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Mélanie Gunia, Mily Leblanc-Maridor, Sylvie Combes, Hervé Garreau, Petitjean Olivia, Marie-Christine Meunier-Salaün, Matthieu Reichstadt, Nathalie Le Floc'H

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THE AHOL (ANIMAL HEALTH ONTOLOGY FOR LIVESTOCK) ONTOLOGY FOR INTEGRATING DATA ON THE MAIN DISEASES OF FARMED ANIMALS: AN EXAMPLE FOR THE RABBIT SECTOR

Gunia M.[1]*, Leblanc-Maridor M. [2], Combes S.[1], Garreau H.[1], Petitjean O.[1], Meunier-Salaün M.-C.[2], Reichstadt M.[3], Le Floc'h N.[4]

[1]GenPhySE, INRAE, Université de Toulouse, ENVT, 31320 Castanet-Tolosan, France
[2]ONIRIS, INRAE, BIOEPAR, 44307 Nantes, France
[3]Université Clermont Auvergne, INRAE, VetAgro Sup, UMR Herbivores, 63122 Saint-Genès-Champanelle, France
[4]PEGASE, INRAE, Institut Agro, 35590 Saint Gilles, France
*Corresponding author: melanie.gunia@inrae.fr

ABSTRACT

Disease management in animal production is essential and requires comprehensive data integration. An ontology is a means of organizing knowledge and represents a set of concepts with logical relationships between them. The Animal Health Ontology for Livestock (AHOL), developed by INRAE, provides a standardized framework for organizing farm animal health traits. AHOL categorizes diseases, symptoms, affected species and pathogens, promoting interoperability and facilitating knowledge sharing. This article presents the development of AHOL and its possible application in the rabbit sector. AHOL offers a valuable resource accessible on its website with data on 60 rabbit diseases, their symptoms and pathogens: https://www.umrh.inrae.fr/ontologies/visualisation/public/ahol/diseases/show. Each of these elements is classified in a tree structure to facilitate the search and organization of information. Ongoing evolution and collaborative efforts are essential to the continuous improvement of AHOL and the extension of its application to animal health management. This tool can be used by professionals or students in animal health, as well as by all scientists or professionals working with farm animals.
Key words: Ontology, Disease, Rabbit, Database.

INTRODUCTION

Health management is crucial in animal production. It involves the identification of diseases and the development of study and methods to prevent, reduce, and cure diseases. Numerous studies and databases exist concerning animal health. However, an efficient disease management necessitates comprehensive data organization and integration. The Animal Health Ontology for Livestock (AHOL), a collaborative initiative led by INRAE with the participation of French Veterinary schools, addresses this need by providing a standardized framework for integrating and structuring information related to the health of farmed animals. An ontology is a way to organize knowledge and represents a set of concepts with the logical relations between these concepts (Ferret, 2021). As such, AHOL, categorizes and organizes information on diseases, symptoms, affected species, and pathogens in livestock. The overarching goal is to establish a common vocabulary that enhances interoperability, facilitates knowledge sharing, and promotes a unified understanding of animal health. The aim of this article is to present the development and application of the AHOL ontology for the rabbit farming sector. The rabbit farming sector is actively engaged in the reduction of antibiotic use and health management. Ontology is therefore a valuable tool to help professionals organize health information in a clear and easy way.

MATERIALS AND METHODS

Creation of the ontology

The Ontology AHOL was created in 2017 to complement the ATOL Ontology (Animal Trait Ontology for Livestock) created in 2009 and the EOL Onotology (Environment Ontology for Livestock) created in 2013. The EOL ontology describes the environmental conditions of domestic animal breeding. More specifically, it describes feeding, environment, farm

structure and breeding systems. ATOL is an ontology of all measurable or observable traits of livestock. It includes growth and meat production, reproduction, animal welfare trait, nutrition trait and other traits. As disease-related traits were not included, the new AHOL ontology was created to fill this gap for farm animals. Working groups for each animal species (or group of animal species) were created with experts from different fields (computer scientists, veterinarians, researchers, experimental farm managers). AHOL is structured into four sections: diseases, symptoms, pathogens and animal species. Diseases are classified into branches according to their type (transmissible, genetic, infectious, genetic), and each disease is linked to associated symptoms, affected species and relevant pathogens. This hierarchical structure enables a clear understanding of the relationships between the different elements of the ontology.

