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Resinous Plant Species of Lesotho Used by Honey Bees (*Apis mellifera* L.) as Raw Materials for Propolis Production

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Introduction

Honey bees (*Apis mellifera* L.) have the ability to look for and collect resinous substances with antimicrobial properties from a wide variety of plants from the environment they live in (Dezmirean et al., 2020). Bees collect resins on their hind legs and deposit them in their hives where the resins are mixed with wax to produce propolis (bee glue) in order to protect their family and hive (Bankova et al., 2019; Wilson et al., 2013). Interestingly, bees make use of the mechanical properties of propolis as well as its biological action. It is responsible for the lower incidence of bacteria and moulds within the hive than in the atmosphere outside (Bankova et al., 2000). The knowledge of botanical origin of resins is important because propolis harvested from colonies in different climatic regions, and thus from different botanical sources, could vary in its chemical composition and antimicrobial properties (Wilson et al., 2013). It is notable that honey bees make discrete choices among many resinous plant species, even among closely related species.

The antimicrobial activity of propolis is an essential characteristic that attracted the attention of the pharmaceutical society (Bankova et al., 2000). It finds applications in wound care and cosmetics (Park & Ikegaki, 1998). In fact, propolis extract can be easily compounded as a cream to aid the wound healing process by decreasing the inflammation at the site of injury through a combination of antimicrobial and anti-inflammatory activities (Hlokoane & Sello, 2021; Nogueira et al., 2016). The medicinal applications of propolis increased the interest of the scientific society in its chemical composition as well as its origin (Park & Ikegaki, 1998).

Propolis is indeed one of the most fascinating honey bee products that could provide alternative medicine and search for new antibiotic discovery (Bankova et al., 2019). In principle, bees have performed a preliminary "screening" and found, in the course of evolution, plant sources that possess pronounced antimicrobial properties (Bankova et al., 2006). Unlike other products derived from medicinal plants, the composition of propolis is extraordinary variable depending on the geographic location, climatic zone and local flora (Wilson et al., 2013). We envisioned that the knowledge of plant sources of propolis from Lesotho could be of great importance toward propolis research and chemical standardization, and thus the formulation of a "local" Lesotho type of propolis based on plant origin. In this paper, we attempt to identify the plant origins of propolis based on the dominant resin-producing plant species options available as honey bee forage. We also specified the flowering seasons to give a rough estimate of the time interval that bees cut small parts of the vegetative apices of young leaves and buds to liberate resins from trichomes and ducts for propolis production.

Methods

Study Location

Lesotho is a small landlocked mountainous country (30,648 km^2) which is completely surrounded by South Africa (Seleteng Kose et al., 2015). The country is divided into 10 districts (Figure 1) with the capital city, Maseru, in Maseru district. It is important to note that the climate of Lesotho is temperate with the entire country lying above 1,400 metres above sea level (Mugomeri et al., 2016).

Data Collection

The study used a predesigned questionnaire to collect information on dominant resin-producing plant species options available as honey bee forage. The questionnaire was used to interview local farmers who were willing to participate in the study. Only farmers who were practicing beekeeping as identified by the officers from the Ministry of Forestry, Lesotho as apiarists were interviewed. The objectives of the study were explained to each interviewee prior to the interview. The interviews were conducted in Sesotho. The respondents were informed that their participation was voluntary and the confidentiality of their information was assured. The questionnaires were primarily aimed to source information on common names in Sesotho and flowering periods of resin-producing plant species within the common foraging range (3.2 km) radius from the hives. The interviews were conducted very close to the hives and the officers from Ministry of forestry Lesotho were confirming the availability of the plant species while being mentioned by the respondents. The scientific names of the plant species were confirmed from literature as documented earlier by Moteetee and Van Wyk (2011); Seleteng Kose et al. (2015) and Mugomeri et al. (2016). The taxonomy of the plant species was validated using "The Plant List" (www.theplantlist.org).

