# TECHNICAL SEMINAR ON

# FOOD AND ENVIRONMENT SAFETY IN COMMERCIAL POULTRY PRODUCTION

21st April 2018

Dhaka Regency Hotel

education organization research

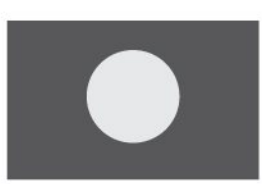
World's Poultry Science Association - Bangladesh Branch

Proceedings of the Seminar

# Food and Environment Safety in Commercial Poultry Production

Dhaka Regency Hotel and Resort, Dhaka, Bangladesh

21 April 2018

**WORLD'S POULTRY SCIENCE ASSOCIATION – BANGLADESH BRANCH**

**Proceedings of the Seminar:**

**Food and Environment Safety in Commercial Poultry Production**

World's Poultry Science Association – Bangladesh Branch

21 April 2018, Dhaka, Bangladesh



Mega Domicile, Flat # B-6

House # 91, Road # 4, Block B

Niketon, Gulshan 1, Dhaka 1212

Bangladesh

**Edited and compiled by:**

Technical Committee

Seminar on "Food and Environment Safety in Commercial Poultry Production"

World's Poultry Science Association – Bangladesh Branch

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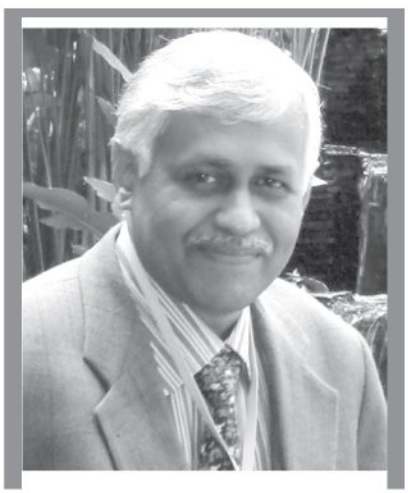
# Foreword

The consumption of adequate safe and nutritious food is critical to our health and well-being. Poultry meat and eggs are the cheapest source of quality animal protein. Commercial poultry production in Bangladesh has made significant progress in the recent years. Consumers often wonder if commercially produced poultry eggs and meat are safe for health. While it is not desirable that the consumers get confused with some unfounded myths regarding the safety of poultry meat and eggs, it is also absolutely necessary to gain consumers' confidence by addressing their concerns from scientific point of view. Like any other food commodity, commercially produced poultry meat, eggs and value added products thereof are also prone to safety risks. Like any other enterprise, commercial poultry production also may pose risk to the environment.To keep our poultry produce and environment safe, it is necessary that all stakeholders clearly understand the potential hazards and risks as well as their mitigation measures at each step of poultry production, from farm to fork. In this context, the Bangladesh Branch of World's Poultry Science Association (WPSA-BB) is organizing a day-long technical seminar on "Food and Environment Safety in Commercial Poultry Production" on 21 April 2018 at Dhaka Regency Hotel and Resort, Dhaka, Bangladesh. Leading national and international experts in this field will present papers covering all areas of the seminar theme. Extended abstracts of all the presentations along with authors' brief biography are recorded in this proceeding.



PROF. DR. MOHAMMAD RAFIQUL ISLAM
Convener, Technical Committee
WPSA-BB Seminar on "Food and Environment
Safety in Commercial Poultry Production"
and
Professor, Department of Pathology
Faculty of Veterinary Science
Bangladesh Agricultural University, Mymensingh

World's Poultry Science Association – Bangladesh Branch

**Seminar on "Food and Environment Safety in Commercial Poultry Production"**

## TECHNICAL COMMITTEE

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World's Poultry Science Association – Bangladesh Branch

**Seminar on "Food and Environment Safety in Commercial Poultry Production"**

PROGRAM

**21 April 2018, Saturday**

0900 hr: Registration

**Session I**

1000 hr: Welcome remarks and Bangladesh status paper - Mr. Shamsul Arefin Khaled, President, WPSA-BB

1025 hr: Risk assessment and management of food and environment safety in poultry production in Bangladesh - Prof. Dr. Emdadul Haque Chowdhury, Department of Pathology, BAU

1050 hr: Good husbandry practices in poultry production to ensure environment and food safety - Prof. Dr. S.D. Chowdhury, Department of Poultry Science, BAU

1110 hr: Tea

**Session II**

1145 hr: New information on the importance of biosecurity at poultry farms - Dr. J.L. Vegad, Former Professor and Head, Department of Pathology, Veterinary College, Jawaharlal Nehru Agricultural University, Jabalpur, India

1210 hr: Prudent use of antimicrobials in poultry - Prof. Dr. Priya Mohan Das, Department of Pathology, BAU

1235 hr: Alternatives to antibiotic growth promoter - Dr. Hannes Meyns, Vetworks, Belgium

1300 hr: Lunch and prayer

**Session III**

1400 hr: Prevention of microbial contamination in commercial poultry production, from farm to fork - Prof. Dr. Sukumar Saha, Department of Microbiology & Hygiene, BAU

1425 hr: Quality assurance and quality control of poultry feed to ensure food safety - Dr. Kai-J. Kühlmann,Trouw Nutrition, Asia Pacific, Bangkok, Thailand

1450 hr: Quality management system for processed poultry products and food safety - Prof. Dr. Syed Sayem Uddin Ahmed, Department of Epidemiology and Public Health, SAU

1510 hr: Tea

**Session IV**

1530 hr: Panel discussion (Answer to written questions from the audience)

Facilitator: Dr. Md. Giasuddin, BLRI

1630 hr: Closing remarks
Convener, Technical Committee;
Secretary, WPSA-BB
President, WPSA-BB

# Welcome Message

SHAMSUL AREFIN KHALED

President
World's Poultry Science Association – Bangladesh Branch
E-mail: anjon@nourish-poultry.com;nourish@gmail.com

Bangladesh is at a historical juncture – the 50th anniversary of our independence (i.e. 2021) is approaching fast, and despite all the socio-political melee, the central focus of national economy is now accelerated and unprecedented economic growth in the coming years. The country has all the potentials to be among the fastest growing economies in the next decade, which will help it take 28th place among the world's most powerful economies by 2030, says a report of global services giant **PricewaterhouseCoopers** (PwC).

To achieve this, the productivity, intelligence, and livelihood of the people of Bangladesh must increase. This is only possible if they have continuous access to safe & balanced food associated with a healthy life. Therefore, the consumption of adequate safe food and the maintenance of a nutritious diet is increasingly becoming a prerequisite in every household of Bangladesh.

At present, poultry is the cheapest source of protein and readily accessible to everyone. However, a common query among consumers nowadays is whether commercially produced poultry eggs and meat are safe for consumption. It is of the utmost importance that we gain the customers' confidence by addressing any inquiries they might have from a well-established scientific point of view.

There are a multitude of risks involved in commercial poultry production and its processing, storage, and preparation. Therefore, an accord by all the stakeholders of the poultry industry is needed to keep our poultry products safe from any and all probable hazards and risks, and any approaches taken to alleviate the diseases among the poultry should be discussed at length before implementing them.

WPSA-BB is organizing a day-long technical seminar on "Food and Environment Safety in Commercial Poultry Production" to be held on 21st April 2018 at Dhaka Regency Hotel in order to disseminate information collected by a vast number of stakeholders so that these risks can be minimized for the benefit of the poultry world as a whole. The participants, which include people from a variety of professional backgrounds including WPSA members, scientists, government regulators, policy makers and representatives of relevant stakeholders, will indubitably be glad that they seized this opportunity to gain valuable insight into the poultry world and learn about the safety precautions we take to keep our poultry products free from contamination.

