White Paper | 11.05.2026

Hilucia™ for Pets: a promising functional ingredient to accelerate the resolution of inflammation

In vitro trials demonstrate that the **hydrosoluble fraction of Hilucia™ for Pets selectively regulates cytokine secretion**, reducing TNF-α while enhancing anti-inflammatory IL-10. This makes Hilucia™ for Pets **ideal for sensitive and health pet diets**.

Gérald Chêne | *Head of Laboratory at Ambiotis*
Laure Saias, PhD | *R&D Business Developer Manager at Ambiotis*
Amélie Maurice | *R&D Engineer at Innovafeed*
Marine Bézagu, PhD | *Head of Product Development at Innovafeed*

KEY MESSAGES

In an established *in vitro* dog cell model, the hydrosoluble fraction of Hilucia™ for Pets showed a strong potential to modulate the secretion of different cytokines, overall promoting the inflammation resolution. More specifically, our findings showed that:

- **The exposure to Hilucia™ for Pets hydrosoluble fraction reduced the secretion of TNF-α, to levels comparable with dexamethasone, a reference anti-inflammatory molecule.**
- **The secretion of IL-10, an anti-inflammatory cytokine, was increased with the presence of Hilucia™ for Pets hydrosoluble fraction**

It is important to note that contrarily to standard anti-inflammatory compounds, such as dexamethasone, that tend to reduce the secretion of all cytokines, Hilucia™ for Pets hydrosoluble fraction selectively reduced or increased the secretion of cytokines depending on their role to solve the inflammation.

This study suggests that Hilucia™ for Pets can be included in diets as an anti-inflammatory ingredient, which is particularly relevant for sensitive or joint health[1] pet food diets.

THE IMPORTANCE OF INFLAMMATION REGULATORS IN PET FOOD AND AQUACULTURE

Acute inflammation is a protective phenomenon meant to protect the body against invading bacteria and to overcome injuries.

Facing a bacterial challenge, the pro-inflammatory immune response is the first to take place. Once the tissues are repaired and healed, that acute inflammation is resolved in a phase called the resolution.

However, **in some circumstances, the resolution fails and chronic inflammation develops**. It can lead to various diseases, such as skin, gastrointestinal or urinary disorders[2], and even cancers in the long term. In the case of osteoarthritis, a common condition in obese or aging dogs, inflammation causes pain and discomfort, thus preventing improvement in the pet's quality of life.[1]

Therefore, there is an important **need for anti-inflammatory ingredients in the feed and pet food industries to ensure the resolution of inflammation and prevent the development of chronic diseases**. Currently, whole foods, phytonutrients from fresh fruits and vegetables, omega-3 fats or dietary fibers can be added to pet food diets to benefit from their anti-inflammatory effects.[3] Insects are explored as a source of polyphenols with antioxidant properties. The addition of fermented mealworm in a pet food diet improved antioxidant and anti-inflammatory indicators measured with spectrophotometric and indirect assays.[4] Researchers recently studied **bioactive peptides obtained from black soldier fly larvae with promising anticancer and antioxidant effects**.[5]

Knowing that our product contains peptides and polyphenols, these recent findings led us to investigate its anti-inflammatory potential.

THE ROLE OF CYTOKINES IN THE INFLAMMATION

Cytokines are small, secreted proteins that play a critical role in cell signaling and communication within the body. They are essential mediators of immune responses, inflammation, and various other physiological processes.[6]

Following a bacterial challenge, **specific cytokines are secreted both during the early pro-inflammatory immune response, and then to resolve the inflammatory state.**

For example, IFN-γ and IL-23 are pro-inflammatory cytokines, while IL-10 and TGF-β are released to resolve it.[2] The study of cytokines expression is therefore relevant to **understand the inflammatory state's progression**.

Given the diverse effects of cytokines, the reduction of all cytokine secretion is not necessarily optimal in accelerating the resolution of inflammation.