A template for collecting disease information
The experts defined the first diseases to be implemented (generally the main diseases present on farms or in INRAE's experimental facilities) and created a template to collect the main disease information (disease name, chronic or acute, pathogen, disease transmission, species affected, sex, age, physiological state, symptoms, effects on production characteristics). The disease template evolved over time, with the addition of new information (type of disease: infectious, nutritional, metabolic, genetic... to help classify the disease in the ontology; aggravating factors, disease evolution, affected breed, description of clinical signs). Finally, a more efficient approach was adopted. The template was simplified and only the main information was retained: disease name and definition, pathogen, disease transmission, affected species, symptoms. The list of rabbit diseases has been extended to provide a more comprehensive overview of rabbit diseases. Some diseases corresponding to syndromes (a combination of symptoms characterizing an abnormal state) have also been added.

Sources of information
AHOL data come from a variety of sources, including scientific publications, veterinary databases and expert opinions. For rabbits, the main sources of information were based on books (Boucher and Nouaille, 2013; Nowland and Brammer, 2015; Varga, 2014) and online veterinary manuals (MSD Veterinary Manual; Diseases of Research Animals DORA). Additional information was sought in specific scientific publications on the disease if necessary. After a first cycle of implementing the diseases in the ontology, the disease definitions were harmonized to include the main elements: type of disease, whether it is a zoonosis, pathogenesis or factors causing the disease, transmission, main symptoms and animal species affected.

Description of symptoms
Symptoms (defined as disorder or sign observable on clinical examination which is the manifestation of a disease and its evolution) have also been organized into branches and definitions have been included, based on other ontologies used in human medicine and animal anatomy (SNOMED CT,CSSO, SYMP ontologies available on https://bioportal.bioontology.org).
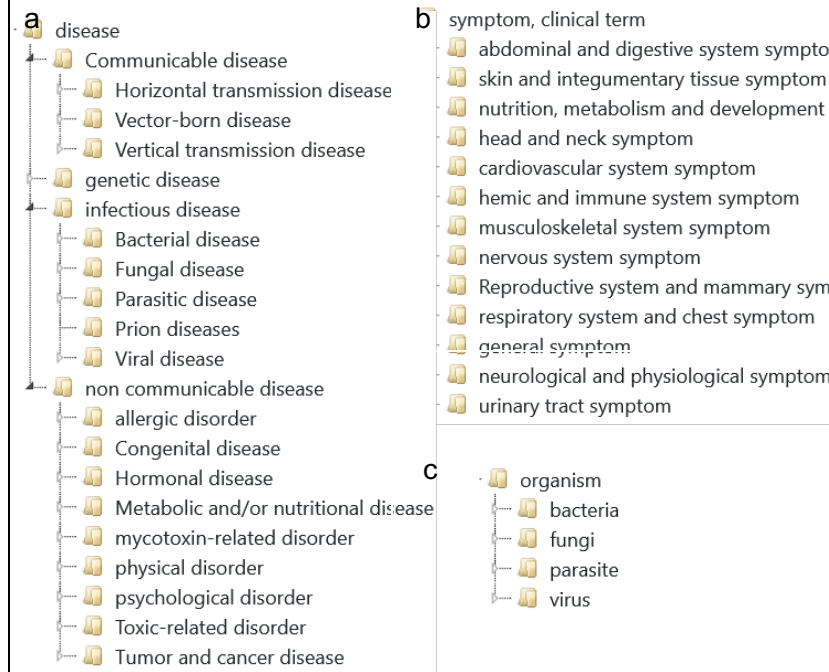
RESULTS AND DISCUSSION
Presentation of the ontology website
The AHOL ontology can be found here:
https://www.umrh.inrae.fr/ontologies/visualisation/public/ahol/diseases/show. A search bar enables a quick search on a specific disease or on diseases affecting rabbits. At present, about 60 rabbit diseases are listed in the ontology.
Three ontology sections (Diseases, Pathogens, Symptoms) are accessible on the left-hand side of the screen. Each section is organized into branches and sub-branches (Figure 1).