As you know, the World's Poultry Science Association-Bangladesh Branch (WPSA-BB) is the local chapter of World's Poultry Science Association. WPSA-BB is playing a pivotal role in development of the poultry industry in Bangladesh, bringing the poultry sector to greater heights with each passing year. Next year, WPSA-BB will organize the 11th International Poultry Show & Seminar 2019, which has already garnered an expected attendance of more than 100,000 people.

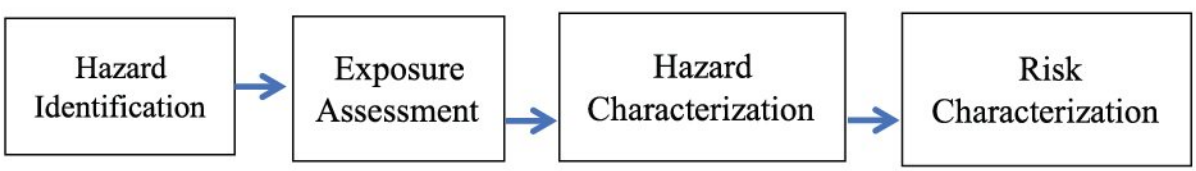
I personally want to thank all the presenters and guests who have travelled here from the different parts of the globe with the intention of attending this seminar. We appreciate your interest in the safety of poultry production as well as your unending devotion to improve the capacity of stakeholders as well as food safety. We hope that you find our seminar to your liking and join us in our future expeditions to make this world a better place.

# Risk assessment and management of food and environment safety in poultry production in Bangladesh

EMDADUL HAQUE CHOWDHURY
Department of Pathology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh, Bangladesh
E-mail: emdad001@yahoo.com; emdaddvm@gmail.com

*Dr. Emdadul Haque Chowdhury is a Professor of Pathology at Bangladesh Agricultural University (BAU), Mymensingh. He obtained PhD from University of Zurich, Switzerland. He received Swiss Federal (Switzerland) and STA fellowships (Japan). Professor Chowdhury has 25 years' teaching experience at BAU, of which 11 years as Professor. He published 107 research papers, a significant number of which has been published in high impact factor journals. His main research areas include infectious diseases of poultry and livestock, risk assessment of foods and biotechnology. He served as national consultants for FAO, Department of Environment (DOE), Bangladesh Institute of Developmental Studies (BIDS), IUCN Bangladesh, PROSHIKA, GMARK consultancy and took leadership role in several foreign aided projects. He has been serving as editor/member of the editorial board for Bangladesh Veterinary Journal, The Bangladesh Veterinarian, Progressive Agriculture, Chittagong Veterinary and Animal Science University Journal and Bangladesh Livestock Journal. In recognition of his outstanding contribution to research, he was awarded Best Young Presentation Award 1999 by Bangladesh Society for Veterinary Education and Research, Best Poster Award 2013 by Centre for Action Research (CARES), Dhaka Bangladesh, Best PublicationAward by BAU Teachers' Association and scored 100% proficiency in molecular diagnosis of goat viral diseases by Joint division of FAO/IAEA, Vienna, Austria. He is a member of European Society of Veterinary Pathology (ESVP), World Veterinary Poultry Association (WVPA), World Poultry Science Association (WPSA), International Goat Association (IGA), Japanese Society of Animal Science, Bangladesh Society for Veterinary Education and Research and Bangladesh Veterinary Association.*

The usual expectation is that foods would be safe in the production, marketing and delivery and preparation for consumption. However, the animal food chain is often associated with hazards in varieties of ways. Animals may ingest chemical agents, toxic plants, or may be treated with therapeutic drugs, e.g. antibiotic or get infection and or contamination with biological agents, e.g. bacteria, viruses etc. The poultry production in Bangladesh has changed from backyard to intensive poultry production that raised concerns for accumulation of large amounts of such potentially hazardous material at single sites. If the production procedure is not properly monitored and assessed, that may have serious implications for food safety. Therefore, there is a need to have comprehensive multidisciplinary integrated approach to reduce the food borne hazards in every step of the food chain starting from farm inputs to production, processing, transportation, marketing and consumption. Risk analysis along the food chain could identify the food hazards and reduce the hazards to an acceptable limit. International organization has proposed "Risk Analysis Framework" that includes three basic steps: risk assessment, risk management and risk communication. Risk assessment can be accomplished in four steps:



Hazard identification identifies hazards and critical control points in every steps of food chain. The exposure assessment identifies entry point of the hazards where likelihood of the occurrence of the clinical disease is assessed by hazard characterization. The risk characterization shows ultimate consequences of the problem. Once risk assessment is completed, attention turns to risk management that include mitigation plan, cost of mitigation with benefits (risk reduction) and impact of current decision on future options.

However, health hazards can come up along any part of the food chain "from farm to fork". Historical records also suggest that poultry food products and environment can be contaminated by microbial, chemical or physical hazards at any steps of the production and supply chain. For example, the use of antibiotics in animal feed can increase the growth rates but may transfer the antibiotic resistance gene to human pathogens. Other new challenges have also emerged from innovations in food technology such as novel food products, food irradiation, and growth promoters, as well as from emerging and re-emerging diseases such as re-assorted avian influenza virus, antibiotic resistant bacterial pathogens.

Although there is no absolute guarantee to get hazard-free foods but unacceptable levels of food-borne hazards can be minimized by appropriate management practices, e.g. compliance with regulatory authority, good husbandry and biosecurity practices, and other health related programs. All stakeholders, e.g. producer, traders, regulators, consumer, etc. should play their role as required. Relevant stakeholder should consider risk assessment techniques to manage and control poultry associated hazards.

# Good husbandry practices in poultry production to ensure environment and food safety

S.D. CHOWDHURY
Department of Poultry Science, Faculty of Animal Husbandry, Bangladesh Agricultural University, Mymensingh, Bangladesh
E-mail: drsdchow@gmail.com

*S.D. Chowdhury was born in 1954 in Hatiya in the district of Noakhali, in Bangladesh. He was graduated from the Faculty of Animal Husbandry, Bangladesh Agricultural University (BAU), Mymensingh in 1976. He was awarded Master of Science in Poultry Science degree from the same university in 1977. He joined as a Teaching Fellow in 1978 and became Lecturer in 1979 at the Department of Poultry Science, BAU and has been serving as a Professor in the same department since 1995. He obtained his PhD degree in 1988 for his research on poultry nutrition with specialization in egg shell quality from Wye College, University of London under Commonwealth Scholarship. He conducted his postdoctoral research in the field of Nutritional Biotechnology at Chung-Ang University, Republic of Korea during 2001-2002. He also got training in poultry nutrition and egg quality from Roslin Institute, Edinburgh, UK and University of Hohenheim, Germany in 1996. During his long teaching and research career, Dr. Chowdhury published 111 scientific papers of which 37 in international journals and 15 in regional journals. He has experience of working with DANIDA, INFPD of FAO, IFC-SEDF and USAID funded research and consulting assignments. At home, Dr. Chowdhury worked for ACI Logistics Ltd, PRTC, CVASU, Evonik (South East Asia) Pte Ltd., Kemin Industries South Asia Private Limited, BRAC and PKSF. He was honoured by "AG Agro Industries Ltd." of Bangladesh in 2015 for his outstanding contribution in teaching and research in poultry science for the development of Bangladesh poultry sector. He is an active member of World's Poultry Science Association, Bangladesh Branch since its inception in which he hold the positions of Vice-President twice and member, EC once. His current research focuses on the use of probiotics, prebiotics and acidifiers in poultry nutrition and studies on their efficacy to combat global warming on broiler and egg production. Dr. Chowdhury is a proud father of a son who is a Naval Architect Engineer and a daughter who is a Software Engineer, both of whom are working at home and abroad with great reputation.*

