_2SO_4$	Ammonium sulphate
NK	Natural killer
nm	Nanometer
ng	Nanogram
nt	Nucleotide
NTC	No-template control
OTU	Operational taxonomic unit
P	Phosphorus
PANDAseq	PAired-eND Assembler for DNA sequences
PCR	Polymerase chain reaction
PCV	Packed cell volume
PP	6-phosphogluconate
PRE	Basal diet + 1% prebiotic IMO
PRO	Basal diet + 0.1% probiotic PrimaLac®
PUFA	Polyunsaturated fatty acid
PVDF	Polyvinyl difluoride
PyNAST	Python Nearest Alignment Space Termination
q	Qscore
QIIME	Quantitative Insights Into Microbial Ecology
qPCR	Quantitative polymerase chain reaction
R^2	Correlation coefficient values
RAM	Random access memory
RBC	Red blood cell
RFO	Raffinose oligosaccharide
RNA	Ribonucleic acid
S	Small
s	Second
SCFA	Short chain fatty acid
SD	Standard deviations
SEM	Standard Error Mean
SFA	Saturated fatty acid
sIgA	Secretory Immunoglobulin A
SMS	Shotgun metagenomic sequencing

SOS	Soy-oligosaccharide
SRA	Sequence Read Archive
STAMP	Statistical Analysis of Metagenomic Profiles
STOC	Sucrose thermal oligosaccharides
SYN	Basal diet + 1% IMO + 0.1% PrimaLac®
TAE	Tris-acetate EDTA
TGF-β	Transforming growth factor beta
Th1	T helper 1
Th2	T helper 2
THF	Tetrahydrofuran
TLR	Toll-like receptor
TMS	Targeted metagenomic sequencing
TOS	Transgalactooligosaccharide
U/L	Units per litre
UFA	Unsaturated fatty acid
V	Volt
v/v	Volume per volume
VFA	Volatile fatty acid
VLDL	Very-low-density lipoprotein
WHO	World Health Organization
XL	Extra large
XOS	Xylooligosaccharide
µg	Microgram
µL	Microliter
µm	Micrometer
µM	Micromolar
µmol	Micromole

CHAPTER 1

INTRODUCTION

Since the late 1940s, antibiotics have been widely used for treatment of animals and as growth promoters for livestock (Aarestrup and Jenser, 2007). The efficiency of antibiotics in improving feed utilization, animal growth, and reducing morbidity and mortality due to clinical and subclinical diseases is well documented (Dibner and Richards, 2005; Niewold, 2007; Hao *et al.*, 2014). The imprudent use of antibiotics in animal production has resulted in the prevalence of antibiotic resistance bacteria and accumulation of antibiotic residues in animal products such as poultry meat and eggs, posing large threats to public health (Vieira *et al.*, 2011; Hao *et al.*, 2014). The prevalence of multi-drug resistant bacteria in poultry and other farm animals are on the rise throughout the world including Malaysia (Ahmed Geidem *et al.*, 2012; Mansouri-najand *et al.*, 2012; Szmolka and Nagy, 2013; Fan *et al.*, 2015). Consequently, many countries have started to restrict or ban the inclusion of antibiotics in poultry diets as routine means of growth promotion. In 2006, European Union banned the use of antibiotic growth promoters (AGPs) in animal feed. The withdrawal of antibiotics as growth promoters in poultry feed instigated the search for new alternatives to maintain animal welfare without affecting health and performance. A strategy envisaging the use of probiotics, prebiotics, or synbiotics, as feed additives in poultry nutrition has been proposed as substitutes for AGPs to enhance gastrointestinal health, poultry performance and produce safe poultry products.

Probiotics have been defined in various ways over the years but the Food Agriculture Organization (FAO)/World Health Organization (WHO) definition of probiotics remains applicable to scientific, industrial and regulatory communities. They coined probiotics as "live microorganisms which when administered in adequate amounts confer a beneficial effect on health of the host" (FAO/WHO, 2002). The majority of probiotics are lactic acid bacteria that belong to the genera *Lactobacillus* and *Bifidobacterium*. The supplementation of probiotics in poultry feed has been reported to improve growth performance (Jin *et al.*, 1998a; Jin *et al.*, 1998b; Kalavathy *et al.*, 2003; Awad *et al.*, 2009; Kalavathy *et al.*, 2009; Mountzouris *et al.*, 2010; Li *et al.*, 2014; Zhang and Kim, 2014; Calik and Ergün, 2015), nutrient retention (Li *et al.*, 2008; Mountzouris *et al.*, 2010; Shim *et al.*, 2012), cecal microbial balance (Teo and Tan, 2007; Mountzouris *et al.* 2007, 2010; Li *et al.*, 2014; Zhang and Kim, 2014; Calik and Ergün, 2015), egg yolk cholesterol contents (Haddadin *et al.*, 1996; Kalavathy *et al.*, 2009; Mikulski *et al.*, 2012) and immune response (Zuklifi *et al.*, 2000; Panda *et al.*, 2008; Molnár *et al.*, 2011; Zhang and Kim, 2014).

Prebiotics on the other hand are defined as "nondigestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of health-promoting bacteria in the colon and thus improve host health" (Gibson and Roberfroid, 1995). Unlike probiotics, prebiotics provide nourishment that enhances growth of the resident microflora in the gastrointestinal

tract. They are non-digestible oligosaccharides (NDOs) that are resistant to digestion in the upper gastrointestinal tract, and resistant to gastric acid and hydrolytic enzymes. Hence, they pass unaltered to the colon where the resident microflora, such as lactobacilli and bifidobacteria, can selectively ferment the NDOs to produce beneficial effects in the hosts. There are several types of NDOs, such as fructooligosaccharides (FOS; oligofructose and inulin), galactooligosaccharides (GOS), transgalactooligosaccharides (TOS), lactulose, glucooligosaccharides, glycol-oligosaccharides, isomaltooligosaccharides (IMO), lactitol, maltooligosaccharides, xylooligosacharides (XOS), stachyose, raffinose and sucrose thermal oligosaccharide, which have been reported to possess prebiotic effects (Patterson and Burkholder, 2003; Desai *et al.*, 2004; Gaggìa *et al.*, 2010; De Souza Oliveira *et al.*, 2011). Prebiotics have been reported to improve intestinal microflora, enhancing the health and well-being of the hosts (Gaggìa *et al.*, 2010). Recently, prebiotics have been shown to confer health benefits in poultry by increasing the number of specific probiotic bacteria such as lactobacilli and bifidobacteria (Shang *et al.*, 2010; Kim *et al.*, 2011; Tako *et al.*, 2014), reducing pathogenic bacteria by mimicking their attachment sites on the intestinal mucosa (Iji and Tivey, 1998; Kim *et al.*, 2011), enhancing ileal digestibility (Huang *et al.*, 2005; Amirdahri *et al.*, 2012), increasing mineral absorption (Sohail *et al.*, 2011) and reducing serum cholesterol levels (Chen *et al.*, 2005a; Li *et al.*, 2007; Al-Saad *et al.*, 2014).

The term "synbiotics" refer to nutritional supplements combining probiotics and prebiotics in a synergistic form. Gibson and Roberfroid (1995) defined synbiotic as "a mixture of probiotics and prebiotics that beneficially affect the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract, thus improving the host health". Synbiotics potentiate the efficacy of probiotic preparations (Awad *et al.*, 2009). It enables the probiotics to survive for a longer period in the gastrointestinal tract of the host (Collins and Gibson, 1999). Most of the previous research on poultry involved the use of probiotics or prebiotics alone whilst the use of synbiotics has emerged in poultry only recently (Abdelqader *et al.*, 2013a, 2013b; Dibaji *et al.*, 2014).

A recent study evaluated the effects of a prebiotic IMO on the performance, cecal bacterial populations and cecal metabolic profiles of broiler chickens (Mookiah *et al.*, 2014). The results of the study demonstrated that the performance of broiler chickens (weight gain and feed efficiency), the populations of cecal beneficial bacteria and the cecal fermentative concentrations improved significantly after supplementation of IMO in broiler chickens. The role of IMO and its combination with a probiotic as a synbiotic however, has not been explored on laying hens.

Therefore, the present study was aimed to evaluate the effect of prebiotic IMO, and a commercial probiotic (PrimaLac®), administered singly, or in a combination as a synbiotic, on laying hens. This is the first study on the dietary effects of the prebiotic (IMO), and its synbiotic on laying hens. This study will also unravel the role of probiotics, prebiotics and synbiotics in modulating cecal microbial diversity.
The specific objectives of the study were:

i. to determine the efficacy of the prebiotic IMO (PRE), and probiotic PrimaLac® (PRO), administered singly, and their combination as a synbiotic (IMO + PrimaLac®) (SYN) on the performance, biochemical and hematological responses, and relative organ weights of the laying hens,

ii. to determine the effects of the PRE, PRO and SYN on egg quality and chemical compositions of egg yolk (total lipids, cholesterol, fatty acid composition, tocopherols and carotenoids) of laying hens,

iii. to evaluate cecal microbial populations, cecal metabolite profile and microbial enzyme activities of laying hens supplemented with PRE, PRO and SYN diets,

iv. to evaluate cecal microbial diversity of hens fed PRE, PRO and SYN using 16S rRNA high-throughput-Next Generation Sequencing (HT-NGS),

v. to investigate the functional potential of hen cecal microbial in response to PRE, PRO and SYN treatments using whole metagenome shotgun sequencing.

REFERENCES

Aarestrup, F.M. and Lars B. Jenser, L.B. (2007). Use of antimicrobials in food animal production. In *Foodborne diseases*, ed. S. Simjee, pp. 405-417. New Jersey: Humana Press.

Abdelqader, A., Al-Fataftah, A.R. and Daş, G. (2013a). Effects of dietary *Bacillus subtilis* and inulin supplementation on performance, eggshell quality, intestinal morphology and microflora composition of laying hens in the late phase of production. *Animal Feed Science and Technology*. 179: 103-111.

Abdelqader, A., Irshaid, R. and Al-Fataftah, A-R. (2013b). Effects of dietary probiotic inclusion on performance, eggshell quality, cecal microflora composition, and tibia traits of laying hens in the late phase of production. *Tropical Animal Health and Production*. 45: 1017-1024.

Abdel-Raheem, S. and Abd-Allah, S.M.S. (2011). The effect of single or combined dietary supplementation of mannan oligosaccharide and probiotics on performance and slaughter characteristics of broilers. *International Journal of Poultry Science.* 10: 854-862.

Abdel-Raheem, S.M., Abd-Allah, S.M.S. and Hassanein, K.M.A. (2012). The effects of prebiotic, probiotic and synbiotic supplementation on intestinal microbial ecology and histomorphology of broiler chickens. *IJAVMS*. 6: 277-289.

Abdulrahim, S.M., Haddadin, M.S.Y., Hashlamoun, E.A.R. and Robinson, R.K. (1996). The influence of *Lactobacillus acidophilus* and bacitracin on layer performance of chickens and cholesterol content of plasma and egg yolk. *British Poultry Science.* 37: 341-346.

Abdulrahim, S.M., Haddadin, M.S., Odetallah, N.H. and Robinson, R.K. (1999). Effect of *Lactobacillus acidophilus* and zinc bacitracin as dietary additives for broiler chickens. *British Poultry Science.* 40: 91-94.

Acinas, S.G., Marcelino, L.A., Klepac-Ceraj, V., and Polz, M.F. (2004). Divergence and redundancy of 16S rRNA sequences in genomes with multiple Rrn operons. *Journal of Bacteriology*. 186: 2629-2635.

Aghaii, A., Chaji, M., Mohammadabadi, T. and Sari, M. (2010). The effect of probiotic supplementation on production performance, egg quality and serum and egg chemical composition of laying hens. *Journal of Animal and Veterinary Advances*. 9: 2774-2777.

Agunos, A., Ibuki, M., Yokomizo, F. and Mine, Y. (2007). Effect of dietary beta1-4 mannobiose in the prevention of *Salmonella enteritidis* infection in broilers. *British Poulty Science.* 48: 331-341.

Ahmadi, F. and Rahimi, F. (2011). Factors affecting quality and quantity of egg production in laying hens: a review. *World's Applied Science Journal*. 12: 372-384.

Ahmed Geidam,Y., Zakaria, Z., Abdul Aziz, S., Bejo, S.K., Abu, J. and Omar, S. (2012). High prevalence of multi-drug resistant bacteria in selected poultry farms in Selangor, Malaysia. *Asian Journal of Animal and Veterinary Advances*. 7: 891-897.

Ahn, D.U., Kim, S.K. and Shu, H. (1997). Effect of egg size and strain and age of hen on the solid content of chicken eggs. *Poultry Science*. 76: 914-919.

Alakomi, H.L., Skytta, E., Saarela, M., Mattila-Sandholm, T., Latva-Kala, K. and Helander, I.M. (2000). Lactic acid permeabilizes Gram-negative bacteria by disrupting the outer membrane. *Applied and Environmental Microbiology*. 66: 2001-2005.

Alander, M., Mättö, J., Kneifel, W., Johansson, M., Kögler, B., Crittenden, R., Mattila-Sandholm, T. and Saarela, M. (2001). Effect of galacto-oligosaccharide supplementation on human faecal microflora and on survival and persistence of *Bifidobacterium lactis* Bb-12 in the gastrointestinal tract. *International Dairy Journal*. 11: 817-825.

Alander, M., Matto, J., Kneifel, W., Johansson, M., Kogler, B., Crittenden, R., Mattila-Sandholm, T. and Saarela, M. (2001). Effect of galactooligosaccharide supplementation on human faecal microflora and on survival and persistence of *Bifidobacterium lactis* Bb-12 in the gastrointestinal tract. *International Dairy Journal*. 11: 817-825.

Alkhalf, A., Alhaj, M. and Al-Homidan, I. (2010a). Influence of probiotic supplementation on immune response of broiler chicks. *Egyptian Poultry Science*. 30: 271-280.

Alkhalf, A., Alhaj, M. and Al-homidan, I. (2010b). Influence of probiotic supplementation on blood parameters and growth performance in broiler chickens. *Saudi Journal of Biological Sciences*. 17: 219-225.

Allen-Vercoe, E., Sayers, A.R. and Woodward, M.J. (1999). Virulence of *Salmonella enterica* serovar Enteritidis aflagellate and afimbriate mutants in a day-old chick model. *Epidemiology and Infection*. 122: 395-402.

Alloui, M.N., Szczurek, W. and Świątkiewicz, S. (2013). The usefulness of prebiotics and probiotics in modern poultry nutrition: review. *Annals of Animal Science*. 1: 17-32.

Al-Saad, S., Abbod, M. and Abo Yones, A. (2014). Effects of some growth promoters on blood hematology and serum composition of broiler chickens. *International Journal of Agriculture Research*. 9: 265-270.

Amirdahri, S., Janmohammadi, H., Taghizadeh, A. and Rafat, A. (2012). Effect of dietary Aspergillus meal prebiotic on growth performance, carcass characteristics, nutrient digestibility, and serum lipid profile in broiler chick low-protein diets. *Turkish Journal of Veterinary and Animal Sciences*. 36: 602-610.

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

An, H.M., Park, S.Y., Lee, D.K., Kim, J.R., Cha, M.K., Lee, S.W., Lim, H.T., Kim, K.J. and Ha, N.J. (2011). Antiobesity and lipid-lowering effects of *Bifidobacterium* spp. in high fat diet-induced obese rats. *Lipids in Health and Disease* 10: 116.

Andersen, J.M., Barrangou, R., Hachem, M.A., Lahtinen, S.J., Goh, Y-J., Svensson, B. and Klaenhammer, T.R. (2012). Transcriptional analysis of prebiotic uptake and catabolism by *Lactobacillus acidophilus* NCFM. *PLoS ONE*. 7: e44409.

Andersson, A.F., Lindberg, M., Jakobsson, H., Bäckhed, F., Nyrén, P. and Engstrand, L. (2008). Comparative analysis of human gut microbiota by barcoded pyrosequencing. *PLoS ONE*. 3: e2836.

Andrews, R.K., Blakeley, R.L. and Zerner, B. (1984). Urea and urease. In G. L. Eichhorn, & L. G. Marzilli (Eds.), *Advances in inorganic biochemistry* (pp. 245-283). New York: Elsevier Science.

Angelakis, E. and Raoult, D. (2010). The increase of *Lactobacillus* species in the gut flora of newborn broiler chicks and ducks is associated with weight gain. *PLoS ONE* 5: e10463.

Anthony, J.C., Merriman, T.N. and Heimbach, J.T. (2006). 90-day oral (gavage) study in rats with galactooligosaccharides syrup. *Food and Chemical Toxicology*. 44: 819-826.

Apajalahti, J., Kettunen, A. and Graham, H. (2004). Characteristics of the gastrointestinal microbial communities, with special reference to the chicken. *Would's Poultry Science Journal.* 60: 223-232.

Apás, A.L., Arena, M.E., Colombo, S. and González, S.N. (2015). Probiotic administration modifies the milk fatty acid profile, intestinal morphology, and intestinal fatty acid profile of goats. *Journal of Dairy Science*. 98: 47-54.

Arndt, D., Xia, J., Liu, Y., Zhou, Y., Guo, A.C., Cruz, J.A., Sinelnikov, I., Budwill, K., Nesbe, C.L. and Wishart, D.S. (2012). METAGENassist: a comprehensive web server for comparative metagenomics. *Nucleic Acids Research.* 40: W88-W95.

Ashayerizadeh, O., Dastar, B., Shams Shargh, M., Ashayerizadeh, A. and Mamooee, M. (2009). Influence of antibiotic, prebiotic and probiotic supplementation to

diets on carcass characteristics, hematological indices and internal organ size of young broiler chickens *Journal of Animal and Veterinary Advances.* 8: 1772-1776.

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

Baffoni, L., Gaggia, F., Di Gloria, D., Satni, C., Mogna, L. and Biawati, B. (2012). A *Bifidobacterium*-based synbiotic product to reduce the transmission of *C. jejuni* along the poultry food chain. *International Journal of Food Microbiology*. 157: 156-161.

Baker, H.A. (1981). Amino acid degradation by anaerobic bacteria. *Annual Review Biochemistry*. 50: 23-40.

Balevi, T., Ucan, U.S., Coskun, B., Kurtoglu, V. and Cetingul, I.S. (2001). Effect of dietary probiotic on performance and humoral immune response in layer hens. *British Poultry Science.* 42: 456-461.

Barberis, A., Alloui, N., Bennoune, O., Ayachi, A. and Agabou, A. (2015). Effect of using an anticoccidial and a prebiotic on production performances, immunity status and coccidiosis in broiler chickens. *Asian Journal of Poultry Science.* 9: 133-143.

Barczynska, R., Slizewska, K., Jochym, K., Kapusniak, J. and Libudzisz, Z. (2012). The tartaric acid-modified enzymeresistant dextrin from potato starch as potential prebiotic. *Journal of Functional Foods*. 4: 954-962.

Barnes, E.M., Mead, G.C., Barnum, D.A. and Harry, E.G. (1972). The intestinal flora of the chicken in the period 2 to 6 weeks of age, with particular reference to the anaerobic bacteria. *British Poultry Science*. 13: 311-26.

Bartram, A.K., Lynch, M.D., Stearns, J.C., Moreno-Hagelsieb, G. and Neufeld, J.D. (2011). Generation of multimillion-sequence 16S rRNA gene libraries from complex microbial communities by assembling paired-end Illumina reads. *Applied Environmental and Microbiology*. 77: 3846 -3852.

