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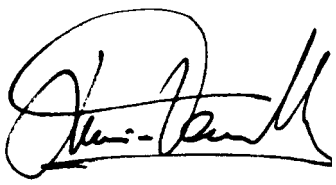
EDITORIAL

As we begin a new year we traditionally review the past and plan for the future. We should define our future expressing our individuality and creativity in our actions. We may be tempted to base our activities simply on the anticipation of profit. Our world is changing so rapidly. However, that we must pause and reflect on our goals and responsibilities.

This year especially, we cannot afford to measure our success from a strictly economic prospective. We should examine our fundamental values and attempt to be more constructive and creative for the sake of humanity. We often read of the famous who follow the same path to financial and political acclaim. Their standards and objectives may be inappropriate to the challenges facing us in the context of global financial crisis.

In our world of increasing specialisation, where action is dictated more by numbers than sentiment, where our decisions, and values run the risk of being reduced to figures on a balance sheet, there is only limited consideration for those who follow not only motives of profit, but also think with their hearts.

With the extensive resources at our disposal, we must strive to define our future role in the advancement of society and express our individuality and creativity in our actions.



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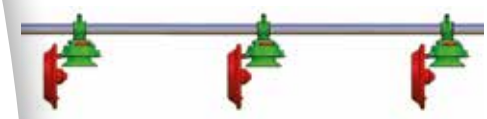

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SUMMARY

The Pirbright and Roslin Institutes funded to create a Marek's Disease vaccine

The Pirbright Institute has recently been awarded joint funding with The Roslin Institute to research how the deadly Marek's disease virus (MDV) causes tumours in poultry, and create a more effective vaccine.

MDV is highly contagious and is a major threat to the poultry industry, with losses estimated to be up to $2 billion worldwide. Nearly 22 billion vaccine doses a year are used in an attempt to control the disease, but the virus continues to evolve and form increasingly virulent strains.

The funding, awarded by the Biotechnology and Biological Sciences Research Council, will allow the Pirbright and Roslin researchers to understand the pathways involved in tumour creation during MDV infection. Dr Yongxiu Yao, leader of the research, said: "*By using the CRISPR/Cas9 gene editing system we intend to disrupt the gene for a virus protein called Meq, which previous data has suggested is a tumour inducing factor. By editing the Meq gene and disrupting its binding with other proteins, we will be able to have a clearer understanding of the pathways involved in tumour formation, which will help us to create better vaccines*." The modifications to the virus that the Pirbright team makes will be analysed by Roslin researchers to identify the major pathways that are most essential for tumour production and indicate the best targets for future vaccines.

The evolution of highly virulent MDV strains has proven extremely problematic for the poultry industry, as many of the vaccines currently used do not induce sufficient protection against infection. The scientists will therefore investigate Meq's role in a highly virulent strain and will attempt to reduce its virulence by deleting and swapping the Meq gene. If the alteration of the Meq gene in these strains is successful, it could pave the way for a new vaccine that is able to protect against the most destructive strains of MDV. This in turn would improve poultry welfare and cut losses to the poultry industry.

EU scientific opinion on antimicrobials

How to assess progress on reduction of antimicrobial resistance and consumption of antimicrobials.

A set of indicators will assist European Union (EU) Member States to assess their progress in reducing the use of antimicrobials and combatting antimicrobial resistance. These indicators have been established by the European Food Safety Authority, the European Medicines Agency and the European Centre for Disease Prevention and Control, following a request from the European Commission.

The indicators address both the human and animal sectors and they reflect antimicrobial consumption and antimicrobial resistance in the community, in hospitals and in food-producing animals. The indicators are based on data already gathered through existing EU monitoring networks.

Examples of indicators to assess antimicrobial resistance in human medicine include the proportion of *Staphylococcus aureus* bacteria that are resistant to methicillin (MRSA) and the proportion *Escherichia coli (E.coli)* bacteria that are resistant to third-generation cephalosporins. These two pathogens are of major public health importance. For veterinary medicine, an example indicator is the proportion of *E. coli* bacteria from food-producing animals that are susceptible or resistant to a number of antimicrobials. In terms of consumption, the suggested primary indicators are the human consumption of antimicrobials, and the overall sales of veterinary antimicrobials.

The indicators, presented in the form of a scientific opinion, are the result of close cooperation between the three EU agencies, each drawing on their specific expertise and data from monitoring of antimicrobial resistance and antimicrobial consumption in animals and humans.

Tenth annual Animal Agriculture Sustainability Summit returning to 2018 IPPE

Reflecting the continuing importance of sustainability to the future of animal agriculture, the 10th Animal Agriculture Sustainability Summit returned to the 2018 International Production & Processing Expo (IPPE) in Atlanta.

The summit, sponsored by the U.S. Poultry & Egg Association (USPOULTRY), focused on current sustainability topics relevant to the animal agriculture industry.

Topics discussed included: A Review of Top Sustainability Concerns for the Animal Agriculture Industry; Meeting Growing Global Pork Demand Sustainably; U.S. Roundtable for Sustainable Beef: Gaining Momentum; Advancing Dairy's Sustainability Framework for a Changing Global Landscape; A Broiler Production Model for Estimating Environmental Footprint; and a panel discussion.

The summit concluded with a ceremony announcing the winners of USPOULTRY's Family Farm Environmental Excellence Awards for 2018.

European commissioner for health & food safety visits former foodstuff processing facility

On 28 November 2017, EFFPA (the European Former Foodstuff Processors Association) organised a factory visit for European Commissioner of Health & Food Safety, Mr Vytenis Andriukaitis, to Agrifirm in Veghel (The Netherlands) to provide a first-hand introduction to former foodstuff processing. Former foodstuff processors transform foodstuffs no longer suitable for commercial human consumption into high-quality animal feed. Examples are broken biscuits, incorrectly shaped chocolates or incorrectly flavoured crisps.

After the visit, **Commissioner Andriukaitis** said: *"I am very satisfied with the visit. It is always useful to see how things are done one the ground. The notion of 'circular economy' becomes very tangible. Indeed, thanks to the top technology you have it in action - a broken biscuit is transformed into safe feed for animals. This is one way of how circular economy works and how food waste is prevented"*.

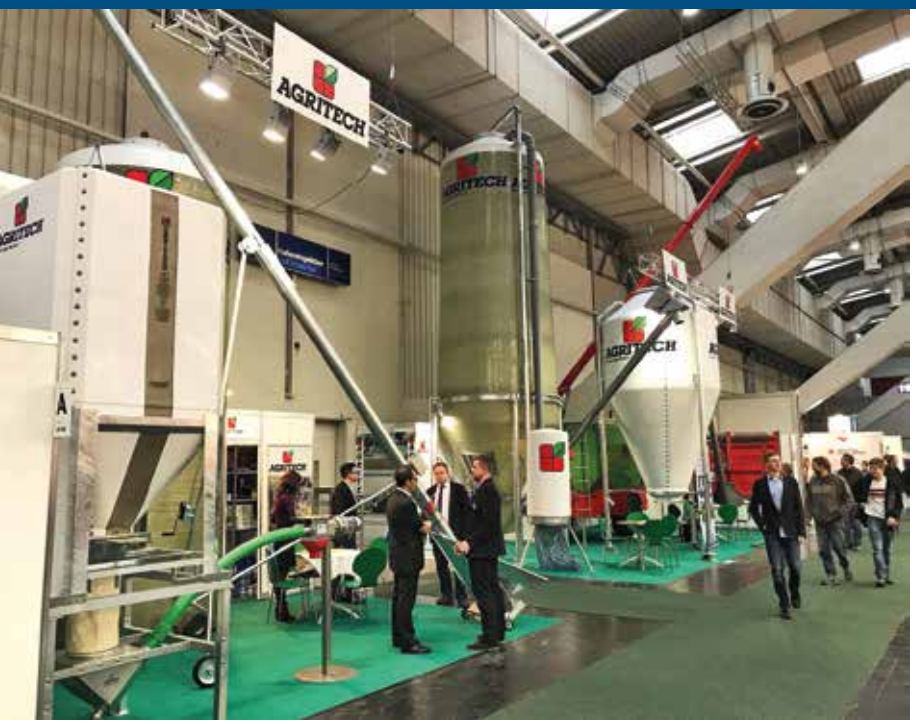
For EFFPA the visit was another milestone in its existence as a sector-representing organisation. **EFFPA President Paul Featherstone**: "*The possibility to showcase the role of former foodstuff processing in the circular economy to European Commissioner Andriukaitis further establishes us as part of safe and sustainable feed production. At the same time, we have clearly demonstrated former foodstuff processing is not in competition with food banks*".

The visit allowed to illustrate former foodstuff processing is an intrinsic part of the food-to-feed chain. EFFPA currently awaits the outcome of the 'trilogue' negotiations on the Circular Economy Package which is expected to confirm that former foodstuffs placed on the market as feed are clearly exempted from the Waste Framework Directive.

EFFPA

EFFPA, the European Former Foodstuff Processors Association, was founded on 1 January 2014. It represents 4 national associations (UK, NL, DE, FR), 3 full member companies (BE, IT, ES), 2 associate member companies (CA, US) and 1 observer company (GR). EFFPA estimates approximately 3.5 million tonnes of former foodstuffs annually are processed into animal feed in the EU. EFFPA estimates the turnover of the European former foodstuff sector industry was over € 1 billion for 2016.

www.effpa.eu



Agritech, twenty years at Agritechnica
The Calvisano company at the Hanover fair

For this company, specialists in the production of fiberglass silos, German sales account for 20% of company turnover. Over the past few weeks, in addition to their participation at Hanover, this relatively small industrial company guided by Floriano Zappettini, was also present at the Farmer Expo in Krasnodar (Russia) and at the Agrilink in Manila (Philippines).

The Agritech company, headquartered in Calvisano (Italy), specialists in the production of fiberglass silos and equipment for agricultural and livestock breeding operations, this year celebrated 20 years of participation at the Hanover Agritechnica Fair. This biennial international exhibition, considered the most important in the agricultural machinery business took place in the German city in November.

"*We are always present at this fair* – explains company **President Floriano Zappettini** – *because Germany is our principal export market valued at 20% of our turnover. Moreover* – he continued – *it is a meeting point for the entire worldwide agricultural mechanization sector*".

"*At Hanover* – adds **Export Manager Mario Ardenghi** – *we always meet distributors from all over the world and establish new business relationships*".

One of the products from the Agritech range that was particularly successful at the German show was their easily transportable small "Cubo" silos. These can be used in Northern Europe for non- agricultural usages such as storage tanks for the salt that is sprinkled on icy roads in wintertime.

Agritech which is about to end 2017 with increased turnover pursues its international ambitions by participating in trade fairs across the globe.

In the weeks preceding Hanover the staff from the Brescia company participated for the third time at the Farmer Expo in Krasnodar (Southern Russia) and for the first time at Agrilink in Manila (Philippines).

Product innovation and increased market share across world markets remain the company's watchwords.

"*We are about to conclude a year with revenues at least in line with 2016 if not slightly higher* – says Mr Zappettini – *helped along by exports but also by positive signs from Italy thanks to increases in milk and pig prices and the new Rural Development plan. We will continue on our path to have a presence in overseas markets as this has always been a reference point for the Agritech company. We were one of the first companies to believe in the Agritechnica Fair* – concludes the company President – *and will continue to do so given the ever-growing numbers that are recorded as being more than 450,000 visitors coming from 115 countries*".

AGRITECH

2.5 million eggs per week from Jamesway machines in Allen Harim's new hatchery

Allen Harim officially broke ground on October 25 to begin the construction phase of a new $22 million state-of-the-art hatchery in Dagsboro, Delaware.

The new 70,000 square-foot facility will be built on the company's 19.84-acre site on Nine Foot Road in Dagsboro. It will have an egg-set capacity of 2.5 million eggs per week. Using water reuse technology, up to 80 percent of the water used at the hatchery will be recycled. The machinery will be supplied by Jamesway Incubator Company Inc. and includes 60 Platinum 2.0 P120 Single Stage Incubators and 30 Platinum 2.0 P40 Single Stage Hatchers. Jamesway equipment fits into Allen Harim's vision, with incubators and hatchers that are the most energy efficient on the market and produce the highest quality of chick with machines that are reliable and easy to use. Jamesway is proud to be supplying the machines for this hatchery, which will also measure its operation's effectiveness with a view to sustainability and environmental consciousness. Jason Anderson, Area Sales Manager, credits the Jamesway name: "*Our customers know that when they buy our machines they are also buying our expertise and service. We are going to help our customer get to where they want to be*." This represents the 6th multi-million dollar hatchery for Jamesway in North America this year. The Dagsboro hatchery was built in 1973 by Cargill, and was purchased by the former Allen Family Foods in 1988. The 38,000-square-foot facility is being used as the backup hatchery for the company, due to the age of the equipment and the infrastructure. The new building's footprint will encompass the old structure, and require all new equipment and systems throughout. It will take about a year to build, and once it is operational, the company will close its main hatchery in Seaford, Delaware. Employees at both facilities will be offered jobs at the new hatchery or at other Allen Harim operations.

JAMESWAY

A new generation of EggsCargo Dividers

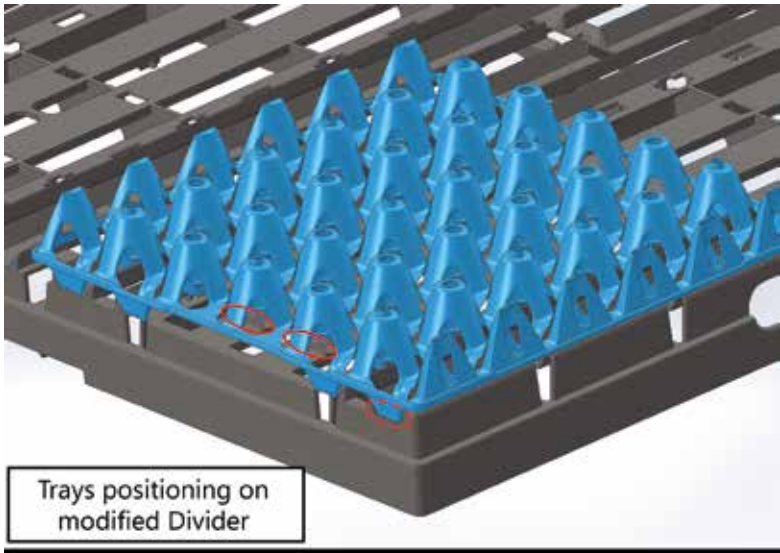
The robotised picking and packing of EggsCargo pallets and dividers has really taken off in the 18 years since the introduction of the EggsCargoSystem. There are now many companies around the world specialising in this branch of automation.

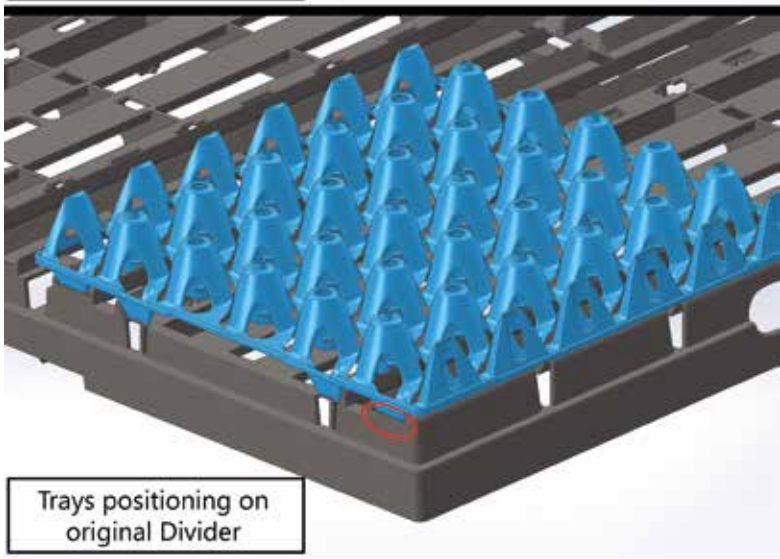
Because the various robots developed for this task are not all able to work to the same level of accuracy, a situation may arise where the stacks of trays cannot be placed within the gutter dimension of the divider. The difference may only be a matter of millimeters, nevertheless this can obviously lead to highly undesirable situations.

At Twinpack they have therefore decided to modify the Eggs-Cargo Divider. As it can be seen from the picture, they have removed the stoppers from the guide slots on either side of the divider, relocating these to the center of the guide slots. This creates a few millimeters of space for the stacks of trays, which solves the situation users have been facing in some cases.