Good husbandry practices in poultry production are usually meant for a number of efforts to be provided targeting proper growth and production of poultry flocks. These efforts seldom take the environment and food safety issues in consideration during the course of live bird production particularly in Bangladesh. Efforts are needed to reduce infection in and/or contamination of live birds with foodborne pathogens before poultry products are dispatched to processing plants since processing plants alone are not able to reduce the incidence of pathogenic bacteria. Therefore, keeping production site clean by destroying infected flocks, sanitizing table/hatching eggs and limiting the introduction and spread of pathogens at the farm through Good Animal Husbandry Practices (GAHPs) are the keys to main control strategy (Hafez, 1999). The major GAHPs include: effective hygienic measures in poultry houses having adherence to strict biosecurity, following hygienic measures for feeds, use of safe antimicrobial feed additives, careful vaccination of poultry flocks and finally the application of hygienic systems during harvesting and transporting birds.

The most common causes of human foodborne bacterial diseases linked to poultry are Salmonella and Campylobacter. In addition verotoxin producing Escherichia coli (VTEC) and several other microorganisms such as Clostridium perfringens and some Listeria species can also enter the food chain through contaminated poultry carcasses. The development of antibiotic resistance in bacteria in both animals and human emerged as public health hazard globally and this has become an increasing concern affecting consumers' acceptability of poultry and poultry products. It is therefore important to concentrate efforts to know how microbial pathogens enter and move through food chain, how live birds and eggs are contaminated/polluted and the conditions that

promote or inhibit the growth of microorganisms threatening environment and the food safety.

**Sanitizing table/hatching eggs:** Eggs are said to be 90% sterile when laid. They become contaminated with bacteria from different sources e.g., feces and surrounding environment. Egg albumen and yolk, the internal contents of egg are ideal growth media for pathogenic bacteria which are hazardous to humans (e.g. Salmonella, Escherichia or Enterobacter). The internal contents, yolk, albumen and membranes may be directly contaminated (vertical transmission) as a result of bacterial shedding infection from the hen's reproductive organs, which takes place before the shell covers the eggs (Messenset al., 2005). Contamination also occurs during the passage of the eggs through the highly contaminated cloaca area (horizontal contamination) at the moment of lay and leads to the penetration of shells by microorganisms (De Reu, 2006). Much of the current research on eggshell and content contamination focuses on salmonellosis. Outbreak of this disease in humans caused by Salmonella enteritidis following consumption of food containing contaminated eggs or their products still represents major food safety problems (De Reuet al., 2008). It is therefore important to reduce the contamination in production chain as far as possible and as far as practicable.

Sanitization of eggshells is important both for table and hatching eggs due to the higher incidence of contamination with pathogens (Turtoi and Borda, 2014). Although most disinfectants are said to be helpful in the control of Salmonellaspp and other microorganisms without reducing egg hatchability, chemical solutions are not able to eliminate contamination. Chemical treatments do not consistently kill all Salmonellaspp on or in eggs and their effectiveness appears to diminish as the amount of time between contamination and treatment increases (Berranget al., 1998; 2000; Cox et al., 2000). To overcome the drawbacks of chemical sanitization, other methods of decontamination have been tested such as immersion in boiling water for three seconds (Hemathongkhamet al., 1999), UV light treatment (De Reuet al., 2006; Wells et al., 2011), hot air (180 °C for eight seconds), hot water (95 °C for 10 seconds), infer-red (210 °C for 30 seconds) and steam (100 °C for 2 seconds) (James et al., 2002). UV light is lethal to most microorganisms found in air, water or on hard surfaces. Cell inactivation is based on the damage of the nucleic acids (DNA and RNA) under UV light. Turtoi and Borda (2014) while reviewing decontamination of eggshells concluded that UV light treatment achieved significantly greater reductions in bacterial population of clean and recently contaminated egg shells compared with methods in which chemical sanitizers were used. It ensured significant reductions of Salmonella spp., the most frequently present pathogen reported in eggs.

**Hygienic measures in poultry houses:** Entrance of visitors to poultry houses and its surroundings should be strictly prohibited. To make it possible, main gate and the doors of houses should be kept locked. Farm staff working there should take all possible precautions before and after entering into houses. These include taking shower, wearing protective cloths, using disinfectant footbath and undergo routine health check up of their own to identify carriers and prevent transmission and cross-contamination on the farm. All possible efforts need to be directed to ensure a stress free environment for the birds. It is always advisable to follow an "all-in all-out" rearing system. Cleaning, disinfection with a safe powerful cost-effective disinfectant and pest control should constitute routine hygienic measures in the farm. Houses should be left empty for 2-4 weeks before introducing a new flock. Producers must procure birds from "clean" and "known" source. Supply of clean and safe drinking water should always be ensured. Feeder, waterers and all other equipment used during the course of production should be regularly cleaned and disinfected. Dead and sick birds should be immediately disposed off following scientific methods. Other biosecurity measures should be strictly followed.

**Feed hygiene:** Quality feed is always preferred for feeding poultry. Feed free of contamination is one of the criteria for quality feed. The most common source of infection in poultry flocks is the Salmonella –contaminated feed. So, contamination of feed ingredients as well as the finished feed needs to be reduced. A number of approaches are being in practice for this purpose. Some of the examples are: keeping feed mill rodent free, procurement of quality raw materials, decontamination by using mechanical methods (e.g. pelleting, pasteurization etc.), physical (extrusion, irradiation) or chemical methods (acid treatment); strict separation of clean and dirty parts of a feed mill (the clean part starts directly after the treatment of the feed); reduction of dust contamination; hygienic storage of all feed ingredients; regular cleaning and disinfection of feed mill; introduction of cleaning and inspection programmes of the feed transportation vehicles.

**Use of safe feed additives:** A number of feed additives are now manufactured and marketed globally and

every manufacturer is claiming his product as safe and performance enhancer. Unfortunately, most of them are not passing through check post or field trial in this country. It is therefore necessary to establish a screening or quality control system so that the industry can derive maximum benefit from safe feed additives. Several organic acids either singly or in combination may be used in drinking water or in feed to improve gut health by creating acidic environment unfavourable for the colonization of Salmonella. Probiotics composed of several strains of lactobacilli, streptococci, bifidobacteria, bacilli and yeasts are able to inhibit the growth of potentially pathogenic microorganisms by lowering pH through production of lactate, lactic acid and volatile fatty acids. Both acidifiers and probiotics are considered to be viable and safe alternatives to antibiotics for growth promotion and safe poultry food production. In line with global interest, researches to find out safe and cost effective feed additives as alternatives to antibiotics are advancing well in Bangladesh.