Beckmann, L., Simon, O. and Vahjen, W. (2006). Isolation and identification of mixed linked beta-glucan degrading bacteria in the intestine of broiler chickens and partial characterization of respective 1,3–1,4-beta -glucanase activities. *Journal of Basic Microbiology.* 46: 175-185.

Begley, M., Hill, C. and Gahan, C.G.M. (2006). Bile salt hydrolase activity in probiotics. *Applied and Environmental Microbiology.* 72: 1729-1738.

Beloshapka, A.N., Dowd, S.E., Suchodolski, J.S., Steiner, J.M., Duclos, L., Swanson, K.S. (2013). Fecal microbial communities of healthy adult dogs fed raw meat-based diets with or without inulin or yeast cell wall extracts as assessed by 454 pyrosequencing. *FEMS Microbiology Ecology*. 84: 532-541.

Bergman, E.N. (1990). Energy contributions of volatile fatty acids from the gastrointestinal tract in various species. *Physiological Reviews.* 70: 567-590.

Beski, S.S.M. 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: 31-36.

Biddle, A., Stewart, L., Blanchard, J. and Leschine, S. (2013). Untangling the genetic basis of fibrolytic specialization by Lachnospiraceae and Ruminococcaceae in diverse gut communities. *Diversity.* 5: 627-640.

Biggs, P., Parsons, C.M. and Fahey, G.C. (2007). The effects of several oligosaccharides on growth performance, nutrient digestibilities, and cecal microbial populations in young chicks. *Poultry Science*. 86: 2327-2336.

Biloni, A., Quitana, C.F., Menconi, A., Kallapura, G., Latorre, J., Pixley, C., Layton, S., Dalmago, M., Hernandez-Velasco, X., Wolfenden, A. Harqis, B.M. and Tellez, G. (2013). Evaluation of effects of EarlyBird associated with FloraMax-B11 on *Salmonella enteritidis*, intestinal morphology, and performance of broiler chickens. *Poultry Science.* 92: 2337-2346.

Binns, N. (2013). The Prebiotic Concept. In Gibson, G.R. and Sanders, M.E. *Probiotics, Prebiotics and the Gut Microbiota.* (pp. 14-15). Belgium: International Life Sciences Institute.

Bolger, A.M., Lohse, M. and Usadel, B. (2014). Trimmomatic: a flexible trimmer for Illumina sequence data. *Bioinformatics.* 30: 2114-2120.

Bomba, A., Nemcová, Mudroňová and Guba, P. (2002). The possibilities of potentiating the efficacy of probiotics. *Trends in Food Science and Technology*. 13: 121-126.

Bonnet, C., Diarrassouba, F., Brousseau, R., Masson, L., Topp, E. and Diarra, M.S. (2009). Pathotype and antibiotic resistance gene distributions of *Escherichia coli* isolates from broiler chickens raised on antimicrobial-supplemented diets. *Applied and Environmental Microbiology*. 75: 6955-6962.

Bozkurt, M., Küçükyilmaz, K., Çatli, A.U., Çınar, M., Bintaş, E. and Çöven, F. (2012). Performance, egg quality, and immune response of laying hens fed diets supplemented with mannan-oligosaccharide or an essential oil mixture under moderate and hot environmental conditions. *Poultry Science.* 91: 1379-1386.

Bradley, F.A. and King, A.J. (2004). Egg basics for the consumer: packaging, storage, and nutritional information, Publications 8154. California: Regents of the University of California, Division of Agriculture and Natural Resources.

Buddington, K.K., Donahoo, J.B. and Buddington, R.K. (2002). Dietary oligofructose and inulin protect mice from enteric and systemic pathogens and tumor inducers. *Journal of Nutrition.* 132: 472-477.

Bustin, S.A., Benes, V., Nolan, T. and Pfaffl, M.W. (2005). Quantitative real-time RT-PCR - a perspective. *Journal of Molecular Endocrinology*. 34: 597-601.

Caballero-Franco, C., Keller, K., De Simone, C., and Chadee, K. (2007). The VSL#3 probiotic formula induces mucin gene expression and secretion in colonic epithelial cells. *American Journal of Physiology, Gastrointestinal and Liver Physiology.* 292: 315-322.

Calik, A. and Ergün, A. (2015). Effect of lactulose supplementation on growth performance, intestinal histomorphology, cecal microbial population, and short-chain fatty acid composition of broiler chickens. *Poultry Science*. 94; 2173-2182.

Callaway, T.R., Dowd, S.E., Wolcott, R.D., Sun, Y., McReynolds, J.L., Edrington, T.S., Byrd, J.A., Anderson, R.C., Krueger, N. and Nisbet, D.J. (2009). Evaluation of the bacterial diversity in cecal contents of laying hens fed various molting diets by using bacterial tag-encoded FLX amplicon pyrosequencing. *Poultry Science*. 88: 298-302.

Campbell, J.M., Fahey, G.C. Jr, Wolf, B.W. (1997). Selected indigestible oligosaccharides affect large bowel mass, cecal and fecal short-chain fatty acids, pH and microflora in rats. *Journal of Nutrition.* 127: 130-136.

Campbell, T.W. (2007). Bioquímica clínica de aves. In M.A. Thrall, D.C. Baker, T.W. Campbell, D. Denicola, M.J. Fettman, E.D. Lassen, A. Rebar and G. Weiser. *Hematologia e Bioquímica Clínica Veterinária* (pp. 448-460). Roca: São Paulo.

Canani, R.B., Costanzo, M.D., Leone, L., Pedata, M., Meli, R. and Calignano, A. (2011). Potential beneficial effects of butyrate in intestinal and extraintestinal diseases. *World Journal of Gastroenterology*. 17: 1519-1528.

Capcarova, M., Chmelnicna, L., Kolesarova, A., Massanyi, P. and Kovacik, J. (2010). Effects of *Enterococcus faecium* M 74 strain on selected blood and production parameters of laying hens. *British Poultry Science*. 51: 614-620.

Caporaso, J.G., Kuczynski, J., Stombaugh, J., Bittinger, K., Bushman, F.D., Costello, E.K., Fierer, N., Peña, A.G., Goodrich, J.K., Gordon, J.I. et al. (2010). QIIME allows analysis of high-throughput community sequencing data. *Nature Methods*. 7: 335-336.

Caporaso, J.G., Lauber, C.L., Walters, W.A., Berg-Lyons, D., Huntley, J., Fierer, N., Owens, S.M., Betley, J., Fraser, L., Bauer, M., Gormley, N., Gilbert, J.A., Smith, G. and Knight, R. (2012). Ultra-high-throughput microbial community analysis on the Illumina HiSeq and MiSeq platforms. *ISME Journal*. 6: 1621-1624.

Cardenas, E. and Tiedje, J.M. (2008). New tools for discovering and characterizing microbial diversity. *Current Opinion in Biotechnology*. 19: 544-549.

Carita, S. (1992). Research Note: Automated droplet application of competitive exclusion preparation. *Poultry Science.* 71: 2125-2128.

Castillo, M., Martín-Orúe, S.M., Manzanilla, E.G., Badiola, I., Martín, M. and Gasa, J. (2006). Quantification of total bacteria, enterobacteria and lactobacilli populations in pig digesta by real-time PCR. *Veterinary Microbiology*. 114: 165-170.

Chakravorty, S., Helb, D., Burday, M., Connell, N. and Alland, D. (2007). A detailed analysis of 16S ribosomal RNA gene segments for the diagnosis of pathogenic bacteria. *Journal of Microbiology Methods*. 69: 330-339.

Chambers, J.R. and Lu, X. (2002). Probiotic and maternal vaccination for *Salmonella* control in broiler chickens. *Journal of Applied Poultry Research.* 11: 320-327.

Chao, Y., Mao, Y., Wang, Z. and Zhang, T. (2015). Diversity and functions of bacterial community in drinking water biofilms revealed by high-throughput sequencing. *Scientific Reports*. 5: 10044.

Chen, Y.C., Nakthong, C. and Chen, T.C. (2005a). Effects of chicory fructans on egg cholesterol in commercial laying hen. *International Journal of Poultry Science.* 4: 109-114.

Chen, Y.C., Nakthong, C. and Chen, T.C. (2005b). Improvement of laying hen performance by dietary prebiotic chicory oligofructose and inulin. *International Journal of Poultry Science.* 4: 103–108.

Chiang, S.H. and Hsieh, W.M. (1995). Effect of direct-fed microorganisms on broiler growth performance and litter ammonia level. *Asian-Australian Journal of Animal Science.* 8: 159-162.

Chichlowski, M., Croom, W.J., Edens, F.W., McBride, B.W., Qiu, R., Chiang, C.C., Daniel, L.R., Havenstein, G.B. and Koci, M.D. (2007). Microarchitecture and spatial relationship between bacteria and ileal, cecal and colonic epithelium in chicks fed a direct-fed microbial, PrimaLac, and salinomycin. *Poultry Science.* 86: 1121-1132.

Cho, K.M., Math, R.K., Islam, S.M.A., Lim, W.J., Hong, S.Y., Kim, J.M., Yun, M.G., Cho, J.J. and Yun, H.D. (2009). Biodegradation of chlorpyrifos by lactic acid bacteria during kimchi fermentation. *Journal of Agriculture and Food Chemistry*. 57: 1882-1889.

Chukwu, H.I. and Stanley, V.G. (1997). Dietary *Saccharomyces cervisiae* and mannan oligosaccharide reduced the deleterious effect of heat stress on White Leghorn laying hens. In Program and Abstracts Association of Research Directors Eleventh Biennial Research Symposium. 1-4 Oct. San Antonio, Texas.

Chung, C. and Day, D. (2004). Efficacy of *Leuconostoc mesenteroides* (ATCC 13146) isomaltooligosaccharides as a poultry prebiotic. *Poultry Science.* 83: 1302-1306.

Ciechanover, A., Orian, A. and Schwartz, A.L. (2000). Ubiquitin-mediated proteolysis: biological regulation via destruction. *BioEssays.* 22: 442-451.

Claesson, H.E., Odlander, B. and Jakobsson, P.J. (1992). Leukotriene B4 in the immune response. *International Journal of Immunopharmacology*. 14: 441-449.

Claesson, M.J., O'Sullivan, O., Wang, Q., Nikkilä, J., Marchesi, J.R., Smidt, H., de Vos, W.M., Ross, R.P. and O'Toole, P.W. (2009). Comparative analysis of pyrosequencing and a phylogenetic microarray for exploring microbial community structures in the human distal intestine. *PLoS ONE*. 4: e6669.

Clinical Diagnostic Division. (1990). *Veterinary Reference Guide*. Rochester, New York: Eastman Kodak Company.

Coles, B. (2007). Aids in Diagnosis. In M. Krautwald-Junghanns. *Essentials of Avian Medicine and Surgery* (pp. 56-102). UK: Blackwell Publishing Ltd.

Collins, J.W., La Ragione, R.M., Woodward, M.J. and Searle, L.E.J. (2009). Application of prebiotics and probiotics in livestock. *Prebiotics and Probiotics Science and Technology.* 1123-1192.

Collins, M.D. and Gibson, G.R. (1999). Probiotics, prebiotics, and synbiotics: approaches for modulating the microbial ecology of the gut. *Americal Journal of Clinical Nutrition.* 69(suppl): 1052S-1057S.

CONCAWE. (2000). The occurrence of selected hydrocarbons in fodd on sale at petrol station shops and comparison with food from other shops - a literature survey. de Wolf, J.M. and van den Beld, C.M.B., Brussels.

Conn, E.E. (1979a). Cyanide and cyanogenic glycosides. In Rosenthal, G.A. & Janzen, D.H. (eds.), Herbivores: Their interaction with secondary plant metabolites, Academic Press, Inc., New York-London, pp 387-412.

Conn, E.E. (1979b). Cyanogenic glycosides. International review of biochemistry. In Biochemistry and Nutrition 1A, Neuberger, A., & Jukes, T.H. (eds), University Park Press, Baltimore, 27: 21-43.

Corr, S.C., Li, Y., Riedel, C.U., O'Toole, P. W., Hill, C., and Gahan, C.G. (2007). Bacteriocin production as a mechanism for the antiinfective activity of *Lactobacillus salivarius* UCC118. *Proceedings of the National Academy of Sciences of the United States of America.* 104: 7617-7621.

Corrier, D.E., Hinton, A., Ziprin, R., Beter, R.C. and DeLoch, J.R. (1990). Effect of dietary lactose on cecal pH, bacteriostatic volatile fatty acids, and *Salmonella typhymurium* colonization of broiler chicks. *Avian Disease*. 34: 617-625.

Cote, G.L. and Willet, J.L. (1999). Thermomechanical depolymerization of dextran. *Carbohydrate Polymers.* 39: 119-126.

Cotter, P.D., Hill, C., and Ross, R.P. (2005). Bacteriocins: developing innate immunity for food. *Nature Reviews in Microbiology*. 3: 777-788.

Courtin, C.M., Swennen, K., Broekaert, W.F., Swennen, Q., Buyse, J., Decuypere, E., Michiels, C.W., De Ketelaere, B. and Delcour, J.A. (2008). Effects of dietary inclusion of xylooligosaccharides, arabinoxylooligosaccharides and soluble arabinoxylan on the microbial composition of caecal contents of chickens. *Journal of the Science of Food and Agriculture*. 88: 2517-2522.

Crittenden, R. (2006). Emerging Prebiotic Carbohydtares. In G.R. Gibson and R. A. Rastall. *Prebiotics: Development and Application.* (pp. 112-133). England: John Wiley & Sons, Ltd.

Crittenden, R. and Playne, M.J. (1996). Production, properties and applications of food-grade oligosaccharides. *Trends in Food Science and Technology*. 7(11): 353-361.

Crittenden, R. and Playne, M.J. (2009). Prebiotics. In Y.K. Lee and S. Salminen. *Handbook of Probiotics and Prebiotics.* (pp. 535-595). New Jersey: John Wiley and Sons.

Crusoe, M., Edvenson, G., Fish, J, Howe, A., McDonald, E., et al. (2014). The khmer software package: enabling efficient sequence analysis. URL http://dx.doi.org/10.6084/m9.figshare.979190.

Cummings, J.H., and Macfarlane, G.T. (1997). Role of intestinal bacteria in nutrient metabolism. *Journal of Parenteral and Enteral Nutrition.* 21: 357-365.

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: 6266.

Danzeisen, J.L., Kim, H.B., Isaacson, R.E., Tu, Z.J. and Johnson, T.J. (2011). Modulations of the chicken cecal microbiome and metagenome in response to anticoccidial and growth promoter treatment. *PLoS ONE*. 6: e27949.

Davis, G.S. and Anderson, K.E. (2002). The effects of feeding the direct-fed microbial, Primalac, on growth parameters and egg production in single comb white leghorn hens. *Poultry Science.* 81: 755-759.

Davis, G.S., Anderson, K.E. and Carroll, A.S. (2000). The effect of long-term caging and molt of Single White Leghorn hens on heterophil to lymphocyte ratios, corticostrone, and thyroid hormones. *Poultry Science.* 79: 514-518.

De Filippo, C., Cavalieri, D., Di Paola, M., Ramazzotti, M., Poullet, J.B., Massart, S., Collini, S., Pieraccini, G. and Lionetti, P. (2010). Impact of diet in shaping gut microbiota revealed by a comparative study in children from

Europe and rural Africa. *Proceedings of the National Academy of Sciences of the United States of America*. 107: 14691-14696.

de Kivit, S., Tobin, M.C., Forsyth, C.B., Keshavarzian, A. and Landay, A.L. (2014). Regulation of intestinal immune responses through TLR activation: implications for pro- and prebiotics. *Fontiers in Immunology*. 5:1-7.

De LeBlanc, A.D.M. and Perdigón (2005). Reduction of ß-glucuronidase and nitroreductase activity by yogurt in a murine colon cancer model. *Biocell*. 29: 15-24.

De Preter, V. Raemen, H., Cloetens, L., Houben, E., Rutgeerts, P. and Verbeke, K. (2008). Effect of dietary intervention with different pre- and probiotics on intestinal bacterial enzyme activities. *European Journal of Clinical Nutrition*. 62: 225-231.

de Sousa, V.M.C., dos Santos, E.F. and Sgarbieri, V.C. (2011). The importance of prebiotics in functional foods and clinical practice. *Food and Nutrition Sciences*. 2: 133-144.

De Souza Oliveira, R.P., Florence, A.C.R., Perego, P., Oliveira, M.N.D. and Converti, A. (2011). Use of latulose as prebiotic and its influence on the growth, acidification profile and viable counts of different probiotics on fermented skim milk. *International Journal of Food Microbiology*. 145: 22-27.

Degnan, P. H., Pusey, A.E., Lonsdorf, E. V., Goodall, J., Wroblewski, E.E., Wilson, M.L., Rudicell, R.S., Hahn, B.H. and Ochman, H. (2012). Factors associated with the diversification of the gut microbial communities within chimpanzees from Gombe National Park. *Proceedings of the National Academy of Sciences of the United States of America*. 109: 13034-13039.

Degnan, P.H. and Ochman, H. (2012). Illumina-based analysis of microbial community diversity. *ISME Journal*. 6: 183-194.

Delgado, G.T.C., Tamashiro, W.M.D.S.C., Junior, M.R.M., Moreno, Y.M.F. and Pastore, G.M. (2011). The putative effects of prebiotics as immunomodulatory agents. *Food Research International.* 44: 3167-3173.

Delzenne, N. M. and Roberfroid, M. R. (1994). Physiological eVects of nondigestible oligosaccharides. *Lebensmittel-Wissenschaft und-Technologie.* 27: 1-6.

DeMilliano, I., Tabbers, M.M., van der Post, J.A., Benninga, M.A. (2012). Is a multispecies probiotic mixture effective in constipation during pregnancy?'A pilot study'. *Nutrition Journal*. 11: 80-87.

Desai, A., Powell, I. and Shah, N. (2004). Survival and activity of probiotic lactobacilli in skim milk containing prebiotics. *Journal of Food Science.* 69: 57-60.

Dethlefsen, L., Huse, S., Sogin, M. L. and Relman, D.A. (2008). The pervasive effects of an antibiotic on the human gut microbiota, as revealed by deep 16s rRNA sequencing. *PLoS Biology.* 6: 2383-2400.

Dibaji, S.M., Seidavi, A., Asadpour, L. and da Silva, F.M. (2014). Effect of a synbiotic on the intestinal microflora of chickens. *Journal of Applied Poultry Research*. 23: 1-6.

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

Dietert, R.R. and Golemboski, K.A. (1998). Avian macrophage metabolism. *Poultry Science*. 77: 990-997.

Dizaji, S.B., and Piromohammadi, R. (2009). Effect of *Saccharomyces cerevisiae* and Bioplus 2B on performance of laying hens. *International Journal of Agriculture and Biology.* 11: 495–497.

Donnet-Hughes, A., Rochat, F., Serrant, P., Aeschlimann, J.M. and Schiffrin, E.J. (1999). Modulation of nonspecific mechanisms of defense by lactic acid bacteria: effective dose. *Journal of Dairy Science*. 82: 863-869.

Dowd, S.E., Callaway, T.R., Wolcott, R.D., Sun, Y., McKeehan, T., Hagevoort, R.G. and Edrington, T.S. (2008). Evaluation of the bacterial diversity in the feces of cattle using 16S rDNA bacterial tag-encoded FLX amplicon pyrosequencing (bTEFAP). *BMC Microbiology*. 8: e125.