"We are convinced that this new generation of EggsCargo Dividers will be an even better match for our customers' requirements"

Jacco Wagelaar,
Twinpack Special Products B.V. Managing Director





It is extremely important that the modified divider is compatible in all respects with other EggsCargo dividers on the market.

"We have tested the modified divider in use with the most common types of robot in use, and as far as we have been able to determine, it will not be necessary to modify existing robots. We also see no need to modify the working method for manual processing. The stack of trays will be restrained by the new stoppers, as was the case in the former situation.

We are convinced that this new generation of EggsCargo Dividers will be an even better match for our customers' requirements. The suppliers of robots will also welcome this development, as it will greatly simplify the adjustment of robots for use with the EggsCargoSystem.

Our hope is that the ongoing development of our EggsCargoSystem on behalf of our customers will allow us to continue to live up to our promise to be ***the world's most reliable system****", commented* **Jacco Wagelaar, Twinpack Special Products B.V. Managing Director.**

EGGS CARGO SYSTEM®

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Reaching full potential with Innova IMPAQT

A real-time impact on performance, availability and quality

A modern poultry processing plant is a complex network of interconnecting processes operating at high speed. It is particularly susceptible to the well-known butterfly effect where a small issue upstream can result in a much larger one downstream.
Empty shackles, whether they occur at hang-on or elsewhere in the process, are a good example of a lost profit opportunity. It is therefore crucially important that plant management has at its fingertips a tool, which can immediately pinpoint such issues and the reasons for them, allowing quick remedial action to be taken.

Marel Poultry's Innova IMPAQT software is just such a tool.

marel.com/impaqt

IMPAQT, the Intelligent Monitoring of Performance Availability and Quality Trends, is a development based on OEE, the industrial standard for measuring production effectiveness.

Minute by minute

By making information available real-time, IMPAQT takes the OEE concept much further. Sensors embedded in equipment from live bird handling through all departments right up to the end of the line continuously gather information, allowing data on performance, availability and quality to be analyzed and scored minute by minute. A 100% IMPAQT score means that there is no downtime, all equipment is operating at its designed capacity and turning out "A" grade end products.

IMPAQT presents its information centrally and by department on clear, easy to read dashboards. Historical data is also available, which allows current effectiveness to be compared to past situations. This helps ensure solid decision making, based on well-founded facts.

Pointing up losses

IMPAQT points up all losses and shows the way to an improved process. If there is an issue with any equipment anywhere in the plant, both the issue itself and its exact location will be immediately visible, allowing production management to draw up fast and effective plan of action. There is no longer any need to wait for written reports at the end of production. Valuable time is gained, as issues which could impact on productivity and profitability can be tackled straight away; IMPAQT is the only tool available in the industry to determine in real time the reasons for loss.

Innova IMPAQT software truly unlocks the full potential of a Marel line. It will also motivate production managers to keep on "upping their game". By impacting positively on performance, availability and quality, IMPAQT can save its users money right from day one.

Innova IMPAQT software IMPAQT points up all losses and shows the way to an improved process.

More on Marel Poultry

(https://marel.com/poultry-processing)

Marel Poultry is global supplier of innovative inline poultry processing equipment for broilers, turkeys and ducks, providing solutions for all process stages and all capacity levels. The product range includes top quality equipment for live bird handling, up to evisceration, giblet harvesting, chilling, grading, cut-up, deboning, bone detection, portioning, batching, end-product logistics, software solutions and service contracts.

DNA Influenza Vaccine licensed for chickens

AgriLabs® announced USDA conditional approval of the first DNA vaccine ever licensed for chickens. The approval also represents the first for AgriLabs' ExactVac™ DNA technology with ENABL® adjuvant, the first DNA vaccine approved for influenza for veterinary use, and among the first DNA vaccines approved in the United States for food animals.

The vaccine is produced by splicing a gene for a specific antigen related to an Avian Influenza High Pathogenic H5 subtype into a bacterial plasmid. The plasmid is then multiplied, purified and administered along with the ENABL adjuvant that improves vaccine delivery into target cells, where antigens produced by the plasmid elicit an immune response.

Realizing the promise of DNA vaccines

The conditional license for high pathogenic H5 will provide a tool for U.S. poultry producers if stockpiling is needed for future avian flu outbreaks. More broadly, this approval represents a significant step in development of an important new technology.

"*This is a major milestone in realizing the promise of DNA vaccines in animal health*," says Steve Schram, president and CEO of AgriLabs. "*Past DNA research for vaccines for food animals has failed to deliver efficacy, cost and convenience. We believe ENABL adjuvant technology has unlocked the key to DNA vaccines. DNA vaccines offer tremendous potential, and our ENABL technology is unique in its ability to help realize that potential*."

According to Schram, DNA vaccines can be tools in the fight against important and emerging animal diseases – via rapid response in vaccine development and production that's far faster than conventional vaccines.

In addition, DNA vaccines are attractive in that they don't expose the animals being treated to disease producing organisms and there is no risk of a modified pathogen mutating back to a virulent form. DNA vaccines also provide the ability to differentiate among infected and vaccinated animals (DIVA).

ENABL adjuvant technology helps realize that promise through more efficient delivery of DNA-based vaccines, which results in a higher absorption of the DNA vaccine and production of antigen, as well as broader immune response, Schram says.

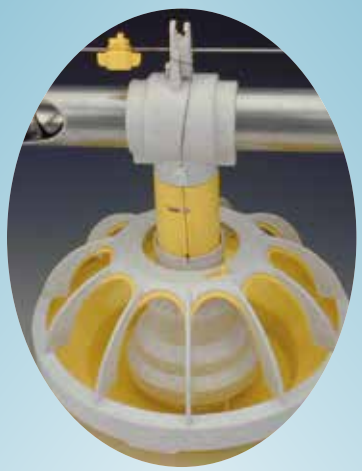
"*ENABL adjuvants feature a patented lipid/polymer matrix that allows for effective dispersion of vaccine micro-particles and more efficient delivery to target cells*," Schram adds. "*In addition to creating a 'micro-depot' effect, this means reduced dosing for DNA vaccines, which makes them economically viable options.*"

Opportunities for other species, licensing outside U.S.

The ExactVac DNA technology is applicable to other disease pathogens and animal species, including AgriLabs' next targets of swine influenza and opportunities in cattle production. AgriLabs is seeking partners to license the DNA technology outside the U.S. market for both food and companion animals.

"*The ExactVac DNA vaccine with ENABL adjuvant represents the next generation of biological innovation in animal health*," Schram says. "*AgriLabs is proud to be delivering this DNA-based innovation, which capitalizes on novel adjuvant technology and rapid-response diagnostics, to the market.*"

Our high-tech feeding systems are suitable for any age of animals



We offer a vast choice in the poultry breeding sector in order to meet the demands of modern animal production

Now we're able to meet any requirement also in the pig breeding and feeding sectors

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An overview of the Poultry CRC's achievements

The Poultry CRC - Cooperative Research Centres (CRC) Programme - commenced operation on 1 July 2003 ending on 30 June 2017. It has been a highly successful CRC, providing solutions to numerous key challenges facing the Australian poultry industry in the areas of research, education, communication, and outreach activities. In brief, it has tremendously enhanced the Australian poultry industry's capacity to travel down the path of sustainable growth well into the future. The following is a succinct summary of its achievements.

M. Choct L.M. Thomson and G.A. Fairy

Poultry CRC, University of New England, Armidale, Australia

Frontier science and state-of-the-art innovations

The Poultry CRC's investment in over 176 research projects has dealt with many pressing issues for the industry. As just one example demonstrates, the Poultry CRC has established over 30 rapid tests at the University of Melbourne's Asia-Pacific Centre for Animal Health, providing industry with a one-stop shop for swift diagnosis and enhanced disease surveillance. Turning to innovations, the Poultry CRC has achieved many breakthroughs, including the discovery of netB, a novel bacterial toxin, which overturned a 30 year dogma that alpha toxin is the causative agent of necrotic enteritis in chickens. At its peak, the

Poultry CRC held 57 patents, marking out its leading position in many areas of poultry science around the world.

Future leaders and workforce

The Poultry CRC has supported 16 interns, 25 postdoctoral fellows, 77 postgraduate students, and 33 honours students, as well as hundreds of students who have undertaken the three poultry specific undergraduate courses. These new industry entrants have significantly reduced the skills shortage in the Australian poultry industry that existed when the CRC started, and will be a source of industry leadership and essential skills for many years to come. The CRC's Avian Health Online course conducted through the University of Melbourne has enabled 39 poultry health professionals to upgrade their skills at either a diploma level or a master's level.

National network with global leverage

The Poultry CRC has constructed a highly effective collaborative network of participant research organisations informed by end-users. The collective expertise of the network generates innovative and unique research initiatives. It solves the problem of critical mass, where no single research institute in Australia has the expertise and facilities to solve the complex scientific and industrial problems the poultry industry will face in the future.

Research challenges

The Cooperative Research Centres (CRC) Programme was established in 1990 with the aim of encouraging private sector investment in collaborative research to deliver frontier science and practical solutions to industry problems. It also has a strong education component with a focus on producing graduates with skills relevant to industry needs.

The Poultry CRC successfully secured two terms of funding, with a total operational life of 14 years from 1 July 2003 to 30 June 2017. The aim of the first term CRC was "*to enhance the competitiveness of the Australian egg and chicken meat industries and supporting industries through the application of strategic programs delivering cost-effective and socially responsible production of safe, quality poultry products for domestic consumption and for emerging export markets".* The objective of the second term CRC was "*to help Australia achieve sustainable, ethical poultry production as population grows."*

The Poultry CRC is an industry-driven CRC and as such its research is primarily applied. The nature of applied research is that it creates incremental gains, rather than the quantum leaps that blue sky research produces from time to time. To address highly complex industry challenges, the Poultry CRC put together an integrated program of research, development and education. This involved the majority of end-users and researcher providers in Australia with significant international participation, covering all key facilities and expertise related to the research focus of the CRC. The mature and genuine collaborative network formed as a result has developed a holistic view of the poultry industry's needs and implemented many effective solutions to them.


© Global Meat News

CRC 1st Term - Australian Poultry CRC

The Australian Poultry CRC commenced operation with five core participants, Australian Egg Corporation Limited, Bioproperties Pty Ltd, Rural Industries R&D Corporation, the University of Melbourne and University of New England. Most key egg and chicken meat producers were also members of the Australian Poultry CRC. The focus of the Australian Poultry CRC was to increase productivity of the Australian poultry industries through the delivery of solutions in nutrition, vaccines and disease diagnostics, environment and welfare, and education and utilisation. A total of 106 research projects, 27 postgraduate students, 14 honours students, and 12 postdoctoral scientists were supported during the six years. The research projects delivered some

lasting solutions to industry. The examples include:

- The use of structural materials in feed to enhance gut health, leading to a paradigm shift in feed processing and presentation;
- Setting up the delivery of a comprehensive set of rapid diagnostics tests for poultry diseases at The University of Melbourne's Asia-Pacific Centre for Animal Health, cutting the time required for disease diagnosis from days to hours and creating a one-stop shop for industry diagnostic service;
- Commercialisation of Vaxsafe PM®, offering a unique live attenuated vaccine for the control of Fowl Cholera due to infection with virulent homologous or heterologous strains of *Pasteurella multocida*; and
- Production of a comprehensive set of teaching materials for poultry health, welfare, nutrition and environment, leading a solid foundation for delivering vocational education and training for the industry.

CRC 2nd Term – Poultry CRC

With overwhelming support from the industry and research partners, the CRC was successful in obtaining a second term of funding, which commenced operation in early 2010. Poultry CRC has three programs, i.e., Health and Welfare, Nutrition and Environment, and Food Safety and Egg Quality.

A total of 71 research projects, 50 postgraduate students, 19 honours students, and 13 postdoctoral scientists were supported in the Poultry CRC. It focussed on addressing practical problems facing the poultry industries, such as production and welfare of free range birds, addressing wet litter problems, identification of the spotty liver pathogen, the use of canola seeds and meals in both layer and broiler diets, minimising avian flu risks, mitigating waste streams, addressing skills shortage and extension. In addition, the Poultry CRC continued the work done previously on a number of vaccines, including:

- Development of an ILTV vaccine as well as live and killed versions of a necrotic enteritis vaccine;
- Investigation of a potential *Campylobacter* vaccine;
- Extensive evaluation of *Salmonella* vaccines; and
- The delivery of an MG vaccine and a haemorrhagic enteritis vaccine for turkeys (both for minor use).

Internships, vet sector, and schools program

As the Poultry CRC's education program was summarised earlier, this section only covers internship, vocational education and training (VET), and schools programs. In the year 2000, when the idea of submitting a CRC proposal for the poultry industry was first canvassed, one of the common issues identified was the difficulty for the poultry industry to attract veterinarians. In order to help industry with this issue, an industry internship program was introduced shortly after the commencement of the Australian Poultry CRC. Despite establishing the framework, it took five years' of stellar effort by some of dedicated industry veterinarians to attract the first interns. As of 2016, the Poultry CRC has attracted 16 interns with 10 of them continuing to work in the industry with an additional 2 working in academia.

Poultry CRC also sponsored the Avian Health Online course at The University of Melbourne. This course enabled 39 poultry health professionals to upgrade their skills to either masters or diploma level. In conjunction with the TAFE NSW New England Institute in Tamworth, the Poultry CRC developed extensive resources for the delivery of VET courses across the country. Employees of many of their industry partners took up training at Certificate III level to further their skills and employment in the poultry industry. In addition, the produced Teachers' Resource Kit has been used by nearly a thousand schools throughout Australia.

Furthermore, the CRC has collaborated with the NSW Department of Education to produce "Keeping Poultry in Schools" video series, which have been made available to all schools in Australia via YouTube and other channels. "Chicken Embryo Development" animation, which was funded from part of a grant received from the WPSA for outreach activities, is a standout educational tool with over 2 million views on YouTube.

Utilisation and extension

The Poultry CRC's approach to research and education is to produce products that are of use to the Australian poultry in-

"The Cooperative Research Centres (CRC) Programme was established in 1990 with the aim of encouraging private sector investment in collaborative research to deliver frontier science and practical solutions to industry problems"

dustry. It was realised from the start that increased utilisation of CRC research and education outcomes could only come from effective two-way communication between researchers and industry. This is because real solutions are much more likely to arise if researchers start with a clear understanding of the problems the poultry industry faces. Therefore, the Poultry CRC has had a heavy emphasis on end-user involvement in identifying pressing issues, evaluating projects and selecting students. This approach has helped the CRC focus on transferrable projects and intellectual property capable of commercialisation. Thus, in the Poultry CRC, utilisation and extension are viewed as two overarching areas, embedded in as many research and education projects as possible. The Poultry CRC knows that communication underpins its public and industry interface. It places great importance on events like the Australian Poultry Science Symposium, Poultry Information Exchange (PIX), the AECL Industry Forum, and its own Ideas Exchange as these are great forums that facilitate lasting interactions between researchers and industry. Of course, the electronic newsletters (eChook), mailouts (Chook Run; final reports; factsheets), and face-to-face meetings are also important features of the Poultry CRC's communication strategy.

The Poultry CRC foundation will act as a stable platform from which the next generation industry leaders and scientists the Poultry CRC has produced will drive the industry forward in a sustainable manner. In addition, a transition body, Poultry Hub Australia based at the University of New England, will maintain and expand the collaborative network established by the Poultry CRC to serve the poultry industry's research and educational needs into the future.

From the Proceedings of the 2017 Australian Poultry Science Symposium

The USA on their way to cage-free egg production

The Lone Cactus Egg Farm in Bouse (Arizona)

Hans-Wilhelm Windhorst

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In June and July 2017, the Author had the chance to visit new large cage-free egg farms in Texas and Arizona. The main results of this research project are presented in two papers. The first paper (see Zootecnica International, December 2017 issue) presented the Red River Valley Egg Farm in Bogata (Texas). This article will focus on the Lone Cactus Egg Farm in Bouse (Arizona).