**Careful vaccination of poultry flock:** Along with biosecurity measures, vaccination is a preventive strategy to combat the outbreak of infectious diseases. Since "one gram of prevention is better than a kilogram of cure" (Chowdhury, 1984), preventive strategy is the key to keep poultry healthy. Different live and inactivated vaccines have been developed globally although type of vaccines produced in Bangladesh is few. It is of utmost important to take adequate care during transportation, preservation, storage and application of vaccine not only to make vaccination effective but also to avoid any sort of contamination. A limited number of vaccines are available commercially for Salmonella typhimurium and Salmonella enteritidis infections. It was reported that vaccine did not eliminate infection but reduced the number of carriers in flocks previously infected with a field strain of Salmonella (Meyer et al., 1998). Results of application of live and inactivated vaccines to reduce Campylobacter colonization also varied (Glunderet al., 1998). Due to the fact that Campylobacter is commonly present in the farm environment and can be introduced into poultry houses in many ways, it is extremely difficult to keep chicken flocks free of infection during production stage (Umar et al., 2016). However, current researches are addressing these issues relating to vaccination.

**Hygienic harvesting and transportation of live birds and eggs:** Clean and disinfected equipment to be used in collecting live birds and eggs. Care should be taken to minimize stress on the birds during loading, transportation and unloading. One trained personnel for supervision may be assigned for this purpose. Vehicles with different systems to transport live birds and eggs are available e.g., loose containers for birds or containers that are fixed. Whatever system is available there should not be any compromise in cleaning and disinfection of vehicles and the containers. Feed should be withheld from the birds travelling to slaughtering plant a few hours before the planned slaughter time. This is to reduce the amount of defecation.

**Conclusion:** Good husbandry practices must be followed for enhancing productivity and ensuring environment and food safety. Since Salmonella, Campylobacter and Escherichia are the major players in making foods of poultry origin unsafe, application of all or even part of measures mentioned in this paper could probably reduce their prevalence to an accepted level. More research is needed to address the key issues relating to potential immune intervention for the production of safe poultry and poultry products.

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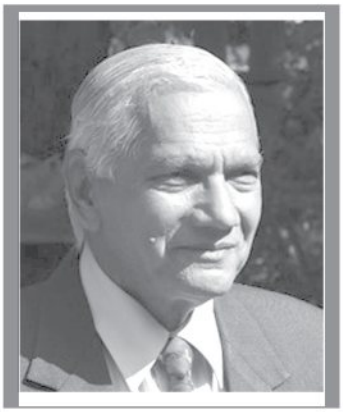
# New information on the importance of biosecurity at poultry farms

J. L. VEGAD

Former Professor and Head, Department of Pathology, Veterinary College, Jawaharlal Nehru Agricultural University, Jabalpur-482001, India
E-mail: jawaharlalvegad@gmail.com



*Dr. J.L. Vegad was Professor and Head, Department of Veterinary Pathology at Jawaharlal Nehru KrishiVishwavidyalaya (JNKVV), Jabalpur, India. He was then Professor Emeritus of the India Council of Agricultural Research (ICAR), New Delhi, for two years. HE obtained PhD from New Zealand (1968) under a Commonwealth Scholarship. His contribution to the study of acute inflammatory response in the sheep and chicken is pioneering. He has published more than 150 research papers, 60 of them in British, American and New Zealand journals. For 10 years he was on the Editorial Board of 'Comparative Haematology International' published from England. He has contributed three textbooks on veterinary pathology and two books on poultry diseases. He was the President of the Indian Association of Veterinary Pathologists, elected Member of the Governing Council of the National Academy of Veterinary Sciences, referee for Avian Pathology (England), and reviewer for World's Poultry Science Journal.*

In nature, there is a continuous war going on between the pathogen on the one hand and the immune system of the bird on the other. Each one tries to get an upper hand for their survival. The pathogen contrives incredible strategies to dodge the immune system of the bird, and unfortunately, currently appears to be winning the war.

The pathogens are extremely powerful and possess huge biotic potential (reproductive capacity). A bacterium, whose doubling time is 50 minutes, reproduces itself to 500 millions just within 24 hours. Escherichia coli the most common bacterial pathogen of poultry which has a doubling time of 20 minutes becomes 500 millions within 9.5 hours. Another example, Clostridium perfringens cause of necrotic enteritis in poultry, has a doubling time of only 7 minutes and becomes 500 millions within 3.5 hours, inflicting heavy mortality. Viruses are a step ahead. Just within a few hours they grow within the cells not only in millions but in billions and trillions and inflict huge losses. Avian influenza is a good example.

On the other hand, vaccines employed to protect the birds are unable to impart full protection. This is not because the vaccines are not good or the farmers technique of their administration is faulty, but because the pathogens are not stable and some of the most important pathogens of poultry keep continuously evolving. Evolution is a gradual change in the genome of a pathogen and its development into an altered form, mostly because of the mutations. The mutated forms of pathogens pose a real problem. As a result, vaccines have limited efficacy and are unable to impart 100% immunity.

For example, virus of avian influenza keeps continuously evolving. Its gene which encodes haemagglutinin is not stable and undergoes mutations all the time. Haemagglutinin glycoprotein is the most important molecule in avian influenza virus, since it plays a major role in the pathogenesis of the disease and the protective antibodies produced following vaccination are against this molecule. Mutation just at one nitrogenous base (point mutation) encodes one new amino acid, which alters the amino acid composition of the haemagglutinin glycoprotein. The antibodies already produced are therefore unable to protect the bird against this altered haemagglutinin. Another example is that of infectious bronchitis. Its virus also continuously evolves not only though mutations but also by genetic recombination. This leads to the generation of a large number of different serotypes, some being regional. The vaccine administered is unable to provide full protection since it would not contain antigens of all the serotypes. In the third example, Mycoplasma gallisepticumadopts a novel strategy. While inside the bird, when it faces destruction by the antibodies produced against it, M. gallisepticum suddenly changes its surfaces antigens through on and off switching of the required genes by a complex phenomenon called phase variation, believed to be governed by epigenetic mechanisms. Thus, it cleverly avoids the antibodies formed against it, since antibodies are unable to recognize the altered M. gallisepticum. The virus of Marek's disease also continues to evolve and increase its virulence and poses a challenge in vaccination.

After vaccination, the farmers believe that birds are fully protected. Under this wrong expectation, they may not take biosecurity seriously, or may even neglect it. While in reality, the protection may be 50%, 60%, or 70% but never 100% because of the changing nature of the pathogens. Under these circumstances to whom the farmer will turn to. That rescuer is biosecurity. The evolving nature of many poultry pathogens has thus enhanced the importance of biosecurity manifold. On this account, the biosecurtiy holds the first position. In fact, biosecurity and vaccination can be termed as "protective synergism".

# Prudent use of antimicrobials in poultry

PRIYA MOHAN DAS

Department of Pathology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh, Bangladesh
E-mail: pmdasbau@yahoo.com

*Professor Dr. Priya Mohan Das is one of the most renowned faces in the field of veterinary education and research in Bangladesh. Affiliated to Department of Pathology, Faculty of Veterinary Science, Bangladesh Agricultural University, Professor Das started his academic career in 1977 and received his doctoral degree from Haryana Agricultural University in 1987. His long academic career is decorated with several reputed awards and funding. Professor Das has authored and co-authored many peer-reviewed scientific papers and presented works at many national and international conferences. He was the Chief Editor of Bangladesh Veterinary Journal for 6 years. His contributions have acclaimed recognition as subject expert around the world. Professor Das is actively associated with several professional organizations, such as World Poultry Science Association, World Veterinary Poultry Association etc. Besides his glorious academic career Professor Das is a famous poultry practitioner and poultry farm consultant, written about 50 popular articles in poultry related Bangla magazines.He worked in the position of National Consultant, HPAI Surveillance of FAO from March 2008 to September 2011. Professor Das is currently leading the Faculty of Veterinary Science, BAU as Dean and working as the Convener of the National Veterinary Dean Council.*

Good health is essential for welfare and for optimal performance. Disease control is thus an essential part of any successful management program. In turn, safe food is produced by healthy animals/birds. Antibiotics (the major antimicrobial) are natural products of microorganisms, or identical synthetic or semi-synthetic products that inhibit the growth of (bacteriostatic) or kill the microorganisms (bacteriocidal). They are used in both humans and veterinary practices. In veterinary practice, antibiotics are widely used as therapeutic, prophylactic and growth promoting agents. The achievements of the use of antimicrobials are jeopardized by rapid emergence and spread of antimicrobial-resistant (AMR) bacteria. Scientists are now concerned about the emergence of "super bugs" that may be resistant to standard antibiotics used now a days. So, injudicious use of antibiotics in humans and agriculture (including veterinary) sectors may be threat for human beings.

