



## Biosis Days

# SPECIAL EDITION - Biosis Days 2020

In biology, BIOSIS is based on 'interactions'. ID4FEED has been created with the idea to generate some innovation through the interaction of two different worlds: the plants on one side and animal nutrition and health on the other side.

Very early in the history of the company, the research work focused on the study of the effects of biotic and abiotic stresses applied to plants, plants ability to synthesize secondary metabolites and how such metabolites can contribute to maintain animal health and performance in challenging environment.

After 3 years, ID4FEED was ready to bring to the industry of animal

nutrition the best of its knowledge on plant secondary metabolites and their benefits for animal health and performance, in form of a scientific conference called the BIOSIS DAYS.

Twelve speakers discussed around the theme of the year "Phytogenics as drivers to fight inflammation of digestive systems" in 3 sessions: "Mechanisms of inflammation", "Plant secondary metabolites: production and analysis" and "Application in farm animal". Due to the COVID-19 pandemic, the event was split between a live webinar (106 participants) and 19 local participants in Les Pensières for Global Health center in Annecy (see box below).



## Les Pensières

To hold our BIOSIS DAYS, we chose an exceptional location! Les Pensières Center for Global Health is a majestic residence located in Veyrier-du-Lac, a charming village near to Annecy. With an exceptional view of the lake and a garden planted with trees, the estate also has a history: it belongs to the Mérieux foundation. The Mérieux Foundation is dedicated to fighting infectious diseases in developing countries. In the 1960s, inspired by his commitment to knowledge sharing, Dr. Charles Mérieux turned his family home into a site dedicated to public health. Today, Les Pensières Center for Global Health is a conference center that is designed to encourage discussions and knowledge sharing to advance public health. As we believe animal health is a full part of public health, this center is the perfect place for the BIOSIS DAYS.

## Abstracts

## Session 1 - "Mechanisms of inflammation"

### Cellular and molecular players of the intestinal immune system in production animals.

Dr. Delphine Le Roux - Researcher and assistant Professor in ENVA.

The innate immune system is the first and rapid line of defense against pathogens. These mechanisms include mechanical barriers, chemical barriers and also innate, tissue-resident effector cells such as the neutrophils or macrophages which are able to phagocytose foreign cells. The innate cells have some receptors called PRRs (Pattern Recognition Receptors), such as Toll-Like Receptors, that recognize non-variable molecular signatures of pathogens called PAMPs (Pathogen-Associated Molecular Patterns). At this point, 95 % of the pathogens don't survive. If the infection persists, the macrophages and dendritic cells produce antigenic peptides in order to activate the adaptive immune response. Once an anti-

gen is recognized by helper T-cell, the adaptive immune system produces immune cells specifically designed to attack that antigen. Adaptive immunity includes a memory that makes future responses against the antigen faster and stronger. The GALT (Gut Associated Lymphoid Tissue) is a player of the mucosal immune system. The GALT is the keeper of intestinal homeostasis, able to prevent an excessive response to dietary antigens and to commensal bacteria (tolerance) and also to mount a protective immune response against enteric pathogens (immunity). The GALT includes the Peyer's patches, an aggregate of lymphoid cells which act as a very important site for the initiation of the immune

response. There are 3 ways for pathogens to go through the intestinal epithelium and initiate immune response: through the epithelial cells, the M-cells or the dendritic cells. Dendritic cells are key player of the GALT in order to mediate tolerance to food antigens, limit reactivity to gut microbiota and also generate protective immune response against pathogens. Local intestinal immune system produces antimicrobial peptides and IgA which contribute to the control of pathogens.

Some dietary ingredients can help the GALT, such as vitamin D (better resistance to infections) or vitamin E and selenium (improvement of primary and secondary immune response).

### Development of a rodent model to study virus-induced inflammation processes.

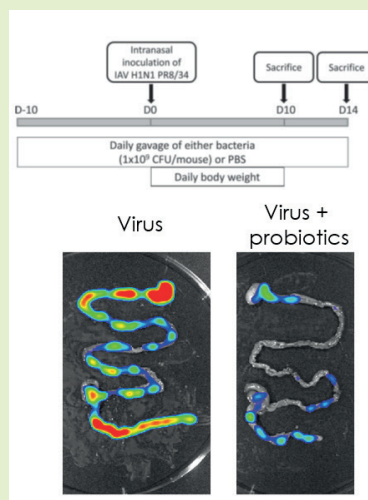
Dr. Ronan Le Goffic - Researcher in INRAE.