- field cases -

The Lone Cactus Egg Farm in Bouse (Arizona)

When driving from Santa Fe via Sedona in a south-westerly direction, a wide plain opens after leaving the mountainous region. The semi-arid plain is only sparsely covered by Creosote bushes, Yuccas and cacti. Only a few irrigated areas interrupt the semi-desert. Parallel to State Highway 72 which leads to the west, runs a railroad spur. Suddenly, the white buildings of the Lone Cactus Egg Farm show up on the right. The hot air is whirring and one understands why the Spanish conquistadores called this region Arizona (dry land). The closest village is Bouse with only 125 inhabitants. It is an agglomeration of degraded houses and trailers without any infrastructure. Larger cities are Wickenburg with 7,100 inhabitants, 160 km to the East, and Needles with 5,000 inhabitants, 160 km to the West. Most of the 120 employees commute daily from small settlements in a distance to the farm of 50 to 70 km.

Rose Acre (Seymour, Indiana), the owner of the egg farm, chose this location in a semi-desert far away from larger settlements for several reasons. The isolated location without any other egg farms reduces the risk of the introduction of the Avian Influenza virus considerably. During the AI outbreaks in 2015, Rose Acre lost almost one quarter of its laying flocks. Other reasons were the comparatively short distance to California, the main market for the produced eggs, the railroad spur and the availability of underground water, because of the closeness to the Colorado River.

Because of the high losses resulting from the AI virus in 2015, the biosecurity has reached a very high standard. When entering the farm premise, a security person asks about prior visits to egg farms, the car is disinfected and the buildings can only be entered with an overall and after hand disinfection.

Photo 1 - The construction of a layer barn using the "wrap-in" method (Photo by Author)

Photo 2 - Pullets are raised in aviaries in the layer barn (Photo by Author)

"Rose Acre (Seymour, Indiana), the owner of the egg farm, chose Bouses, in Arizona, for several reasons. The isolated location without any other egg farms reduces the risk of the introduction of the Avian Influenza virus considerably"

A new way in building an egg farm

After the purchase of 800 hectares in 2014 and the construction of a road to the future location of the farm, building the barns started in 2015. In fall 2016 the first house was populated with white hens. The short time between starting the building and populating the barns is a result of a new way in erecting layer farms. It was developed by Summit Livestock Facilities (Remington, Indiana) and is called the "wrap-in method".

In contrast to Europe, where the building is completed first and the equipment installed afterwards, the "wrap-in method" goes the opposite way. The construction begins with the equipment (*Photo 1*). Once it is completed, it is wrapped in by the side-walls and the roof. This method reduces the construction time considerably.

A barn with 400,000 places can be erected within three to four months. It also permits an earlier population of the houses. The equipment has also static functions which allows lighter walls and so saves costs. After completing the sixth barn, the whole farm will have 2.4 mill. layer places.

Photo 3 - The three-level aviary in the Lone-Cactus Egg Farm (Photo by Author)

An unusual way to raise pullets

The egg farm in Bouse does not need pullet farms because of a new way of raising them. This method was developed by Marcus Rust, president of Rose Acre, in co-operation with FACCO, the Italian equipment company, and the Humane Society of the United States, the leading animal welfare organization in the USA.

The farm has three stories, each story large aviaries with three levels. In compartments which can be closed by wire mesh doors, the one-day old chicks are raised until week 16 (*Photo 2*). Then the compartments are opened and the pullets can move in the whole aviary (*Photo 3*). Until day 8, the chicks are kept on chicken paper and fed by hand. Then the paper is removed and the chicks feed and drink from the feed troughs and nipple drinkers. This new way of raising pullets has been very successful according to the farm manager. The pullets have not to be moved from the pullet houses to the layer barns. This reduces the stress and results in a very low mortality rate of only 0.8%.

The produced eggs are transported via conveyor belts directly to the processing building where the eggs are washed, graded and packed (*Photo 4*).

Further steps

The sixth barn has been completed in late fall of 2017 and then populated. From the adjacent railroad spur, a loop with a diameter of 1 km has been built to the already completed feedmill. The loop makes it possible to unload a whole train with up to 100 cars, each containing about 30 t of corn or soybeans. The silos, which have also been completed at the end of 2017, can store about 6,000 t. After completing the loop and the silos, the feedmill started production and it was then no longer necessary to haul the feed from Buckeye over a distance of 160 km.

A flat lagoon will be built to store the water which is need for cleaning the barns and washing the eggs. Because of the high outside temperatures in summer (over 40°C), high evaporation rates are expected which will make a spreading of the water unnecessary. A lake in a semi-desert could be attractive to wild water fowl. Because of the distance of 160 km between the farm and Lake Havasu, a reservoir, the risk of migrating wild birds entering the premise is, however, low.

Low egg prices do not cover production costs

In July 2017, the production cost for white large eggs ranged between 85 and 90 $-cents. To produce one dozen of eggs, 1.8 kg of feed was needed, resulting in a feed conversion rate of 1.9. Despite the good results, the prices which were received at farm gate did not cover the production costs. Because of the oversupply in the U. S. egg market, about 90% of the eggs had to be sold with a considerable loss in California, and only 10% could be sold as cage-free eggs to a cost-covering price.

The eggs, delivered to California, were marketed under the label "California approved". This regulation requires that the available space per hen is at least 750 cm^2 and that the hens were vaccinated against *Salmonella*. The available space per hen in the farm is higher with 900 cm^2. This makes it possible to market the eggs also in states which in future will request a larger available space than 750 cm^2.

Photo 4 - Egg washing, grading and packing (Photo by Author)

Because of the unsatisfactory economic situation, the plan to build another farm of the same size about 10 miles west of the present location was postponed. Construction will not begin before the prices received at farm gate will cover at least the production costs. The farm manager expected that this balance will not be reached before the second quarter of 2018.

What about the future of cage-free production?

The present economic situation on the U.S. egg market is confusing. Despite the statements of more than 200 companies to no longer sell or use eggs produced in conventional cages from 2022 to 2025 on, the produced cage-free eggs obviously surpass demand. The economic losses for the companies which already installed the new housing system are considerable and, with a few exceptions, they have stopped further investments. To make profit again, the number of table egg layers and of egg production have to be reduced. At the moment is seems as if the benchmark of 71% of all layers in cage-free systems in 2025 will not be reached. For this would require the construction of 12 and 15 million cage-free layer places per year.

How many new non-cage layer places will be built over the next years will also depend on the willingness of the consumers to accept the considerably higher egg prices. At the moment, most of the consumers stick to the lower prices for eggs produced in conventional cages. The estimate of the Author is that in 2025 between 45 and 50% of the eggs will produced in cage-free farms.

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Alternatives to antibiotics in organic poultry

Novel strategies to reduce foodborne pathogens

Organic poultry production is one of the fastest growing segments of organic agriculture with a 20% average annual increase since the establishment of the National Organic Program (NOP). Interest in these products has shifted from being a lifestyle choice for a small share of consumers to being consumed at least occasionally by two-thirds of Americans. Organic poultry meat is the most commonly available and consumed organic meat product, followed closely by eggs, preferred by over 70% of consumers.

The latest census of agriculture reported that the top organic sector in sales was livestock and poultry. The sale of organic broiler chickens and eggs amounted to $372 and $420 million respectively, and annual sales are expected to continue growing. With increasing consumer demand for organic poultry and poultry products, producers are challenged to meet the growing demand and at the same time, facilitate sustained growth of the organic poultry industry by developing practical, effective and environmentally-friendly methods for improving food safety and quality of poultry products.

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Although most management practices in organic production are designed to promote bird health and prevent disease, the lack of consistent and long lasting organic therapeutics for enteric diseases can adversely influence bird health and wholesomeness of poultry products. Enteric diseases such as necrotic enteritis, and food safety concerns due to pathogens such as *Salmonella* and *Campylobacter,* are high priority issues for organic poultry producers.

While the conventional poultry industry is equipped with several interventions to control pathogens in broiler chickens, organic poultry producers have access to only a limited number of antibacterials that are safe, effective and approved for organic poultry production. Therefore, there is a critical need for developing strategies to promote gut health and limit disease/pathogens in organically-raised birds.

Through an Organic Research and Extension Initiative (OREI, NIFA) funded project, a team of poultry researchers from across the United States have collaborated to target this issue and provide organic farmers with viable, easy to implement solutions that improve poultry health and safety. Research from some laboratories indicates that plant-based, food-grade, natural and environmentally-safe compounds such as β-resorcylic acid, eugenol and carvacrol have significant antimicrobial efficacy against poultry pathogens and could address food safety and disease concerns in organic production systems.

Challenges for organic poultry producers

Since the central philosophy of organic agriculture is to reduce the impact of agriculture practices on animals, humans and the environment, organic farming restricts the use of synthetic compounds (e.g. antibiotics, hormones, pesticides, and herbicides) that could adversely affect the animals, environment and the public.

According to the Organic Farming Research Foundation (OFRF), complying with the organic standards is one of the most pressing needs of organic livestock and poultry production. *Salmonella* and *Campylobacter* are two major food-

borne pathogens epidemiologically linked to the consumption of chicken and eggs which together account for most of the laboratory-confirmed cases of bacterial gastroenteritis in the United States. Enteric diseases such as necrotic enteritis, and food safety concerns due to pathogens such as *Salmonella* and *Campylobacter,* are high priority issues for organic poultry producers.

Food safety implications

Each year, an estimated 48 million Americans (1 in 6) become ill from consuming contaminated foods or beverages. Both conventional and organic poultry products have been identified as important vectors for the transmission of two of the major sources of bacterial foodborne gastroenteritis: *Salmonella and Campylobacter*. Although organic food products may represent a safer alternative with regards to chemical contamination of the product, control of foodborne pathogens in organic poultry is particularly important because consumers of these products perceive them as being safer and choose them for children, the elderly and immunocompromised people. This is a concern for organic producers because they cannot control proper cooking and other food safety practices of consumers once the poultry products are sold.

Natural plant compounds and extracts have been an important component of most traditional medical systems and may offer an effective solution to address the food safety concerns associated with the organic poultry production. The specific extracts of these plants that possess the highest activity, include trans-cinnamaldehyde from cinnamon, thymol from thyme or oregano and eugenol from clove. Another alternative is caprylic acid, which occurs naturally in milk and coconut oil. These extracts have shown both *in vitro* and *in vivo* efficacy against the pathogenic bacteria *Escherichia coli, Staphylococcus aureus, C. jejuni, Salmonella* spp. and *Clostridium spp.* The team evaluated these natural, effective and safe alternatives to address health issues in birds, along with the prevention of foodborne diseases associated with poultry products. They tested these compounds due to their potential antimicrobial efficacy, their Generally Recognized as Safe (GRAS) status, and National Organic Program (NOP) allowed status.

The OREI project which has recently been completed investigated the efficacy of natural strategies, using numerous plant compounds for promoting gut health and controlling enteric diseases, including necrotic enteritis, and other pathogens in live chickens (*Table 1*). Results from the research indicated that the aforementioned natural compounds exerted a significant antibacterial effect on enteric pathogens in poultry, and offer

potentially safe and effective strategies for controlling pathogens in pre-harvest organic poultry and comply with NOP standards. This project has generated over a dozen published peer reviewed manuscripts. Members of the team introduced the online Organic Poultry Production Forum in the Livestock group topic in eOrganic (www.eorganic.info) and a Poultry Production group in their System group. A Community of Practice (CoP) at the eXtension website was established to make this information available to small, medium and backyard poultry producers and materials are being produced for dissemination through both websites. To date, more than 35 presentations and 63 webinars have been conducted, and hundreds of articles were published in eOrganic and eXtension.org/poultry.

Table 1 - *Plant compounds tested during the period of study and their sources*

Plant compounds tested by the OREI team	Source
Caprylic acid	Milk, Coconut oil
Thymol	Thyme *(Thymus vulgaris)*
Carvacrol	Oregano oil *(Origanum vulgare)*
Eugenol	Clove *(Syzygium aromaticum)*
Trans-cinnamaldehyde	Cinnamon *(Cinnamomum verum)*
Beta resorcylic acid	Angiosperms

For this presentation the Authors highlight some of the research findings and address future needs and directions for research.

The efficacy of the natural plant extracts

Thymol and Carvacrol against Campylobacter colonization in broiler chickens

The efficacy of natural plant extracts, such as thymol and carvacrol, have been tested against pathogens such as, *E. coli* O157:H7, *Salmonella* spp., *Shigella* and *Listeria monocytogenes in vitro.* However, information on their ability to reduce *Campylobacter* in chickens is lacking. The objective of this study was to determine the efficacy of a range of concentrations and combinations of thymol and carvacrol in the feed to reduce *Campylobacter* in broilers.

To evaluate *in vivo* efficacy, day old broiler chicks (n=10 chicks/dose) were fed 0% (controls) or selected doses of thymol or carvacrol or combinations of these compounds in feed throughout the study period. Birds were orally challenged with a five strain mixture of wild type of *C. jejuni* strains at day 3 and at day 10, cecal samples were collected for *C. jejuni* enumeration. Four trials were conducted in which birds were fed thymol or carvacrol or their combinations throughout the 14 day study period. *Campylobacter* counts were reduced for 0.25% thymol (Trial 1), 1% carvacrol or 2% thymol (Trial 2) treatments, or a combination of both thymol and carvacrol at 0.5% (Trial 3) in this study. These results indicate that supplementation of these compounds in the feed may control the colonization of *Campylobacter* in chickens but, additional research is required to develop treatment regimens that could assure consistent efficacy.

Investigating the efficacy of the natural compound

P-resorcylic acid, against C. jejuni colonization in broiler chickens

The objective of this study was to evaluate if P-resorcylic (BR) acid would reduce enteric *Campylobacter* colonization in birds. To accomplish this, day of hatch chicks (n=10 birds/treatment) were fed one of four treatments (0, 0.25, 0.5, or 1% BR) in two replicate trials. Birds were challenged with four wild strains of *C. jejuni* (approx. 10^6 CFU/ml) on day 7 and cecal samples were collected on day 14 and enumerated for *Campylobacter*.

Data were logarithmically transformed and treatment means were partitioned by LSMEANS analysis ($P < 0.05$). Supplementation of BR in poultry feed for 14 days at 0.5 and 1% reduced *Campylobacter* populations in cecal contents by ~ 2.5 and 1.7 Log CFU/g, respectively ($P<0.05$). No significant differences in feed intake and body weight gain were observed between control and treatment birds fed the compound ($P>0.05$).

These results suggest that BR could potentially be used as a feed additive to reduce *Campylobacter* colonization in broilers.

Effect of therapeutic supplementation of plant compounds

Trans-cinnamaldehyde and eugenol on Salmonella enterica serovar Enteritidis colonization in market-age broiler chickens

This study investigated the therapeutic efficacy of plant compounds, trans-cinnamaldehyde (TC) and eugenol (EG) on reducing *Salmonella enterica serovar Enteritidis* in commercial, market-age broiler chickens. The results suggest that TC and EG supplemented through feed could reduce *Salmonella Enteritidis* colonization in market-age chickens.

Evaluating the efficacy of two GRAS-status, natural antimicrobials

P-resorcylic acid and trans-cinnamaldehyde as in-feed supplements to reduce the carriage of Salmonella Heidelberg in broiler chickens

This study investigated the efficacy of two GRAS-status, natural antimicrobials, P-resorcylic acid (BR) and trans-cinnamaldehyde (TC) as in-feed supplements to reduce the carriage of *Salmonella* Heidelberg (SH) in broiler chickens. Two hundred, day-old chicks were randomly allocated to ten treatments (n=20); (1) a negative control (no SH challenge or supplemented compound), (2 and 3) BR controls (no SH, but 0.75 or 1% BR), (4 and 5) TC controls (no SH, but 0.5 or 0.75% TC) (6) a positive control (SH challenge, but no TC or BR) (7 and 8) BR treatment (SH and 0.75 or 1% BR), and (9 and 10) TC treatment (SH and 0.5 or 0.75% TC).

TC and BR were supplemented in the feed for 20 days, starting on day 0. On day 8, birds in the positive control, TC and BR treatments were challenged with SH (8 $\log_{10}$ CFU/bird) by

crop gavage. After 10 days of challenge, 10 birds per treatment (n=10) were sacrificed by CO_2 asphyxiation, and cecum, liver and crop from each bird were collected for SH enumeration. All TC and BR treatments decreased S. *Heidelberg* on day 1; 0.75% TC reduced the pathogen count to ~ 2.5 $\log_{10}$ CFU/ml compared to controls (P<0.05). TC (0.75%) and BR (1%) significantly decreased SH in the cecum to ~1.5 $\log_{10}$ CFU/ml and undetectable levels, respectively. All treatments were effective in reducing *S*. Heidelberg in liver and crop when compared to controls (P<0.05).