Drasar, B.S. and Hill, M.J. (1974). Human Intestinal Flora. London, New York and San Francisco: Academic press.

Duan, Q., Zhou, M., Zhu, L., Zhu, G. (2013). Flagella and bacterial pathogenicity. *Journal of Basic Microbiology*. 53: 1-8.

Dubinsky, E.A., Esmaili, L., Hulls, J.R., Cao, Y., Griffith, J.F. and Andersen, G.L. (2012). Application of phylogenetic microarray analysis to discriminate sources of fecal pollution. *Environmental Science and Technology*. 46: 4340-4347.

Duggan, C., Gannon, J. and Walker, W.A. (2002). Protective nutrients and functional foods for the gastrointestinal tract. *American Journal of Clinical Nutrition.* 75: 789-808.

Dumas, M.D., Polson, S.W., Ritter, D., Ravel, J., Gelb Jr., J., Morgan, R. and Wommack, K.E. (2011). Impacts of poultry house environment on poultry litter bacterial community composition. *PLoS ONE*. 6: e24785.

Dunbar, J., White, S. and Forney, L. (1997). Genetic diversity through the looking glass: effect of enrichment bias. *Applied and Environmental Microbiology*. 63: 1326-1331.

Duncan, S.H., Belenguer, A., Holtrop, G., Johnstone, A.M., Flint, H.J. and Lobley, G.E. (2007). Reduced dietary intake of carbohydrates by obsess subjects results in decreased concentrations of butyrate and butyrate-producing bacteria in feces. *Applied and Environmental Microbiology*. 73: 1073-1078.

Edelman, S., Weaterlund-Wikstrom, B., Leskela, S., Kettunen, H., Rautonen, N., Apajalahti, J. and Korhonen, T.K. (2002). *In vitro* adhesion specificity of indigenous lactobacilli within the avian intestinal tract. *Applied and Environmental Microbiology.* 61: 51-62.

Eeckhaut, V., Van Immerseel, F., Dewulf, J., Pasmans, F., Haesebrouck, F., Ducatelle, R., Courtin, C.M., Delcour, J.A. and Broekaert, W.F. (2008). Arabinoxylooligosaccharides from wheat bran inhibit *Salmonella* colonization in broiler chickens. *Poultry Science*. 87: 2329-2334.

El-Sissi, A.F. and Mohamed, S.H. (2011). Impact of synbiotic on the immune response of broiler chickens against NDV and IBV vaccines. *Global Journal of Biotechnology and Biochemistry*. 6: 186-191.

Ewing, W.N. and Cole, D.J.A. (1994). The Microbiology of the Gastrointestinal Tract. In W.N. Ewing and D.J.A. Cole. *The Living Gut: An Introduction to Microorganisms in Nutrition.* (pp.45-65). Dungannon, Ireland: Context Publications.

Fakruddin, M. and Mannan, K.S. (2013). Methods for analyzing diversity of microbial communities in natural environments. *Ceylon Journal of Science (Biological Science*s). 42: 19-33.

Falaki, M., Shams Shargh, M., Dastar, B. and Zerehdaran, S. (2011a). Effects of different levels of probiotic and prebiotic on performance and carcass characteristics of broiler chickens. *Journal of Animal and Veterinary Advances*. 10: 378-384.

Falaki, M., Shams Shargh, M., Dastar, B., Zerehdaran, S. and Khomairi, M. (2011b) The investigation of intestinal microflora and growth response of young broilers given feed supplemented with different levels of probiotic and prebiotic. *Journal of Animal and Veterinary Advances*. 10: 385-390.

Fan, Y., Li, S.M., Deng, B.G. and Zhao, Y.X. (2015). Prevalence and relevance of multidrug-resistant *Staphylococcus aurues* of meat, poultry and human origin. *Indian Journal of Animal Research*. 49: 86-90.

FAO. (2013). 2013 FAO Statistical Year Book: World food and agriculture. Food and Agriculture Orgaization of the United Nations, Rome.

FAO. (2014). Statistical Division of the FAO. http://www.fao.org (last accessed 26 March 2014).

FAO/WHO. (2002). Guidelines for the evaluation of probiotics in food. Report of a joint FAO/WHO working group on drafting guidelines for the evaluation of probiotics in food. London, Ont., Canada.

FASS (Federation of Animal Science Societies). (2010). Guide for the Care and Use of Agricultural Animals in Research and Teaching.

Fernandez, F., Hinton, M. and Van Gils, B. (2000). Evaluation of the effect of mannanoligosaccharides on the competitive exclusion of *Salmonella enteritidis* colonization in broiler chicks. *Avian Pathology*. 29: 575-581.

Fernandez, F., Hinton, M. and Van Gils, B. (2002). Dietary mannan-oligosaccharides and their effect on chicken caecal microflora in relation to *Salmonella enteritidis* colonization. *Avian Pathology.* 31: 49-58.

Fey, A., Eichler, S., Flavier, S., Christen, R., Hofle, M.G. and Guzman, C.A. (2004). Establishment of a real-time PCR-based approach for accurate quantification of bacterial RNA targets in water, using Salmonella as a model organism. *Applied Environmental and Microbiology*. 70: 3618-3623.

Figueroa-González, I., Cruz-Guerrero, A. and Quijano, G. (2011). The benefits of probiotics on human health. *Journal of Microbial and Biochemical Technology*. S1: 003.

Fletouris, D.J., Botsoglou, N.A., Psomas, I.E., Mantis, A.I. (1998). Rapid determination of cholesterol in milk and milk products by direct saponification and capillary gas chromatography. *Journal of Dairy Science.* 81: 2833-2840.

Flint, H.J., Scott, K.P., Duncan, S.H., Louis, P. and Forano, E. (2012). Microbial degradation of complex carbohydrates in the gut. *Gut Microbes.* 3: 289-306.

Flock, D.K. (2015). Demand driven productivity in egg business: Combining Advances in genetics, health control and nutrition to meet changing consumer preferences. *Lohmann Information.* 49: 30-38.

Folch, J., Lees, M., Sloane Stanley, G.H. (1957). A simple method for the isolation and purification of total lipid from animal tissues. *Journal of Biological Chemistry.* 226: 497-509.

Foo, H.L., Loh, T.C., Law, F.L., Lim, Y.Z., Kufli, C.N. and Rusul, G. (2003). Effects of feeding *Lactobacillus plantarum* I-UL4 isolated from Malaysian Tempeh on growth operformance, faecal flora and lactic acid bacteria and plasma cholesterol concentrations in post-weaning rats. *Journal of Food Science and Biotechnology*. 12: 403-408.

Forder, R.E.A., Howarth, G.S., Tivey, D.R. and Hughes, R.J. (2007). Bacterial modulation of small intestinal goblet cells and mucin composition during early posthatch development of poultry. *Poultry Science.* 86: 2396-2403.

Forestier, C., De Champs, C., Vatoux, C. and Joly, B. (2001). Probiotics activity of *Lactobacillus casei rhamnous*: in-vitro adherence to intestinal cells and antimicrobial activity. *Research in Microbiology*. 152: 167-173.

Frampton, E.W. and Restaino, L. (1993). Methods for *Escherichia coli* identification in food, water and clinical samples based on beta-glucuronidase detection. *Journal of Applied Bacteriology*. 74: 223-233.

Franklin, S.T., Newman, M.C., Newman, K.E. and Meek, K.I. (2005). Immune parameters of dry cows fed mannan oligosaccharide and subsequent transfer of immunity to calves. *Journal of Dairy Science.* 88: 766-775.

Fujii, A., and Cook, E.S. (1973). Probiotics. Antistaphylococcal and antifibrinolytic activities of omega-guanidine acids and omega-guanidinoacyl-L-histidines. *Journal of Medical Chemistry*. 16: 1409-1411.

Fujita, K., Kitahata, S., Kozo, H. and Hotoshi, H. (1992). Production of Lactosucrose and Its Properties. In M.A. Clarke. *Carbohydrates in Industrial Synthesis.* (pp. 68-76). Proceedings in Symposium of the Division of Carbohydrate Chemistry of the American Chemical Society. Bartens, Berlin.

Fukuda, S., Toh, H., Taylor, T. D., Ohno, H., and Hattori, M. (2012). Acetate producing bifidobacteria protect the host from enteropathogenic infection via carbohydrate transporters. *Gut Microbes.* 3: 449-454.

Fukushima, M. and Nakano, M. (1995). The effect of a probiotic on faecal and liver lipid classes in rats. *British Journal of Nutrition* 73: 701-710.

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

Fuller, R. (1992). Probiotics: The Scientific basis. London: Chapman & Hall.

Gaggìa, F., Mattarelli, P. and Biavati, B. (2010). Probiotics and prebiotics in animal feeding for safe food production. *International Journal of Food Microbiology.* 141: S15-S28.

Gallazzi, D., Giardini, A., Mangiagalli, M.G., Marelli, S., Ferrazzi, V., Orsi, C. and Cavalchini, L.G. (2008). Effects of *Lactobacillus acidophilus* D2/CSL on laying hen performance. *Italian Journal of Animal Science*. 7: 27-37.

García-García, E. and Rosales, C. (2002). Signal transduction during Fc receptor-mediated phagocytosis. *Journal of Leukocyte Biology*. 72: 1092-1108.

Garcia-Mazcorro, J.F., Lanerie, D.J., Dowd, S.E., Paddock, C.G., Grützner, N., Steiner, J.M., Ivanek, R. and Suchodolski, J.S. (2011). Effect of a multi-species synbiotic formulation on fecal bacterial microbiota of healthy cats and dogs as evaluated by pyrosequencing. *FEMS Microbiology. Ecology*. 78: 542-554.

Ghafoor, A., Naseem, S., Younus, M. and Nazir, J. (2005). Immunomodulatory effects of multistrain probiotics (Protexin™) on broiler chicken vaccinated against avian influenza virus (H9). *International Journal of Poultry Science.* 4: 777-780.

Ghasemian, M. and Jahanian, R. (2016). Dietary mannan-oligosaccharides supplementation could affect performance, immunocompetence, serum lipid metabolites, intestinal bacterial populations, and ileal nutrient digestibility in aged laying hens. *Animal Feed Science and Technology*. Article in press.

Gibson, G.R. and Roberfroid, M.B. (1995). Dietary modulation of the human colonic microbiota: introducing the concept of prebiotics. *Journal of Nutrition.* 125: 1401-1412.

Gibson, G.R., Probert, H.M., Van Loo, J.A.E. and Roberfroid, M.B. (2004). Dietary modulation of the human colonic microflora: updating the concept of prebiotics. *Nutrition Research Reviews.*17: 257-259.

Gibson, G.R., Scott, K.P., Rastall, R.A., Tuohy, K.M., Hotchkiss, A., Dubert-Ferrandon, A., Gareau, M., Murphy, E.F., Saulnier, D., Loh, G., Macfarlane, S., Delzenne, N., Ringel, Y., Kozianowski, G., Dickmann, R., Lenoir-Wijnkoop, I., Walker, C. and Buddington, R. (2010). Dietary prebiotics: current status and new definition. *Food Science and Technology Bulletin: Functional Foods.* 7: 1-19.

Gilliland, S.E., Nelson, C.R. and Maxwell, C. (1985). Assimilation of cholesterol by *Lactobacillus acidophilus*. *Applied and Environmental Microbiology* 49: 377-381.

Gloor, G.B., Hummelen, R., Macklaim, J.M., Dickson, R.J., Fernandes, A.D., MacPhee, R. and Reid, G. (2010). Microbiome profiling by Illumina sequencing of combinatorial sequence-tagged PCR products. *PLoS ONE*. 5: e15406.

Godoy-Vitorino, F., Ley, R.E., Gao, Z., Pei, Ortiz-Zuazaga, H., Pericchi, L.R., Garcia-Amado, M.A., Michelangeli, F., Blaser, M.J., Gordon, J.I. and Domínguez-Bello, M.G. (2008). Bacterial community in the crop of the hoatzin, a neotropical folivorous flying bird. *Applied and Environmental Microbiology*. 74: 5905-5912.

Goldin, B.R. and Gorbach, S.L. (1984). Alterations of the intestinal microflora by diet, oral antibiotic, and *Lactobacillus*: decreased production of free amines from aromatic nitro compounds, azo dyes, and glucoronides. *Journal of National Cancer Institute.* 73: 689-695.

González, F.H.D. and Silva, S.C. (2006). Perfil bioquímico sangüíneo. In: González FHD, Silva SC (eds) Introdução à Bioquímica Clínica Veterinária, 2nd edn. UFRGS, Porto Alegre, pp 313–358.

Gordon, D., Macrae, J. and Wheater, D.M. (1957). A *Lactobacillus* preparation for use with antibiotics. *The Lancet.* 269: 899-901.

Griffin, H. and Hermier, D. (1988). Plasma lipoprotein metabolism and fattening in poultry. Leaness in Domestic Birds. In: B. Leclercq and C.C. Whitehead. London: Butterworth and Co. Ltd.

Grimes, J.L., Maurice, D.V., Lightsey, S.F. and Lopez, J.G. (1997). The effect of dietary Fermacto on layer hen performance. *Journal of Applied Poultry Research.* 6: 399-403.

Griswold, K.E., White, B.A. and Mackie, R.I. (1999). Diversity of extracellular proteolytic activities among *Prevotella* species from the rumen. *Current Microbiology.* 39:187-194.

Grobas, S., Méndez, J., Lopez Bote, C., De Blas, C. and Mateos, G.G. (2002). Effect of vitamin E and A supplementation on egg yolk α-tocopherol concentration. *Poultry Science.* 81: 376-381.

Grootaert, C., Delcour, J. A., Courtin, C. M., Broekaert, W. F., Verstraete,W. and VandeWiele, T. (2007). Microbial metabolism and prebiotic potency of arabinoxylan oligosaccharides in the human intestine. *Trends in Food Science and Technology*. 18: 64-71.

Guarner, F. (2006). Enteric flora in health and disease. *Digestion.* 73(Suppl. 1): 5-12.

Guillot, J.F. (2009). Consequences of probiotics release in the intestine of animals. Universite de Tours-IUT 29 rue de Pont-Vollant, 37082 Tours Cedex 2, France: 17-21.

Gusils, C., Perez, C.A., Gonzalez, S.N. and Oliver, G. (1999). Lactobacilli isolated from chicken intestine: potential use as probiotics. *Journal of Food Protection.* 62: 252-256.

Gutzwiller, A. (1993). The effect of a diet containing cyanogenic glycosides on the selenium status and the thyroid function of sheep. *Animal Production*. 57: 415-419.

Haddadin, M.S.Y., Abdulrahim, S.M., Hashlamoun, E.A.R. and Robinson, R.K. (1996). The effect of *Lactobacillus acidophilus* on the production and chemical composition of hen's eggs. *Poultry Science.* 75: 491-494.

Haghighi, H.R., Gong, J.H., Gyles, C.L., Hayes, M.A., Zhou, H., Sanei, B., Chambers, J.R. and Sharif, S. (2006). Probiotics stimulate production of natural antibodies in chickens. *Clinical and Vaccine Immunology.* 13: 975-980.

Hamilton-Miller, J.M.T., Gibson, G.R. and Bruck, W. (2003). Some insight into the derivation and early uses of the word 'probiotic'. *British Journal of Nutrition*. 90: 845.

Hammes, W.P. and Vogel, R.F. (1995). The Genus *Lactobacillus*. In B.J.B. Wood and W.H. Holzapfel. *The Genera of Lactic Acid Bacteria* (pp. 9-54). United Kingdom: Blackie Academic and Professional.

Handelsman, J. (2004). Metagenomics: application of genomics to uncultured microorganisms. *Microbiology and Molecular Biology Reviews*. 68: 669-685.

Handl, S., Dowd, S.E., Garcia-Mazcorro, J.F., Steiner, J.M. and Suchodolski, J.S. (2011). Massive parallel 16S rRNA gene pyrosequencing reveals highly diverse fecal bacterial and fungal communities in healthy dogs and cats. *FEMS Microbiology Ecology*. 76: 301-310.

Hao, H., Cheng, G., Iqbal, Z., Ai, X., Hussain, H.I., Huang, L., Dai, M., Wang, Y., Liu, Z. and Yuan, Z. (2014). Benefits and risks of antimicrobial use in food-producing animals. *Frontiers in Microbiology*. 5: 288.

Hara, H., Haga, S., Aoyama, Y. and Kiriyama, S. (1999). Short-chain fatty acids suppress cholesterol synthesis in rat liver and intestine. *Journal of Nutrition.* 129: 942-948.

Hargis, P.S. (1988). Modifying egg yolk cholesterol in the domestic fowl: a review. *World's Poultry Science Journal.* 44:17-29.

Harismendy, O., Ng, P.C., Strausberg, R.L., Wang, X., Stockwell, T.B., Beeson, K. Y., Schork, N.J., Murray, S.S., Topol, E.J., Levy, S. and Frazer, K.A. (2009). Evaluation of next generation sequencing platforms for population targeted sequencing studies. *Genome Biology*. 10: R32.

Harris, P.J. and Ferguson, L.R. (1999). Dietary fibers may protect or enhance carcinogenesis. *Mutation Research/ Genetic Toxicology and Environmental Mutagenesis.* 443: 95-110.

Hassanein, S.M. and Soliman, N.K. (2010). Effect of probiotic (*Saccharomyces cerevisiae*) adding to diets on intestinal microflora and performance of Hy-Line layer hens. *Journal of American Sciences.* 6: 159-169.

Haugh, R.R. (1973). The Haugh unit for measuring egg quality. *US Egg Poultry Magazine.* 43: 522-555, 572-573.

Havenaar, R., and Huisint'Veld, J. H. J. (1992). Probiotics: a general view. In B.J.B. Wood (Ed.) *The lactic acid bacteria.* The lactic acid bacteria in health and disease vol. I (pp. 151-170). New York, USA: Springer Publishing.

Havenaar, R., and Spanhaak, S. (1994). Probiotics from an immunological point of view. *Current Opinion in Biotechnology.* 5: 320-325.

Heilig, H.G., Zoetendal, E.G., Vaughan, E.E., Marteau, P., Akkermans, A.D. and de Vos, W.M. (2002). Molecular diversity of *Lactobacillus* spp. and other lactic acid bacteria in the human intestine as determined by specific amplification

of 16S ribosomal DNA. *Applied and Environmental Microbiology*. 68: 114-123.

Helal, M.S., Youssef, F.M., Moursi, M.K., Khalil, W.F. and Abdel-Daim, M. (2015). Effectiveness of prebiotic as an alternative to the antimicrobial growth promoter on growth performance, blood constituents, intestinal healthiness and immunity of broilers. *Alexander Journal of Veterinary Sciences*. 45: 13-25.

Henneke, P. and Golenbock, D.T. (2004). Phagocytosis, innate immunity, and host-pathogen specificity. *Journal of Experimental Medicine*. 199: 1-4.

Henningsson, Å., Björck, I. and Nyman, M. (2001). Short-chain fatty acid formation at fermentation of indigestible carbohydrates. *Scandinavian Journal of Nutrition*. 45: 165-168.

Hidaka, H., Hirayama, M. and Sumi, N. (1988). A fructooligosaccharide-producing enzyme from *Aspergillus niger* ATCC 20611. *Agricultural and Biological Chemistry* 52: 1181-1187.

Higgins, J.P., Higgins, S.E., Vicente, J.L., Wolfenden, A.D., Tellez, G. and Hargis, B.M. (2007). Temporal effects of lactic acid bacteria probiotic on *Salmonella* in neonatal broilers. *Poultry Science.* 86: 1662-1666.