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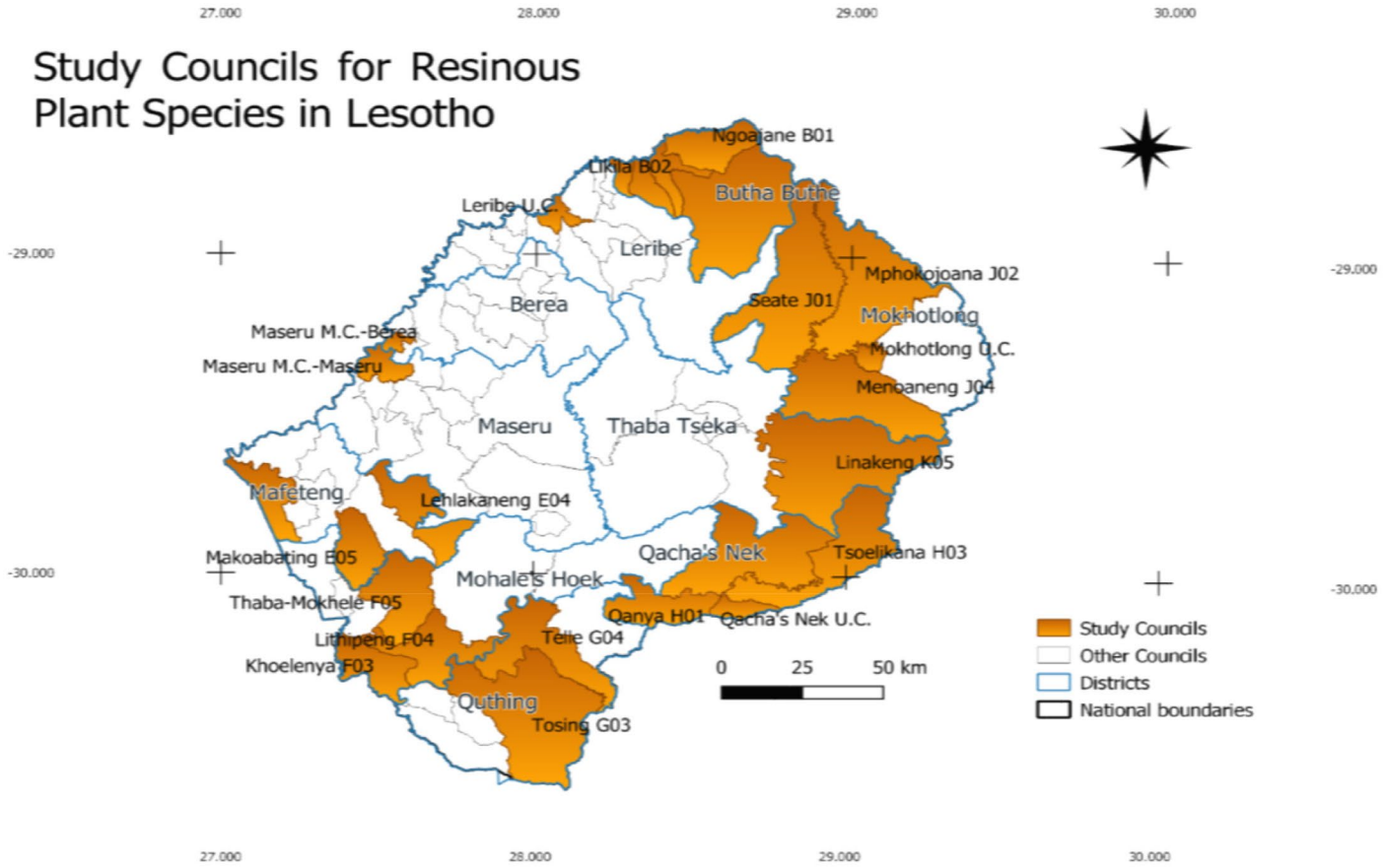

Figure 1. Study councils are the community councils in ten districts of Lesotho where the data was collected.

Results

Sixty-six beekeepers from 22 community councils (three interviewees per council) were interviewed. A total of 29 resinous plants from 23 genera belonging to 15 families were identified as targets for foraging bees (Table S1). The most represented plant family was Xanthorrhoeaceae (about 21%); indicating the presence of various *Aloe* species, namely, *A. marlothii* A. Berger, *A. maculate* All., *A. striatula* Haw., *A. polyphylla* Pillans, *A. aristata* Haw., and *A. ferox* Mill. Also, family Rosaceae (about 21%) was equally represented, followed by the family Anacardiaceae (10%) (Figure 2). Summarised in Figure 3 are the scientific names of the resin-producing plants that were identified within the common foraging range of 3.2 km from the hives and compares their dominancy in study areas. The study found that *Eucalyptus spp.* (about 9%), *Prunus persica* (L.) Batsch (about 8%), *Populus nigra* L. (about 7%) and *Salix babylonica* L. (about 7%) were most dominant species. Lastly, in Figure 4, the study discloses that the dominant plant species flower in spring (41%) to summer (29%).

