Text mining tools for extracting information about microbial biodiversity in food

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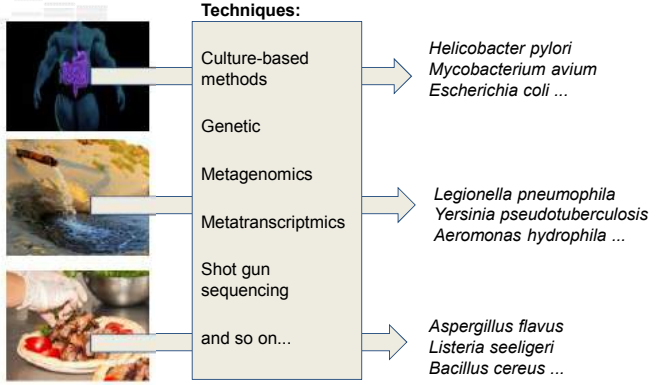
Microbial ecosystems

Which microbes live in an environment?



Properties of environment? Microbial Interaction?

Crossing between microbial species and habitats

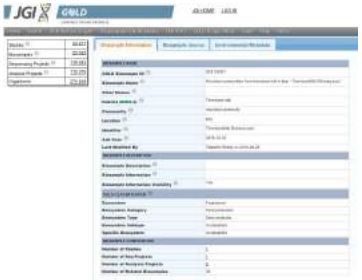
Difficulty : Highly variable forms in text or genomics database (GOLD, SRA, GenBank)


RESEARCH LETTER
Biogenic amine-forming microbial communities in cheese

"Bacteria of the genera *Enterococcus* and *Lactobacillus* and coliform bacteria were isolated from Dutch-type semi-hard cheese"


High incidence of *Listeria monocytogenes* in European red smear cheese

"Out of European red-smear cheese samples of various types [...] 1.2% of the samples were contaminated with *L. seeligeri*"



e.g.
- Artisanal cheeses from Tucuman
- Dairy cheese
- Caciocavallo cheese in Italy

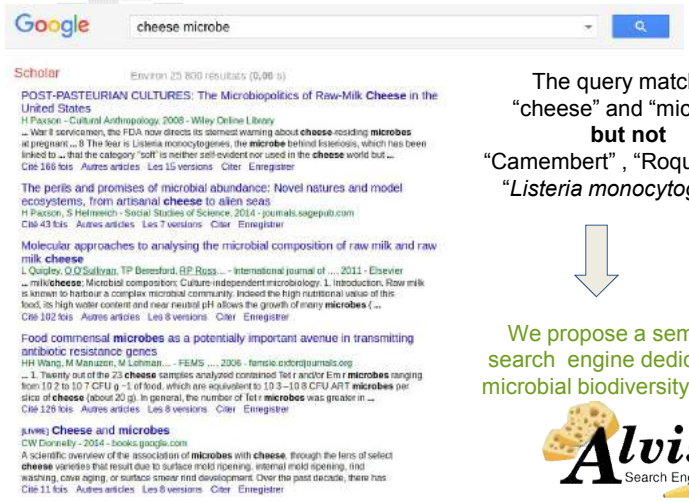
Habitat information is neither queryable nor comparable

Described at different levels of accuracy and not standardized

What is the cheese microflora?

"Geotrichum candidum strains isolated from a traditional Spanish goats' milk cheese."
"Escherichia coli O157:H7 isolated from raw beef, soft cheese and vegetables in Lima"
"Microbial ecology of Gorgonzola rinds and occurrence of different biotypes of *Listeria monocytogenes*."

Classic search engine query



The query matches
“cheese” and “microbe”
but not
“Camembert” , “Roquefort” or
“*Listeria monocytogenes*”

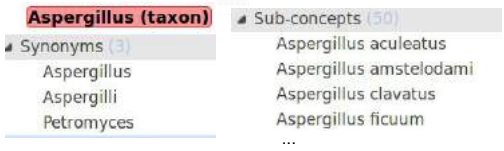
We propose a semantic search engine dedicated to microbial biodiversity in food.

Alvis Search Engine

Semantic search engine of microbial habitat in food

Interpretation of the query

Aspergillus :



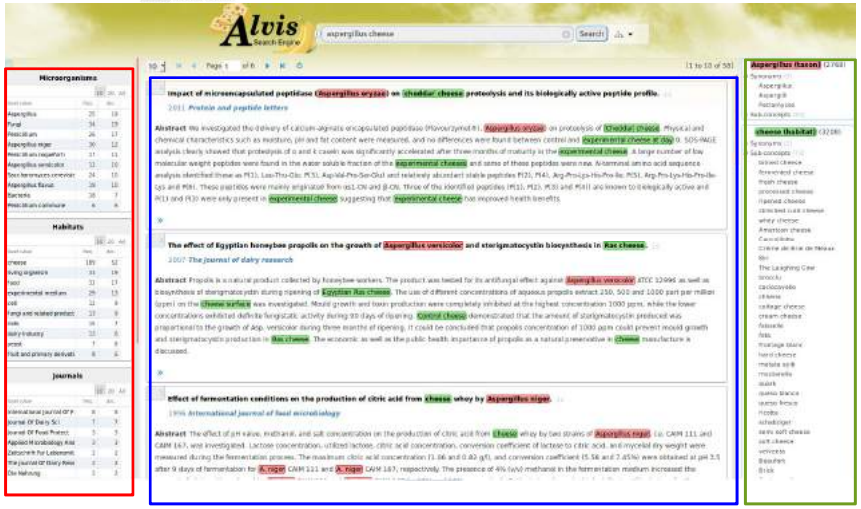
Cheese :