Higgins, S.E., Higgins, J.P., Wolfenden, A.D., Henderson, S.N., Torres-Rodriguez, A., Tellez, G. and Hargis, B.M. (2008). Evaluation of a *Lactobacillus*-based probiotic culture for the reduction of *Salmonella enteritidis* in neonatal broiler chicks. *Poultry Science.* 87: 27-31.

Higgins, S.E., Torres-Rodriguez, A., Vicente, J.L., Sartor, C.D., C.M. Pixley, C.M. Nava, G.M., Tellez, G., Barton, J.T. and Hargis, B.M. (2005). Evaluation of intervention strategies for idiopathic diarrhea in commercial turkey brooding houses. *Journal of Applied Poultry Research.* 14: 345-348.

Higgins, S.E., Wolfenden, A.D., Tellez, G., Hargis, B.M. and Porter, T. (2011). Transcriptional profiling of cecal gene expression in probiotic and *Salmonella* challenged neonatal chicks. *Poultry Science*. 90: 901-913.

Hijova, E. and Chmelarova, A. (2007). Short chain fatty acids and colonic health. *Bratislava Medical Journal*. 108: 354-358.

Hill, J.E., Fernando, W.M.U., Zello, G.A., Tyler, R.T., Dahl, W.J. and Van Kessel, A.G. (2010). Improvement of the representation of bifidobacteria in fecal microbiota metagenomic libraries by application of the *cpn60* universal primer cocktail. *Applied and Environmental Microbiology*. 76(13): 4550-4552.

Hintz, H.F. (1993). Flaxseed: friend or foe. *Equine Practice*. 15: 6-9.

Hofacre, C.L., Beacorn, I.T., Collett, S. and Mathis, G. (2003). Using competitive exclusion, mannan-oligosaccharide and other intestinal products to control necrotic enteritis. *Journal of Applied Poultry Research.* 12: 60-64.

Holzapfel, W.H. and Wood, B.J.B. (1995) Lactic Acid Bacteria in Contemporary Perspective. In B.J.B. Wood and W.H. Holzapfel. *The Genera of Lactic Acid Bacteria* (pp. 1-6). United Kingdom: Blackie Academic and Professional.

Holzapfel, W.H., Haberer, P., Snel, J., Schillinger, U. and Huisin't Veld, J.H.J. (1998). Overview of gut flora and probiotics. *International Journal of Food Microbiology.* 41: 85-101.

Hong, S., Bunge, J., Leslin, C., Jeon, S., and Epstein, S.S. (2009). Polymerase chain reaction primers miss half of rRNA microbial diversity. *ISME Journal*. 3: 1365-1373.

Hooper, L.V., Midtvedt, T. and Gordon, J.I. (2002). How host-microbial interactions shape the nutrient environment of the mammalian intestine. *Annual Review of Nutrition.* 22: 283-307.

Hosono, A., Ozawa, A., Kato, R., Ohnishi, Y., Nakanishi, Y., Kimura, T. and Nakamura, R. (2003). Dietary fructooligosaccharides induce immunoregulation of intestinal IgA secretion by murine Peyer's patch cells. *Bioscience, Biotechnology and Biochemistry.* 67: 758-764.

Hosono, A., Ozawa, A., Kato, R., Ohnishi,Y., Nakanishi, Y., Kimura, T. and Nakamura, R. (2003). Dietary fructooligosaccharides induce immunoregulation of intestinal IgA secretion by murine Peyer's patch cells. *Bioscience, Biotechnology and Biochemistry*. 67: 758-764.

Hu, F.B., Stampfer, M.J., Rimm, E.B., Manson, J.E., Ascherio, A., Colditz, G.A., Rosner, B.A., Spiegelman, D., Speizer, F.E., Sacks, F.M., Hennekens, C.H. and Willett, W.C. (1999). A prospective study of egg consumption and risk of cardiovascular disease in men and women. *Journal of American Medical Association.* 281: 1387-1394.

Huang, R.-L., Yin, Y.-L., Wu, G.-Y., Zhang, Y.-G., Li, T. J., Li, L.-L., Li, M.-X., Tang, Z.-R., Zhang, J., Wang, B. He, J.-H. and Nie, X.-Z. (2005). Effect of dietary oligochitosan supplementation on ileal digestibility of nutrients and performance in broilers. *Poultry Science.* 84: 1383-1388.

Huang, R.-L., Yin, Y.-L., Wu, G.-Y., Zhang, Y.-G., Li, T.-J., Li, L.-L., Li, M.-X., Tang, Z.-R., Zhang, J., Wang, B., He, J.-H. and Nie, Z.-Z. (2005). Effect of dietary oligochitosan supplementation on illeal digestibility of nutrients and performance in broilers. *Poulty Science.* 84: 1383-1388.

Hugenholtz, P. (2002). Exploring prokaryotic diversity in the genomic era. *Genome Biology*. 3: Reviews0003-reviews0003.8.

Hugenholtz, P. and Tyson, G.W. (2008). Metagenomics. *Nature*. 455: 481-483.

Huijsdens, X.W., Linskens, R.K., Mak, M., Meuwissen, S.G.M., Vandenbroucke-Grauls, C.M.J.E. and Savelkoul, P.H.M. (2002). Quantification of bacteria adherent to gastrointestinal mucosa by real-time PCR. *Journal of Clinical Microbiology.* 40: 4423-4427.

Hume, M.E. (2011). Hostoric perspective: Prebiotics, probiotics, and other alternatives to antibiotics. *Poultry Science.* 90: 2663-2669.

Huse, S.M., Dethlefsen, L., Huber, J.A., Mark Welch, D., Relman, D.A. and Solgin, M.L. (2008). Exploring microbial diversity and taxonomy using SSU rRNA hypervariable tag sequencing. *PLoS Genetics*. 4: e1000255.

Huson, D.H., Mitra, S., Ruscheweyh, H.-J., Weber, N. and Schuster, S.C. (2011). Integrative analysis of environmental sequencing using MEGAN4. *Genome Research.* 21: 1552-1560.

Huyghebaert, G., Ducatelle, R. and Van Immerseel, F. (2011). An update on alternatives to antimicrobial growth promoters for broilers. Veterinary Journal 187: 182–188.

Hwang, D. (1989). Essential fatty acids and immune response. *Federation of American Societies for Experimental Biology Journal.* 3: 2052-2061.

Ibuki, M., Kovacs-Nolan, J., Fukui, K., Kanatani, H. and Mine, Y. (2010). Analysis of gut immune-modulating activity of β-1,4-mannobiose using microarray and real-time reverse transcription polymerase chain reaction. *Poultry Science*. 89: 1894-1904.

Iji, P.A., Tivey, D.R. (1998). Natural and synthetic oligosaccharides in broiler chicken diets. *World's Poultry Science Journal* 54: 129-143.

Imaizumi, K., Hirata, K., Yasni, S. and Sugano, M. (1992). Propionate enhances synthesis and secretion of bile acids in primary cultured rat hepatocytes via succinyl CoA. *Bioscience, Biotechnology and Biochemistry.* 56: 1894-1896.

Isolauri, F., Sütas, Y., Kankaanpää, P., Arvilommi, H. and Salminen, S. (2001). Probiotics: effects on immunity. *American Journal of Clinical Nutrition*. 73: 444S-450S.

Jackson, F.L. (1994). The bioantropological impact of chronic exposure to sublethal cyanogens in Africa. *Acta Horticulturae*. 375: 295-309.

Jadamus, A., Vahjen, W. and Kühn, I. (2000). The effects of the probiotic toyocerin in fattening poultry. *Lohmann information* 23:3-6.

Jahanian, R. and Ashnagar, M. (2015). Effect of dietary supplementation of mannan-oligosaccharides on performance, blood metabolites, ileal nutrient digestibility, and gut microflora in *Escherichia coli*-challaged laying hens. *Poultry Science*. 94: 2165-2172.

Jain, I., Kumar, V. and Satyanarayana, T. (2015). Xylooligosaccharides: an economical prebiotic from agroresidues and their health benefits. *Indian Journal of Experimental Biology*. 53: 131-142.

Janardhana, V., Broadway, M.M., Bruce, M.P., Lowenthal, J.W., Geier, M.S., Hughes, R.J. and Bean, A.G.D. (2009). Prebiotics modulate immune responses in the gut-assoicated lymphoid tissue of chickens. *Journal of Nutrition.* 139: 1404-1409.

Jayasekara, S. and Horadagoda, N.U.(1992). Hydrocianic acid content in *Manihot glaziovii* (cearra rubber) leaves and toxicologic effects in goats. *Sri Lankan Journal of Agricultural Sciences*. 29: 9-15.

Jeremy, J.Y., Nystrom, M.L., Barradas, M.A. and Mikhailidis, D.P. (1994). Review: eicosanoids and septicaemia. *Prostaglandin Leukotrienes Essential Fatty Acids*. 50:287-297.

Jiang, H.Q., Gong, L.M., Ma, Y.X., He, Y.H., Li, D.F. and Zhai, H.X. (2006). Effect of stachyose supplementation on growth performance, nutrient digestibility and cecal fermentation characteristics in broilers. *Birtish Poultry Science*. 47: 516-522.

Jin, L.Z., Ho, Y.W., Abdullah, N. and Jalaludin, S. (1996b). Influence of dried *Bacillus subtilis* and lactobacilli cultures on intestinal microflora and performance in broilers. *Asian-Australasian Journal of Animal Science.* 9(4): 397-403.

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

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: 886-891.

Jin, L.Z., Ho, Y.W., Abdullah, N., Ali, A.M. and Jalaludin, S. (1998b). Effects of adherent *Lactobacillus* cultures on growth, weight of organs and intestinal microflora and volatile fatty acids in broilers. Animal *Feed Science and Technology.* 70: 197-209.

Jin, L.Z., Ho, Y.W., Ali, A.M., Abdullah, N. and Jalaludin, S. (1996a). Effect of adherent *Lactobacillus* spp. on *in vitro* adherence on Salmonellae to the intestinal epithelial cells of chickens. *Journal of Applied Bacteriology*. 81: 201-206.

Jin, L.Z., Ho, Y.W., Ali, M.A., Jalaludin, S. (1998b). Effects of adherent *Lactobacillus* cultures on growth, weight of organs and intestinal microflora and volatile fatty acids in broilers. *Animal Feed Science and Technology*. 70: 197-209.

Johansen, H.N., Glitso, V. and Knudsen, K.E.B. (1996). Influence of extraction solvent and temperature on the quantitative determination of oligosaccharides from plant materials by high-performance liquid chromatography. *Journal of Agricultural and Food Chemistry*. 44: 1470-1474.

Jovanovic-Malinovska, R., Kuzmanova, S. and Winkelhausen, E. (2014). Oligosaccharide profile in fruits and vegetables as sources of prebiotics and functional foods. *International Journal of Food Properties*. 17: 949-965.

Jumpstart Consortium Human Microbiome Project Data Generation Working Group. (2012). Evaluation of 16S rDNA-based community profiling for human microbiome research. *PLoS ONE*. 7: e39315.

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

Kalavathy, R., Abdullah, N., Jalaludin, S. and Ho, Y.W. (2003). Effects of *Lactobacillus* cultures on growth performance, abdominal fat deposition, serum lipids and weights of organs of broiler chickens. *British Poultry Science.* 44:139-144.

Kalavathy, R., Abdullah, N., Jalaludin, S., Wong, C. M.V.L. and Ho, Y.W. (2005). Effects of *Lactobacillus* cultures on performance and egg quality of laying hens during the early stage of the egg production cycle. *Journal of Animal and Feed Sciences.* 14: 2.

Kalavathy, R., Abdullah, N., Jalaludin, S., Wong, M. and Ho, Y.W. (2009). Effects of *Lactobacillus* cultures on performance of laying hens, and total cholesterol, lipid and fatty acid composition of egg yolk. *Journal of Science of Food and Agriculture.* 89: 482-486.

Kalavathy, R., Abdullah, N., Jalaludin, S., Wong, M.C.V.L. and Ho, Y.W. (2006). Effects of *Lactobacillus* feed supplementation on cholesterol, fat content and fatty acid composition of the liver, muscle and carcass of broiler chicken. *Animal Research*. 55: 77-82.

Kalavathy, R., Abdullah, N., Jalaludin, S., Wong, M.C.V.L. and Ho, Y.W. (2008). Effects of *Lactobacillus* cultures and oxytetracycline on the growth performance and serum lipids of chickens. *International Journal of Poultry Science.* 7: 385-389.

Kamalu, B.P. (1993). Pathological changes in growing dogs fed on a balanced cassava (*Manihot esculenta Crantz*) diet. *British Journal of Nutrition*. 69: 921-934.

Kaneko, T., Kohmoto, T., Kikuchi, H., Shiota, M., Iino, H. and Mitsuoka, T. (1994). Effects of isomaltooligosaccharides with different degrees of polymerization

on human faecal bifidobacteria. *Bioscience, Biotechnology, and Biochemistry*. 58: 2288-2290.

Karadas, F., Grammenidis, E., Suria, P.F., Acamovic, T. and Sparks, N.H. (2006). Effects of carotenoids from lucerne, marigold and tomato on egg yolk pigmentation and carotenoid composition. *British Poultry Science.* 47: 561-566.

Karr-Lilienthal, L.K., Kadzere, C.T., Grieshop, C.M. and Fahey, G.C.Jr. (2005). Chemical and nutritional properties of soybean carbohydrates as related to nonruminants. *Livestock Production Science*. 97: 1-12.

Kawase, M., Pilgrim, A., Araki, T. and Hashimoto, K. (2001). Lactosucrose production using a simulated moving bed reactor. *Chemical Engineering Science*. 56: 453-458.

Kelly, D. and King, T.P. (2001). Luminal Bacteria: Regulation of Gut Function and Immunity. In A. Piva, K.E. Bach Knudsen and J.E. Lindberg. *Gut Environment of Pigs.* (pp. 113-131). Nottingham, UK: Nottingham University Press.

Khajali, F., Karimi, S. and Qujeq, D. (2008). Probiotics in drinking water alleviate stress of induced molting in feed-deprived laying hens. *Asian-Australian Journal of Animal Science.* 21: 1196-1200.

Khaksefidi, A. and Rahimi, Sh. (2005). Effect of probiotic inclusion in the diet of broiler chickens on performance, feed efficiency and carcass quality. *Asian-Australian Journal of Animal Sciences*. 18: 1153-1156.

Khan, S.H., Atif, M., Mukhtar, N., Rehman, A. and Fareed, G. (2011). Effects of supplementation of multi-enzyme and multi-species probiotic on production performance, egg quality, cholesterol leveland immune system in laying hens. *Journal of Applied Animal Research.* 39: 386-398.

Kim, C.H., Shin, K.S., Woo, K.C. and Paik, I.K. (2009). Effect of dietary oligosaccharides on the performance, intestinal microflora ane serum immunoglobulin contents in laying hens. *Korean Journal of Poultry Science*. 36: 125-131.

Kim, D.H. and Jin, Y.H. (2001). Intestinal bacterial b-glucuronidase activity of patients with colon cancer. *Archives of Pharmacal Research*. 24: 564-567.

Kim, G.-B., Seo, Y.M., Kim, C.H. and Paik, I.K. (2011). Effect of dietary prebiotic supplementation on the performance, intestinal microflora, and immune response of broilers. *Poultry Science*. 90: 75-82.

Kim, K., Lee, W.-S. and Benevenga, N.J. (1998). Feeding diets containing high levels milk products or cellulose decrease urease activity and ammonia production in rat intestine. *Journal of Nutrition*. 128: 1186-1191.

Kim, W.K., Donalson, L.M., Mitchell, A.D., Kubena, L.F., Nisbey, D.J. and Ricke, S.C. (2006). Effects of alfafa and fructooligosaccharide on molting parameters and bone qualities using dual x-ray absorptiometry and conventional bone assays. *Poultry Science.* 85: 15-20.

Kishino, S., Takeuchi, M., Park, S-B, Hirata, A., Kitamura, N., Kunisawa, J., Kiyono, H., Iwamoto, R., Isobe, Y., Arita, M., Arai, H., Ueda, K., Shima, J., Takahashi, S., Yokozeki, K., Shimizu, S. and Ogawa, J. (2013). Polyunsaturated fatty acid saturation by gut lactic acid bacteria affecting host lipid composition. *PNAS*. 110: 17808-17813.

Klasing, K.C. (2007). Nutrition and the immune system. *British Poultry Science.* 48: 525-537.

Klaver, F.A.M. and van der Meer, R. (1993). The assumed assimilation of cholesterol by Lactobacilli and *Bifidobacterium bifidum* is due to their bile salt-deconjugating activity. *Applied and Environmental Microbiology.* 59: 1120-1124.

Kljak, K., Drdić, M., Karolyi, D. and Grběsa, D. (2012). Pigmentation efficiency of Croation corn hybrids in egg production. *Croatian Journal of Food, Technology and Biotechnology Nutrition.* 7(Special issue): 23-27.

Klose, V., Mohnl, M., Plail, R., Schatzmayr, G. and Loibner, A.P. (2006). Development of a competitive exclusion product for poultry meeting the regulatory requirements for registration in the European Union. *Molecular Nutrition and Food Research*. 50: 563-571.

Kogut, M.H. (2013). The gut microbiota and host innate immunity: Regulators of hostmetabolism and metabolic diseases in poultry? *The Journal of Applied Poultry Research*. 22: 637-646.

Kolb, H. (1955). Die Behandlung acuter Infekte unter dem Gesichtswinkel der Prophylaxe chronischer Leiden. Über die Behandlung mit physiologischen bakterien. *Microecology and Therapy.* 1: 15-19.

Kollath, W. (1953). Nutrition and the tooth system; general review with special reference to vitamins. *Deutsche zahnarztliche Zeitschrift.* 8: 7-16.

König, H. and Fröhlich, J. (2009). Lactic Acid Bacteria. In König, H., Unden, G. and Fröhlich, J. *Biology of Microorganisms on Grapes, in Must and in Wine* (pp 3-29). Berlin: Springer Verlag.

Kotera, M., Bayashi, T., Hattori, M., Tokimatsu, T., Goto, S., Mihara, H. and Kanehisa, M. (2010). Comprehensive genomic analysis of sulfur-relay pathway genes. *Genome Informatics*. 24: 104-115.

Kuczynski, J., Lauber, C.L., Walters, W. A., Parfrey, L.W., Clemente, J.C., Gevers, D. and Knight, R. (2012). Experimental and analytical tools for studying the human microbiome. *Nature Reviews Genetics*. 13: 47-58.

Kunin, V., Copeland, A., Lapidus, A., Mavromatis, K. and Hugenholtz, P. (2008). A bioinformatician's guide to metagenomics. *Microbiology and Molecular Biology Reviews*. 72: 557-578.

Kurilich, A.C. and Juvik, J.A. (1999). Quantification of carotenoid and tocopherols antioxidants in *Zea mays. Journal of Agricultural and Food Chemistry*. 47: 1948-1955.

Kuroda, K., Caputo, G.A. and DeGrado, W.F. (2009). The role of hydrophobicity in the antimicrobial and hemolytic activities of polymethacrylate derivatives. *Chemistry A European Journal*. 15: 1123-1133.

Kurtoglu, V., Kurtoglu, F., Seker, E., Coskun, B., Balevi, T. and Polat, E.S. (2004). Effect of probiotic supplementation on laying hen diets on yield performance and serum and egg yolk cholesterol. *Food Additives and Contaminants.* 21: 817-823.