World Health Organization (WHO 2018) reported that prevalence of non-prescription antibiotics in low-and middle-income countries is high, such as in Bangladesh, Brazil and Sudan. Prevalence of antimicrobial self-medication is 39%. Main sources of self-medication antibiotics were found to be pharmacies, drugstores and left over or borrowed drugs. Antibiotics provided by non-qualified personnel exacerbate inappropriate use which includes not completing the course or taking an insufficient dose, taking for wrong indications (viral infection and inflammation) and sharing antibiotics. Health professionals who prescribe or dispense antibiotics, when motivated by financial incentives, induce demand through the unnecessary use of antibiotics. The same statement is true for poultry sector in Bangladesh. Islamet al. (2016) studied the antibiotic usage patterns in selected broiler farms of Bangladesh and reported that all the 73 broiler farms, selected for study, used at least one antibiotic. More than 60% farmers used antibiotics without prescription and approximately 70% followed multi-drug practice. Existence of residual antibiotics was in 26%samples andfluoroquinolones(68.4%) were the mostcommonly detected antibiotics. Antibiotics used was 43.8%for therapeutic purpose; 31.5% for prophylaxis, 47.9% for both prophylaxis and therapeutic and 8.2% for growth promotion.Sarminaet al. (2016) detected the residues of tetracycline, amoxicillin, ciprofloxacin and enrofloxacin in poultry tissues like in livers, kidneys, thigh and breast muscles. Liver had the highest level of antibiotic residues in comparison to other samples.

Injudicious use of antibiotics leads to (1) antibiotics residues in tissues whichmay be detrimental to human

health becauseof hypersensitivity reaction, toxic aplastic anemia, liver and kidney damage, disruption of gut eco-system,carcinogenicity, genotoxicity and teratology; (2) emergence of antibiotic resistancein organismswhich may spread to their progeny, organisms of the same species,and even to organisms of different species through plasmid mediated transfer.Antibiotics when enter into the food chain, they become more dangerous. About 90% of antibiotics used in poultry are excreted into the environment and may be the source of pollution.Quality of drugs in Bangladesh is also questionable.

In the poultry sector antibiotics are used in two ways: (1)as antibiotic grow promoters (AGPs) and (2) for therapeutic purposes. The use of antimicrobials as AGPs (feed additives) has been a controversial issue, and is now widely discouraged. Common antibiotics use as feed additives in poultry are: Avilamycin, Falvomycin, Virginiamycin, Zinc bacitracin, Lincomycin, Oxytetracycline, Chlortetracycline, Amoxicillin, Tylosin, Tialin, Colistin etc. Phase-wise avoidance is advocated.

The therapeutic use of antibiotics should take into consideration the choice of drug, route of administration, dose, frequency of administration, duration of administration etc. Diagnosis of the disease and selection of the drug are important. Multi-drug practice should be avoided as far as possible. Safe feed and water, appropriate wild life control, effective effluent management and stress reduction should be emphasized. FAO is assisting Bangladesh for improvement of food security and public health through strengthening veterinary services and combating antimicrobial resistance using One Health approach.

WHO classified antibiotics into 3 groups: (1) Key ACCESS – choice for common infections, widely available, affordable price and narrow spectrum with low AMR risk; (2) WATCH – have significant resistance potential, recommended for limited treatments and highest priority agents of critically important antimicrobials for human medicinel; (3) RESERVE – considered as the last resort option (MDR infection), have high resistance potential, not to be used in livestock. So, the prescribers should use ACCESS narrow spectrum antibiotics aftercorrect diagnosis, avoid using WATCH antibiotics as much as possible and not use RESERVE antibiotics.

WHO defined prudent use of antimicrobials as "usage of antimicrobials which maximizes therapeutic effect and minimizes the development of antimicrobials resistance". Stephen (2011) reviewed 12 guidelines on prudent (judicious) use of antimicrobial agents. The key issues for the prudent use of antibiotics are: (i) using them when they can be useful, (ii) knowing when to stop using them (as soon as possible), (iii) knowing about PK, PDcharacteristics, (iv) knowing about their residues, (v) respecting thewithdrawal period, and (vi) knowing that antibiotics are only part of the treatment of sick animals.

As per Asian guideline the basic principles of prudent use of antimicrobials are: (i) The use of antimicrobial drugs in food-producing animals should be limited to those uses that are considered necessary for assuring animal health and welfare; (ii) The use of antimicrobial drugs in food-producing animals should be limited to those uses that include veterinary oversight and consultation; (iii) Only antimicrobial agents meeting the criteria of safety, quality and efficacy should be used in food-producing animals, and used according to the approved and intended uses; (iv) Use "as little as possible, as much as necessary"; (v) Activities associate with the responsible and prudent use of antimicrobials involve all relevant stakeholders; (vi) Prudent and responsible use of antimicrobials is the part of good veterinary and good animal husbandry practice and takes into consideration disease prevention practices such as the use of vaccination and improvement in husbandry conditions; and (vii) Surveillance, monitoring and the collection of reliable data provide evidenceto guide politics and inform on effectiveness of measures associated with prudent use of antimicrobials in livestock.

By changing our attitude, with firm determination, acquiring perfect knowledge and doinggood practice, we can overcome the problem of injudicious use of antimicrobials. Let us ask ourselves, "if the organisms can change their genetic characters for survival, can't we change our attitude for betterment of ourselves and the future generation?"