In dogs, there are numerous novel therapies that inhibit TNF-α expression to treat gastrointestinal disorders (enteropathies). Dietary therapy is also often beneficial in the treatment of chronic canine enteropathies, especially with novel or hydrolyzed proteins.[7]

In Aquaculture, inflammatory processes are also involved in fish health. Due to the use of soybean meal, Atlantic Salmon tends to suffer enteritis, a distal intestinal pathology that can lead to reduced growth and feed efficiency.[8]

The expression of pro-inflammatory cytokines (as TNF-α) is increased, while the expression of anti-inflammatory cytokines (as IL-10) is reduced.[9] The addition of an inflammatory regulator could balance the expression of these cytokines.

OUR RESULTS HIGHLIGHT THE ANTI-INFLAMMATORY PROPERTIES OF HILUCIA™ FOR PETS

In a study conducted by Ambiotis, a Contract Research Organization (CRO) specialized in the active resolution of inflammation, **the secretion of cytokines was measured in canine whole blood incubated with the hydrosoluble fraction of Hilucia™ for Pets**, 18 hours after immune response stimulation by LPS (a pyrogenic bacterial endotoxin). Three cytokines were quantified:

- **IL-6, which has both pro- and anti-inflammatory effects**
- **TNF-α, which is a pro-inflammatory cytokine**
- **IL-10, an anti-inflammatory cytokine**

The amount of each cytokine produced in the absence of contact with insect hydrosoluble fraction was also measured and is represented as negative control. The effect of dexamethasone, a known anti-inflammatory compound, on cytokine production was assessed similarly and is identified as the positive control.

Regarding the pro-inflammatory cytokine TNF-α[10], the exposure to Hilucia™ for Pets hydrosoluble fraction decreased its production in canine blood. **A concentration of 1 g of Hilucia™ for Pets hydrosoluble fraction per liter of blood is sufficient to observe a similar effect as 1 µM of dexamethasone, indicating a strong anti-inflammatory effect of Hilucia™ for Pets**. At the highest concentration tested, the secretion of TNF-α is higher than at lower concentrations, but remains lower than the negative control (blood without compound). Additional testing would be required to determine the maximum concentration that can be reached in canine blood through a diet containing Hilucia™ for Pets, and to establish whether there is an optimal or minimal inclusion rate.

The production of **IL-10, one of the most important anti-inflammatory cytokine**[10], was increased following the exposure to Hilucia™ for Pets hydrosoluble fraction, even at lowest tested concentrations. **The increase in IL-10 concentration with the increase of Hilucia™ for Pets concentration demonstrates the effect of Hilucia™ for Pets in solving inflammation**.

The exposure of blood to Hilucia™ for Pets hydrosoluble fraction modulated the release of cytokine IL-6. At low concentrations, the product had an inhibitory effect on the production of IL-6, with a similar effect to dexamethasone between 1 to 2 g of Hilucia™ for Pets hydrosoluble fraction per liter of blood. Increasing further the concentration increased the production of IL-6 above the negative control from 16 g of Hilucia™ for Pets hydrosoluble fraction per liter of blood.

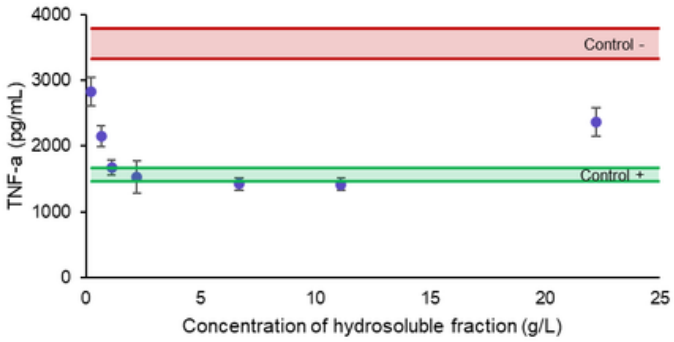

Fig.1 Average concentration of TNF-α depending on the concentration of Hilucia™ for Pets hydrosoluble fraction introduced