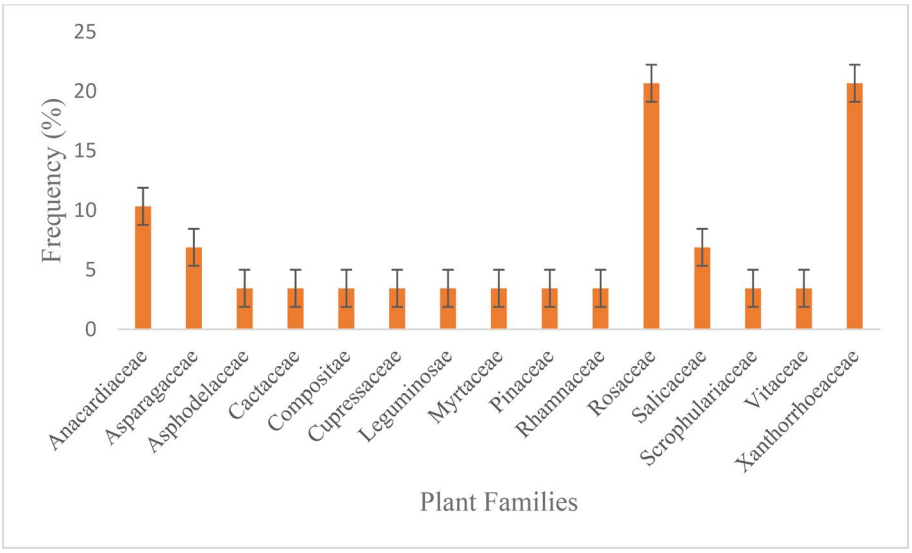

Figure 2. Comparison of species dominancy by family.

Discussions

In this study, we attempted to identify the plant origin of Lesotho propolis by employing the approach that identifies the dominant resin-producing plant species options available as honey bee forage within the common foraging range of 3.2 km from the hives. We found that families Xanthorrhoeaceae (about 21%) and Rosaceae (about 21%) were the most represented plant families. Again, our results suggest that *Eucalyptus spp.* (about 9%), *Prunus persica* (L.) Batsch (about 8%), *Populus nigra* L. (about 7%) and *Salix babylonica* L. (about 7%) were the most frequent sources of resins for bees. Furthermore, we determined that most plants species (about 41%) flower during spring season. At these time intervals the bees cut small parts of the vegetative apices of young leaves and buds which then liberate resins for bees. It is important to note that the plants were