Lamendella, R., Santo Domingo, J.W., Ghosh, S., Martinson, J., Oerther, D.B. (2011). Comparative fecal metagenomics unveils unique functional capacity of the swine gut. *BMC Microbiology.* 11:103.

Lan, P.T.N., Sakamoto, M. and Benno, Y. (2004). Effects of two probiotic *Lactobacillus* strains on jejuna and caecal microbiota of broiler chickens under acute heat stress condition as revealed by molecular analysis of 16S rRNA genes. *Microbiology and Immunology*. 48: 917-929.

Lankaputhra, W.E.V. and Shah, N.P. (1998). Antimutagenic properties of probiotic bacteria and of organic acids. *Mutation Research.* 397: 169-182.

Latour, M.A., Peebles, E.D., Doyle, S.M., Pansky, T., Smith, T.W. and Boyle, C.R. (1998). Broiler breeder age and dietary fat influence the yolk fatty acid profiles of fresh eggs and newly hatched chicks. *Poultry Science.* 77: 47-53.

Layton, S.L., Hernandez-Velasco, X., Chaitanya, S., Xavier, J., Menconi, A., Latorre, J.D., Kallapura, G., Kuttappan, V.A., Wolfenden, R.E., Filho, R.L.A., Hargis, B.M. and Téllezl, G. (2013). The effect of a *Lactobacillus*-based probiotic for the control of necrotic enteritis broilers. *Food and Nutrition Sciences.* 4: 1-7.

Lea, H., Spring, P., Taylor-Pickard, J., andBurton, E. (2012). A natural carbohydrate fraction Actigen™ from *Saccharomyces cerevisiae* cell wall: effects on goblet cells, gut morphology and performance of broiler chickens. *Journal of Applied Animal Nutrition*. e9: 1-7.

Leser, T.D., Amenuvor, J.Z., Jensen, T.K., Lindecrona, R.H., Boye, M. and Moller, K. (2002). Culture-independent analysis of gut bacteria, the pig gastrointestinal tract microbiota revisited. *Applied and Environmental Microbiology*. 68: 673-690.

Li, L.L., Hou, Z.P., Li, T.J., Wu, G.Y., Huang, R.L., Tang, Z.R., Yang, C.B., Gong, J., Yu, H. and Kong, X.F. (2008). Effects of dietary probiotic

supplementation on ileal digestibility of nutrients and growth performance in 1- to 42-day-old broilers. *Journal of the Science of Food and Agriculture.* 88: 35-42.

Li, S.P., Zhao, X.J. and Wang, J.Y. (2009). Synergy of *Astragalus* polysaccharides and probiotics (*Lactobacillus* and *Bacillus cereus*) on immunity and intestinal microbiota in chicks. *Poultry Science*. 88: 519-525.

Li, X., Liu, L., Li, K., Hao, K. and Xu, C. (2007). Effect of fructooligosaccharides and antibiotics on laying performance of chickens and cholesterol content of egg yolk. *British Poultry Science.* 48: 185-189.

Li, X., Liu, L.Q. and Xu, C.L. (2008). Effect of supplementation of fructo-oligosaccharide and/ or *Bacillus subtilis* to diets on performance and intestinal microflora of broilers. *Archiv für Tierzucht.* 51: 64-70.

Li, Y.B., Xu, Q.Q., Yang, C.J., Yang, X., Ly, L., Yin, C.H., Liu, X.L. and Yan, H. (2014). Effects of probiotic on the growth performance and intestinal microflora of broiler chickens. *Pakistan Journal of Pharmaceutical Sciences*. 17(3Suppl): 713-717.

Liao, N., Yin, Y., Sun, G., Xiang, C., Liu, D., Yu, H.D. and Wang, X. (2012). Colonization and distribution of segmented filamentous bacteria (SFB) in chicken gastrointestinal tract and their relationship with host immunity. *FEMS Microbiology Ecology*. 81: 395-406.

Lilly, D.M. and Stillwell, R.H. (1965). Probiotics: Growth-promoting factors produced by microorganisms. *Science.* 147: 747-748.

Lin, C.C., Yeh, Y.C., Yang, C.Y., Chen, C.L., Chen, G.F., Chen, C.C. and Wu, Y.C. (2002). Selective binding of mannose-encapsulated gold nanoparticles to type 1 pili in *Escherichia coli*. *Journal of the American Chemical Society.* 124: 3508-3509.

Lina, B. A. R., Jonker, D. and Kozianowsky, G. (2002). Isomaltulose (Palatinose): A review of biological and toxicological studies. *Food and Chemical Toxicology*. 40: 1375-1381.

Liong, M.T., Dunshea, F.R. and Shah, N.P. (2007). Effects of a synbiotic containing *Lactobacillus acidophilus* ATCC 4962 on plasma lipid profiles and morphology of erythrocytes in hypercholesterolemic pigs on high- and low-fat diets. *British Journal of Nutrition.* 98: 736-744.

Liu, X., Yan, H., Lv, L., Xu, Q., Yin, C., Zhang, K., Wang, P . and Hu, J. (2012). Growth performance and meat quality of broiler chickens supplemented with *Bacillus licheniformis* in drinking water. *Asian-Australasian Journal of Animal Sciences*. 25: 682-689.

Liu, Z., DeSantis, T.Z., Andersen, G.L., and Knight, R. (2008). Accurate taxonomy assignments from 16S rRNA sequences produced by highly parallel pyrosequencers. *Nucleic Acids Research*. 36: e120.

Logares, R., Sunagawa, S., Salazar, G., Cornejo-Castillo, F. M., Ferrera, I., Sarmento, H., Hingamp, P., Ogata, H., de Vargas, C., Lima-Mendez, G., Raes, J., Poulain, J., Jaillon, O., Wincker, P., Kandels-Lewis, S., Karsenti, E., Bork, P. and Scinas, S.G. (2013). Metagenomic 16S rDNA illumina tags are a powerful alternative to amplicon sequencing to explore diversity and structure of microbial communities. *Environmental Microbiology*. 16: 2659-2671.

Loh, G., Eberhard, M., Brunner, R.M., Hennig, U., Kuhla, S., Kleessen, B. and Metges, C.C. (2006) Inulin alters the intestinal microbiota and short-chain fatty acid concentrations in growing pigs regardless of their basal diet. *Journal of Nutrition.* 136: 1198-1202.

Loman, N.J., Constantinidou, C., Chan, J.Z., Halachev, M., Sergeant, M., Penn, C.W., Robinson, E.R. and Pallen, M.J. (2012). High-throughput bacterial genome sequencing: an embarrassment of choice, a world of opportunity. *Nature Reviews Microbiology*. 10: 599-606.

Louis, P. and Flint, H.J. (2009). Diversity, metabolism and microbial ecology of butyrate-producing bacteria from the human large intestine. *FEMS Microbiology Letters*. 294: 1-8.

Lowry, V.K., Farnell, M.B., Ferro, P.J., Swaggerty, C.L., Bahl, A. and Kogut, M.H. (2005). Purified β-glucan as an abiotic feed attitive up-regulates the innate immune response in immature chickens against *Salmonella enterica* serovar *Enteritidis*. *International Journal of Food Microbiology.* 98: 309-318.

Lu, J., Idris, U., Harmon, B., Hofacre, C., Maurer, J.J. and Lee, M.D. (2003). Diversity and succession of the intestinal bacterial community of the maturing broiler chicken. *Applied and Environmental Microbiology*. 69: 6816-6824.

Lye, H.S., Rusul, G. and Liong, M.T. (2010). Removal of cholesterol by Lactobacilli via incorporation of and conversion to coprostanol. *Journal of Dairy Science.* 93: 1383-1392.

Macbeth, W.A.A.G., Kass, E.H. and McDermott, W.V., Jr. (1965). Treatment of hepatic encephalopathy by alteration of intestinal flora with *Lactobacillus acid-ophilus*. *Lancet*. 1: 399-403.

Macfarlane, G.T. and Macfarlane, S. (2012). Bacteria, colonic fermentation, and gastrointestinal health. *Journal of AOAC International.* 95(1): 50-60.

Macfarlane, G.T., Steed, H. and Macfarlane, S. (2008). Bacterial metabolism and health-related effects of galacto-oligosaccharides and other prebiotics. *Journal of Applied Microbiology.* 104: 305-344.

Macfarlane, S. and Macfarlane, G.T. (2003). Regulation of short-chain fatty acid production. *Proceedings of the Nutrition Society.* 62: 67-72.

Madsen, K., Cornish, A., Soper, P., McKaigney, C., Jijon, H., Yachimec, C., Doyle, J., Jewell, L. and DeSimone, C. (2001). Probiotic bacteria enhance murine and human intestinal epithelial barrier function. *Gastroenterology.* 121: 580-591.

Mahdavi, A.H., Rahmani, H.R. and Pourreza, J. (2005). Effect of probiotic supplements on egg quality and laying hen's performance. *International Journal of Poultry Science.* 4: 488-492.

Mansouri-najand, L., Saleha, A.A. and Wai, S.S. (2012). Prevalence of multidrug resistance *Campylobacter jejuni* and *Campylobacter coli* in chickens slaughtered in selected markets, Malaysia. *Tropical Biomedicine*. 29: 231-238.

Marteau, P., Seksik, P., Lepage, P. and Dore, J. (2004). Cellular and physiological effects of probiotics and prebiotics. *Mini Reviews in Medicinal Chemistry.* 4: 889-896.

Martin, C., Dunlap, E., Caldwell, S., Barnhart, E., Keith, N. and DeLoach, J.R. (2000). Drinking water delivery of a defined competitive exclusion culture (Preempt^{TM}) in 1-day-old broiler chicks. *Journal of Applied Poultry Research.* 9: 88-91.

Masella, A.P., Bartram, A.K., Truszkowski, J.M., Brown, D.G. and Neufeld, J.D. (2012). PANDAseq: paired-end assembler for illumine sequences. *BMC Bioinformatics*. 13: 31.

Matsui, H., Ogata, K., Tajima, K., Nakamura, M., Nagamine, T., Aminov, R.I., and Benno, Y. (2000). Phenotypic characterization of polysaccharidases produced by four *Prevotella* type strains. *Current Microbiology.* 41: 45-49.

Mattila-Sandholm, T., Myllärinen, P., Crittenden, R., Fondén, R., and Saarela, M. (2002). Technological challenges for future probiotic foods. *International Dairy Journal.* 12: 173-182.

Maxwell, M.H. and Robertson, G.W. (1998). The avian heterophil leucocyte: a review. *World Poultry Science Journal.* 54: 151-178.

Maysa, M.H. (2010). Effect of dietary inulin supplementation on intestinal calcium and phosphorus absorption and egg shell quality in Bandarah laying hens. *Egyptian Poultry Science.* 30: 799-811.

Menconi, A., Kuttappan, V.A., Hernandez-Velasco, X., Urbano, T., Matté, F., Layton, S., Kallapura, G., Latorre, J., Morales, B.E., Prado, O., Vicente, J.L., Barton, J., Filho, R.L.A., Lovato, M., Hargis, B.M. and Tellez, G. (2014). Evaluation of a commercially available organic acid product on body weight loss, carcass yield, and meat quality during preslaughter feed withdrawal in

broiler chickens: a poultry welfare and economic perspective. *Poultry Science*. 93: 448-455.

Meng, Q.W., Yan, L., Ao, X., Jang, H.D., Cho, J.H. and Kim, I.H. (2010a). Effects of chito-oligosaccharide supplementation on egg production, nutrient digestibility, egg quality and blood profiles in laying hens. *Asian-Australian Journal of Animal Science.* 23: 1476-1481.

Meng, Q.W., Yan, L., Ao, X., Zhou, T.X., Wang, J.P., Lee, J.H. and Kim, I.H. (2010b). Influence of probiotics in different energy and nutrient density diets on growth performance, nutrient digestibility, meat quality, and blood characteristics in growing-finishing pigs. *Journal of Animal Science.* 88: 3320-3326.

Metzker, M.L. (2010). Sequencing technologies - the next generation. *Nature Reviews Genetics*. 11: 31-46.

Midilli, M., Alp, M., Kocabağli, N., Muölali, O.H., Turan, N., Yılmaž, H. and Cakir, S. (2008). Effects of dietary probiotic and prebiotic supplementation on growth performance and serum IgG concentration of broilers. *South African Journal of Animal Science*. 38: 1.

Mikkelsen, L.L. Jakobsen, M. and Jensen, B.B. (2003). Effects of dietary oligosaccharides on microbial diversity and fructo-oligosaccharide degrading bacteria in faeces of piglets post-weaning. *Animal Feed Science and Technology.* 109: 133-150.

Mikulski, D., Jankowski, J., Naczmanski, J., Mikulska, M. and Demey, V. (2012). Effects of dietary probiotic (*Pediococcus acidilactici*) supplementation on performance, nutrient digestibility, egg traits, egg yolk cholesterol, and fatty acid profile in laying hens. *Poultry Science.* 91: 2691-2700.

Ministry of Agriculture and Agro-Based Industry Malaysia. (2012). e-Book Version Agro Food Statistical Book 2012. http://www.moa.gov.my/web/guest/buku-perangkaan-agro-makanan. (Last accessed 4 April 2014).

Mitchell, E.B. and Johns, J. (2008). Avian hematology and related disorders. *Veterinary Clinics Exotic Animal Practice.* 501-522.

Mohamed, M.A. and Hafez, M.S.A. (2011). The effect of a mannanoligosaccharides (Biomos®) on necrotic enteritis infection in broiler chickens. *International Journal of Poultry Science*. 10: 685-690.

Mohammadian, A., Mehdizadeh, S.M., Lotfollahian, H., Mirzaei, F. and Noroozian, H. (2013). Influence of dietary probiotic (Biomin IMBO) on performance of laying hen. *Agricultural Sciences.* 4: 23-26.

Mohan, B., Kadirvel, R., Bhaskaran, M. and Natarajan, A. (1996). Effect of probiotic supplementation on growth, nitrogen utilization and serum cholesterol in broilers. *British Poultry Science.* 37: 395-401.

Mohd Shaufi, M.A., Sieo, C.C., Chong, C.W., Gan, H.M. and Ho, Y.W. Deciphering chicken gut microbial dynamics based on high-throughput 16S rRNA metagenomics analyses. *Gut Pathogen.* 7:4.

Mohebbifar, A., Kashani, S., Afsari, M. and Torki, M. (2013). Effects of commercial prebiotic and probiotics of diet on performance of laying hens, egg traits and some blood parameters. *Annual Review and Research in Biology.* 3: 921-934.

Molnár, A.K., Podmaniczky, B., Kürti, P., Tenk, I., Glávits, R., Virág, G.Y. and Szabó, Z.S. (2011). Effect of different concentrations of *Bacillus subtilis* on growth performance, carcase quality, gut microflora and immune response of broiler chickens. *British Poulty Science.* 53: 658-665.

Monedero, V., Yebra, M. J., Poncet, S., and Deutscher, J. (2008). Maltose transport in *Lactobacillus casei* and its regulation by inducer exclusion. *Research in Microbiology.* 159: 94-102.

Montalto, M., Maggiano, N., Ricci, R., Curigliano, V., Santoro, L., Di Nicuolo, F., Vecchio, F.M., Gasbarrini, A. and Gasbarrini, G. (2004). *Lactobacillus acidophilus* protects tight junctions from aspirin damage in HT-29 cells. *Digestion.* 69: 225-228.

Mookiah, S., Sieo, C.C., Kalavathy, R. 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 Science of Food and Agriculture* 94: 341-348.

Morgan, A.J., Mul, A.J., Beldman, G. and Voragen, A.G.J. (1992). Dietary oligosaccharides – new insights. *Agro Food Industry Hi-Technology.* 3(6): 35-38.

Mori, A.V., Mendonça Jr., C.X. and Santos, C.O.F. (1999). Effect of dietary lipid-lowering drugs upon plasma lipids and egg yolk cholesterol levels of laying hens. *Journal of Agricultural and Food Chemistry*. 47: 4731-4735.

Moshfegh, A.J., Friday, J.E., Goldman, J..P. and Chug Ahuja, J.K. (1999). Presence of inulin and oligofructose in the diets of Americans. *The Journal of Nutrition*. 129: 1407S-1411S.

Mountzouris, K.C., Tsirtsikos, P., Kalamara, E., Nitsh, 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 caecal microflora composition and metabolic activities. *Poultry Science.* 86: 309-317.

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

Mubito, E.P., Shahada, F., Kimanya, M.E. and Buza, J.J. (2014). Sulfonamide residues in commercial layer chicken eggs in Dar-es-Salaam, Tanzania. *American Journal of Research Communication*. 2: 124-132.

Munro, T.C., Newberne, P.M., Young, V.R. and Bär, A. (2004). Safety assessment of –y-cyclodextrin. *Regulatory Toxicology and Pharmacology*. 39: S3-S13.

Murphy, E.F., Cotter, P.D., Healy, S., Marques, T.M., O'Sullivan, O., Fouhy, F., Clarke, S.F., O'Toole, P.W., Quigley, E.M., Stanton, C., Ross, P.R., O'Doherty, R.M. and Shanahan, F. (2010). Composition and energy harvesting capacity of the gut microbiota: relationship to diet, obesity and time in mouse models. *Gut*. 59: 1635-1642.

Mussatto, S.I. and Mancilha, I.M. (2007). Non-digestible oligosaccharides: A review. *Carbohydrate Polymers.* 68: 587-597.

Muyzer, G., De Waal, E.C. and Uitterlinden, A.G. (1993). Profiling of complex microbial populations by denaturing gradient gel electrophoresis analysis of polymerase chain reaction-amplified genes coding for 16S rRNA. *Applied and Environmental Microbiology*. 59: 695-700.

Nabizadeh, A. (2012). The effect of inulin on broiler chicken intestinal microflora, gut morphology, and performance. *Jounal Animal Feed Science*. 21: 725-734.

Nagura, T., Hachimura, S., Hashiguchi, M., Ueda, Y., Kanno, T., Kikuchi, H., Sayama, K. and Kaminogawa, S. (2002). Suppressive effect of dietary raffinose on T-helper 2 cell-mediated immunity. *Britich Journal of Nutrition.* 88: 421-426.

Nahashon, S.N., Nakaue, H.S. and Mirosh, L.W. (1992). Effect of direct-fed microbials on nutrient retention and production parameters of laying pullets. *Poultry Science* 71(supplement 1): 111 (abstract).

Nahashon, S.N., Nakaue, H.S. and Mirosh, L.W. (1994a). Production variables and nutrient retention in Single Comb White Leghorn laying pullets fed diets supplemented with direct-fed microbials. *Poultry Science.* 73: 1699-1711.

Nahashon, S.N., Nakaue, H.S. and Mirosh, L.W. (1996a). Performance of Single Comb White Leghorn fed a diet supplemented with a live microbial during the gowth and egg laying phases. *Animal Feed Science and Technology.* 57: 25-38.

Nahashon, S.N., Nakaue, H.S., Synder, S.P, and Mirosh, L.W. (1994b). Performance of Single Comb White Leghorn layers fed corn-soybean mean and barley-corn-soybean meal diets supplemented with a direct-fed microbial. *Poultry Science.* 73: 1712-1723.

Nahashon, S.N., Nakaue, H.S. and Mirosh, L.W. (1996b). Nutrient retention and production parameters of Single Comb White Leghorn layers fed diets with

varying crude protein levels and supplemented with direct-fed microbials. *Animal Feed Science and Technology.* 61: 17-26.