# Alternatives to antimicrobial growth promotors

HANNES MEYNS, DVM
Vetworks
E-mail: hannes.meyns@vetworks.eu

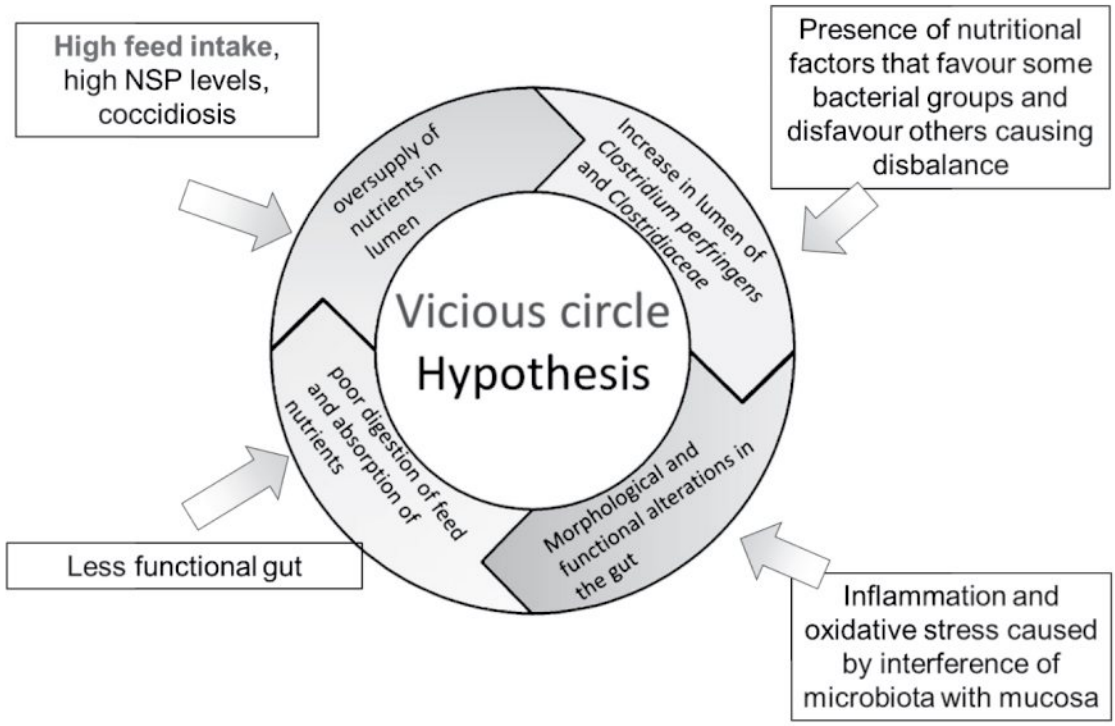
*Hannes is born in 1992, in Ostend, Belgium and grew up on a Belgian broiler farm, where he learned at a very young age the problems and needs of poultry farming business. Before graduating in 2016 as Master of Veterinary Medicine, specialization 'Swine, Poultry & Rabbits' at Ghent University, he had already gained a huge amount of practical knowledge in the sector. In 2016 he joined Vetworks as a young talent giving consultancy, technical support and trainings to the pharmaceutical and poultry industry worldwide. Additionally, Hannes is working as poultry veterinarian in a major poultry veterinary practice in Belgium and is the manager of a poultry trial farm.*

The impressive genetic improvement of broiler growth rate has enabled the poultry industry to meet with a worldwide increased demand for poultry meat. Compared to the broiler production in 1950-1960s, the birds today grow twice as fast. This improvement in growth and the corresponding feed conversion ratios put enormous pressure on the digestive system of the birds. Therefore it is essential to maintain optimal gut functions throughout the whole growth period to avoid enteric diseases, like necrotic enteritis (NE) and bacterial enteritis (BE) or dysbacteriosis. BE is often confused with other conditions of the gut such as coccidiosis or necrotic enteritis. Although the etiology of BE is multifactorial, it is hypothesised that in modern broiler breeds abundance of non absorbed nutrients in the gut lumen, in absence of growth promoters with antibacterial properties, causes a chain of events that exacerbates the proliferation of some clusters of bacteria that leads to a reaction of the gut wall. This reaction of the gut wall on its turn instigates a couple of microscopic and in sometimes also macroscopic changes that, as in a vicious cycle, will lead to poorer physiologic status of the intestine and to poor digestive and absorptive functions, resulting in even more nutrients in the intestinal lumen, and more substrate for bacterial growth. Additionally, activation of immune system and repair processes will cost valuable nutrients and energy. Considering all of the above, financial success of the poultry business is directly depending on intestinal health.

## The vicious cycle

The pathogenesis of BE can be described as a vicious cycle consisting out of 4 steps. In the **first step**, the shift of the healthy gut towards BE starts with oversupply of nutrients in the intestinal lumen. In a modern bird, the very high feed intake has accelerated the general feed passage rate in the intestine. So, even minor violations of the digestion and absorption will lead to an increase of the number of nutrients, especially of undigested proteins and high-energy nutrient particles in the hind gut. Among gut damaging factors of infectious origin, coccidiosis is considered to be the most important one. Furthermore, virus infections can destroy intestinal epithelia, shorten intestinal villi and lead to poor absorption in the intestine. The stressors of non-infectious origin are dietary changes, nutritional imbalance, soluble non-starch polysaccharides (NSP), enzymatic dysfunctions, mycotoxins and management issues. As a consequence of the oversupply of nutrients in the intestinal lumen, a shift in proliferation of some clusters of bacteria happens in the small intestine in **step 2** of the vicious cycle. The presence of excessive nutritional factors mainly favours the proliferation of Clostridium perfringens and other members of Clostridiaceaeand disfavours Lactobacilli group. In **step 3,** this disruption of a very fine balance in gut microbial constellation may shift intestinal immune tolerance towards pathological inflammation reactions and oxidative stress in the gut wall, so morphological and functional alterations in the intestine occur. In case of overgrowth of Clostridium spp. producing Netβ toxin, these alterations even results in necrotic enteritis, as Netβ toxin directly destroys the intestinal lining. **Step 4** of the vicious cycle of BE is characterised

by poor digestion of feed and poor absorption of nutrients, as the damaged intestine is not able to fulfil its functions. Above described 4 steps of the vicious cycle result in a less functioning gut, which in turn leads to further oversupply of nutrients in the intestinal lumen, so that the spiral of the vicious cycle of BE continues.




**Strategic use of alternatives**

The choice of best alternative solutions should be tailor made for each operation, looking at the 4 steps of the vicious circle and what contributing factors are causing damage to intestinal health. The range of alternative products available for poultry is expanding continuously, starting from organic acids, pre- and probiotics to phytotherapeutics, enzymes and bacteriophages. Alternative solutions work on different parts of the cycle and some products have a synergistic effect. Thus, each single product has to be reviewed before use to understand what its exact properties are, its mode of action and its relation to other alternative products. During critical periods like high coccidiosis challenge, feed changes, vaccinations and other stress factors or after antibiotic use, additives can be used to restore balance in the microbial community and recovery of damaged intestinal mucosa.

**Conclusions**

In conclusion, BE remains a widespread condition, present in most commercial poultry flocks all over the world. It has a significant financial consequence and understanding the pathogenesis of BE provides opportunities to use a different approach than just a standard prevention with antibiotics. The best strategy is to take action against the disease in all 4 stages of the vicious cycle, looking for products that work in synergy to improve intestinal health.

# Prevention of microbial contamination in poultry supply chain

SUKUMAR SAHA
Department of Microbiology & Hygiene, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh, Bangladesh
E-mail: sukumar07@gmail.com

*Dr. SukumarSaha is a Professor of Department of Microbiology and Hygiene of Bangladesh Agricultural University (BAU), Mymensingh. He is also serving as a Coordinator of Food Quality and Safety Laboratory at Interdisciplinary Center for Food Security (ICF) of BAU and Additional Director at Institutional Quality Assurance Cell (IQAC) of BAU. He completed his graduation with Doctor of Veterinary Medicine (DVM) and MS in Microbiology in 1994 and 1997, respectively, from BAU, Mymensingh. He received gold medal for his academic achievement in MS Examination. He joined as a Lecturer at the Department of Microbiology and Hygiene of BAU in July, 1998. He has been working as a Professor in the same department since 2012. Dr. SukumarSaha received for his PhD study and obtained his Ph.D. in Immunology in March 2007 from Yokohama City University Graduate School of Medicine, Yokohama, Japan with MONBUKAGAKUSHO scholarship. Dr. Saha received Post-doctoral training from Indiana University School of Medicine-Northwest, USA from 2007 through 2010. Dr. Saha got best publication award in 2011 by Bangladesh Agricultural University Teacher's Association. He was also awarded Travel Grant Award to attend 8th annual conference on vaccine research (organized by NFID, USA) in 2005, Bethesda, MD, and USA. His research interests mainly lie in the area of immunology, microbial risk assessment of food and multidrug resistant (MDR) foodborne pathogens. He participated in a number of training workshops on Food Safety and Risk Assessment at home and abroad. He presented his research findings in a number of seminar and conferences of different countries. He has supervised 44 MS students in Microbiology and Veterinary Public Health and Food Hygiene. Dr. Saha has contributed more than 45 publications including original research article in national and international peer reviewed journals.*