Significant findings from pilot studies on postharvest safety and future directions

Organic poultry processors have very limited strategies that are safe, effective and approved for reducing pathogens on poultry carcass and/or eggs, other than chlorine and peracetic acid. Incorporating a holistic and systems approach based on scientifically-validated natural interventions at critical points to control pathogens in the post-processing/handling chain of poultry products will not only support the organic production values and philosophy, but also strengthen the sustainability and economic viability of the organic poultry sector. This will significantly enhance food safety and quality of organically produced poultry meat and eggs, thereby improving public health. Preliminary research from team's laboratories indicates that plant- based, food-grade, natural and environmentally-safe compounds Authors used in their preharvest work have promise for postharvest meat and egg pathogen reduction. A few of the pilot studies showing efficacy are detailed below.

Evaluating the efficacy of P-resorcylic acid as a wash for reducing Campylobacter jejuni on chicken skin and meat

Post harvest trials were conducted in chicken thigh skin and meat samples using four treatment solutions (0, 0.5, 1 and 2% BR) made in Butterfield's phosphate diluent at 42 °C (n=10 skin or meat sample/dose). Samples were thawed to room temperature, inoculated with 50pl of four wild strains of *C. jejuni* (~10 CFU/ml) and were allowed 30 min for attachment. Samples were dipped in treatment solution for 30 seconds and *Campylobacter* populations were determined at 2 minutes after treatment. Data were logarithmically transformed and analyzed using SAS 9.3 (P<0.05). All of the treatments showed significant reduction of *C. jejuni* on chicken skin and meat samples. These results signify potential use of P-resorcylic acid in processing plant.

Evaluating the efficacy of eugenol (EUG) and carvacrol (CR) as a wash for reducing Salmonella on eggs

Previous research from team's laboratories indicated that several plant compounds were effective in rapidly reducing large populations of *Salmonella* on tomatoes and eggs. Research revealed that antimicrobial wash with plant compounds rapidly inactivated *S. Enteritidis* on eggs to below detection limit at 32 ˚C.

Conclusions

This research has led to the development of several effective and easy to implement strategies to promote gut health and limit disease/pathogens in these birds. As organic poultry producers have a limited number of safe, effective and approved organic strategies to prevent and treat health problems in their flocks, these findings have produced effective solutions. Results indicate that essential plant extracts have antimicrobial efficacy against poultry enteric pathogens. These compounds are permitted under NOP and address food safety and disease concerns in organic production systems. Further, these compounds potentially could also be used during post-harvest processing to reduce the prevalence of foodborne pathogens on post-harvest poultry products, however, more research is needed in this area.

Acknowledgments

These studies were funded in part by USDA-NIFA-OREI 2011-01955

References are available on request

From the Proceedings of the 2017 Midwest Poultry Federation

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Contours of change - global egg and poultry meat production in retrospect

In the past two decades, global egg and poultry meat production showed remarkable dynamics. The increase was not homogeneous, however, but led to considerable spatial shifts. This will be documented in the first part of a series of two papers. The second paper will then present a projection of the expected future dynamics.

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An overview on the dynamics of egg and poultry meat production between 1994 and 2014

Table 1 and *Figure 1* show that global egg production grew by 28.8 mill. t or 70.3 % between 1994 and 2014. In the same time period, poultry meat production increased by 62.0 mill. t or 121.8 %. To this increase, chicken meat contributed 56.7 mill. t or 91.5 %.

While the gap between egg and poultry meat production was only 10 mill. t in 1994, it was already as wide as 43.1 mill. t in 2014. When focusing on chicken meat only, the difference in the production volumes increased from 2.7 mill. t to 30.6 mill. t. Only these few data documents the remarkable success of chicken meat production, of which 90 % is broiler meat. It will have to be explained which factors caused the remarkably high growth rates.

Compared to chicken meat, the other poultry meat types are less important. Turkey meat

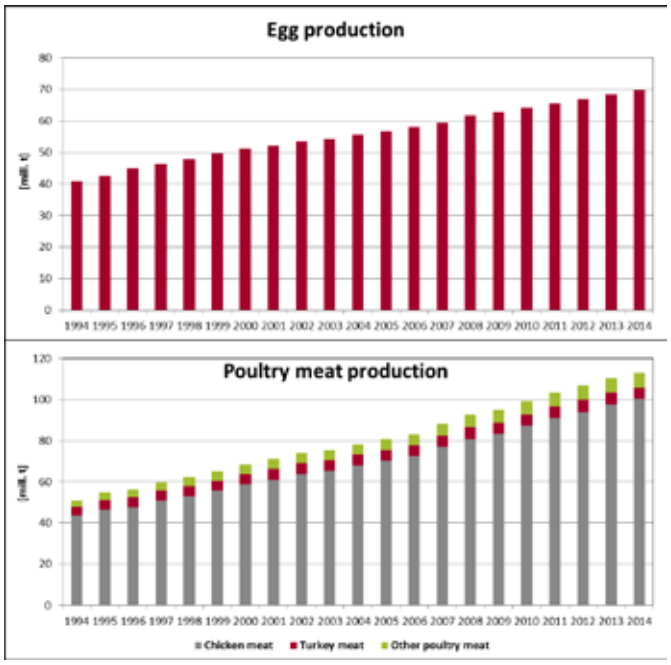


Figure 1 - *The development of global egg production between 1994 and 2014 (Source: FAO database)*

Table 1 - *The development of global egg and poultry meat production between 1994 and 2014, data in 1,000 t (Source: FAO database)*

Year	Eggs	Poultry meat total	Chicken meat	Turkey meat	Duck meat	Goose meat*
1994	40,976	50,917	43,688	4,252	1,894	1,064
2014	69,791	112,933	100,353	5,611	4,331	2,617
Increase (%)	70.3	121.8	129.7	32.0	128.7	146.0

** Includes meat of guinea fowl*

showed the lowest absolute and relative growth rates between 1994 and 2014 with 1.4 mill. t respectively 32.0 %. Without going into detail one can conclude that this is the result of the concentration of turkey meat production in the USA and some EU member countries with a comparatively high per capita consumption. Turkey meat is of only minor importance in Africa, Asia and Oceania.

Because of the dominance of chicken meat, the analysis of the dynamics in poultry meat production in this report will concentrate on chicken meat.

The development of global egg production

In *Table 2*, the development of global egg production at continent level is documented. The highest absolute and relative growth rates showed Asia. This continent alone contributed 70.2 % to the global increase.

In North America, the production volume grew by 3.1 mill. t or 51.3 %; in Central and South America by 2.7 mill. t or 93.2%. The lowest relative growth rate was to be found in Europe with only 14.1 %. Despite a remarkable relative increase, Africa only shared 4.4 % of the global production volume in 2014.

In contrast to Asia and Central and South America, Europa and North America were not able to maintain their share in global egg production. Europa lost 7.7 % of its share in 1994, North America 1.6 %; on the other hand, Asia gained 8.1 % and Central and South America 1.0 %. The spatial shift from Europe and North America to Asia and South America is obvious (*Figure 2*).

"Global egg and poultry meat production showed a remarkable dynamic between 1994 and 2014. Poultry meat production grew even much faster than that of eggs. The high absolute and relative increase of poultry meat production is mainly a result of the extraordinary dynamics in chicken meat production"

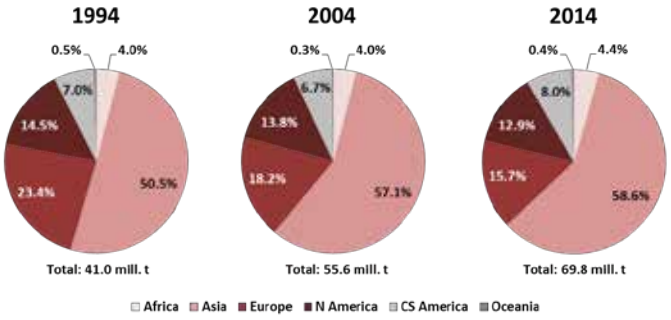


Figure 2 - *The changing contribution of the continents to global egg production between 1994 and 2014 (Source: own calculation)*

Table 2 - *The development of global egg production between 1994 and 2014 at continent base; data in 1,000 t (Source: FAO database)*

Continent	1994	Share (%)	2014	Share (%)	Increase (%)
Africa	1,651	4.0	3,054	4.4	85.0
Asia	20,710	50.5	40,925	58.6	97.6
Europe	9,590	23.4	10,940	15.7	14.1
N America*	5,959	14.5	9,016	12.9	51.3
CS America	2,872	7.0	5,550	8.0	93.2
Oceania	194	0.5	305	0.4	57.2
World	**40,976**	**100.0**	**69,791**	**100.9**	**70.3**

** Canada, Mexico, USA*

The global chicken meat production

The dynamics in global chicken meat production differed considerably from that in egg production as can be seen from the data in *Table 3*. Asia showed the highest absolute increase with 21.4 mill. t, but the contribution to the growth of the global production volume was much lower with 37.7 % compared to 70.2% in egg production. This is due to the remarkable growth of chicken meat production in Central and South America with 14.4 mill. t and the also considerable absolute growth in North America (+ 8.9 mill. t) and Europe (+ 7.9 mill. t).

Despite the high absolute increase in their production volumes, North America lost 7.7% of its share in 1994 and Europe 3.5%; in contrast, Central and South America gained 5.9% and Asia 4.5%.

While the contribution of Asia and North America to the global production volume was almost identical in 1994, chicken meat production in Asia and Central and South America grew much faster in the following two decades as can be seen from the relative growth rates of these two continents. With a relative increase of 220.6%, Central and South America showed an extraordinary dynamic. Despite the high relative growth, Africa´s share in global chicken meat production increased by only 0.7% (*Figure 3*).

In retrospect, the following contours of change can be identified:

- Global egg and poultry meat production showed a remarkable dynamic between 1994 and 2014. Poultry meat production grew even much faster than that of eggs.
- The high absolute and relative increase of poultry meat production is mainly a result of the extraordinary dynamics in chicken meat production. With a production volume of more than 100 mill. t, chicken meat surpassed egg production by over 30 mill. t.
- The success stories of these two commodities are a result

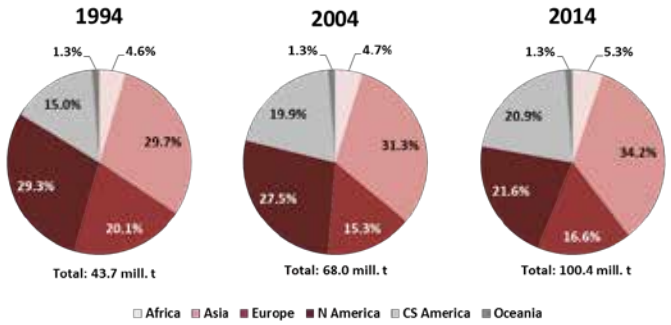


Figure 3 - *The development of global egg production between 1994 and 2014 (Source: FAO database)*

Table 3 - *The changing contribution of the continents to global chicken meat production between 1994 and 2014 (Source: own calculation)*

Continent	1994	Share (%)	2014	Share (%)	Increase (%)
Africa	2,014	4.6	5,353	5.3	165.8
Asia	12,984	29.7	34,354	34.2	164.6
Europe	8,787	20.1	16,692	16.6	90.0
N America*	12,812	29.3	21,700	21.6	69.4
CS America	6,532	15.0	20,940	20.9	220.6
Oceania	559	1.3	1,314	1.3	135.1
World	**43,688**	**100.0**	**100,353**	**100.0**	**129.7**

** Canada, Mexico, USA*

of progress in breeding, feeding and housing systems. In addition, the fact that no religious taboos speak against the consumption of eggs and poultry meat explains the fast globalisation of these commodities.

- In egg as well as in chicken meat production, a considerable shift from Europe and North America to Asia and Central and South America occurred in the analysed time period.
- In egg production, Asia reached a dominating position with a share of 58.6 % in the global production volume. In chicken meat production Asia also showed the highest absolute growth, but the relative increase was highest in Central and South America.
- Despite a considerable increase in their production volumes Europa and North America lost shares in global egg as well as in chicken meat production.
- It can be expected that because of the favourable feed conversion of laying hens and broilers, egg and chicken meat will gain in importance as protein sources for the alimentation of a growing global population.

The paper is abridged version of a special report which the Author prepared for the International Egg Commission (IEC)

Turkeys - Making the most of Genetic Potential

Successful and profitable turkey production occurs across a wide range of production systems and farming environments. Breed choice, farming facilities, equipment, management, nutrition and flock health have significant influences on flock performance.

Genetic Potential

Successful and profitable turkey production occurs across a wide range of production systems and farming environments. Breed choice, farming facilities, equipment, management, nutrition and flock health have significant influences on flock performance.

The genetic potential of turkey breeds is constantly improving due to the efforts by the breeding companies and is seen across a wide range of biological traits. Exploitation of genetic potential requires constant evolution of nutrition and management systems to ensure previously accepted methods have not reached a limiting threshold. Factors which might limit full exploitation of genetic potential vary between companies. Collecting measurements of bird performance and analysis of this data will help identify areas of opportunity.

Turkey breeding is a highly specialised business requiring significant investment in the latest technologies to deliver balanced breed improvements in production, health and welfare. This enhances the competitiveness of turkey production relevant to other animal protein sources not only in financial terms but also in environmental and welfare criteria and other market relevant traits.

With good management and nutrition, producers can exploit the bird's genetic potential and maximise the value generated. Understanding this value is crucially important to the success of the turkey industry. Producers are looking for the breed which maximises the difference between the value the product brings against the price paid. This can only happen when there is an understanding of breed value, without which the choice comes down to a matter of price which may not be the producer's profit maximising choice.

Aviagen Turkeys

John Ralph, Aviagen Turkeys R&D Director

By courtesy of Aviagen Turkeys

Poor understanding of value therefore pressurises breeders to reduce costs and limits their potential to invest in the technologies required for further breed improvement. The net result is a loss of opportunity for both the producer and the breeder and competitiveness of turkey meat production. So maximising breed value by ensuring breed genetic potential is being utilised is important to turkey producers and breeders alike.

A good understanding of production results is the key to assessing how much of the breed's genetic potential is being exploited and the additional value which could be gained by improving the production system.

Analysing Performance

Turkey producers typically collect data on bird performance at all stages in the supply chain. This information is used by agricultural and financial departments to check progress against business goals. Further analysis can identify opportunities to improve bird management with significant effects on bird and bottom-line performance. Collection of additional flock factors such as placement and terminal stocking densities, clean-out time, nutritional details, vaccination, equipment and facility details can help identify other opportunities for improvement. Remember, it is easier to collect the information during the flock lifetime than to seek it sometime after depletion.

Companies which are proactive in gathering and analysing performance data are also in a stronger position to deal with new or unexpected challenges and can significantly reduce the time it takes to understand a situation.

Data analysis

Good analysis starts with good data quality. Data should be collected in a systematic way and ideally electronically at the point of gathering to reduce the possibility of transcription errors and where miskeyed or out-of-range data can be checked and corrected.

Data should be organised in a database where each field contains information in a consistent format e.g. names of farms and breeds, defined measurement units, and completeness of data. A variety of systems from dedicated production management programmes through to spreadsheets can be used to hold this. Regardless of the system, access to flock by flock information in a suitable format for further exploration through charting, summary tables and statistical analysis is key to understanding the factors affecting performance.

Analytical challenges

Before starting a performance analysis, it is important to have an understanding of the production system and account for this. For example, some flocks, especially in certified production systems, will be managed and fed to meet particular end product specifications and so it may not be appropriate to include these along with standard production flocks.

Some common challenges in handling production data are outlined below.

Adjusting data to common ages or weights

Flocks are sent for processing at different ages depending on planning needs. For comparisons, the data will need to be adjusted to a common age or weight depending on the operational needs. It is always helpful to adjust feed conversion rate (FCR) to a common weight so that the comparison is not confounded with differences in weight.

There are many ways of adjusting data (*Table 1*); each has their advantages and disadvantages. In all cases, it is important to limit how far the adjustment can be made. For terminal weight turkeys, adjustments of +/- 7 days and +/- 2 kg would be considered reasonable, however widening of this range reduces the reliability of the adjustment.