Nakai, H., Baumann, M.J., Petersen, B.O., Westphal, Y., Schols, H., Dilokpimoi, A., Hachem, M.A., Lahtinen, S.J., Duus, J.O., and Svensson, B. (2009). The maltodextrin transport system and metabolism in *Lactobacillus acidophilus* NCFM and production of novel α-glucosides through reverse phosphorolysis by maltose phosphorylase. *Federation of European Biochemical Societies Journal.* 276: 7353-7365.

Nakamura, A., Ota, Y., Mizukami, A., Ito, T., Ngwai, Y.B. and Adachi, Y. (2002). Evaluation of aviguard, a commercial competitive exclusion product for efficacy and after-effect on the antibody response of chicks to *Salmonella*. *Poultry Science.* 81: 1653-1660.

Nakamura, J., Kubota, Y., Miyaoka, M., Saitoh, T., Mizuno, F. and Benno, Y. (2002). Comparison of four microbial enzymes in Clostridia and Bacteroides isolated from human feces. *Microbiology and Immunology*. 46: 487-490.

Nakamura, Y., Nosaka, S., Suzuki, M., Nagafuchi, S., Takahashi, T., Yajima, T., Takenouchi-Ohkubo, N., Iwase, T. and Moro, I. (2004). Dietary fructooligosaccharides up-regulate immunoglobulin A response and polymeric immunoglobulin receptor expression in intestines of infant mice. *Clinical and Experimental Immunology*. 137: 52-58.

Nakphaichit, M., Thanomwongwattana, S., Phraephaisarn, C., Sakamoto, N., Keawsompong, S., Nakayama, J. and Nitisinprasert, S. (2011). The effect of including *Lactobacillus reuteri* KUB-AC5 during post-hatch feeding on the growth and ileum microbiota of broiler chickens. *Poultry Science* 90: 2753-2765.

Napolitano, A., Costabile, A., Martin-Pelaez, S., Vitaglione, P., Klinder, A., Gibson, G.R. and Fogliano, V. (2009). Potential prebiotic activity of oligosaccharides obtained by enzymatic conversion of durum wheat insoluble dietary fibre into soluble dietary fibre. *Nutrition, Metabolism and Cardiovascular Diseases*. 19: 283-290.

Nayebpor, M., Farhomand, P. and Hashemi, A. (2007). Effects of different levels of direct fed microbial (PrimaLac) on growth performance and humoral immune response in broiler chickens. *Journal of Animal and Veterinary Advances.* 6: 1308-1313.

Neal-McKinney, J., Lu, X., Duong, T., Larson, C.L., Call, D.R., Shah, D.H. and Konkel, M.E. Production of organic acids by probiotic lactobacilli can be used to reduce pathogen load in poultry. *PLoS ONE.* 7: e43928.

Neyrinck, A.M., Possemiers, S., Druart, C., Van de Wiele, T., De Backer, F., Cani, P.D., Larondelle, Y. and Delzenne, N.M. (2011). Prebiotics effects of wheat arabinoxylan related to the increase in Bifidobacteria, Roseburia and Bacteroides/Prevotella in diet induced obese mice. *PLoS ONE.* 6: e20944.

Ngoc Lan, P.T., Binh, L.T. and Benno, Y. (2003). Impact of two probiotic *Lactobacillus* strains feeding on fecal lactobacilli and weight gains in chicken. *The Journal of General and Applied Microbiology*. 49: 29-36.

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

Nittynen, L., Kajander, K. and Korpela, R. (2007). Galacto-oligosaccharides and bowel function. *Scandinavian Journal of Food and Nutrition*. 51: 62-66.

Noble, R.C., Cocchi, M. and Turchetto, E. (1990). Egg fat: a case for concern? *World's Poultry Science Journal.* 46: 109-118.

Nocker, A., Burr, M. and Camper, A.K. (2007). Genotypic microbial community profiling: a critical technical review. *Microbial Ecology*. 54: 276-289.

Noh, D.O., Kim, S.H. and Gilliland, S.E. (1997). Incorporation of cholesterol into the cellular membrane of *Lactobacillus acidophilus* ATCC 43121. *Journal of Dairy Science* 80: 3107-3113.

Nordentoft, S., Mølbak, L., Bjerrum, L., De Vylder, J., Van Immerseel, F. and Pedersen, K. (2011). The influence of the cage system and colonization of *Salmonella* Enteritidis on the microbial gut flora of laying hens studied by T-RFLP and 454 pyrosequencing. *BMC Microbiology*. 11: 187.

Noujaim, J.C., Andreatti Filho, R.L., Lima, E.T., Okamoto, A.S., Amorim, R.L. and Neto, R.T. (2008). Detection of T lymphocytes in intestine of broiler chicks treated with *Lactobacillus* spp. and challenged with *Salmonella enterica* serovar Enteritidis. *Poultry Science*. 87: 927-933.

Noverr, M.C. and Huffnagle, G.B. (2004). Does the microbiota regulate immune responses outside the gut? *Trends in Microbiology.* 12: 562-568.

NRC. (1994). Nutrient Requirements of Poultry. *National Research Council, 9th rev*. ed. National Academy Press, Washington, DC.

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

Nurmi, E., Nuotio, L. and Schncitz, C. (1992). The competitive exclusion concept: Development and future. *International Journal of Food Microbiology.* 15: 237-240.

Ogata, H., Goto, S., Sato, K., Fujibuchi, W., Bono, H. and Kanehisa, M. (1999). KEGG: Kyoto encyclopedia of genes and genomes. *Nuclei Acids Research.* 27: 29-34.

Ogawa, T., Asai, Y., Tamai, R., Makimura, Y., Sakamoto, H., Hashikawa, S. and Yasuda, K. (2005). Natural killer cell activities of synbiotic *Lactobacillus*

casei ssp. *casei* in conjunction with dextran. *Clinical and Experimental Immunology*. 143: 103-109.

Ogundipe, S.O., Sa'adu, G., Bale, J.O., Aduku, A.O. and Balogun, T.F. (1992). Untilization of minimal manure in poultry diets. National Animal Production Research Institute. Shika-Zaria Nigeria: Ahmadu Bello University.

Oliveros, J.C. (2007). VENNY. An interactive tool for comparing lists with Venn diagrams. http://bioinfogp.cnb.csic.es/tools/venny/index.html. Accessed on 4 Mac 2015.

Oloyo, R.A. (2003). Effect of age on total lipid and cholesterol of hen eggs. *Indian Journal of Animal Sciences*. 73: 94-96.

Ooi, L-G. and Liong, M-T. (2010). Cholesterol-lowering effects of probiotics and prebiotics: A review of *in vivo* and *in vitro* findings. *International Journal of Molecular Sciences.* 11: 2499-2522.

Ouwehand, A.C., Kirjavainen, P.V., Shortt, C. and Salminen, S. (1999). Probiotics: Mechanisms and established effects. *International Dairy Journal*. 9: 43-52.

Ozutsumi, Y., Hayashi, H., Sakamotom, M., Itabashi, H. and Benno, Y. (2005). Culture independent analysis of fecal microbiota in cattle. *Bioscience, Biotechnology and Biochemistry*. 69: 1793-1797.

Panda, A.K., Rama Rao, S.S., Raju, M.V.L.N., Sharma, S.S. (2008). Effect of probiotic (*Lactobacillus sporogenes*) feeding on egg production and quality, yolk cholesterol and humoral immune response of white leghorn layer breeders. *Journal of the Science of Food and Agriculture.* 88: 43-47.

Panda, A.K., Reedy, M.R., Rama Rao, S.V. and Praharaj, N.K. (2003). Production, serum/yolk cholesterol and immune competence of white leghorn layers as influenced by dietary supplementation with probiotic. *Tropical Animal Health and Production.* 35: 85-94.

Panigraki, S., Rickard, J., O'Brien, G.M. and Gay, G. (1992). Effects of different rates of drying cassava root on its toxicity to broiler chicks. *British Poultry Science*. 33: 1025-1041.

Parche, S., Amon, J., Jankovic, I., Rezzonico, E., Beleut, M., Barutcu, H., Schendel, I., Eddy, M.P., Burkovski, A., Arigoni, F. and Titgemeyer, F. (2007). Sugar transport systems of *Bifidobacterium longum* NCC2705. *Journal of Molecular Microbiology and Biotechnology*. 12: 9-19.

Park, S-O and Park, B-S. (2012). Effect of feeding inulin oligosaccharides on cecum bacteria, egg quality and egg production in laying hens. *African Journal of Biotechnology.* 11: 9516-9521.

Parker, R.B. (1974). Probiotics, the other half of the story. *Animal Nutrition and Health.* 29: 4-8.

Parks, D.H., Tyson, G.W., Hugenholtz, P. and Beiko, R.G. (2014). STAMP: statistical analysis of taxonomic and functional profiles. *Bioinformatics*. 30: 3123-3124.

Parks, D.H., Tyson, G.W., Hugenholtz, P. and Beiko, R.G. (2014). STAMP: statistical analysis of taxonomic, and functional profiles. *Bioinformatics.* 30: 3123-3124.

Partanen, K. (2001). Organic acids – Their efficacy and modes of action in pigs. In: Gut Environment of Pigs. In A. Piva, K.E. Bach Knudsen and J.E. Lindberg. (pp. 201- 218). Nottingham, UK: Nottingham University Press.

Partanen, K.H. and Mroz, Z. (1999). Organic acids for performance enhancement in pig diets. *Nutrition Research Reviews.* 12: 117-145.

Pascual, M., Hugas, M., Badiola, J., Monfort, J. and Garriga, M. (1999). *Lactobacillus salivarius* CTC2197 prevents *Salmonella enteritidis* colonization in chickens. *Applied and Environmental Microbiology*. 65: 4981-4986.

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

Peebles, E. D. and McDaniel, C.D. (2004). A Practical Manual for Understanding the Shell Structure of Broiler Hatching Eggs and Measurements of Their Quality. Mississippi Agricultural and Forestry Experiment Station http://msucares.com/pubs/bulletins/b1139.pdf (last accessed 12 September 2014).

Pellerin, P., Gosselin, M., Lepoutre, J.P., Samain, E. and Debeire, P. (1991). Enzymatic production of oligosaccharides from corncob xylan. *Enzyme and Microbial Technology*. 13: 617-621.

Peng, Y., Leung, H.C., Yiu, S.M. and Chin, F.Y. (2012). IDBA-UD: a de novo assembler for single-cell and metagenomic sequencing data with highly uneven depth. *Bioinformatics.* 28: 1420-1428.

Perry, A., Rasmussen, H. and Johnson, E.J. (2009). Xanthophyll (lutein, zeaxanthin) content in fruits, vegetables and corn and egg products. *Journal of Food Composition and Analysis.* 22: 9-15.

Perugino, G., Trincone, A., Rossi, M. and Moracci, M. (2004). Oligosaccharide synthesis by glycosynthases. *Trends in Biotechnology.* 22: 31-37.

Perumalla, A.V.S., Hettiarachchy, N.S. and Ricke, S.C. (2012). Current perspectives on probiotics in poultry preharvest food safety. In T.R. Callaway and S.C. Ricke. (pp. 89-120). *Direct-Fed Microbials and Prebiotics for Animals.*. New York, USA: Springer Science+Business Media.

Pettengill, J.B., Mcavoy, E., White, J.R., Allard, M., Brown, E. and Ottesen, A. (2012). Using metagenomic analyses top estimate the consequences of enrichment bias for pathogen detection. *BMC Research Notes.* 5: 378.

Popeila, E., Króliczewska, B., Zawadzki, W., Opaliński and Skiba, T. (2013) Effect of extruded amaranth grains on performance, egg traits, fatty acids composition, and selected blood characteristics of laying hens. *Livestock Science.* 155: 308-315.

Porter, R.Jr. (1998). Bacterial enteritides of poultry. *Poultry Science*. 77: 1159-1165.

Pour, J.B. and Kermanshahi, H. (2010). Effects of cecal cultures and a commercial probiotic (PrimaLac®) on performance and serum lipids of broiler chickens. *Journal of Animal and Veterinary Advances.* 9(10): 1506-1509.

Pourabedin, M., Xu, Z., Baurhoo, B. Chevaux, E. and Zhao, X. (2014). Effects of mannan oligosaccharide and virginiamycin on the cecal microbial community and intestinal morphology of chickens raised under suboptimal conditions. *Canadian Journal of Microbiology*. 60: 255-266.

Pourabedin, M., Guan, L. and Zhao, X. (2015). Xylo-oligosaccharides and virginiamycin differentially modulate gut microbial composition in chickens. *Microbiome*. 3: 15.

Price, M.N., Dehal, P.S. and Arkin, A.P. (2009). FastTree: Computing large minimum evolution trees with profiles instead of a distance matrix. *Molecular Biology and Evolution*. 26: 1641-1650.

Priyankarage, N., Silva, S.S.P., Gunaratne, S.P., Kothalawala, H., Palliyaguru, M.W.C.D. and Gunawardana, G.A. (2003). Efficacy of probiotics and their effects on performance, carcase characteristics, intestinal microflora and *Salmonella* incidence in broilers. *British Poultry Science*. 44: 26-27.

R.J. (2008). Review article: the role of butyrate on colonic function. *Alimentary Pharmacology Therapeutics*. 27: 104-119.

Rabiu, B.A., Jay AJ, Gibson, G.R., Rastall, R.A. (2001). Synthesis and fermentation properties of novel galacto-oligosaccharides by beta-galactosidases from *Bifidobacterium* species. *Applied and Environmental Microbiology.* 67: 2526-2530.

Ragione, R.M., Sayers, A.R. and Wooward, M.J. (2000). The role of fimbriae and flagella in the colonization, invasion and persistence of *Escherichia coli* 78:K80 in the day-old-chick model. *Epidemiology and Infection*. 124: 351-363.

Ragoobirsingh, D., Robinson, H.M., Morrison, E.Y. and St, A. (1993). Effects of cassava cyanoglucoside linamarin on blood sugar levels in the dog. *Journal of Nutritional Biochemistry*. 11: 625-629.

Rampelli, S., Can dela, M., Turroni, S., Biagi, E., Collino, S., Franceschi, C., O'Toole, P.W. and Brigidi, P. (2013). Functional metagenomic profiling of intestinal microbiome in extreme ageing. *Aging.* 5: 902-912.

Rastogi, G. and Sani, R.K. (2011). Molecular Techniques to Assess Microbial Community Structure, Function, and Dynamics in the Environment. In Ahmad, I. Farah, A. and John, P. *Microbes and Microbial Technology: Agricultural and Environmental Applications*. (pp. 29-57). New York: Springer Science+Business Media.

Rastogi, R., Wu, M., Dasgupta, I. and Fox, G.E. (2009). Visualization of ribosomal RNA operon copy number distribution. *BMC Microbiology.* 9: 208.

Reid, G. (1999). The scientific basis for probiotic strains of *Lactobacillus*. *Applied and Environmental Microbiology.* 65: 3763-3766.

Respondek, F., Goachet, A.G. and Julliand, V. (2008). Effects of dietary short-chain fructooligosaccharides on the intestinal microflora of horses subjected to a sudden change in diet. *Journal of Animal Science.* 86: 316-323.

Rho, M., Tang, H. and Ye, Y. (2010). FragGeneScan: predicting genes in short and error-prone reads. *Nuclei Acids Research*. 38: e191.

Ricke, S.C. (2003). Perspectives on the use of organic acids and short chain fatty acids as antimicrobials. *Poultry Science.* 82: 632-639.

Ricke, S.C., Woodward, C.L., Kwon, Y.M., Kubena, L.F. and Nisbet, D.J. (2004). Limiting avian gastrointestinal tract *Salmonella* colonization by cecal anaerobic bacteria, and a potential role for methanogens. In R.C. Beier, S.D. Pillai, T.D. Phillips, and R.L. Ziprin. (pp. 141-150). *Preharvest and postharvest food safety: Contemporary issues and future directions*. Ames: Blackwell Publ. Prof.

Riesenfeld, C.S., Schloss, P.D. and Handelsman, J. (2004). Metagenomics: genomic analysis of microbial communities. *Annual Review of Genetics.* 38: 525-552.

Rinttilä, T., Kassinen, A., Malinen, E., Krogius, L. and Palva, A. (2004). Development of an extensive set of 16S rDNA-targeted primers for quantification of pathogenic and indigenous bacteria in faecal samples by real-time PCR. *Journal of Applied Microbiology*. 97: 1166-1177.

Ritchie, L.E., Steiner, J.M. and Suchodolski, J.S. (2008). Assessment of microbial diversity along the feline intestinal tract using 16S rRNA gene analysis. *FEMS Microbiology Ecology*. 66: 590-598.

Roberfroid, M. (2007). Prebiotics: The concept revisited. *Journal of Nutrition*. 137: 830S-837S.

Roberfroid, M.B. (2005). Introducing inulin-type fructans. *British Journal of Nutrition*. 93: S13-S25.

Roberts, G.L. (2000). Fusobacterial infections: an underestimated threat. *British Journal of Biomedical Science*. 57:156-162.

Roland Sr., D.A. (1988). Research note: eggshell problems, estimates of incidence and economic impact. *Poultry Science.* 67: 1801-1803.

Rosenberg, E. and Zilber-Rosenberg, I. (2013). Prebiotics, Probiotics, Synbiotics and Phage Therapy. In E. Rosenberg and I. Zilber-Rosenberg. *The Hologenome Concept: Human, Animal and Plant Microbiota.* (pp. 151-162). New York: Springer Science+Business Media.

Roush, W.B. (1981). T159 calculator program for Haugh Unit calculation. *Poultry Science.* 60: 1086-1088.

Roy, B.C., Chowdhury, S.D. and Lutful Kabir, S.M (2015). Effects of feeding *Bacillus subtilis* to heat stressed broiler chickens with or without an antibiotic growth promoter. *Asian Journal of Medical and Biological Research*. 1: 80-88.

Rudi, K., Høidal, H.K., Katla, T., Johansen, B.K., Nordal, J. and Jakobsen, K.S. (2004). Direct real-time PCR quantification of Campylobacter jejuni in chicken fecal and cecal samples by integrated cell concentration and DNA purification. *Applied and Environmental Microbiology*. 70: 790-797.

Šabatková, J., Kumprecht, I., Zobač, P., Suchý, P. and Čermák, B. (2008). The probiotic Bioplus 2B as an alternative to antibiotics in diets for broiler chickens. *Acta Veterinaria Brno.*77: 569-574.

Sadeghi, A.S., Mohammadi, A., Shawrang, P. and Aminafshar, M. (2013). Immune responses to dietary inclusion of prebiotic-based mannan-oligosaccharide and b-glucan in broiler chicks challenged with *Salmonella enteritidis*. *Turkish Journal of Veterinary Animal Sciences*. 37: 206-213.

Saki, A.A., Harcini, R.N., Rahmatnejad, E. and Salary, J. (2012). Herbal additives and organic acids as antibiotic alternatives in broiler chickens diet for organic production. *African Journal of Biotechnology*. 11: 2139-2145.

Sako, T., Matsumoto, K. and Tanaka, R. (1999). Recent progress on research and applications of non-digestible galacto-oligosaccharides. *International Dairy Journal*. 9: 69-80.

Salanitro, J.P., Blake, I.G., Muirhead, P.A., Maglio, M. and Goodman, J.R. (1978). Bacteria isolated from the duodenum, ileum, and cecum of young chicks. *Applied and Environmental Microbiology*. 35: 782-79.

