Press release – 24 July 2023

Lyme disease: an innovative vaccine candidate to make ticks less dangerous

Ticks are the leading vector of disease for animals, and rank second for humans. Lyme disease, the best-known tick-borne illness, is caused by a bacterium. Tests have been conducted on an innovative vaccine targeting the tick microbiota, with a view to reducing tick infection by this bacterium. This work was carried out by INRAE in collaboration with ANSES and the Alfort National Veterinary School, and the results were published in the journal *Microbiome* on 24 July.

Lyme disease is caused by bacteria of the genus *Borrelia,* which are carried and transmitted by ticks, mainly *Ixodes ricinus* in Europe and *Ixodes spacularis* in the United States and Canada. Despite extensive research, no vaccine is available against this disease. For this reason, researchers at INRAE, in collaboration with ANSES and the Alfort National Veterinary School, are proposing a new form of indirect vaccination to combat Lyme disease, by targeting ticks.

The concept is based on a vaccine that disrupts the tick's microbiota[1]. For their experiments, the researchers injected mice with the vaccine. Specifically, they used another bacterium, harmless in this context, as a Trojan horse.

Once in the body, this harmless bacterium[2] causes mice to produce antibodies. If the mouse is then bitten by a tick, these antibodies interact with and alter the tick's microbiota.

Analysis of post-bite ticks showed that they carried much less *Borrelia* than ticks that had bitten unvaccinated animals. When administered to a mouse, therefore, this vaccine "protects" the tick from colonisation by *Borrelia* (but does not protect the mouse from the disease).

The work concluded with a twofold advance: new knowledge on the importance of the microbiota in the infection of ticks by *Borrelia,* and a potential innovative vaccination strategy. The results confirm that the tick microbiota is a key factor in the development of *Borrelia* in ticks. This essential information raises the possibility of developing an innovative vaccination strategy aimed at disrupting the microbiota of vectors of the agent responsible for Lyme disease.

[1] The *Borrelia* bacterium lives in the tick's microbiota.

[2] A harmless strain of *Escherichia coli* was used in the experiment. This bacterium has many varieties, some of which can be harmful.

A global issue

Ticks are not the only vectors of disease. There are also mosquitoes, which transmit numerous diseases such as dengue fever, Zika and malaria. Controlling and protecting against these vectors, and the diseases they carry, is therefore a global public health issue. There are currently no vaccines able to protect humans from contracting these diseases, only treatments designed to cure or relieve patients. Anti-microbiota vaccines represent an opportunity to develop innovative vaccines against vector-borne pathogens.

Reference: Wu-Chuang A./ Mateos-Hernandez L./ Maitre A. *et al.* (2023). **Microbiota perturbation by anti-microbiota vaccine reduces the colonization of *Borrelia afzelii* in *Ixodes ricinus.* Microbiome.** DOi: 10.1186/s40168-023- 01599-7

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About INRAE

INRAE, the French National Research Institute for Agriculture, Food and the Environment, is a major player in research and innovation. The Institute brings together a community of around 12,000 people, with 273 research, support and experimental units located in 18 centres throughout France. Specialising in targeted research, the institute is one of the world's top research organisations in agricultural, food, plant and animal sciences, as well as in ecology and the environment. It is the world's leading research organisation specialising in the "agriculture-food-environment" complex. INRAE's ambition is to be a key player in the transitions needed to address society's greatest global issues. In the face of population growth and the challenges of food security, climate change, resource scarcity and biodiversity decline, the institute has a major role to play to build solutions and support the necessary acceleration of the agricultural, food and environmental transitions.

About ANSES

The French Agency for Food, Environmental and Occupational Health & Safety (ANSES) provides public decision-makers with the scientific benchmarks needed to protect humans and the environment from health risks. It studies, assesses and monitors all the chemical, microbiological and physical risks to which humans, animals and plants are exposed, thereby helping the public authorities take the necessary measures, including in the event of a health crisis. A national agency working in the public interest, ANSES comes under the responsibility of the French Ministries of Health, the Environment, Agriculture, Labour and Consumer Affairs.

About the Alfort National Veterinary School

The Alfort National Veterinary School (EnvA), a higher education and research institute of the French Ministry of Agriculture, is a reference in animal care. Its key areas of activity are training future veterinarians, advancing scientific knowledge of animal diseases, and caring for animals in four university veterinary hospitals (for pets, horses, farm animals and wildlife). The school's research focuses on animal diseases, infectious and zoonotic risks, and the pathophysiology and treatment of muscular, locomotor and reproductive disorders. EnvA is the oldest veterinary school still on its original site; it has been in Alfort since 1766.