In order to understand the mechanisms of host response to infection, a mouse model was developed to visualize the host's immune defense when it is challenged with an influenza virus. Dr. Le Goffic's team created transgenic mouse with a luminescent gene (luciferase) associated with the expression of the NF- $\kappa$ B gene. NF- $\kappa$ B is a transcription factor involved in inflammatory responses. The luminescence of this reporter gene can be tracked in real time in live animals, allowing the research team to locate and quantify the expression of genes of inflammation *in situ*. This transgenic mouse model is used to study the importance of the host's immune response based on viral infection with influenza viruses from avian origin, a highly plastic virus that can contaminate a wide diversity of animal species.

This model, along with the creation of a luminescent virus, made it possible to better understand the consequences of the infection: despite the fact that the virus remains in the respiratory sphere, the virus triggers inflammation at the intestinal level.

Four different academic studies and three applied works have been presented. As an example of academic work, the consequences of intestinal inflammation on gut microbiota population was studied. The researchers sequenced the gut microbiota before inoculation and observed again the population after six days. Some populations of bacteria increased (eg Firmicutes) and some others decreased. Thus, even if the virus infected exclusively the respiratory tract, there were some side effects in the gut. As an example of applied work, a new probiotic candidate was tested for its prophylactic properties. A daily gavage of the probiotic to the mice was done. The image showed that the probiotics were protecting the gut of the mice, as the virus was present in the lungs but not in the intestine.

The use of the luminescent mouse and virus model could be used to measure the effectiveness of various therapeutic molecules or dietary supplements, like plant secondary metabolites. It is a robust model which is cheap, reproducible and easy to set up.



Example of an applied study with the model to test a new probiotic candidate

### How plant secondary metabolites could interfere with inflammatory pathways?

Dr. Francis Hadji-Minaglou - Founder and Scientific Director of Botanicert.

Plants are autotrophic organisms with reduced mobility and in consequence, have high plasticity. They developed the capacity to transform what they absorb into primary metabolites for growth and development (sugars, lipids, amino acids as examples), and secondary metabolites, *i.e.* small size molecules specifically synthesized for plant defense and signalization and highly specific to a family or even a species (eg morphine only in two species of poppy: *Papaver somniferum* and *setigerum*).

Secondary metabolites may be subdivided 4 groups:

- Nitrogen compounds and among them the alkaloids and betalains.
- Phenolic compounds: condensed tannins, anthocyanins (colored compounds) and the wide family of flavonoids with large possibility of hydroxylations, methylations, glycosylations modulating their biological activity and stability level.
- Terpenoids.
- Heterosides (glucosinolates, saponosides).

Most of the plant defense molecules may support the immune system of animals, however there's a strong link between the structure of a molecule and its biological activity. As an example, the anti-inflammatory and antioxidant activity of rosmarinic acid and its derivatives depends on the existence and localization of the phenol hydroxyls and length of the alkoxy groups. Some molecules such as lignans could also be transformed by the gut microbiota and see their activity modified during their journey in the gut.

Finally, in order to optimize the selection of a plant for a specific application, it is necessary to follow a specific process: identify a candidate (plant species/metabolic family), validate it by metabolic analysis (HPLC, GC with either MS, UV, FID, ELSD detection), select an extraction strategy, test the effectiveness of the extract (*in vitro* and *in vivo*) and exacerbate it through the adequate formulation.



## Abstracts Session 2 - "Plant secondary metabolites: production and analysis"

### Meet on the bridge : The Main big movers of well-being market in digestive health.

Dr. Leila Falcao - CEO of Inaturals.

The gut-brain axis is a complex mechanism which consists of bidirectional communication between the central and the intestinal nervous system. Despite the fact that all the mechanisms are not fully understood, there is increasing evidence that show this relationship might influence inflammatory activity. Non-resolution of inflammation is actually considered as one of the major drivers of some human diseases (eg obesity, asthma).