Salarmoini, M. and Fooladi, M.H. Efficacy of *Lactobacillus acidophilus* as probiotic to improve broiler chicks performance (2011). *Journal of Agricultural Science and Technology*. 13: 165-172.

Salminen, S., Ouwehand, A., Benno, Y. and Lee, Y.K. (1999). Probiotics: How should they be defined? *Trends in Food Science and Technology.* 10: 107-110.

Samarasinghe, K., Wenk, C., Silva, K.F.S.T. and Gunasekera, J.M.D.M. (2003). Turmeric (Curcuma longa) root powder and mannanoligosaccharides as alternatives to antibiotics in broiler chicken diets. *Asian-Australian J ournal of Animal Sciences*. 10: 1495-1500.

Samuelsson, B. (1991). Arachidonic acid metabolism: role in inflammation. *Zeitschrift für Rheumatologie*. 50(Suppl 1): 3-6.

Sanchez-Mata, M.C., Penuela-Teruel, M.J., Camara-Hurtado, M., Daez-Marques, C., Torija-Isasa, M.E. (1998). Determination of mono-, di-, and oligosaccharides in legumes by high-performance liquid chromatography using an amino-bonded silica column. *Journal of Agricultural and Food Chemistry* 46:3648–52.

Sangeetha, P.T., Ramesh, M.N. and Prapula, S.G. (2005). Fructooligosaccharide production using fructosyl transferase obtained from recycling culture of *Aspergillus oryzae CFR 202*. *Process Biochemistry*. 40: 1085-1088.

Santin, E., Maiorka, A. and Macari, M. (2001). Performance and intestinal mucosa development of broiler chickens fed diets containing *Saccharomyces cerevisiae* cell wall. *Journal of Applied Poultry Research*. 10: 236-244.

Sarbu, A., Gonçalves, F. and Norberta de Pinho, M. (2003a). Oat spelts xylan molecular mass estimation by size exclusion chromatography. *Carbohydrate Polymers.* 53: 297-304.

Sarbu, A., Gonçalves, F. and Norberta de Pinho, M. (2003b). Radical initiated oxidative degradation of oat-spelts xylan. *Carbohydrate Polymers.* 53: 1-8.

Scheideler, S.E., Weber, P. and Monsalve, D. (2010). Supplemental vitamin E and selenium effects on egg production, egg quality, and egg deposition of α-tocopherol and selenium. *Journal of Applied Poultry Research.* 19: 354-360.

Schiffrin, E.J., Rochat, F., Link-Amster, H., Aeschlimann, J.M. and Donnet-Hughes, A. (1995). Immunomodulation of human blood cells following the ingestion of lactic acid bacteria. *Journal of Dairy Science.* 78: 491-497.

Schloss, P.D. and Handelsman, J. (2008). A statistical toolbox for metagenomics: assessing functional diversity in microbial communities. *BMC Bioinformatics*. 9:34.

Schloss, P.D., Gevers, D. and Westcott, S.L. (2011). Reducing the effects of PCR amplification and sequencing artifacts on 16s rRNA-based studies. *PLoS ONE*. 6: e27310.

Schmieder, R. and Edwards, R. (2011). Fast identification and removal of sequence contamination from genomic and metagenomic datasets. *PLoS ONE*. 6: e17288.

Schnaar, R.L. (1991). Glycosphingolipids in cell surface recognition. *Glycobiology*. 1: 477-485.

Schrezenmeir, J. and de Vrese, M. (2001). Probiotics, prebiotics, and synbiotics - approaching a definition. *The American Journal of Clinical Nutrition.* 73: 361-364.

Scupham, A.J. (2007). Succession in the intestinal microbiota of preadolescent turkeys. *FEMS Microbiology Ecology*. 60: 136-147.

Servin, A.L. and Coconnier, M.H. (2003). Adhesion of probiotic strains to the intestinal mucosa and interaction with pathogens. *Best Practice Research Clinical Gastroenterology*. 17: 741-754.

Sghir, A., Gramet, G., Suau, A., Rochet, V., Pochart, P. and Dore, J. (2000). Quantification of bacterial groups within human fecal flora by oligonucleotide probe hybridization. *Applied and Environmental Microbiology*. 66: 2263-2266.

Shah, N., Tang, H., Doak, T.G. and Ye, Y. (2010). *Comparing bacterial communities inferred from 16S rRNA gene sequencing and shotgun metagenomics*. In WSPC Proceedings. 20 September. 17: 6.

Shalaei, M., Hosseini, S.M. and Zergani, E. (2014). Effect of different supplements on eggshell quality, some characteristics of gastrointestinal tract and performance of laying hens. *Veterinary Research Forum*. 5: 277-286.

Shang, H. M., Hu, T.M., Lu, Y.J. and Wu, H.X. (2010). Effects of inulin on performance, egg quality, gut microflora and serum and yolk cholesterol in laying hens. *British Poultry Science.* 51: 791-796.

Sharpton, T.J. (2014). An introduction to the analysis of shotgun metagenomic data. *Frontiers in Plant Science*. 5(Article 209): 1-14.

Sharpton, T.J., Riesenfeld, S.J., Kembel, S.W., Ladau, J., O'Dwyer, J.P., Green, J.L., Eisen, J.A. and Pollard, K.S. et al. (2011). PhylOTU: a high-throughput procedure quantifies microbial community diversity and resolves novel taxa from metagenomic data. *PLoS Computational Biology*. 7:e1001061.

Shashidhara, R.G., and Devegowda, G. (2003). Effect of dietary mannan oligosaccharide on broiler breeder production traits and immunity. *Poultry Science.* 82:1319-1325.

Shen, T.Y., Qin, H.L., Gao, Z.G., Fan, X.B., Hang, X.M. and Jiang, Y.Q. (2006). Influences of enteral nutrition combined with probiotics on gut microflora

and barrier function of rats with abdominal infection. *World Journal of Gastroenterology*. 12: 4352-4358.

Shi, X. and Noblet, J. (1993). Contribution of the hindgut to digestion of diets in growing pigs and adult sows: effect of diet composition. *Livestock Production Science.* 34: 237-252.

Shim, Y.H., Ingale, S.L., Kim, J.S., Kim, K.H., Seo, D.K., Lee, S.C., Chae, B.J. and Kwon, I.K. (2012). A multi-microbe probiotic formulation processed at low and high drying temperatures: effects on growth performance, nutrient retention and caecal microbiology of broilers. *British Poultry Science*. 53: 482-490.

Shini, S., Shini, A. and Blackall, P.J. (2013). The potential for probiotics to prevent reproductive tract lesions in free-range laying hens. *Animal Production Science*. 53: 1298-1308.

Shoaf, K., Mulvey, G.L., Armstrong, G.D. and Hutkins, R.W. (2006). Prebiotic galactooligosaccharides reduce adherence of enteropathogenic *Escherichia coli* to tissue culture cells. *Infection and Immunity.* 74: 6920-6928.

Shojadoost, B., Vince, A.R. and Prescott, J.F. (2012). The successful experimental induction of necrotic enteritis in chickens by *Clostridium perfringens*: a critical review. *Veterinary Research*. 43: 74.

Silversides, F.G. and Scott, T.A. (2001). Effect of storage and layer age on quality of eggs from two lines of hens. *Poultry Science.* 80: 1240-1245.

Simon, C. and Daniel, R. (2011). Metagenomic Analyses: Past and Future Trends. *Applied and Environmental Microbiology*. 77: 1153-1161.

Singh, K.M., Shah, T., Deshpande, S., Jakhesara, S.J., Koringa, P.G., Rank, D.N. and Joshi, C.G. (2012). High through put 16S rRNA gene-based pyrosequencing analysis of the fecal microbiota of high FCR and low FCR broiler growers. *Moleculer Biology Reports*. 39: 10595-10602.

Singh, M., Sharma, R., and Banerjee, V.C. (2002). Biotechnological applications of cyclodextrins. *Biotechnology Advances*. 20: 341-359.

Sirdar, M.M., Picard, J., Bisschop, S., Jambalang, A.R. and Gummow, B. (2012). A survey of antimicrobial residues in table eggs in Khartoum State, Sudan, 2007-2008. *Onderstepoort Journal of Veterinary Research*. 79: 1-9.

Smith, A. (2011). Malaysian egg market set for continued growth. http://www.wattagnet.com/Malaysian_egg_market_set_for_continued_growth.html. Poultry International. (Last accessed 26 March 2014).

Smith, C.J. and Osborn, A.M. (2009). Advantages and limitations of quantitative PCR (Q-PCR)-based approaches in microbial ecology. *FEMS Microbiology Ecology*. 67: 6-20.

Snel, J., Harmsen, H.J.M., Van de Wielen, P.W.J.J. and Williams, B.A. (2002). Dietary Strategies to Influence the Gastrointestinal Microflora of Young Animals, and Its Potential to Improve Intestinal Health. In M.C. Blok. *Nutrition and Health on the Gastrointestianl Tract.* (pp. 37-69). Netherlands: Wageningen Academic Publishers.

Sobczak, A. and Kozłowski, K. (2015). The effect of a probiotic preparation containing *Bacillus subtilis* ATCC PTA06737 on egg production and physiological parameters of laying hens. *Annals of Animal Science*. 15: 711-723.

Sohail, M.U., Hume, M.E., Anwar, H., Hussain, G., Shabbir, M.Z., Nisbet, D.J., Ahmad, S. and Kamran, Z. (2014). Metagenomics of prebiotic and probiotic supplemented broilers gastrointestinal tract microbiome. *Indo American Journal of Pharm Research.* 4: 3780-3784.

Sohail, M.U., Rahman, Z.U., Ijaz, A., Yousaf, M.S., Ashraf, K., Yaqub, T., Zaneb, H., Anwar, H. and Rehman, H. (2011). Single or combined effects of mannan-oligosaccharides and probiotic supplements on the total oxidants, total antioxidants, enzymatic antioxidants, liver enzymes, and serum trace minerals in cyclic heat-stressed broilers. *Poultry Science.* 90: 2573-2577.

Songer, J.G. (2004). The emergence of *Clostridium difficile* as a pathogen of food animals. *Animal Health Research Reviews.* 5: 321-326.

Souza, J.G., Costa, F.G.P., Queiroga, R.C.R.E., Silva, J.H.V., Schuler, A.R.P. and Goulart, C.C. (2008). Fatty acid profile of eggs of semi-heavy layers fed feeds containing linseed oil. *Brazilian Journal of Poultry Science.* 10: 37-44.

Sperti, G.S. (1971). Probiotics. (pp.121). Westpoint, CT, USA: Avi Publishing Co.

Spiegel, J. E., Rose, R, Karabell, P., Frankos, V. H. and Schmitt, D. F. (1994). Safety and benefits of fructooligosaccharides as food ingredients. *Food Technology.* 48: 85-89.

Spring, P., Wenk, C., Dawson, K.A. and Newman, K.E. (2000). The effects of dietary mannaoligosaccharides on cecal parameters and the concentrations of enteric bacteria in the ceca of *Salmonella*-challenged broiler chicks. *Poultry Science.* 79: 205-211.

SPSS Inc. (1999). SPSS for window (Release 16.0), Standard Version. SPSS Inc. Headquaters, 233 S. Wacker Drive, 11 th floor Chicago, Illinois 60606, USA.

Stam, J., van Stuijvenberg, M., Garssen, J., Knipping, K. and Sauer, P.J.J. (2011). A mixture of three prebiotics does not affect vaccine specific antibody responses in healthy term infants in the first year of life. *Vaccine.* 29: 7766-7772.

Standley, D., Denman, S.E., Hughes, R.J., Geier, M.S., Crowley, T.M., Chen, H., Harling, V.R. and Moore, R.J. (2012). Intestinal microbiota associated with

differential feed conversion efficiency in chickens. *Applied Microbiology and Biotechnology*. 96: 1361-1369.

Steer, T., Carpenter, H., Tuohy, K. and Gibson, G.R. (2000). Perspectives on the role of the human gut microbiota and its modulation by pro and prebiotics. *Nutrition Research Reviews.* 13: 229-254.

Stevens, C.E. and Hume, I.D. (1998). Contributions of microbes in vertebrate gastrointestinal tract to production and conservation of nutrients. *Physiological Reviews.* 78: 393-427.

Stingl, U., Maass, A., Radek, R. and Brune, A. (2004). Symbionts of the gut flagellate *Staurojoenina* sp. from *Neotermes cubanus* represent a novel, termite-associated lineage of *Bacteroidales*: description of '*Candidatus* Vestibaculum illigatum'. *Microbiology.* 150: 2229-2235.

St-Onge, M.P., Farnworth, E.R. and Jones, P.J.H. (2000). Consumption of fermented and nonfermented dairy products: effects on cholesterol concentrations and metabolism. *American Journal of Clinical Nutrition*. 71: 674-681.

Strlic, M., Kocar, D., Kolar, J., Rychlý, J. and Pihlar, B. 2003. Degradation of pullulans of narrow molecular weight distribution – the role of aldehydes in the oxidation of polysaccharides. *Carbohydrate Polymers.* 54: 221-228.

Su, C., Lei, L., Duan, Y., Zhang, K.Q. and Yang, J. (2012). Culture-independent methods for studying environmental microorganisms: Methods, application, and perspective. *Applied Microbiology and Biotechnology*. 93: 993-1003.

Suenaga, H. (2012). Targeted metagenomics: a high-resolution metagenomics approach for specific gene clusters in complex microbial communities. *Environmental Microbiology*. 14: 13-22.

Sugiharto, S. (2014). Role of nutraceuticals in gut health and growth performance of poultry. *Journal of the Saudi Society of Agricultural Sciences*. In press.

Sujoy, B. and Aparna, A. (2013). Potential clinical significance of urease enzyme. *European Scientific Journal*. 9(21): 94-102.

Sun, Y. and O'Riordan, M.X.D. (2013). Regulation of bacterial pathogenesis by intestinal short-chain fatty acids. *Advances in Applied Microbiology*. 85: 93-118.

Sundram, K. and Nor, R.M. (2002). Analysis of Tocotrienols in Different Sample Matrixes by HPLC. In D. Armstrong. Methods in Molecular Biology: Oxidative Stress Biomarkers and Antioxidant Protocols. (pp. 221-232). Totowa: Humana Press Inc.

Surai, P.F. and Sparks, N.H.C. (2001). Designer eggs: from improvement of egg composition to functional food. *Trends in Food Science and Technology*. 12: 7-16.

Surai, P.F., Speake, B.K., Wood, N.A.R., Blount, J.D., Bortolotti, G.R. and Sparks, N.H. (2001). Carotenoid discrimination by the avian embryo: a lesson from wild birds. *Comparative Biochemistry and Physiology Part B: Biochemitry and Molecular Biology*. 128: 743-750.

Swanson, K.S., Grieshop, C.M., Flickinger, E.A., Bauer, L.L., Healy, H.P., Dawson, K.A., Merchen, N.R. and Fahey Jr, G.C. (2002). Supplemental fructooligosaccharides and mannanoligosaccharides influence immune function, ileal and total tract nutrient digestibilities, microbial populations and concentrations of protein catabolites in the large bowel of dogs. *Journal of Nutrition.* 132: 980-989.

Swennen, K., Courtin, C.M. and Delcour, J.A. (2006). Non-digestible oligosaccharides with prebiotic properties. *Critical Reviews in Food Science and Nutrition.* 46: 459-471.

Świątkiewicz, S., Koreleski, J. and Arczewska, A. (2010). Laying performance and eggshell quality in laying hens fed diets supplemented with prebiotics and organic acids. *Czech Journal of Animal Science*. 55: 294-306.

Szmolka, A. and Nagy, B. (2013). Multidrug resistant commensal *Escherichia coli* in animals and its impact for public health. *Frontiers in Microbiology*. 4: 258.

Tabacchioni, S., Chiarini, L., Bevivino, A., Cantale, C. and Dalmastri, C. (2000). Bias caused by using different isolation media for assessing the genetic diversity of a natural microbial population. *Microbial Ecology*. 40: 169-176.

Taherpour, K., Moravej, H., Shivazad, M., Adibmoradi, M. and Yakhchali, B. (2009). Effects of dietary probiotic, prebiotic and butyric acid glycerides on performance and serum composition in broiler chickens. *African Journal of Biotechnology*. 8: 2329-2334.

Tako, E., Glahn, R.P., Knez, M. and Stangoulis, J.C.R. (2014). The effect of wheat prebiotics on the gut bacterial population and iron status of iron deficient broiler chickens. *Nutrition Journal*. 13: 58.

Talebi, A., Amani, A., Pourmahmod, M., Saghaei, P. and Rezaie, R. (2015). Synbiotic enhances immune responses against infectious bronchitis, infectious bursal disease, Newcastle disease and avian influenza in broiler chickens. *Veterinary Research Forum*.6: 191-197.

Talebi, A., Amirzadeh, B., Mokhtari, B. and Gahri, H. (2008). Effects of a multi-strain probiotic (PrimaLac) on performance and antibody responses to Newcastle disease virus and infectious bursal disease virus vaccination in broiler chickens. *Avian Pathology*. 37: 509-512.

Tanaka, R., Takayama, H., Morotomi, M., Kuroshima, T., Ueyama, S., Matsumoto, K., Kuroda, A. and Mutai, M. (1983). Effects of administration of TOS and *Bifidobacterium breve* 4006 on the human fecal flora. *Bifidobacteria Microflora*. 2: 17-24.

Tang, S.G.H., Sieo, C.C., Kalavathy, R., Saad, W.Z., Yong, S.T., Wong, H.K. and Ho, Y.W. (2015). Chemical compositions of egg yolks and egg quality of laying hens fed prebiotic, probiotic, and synbiotic diets. *Journal of Food Science.* 80: C1686-C1695.

Tanwir, F. and Ahmed, U. (2013). Probiotics: an emerging prospect for the periodontal problems. *Pakistan Oral and Dental Journal*. 33: 343-345.

Tennant BC (1997) Hepatic function. In: Kaneko JJ, Harvey JW, Bruss ML (eds) Clinical biochemistry of domestic animals, 5th edn. Academic Press, London, pp 327–352.

Teo, A.Y. and Tan, H.M. (2007). Evaluation of the performance and intestinal gut microflora of broilers fed on corn-soy diets supplemented with *Bacillus subtilis* PB6 (CloSTAT). *Journal of Applied Poultry Research.* 16: 296-303.

Thanh, N., Loh, T.C., Foo, H.L., Hair-Bejo, M. and Azhar, B. (2009). Effects of feeding metabolite combinations produced by *Lactobacillus plantarum* on growth performance, faecal microbial population, small intestine, villus height and faecal volatile fatty acids in broilers. *British Poultry Science*. 50: 298-306.

Thitaram, S.N., Chung, C.H., Day, D.F., Hinton Jr., A., Bailey, J.S. and Siragusa, G.R. (2005). Isomaltooligosaccharide increases cecal Bifidobacterium population in young broiler chickens. *Poultry Science.* 84: 998-1003.

Torok, V.A., Allison, G.E., Percy, N.J., Ophel-Keller, K. and Hughes, R.J. (2011). Influence of antimicrobial feed additives on broiler commensal posthatch gut microbiota development and performance. *Applied and Environmental Microbiology.* 77: 3380-3390.

Tortuero, F. (1973). Influence of implantation of *Lactobacillus acidophilus* in chicks on the growth, feed conversion, malabsorption of fats syndrome and intestinal flora. *Poultry Science.* 52: 197-203.

Tremaroli, V. and Backhed, F. (2012). Functional interactions between the gut microbiota and host metabolism. *Nature*. 489: 242-249.