American cheese
Cancoillotte
Crème de Brie de Meaux
Kiri
The Laughing Cow
brocciu
caciocavallo
chhena
cottage cheese
cream cheese

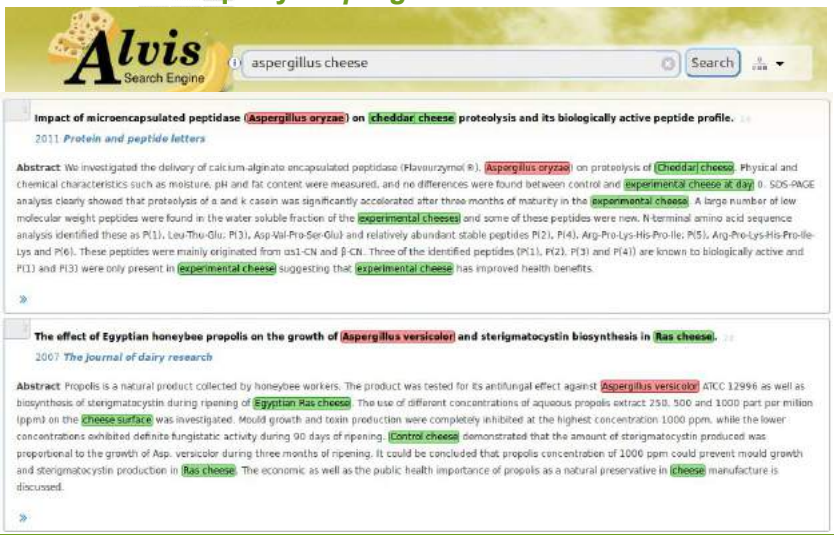
http://bibliome.jouy.inra.fr/demo/food/alvisir/webapi/search
Mini-link: https://frama.link/AlvisFood

Has *Aspergillus* been isolated in cheese?

Results of the query: *aspergillus* cheese



Result of the query: *aspergillus* cheese



Does *Aspergillus* lives in cheese ?

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Result of the query: aspergillus ~livesin cheese

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Behind the AlvisFood Search Engine

- Our approach is to extract from text
  - →"Microbe" and "Habitat" concepts
  - →Links between them
- We use
  - →AlvisNLP: Methods and tools for automatic extraction and analysis of biological text (*i.e.* Text Mining and Natural Language Processing)
  - →Machine learning methods trained with examples from microbiological and food domain experts
  - →Internal and external resources
- AlvisFood Search Engine: > 100,000 references from PubMed
  - →Selected by MeSH terms

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Microbial entity detection

NCBI taxonomy

- Fungi (fungi) *Click on organism name to get more information.*
  - Blastocladiomycota
    - Blastocladiomycetes
      - Blastocladiales
      - Blastocladiales incertae sedis
    - environmental samples
      - uncultured Blastocladiomycota
  - Chytridiomycota
    - Chytridiomycetes
      - Chytridiales
      - Cladochytriales
      - Gromochytriales
      - Lobulomycetales
      - Mesochytriales
      - Polychytriales
      - Rhizophlyctidales
      - Rhizophydiales
      - Spizellomycetales
      - unclassified Chytridiomycetes
      - Chytridiomycetes incertae sedis
      - environmental samples
    - Monoblepharidomycetes
      - Monoblepharidales
      - unclassified Monoblepharidomycetes

Habitat entity detection

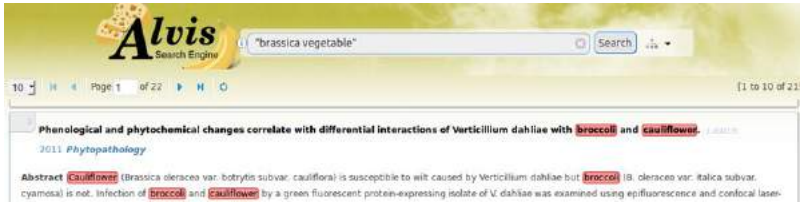
➢Detection in text of nominal or adjectival groups

➢Categorization of these groups with the *Ontobiotope ontology*
→Formal and structured representation of microbial habitats
→Partially reused in AlvisFoodSE

Food sub-categories of Ontobiotope ontology

➢From the EFSA classification
➢Enrichment by microbial and food domains experts

➢Formal indication that “Roquefort” is a “Cheese”
→allows semantic search
➢Our automatic AlvisNLP tools link groups of words from the text to an Ontobiotope category
→achieve normalisation



Relationship between Microbe and Habitat

➢Extraction of ~livesin relationship
➢Hard problems in automatic language processing and artificial intelligence
➢Achieved by machine learning methods trained with annotated examples

What are the taxa living in food?
A query : {taxon}* ~livesin food

Results downloadable as table with occurrence counts.
Displayed as facets

To conclude

http://bibliome.jouy.inra.fr/demo/food/alvisir/webapi/search
Mini-link: https://frama.link/AlvisFood

➢Our tools are pioneers in the field of text-mining for microbial biodiversity

➢Bibliome is a research team so:
→If you use AlvisFoodSE for your research, please cite us
→If you see an error, please send us an email, this will help us to improve our tools

Thank you for your attention

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On going work

➢Ambiguous cases for automatic tools

"Byssochlamys fulva and *Neosartorya fischeri* are heat-resistant fungi which are a concern to food industries"

➢Automatic detection of microbial phenotypes

i.e. halophile, thermophile, phototroph ...

Acknowledgments

INRA Ontobiotope and Florilège working groups
Food Microbiome project

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