Table 1 - *Common methods and examples used to adjust data to common ages or weights*

Method	Example
% of performance objective	If flock was 95% of objective at 115 days then it is assumed to be 95% at 120 days. Use either the performance objective from the breeder or one based on historical own performance.
Average daily gain (adg)	Adjusting weight from 115 days to 120 days means adding 5 x adg to 115 day weight
Interpolation	Where more than 1 weight is available, use linear interpolation. If weights at 115 days and 125 days are available the 120 day weight can be calculated.
Adjustment factors	Derived from historical data or breed performance objective. For FCR, the breed performance objective can be used to calculate the change in FCR per kg e.g. 0.06/kg.
Modelling	Use of statistical models to predict performance

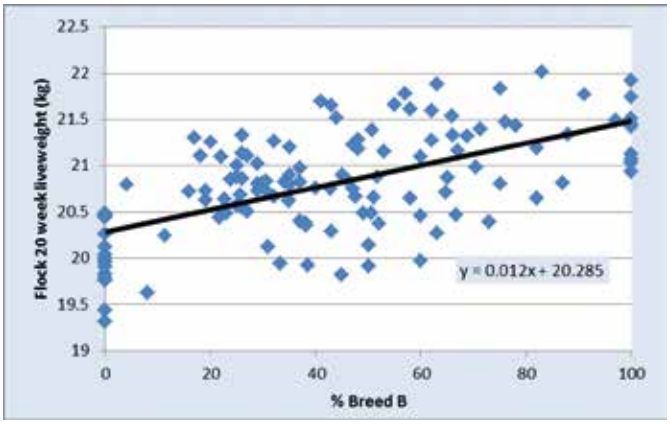


Figure 1 - *Use of linear regression to examine the breed effect on 20 week male liveweight using data from mixed breed flocks. The slope of the line shows that Breed B is +1.2kg greater than the alternative breed*

"Turkey breeding is a highly specialised business requiring significant investment in the latest technologies to deliver balanced breed improvements in production, health and welfare"

Mixed breeds

Producers with 2 breeds will commonly have mixed placements. Comparisons of pure flocks can be made but will limit the number of results for analysis. The flock breed definition can be widened to flocks with greater than around 70% of one breed. Where the majority of flocks are mixed, for example during a breed transition, a linear regression of the trait against breed percent is useful, the slope of the line determining the breed effect (*Figure 1*).

Mixed sex growing

In mixed sex flocks, although weight and mortality is recorded by sex, as feed is fed to the entire flock from the same bin, FCR is confounded with sex. The combined FCR can be adjusted to a set female weight and set male weight to facilitate comparisons.

Actual FCR + (7kg-actual female weight)*female FCR adjustment factor + (14.5kg-actual male weight)*male adjustment factor.

Contemporary comparisons

It is important to understand the information behind average values in summary tables and charts. This is particularly important for turkeys where there is a significant difference between summer and winter performance and also where companies have different production complexes where there may be differences in facilities, management, nutrition etc. Breed comparisons should only include data where there is consistency in production month and production base.

Convention differences

When comparing across operations, there can be differences in the way data is recorded. For example, definition of a settable egg, first week of egg production, classification of breast meat yield (skin on or off, inner and outer fillets, shoulder meat inclusion). In some instances, this can be accounted for in the analysis but in any event, awareness will prevent misleading conclusions.

Figure 2 - *BUT Premium average and top 25% 18 week liveweights across different production systems*

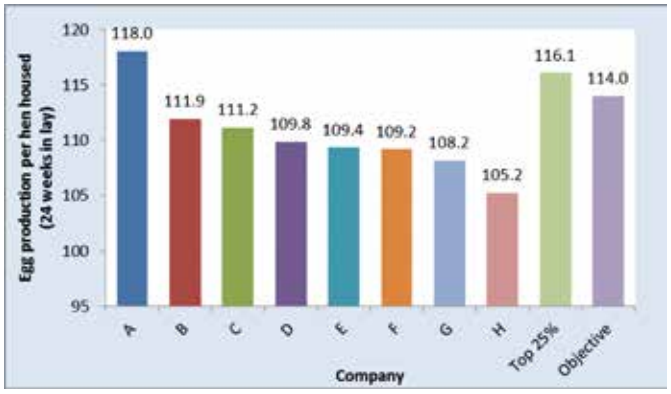


Figure 3 - *Industry-wide benchmarking of BUT6 egg production showing average 24 week egg production per hen housed, top 25% performance and the 2017 BUT6 breed performance objective*

Factors affecting exploitation of genetic potential

For most businesses, analysis of production data using summary tables and charts will meet their needs. Looking at the top 25% of results gives an indication of genetic potential of the birds if conditions allow. Typical types of analysis include looking at changes over time and investigating relationships between different factors (e.g. clean-out time and livability). Ranking of farm performance can lead to deeper investigations into what is different about the best farms.

Production variables will affect the extent of exploitation of genetic potential. The key for producers is through data analysis, to identify those that they can influence either through capital investment in equipment and facilities or management of nutrition, husbandry and health.

More sophisticated statistical analysis can also be performed on the data. With sufficient data, multiple factors can be analysed and their effects quantified simultaneously. This requires an understanding of the appropriate statistical methodology but can offer high performing companies the opportunity to fine tune their production operations.

One key point to remember is that the breed is constantly evolving and as a result, previously established best practices may no longer be appropriate and will need to be revised to take advantage of the improved genetic potential of the breed.

Look outside the business

Extending evaluation of own performance to look at the same breed grown outside the organisation may reveal an even greater genetic potential and stimulate a re-evaluation of the way birds are grown within the organisation (*Figure 2*).

Breeders, through working with many producers, are well placed to give this inter-company and international benchmarking perspective which will show breed potential and identify opportunities for further improvement (*Figure 3*).

In general, high performing businesses have a willingness to share production data in return for feedback in their quest for marginal gains. Sharing of data also means the breeder's product performance objectives and support will be as relevant as possible to achievable performance and genetic potential and that the breeding programme goals are closely aligned to industry needs.

Conclusion

Turkey breeders are focussed on improving the genetic potential of their breeds. Investment by producers in evaluation of bird performance data will pay dividends by directing the evolution of husbandry, management and nutrition to make best use of this potential.

www.aviagenturkeys.com

Managing CO_2 and fresh air to optimise hatchability

Last year Pas Reform's senior hatchery specialist Tiny Barten was invited to a layer hatchery that was reporting slightly lower hatchability than its sister hatcheries, despite using eggs from the same flocks with the same pre-setting treatment.

"The hatchery was using several generations of incubators, from very old to relatively new machines. Hatchabilities had not been assigned to machine type, which complicated our investigation, and one common issue was that none of the setters could achieve unrealistically high humidity set points. This was partially due to very dry inlet air, which forced the setters' humidifiers to work constantly and created cold spots that extended the hatch window.

On day two, there was a hatch. While chick quality was pretty good, a breakout of unhatched eggs from various machines revealed too many embryos dying just before internal pipping. Air cells were large enough and the embryos had a normal, dry appearance, so this was not due to insufficient weight loss.

What then was the cause?

Studying climate graphs from recent hatcher cycles revealed that although the newest hatchers were equipped with CO_2 sensors, these were not being used to automatically control fresh air supply. In-

Martin Barten, senior hatchery specialist, Pas Reform Hatchery Technologies

stead, these modern hatchers were being managed traditionally, using stepped set-point increases to position the air valve.

The CO_2 line in the climate graph showed much higher values than recommended, ranging from 0.8% right after transfer to over 1% - and at times, even higher values than the sensor could measure (> 1.3 %). Sharing these findings with the hatchery manager, we agreed that these high CO_2 levels were the most likely cause of late embryo mortality and so two remedial options were suggested:

1) Fine-tune valve set points on measured CO_2 values: aim for 0.5% immediately after transfer, to a maximum of 0.8% at the onset of hatch and reducing again when the hatch is complete. For older hatchers without CO_2 sensors, our advice was to increase valve positions, to create a similar profile from transfer to the completion of hatch,

Or

2) As an alternative, use CO_2 set points to automatically control valve positions.

Initially the hatchery manager chose the first option, which was more familiar to him. However, some months later, he called to tell that the second proposed suggestion, using automatic valve control in the newest hatchers, was much easier and, more importantly, that hatchability was now consistently *very good*".

Martin 'Tiny' Barten, senior hatchery specialist, Pas Reform Hatchery Technologies

Pas Reform
Hatchery Technologies

For further information contact:
www.pasreform.com

Poultry expertise at IDEXX

In a rapidly evolving poultry production environment with fewer treatment options, disease prevention and identification are more important than ever. Reliable lab diagnostics play a crucial role in safeguarding the health of poultry flocks around the globe. IDEXX is the leading expert in livestock and poultry diagnostics.

The poultry sector is growing rapidly, driven in part by major improvements in the control and eradication of infectious diseases. As a leading expert in livestock and poultry diagnostics, IDEXX is dedicated to maintaining its key role in the sector, as evidenced by its ongoing investment in services and expertise. IDEXX is pleased to announce the addition of two new experts to its poultry team: Antonio Ricci and Willem Wijmenga, both doctors of veterinary medicine. The company is dedicated to supporting customers in making more confident flock management decisions based on reliable, efficient testing.

Continuing growth in the poultry sector

Poultry production has grown enormously over the past 50 years. According to a 2016 report by the Food and Agriculture Organization (FAO), poultry meat production will grow at around 2.3% per year to around 134.5 million tones up to 2023, making it the largest meat sector from 2020 onwards (even without including the eggs industry). The phenomenal growth in production of poultry has been made possible by a number of developments. Genetic improvement continues to be an important factor. However, one of the main factors in the ability to keep larger individual flocks has been major strides in the control and eradication of infection diseases. Routine medication has been a successful strategy for diseases like coccidiosis. Vaccines on their own or in combination with isolation have been effective in controlling endemic viral infection (e.g. vaccination for Marek, supplemented by isolation for Newcastle Disease). Finally, various important infectious diseases have been eradicated altogether through separation of the generations, selective medication and isolation of stock; this includes Mycoplasma and some Salmonella infections. Reliable, fast, cost-efficient diagnostics are a crucial part of identifying and treating poultry disease.

Antonio Ricci

Wijmenga Willem

Leading expertise in poultry diagnostics

Laboratories, clinics and veterinarians around the world depend on IDEXX diagnostic tests and technologies to make confident decisions about flock and herd health. IDEXX tests, instruments and software provide reliable results for many of the most prevalent livestock and poultry diseases. IDEXX has spent more than 30 years perfecting the technology, building expertise, and earning customers' trust. The expertise that has been developed over the years is the foundation for an effective flock health management program, allowing better prediction, interpreting and monitoring with confidence. The company continues to invest in poultry services, as evidenced by the recent addition of Antonio Ricci DVM for the EMEA region and Willem Wijmenga DVM as Senior Marketing Manager for the Poultry Product Line globally. IDEXX is pleased and proud to welcome them to the team.

Antonio Ricci DVM

In his current role as Poultry Specialist, Antonio Ricci promotes and supports the use of IDEXX poultry diagnostic solutions to key poultry stakeholders with the customer-facing IDEXX organization in the EMEA region. Antonio grew up working on his family's commercial broiler farm in Italy, graduating from the Veterinary University of Naples, Italy, in 2010 as a Doctor of Veterinary Medicine. Since then, he has been working in the UK, first as a poultry veterinarian for the government and then as a senior poultry veterinarian with Poultry Health Service. Antonio spent a large part of his time caring for broiler and layers birds within the poultry industry and has developed key expertise in reviewing bio security, hygiene, vaccination, disease monitoring on clients' farms. He has been working closely with vets and poultry producers, providing advice on all aspects of poultry health management.

Test **with Confidence**™ IDEXX

Willem Wijmenga DVM

Willem Wijmenga joined IDEXX Livestock and Poultry Diagnostics as Senior Marketing Manager earlier this year, leading global product-line marketing for the IDEXX poultry product business. Willem graduated from Utrecht University in 1996 as a Doctor of Veterinary Medicine. Over the five years following graduation, he worked as a field veterinarian in the Netherlands and Belgium focusing on swine and poultry health, after which he joined the pharmaceutical industry at Fort Dodge Animal Health/Pfizer/Zoetis in 2001. His extensive experience since then has included sales, international technical analysis services, and marketing support and strategy for swine and poultry vaccines. Most recently, he served as Global Director for Swine and Poultry Vaccines at Elanco.

IDEXX poultry diagnostics and flock management

As a leading expert in the sector, IDEXX has been advancing poultry diagnostics and flock management ever since the first commercial ELISA was launched more than 32 years ago. IDEXX's global network of scientists works together to develop proven solutions, leading to a number of major benefits. For instance, the specialists at IDEXX and their solutions help reduce the need to repeat testing by providing assays that are rapid, simple to perform and easily automated. These diagnostic tools are supported by user-friendly software (xChekplus) for reading and interpreting results and for analyzing, reporting and managing health data.

Ongoing innovations and new solutions

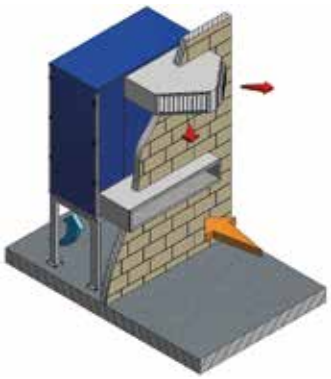
New solutions are being developed all the time, complementing the extensive portfolio available at IDEXX. Recent product launches include solutions for timely, cost-effective identification of Salmonella, such as the IDEXX *Salmonella enteritidis* Ab X2 Test. Another new product, the RealPCR MG/MS DNA Mix, provides highly accurate DNA identification, detecting antigens and providing a perfect complementary test to ELISA. The top-quality IDEXX tests are backed by a team of dedicated IDEXX customer support and technical support experts who help veterinarians, producers, processors, researchers and technicians around the world. IDEXX supports customers in poultry diagnostics and flock management by ensuring they get the answers they need as quickly, confidently and cost-effectively as possible.

About IDEXX

IDEXX was founded on poultry diagnostics. And since 1985, laboratories, veterinarians and producers around the world have relied on IDEXX diagnostic technologies to make confident decisions around flock health to improve productivity, return on investment and public health.

For more info visit idexx.com/poultry

Ekocikki heater, duck farm. Spain.


Ekocikki outside installation scheme.


Supercikki heaters, broiler house. Australia.

Tecnoclima SpA, at the forefront of innovation

Tecnoclima SpA is a leading Italian company that has been operating in the Warm Air heating market for more than 40 years, offering solutions and products for the livestock farming and agriculture.

All products are entirely designed and manufactured in Italy, certified according to current regulations in various international markets and subjected to the most rigorous quality and reliability controls. Innovation, technology and customer focus have always been the hallmarks of Tecnoclima proposal.

Tecnoclima sales organization supports customers in identifying the best heating and ventilation solutions. The technical service assures a timely and competent presales assistance and service support after installation.

The heaters developed by Tecnoclima for poultry applications have been designed considering the needs of the farmers and the experience gained from thousands of successful installations around the world:

- quick and easy installation;
- accessories to meet any requirement and different types of installations;
- reliable and durable operation;
- ideal heating level for the different stages of growth;
- high quality of air;
- high efficiency and fuel saving;
- choice of the highest quality materials specifically suitable for use in poultry farms and livestock;
- technical assistance service.

SUPERCIKKI - Proven Technology

Direct air heater **Supercikki** has a great success on the international markets due to its reliability, efficiency, safety and simplicity of use. Updated over the years, today's Supercikki offers an output of 80 kW and easy installation solutions to fit any type of poultry building. The possibility to install heaters also outside is especially appreciated, as well as fresh air intake or the possibility to mix fresh and return air. Thousands of units sold each year confirm farmers trust around the world for this simple, re-

liable and flexible solution. Last year Tecnoclima provided Supercikki heaters specifically certificated in conformity with the strict Australian AGA gas regulations. 180 heaters with 100% thermal efficiency, installed outside and working with fresh air, with reduced production of CO_2 and water vapor, fully satisfied the requirements for safe and efficient heating of 70.000 m^2 poultry farm, creating the best conditions for chicks raising in all their life stages.

EKOCIKKI - Clean warm air in the poultry farms

Climatic environment is of a great importance for the well-being of birds, which affects directly the productivity of a poultry farm and finally the quality of resulting meat. The main climatic factors are temperature, humidity, air movement and air purity. Therefore, besides the direct heating technology, Tecnoclima offers a full product range and solutions with sealed combustion technology to ensure heating with a *clean warm air* in the farms.

