

Improving honey production and obtaining new value-added products through the use of fungi with functional applications

Summary

Bees are one of the main indicators of the health of our planet as they are very **sensitive to environmental changes**. Over time, traditional bee-keeping techniques stop working in terms of bee health. Today, bees are not only threatened by environmental factors, mainly due to climate change, but also by other gradually emerging ones, such as the use of agricultural pesticides and new predators, viruses and parasites, which contribute to the widespread loss of colonies. In this context, bee-keepers currently spend more time trying to solve health issues than extracting products. In addition, inappropriate use of medicinal products without proper bee-keeping management as part of a comprehensive *Varroa* mite control strategy, can jeopardise the quality of honey and other bee products reaching the consumer. This not only leads to bee health problems but also the development of resistance, thereby reducing the efficacy of the acaricide. This is why the focus has begun to **shift to bee food supplementation with fungal extracts, which are known to produce a wide range of bioactive compounds such as polysaccharides, triterpenes, flavonoids, sterols and fatty acids, among others, which, in addition to their nutritional value, may also have antioxidant, anti-inflammatory, immunomodulatory and antimicrobial activity against bacteria, other fungi or viruses**. Two types of mushroom with bee-health potential are *Ganoderma lucidum*, known as reishi, and *Lentinula edodes*, known as shiitake. Reishi is the only known source of a group of triterpenes, known as ganoderic acids, which have a molecular structure similar to steroid hormones. It is also a source of biologically active polysaccharides, unsaturated fatty acids, alkaloids, coumarin, ergosterol, lactones, mannitol, vitamins and minerals. Shiitake is a highly prized mushroom, both as a foodstuff and for its therapeutic properties. It contains several bioactive compounds such as β -glucans, including lentinan, which has an anticancer and immunostimulatory action, chitin, erythadenine and ergosterols, which are vitamin D2 precursors, and soluble fibre and fatty acids, mainly palmitic and linoleic acid, as well as 24,25 dihydroxycholecalciferol.

Supplementing bees with mushroom extracts does not disrupt their feeding habits, as they have been observed to feed on the mycelium of mushrooms, suggesting they may obtain medicinal or nutritional value from the fungi. Therefore, a good strategy to reduce and/or stop the loss of bee colonies is to strengthen and stimulate the bee immune system by using fungal extracts with functional applications, such as **reishi and shiitake**. **Furthermore, besides bee health, the success of this project could lead to the marketing of a promising new food with immunomodulatory properties. The decline in bee populations observed worldwide is directly affecting the quantity and quality of bee products, mainly honey.** Currently, its production in the European Union (EU) fails to cover even half of the internal demand for honey, making the EU a major importer of the product. Thus, in order to operate in highly competitive markets, honey production in Catalonia needs to improve and increase, as the market has the capacity to absorb all the product it produces. **Given that honey composition can be affected by dietary factors, it is plausible to hypothesise that the healthy compounds present in mushrooms could be passed on to honey and thus confer additional beneficial properties with a potentially favourable impact on human health. Therefore, another of the main objectives of this project is to characterise and quantify bioactive compounds in the fungi (or derived metabolites) that could appear in the honey and serve as indicators its health properties, such as beta-glucans, triterpenes, fatty acids, ergosterol, and the general metabolite profile of honey using an omics approach: metabolomics.**

Taking into account the health potential of reishi and shiitake mushroom extracts and honey, **in this project we also hypothesise that the addition of honey and mushroom extract(s) to a syrup could enhance basic aspects of the human immune system, such as the response to pathogenic bacteria.**

Objectives

The main specific objectives of the project are:

1. **Improving bee immunity and honey production** through the supplementation of fungal and mushroom-based functional foods.
2. **Producing two value-added products:** honeys enriched with the bioactive compounds present in the mushrooms fed to the bees; and a syrup made from honey and mushroom extracts for human consumption.

Description of the actions carried out in the project

The summary work plan is as follows:

1. Installation of hives.
2. Mushroom growing.
3. Obtaining extracts for bees and syrup.
4. Analysis of the non-alcoholic extracts and the composition of the honey to be included in the syrup.
5. Developing and producing the solid feed formula.
6. Treatments in hives.
7. Syrup formulation development and validation.
8. Analysis of bees and honey.
9. Dissemination plan.
10. Drafting the documents.

Final results and practical recommendations

The following products are expected to be **developed** through the use of mushroom extracts with functional properties:

1. **Two solid bee feeds based on reishi and shiitake extracts (one feed for each mushroom)**, which boost the bee immune system (individual and colony immunity), thereby increasing defences against disease, which may lead to improved survival and greater honey production compared to untreated hives.
2. **Two honeys enhanced** with these foods (enriched with compounds present in the fungi or metabolites formed during passage through the bee digestive tract).
3. **A honey-based syrup** with functional applications for marketing in para-pharmacies.

Leader of the Operational Group

ORGANISATION: TORRONS I MEL ALEMANY, SL

Coordinator of the Operational Group

ORGANISATION: TORRONS I MEL ALEMANY, SL

Other members of the Operational Group (grant recipients)

ORGANISATION: CLARIA SAT NUM 1339 CAT

Other members of the Operational Group (not recipients of the grant)

ORGANISATION: FOREST SCIENCES AND TECHNOLOGY CENTRE OF CATALONIA (CTFC)

ORGANISATION: EURECAT FOUNDATION

Subject area(s) of application

- Agricultural production system
- Agricultural practice
- Agricultural equipment and machinery
- Livestock farming and animal welfare
- Vegetable production and horticulture
- Landscape / Territorial management
- Pest and disease control
- Fertilisation and nutrient management
- Soil management
- Genetic resources

<input type="checkbox"/>	Forestry
<input type="checkbox"/>	Water management
<input checked="" type="checkbox"/>	Climate and Climate Change
<input type="checkbox"/>	Energy management
<input type="checkbox"/>	Waste and by-product management
<input checked="" type="checkbox"/>	Biodiversity and environmental management
<input checked="" type="checkbox"/>	Food quality/processing and nutrition
<input checked="" type="checkbox"/>	Supply chain, marketing and consumption
<input type="checkbox"/>	Competitiveness and agricultural and forestry diversification
<input checked="" type="checkbox"/>	General

Geographical area(s) of application

PROVINCE(S)	REGION(S)
All of Catalonia	All of Catalonia

Dissemination of the project (publications, conferences, multimedia, etc.)

Dissemination will be carried out through the operational group members' own channels (web portals, blogs and social media), the media (Ruralcat and press releases) and knowledge transfer to social groups.

Project website

It will not have a website.

More information on the project

PROJECT DATES	TOTAL BUDGET	
Starting date: July 2021	Total budget:	€233,539.20
	DACC funding:	€108,000.86
Current status: Under way	EU funding:	€81,474.34
	Own funding:	€44,064.00

With funding from:

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Order ARP/113/2021 of 20 May, approving the regulatory bases for grants for cooperation for innovation by promoting the creation of European Association for Innovation operational groups in the areas of agricultural productivity and sustainability and the execution of innovative pilot projects by those groups, and Resolution ACC/1660/2021, of 27 May, announcing the call for the grant.



Generalitat de Catalunya
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Ramaderia, Pesca i Alimentació



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