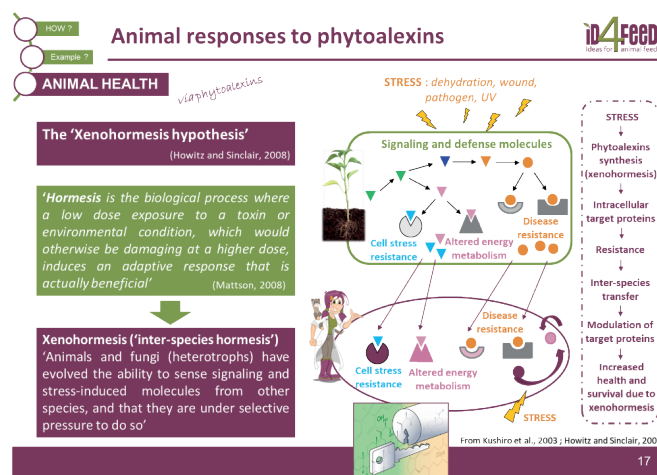
Digestive health is one of the top-trends in the human well-being market. It's a growing market, dominated by North America with a Compound annual growth rate (CAGR) of 13.6 % between 2010 and 2016. According to Euromonitor (2018), the most popular solutions are: probiotics (54 %), digestive enzymes (12 %), psyllium, turmeric, homeopathic and ginger. Concurrently, the number of scientific articles dealing on botanicals

and human health is increasing. One interesting example is turmeric as a source of curcumin. The bioavailability of curcumin is often questioned due to poor absorption associated with poor solubility. This is why we can find innovative patented products which intend to enhance the bioavailability and reduce the daily oral dose (from 3000 mg to 1500 mg). Other interesting examples in human nutrition are ginger root (source of gingerol) for digestive application, milk thistle (source of silymarin) for liver function and psyllium (prebiotic application with around 70 % of hemicellulose). To make the bridge between humans and animals, a question has been asked to the audience: "What solution(s) do you use to support digestive health of animals?". The poll answered organic acids (93 %), phytochemicals (86 %) and probiotics (59 %).

### Better understand the immunity of plants and animals to select plant secondary metabolites. Dr. Camille Rozier - ID4FEED R&D Manager.

As plants are not able to flee in case of an attack, they remain totally subject to the numerous environmental changes of their area of growth such as extreme temperatures or lights, salinity, nutrient deficiency (abiotic stress) or predators, pathogens (biotic stress). A stress or a combination of stress can remain a beneficial stress ("eustress") because it increases the plant resistance, or become a harmful stress ("distress") if it disrupts the plant homeostasis and generates damages in the plant. Plant defense responses are built around a passive strategy with pre-existing structural or chemical defenses (constitutive and localized defenses and phytoanticipins). Unlike animals, plants do not possess mobile defender cells or a somatic adaptive immune system. Then, in addition to pre-existing defenses, they have to induce several biosynthesis cascades in response to extracellular PAMPs (Pathogen Associated Molecular Patterns) or intracellular effectors recognition. This triggers the synthesis of both rapid/local and systemic defenses such as oxidative burst, *de novo* synthesis of secondary metabolites of defenses (SM). When SM are produced as an answer to a stress, we call them phytoalexins. A wide number of biological benefits have been recorded in using plant SM in animals. Two hypotheses have been highlighted to understand the reasons why animals are able to recognize plant specific molecules and use them through specific receptors.

The first one is the 'common origin hypothesis', based on the existence of a common ancestor of plant and animals in the biosynthetic pathways (Kushiro *et al.*, 2003). The second one is the 'xenohormesis hypothesis' (Howitz and Sinclair, 2008) based on the co-evolution of plant and animals that developed the ability to sense stress-induced molecules from other species.



*The explanation why they are then able to recognize plant specific molecules and use them through specific receptors is not so evident – Xenohormesis hypothesis*

Howitz *et al.* (2008). Xenohormesis: sensing the chemical cues of other species. *Cell*, 133(3), 387-391.

Kushiro *et al.* (2003). Hormone evolution: the key to signalling. *Nature*, 422(6928), 122-122.

### Benefits of metabolomics in the analysis of natural products and in the discovery of bioactive molecules. Dr. Serge Michalet - Lecturer at University Claude Bernard Lyon 1.

Metabolomics is the study of the ultimate translation, from genotype to phenotype, of what could happen (genomics, transcriptomics, proteomics) into what is really happening in an organism. The metabolome corresponds to the complete set of low molecular weight molecules, endogenous or exogenous, found within a biological sample at a given time.