Ekocikki is just the latest product of the family of indirect fired warm air heaters with heat exchanger that meets growing market demand for ideal environment for birds.

These warm air heaters are based on a thermal exchange between combustion products of a forced draft burner (can work with gas or oil) and air flow produced by a high performance fan unit. **Such heating system has the advantage of blowing into the environment only clean air, completely free of harmful contaminates, such as carbon dioxide, carbon monoxide and nitrogen oxides.**

Recently Tecnoclima proposed an efficient solution to meet the requirements of the Spanish farmers who were aiming to create the best conditions for ducks raising. With a special focus on birds health, an air heating solution using Ekocikki was realized on 1.000 m^2 duck nursery farm in Spain. The heaters are installed outside of the building to avoid the space restriction, while the clean warm air is blown through diffusion plenums fixed just under the ceiling. The combustion gases are exhausted through a dedicate pipe system and the air necessary for combustion is taken from outside. Outside installation is often an appreciated solution not only for saving productive space, but also from the point of view of cleaning, maintenance, fire risk and related assurance. Such great comfort created for birds allows for their no-stress growing, putting on more weight and achieving better meat quality with less pharma.

Additionally, this heating system permits a remarkable operating economy. The use of Ekocikki heaters reduces the fuel consumption for about 25%, compared to traditional direct-fired heaters, thanks to a reduced need for ventilation. This is an important advantage for investors also, in terms of payback of the project.

Ventilation and heating issues during cold weather

Many problems during cool and cold weather can be traced to inappropriate ventilation rates. Poor broiler health, respiratory problems, and breast blisters are common with poor ventilation or insufficient heating.

Ventilation and moisture

Moisture removal is one of the key factor for cold weather ventilation. The minimum ventilation rate is the quantity of fresh outside air to be moved through the building to remove the inside moisture. Further ventilation rates will provide a fresher environment while increasing heating costs. A 50-70% relative humidity will prevent excessively dusty conditions while staying within a range where pathogens are less viable.

The strategy for cold weather ventilation moisture removal is to use cold, but relatively dry, outside air as a 'sponge' for absorbing moisture within the building. The moisture-laden air is then exhausted from the house. This process depends on heating the cold air to increase its moisture-holding capacity.

Minimum ventilation rates for poultry depend on factors such as moisture, temperature of outside air, inside relative humidity, management practice, drinking water systems which are used and litter management.

In current ventilation control systems, air temperature is used to control fans and heaters during cold weather conditions. Instruments, like sensors and controllers, are available for spot-checking RH level so that a producer can fine tune the ventilation system control strategy. With some bird management practices, ammonia level or other air quality issues may demand a higher minimum ventilation rate than that needed for moisture removal. For broilers reared on litter, the method of litter handling between flocks can have a substantial impact on air quality and heating fuel use. Many operations practice limited litter removal between flocks.

Broilers eliminate moisture through respiration, evaporation, and fecal evacuation. Broiler size, environmental temperature, housing type, manure handling practice, and watering systems all contribute to apparent moisture production. Significant differences in moisture production between broilers raised in houses with conventional versus tunnel ventilation have been found. This difference is presumed to be due primarily to changes in water delivery systems.

Moisture balance occurs when the rate that water vapor produced by broilers, feces, and the drinking system equals the rate that water vapor is expelled by the ventilation system. The ventilation rate needed to achieve the moisture balance is the minimum ventilation rate, usually expressed in cubic feet per minute (CFM).

Ventilation rates

The recommended values for minimum ventilation rate start at 0.04 CFM per chick for young broilers and increase as broilers grown and their moisture production increases. Broilers reared on fresh litter can withstand short periods of low ventilation because the litter can absorb moisture. However, excess litter moisture will lead to ammonia and disease problems. If a low ventilation rate is used, the moisture must be removed later in the production cycle using higher ventilation rates. If broilers

"Radiant brooders use radiation to direct heat energy at the floor and at broilers near the heater. The amount of radiant heat felt on a surface is dependent on the temperature of the radiating element and the distance between the radiating element and the surface"

are raised on previously used litter, the required minimum ventilation could be as much as nine times that normally recommended to keep ammonia levels within the desired range. For broilers, recent research suggests that today's young broilers and production practices result in significant higher moisture production than two decades ago. This translates into higher minimum ventilation rates to remove this moisture.

The cold weather minimum ventilation rate in broiler barns is often far below the capacity of a single-speed, 36- or 48-inch fan. Continuously modulated airflow, such as that provided by a variable-speed fan, is preferred for varying the cold weather airflow. It takes a tightly-constructed house to allow one or two smaller fans to create the static pressure necessary for proper inlet functioning throughout a large poultry house. Since not all houses are tightly constructed, many use a higher capacity fan on an interval timer for cold weather ventilation. However, the broilers are breathing, water is evaporating, manure gases are volatilizing, and heaters are venting continuously while fresh air is only added a fraction of the time.

An excessive ventilation rate causes:

- Excess fuel use.
- Temperatures that are too cool; inability to maintain blood temperatures.
- High concentration of dust.

An insufficient ventilation rate causes:

- High concentration of ammonia and air contaminants.
- Areas of excessive moisture.
- Condensation on interior surface.

Poor air distribution (improper inlet function) causes:

- Drafts.
- Uneven temperatures; cold spots and/or hot spots.
- Areas of excessive moisture.

Heating

Heating requirements will vary with the type of broiler, stage of growth, broiler density, outside weather conditions, ventilation rates, and desired indoor temperatures. The preferred method of heating will depend on the percentage of building space being occupied by the broilers, energy costs, and stage of broiler growth. At times, more than one heating method will be used to economically provide the necessary supplemental heat throughout the growing cycle.

To determine heating needs, heat loss through ventilation air and building surfaces is compared to heat gain from bird heat dissipation. When heat loss is greater than the heat gain, supplemental heat is needed to maintain temperatures in the bird's thermal comfort zone.

Building heat loss consists of heat transfer from the building interior to the outside through conduction, convection and radiation. Heat loss through the ventilation system typically demands the greatest share of fuel in cold weather. More than 50% of building heat loss is from ventilation air exchange. For each cubic foot of cold air brought into a building by fans or natural ventilation, a cubic foot of warm, moist air is exhausted. The cold air must be heated to maintain the desired temperature.

Typical sensible heat loss rates for poultry range from 0 to 17 BTU per hour per pound live weight with the lower values for warm air temperatures. Bird heat loss is also greatly affected by lighting, with heat loss rates being much greater when lights are on than when they are off.

Equipment

Two types of heaters are common in poultry facilities: forced hot-air space heaters and radiant brooders. Space heaters heat the air in the building. Radiant brooders, such as pancake and infrared heaters provide some heat to the air but

are used primarily to heat the birds and floor. Both types of heaters can use natural or propane gas and are rated by their BTU per hour (BTUh) heat output. Houses may employ one or both types of heaters.

The decision on whether to use space or radiant heaters or a combination of the two is not clear-cut. Broilers are successfully raised using all three systems. When the emphasis is chick comfort up to about two weeks of age, floor-level temperatures are very important and radiant brooders are generally used. Older broilers are more tolerant of cool temperatures and have learned to move around to find a comfortable temperature. For these situations, space heaters may be more economical. Many producers have found that the increased initial cost and great complexities, when using both types of heating equipment are offset by long-term energy savings and bird comfort.

The temperature in a house with a well-designed forced-air space heating system is relatively uniform from floor to ceiling and around the house. Agricultural forced-air heaters range from 15,000 BTUh to over 300,000 BTUh, with poultry houses commonly rated between 80,000 to 250,000 BTUh. The industry standard is to provide around four heaters in a 500-foot long broiler house, rather than one or two large heaters. This improves heat distribution in the house.

Large heaters are only marginally more expensive than units with half the BTUh capacity, so it is common to over-design for houses that will contain brooding chicks. Some heaters can operate down to 60% of their rated capacity without sacrificing combustion efficiency. Units are often installed near one sidewall. Heated air is distributed with the heater fan and through mixing with the incoming ventilation air jet. Maintaining warm temperatures near the floor during early brooding is a common problem with space heaters.

Most space heaters use interior air and are unvented, which means they exhaust carbon dioxide, moisture, and incomplete combustion products directly into the building. Approximately 1.7 lbs of water vapor is producer per lb propane gas combusted. Thus, to prevent moisture accumulation caused by unvented heaters, it is recommended that minimum ventilation rate be increased by 2.5 CFM per 1,000 BTUh heater capacity.

Radiant brooders use radiation to direct heat energy at the floor and at broilers near the heater. The amount of radiant heat felt on a surface is dependent on the temperature of the radiating element and the distance between the radiating element and the surface. In order to be heated, an object must be able to 'see' the hot radiant element in the brooder. Broilers are warmed by the thermal radiation from the brooder and warm floor.

The comfortable temperature zone of a radiant brooder is doughnut-shaped, as is reflected in the pattern in which chicks distribute themselves under the brooder. For example, with a conventional pancake brooder, floor temperatures directly under the unit may be as high as 150°F, while seven feet away the temperature is down to 75°F. Brooder location recommendations are often based on how many chicks they can comfortably warm without causing chicks to pile up under the brooder unit. Use space heaters in addition to the radiant heaters if air temperatures cannot be maintained or if inadequate radiant

"The strategy for cold weather ventilation moisture removal consists in using cold but relatively dry, outside air as a 'sponge' for absorbing moisture within the building. The moisture- laden air is then exhausted from the house. This process depends on heating the cold air to increase its moisture-holding capacity"

"Heating requirements will vary with the type of broiler, stage of growth, broiler density, outside weather conditions, ventilation rates, and desired indoor temperatures. The preferred method of heating will depend on the percentage of building space being occupied by the broilers, energy costs, and stage of broiler growth"

heat zones exist. Perimeter insulation becomes more important in radiant-heated houses, since it will reduce heat loss through the warmed floor.

Temperatures in radiant heated houses are not uniform from floor to ceiling as space-heated houses and may feel cool to the operator. A desirably warm temperature can be maintained at broiler-level while the surrounding air is often 5-10°F cooler. Temperature sensors for brooders should be placed about 6 inches off the floor for proper zone control. Provide radiant protection for the sensor, or it too will be heated by the radiant energy and not reflect a true air temperature in the floor zone.

Radiant or infrared brooders come with two major types of radiant elements: a small ceramic disk or large stainless steel cone. Traditionally, radiant 'pancake' brooders have been spaced uniformly, hanging near the feed lines and within 18-30 inches of the floor along the brooding section of a house.

Modern radiant brooders have automatic ignition and more uniform radiant heating than older models. Good radiant brooders have large radiant zones because they have large radiant elements, are fuel efficient, and can be hung five feet from the floor. They typically provide a 30-40 foot diameter heated zone.

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Effects of early enrichment on range use in free-range laying hens

The outdoor environment exposes hens to unpredictable conditions. There are few data on the impacts of early enrichment on range use in free-range systems.

D.L.M. Campbell[1,2], G.N. Hinch1 and C. Lee[2]

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Free-range laying hen production systems are perceived to be preferable for hens' ethological needs. However, not all hens use the range daily with some hens rarely venturing outdoors. Free-range hens are typically reared indoors until point-of-lay, when they are first provided outdoor access. The outdoor environment exposes hens to unpredictable conditions including variable weather and predation, in comparison to the controlled, sheltered indoor environment in which pullets are reared. Thus hens may be reluctant to use the outdoor range. Modifications to housing environments or management practices during rearing can alter hen behaviour as adults within indoor housing systems but there are few data on the impacts of early enrichment on range use in free-range systems.

Material and methods

In this study, 300 Hy-line Brown day-old chicks were reared in 2 rooms (n = 150 chicks/room) with unpredictable, variable environmental enrichments provided in 1 room from 4 – 21 days, and standard rearing conditions (non-enriched) in the other room.

"Free-range laying hen production systems are perceived to be preferable for hens' ethological needs. However, not all hens use the range daily with some hens rarely venturing outdoors"

From 21 days onwards, all birds were provided the same housing conditions. At 12 weeks of age, pullets were transferred to an experimental free-range facility, equally divided into 6 pens (n = 3 enriched rearing treatment, n = 3 non-enriched rearing treatment) and all birds leg-banded with microchips.

From 22 – 41 weeks of age, hens were provided daily range access with individual range use tracked via radio-frequency identification technology.

From 39 – 41 weeks of age the range was shrunk to 20% of its original size to measure hens' range use responses to environmental change. Additionally, occurrences of natural hen disturbance behaviours (hens suddenly running towards the pop holes) on the range were decoded from video recordings at 23-25 and 35-36 weeks of age. All data were analysed using General Linear Models in JMP® 12.1.0.

"The outdoor environment exposes hens to unpredictable conditions including variable weather and predation, in comparison to the controlled, sheltered indoor environment in which pullets are reared"

Results

Results showed the enriched hens on average, spent more hours on the range daily in the first 3 weeks of range access (22 – 25 weeks of age) ($P = 0.03$) including more individual visits to the range ($P < 0.0001$). Conversely, during weeks 35-38, the non-enriched hens spent more hours on the range daily ($P < 0.0001$) with more visits to the range ($P = 0.002$). After the range was reduced in size all hens spent less time on the range but there was no difference between treatment groups in the magnitude of reduction in daily time ranging ($P = 0.11$).

The enriched hens however did increase their number of visits to the range more than the non-enriched-reared hens did ($P = 0.005$), spending less time per individual visit ($P < 0.0001$). There were no differences between treatment groups ($P = 0.11$) in occurrence of natural disturbance behaviours but significantly fewer disturbances on the range occurred at 35 – 36 weeks of age compared to 23 – 25 weeks of age ($P < 0.0001$).

Conclusion

These preliminary results show environmental enrichments provided during early development increased range use when birds were first provided range access but over time this pattern changed. The rearing treatments impacted birds' responses to environmental change but further replication of the enrichment rearing treatment, including trailing different types of enrichment (e.g. manipulable versus structural) are needed.

Acknowledgment

The Authors thank the Poultry CRC for financial support.

From the Proceedings of the Australian Poultry Science Symposium

The bioavailability of zinc in poultry: what does literature say?

Zinc is an essential trace element for all the animals, including broilers. In case of deficiency, alteration of growth performance and distortion of the leg bones can be observed. Supplementing broiler feeds with zinc is necessary in order to fulfil the requirements of the animal.

Agathe Roméo,
Animine, France

Some zinc sources can be used, but they are not all equal. Physical and chemical properties, including zinc concentration, vary from one source to another. The effect of zinc supplementation on animal performance has been studied these last decades but the methodology to assess the bioavailability of Zn sources has made much progress these last years. As there is a need to reduce safety margin for mineral supplementation, a fine tuned definition of the performance of each zinc source is required.

What is bioavailability?

According to O'Dell (1997), the bioavailability of an element is "the proportion of the element consumed that is utilized for a biochemical or physiological function". A part of the ingested elements is solubilised in the gastro-intestinal environment and consequently becomes absorbable across the enterocytes; these elements are termed 'bioaccessible'. When the elements are not solubilised, they pass through the intestine and are excreted. Elements which are absorbed through the intestinal barrier and which reach the systemic circulation are bioavailable and can take part to specific functions in the animal organism.

Comparing bioavailability of zinc sources is possible through some measurements in the animals. The zinc concentration in some organs and the activity of specific enzymes can provide a good indication concerning the bioavailability of dietary zinc. These parameters vary with the

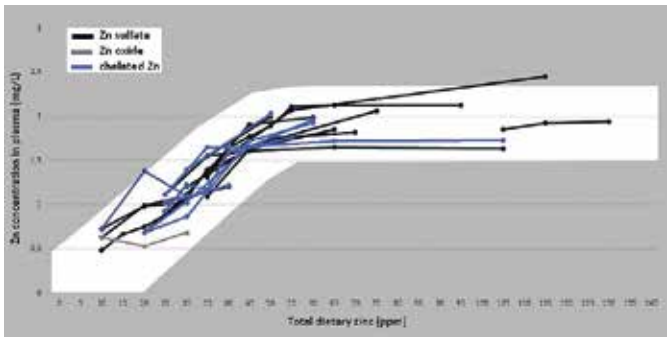

Figure 1 - *Plasma zinc concentration according to total dietary zinc*

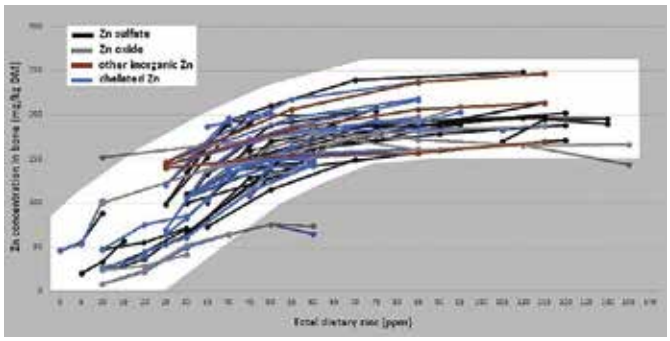

Figure 2 - *Tibia zinc concentration according to total dietary zinc*

proportion of ingested zinc. The criteria to select as reliable biomarkers of zinc status can vary with the animal species. For example, a strong relationship exists between plasmatic alkaline phosphate activity and ingested zinc in pigs, but these variables seem independent in poultry. In monogastrics, zinc concentrations in the pancreas, kidney, liver and intestinal mucosa increase when dietary zinc increases. Metallothionein concentrations in soft tissues are also sometimes measured in bioavailability studies. But, in case of excess, zinc is stored before its excretion, so that zinc concentration and metallothionein level in these tissues are not necessarily bound to the proportion of zinc utilized for biochemical or physiological functions.

