Design and development of a smart hive with lignocellulosic material

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Introduction

The honey bee (*Apis mellifera* Linnaeus, 1758) is the most widely used bee species in beekeeping. It requires optimal brood nest temperatures between 30.7 and 37°C, environmental conditions that may be affected by climate change, specially in sensitive areas such as the Mediterranean region. Wooden hives are the most common in the beekeeping sector despite not being the best insulating material. In recent years, polystyrene hives have been developed, although they have disadvantages such as low sustainability, durability and incompatibility in organic beekeeping.

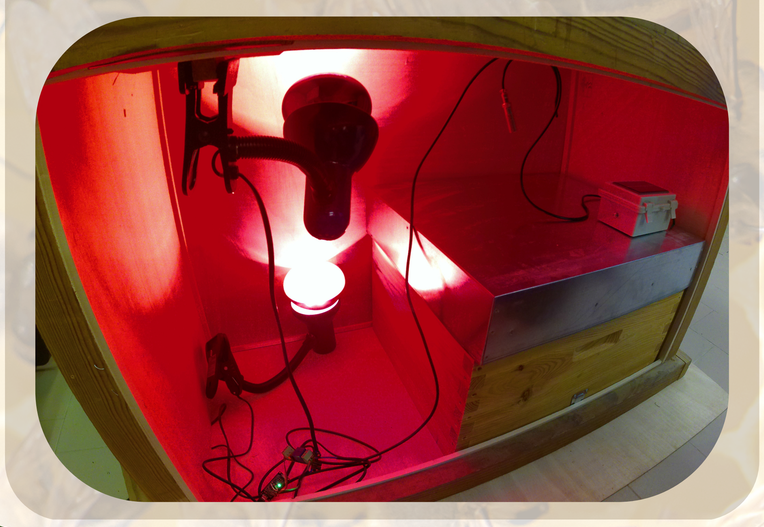
Aims

The aim of this research has been to develop an insulating hive based on the study of different natural fibres, as well as to incorporate a sensory network to monitor the environmental variables in the apiary and verify the insulating improvement of the designed prototype.

Methods

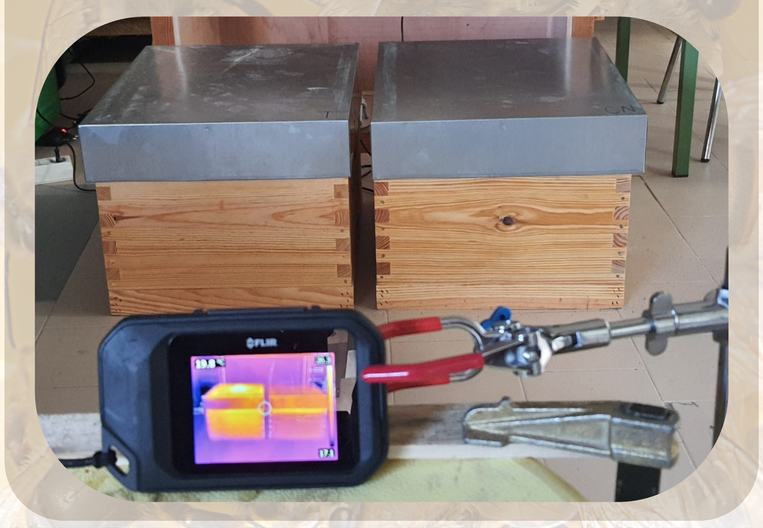
Laboratory simulation with external heat source

Tests in a closed wooden chamber, subjecting the different materials to a controlled heat source, to determine their insulating capacity with humidity and temperature sensors.



Laboratory simulation with internal heat source

Tests with a thermographic camera comparing heat transfer from a controlled internal heat source through the surface temperature of the insulating hive and the model hive.