In order to interpret metabolomic data with accuracy it is essential to design an appropriate workflow to the biological question (sampling until data processing and understanding). Two approaches could be followed. First, in case the experimenter already has in mind the metabolite or chemical family (i.e profile) to be investigated, targeted analysis (with a priori), should be used. This strategy will procure a specific and extensive knowledge on these molecules, such as content variations. Another preferable option when the

goal is to observe the global and relative differences between samples is the use of untargeted analysis (or metabolite fingerprinting). This method takes into account all detected metabolites without a priori. The data acquisition, i.e metabolite separation and detection, strongly depends on the strategy and workflow, among the most prominent: LC/GC-MS, LC-DAD, NMR, IR. A variety of area may use metabolomic studies, such as medicine, taxonomy, agrochemistry, chemical ecology. To mention just a few applications, it allows to follow biomarkers, finely characterize a sample or even perform quality control. As an example of applied work, it is possible to combine metabolomics with transcriptomics in order to evaluate the modulation in roots and leaves of flavonoids, ellagi/gallotannins, stilbenes after an inoculation of grapevine roots with a growth-promoting bacterial strain.

## Abstracts

### Effects of elicitation treatments on carotenoids and capsaicinoids concentrations of two chili genotypes. Coline Pons - PhD Student ID4FEED and Avignon University.

In *Capsicum* genus (chili), several secondary metabolites have interesting properties to support animal performance and welfare, such as carotenoids (CAR) and capsaicinoids (CAPS). CAR are known to be powerful antioxidants. Their biosynthetic pathway takes place in the chloroplasts and chromoplasts. Interestingly, the total CAR amount is 6-fold increased during fruit ripening (Menichini *et al.*, 2009). CAPS are defense compounds which are responsible for pungent properties. The spiciness ("heat") level is traditionally measured by the Scoville scale. CAPS have been shown to act on the reactions of the oxido-inflammatory cycle of animals. They are synthesized in the placenta.

The synthesis of secondary metabolites can be influenced by several biotic or abiotic stresses. Elicitation is the induction of stress which is applied voluntarily on a culture to stimulate the production of biochemical intermediates (Vasconsuelo and Boland, 2007). As part of a thesis in collaboration between ID4FEED and Avignon University, several elicitation treatments and combinations are studied in order to increase the contents of CAR and CAPS in the chili fruit. First, a chemical characterization in CAR and CAPS of the fruits from genotypes with different ranges of pungency was completed. The identified CAR in chili are carotenes, xanthophylls and xanthophyll esters. Cap-

santhin and capsanthin esters represent 42 % of total CAR. One molecule remains unknown and a purification is currently attempted in order to try to identify this molecule. Several experiments are in progress. Light (UV) and chemical (H<sub>2</sub>O<sub>2</sub>) treatments will be applied on chili pepper plants during cultivation or on harvested fruits. Then, CAR and CAPS concentrations in fruits and gene expression of some genes of biosynthetic pathways will be analyzed.

Menichini F *et al.* (2009) The influence of fruit ripening on the phytochemical content and biological activity of *Capsicum chinense* Jacq. cv Habanero. Food Chem 114: 553-560.

Vasconsuelo A *et al.* (2007) Molecular aspects of the early stages of elicitation of secondary metabolites in plants. Plant Sci 172: 861-875.

### Controlled elicitation in white mustard (*Sinapis alba*) increases glucosinolate production in the whole plant and seed. Pr. Ramon Guevara - University of Queretaro.

Plant exposure to environmental stress with distinct severity, duration, frequency and combinations could either lead, with several growth or development modifications, to the plant resistance (eustress) or death (distress). While stress factors (effectors/PAMPs) are recognized by the plant cell, some enzymes responsible for superoxide/hydrogen peroxide transformation and oxido-reduction state internal control are induced. This triggers phytohormones responses (salicylic and jasmonic acid, ethylene). Finally, this cascade leads to the synthesis of secondary metabolites such as phenylpropanoids (PAL), terpenes or alkaloids to cope with the stress. 'A controlled elicitation is a strategy to look for eustress doses for a stress factor applied during plant cultivation to control the plant defense response in a suitable manner' (Vasquez-Hernandez *et al.*, 2019). It is necessary to follow immunity indicator contents (H<sub>2</sub>O<sub>2</sub>, SOD, CAT, PAL) to optimize the time, intensity and frequency of an elicitation. Indeed, plant allocation to growth/immunity/reproduction is different in case of elicitation (reinforced immunity) or biostimulation (boosted growth). Then, it is essential to find a balance between elicitation and biostimulation responses.