In poultry and in pigs, a good correlation exists between dietary zinc at nutritional level and plasma zinc concentration. Bone zinc concentration is also a good criterion concerning the zinc status of the animal. When dietary zinc concentration clearly exceeds physiological requirements, blood and bone zinc concentrations reach a plateau.

Other measurements are possible, like the immunological system's response (thymus weight, spleen weight, IgA concentration, macrophages) and the quantification of gene expression (metallothionein, transporters ZnT), but their relevance has not be proven either. The interpretation of such biological markers can be misleading.

Scientific literature

A few dozen of bioavailability studies were conducted in poultry during the past twenty five years. A literature review was prepared by selecting 37 of these studies, which evaluated the evolution of some physiological parameters according to the zinc concentration in the feed.

In the field, the range for native zinc concentration in poultry diets is 25-45 ppm. As zinc requirement for broilers is estimated between 40 and 60 ppm by different scientific bodies (NRC, INRA), supplementing diets with zinc is necessary. In all trials, zinc concentration in basal diets varied between 1 and 100 ppm; zinc concentration in experimental diets ranged from 4 to 500 ppm. At 150 ppm, zinc level is twice or even three times higher than broiler requirement. Consequently, data over 150 ppm of zinc were not retained in our review: at this level, zinc is clearly supplied in excess, and changes in bone or in plasma are small or nul.

Studies used for this review were conducted in different countries (essentially United States of America, France and China) on some well-known broiler strains (Ross, Hampshire x Columbian, Abor Acres). In general, only male chicks were used. When both sexes were studied, only data from males were selected.

Evaluation parameters

Various parameters were used to evaluate zinc bioavailability: growth performance, zinc concentration in some organs, metallothionein concentration in some tissues, zinc balance (ingested zinc *versus* excreted zinc). Depending on the experiment, zinc concentration was measured in pancreas, liver, kidney, plasma and in some bones (tibia, toe, femur). For our review, only zinc concentrations in plasma and in the tibia were compared: these two biomarkers are the most relevant. In general, tibia zinc concentration was calculated on the basis of dry matter content; this basis was considered as the most appropriate. When zinc concentration was calculated on the basis of ash content, and when this content was not specified, ash content was estimated at around 500 g/kg of dry matter content.

Many zinc sources have been evaluated in these 37 studies: zinc sulphate, zinc oxide, zinc methionine, zinc lysine, zinc chloride, zinc proteinate, zinc polysaccharide complex, zinc glycine chelate, zinc propionate, zinc acetate. In our review, 4 categories are constituted:

- zinc sulphate;
- zinc oxide products;
- other inorganic zinc sources;
- chelated zinc sources;

Zinc sulphate was generally used as a reference and represented by itself more than half of the measures.

No superior bioavailability

When comparing scientific literature, zinc concentration in bone was a more common criterion than zinc concentration in plasma. More than 50 measurements of zinc in the tibia were recorded in our literature review; only 20 measurements of zinc in plasma were available. A plateau could be observed for both criteria. Requirements in zinc are considered satisfied when zinc concentration does not increase any further in the bone or in the blood.

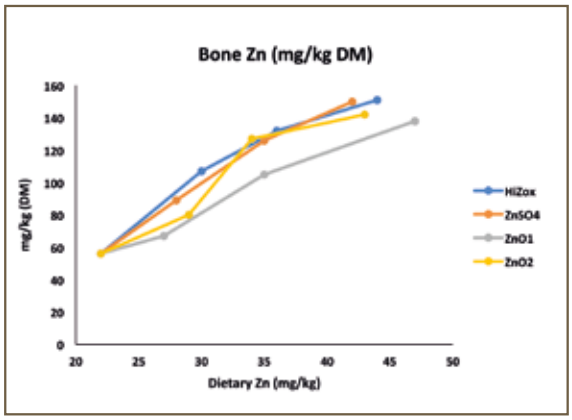

Figure 3 - *Tibia zinc concentration according to total dietary zinc (INRA)*

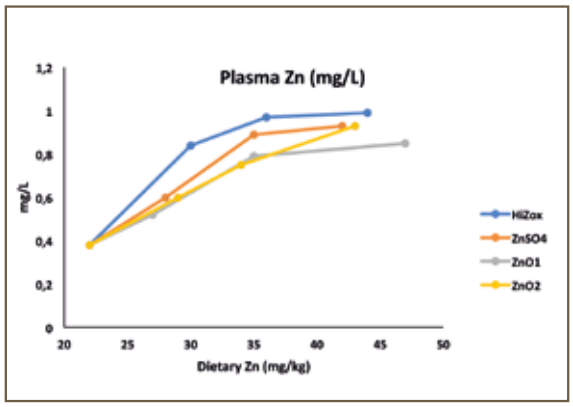

Figure 4 - *Plasma zinc concentration according to total dietary zinc (INRA)*

Plasma zinc concentration reaches a plateau when total dietary zinc is between 45 and 60 ppm (*Figure 1*). However the small number of measures does not permit a generalization of this conclusion.

On the contrary, zinc concentration in the tibia was represented by a high number of points. All the curves followed the same direction, but the maximum Zn tibia concentration varied between 150 and 250 ppm (*Figure 2*). Maximum value seemed to be independent from the zinc source. It is difficult to determine when the plateau is reached, but it can be concluded that zinc requirements in broilers would be satisfied at 70 ppm. Zinc concentration in the bone is stable when total dietary zinc exceeds 70 ppm.

There are very few data comparing inorganic zinc sources. Ge-

	RBV Zn, % Bone	RBV Zn, % Plasma
Hizox®	105[a]	126[a]
$ZnSO_4$	100[b]	100[a]
ZnO 1	66[c]	84[b]
ZnO 2	92[b]	83[b]

Table 1 - *Relative biological value (RBV) of 4 zinc sources (INRA)*

nerally, the chemical and physical description of tested products is scarce. Zinc oxide products showed a lower but highly variable bioavailability compared to the sulphate form. The lack of analytical method to characterise chelated products does not help for understanding. A recent meta-analysis showed that the bioavailability of chelated zinc sources and of zinc sulphate were similar in broilers.

It is now a common practice to calculate the relative biological value (RBV) of zinc sources when assessing their bioavailability. RBV is estimated by using the slopes of the regression lines. When the RBV is high, the dietary zinc concentration, which is necessary to reach the plateau is low. Calculating RBV's requires a strict methodology if robust conclusions are needed. For example, it implies that Zn dosages are tested below animal requirements.

Significant differences

A study performed by INRA (National Institute of Agronomic Research, France) measured the bioavailability of four zinc sources: HiZox® (a potentiated zinc oxide from Animine) and two feed grade sources of zinc oxide collected from the market were compared to zinc sulphate. In this trial, 117 male broilers were fed in individual cages, from 5 to 21 days of age. The basal diet contained 22 ppm of zinc and fulfilled other requirements of the animals; 12 other experimental diets were prepared by adding 7, 14 or 21 ppm of each zinc source. Zinc bioavailability was evaluated by measuring zinc concentration in plasma and in bone.

Significant differences were observed on plasma and bone zinc concentrations: in the group fed the potentiated zinc oxide, the zinc level increased by 16 to 29% in the plasma (*Figure 3*) and by 7 to 26% in the bone (*Figure 4*), compared to the other groups. Calculated RBV confirmed that the bioavailability of HiZox® is not only higher than the bioavailability of other zinc oxide sources, but also than the bioavailability of zinc sulphate (*Table 1*).

Sustainable animal production chains have to reduce safety margins between physiological requirements and excess zinc supplementation levels. Thus, nutritionists need to use feed grade zinc sources which are well characterised and with high bioavailability. Further research is still warranted to identify sensitive biomarkers of Zn status from birds under various nutritional and sanitary stress factors.

List of Journals used for the literature review (title and years): Animal (2007, 2010, 2013) - Animal Feed Science and Technology (1999, 2002, 2013) - Annals of Biological Research (2012) - Biotechnology in Animal Husbandry (2012) - British Poultry Science (1999, 2003, 2004, 2007, 2011) - ESPN (2007) - International Journal of Poultry Science (2006) - Journal of Animal Science (1990, 1992, 1997, 1999, 2000, 2009) - Journal of Applied Poultry Research (2000, 2008, 2013) - Polish Journal of Food and Nutrition Sciences (2007) - Poultry Science (1991, 1993, 1996, 1998, 2001, 2007, 2009, 2012) - Revista Brasileira de Zootecnia (2008, 2009).

A cost-effective solution to partially replace vitamin E

Oxidative imbalance can reduce animal productivity. If severe, it can lead to inflammation, reduced immune function and increased susceptibility to diseases. Livestock producers typically use vitamin E to increase the antioxidant capacity of animals and minimise economic losses.

Recently, the price of vitamin E has risen significantly and might increase further, giving livestock producers a good reason to review their antioxidant sources and include new feed additives.

Oxidative imbalance can reduce animal productivity

The oxidative status of animals is affected by many factors, including diet quality, health status, and growth rate. These and other factors contribute to free radical formation. Excessive levels of free radicals can result in oxidative imbalance and stress. This imbalance can cause damage to DNA, proteins, and unsaturated fatty acids, leading to a decrease in productivity. Animals living close to ideal conditions, i.e. high quality diet and adequate environments are expected to require a vitamin E intake as indicated by the National Research Council (NRC) recommendations. However, if any of these conditions are not met, as in the case of animals raised in intensive production systems, then the antioxidant requirements are estimated to increase above the NRC recommendations.

The most used strategy to avoid the consequences of oxidative imbalance is feeding vitamin E to animals, as an antioxidant. Vitamin E serves two main functions as is described in literature. The first, is the minimum requirement for gene expression, enzymatic activity regulation and neurological functions; the second is as an antioxidant. The first is specific for vitamin E and cannot be replaced by other compounds. The second, however, can be satisfied by other antioxidants.


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Polyphenols can be more efficient than vitamin E to reduce oxidative pressure

Vitamin E is not unique in its ability to neutralise free radicals. It belongs to a family of antioxidant compounds called polyphenols. Within this very diverse family, there are molecules having a greater antioxidant capacity per gram than vitamin E. Furthermore, some polyphenols have improved bioavailability. Thus, these improved activity and availability of some polyphenols result in a more effective antioxidant supply in livestock than vitamin E alone.

Studies show that feed additives can safely replace part of the vitamin E

Some nutrition companies have proved the efficacy of specifically selected polyphenols in both swine and poultry using a heat challenge model. Animals were fed either a negative control diet containing NRC-recommended levels of vitamin E, a positive control diet containing industry-standard levels of supplementation (above NRC), or a test diet in which the vitamin E above NRC was replaced by the polyphenol blend Selko AOmix. The results indicated that animals under a heat challenge, when fed vitamin E at NRC recommendations, presented signs of oxidative imbalance, showing a lower performance. This increase of oxidative imbalance was ameliorated by both, the higher level of vitamin E treatment and the treatment containing NRC levels of vitamin E plus Selko AOmix. There were no significant differences in terms of performance and antioxidant status between the higher level vitamin E treatment and that containing Selko AOmix.

Properly selected polyphenols, with a good bio-availability and a good *in vivo* antioxidant action, such as Selko AOmix can provide antioxidant protection, helping animals to perform under challenging conditions.

Effectiveness of a double choice test to assess dietary taste preferences in broiler chickens

An ample study on dietary taste preferences for broiler is lacking. Searches into the taste system of chickens help to improve poultry feeding strategies.

A. Iqbal, M. Navarro and E. Roura

The University of Queensland, St Lucia Campus, QLD

Australia

Investigations into the taste system of chickens can help to improve poultry feeding strategies. However, a comprehensive study on dietary taste preferences for broilers is lacking. Dietary preferences are conventionally tested by presenting a choice of two diets simultaneously to individual or grouped chickens (double choice test) followed by a comparison of the intakes of both diets. Current double choice methods allow testing only a few nutrients and are carried out over relatively long periods of time. Using wheat as a delivery matrix, Cho *et al*. (2016) demonstrated that laying hens can show preferences in 1 hour tests. To validate this method in broilers, the current study aimed at optimizing the number of birds and feed withdrawal time prior to the test.

Material and methods

Two hundred and twenty four 21 day-old Ross-308 broilers were assigned to six experimental groups following a 2 × 3 factorial arrangement, with 2 levels of feed withdrawal (0 hr vs 2 hr) and 3 group sizes (1, 2 or 4 birds/cage).

Pens were divided into 8 blocks of 12 pens each resulting in 2 replications per treatment per block. Broilers were trained for 5 days to habituate to a double choice feeding regime.

Subsequently, for each pen, 4 tastants (NaCl), monosodium glutamate (MSG), citric acid (CA) and Alanine (Ala) at 3 inclusion levels (0.1%, 1% and 10%) were added to wheat and tested

against a wheat only control during 10 days with two tasting sessions per day.

The differences in consumption between treatment and control were tested against 0 g (implying no difference). In addition, the percentage of tasting intake relative to the total intake of the two feeders (preference) was compared with the neutral value of 50% using the t-test. To see the effect of withdrawal and number of birds per pen on the differences in intakes, the data was analysed using the GLM procedure of SAS.

Broilers could show their preferences in a short term double-choice model. However, the use of wheat as a delivery matrix resulted in an unexpected low intake"

Results

Broilers preferred complete feed to wheat (P<0.05) regardless of group size and withdrawal. The wheat-based treatments experienced very low intakes.

For instance, the overall intakes of 0.1% NaCl, 0.1% MSG, 0.1% CA and 0.1% Ala were respectively 1.9±0.6 g, 1.9±0.5 g, 2.6±0.5 g and 2.2±0.6 g.

Similarly, the intakes of 1% inclusion level of NaCl, MSG, CA and Ala were 2.2±0.6 g, 2.0±0.6 g, 1.7±0.6 g 1.3±0.5 g.

The intakes for 10% inclusion levels of NaCl, MSG, CA and Ala were 1.7±0.5, 2.4±0.5, 1.6±0.5 and 1.9±0.5 respectively in the first test. Similar intakes were observed in the second test.

Based on t-tests against 50% neutral value, rejections could be detected for 0.1% CA in 1 and 2 birds/cage (P<0.05) in the first test. Similarly 1% and 10% Ala, 10% MSG were (P<0.05) rejected at the first test in the group size with 1 bird per cage and 10% NaCl was rejected by the group with 2 birds per cage in the second test.

In conclusion, broilers could show their preferences in a short term double-choice model. However, the use of wheat as a delivery matrix resulted in an unexpected low intake. Group size did not influence the intakes; this was also observed for feed withdrawal period. The use of delivery systems alternative to wheat should be explored to improve double-choice tests in broiler chickens.

Acknowledgements

Project funded by Rural Industries Research and Development Corporation. The authors are thankful to Shahram Niknafs for help in managing the chickens and Clare A. McGrory for help with the statistical analysis.

References are available on request

From the Proceedings of the 2017 Australian Poultry Science Symposium


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Field experience on the use of probiotics in chickens and turkeys

Probiotics have been used for several years in an attempt to improve intestinal health. Recently, microbial products have been extensively studied as supportive treatments for raising poultry without antibiotics.

Anita Menconi and James Barton Pacific Vet Group, Fayetteville, AR USA

Probiotics can improve health and performance of chickens and turkeys under field conditions, confirming the research trials previously performed.