Tuomola, E., Ouwehand, A. and Salminen, S. (1999). The effect of probiotic bacteria on the adhesion of pathogens to human intestinal mucus. *FEMS Immunology and Medical Microbiology*. 26: 137-142.

Turnbaugh, P.J., Ley, R.E., Mahowald, M.A., Magrini, V., Mardis, E.R., Gordon, J.I. (2006). An obesity-associated gut microbiome with increased capacity for energy harvest. *Nature*. 444: 1027-1031.

Tzortzis, G., Goulas, A.K., Gee, J.M. and Gibson, G.R. (2005). A novel galactooligosaccharide mixture increases the bifidobacterial population numbers in a continuous in vitro fermentation system and in the proximal colonic contents of pigs in vivo. *Journal of Nutrition*. 135: 1726-1731.

University of Rhode Island (URI). (2015). Calculator for determining the number of copies of a template. http://web.uri.edu/gsc/dsdna-calculator/ (last accessed 9 June 2015).

Upadrasta, A., O'Sullivan, L., O'Sullivan, O., Sexton, N., Lawlor, P.G., Hill, C., Fitzgerald, G.F., Stanton, C. and Ross, R.P. (2013). The effect of dietary supplementation with spent cider yeast on the swine distal gut microbiome. *PLoS ONE.* 10: e75714.

USDA (United States Department of Agriculture). (2000). Egg grading manual. Agricultural handbook number 75, USDA, Washington, DC.

Vahdatpour, T., Nikpiran, H., Babazadeh, D., Vahdatpour, S. and Ali Jafargholipour, M. (2011). Effects of Protexin®, Fermacto® and combination of then on blood enzymes and performance of Japanese quails. *Annals of Biological Research.* 2: 283-291.

Van den Broek, L.A., Hinz, S.W., Beldman, G., Vincken, J.P. and Voragen, A.G. (2008). *Bifidobacterium* carbohydrases-their role in breakdown and synthesis of (potential) prebiotics. *Molecular Nutrition and Food Research*. 52: 146-163.

van der Wielen, P.W.J.J., Biesterveld, S., Notermans, S., Hofstra, H., Urlings, B.A.P. and van Knapen, F. (2000). Role of colatile fatty acids in development of the cecal microflora in broiler chickens during growth. *Applied and Environmental Microbiology*. 66: 2536-2540.

van der Wielen, P.W., Lipman, L.J., van, K.F., Biesterveld, S. (2002). Competitive exclusion of *Salmonella enterica* serovar Enteritidis by *Lactobacillus crispatus* and *Clostridium lactatifermentans* in a sequencing fed-batch culture. *Applied and Environmental Microbiology.* 68: 555-559.

Van Immersel, F., De Buck, J., Boyen, F., Bohez, L., Pasmans, F., Volf, J., Sevcik, M., Rychlik, I., Haesebrouck, F. and Ducatelle, R. (2004). Medium-chain fatty acids decrease colonization and invasion through *hilA* suppression shortly after infection of chickens with *Salmonella enterica* serovar Enteritidis. *Applied and Environmental Microbiology*. 70: 3582-3587.

Van Immerseel, F., Ducatelle, R., DeVos, M., Boon, N., Van De Wiele, T., Verbeke, K., Rutgeerts, P., Sas, B., Louis, P. and Flint, H.J. (2010). Butyric acid-producing anaerobic bacteria as a novel probiotic treatment approach for inflammatory bowel disease. *Journal of Medical Microbiology.* 59: 141-143.

Van Laere, K.M.J. (2000). *Degradation of structurally different non-digestible oligosaccharides by intestinal bacteria: glycosylhydrolases of Bifidobacterium adolescentic*. Unpublished doctoral dissertation, Wageningen University, Netherlands.

Van Loo, .J, Coussement, P., De Leenheer, L., Hoebregs, H. and Smits, G. (1995). On the presence of inulin and oligofructose as natural ingredients in the Western diet. *Critical Reviews in Food Science and Nutrition*. 35: 525-552.

Vasiljevic, T. and Shah, N.P. (2008). Probiotics-From Metchnikoff to bioactives. *International Dairy Journal.* 18: 714-728.

Vázquez, M.J., Alonso, J.L., Domínguez, H. and Parajó, J.C. (2000). Xylooligoasacchaides: manufacture and applications. *Trends in Food Science and Technology*. 11: 387-393.

Ventura, M., Canchaya, C., Tauch, A., Chandra, G., Fitzgerald, G.F., Chater, K.F. and van Sinderen, D. (2007). Genomics of Actinobacteria: Tracing the evolutionary history of an ancient phylum. *Microbiology and Molecular Biology Reviews.* 71: 495-548.

Ventura, M., O'Flaherty, S., Claesson, M.J., Turroni, F., Klaenhammer, T.R., Van Sinderen, D. and O'Toole, P.W. (2009). Genome-scale analyses of health-promoting bacteria: probiogenomics. *Nature Reviews Microbiology*. 7: 61-71.

Vergin, F. (1954). Anti- und Probiotika. *Hippokrates.* 25: 116-119.

Vetter, J. (2000). Plant cynogenic glycosides. *Toxicon*. 38: 11-36.

Vidanarachchi, J.K., Mikkelsen, L.L., Constantinoiu, C.C., Choct, M. and Iji, P.A. (2013). Natural plant extracts and prebiotic compounds as alternatives to antibiotics in broiler chicken diets in a necrotic enteritis challenge model. *Animal Production Science*. 53: 1247-1259.

Videnska, P., Faldynova, M., Juricova, H., Babak, V., Sisak, F., Havlickova, H. and Rychlik, I. (2013a). Chicken fecal microbiota and disturbances induced by single or repeated therapy with tetracycline and streptomycin. *BMC Veterinary Research*. 9: 30.

Videnska, P., Rahman, M.M., Faldynova, M., Babak, V., Matulova, M.E., Prukner-Radovcic, E., Krizek, I., Smole-Mozina, S., Kovac, J., Szmolka, A., Nagy, B., Sedlar, K., Cejkova, D. and Rychlik, I. (2014a). Characterization of egg laying hen and broiler fecal microbiota in poultry farms in Croatia, Czech Republic, Hungary and Slovenia. *PLoS ONE*. 9: e110076.

Videnska, P., Sediar, K., Lukac, M., Fuldynova, M., Gerzova, L., Cejkova, D., Sisak, F. and Rychlik, I. (2014b). Succession and replacement of bacterial populations in the caecum of egg laying hens over their whole life. *PLoS ONE*. 9: e1151542.

Videnska, P., Sisak, F., Havlickova, H., Faldynova, M. and Rychlik, I. (2013b). Influence of *Salmonella enterica* serovar Enteritidis infection on the composition of chicken cecal microbiota. *BMC Veterinary Research*. 9: 140.

Vieira, A.R., Collignon, P., Aarestrup, F.M., McEwen, S.A., Hendriksen, R.S., Hald, T. and Wegener, H.C. (2011). Association between antimicrobial resistance in *Escherichia coli* isolates from food animals and blood stream isolates from humans in Europe: an ecological study. *Foodborne Pathogens and Disease.* 8: 1295-1301.

Vila, B., Fontgibell, A., Badiola, I., Esteve-Garcia, E., Jiménez, G., Castillo, M. and Brufau, J. (2009). Reduction of *Salmonella enteric* var. *enteritidis* colonization and invasion by *Bacillus cereus* var. *toyoi* inclusion in poultry feeds. *Poultry Science.* 88: 975-979.

Villamiel, M., Corzo, N., Foda, M. I., Montes, F. and Olano, A. (2002). Lactulose formation catalysed by alkaline-substituted sepiolites in milk permeate. *Food Chemistry*. 76: 7-11.

Vindolo, M.A.R., Rodrigues, H.G., Nachbar, R.T. and Curi, R. (2011). Regulation of inflammation by short chain fatty acids. *Nutrients.* 31: 858-876.

Vital, M., Howe, A.C. and Tiedje, J.M. (2014). Revealing the bacterial synthesis pathways by analyzing (meta)genomic data. *MBio*. 5: e00889.

Vodela, J.K., Lenz, S.D., Renden, J.A., McElhenney, W.H. and Kemppainen, B.W. (1997). Drinking water contaminants (arsenic, cadmium, lead, benzene, and trichloroethylene). 2. Effects of reproductive performance, egg quality, and embryo toxicity in broiler breeders. *Poultry Science.* 76: 1493-1500.

Voragen, A.G.J. (1998). Technological aspects of functional food-related carbohydrates. *Trends in Food Science and Technology.* 9: 328-335.

Vos AP, Haarman M, Buco A, Govers M, Knol J., Garssen, J., Stahl, B., Boehm, G. and M'Rabet, L. (2006). A specific prebiotic oligosaccharide mixture stimulates delayed-type hypersensitivity in a murine influenza vaccination model. *International Immunopharmacology*. 6: 1277-1286.

Vos, A.P., Knol, J., Stahl, B., M'Rabet, L. and Garssen, J. (2010). Specific prebiotic oligosaccharides modulate the early phase of a murine vaccination response. *International Immunopharmacology.* 10: 619-625.

Vos, A.P., M'Rabet, L., Stahl, B., Boehm, G. and Garssen, J. (2007). Immune-modulatory effects and potential working mechanisms of orally applied nondigestible carbohydrates. *Critical Reviews in Immunology.* 27: 97-140.

Vulevic, J., Drakoularakou, A., Yaqoob, P., Tzortzis, G. and Gibson, G.R. (2008). Modulation of the fecal microflora profile and immune function by a novel *trans*-galactooligosaccharide mixture (B-GOS) in healthy elderly volunteers. *American Journal of Clinical Nutrition*. 88: 1438-1446.

Waite, D.W. and Taylor, M.W. (2014). Characterizing the avian gut microbiota: membership, driving influences, and potential function. *Fontiers in Microbiology.* 5: 223.

Walter, J., Hertel, C., Tannock, G.W., Lis, C.M., Munro, K. and Hammes, W.P. (2001). Detection of *Lactobacillus*, *Pediococcus*, *Leuconostoc*, and *Weissella* species in human feces by using groupspecific PCR primers and denaturing gradient gel electrophoresis. *Applied and Environmental Microbiology*. 67: 2578-2585.

Wang, Y., Hollingsworth, R.I. and Kasper, D.L. (1982). Ozonolytic depolymerization of polysaccharides in aqueous solution. *Carbohydrate Research.* 319: 141-147.

Wang, Y., Sunwoo, H., Cherian, G. and Sim, J.S. (2000). Fatty acid determination in chicken egg yolk: a comparison of different methods. *Poultry Science.* 79: 1168-1171.

Weggemans, R.M., Zock, P.L. and Katan, M.B. (2001). Dietary cholesterol from eggs increases the ratio of total cholesterol to high-density lipoprotein cholesterol in humans: A metaanalysis. *American Journal of Clinical Nutrition*. 73: 885-891.

Wehrli, M. and Nordskog, A.W. (1963). Evidence for genetic influrnce on rate of egg weight increase. *Poultry Science.* 42: 1316.

Wei, S., Morrison, M., Yu, Z. (2013). Bacterial census of poultry intestinal microbiome. *Poultry Science*. 92: 671-683.

Williams, K.C. (1992). Some factors affecting albumen quality with particular reference to Haugh unit score. *World's Poultry Science Journal.* 48: 5-16.

Windhorst, H.W. (2008). Asia's changing role in the global egg industry-an analysis of past, present and foreseeable future dynamics. *World's Poultry Science Journal*. 64: 533-552.

Wise, M.G. and Siragusa, G.R. (2007). Quantitative analysis of the intestinal bacterial community in one- to three-week-old commercially reared broiler chickens fed conventional or antibiotic-free vegetable-based diets. *Journal of Applied Microbiology*. 102: 1138-1149.

Wolgemuth, S., Loh, G. and Blaut, M. (2010). Recent developments and perspectives in the investigation of probiotic effects. *International Journal of Medical Microbiology.* 300: 3-10.

Wong, H.K. (1997). Production of omega-3 polyunsaturated fatty acid enriched egg. (MARDI Occasional Paper 15). Serdang: MARDI.

Wong, H.K. (2010). Designer egg and meat products. In H.K. Wong. Manipulation of Nutrient Composition in Poultry. (pp.10-27). Malaysia: Malaysian Agricultural Research and Development Institute.

Wong, H.K. and Sundram, K. (1998). Fatty acids and tocopherols composition in eggs. Proc.20th MSAP, p. 163 –164.

Wong, H.K., Yong, S.T., Chan, F.J. and Mardhati, M. (2013). Analysis of lutein and zeaxanthin in gojiberry (*Lycium* species) and corn by high performance liquid chromatography. *Journal of Science and Technology in the Tropics*. 9: 133-141.

Wrzodek, C., Drager, A. and Zell, A. (2011). KEGGtranslator: visualizing and converting the KEGG pathway database to various formats. *Bioinformatics.* 27: 2314-2315.

Wylie, K.M., Truty, R.M., Sharpton, T.J., Mihindukulasuriya, K.A., Zhou, Y., Gao, H., Sodergren, E., Weinstock, G.M. and Pollard, K.S. (2012). Novel bacterial taxa in the human microbiome. *PLoS ONE.* 7: e35294.

Xia, S.Q., Duan, L., Song, Y.H., Li, J.X., Piceno, Y.M., Andersen, G.L., Alvarez-Cohen, L., Moreno-Andrade, I., Huang, C-L. and Hermanowicz, S.W. (2010). Bacterial community structure in geographically distributed biological wastewater treatment reactors. *Environmental Science and Technology*. 44: 7391-7396.

Xiao, R., Power, R.F., Mallonee, D., Routt, K., Spangler, L., Pescatore, A.J., Cantor, A.H., Ao, T., Pierce, J.L. and Dawson, K.A. (2012). Effects of yeast cell wall-derived mannan-oligosaccharides on jejunal gene expression in young broiler chickens. *Poultry Science*. 91: 1660-1669.

Xu, Z., Hu, C., Xia, M., Zhan, X. and Wang, M. (2003). Effects of dietary fructooligosaccharide on digestive enzyme activities, intestinal microflora and morphology of male broilers. *Poultry Science.* 82: 1030-1036.

Yadav, H., Jain, S. and Sinha, P.R. (2007). Production of free fatty acids and conjugated linoleic acid in probiotic dahi containing *Lactobacillus acidophilus* and *Lactobacillus casei* during fermentation and storage. *International Dairy Journal*. 17: 1006-1010.

Yang, Y., Iji, P.A. and Choct, M. (2009). Dietary modulation of gut microflora in broiler chickens: a review of the role of six kinds of alternatives to in-feed antibiotics. *World's Poultry Science Journal.* 65: 97-114.

Yang, Y., Iji, P.A., Kocher, A., Mikkelsen, L.L. and Choct, M. (2008b) Effects of mannanoligosaccharide and fructooligosaccharide on the response of broilers to pathogenic *Escherichia coli* challenge. *British Poultry Science*. 49: 550-559,

Yang, Y., Iji, P.A., Kocher, A., Thomson, E., Mikkelsen, L.L. and Choct, M. (2008a). Effects of mannanoligosaccharide in broiler chicken diets on growth performance, energy utilization, nutrient digestibility and intestinal microflora. *British Poultry Science.* 49: 186-194.

Yeo, J. and Kim, K. (1997). Effect of feeding diets containing an antibiotic, a probiotic or yucca extract on growth and intestinal urease activity in broiler chicks. *Poultry Science.* 76: 381-385.

Yi, H., Hwang, K.T., Regenstein, J.M. and Shin, SW. (2014). Fatty acid composition and sensory characteristics of eggs obtained from hens fed flaxseed oil, dried whitebait and/or fructo-oligosaccharide. *Asian-Australasian Journal of Animal Science.* 27: 1026-1034.

Yilmaz-Ersan, L. (2013). Fatty acid composition of cream fermented by probiotic bacteria. *Izvorni znanstveni rad*. 63-132-139.

Yörük, M.A., Gü, M., Hayirli, A. and Macit, M. (2004). The effects of supplementation of humate and probiotic on egg production and quality parameters during the late laying period in hens. *Poultry Science*. 83: 64-88.

Youssef, A.W., Hassan, H.M.A., Ali, H.M. and Mohamed, M.A. (2013). Effects of probiotics, prebiotics and organic acids on layer performance and egg quality. *Asian Journal of Poultry Science.* 7: 65-74.

Yurong, Y., Ruiping, S., Shimin, Z. and Yibao, J. (2005). Effect of probiotics on intestinal mucosal immunity and ultrastructure of cecal tonsils of chickens. *Archives of Animal Nutrition* 59: 237-246.

Zaghini, A., Martelli, G., Roncada, P., Simioli, M. and Rizzi, L. (2005). Mannanoligosaccharides and aflatoxin B1 in feed for laying hens: effects on egg quality, aflatoxins B1 and M1 residues in eggs, and aflatoxin B1 levels in liver. *Poultry Science.* 84: 825-832.

Zarei, M., Ehsani, M. and Torki, M. (2011). Dietary inclusion of probiotics, prebiotcis and synbiotic and evaluating performance of laying hens. *American Journal of Agricultural and Biological Sciences.* 6: 249-255.

Zemková, L.', Simeonovová, J., Lichovníková, M. and Somerlíková, K. (2007). The effects of housing systems and age of hens on the weight and cholesterol concentration of the egg. *Czech Journal of Animal Science.* 52: 110-115.

Zeyaullah, M., Kamli, M.R., Islam, B., Atif, M., Benkhayal, F.A., Nehal, M., Rizvi, M.A. and Ali, A. (2009). Metagenomics - An advanced approach for noncultivable microorganisms. *Biotechnology and Molecular Biology Reviews*. 4(3): 49-54.

Zhang, J.L., Xie, Q.M., Ji, J., Yang, W.H., Wu, Y.B., Li, C., Ma, J.Y. and Bi, Y.Z. (2012). Different combinations of probiotics improve the production performance, egg quality, and immune response of layer hens. *Poultry Science.* 91: 2755-2760.

Zhang, W.F., Li, D.F., Lu, W.Q. and Yi, G.F. (2003). Effects of isomalto-oligosaccharides on broiler chicken performance and intestinal microflora. *Poultry Science*. 82: 657-663.

Zhang, Z.F. and Kim, I. H. (2014). Effects of multistrain probiotics on growth performance, apparent ileal nutrient digestibility, blood characteristics, cecal

microbial shedding, and excreta odor contents in broilers. *Poultry Science*. 93: 364-370.

Zhang, Z.F. and Kim, I.H. (2013). 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: 4781-4787.

Zhao, Y., Tang, H. and Ye, Y. (2012). RAPSearch2: a fast and memory-efficient protein similarity search tool for next-generation sequencing data. *Bioinformatics.* 28: 125-126.

Zhou, J., He, Z., Yang, Y., Deng, Y., Tringe, S.G., Alvarez-Cohen, L. (2015). High-throughput metagenomic technologies for complex microbial community analysis. *mBio*. 5: e02288-14.

Ziemer, C.J. and Gibson, G.R. (1998). An overview of probiotics, prebiotics and synbiotics in the functional food concept: Perspectives and future strategies. *International Dairy Journal.* 8: 473-479.

Zulkifli, I., Abdullah, N., Azrin, N.M. and Ho, Y.W. (2000). Growth performance and immune response of two commercial broiler strains fed diets containing *Lactobacillus* cultures and oxytetracycline under heat stress conditions. *British Poultry Science.* 41: 593-597.