This strategy was tested to increase the production of glucosinolates in white mustard plants and seeds to enhance their insecticide, antiparasitic, antimicrobial, herbicide, anticarcinogenic properties. Under greenhouse conditions, 3 elicitors, salicylic acid (1 mM), chitosan (100 ppm), oligosaccharide (6 ppm), were weekly applied on the plantlets during 60 days, as the effect on H<sub>2</sub>O<sub>2</sub> generation disappears after 7 to 9 days. Foliar application of chitosan significantly increased the leaf, flower and seed content of glucosinolates.

Specific glucosinolates levels detected in white mustard plants elicited with chitosan 100 mg/mL

Identified Glucosinolate	Control (mock-elicited)	Chitosan 100 mg/mL
Sinigrin	34292470 b**	205666629a
Gluconapin	86383525b	561834561a
Glucoiberivin	ND*	602725a
Glucotropaeolin	92611944 b	170879979a
Gluconasturtiin	94116 b	464154a
Sinalbin	33659989 b	64907781a

\* ND: Not detectable - \*\* Values represent area under curve in the mass spectra (GC-MS)

NOTE: In seeds, sinalbin was the main glucosinolate detected and increased in 5-fold with chitosan 100 ppm in comparison with control

*Effect of the elicitation of white mustard plantlets with chitosan and changes in their glucosinolate contents*

Controlled elicitation is a promising strategy to increase in a sustainable way the levels of phytochemicals of industrial interest.

Vázquez-Hernández *et al.* (2019). Eustressors: Chemical and physical stress factors used to enhance vegetables production. Scientia Horticulturae, 250, 223-229.



First edition of The Biosis Days by ID4FEED in October 2020 in Annecy, France



## Abstracts

## Session 3 - "Application in farm animals"

### Field experiences with ID PHYT CAPCIN in Jamaica, Sri Lanka and Saudi Arabia in broilers. Dr. Eilir Jones – Director of Poultry Nutrition Ltd.

Nutrition and feed are one of the 4 interlinked drivers of broiler performance, together with health and biosecurity; genetics and chick quality; and husbandry and environment. All 4 parameters need to be strictly controlled in order to achieve the "world class" performance.

The main desired function of the avian gut consists in digestion and absorption but the gut also has an essential secondary function to defend the organism. Gut innate immune response includes inflammation, that might be enhanced by specific situations, such as heat stress. Therefore, the gut can be a major user of dietary energy and nutrients. One driver to ensure gut health is to reduce the impact of inflammation and this could be achieved thanks to the help of induced\* *Capsicum*.

The effect of ID PHYT CAPCIN supplementation on broiler performance has been tested in three different parts of the world between 2014 and 2020 in standard conditions of production; performance results are summarized in the table on the right. In all three conditions, the benefits of the supplementation on broiler performance in situations of stress have been verified by the companies testing the product in different facilities.

Summary of Dr. Eilir Jones experiences with ID PHYT CAPCIN between 2014 and 2020

	Central America (Jamaica)	Middle East (Saudi)	South Asia (Sri Lanka)
Genetics	Mix of breeds	Ross 308	Cobb 500
Company	1 company 500,000 birds a week	1 company 4 million birds a week	2 integrated companies 0.6 million birds a week
Environment	Very high temperatures Very high humidity	Seasonally high temperature Low humidity	High temperature High humidity
Facilities	From modern to old	Modern facilities	From modern to old
Litter	Aged litter	Clean litter	Clean litter
Main challenge	Climate ('hot/cool' seasonal performance)	Severe field virus challenges	Climate
Diets	Corn/soy	Corn/soy	Corn/soy/particulate organic matter
ID PHYT CAPCIN dosage (g/t)	Program: 200/175	Program: 200/200/150/100	200
Results (Key Performance Indicators)	Weight: 2.32 kg at 39 days FCR: 1.76 EPEF*: NA	Weight: 1.8 kg at 32 days FCR: 1.38 EPEF*: 424	Weight: 1.81 kg at 32 days FCR: 1.63 EPEF*: 344
Results (Comment)	Almost no more impact of the hot season on the ADG Continuous improvement of the performance	Very good performance and less consequences of the virus	Despite the heat challenge, very good performance as compared to the regional standards