Regardless of the intended use, when testing a probiotic product efficacy, effects on commercial flocks are an essential consideration. Therefore, the goal of this research was to analyze the effects of commercial probiotics on poultry health and performance under field condition.

Selected field application of three different probiotic products was evaluated.

Material and methods

The probiotic products tested were a hatchery applied lactic acid bacteria probiotic, FloraStart®, a water administered lactic acid bacteria probiotic, FloraMax-B1®, and a feed administered *Bacillus subtilis* spore direct fed microbial, Sporulin®.

Four field experiments were conducted to evaluate the impact of FloraStart® on seven days mortality and body weight of commercial broiler chicks.

Results

In experiments 1 and 2, a decrease in the 7 days cumulative mortality was observed in the houses where chicks received probiotic in the hatchery. In experiments 3 and 4, chicks sprayed with the probiotic product at the hatchery showed significant ($P < 0.05$) higher body weight at 7 days of age compared to controls. Three field

experiments were conducted to evaluate the influence of FloraMax-B11® on performance and mortality of commercial broilers and turkeys.

In experiment 1, FloraMax-B11® was administered to turkey hens at feed changes. Significant (P < 0.05) increase on average daily gain and market body weight as well as improvement in feed conversion was observed.

In experiment 2, FloraMax-B11® was administered to broilers at 2, 11, and 22 days. Increase on average daily gain and market body weight and significant (P <0.05) decrease in feed conversion and final mortality was observed.

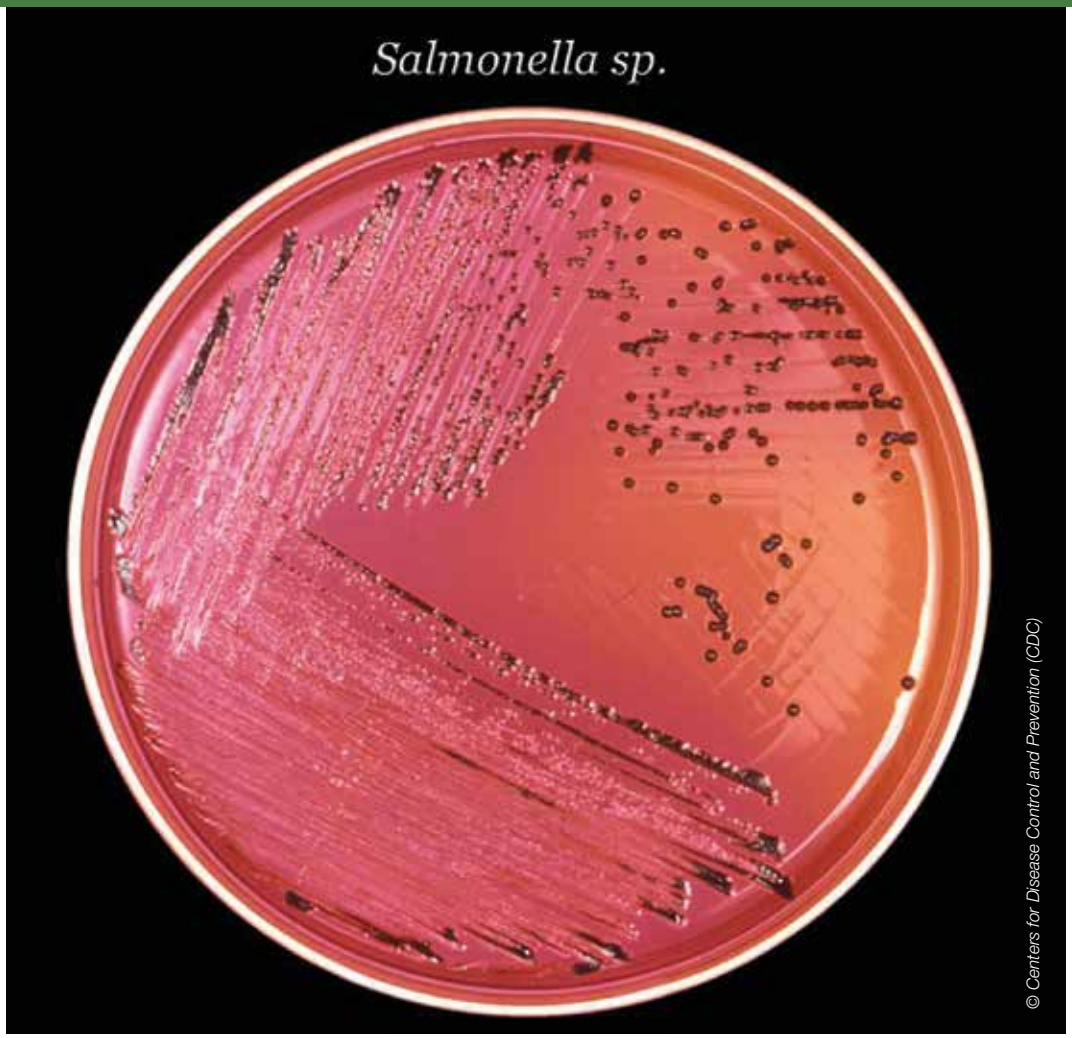
In experiment 3, two broiler flocks (Control and FloraMax-B11® at days 8, 21, and 35) were compared at processing. FloraMax-B11® treated broilers showed significant (P < 0.05) improvement on body weight, feed conversion, and mortality compared to control. Moreover, the association of one dose of FloraStart® in the hatchery and one dose of FloraMax-B11® in the field showed improvement of body weight, mortality, and condemnation of broilers at market age.

Additionally, two field experiments were conducted to evaluate the impact of Sporulin® on performance, mortality, and *Salmonella* spp. reduction. In experiment 1, Sporulin in the feed significantly (P< 0.05) improved body weight gain and reduced *Salmonella* spp. count in cecal contents. In experiment 2, Sporulin® in the feed reduced cumulative flock mortality and improved feed conversion and body weight in broilers.

"The goal of this research was to analyze the effects of commercial probiotics on poultry health and performance under field condition"

Generally, commercial field trials differ from controlled research trials by several aspects such as higher variability, including issues with blocking and measurement assessment. Due to this, it is essential to test and analyze probiotic products under both controlled and commercial conditions in order to evaluate and validate their effects.

From the Proceedings of the 87th Northeastern Conference on Avian Diseases



Isoquinoline alkaloids lower the prevalence of *salmonella Heidelberg* in broiler chickens

Worldwide, tens of millions human cases are reported every year for salmonellosis. This makes it one of the most common foodborne diseases, which can end lethally, depending on the salmonella strain and host factors. More than 2,600 different serovars are known nowadays. Poultry meat is a potential carrier for the animal-food-human transmission route.

A. Pastor[1], G. Mathis[2] and C.L. Hofacre[3]

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[2] Southern Poultry Research, Inc., Athens, USA
[3] The University of Georgia, PDRC, Athens, USA

In North America, *Salmonella enterica* serovar *Heidelberg* is one of the most common serovars isolated from people suffering from salmonellosis. Furthermore, *Salmonella enterica* may carry antimicrobial resistance genes adding further to a potential risk for animals and humans. The objective of the study was to investigate the effect of a standardized blend of plant-derived isoquinoline alkaloids (IQs, Sangrovit® G Premix) in broiler chickens infected with *Salmonella enterica* serovar *Heidelberg*.

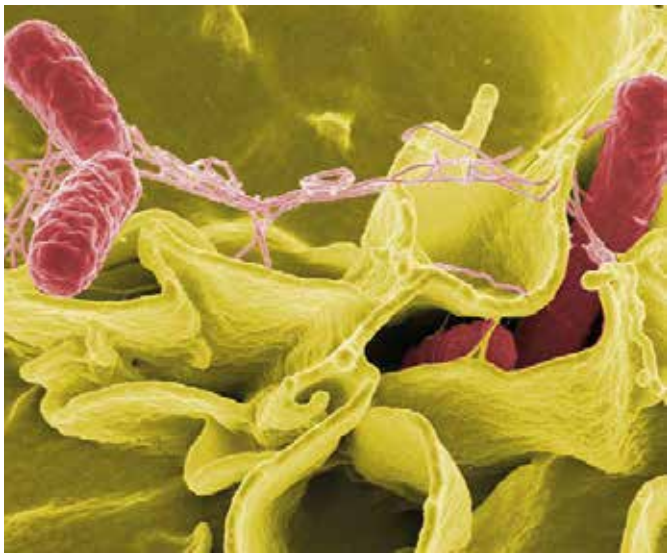
1,200 male day-old chicks (Ross 308) were split into two groups: 1) Control (CON): infected, no feed additive 2) Feed additive (IQ): infected, IQs (120 ppm throughout the study).

At study initiation, fifty broiler chicks were allocated to twenty-four floor pens (n=12) with fresh litter in a modified conventional poultry house. Three rations were used: starter (d 0 - 14), grower (d 14 - 28), and finisher (d 25 - 35).

Feed formulations consisted of non-medicated

commercial type broiler feed and birds had *ad libitum* access to feed and water. The challenge in this study was a natural seeder bird method where 13 birds (25%) per pen were orally gavaged with 4 x 10^5 CFU/ml of a nalidixic-acid resistant *Salmonella enterica* serovar *Heidelberg* at four days of age. The gavaged birds were tagged. Boot socks swab samples were collected for *Salmonella* environmental contamination determination from all pens on d 14 and 35. Furthermore, caecal sampling was completed on d 35 for evaluating *Salmonella* counts using MPN (Most Probable Number). Ten non-tagged birds were taken from each individual pen, euthanized by cervical dislocation and cecas aseptically removed. After removal the caecal samples were placed in sterile plastic bags, labeled, stored on ice, and analyzed. Generalized estimating equations logistic models were applied for statistics, where $P < 0.05$ was considered significant. MPN values were log-transformed prior to statistical analysis. On d 35, no significant differences were observed for feed intake and average weight gain between CON and IQ. Birds fed IQs showed a significantly improved adjusted FCR compared to control birds (1.744 and 1.799, respectively). IQ treated birds showed a numerical reduction in *Salmonella* prevalence (boot sock samples) compared to birds of the control group (87.5% and 100%, respectively). Furthermore, caecal *Salmonella* MPNs for culture-positive ceca samples were lower in IQ fed birds than in untreated birds (0.40 and 0.55; $P > 0.05$).

The use of IQs reduced the prevalence and *Salmonella* level in the positive ceca. This will decrease the pathogen pressure for the next growout as chicks are exposed to less *Salmonella*. Consequently, this can lead to a significant *Salmonella* reduction in the broiler house over time. Furthermore, a beneficial significant effect on FCR was observed in challenged chicks if IQs were applied, improving economics.



In conclusion, the use of a standardized blend of plant-derived isoquinoline alkaloids offers a promising solution to support broiler chickens challenged with *Salmonella* and contribute to food safety and an economical broiler production.

From the Proceedings of the Australian Poultry Science Symposium

Hatcheries

Breeders

Equipment

UPCOMING EVENTS

2018

March, 13 to 15
MPF Convention

New location for 2018:
Minneapolis Convention Center
Minneapolis, Minnesota

For information please contact:
Midwest Poultry Federation
108 Marty Drive
Buffalo, MN 55313-9338, USA
Website: www.midwestpoultry.com

March 14 to 16
AgroWorld Uzbekistan

Uzexpocentre - Tashkent

For information please contact:
ITE Group
105 - 109 Salusbury Road
London
NW6 6RG
Tel: +44 (0)20 7596 5000
Website: http://agroworld.uz/

March, 21 to 23
Turkey Science and Production Conference

Carden Park Hotel, Cheshire
Cheshire, United Kingdom

For information please contact:
Tel.: +44 (0) 1829 733778
Mobile: +44 (0) 7710 063654
Email: 2017@turkeytimes.co.uk
Website: www.turkeytimes.co.uk

March, 25 to 27
11th Asian Pacific Poultry Conference

Paza Athénée - Royal Méridien Hotel
Bangkok, Thailand

For information please contact:
Dr Charoen Parchariyanon
Email: charoen@pcakinter.com
Website: www.appc2018.com

March 27 to 29
VICTAM ASIA 2018

Bangkok International Trade & Exhibition Centre
Bangkok, Thailand

For information please contact:
Tel.: +66 (02) 749 3939
Email: info@bitec.net
Website: www.bitec.net/

April 8 to 10
IEC Business Conference London 2018

London, UK

For information please contact:
International Egg Commission
Global Headquarters
Second Floor
89 Charterhouse Street
London, United Kingdom
EC1M 6HR
Tel.: +44 (0) 1694 723 004
Fax: +44 (0) 1694 722 048

April 25 to 26
Aviana Nigeria 2018

International Conference Centre
Ibadan, Nigeria

For information please contact:
Aviana Nigeria Team
Tel.: +26 097 1095116
Email: info@avianaafrica.com
Website: www.avianaafrica.com

May, 9 to 12
International Poultry Congress

Cultural and Convention Center
Omer Halisdemir University
Nidge, Turkey

For information please contact:
Prof Dr Ahmet Sekeroglu
Email: ahmet.sekeroglu@ohu.edu.tr
Website: www.ipc2018.org

May, 15 to 16
British Pig & Poultry Fair

NAEC Stoneleigh,
Stoneleigh Park, Warks
CV8 2LGGrandstand
Stoneleigh Events Ltd
Stoneleigh Park Warwickshire
CV8 2LG, United Kingdom

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May 15 to 17
World and Russian poultry breeding development trends, the realities and future challenges

Federal Scientific Centre
«All-Russian Research and
Technological Institute of Poultry»
Russian Science Academy (FSC
"VNITIP" RSA),
Serguiyev Posad, Moscow Region

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May 16 to 18
Feed Additives Asia

Bangkok, Thailand

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June 20 to 22
VIV-Europe 2018

Jaarbeurs, Utrecht,The Netherlands

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Registrazione Tribunale di Firenze n.3162
Spedizione in A.P. Art.2 comma 20/B
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Art Direction & Layout
Laura Cardilicchia - ellecigrafica.com

Cover Image:
© Denise Vernillo

Printed
Nova Arti Grafiche, Florence

English Edition
Year XL • February 2018

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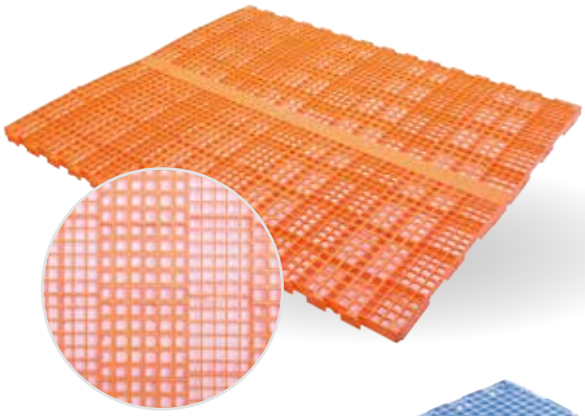

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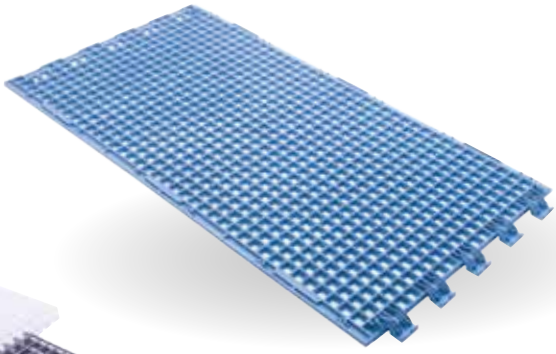

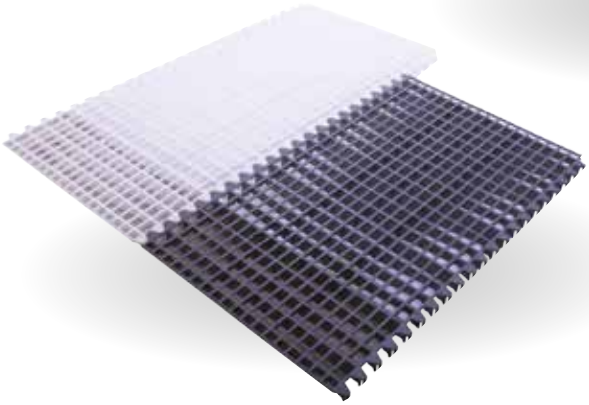

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