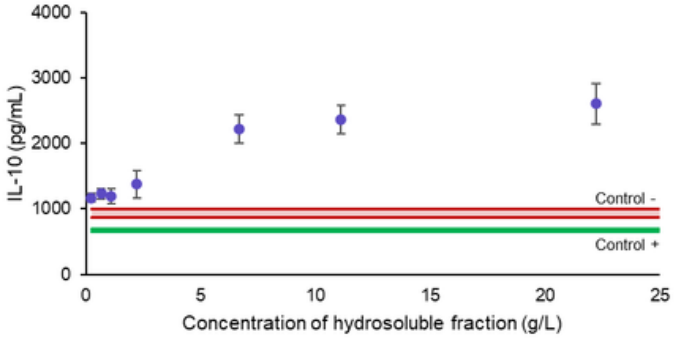

Fig.2 Average concentration of IL-10 depending on the concentration of Hilucia™ for Pets hydrosoluble fraction introduced

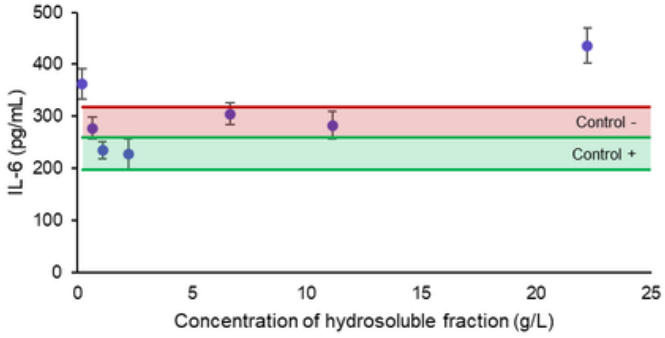

Fig.3 Average concentration of IL-6 depending on the concentration of Hilucia™ for Pets hydrosoluble fraction introduced

Knowing the **dual effect of IL-6 on inflammation**[10], it is interesting to notice that the effect of **Hilucia™ for Pets hydrosoluble fraction can promote or inhibit the production** of the cytokine depending on its concentration.

CONCLUSION AND RECOMMENDATIONS

On a dog blood *in vitro* model, Hilucia™ for Pets hydrosoluble fraction increases the production of anti-inflammatory cytokine IL-10 and decreases the production of pro-inflammatory cytokine TNF-α. Based on recent articles and the composition of Hilucia™ for Pets' hydrosoluble fraction, **the effect is most likely due to the presence of polyphenols and other bioactive compounds such as short-chain peptides in this product**. This new study confirms the functional character of the BSFL-derived ingredients and reinforces their positioning as a **key health ingredient to improve and accelerate the resolution of inflammation in animals**.

The positive effects of Hilucia™ for Pets hydrosoluble fraction were observed at concentrations above 1 g of product per liter of blood. While the exact inclusion rate of Hilucia™ for Pets required to induce the same active concentration in blood cannot be determined precisely without further in vivo testing, an estimation can be proposed here based on the assumed product's bioavailability and the average dog's blood volume. We can therefore **hypothesise that a 3% inclusion rate of Hilucia™ for Pets in dog kibble, would release a sufficient quantity of compounds into the animal's bloodstream to observe an effect on its inflammatory state.**

Gérald Chêne | *Head of laboratory at Ambiotis*

The resolution of inflammation is a key physiological process that restores tissue balance while maintaining immune system effectiveness. Through its dual modulation of cytokines—stimulating IL-10 and inhibiting TNF-α — ***Hilucia™ provides an innovative mechanism of action that naturally activates the body's own pathways for resolving inflammation.***

Please note: The study has been conducted with specific ingredients and inclusion levels. The statements, results and potential benefits mentioned herein should be regarded as sources of inspiration that may be further developed into (claims for) end-products that must be compliant with the local legal requirements.

MATERIAL AND METHODS

INSECT MEAL INGREDIENT MANUFACTURING

Black Soldier Fly larvae were reared at Innovafeed, France. They were fed for about 15 days with wheat byproducts, before being harvested through a sieving process. After larvae blanching and washing, they were submitted to a transformation process consisting of defatting the larvae with a centrifuge system, then drying and collecting the defatted BSFL meal. The ingredient tested, Hilucia™ for Pets hydrosoluble fraction, corresponds to the concentrated hydrosoluble fraction obtained after the centrifuge system, before its reintroduction in the drier to obtain our commercial product sold under the name Hilucia™ Protein. The soluble fraction, known as 'stickwater' in other industries, was used directly containing 40% dry matter.