\*Induced *Capsicum*: see the presentation related to elicitation

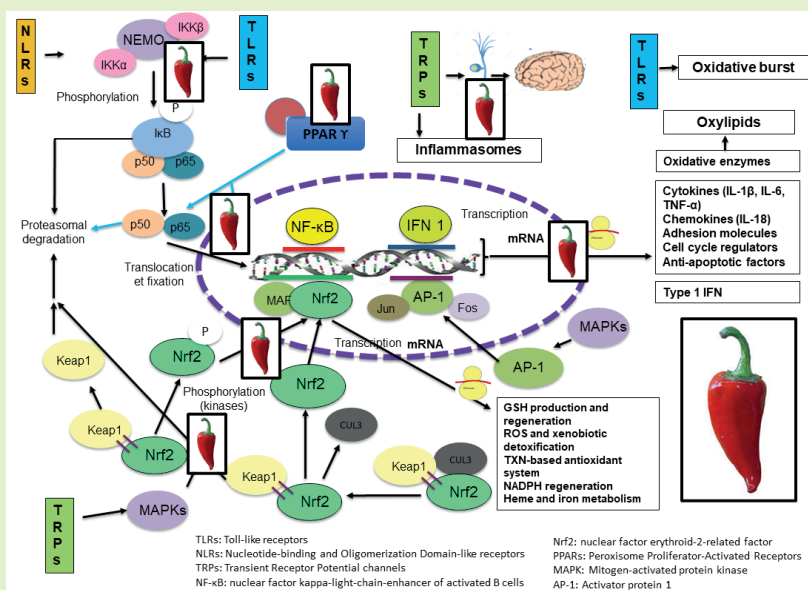
\*\*EPEF= European Production Efficiency Factor= (ADG\* % survival rate) / FCR \* 10

### Application of plant extracts in animal nutrition to fight inflammation of the digestive tract. Dr. Michel Magnin - ID4FEED former R&D Director and consultant.

The immune system is the tool box used by the organism to answer and fight against many stimulators / aggressors (tissue injury or malfunction, excessive nutrients and metabolites, toxins, parasites or microbial infection) and inflammation is its essential, coordinated and adaptable immune response. As Inflammation may also have undesirable consequences, including potentially exacerbating tissue damage, sepsis, immune dysfunction, organ failure and diverting nutrients away from productive purposes, it is necessary to modulate the immune response.

Inflammatory actors and pathways are complex but more and more well-known; they are also identified as targets for the action of many plant secondary metabolites, at least through in vitro studies as the direct demonstration of the effects on animal health and performance in livestock is often limited. Hot pepper fruits contain some compounds (capsaicinoids, luteolin) which have shown positive effects by downregulating the pro-oxidative and pro-inflammatory and upregulating the antioxidative and anti-inflammatory responses. Very positive effects were observed in different species like poultry, pigs or cattle.

Promising ways of improvement could be the synergistic combination of different plant extracts to get a larger spectrum of action, a better dose-response approach, and the vectorization (application of specific galenic forms allowing a better targeting of the delivery and of the action) of the plant extracts.



Identified sites of action of Capsicum metabolites on pro-inflammatory and anti-inflammatory pathways



## Abstracts

### Supplementing Induced *Capsicum* in Diet on Growth Performance and meat quality of growing-fattening pigs.

Pr. Dr. Chaiyapoom Bunchasak - Lecturer in Kasetsart University.

How to find efficient alternatives to antibiotics? Three criteria can be used: the potential of the product to promote feed digestion and absorption, its capacity to promote gut microbiota balance and the positive effect on the gut-brain axis. Looking at these three criteria, chili powder with high content in capsaicinoids may be a good alternative to promote pig welfare and performance (Dray, 1992; Kang Chao et al. 2017; Ramakrishna et al. 2003).

In 2020, an experimental trial was done in growing-finishing pigs (Kasestart University, Thailand). 36 pigs were allocated in 2 groups with 6 replications per group and 3 pigs per replicate. Pigs were fed ad libitum with water available at all times. During the experimental period of 67 days, all groups were fed with the same basal diet and only pigs from the second group were supplemented with ID PHYT CAPCIN at 200 g/t, bringing 1 ppm of capsaicinoids. The experimental diets were formulated according to NRC recommendations (2012), without any antimicrobial agents.