Figure 1: Hierarchical organization of the ontology into branches for the a) diseases section, b) symptom sections, c) pathogens section of the AHOL Ontology.

a) disease
- Communicable disease
  - Horizontal transmission disease
  - Vector-born disease
  - Vertical transmission disease
- genetic disease
- infectious disease
  - Bacterial disease
  - Fungal disease
  - Parasitic disease
  - Prion diseases
  - Viral disease
- non communicable disease
  - allergic disorder
  - Congenital disease
  - Hormonal disease
  - Metabolic and/or nutritional disease
  - mycotoxin-related disorder
  - physical disorder
  - psychological disorder
  - Toxic-related disorder
  - Tumor and cancer disease

b) symptom, clinical term
- abdominal and digestive system sympto
- skin and integumentary tissue symptom
- nutrition, metabolism and development
- head and neck symptom
- cardiovascular system symptom
- hemic and immune system symptom
- musculoskeletal system symptom
- nervous system symptom
- Reproductive system and mammary sym
- respiratory system and chest symptom
- general symptom
- neurological and physiological symptom
- urinary tract symptom

c) organism
- bacteria
- fungi
- parasite
- virus

Each disease is assigned to at least one branch. Many infectious diseases are found in two branches: an infectious disease can be a transmissible disease. For example, colibacillosis will be found in the communicable disease/ horizontal disease branch and in the infectious disease/ bacterial disease/Escherichia coli infection branch.

The symptoms section is organized into 13 branches according to the affected system (respiratory, digestive, etc.). The pathogen section is divided into four branches (bacteria, fungi, parasites, viruses). Clicking on a disease or symptom opens a sheet containing the name and the definitions in English and French. The disease sheet (example Figure 2) presents also the list of main symptoms, the pathogen(s) causing the disease and the animal species affected.

Ontology uses

AHOL helps standardize data, promote interoperability and foster a common understanding of diseases. The ontology's structured format enables efficient cross-referencing of information, facilitating access for researchers, veterinarians and other stakeholders. The ontology can be used by researchers to reference a common vocabulary, add metadata to scientific articles or databases deposited in public repositories, and for meta-analyses. The ontology can also be used as a pedagogical tool for animal health students. Indeed, AHOL provides a complete and organized summary containing only the main information. More generally, ontology can be used for animal health management, to explore the link between pathogen and symptoms, or between pathogens, or to compare diseases between animal species.

Adaptation and improvements

The AHOL ontology is still evolving, with many diseases still missing. Eventually, links could be built between different ontologies whose terms are interoperable, as for example with ATOL whose traits can be linked to symptoms in AHOL. An important development would be the ability to search for a symptom and obtain the corresponding diseases as a result. The rabbit diseases presented here mainly concern animals raised in a temperate European environment. The inclusion of diseases presents in other environments around the world would be necessary. The ontology is the result of a collaborative effort. If you have any suggestions for improving the ontology or implementing other rabbit diseases, please contact the corresponding author.

Figure 1: Screenshot of the Pasteurellosis disease sheet in the online AHOL ontology

CONCLUSIONS

The development and application of AHOL represents a crucial step towards a standardized, interoperable system for organizing farm animal health data. AHOL provides a comprehensive framework for organizing health information. It needs to be continually adapted and extended. AHOL can be a valuable resource for researchers, veterinarians, industry and educators.

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