CYTOKINES PRODUCTION IN WHOLE BLOOD ASSAY

The trial was conducted by Ambiotis (Toulouse, France). Blood from male beagles was provided by OCCILIFE (Fontenilles, France). Upon arrival, it was plated in 96-well plates with antibiotics. The hydrosoluble fraction of Hilucia™ for Pets was added for a preincubation duration of 6h. PBS-/- was used in vehicle and negative control, while dexamethasone was used as positive control. Inflammatory stimulation was performed with LPS. After a total of 24h of incubation, blood was centrifuged to collect plasma. The concentration is expressed as the quantity of Hilucia™ for Pets hydrosoluble fraction added to obtain one liter of solution, ranging from 0.22 to 22.2 g.

Cytokines (IL-6, IL-10, and TNF-α) were analysed in plasma using a milliplex assay kit from MERCK-MILLIPORE (Darmstadt, Allemagne) and measured on a Luminex MAGPIX (Austin, USA).

STATISTICAL ANALYSIS

Data are presented as the mean of six replicates ± standard deviation. Concentration 3.125 g/L was tested on three different batches of Hilucia™ for Pets hydrosoluble fraction. The mean of eighteen replicates was then plotted with the associated standard deviation. The controls are represented by the mean plus and minus the standard deviation, based on six replicates.

REFERENCES

1. The importance of an anti-inflammatory diet for dogs - Guides | Big Dog Pet Foods. Accessed January 7, 2026. https://www.bigdogpetfoods.com/guides/antiinflammatory-diet-for-dogs

2. Neurath MF. Resolution of inflammation: from basic concepts to clinical application. Semin Immunopathol. 2019;41(6):627-631. doi:10.1007/s00281-019-00771-2

3. The importance of an anti-inflammatory diet for dogs - Guides | Big Dog Pet Foods. Accessed January 7, 2026. https://www.bigdogpetfoods.com/guides/antiinflammatory-diet-for-dogs

4. Yu YH, Huh CK, Kim HJ, Kim SH. Positive impact of fermented mealworms in pet food associated with preservation, antioxidant activity, anti-inflammatory effects, nutrition, and digestion. J Insects Food Feed. 2025;1(aop):1-10. doi:10.1163/23524588-bja10320

5. Praseatsook K, Vachiraarunwong A, Taya S, et al. Anticancer and Antioxidant Effects of Bioactive Peptides from Black Soldier Fly Larvae (Hermetia illucens). Nutrients. 2025;17(4):645. doi:10.3390/nu17040645

6. Bio M. Cytokine %. Massive Bio. December 23, 2025. Accessed January 7, 2026. https://massivebio.com/cytokine-bio/

7. German A j., Hall E j., Day M j. Chronic Intestinal Inflammation and Intestinal Disease in Dogs. J Vet Intern Med. 2003;17(1):8-20. doi:10.1111/j.1939-1676.2003.tb01318.x

8. Bledsoe J, Redman N, Simmons D, et al. Proteomic mechanisms underlying soybean meal-induced enteritis resistance in selected rainbow trout. J World Aquac Soc. 2025;56(6):e70068. doi:10.1111/jwas.70068

9. Zhang W, Tan B, Deng J, Haitao Z. Multiomics analysis of soybean meal induced marine fish enteritis in juvenile pearl gentian grouper, Epinephelus fuscoguttatus ♀ × Epinephelus lanceolatus ♂. Sci Rep. 2021;11(1):23319. doi:10.1038/s41598-021-02278-z

10. Stenvinkel P, Ketteler M, Johnson RJ, et al. IL-10, IL-6, and TNF-α: Central factors in the altered cytokine network of uremia—The good, the bad, and the ugly. Kidney Int. 2005;67(4):1216-1233. doi:10.1111/j.1523-1755.2005.00200.x

Ingredients with Benefits, Backed by Science

INNOVAFEED

ambiotis resolve inflammation