Poultry industry is growing rapidly in Bangladesh and it has significant role in creating employment opportunities, reducing poverty, contributing to country's economic growth as well as ensuring the sufficient protein supply to the daily meal of people and improving the status of food security. The poultry sector accounts for 14% of the total value of livestock output. There are 33 government and 77,880 registered private poultry farms in Bangladesh. Poultry meat alone contributes 37% of the total meat production. Poultry meat production increased from 1.13 MMT in 2005-2006 to 6.53 MMT in 2015-2016 and egg production increased from 5,422 million in 2005-2006 to 11,912 million in 2015-2016 indicating the progress of food security in protein rich diet. Poultry is a recognized reservoir of human pathogen and in context of Bangladesh, there are possibilities of microbial contamination in every step of poultry supply chain that may cause foodborne disease outbreaks, multidrug resistant microorganisms and huge production loss. In general, common microorganisms causing food-borne diseases through poultry chain are Campylobacter, Salmonella, Listeria, pathogenic E. coli, Yersinia, Staphylococcus, Clostridium, Bacillus and some pathogenic fungi. Regarding food safety issues and for protecting human health, it is important to detect the source and route of microbial transmission to the supply chain of poultry. This paper will focus on the prevention of microbial contamination of poultry emphasizing on the parent stock, hatcheries, farming, production and processing, transportation and consumption.

Parent stock is the ultimate source of layer and meat birds for human consumption. Pathogen reduction begins with procurement of clean pathogen-free parent stock and requires strict biosecurity, vaccination, and regular surveillance of the breeder flocks for pathogens, especially Salmonella enteritidis. Salmonella transmission occurs both by vertical and horizontal transmission. Because of the known routes of bacterial transmission, a healthy breeder stock, clean environment, clean source of drinking water and clean feed are critical during all

phases of poultry production. Control of all types of vermin such as rats, mice, insects and wild birds should be carried out consequently and frequently. Eggs contaminated during and after the laying process introduce pathogens into the commercial hatchery. Sanitation in the hatchery using disinfectants and sanitizers retards the growth of pathogens. Stringent microbial monitoring and sampling of the hatchery environment and equipment is essential to ensure the effectiveness of sanitation program. Evaluation of first-day mortality is a practical indicator of the effectiveness of hatchery intervention programs. Moreover, the farm biosecurity should be ensured at every point of conceptual, structural and operational level for preventing microbial contamination.

Pathogens such as Salmonella, E. coli, Listeria, Clostridium and Staphylococcus can also be introduced in supply chain through feed. Load of microbes in feed ingredients vary based on ingredient types, for example high mycotoxin content in wet feed. In feed mill, true heat treatment, irradiation as well as pelleting should be ensured for the production of pathogens free feed. Probiotics can be used in poultry feed for the prevention of colonization of pathogens in the gut of poultry.Regular maintenance of drinkers, biosecurity, routine changing of boots to individual bird house and improved ventilation are important tools for on-farm intervention of Salmonella and Campylobacter.

Another source of microbial contamination is transportation of poultry and poultry products from farm to farm and farm to fork. To escape from this contamination stress should be minimized, feed deprivation should be maintained prior to loading, transport vehicles and equipment should be disinfected properly before loading and after unloading.

Slaughter plants play a significant role in spreading zoonotic agents. During processing poultry meat can be contaminated by intestinal bacteria and also from the feathers. So hygienic condition and personal safety within the slaughter house should be strictly maintained for controlling micro-flora of slaughtered animals. Processing and production plant of poultry meat should apply GHP (Good Hygienic Practice) conditions, which can be based on a HACCP plan. Poultry meat and carcasses should be refrigerated and consumed immediately after slaughter to reduce the risk of pathogens multiplying on carcass.

Potential dangers may exist in fresh food from poultry origin. So, both the retailers and consumers should maintain kitchen hygiene, proper heat treatment, proper chilling, packaging and storage, as frozen meat products are not always pathogen free such as Listeria release toxin at freezing temperature. Moreover, consumers should avoid date expired products, spoiled meat and egg and practice good hygiene before consumption for reducing health hazards.

# Quality assurance and control of poultry feed to ensure food safety

K.-J. KÜHLMANN
Trouw Nutrition, Asia Pacific, Bangkok, Thailand
E-mail: kai.kuehlmann@trouwnutrition.com

*Dr. sc. agr. Kai-Jens Kühlmann is the Technical Commercial Manager, Feed Quality, at Trouw Nutrition and is an Integral part of its Asia Pacific Technical team based in Bangkok, Thailand. He is a Technical Applications Manager experienced in research and usage of feed additives, more specifically organic acids, in the livestock and aquaculture industry. Currently his work is focused on implementing mycotoxin management, feed-mill hygiene and feed production efficiency solutions. Dr. Kai obtained his M.Sc in Ichthyology from Humboldt University of Berlin and PhD in Animal Nutrition from University of Honenheim, Germany. He served as Engineer, Inland Fisheries & Fisherman, Germany and a Lecturer at several Universities and Colleges in Germany and the Philippines. He has more than 25 years working experience in Asia; 12 years in the Philippines and 9 years in Thailand. Before joining Trouw Nutrition in January 2015, he was a Technical Advisor on coastal resource management with the German Development Service in the Philippines. Dr. Kai has more than 75 publications including technical papers, books and movies. He served as a reviewer of original research for aquaculture and animal science journals. He has two children and is multi-linguistic.*

Global contemporary animal production quadrupled during the past 50 years and totaled in about 315 million MT of meat in 2016. Asia is the main animal production center and has leading responsibility and contribution to decreasing the world hunger by 2050. In more detail, the world's population will increase by about 30% to 9.1 billion by 2050 with most of its population in developing countries. Urbanization will continue worldwide to reach 70% by 2050 compared to 49% today. In order to feed this larger and more urbanized population, global food production needs to increase by about 70% consisting of an annual cereal production rising to about 3 billion tons (from 2.1 billion today) and an annual meat production to 470 million tons, respectively (FAO 2009).

Considering, however, the annually declining growth rates of major cereal crops globally, the agricultural sector needs to develop new technologies to manage declining natural resources (land, water), climate change and habitat preservation with intensified, but safe feed to food production. To manage these generally outlined challenges we need to produce more from less land with fewer hands resulting to an estimated 1 billion tons annually as to comply with the increasing demand on animal protein in agricultural husbandry (livestock, dairy and aquaculture) (IFIF 2012).

Leading agricultural companies strive to new program-oriented technologies in the premix and feed additive market by providing a unique combination of poultry specific solutions, precision nutrition models and costumer tailored services in feed to food safety, thereby boosting high quality animal feed production and farming in the Asia-Pacific region. With Nutrace – a quality assurance package – global feed ingredient supplying companies assure feed to food quality and safety through its pillars of (i) regulatory affairs, (ii) ingredient evaluation, management and monitoring, (iii) risk management as well as (iv) tracking and tracing. This leads to guarantee best standards based on strict control measures thereby, limiting hazard risks in feeds, animal nutrition and safeguarding quality and nutritional value.