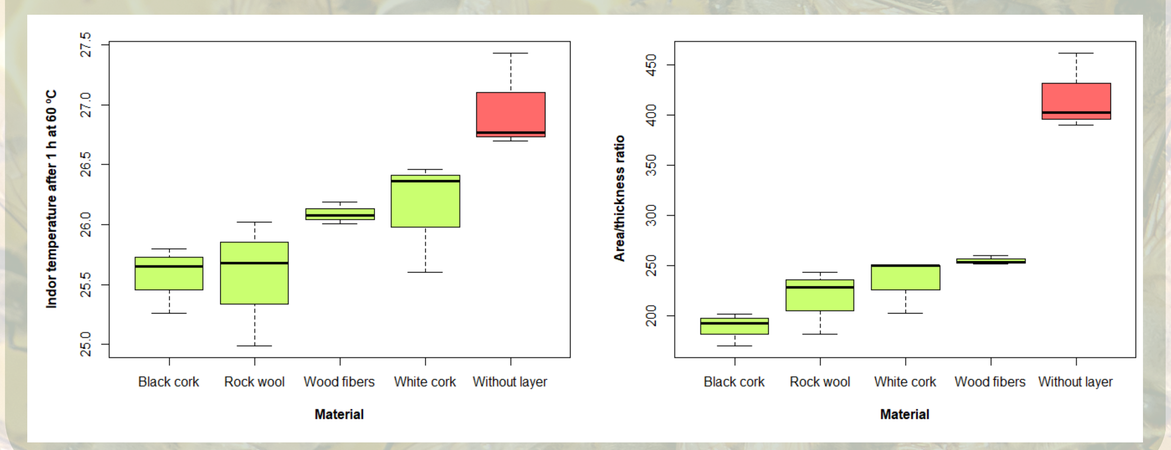
Field test with bees

Establishment of the best insulating prototype in the field, incorporating bee colonies and the sensory network for remote data collection. Measurement of honey and propolis production, as well as environmental variables inside and outside the hive.

Results

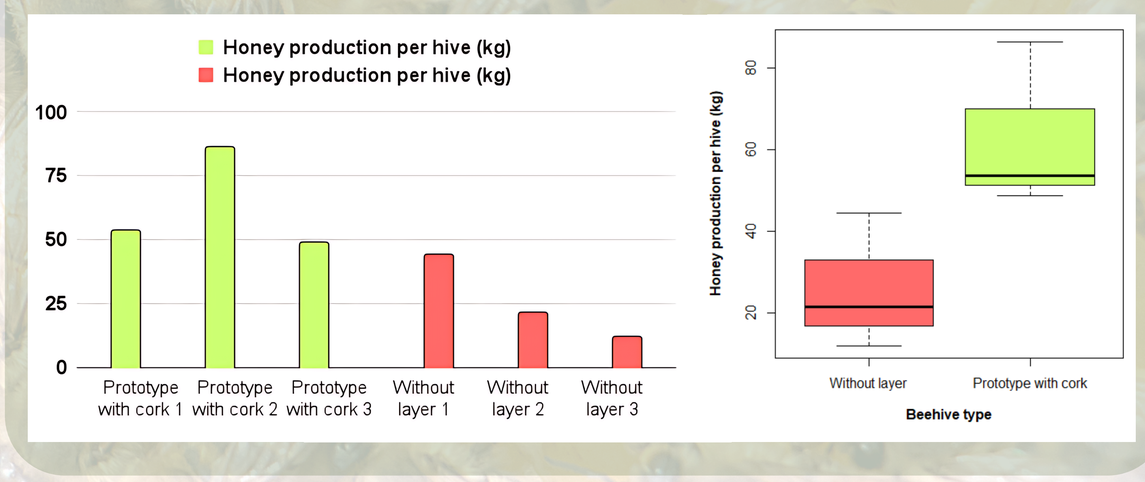
Laboratory results

The ANOVA of the laboratory test showed a greater insulating capacity in all the natural fibers studied compared to the control hives with wood, although no significant differences were observed between the different types of insulators chosen.



Field results

The beehive prototype placed in the field with an insulating layer of white cork obtained significantly greater honey production in the 3 replicas compared to the control hives.



Conclusions

The results are promising and demonstrate that the incorporation of natural fibers in the hive improves its thermal insulation, increasing honey production by reducing the energy demand of the colony in summer. The sensory network installed in the hives will allow bioclimatic data to be obtained in real time throughout the beekeeping season, to determine if the incorporated insulation also generates a positive effect on the bee colony in winter and increases its survival.

Acknowledgments

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