Overall, the supplementation did not affect the final body weight but significantly improved the FCR ( $2.42 \pm 0.04$  vs  $2.30 \pm 0.10$ ,  $p < 0.05$ ) and the ROI ( $p < 0.05$ ). Feed consumption was decreased in this trial. In terms of small intestine morphology, the supplementation tended to im-

prove the villus height in the duodenum ( $p = 0.08$ ), jejunum ( $p = 0.09$ ) and ileum ( $p = 0.09$ ). The blood profile showed a tendency to decrease blood urea nitrogen ( $p = 0.08$ ) and the percentage of monocytes ( $p = 0.06$ ) while a significant increase of eosinophils and basophils contents ( $p < 0.05$ ) was observed with the supplementation. This might lead to decrease contents of glucocorticoid production, a stress hormone, but the mechanism has to be deeper studied. In the feces, there was a tendency to decrease the nitrogen content ( $p = 0.09$ ) and a numerically increased dry matter content. Back fat thickness of the carcass was significantly decreased ( $p < 0.05$ ) and there was a tendency to decrease the % fat ( $p = 0.05$ ) and increase the % lean ( $p = 0.06$ ). The protein content in the meat was significantly increased and the crude fat was significantly decreased ( $p < 0.05$ ). On the texture profile analysis, the springiness was significantly higher ( $p < 0.01$ ) and this is probably linked to the higher content of protein in the meat.

Ramakrishna Rao et al. (2003) "In vitro influence of spices and spice active principles on digestive enzymes of rat pancreas and small intestine." *Food/Nahrung* 47.6, 408-412.

Kang, Chao, et al. (2017) "Gut microbiota mediates the protective effects of dietary capsaicin against chronic low-grade inflammation and associated obesity induced by high-fat diet." *MBio*, 8.3.

Dray, Andy. (1992) "Neuropharmacological mechanisms of capsaicin and related substances." *Biochemical pharmacology* 44.4, 611-615.

## News

### New image for ID Phyt Capcin

We have created an image for one of our most beautiful achievements: ID PHYT CAPCIN! A logo that represents well the performance of our product.



### Webinar Altilis

Zoom the virtual edition of SPACE 2020. Our partner Altilis organized a webinar about pig and poultry nutrition. They received 5 speakers who addressed various topics, such as the use of phytase for amino acid digestibility or sustainable animal protein. Michel Magnin, former R&D Director of ID4FEED, presented the results of a trial with ID PHYT CAPCIN in the diet of lactating sows and piglets after weaning.

### ID4FEED capacities to develop customized feed solutions.

François Gautier - General manager of ID4FEED & ID4TECH.

The *Capsicum* project started in 2014, and is the resultant of multiple partnerships in France and abroad (University of Queretaro, Bordas, CESN, VetAgroSup, etc). *Capsicum* plant is a kind of an "in vivo biofactory" able to answer to different types of stress and produce a wide diversity of secondary metabolites (capsaicinoids, carotenoids, flavonoids, ...). When humans apply some stress to a plant to increase the product of such metabolites, we call it induction. Actually, capsaicinoids are the most widely used secondary metabolites in the world. Extraction is not adapted to induced plant, because we get rid of a part of the interesting metabolites. This is why ID4FEED is promoting the "totum" of the induced plant and this is part of ID4FEED intellectual property. ID4FEED mission is to provide feed supplements and services based on plant and plant extracts. ID4FEED has a strong collaboration with its sister company ID4TECH, which is a research and development and production company with strong eco-extraction capacities. Together, ID4FEED and ID4TECH are the unique association of three competences:

- Plants: one important tool is the use of metabolomics to understand what happens when plants are induced.
- Technologies: from traditional technologies (adsorption, liquid application, emulsion), to innovative technologies such as activation (solubilization and encapsulation of active ingredients in a biologically active matrix), vectorization (encapsulation with targeted release) or kneado-granulation (3-steps process to produce innovative feed supplements). The step 3 of the project (granulation) will be implemented in 2021.
- BIOSIS: this means the effect of such products on animal performance and health.

ID4FEED product range is playing at different steps of the oxido-inflammatory cycle. Tailor-made products can also be developed, and especially the combination of *Capsicum* with a lot of different ingredients.



## DIARY

### Virtual Edition

IPPE (International Production & Processing Expo)

26-28 Jan.

### Virtual Edition

JRP (Journée de la recherche porcine)

1-4 Feb.

### Virtual Edition

Eurotier

9-12 Feb.