Bangladesh weather exposes local and imported feed raw materials to a high risk of microbial contamination, mold and mycotoxin development with concomitantly increasing feed market demand at its expanding poultry industry. Often, reduced feed intake and daily weight gain accompanied with severe diseases, high mortality and inefficient feed conversion or poor reproduction results in heavy economic losses to the animal producing

farmer or integrator caused by feed safety issues of mold, enterobacteria, salmonella or mycotoxin contamination. To safeguard high pellet and mash feed quality, production areas such as feed mill, farm and laboratory are scanned to determine microbial and mycotoxin occurrence at feed raw materials and finished feeds as one of the services to obtain feed mill hygiene in strong partner's collaboration.

Aside from increasing animal production efficiency, but to keep the increasing consumer demand at high-quality food chain, environmentally sound socially responsible and economic viable production schemes in reducing antimicrobial resistance though antibiotic growth promoters (AGP)-replacement need to be established. Here, the integration of feed, farm and animal health management is at stake to support gut health and immune modulation.

Combining quality assurance and control with the feed to food safety programs presently in development encompasses concepts, products and nutritional know-how contributing to the ultimate human goal of 'Feeding the Future'.

# Quality management system for processed poultry products and food safety

SYED SAYEEM UDDIN AHMED

Department of Epidemiology and Public Health, Sylhet Agricultural University, Bangladesh

E-mail: ahmedssu.eph@sau.ac.bd

*Syed Sayeem Uddin Ahmed was borne in 1978, in Habiganj, Bangladesh. He obtained his first degree in veterinary medicine from the University of Chittagong, in 2003. He received his master degree in Epidemiology from the University of Utrecht in 2007, and Ph.D. in Epidemiology from the University of Copenhagen in 2012. Dr. Ahmed completed his postdoctoral training at Technical University of Denmark from 2014 through 2015. Dr. Ahmed received several fellowship and awards through his academic career. Besides the formal degree programs, he joined a series of continuing professional development training in epidemiology and health economics, offered by reputed institutes including Imperial College London. Dr. Ahmed has an excellent track record of research productivity given his years of experience. He has authored or co-authored 40 peer-reviewed journal articles. The majority of them are in infectious disease epidemiology. Further, Ahmed contributes as a reviewer for several peer-reviewed journals including The Journal of Infectious Diseases and Emerging Infectious Diseases. Besides, he is the member of several professional organizations. Ahmed's research interests are infectious disease epidemiology and ecology, spatiotemporal epidemiology, register-based epidemiology, quantitative epidemiology and modeling. Dr. Ahmed has worked for several international organizations over last eight years as an epidemiologist. At present, he is working as a Professor of Epidemiology at the Department of Epidemiology and Public Health, Sylhet Agricultural University.*

The primary goal of poultry processing is to produce human food, more specifically to meet the demand of the dietary protein requirement. Concerning food safety, raw poultry and processed poultry products are among the highest-risk categories, as evidenced by frequent recalls and safety scandals that impact public health (Hoffmann et al., 2017; Alan and Christine, 2010; Bean and Griffin, 1990). Processed poultry have often been connected to the outbreak of foodborne illnesses (Hoffmann et al., 2017). Thus, the safety of processed poultry product regarding public health is an utmost important component in modern days food industry. The term "processed poultry product" includes a range of poultry products – namely, a slaughtered carcass to a further processed product such as sausage, fillet, hot wings, nugget and so on. Consumer demand for variety is forcing constant expansion of the processed poultry product range. Thus, a variety of manufacturing processes are used for poultry processing. Poultry processing is a complex phenomenon that combines biology, food chemistry, process engineering, product marketing, and economics (Alan and Christine, 2010). Given the complexity of the production process, sophisticated quality management is needed to ensure that every component maintains its quality and safety through all stages of poultry processing, packaging, transportation and storage.

There is much misinterpretation about quality management system of processed poultry product. People differ on what it is and how it can be achieved. Though everyone favors quality management of processed poultry product, quality management of poultry processing remains elusive. Quality management has two components, quality assurance and quality control. Both form an integral part of the quality management system of poultry processing. Quality assurance resides independent of manufacturing and operations, and quality control resides within manufacturing and operations. Quality assurance is sets of proactive activities and intended to prevent the production of noncompliant poultry products. On the other hand, quality control is reactive activities, designed to detect and set aside noncompliant poultry products using inspection and testing.

Quality assurance aims to prevent defects, from entering the total value chain of poultry processing (farm to fork) in the first place, through process management (ViaeneandVerbeke,1998). The quality assurance shall be

focused on planning, documenting and agreeing on a set of guidelines that are necessary to assure the quality of poultry products. With proper planning, provision can be made for safe input materials and total production process. In the sourcing ingredients and monitoring manufacturing operations, safety, traceability, quality, and welfare are the key considerations. Quality assurance planning should potentially consider, letters of guarantee for all ingredients and incoming goods inspections; calibration program for essential testing equipment; self-inspection reports; waste removal program; air filter cleaning and replacement program, condensation prevention and removal plan; pesticide and chemical storage requirement; metal detection procedures, truck trailer inspection; grounds maintenance program; pest control program and documentation; good manufacturing and good hygienic practice audit; file of product-testing results; packaging and label auditing; cold chain management of finished products, visiting customer establishments, shelf life studies; customer complaint file and a functioning recall program. Also, an emergency response plan that includes product testing and disposition procedures.

As stated earlier, quality control inspects and tests the product conformance against desired quality levels. A range of inspection and testing services is required for providing accurate and reliable information about the quality and safety of poultry products. Quality control inspection and testing protocols should be based on extensive know-how, regulatory standards, and in-house specifications. Obvious monitoring may include microbiological, chemical, nutritional tests and sensory testing (organoleptic) of product. Quality control task in poultry processing typically includes meat identification, freshness control, grading, identify residues and biotoxins, process control, standard size control, defectives check, shelf life and stability study, identifying indicator organisms and pathogens and nutritional profiling. The samples need to test are range from raw poultry, further processed, fully cooked, mechanically separated chicken and blood samples for antibody titers.

Poultry processors should follow some quality management system either as defined by the self-developed system or current quality programs used in the industry. Some commonly used quality management system in the industry is Total Quality Management (TQM), zero-defect systems, six sigma, and other programs (Douglas, 2010). Regardless of self-developed system or current quality programs used in the industry, the processor should maintain comprehensive quality management manual that includes quality assurance and quality control and other functions for the use of the stakeholders of the company. The manual could be used for training of the newly recruited employees, customers as well as for auditors or regulators. Overall, quality management system ensures excellent quality and hygienic practice throughout the value chain to meet the perceptions and expectations of desirable quality by consumers and regulatory bodies at a competitive price.

The quality management system is essential aspects of poultry processing yet overlooked by many poultry processors. The quality management system should potentially help to mitigate food safety risks, ensures high-quality products, meet customer specifications, provide confidence to customers and overall aid in the growth of the business. Thus, poultry processors should encompass some quality management system for their production process.

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World's Poultry Science Association - Bangladesh Branch

**World's Poultry Science Association-Bangladesh Branch**

Mega Domicile, Flat: B-6, House: 91, Road: 04, Block: B
Niketon, Gulshan-1, Dhaka-1212, Bangladesh
Email: info@wapsa-bb.com  Web: www.wpsa-bb.com