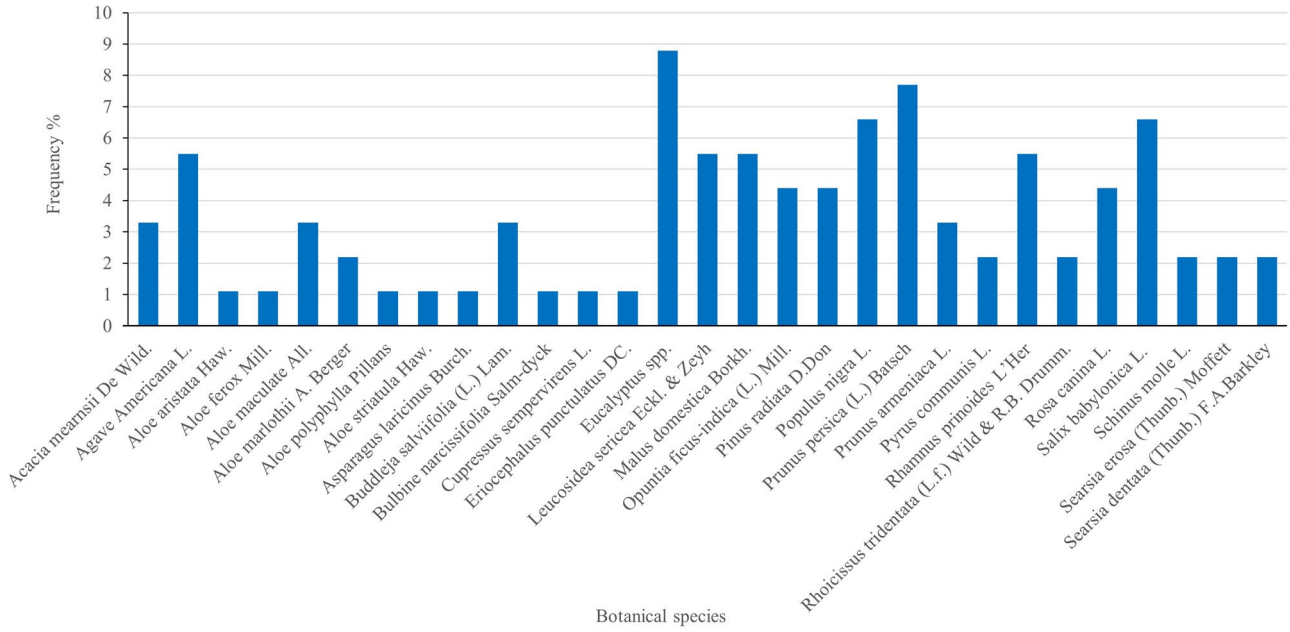

Figure 3. Comparison of plant species dominancy.

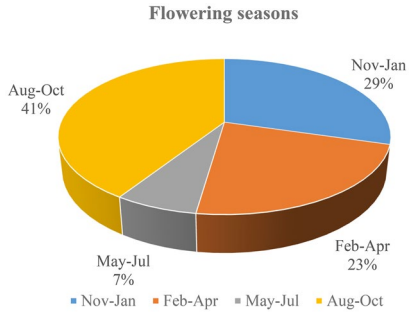

Figure 4. Flowering seasons of resin-producing species.

interspersed among each other with the non-resinous plants in the study area. These findings are in line with those reported by Dongock et al. (2007) who reported *Eucalyptus spp.* as the most utilised melliferous plant species. Moreover, in temperate climates, exudates from buds of the *Populus* species as well as *Salix* (willow) were the main source of resins for bees (Dezmirean et al., 2020; Wilson et al., 2013). Although, the precise information on the plant sources used by *Apis mellifera* in Lesotho is lacking, earlier studies confirmed that honeybees in temperate regions make distinct choices by preferring resins from *Populus* and *Salix* species over others (Bankova et al., 2006; Drescher et al., 2019; Ghisalberti, 1979; Greenaway et al., 1990). This study is the first report regarding the dominant plant species of Lesotho important as honey bee forage for propolis production. The direct evidence of plant origin based on chemical comparison of plant resins and propolis extracts as well as the pollen spectrum analysis of propolis is underway in our laboratory and the results will be reported in due course.

Conclusion

This study identified the plant origin of Lesotho propolis by employing the approach that identifies the dominant resin-producing plant species options available as honey bee forage within the common foraging range of 3.2 km from the hives and concludes that *Eucalyptus spp.* (about 9%), *Prunus persica* (L.) Batsch (about 8%), *Populus nigra* L. (about 7%) and *Salix babylonica* L. (about 7%) were the most frequent sources of resins for bees during spring season. This study is the first report regarding the dominant plant species of Lesotho important as honey bee forage and results can be used to provide direction toward propolis research and chemical standardization of, and thus the formulation of a "local" Lesotho type of propolis based on plant origin.

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Disclosure Statement

No potential conflict of interest was reported by the authors.

Supplementary Material

Supplementary Table S1 is available via the "Supplementary" tab on the article's online page (https://dx.doi.org/10.1080/00005772X.2022.2076972)

References

Bankova, V., Bertelli, D., Borba, R., Conti, B. J., da Silva Cunha, I. B., Danert, C., Eberlin, M. N., I Falcão, S., Isla, M. I., Moreno, M. I. N., Papotti, G., Popova, M., Santiago, K. B., Salas, A., Sawaya, A. C. H. F., Schwab, N. V., Sforcin, J. M., Simone-Finstrom, M., Spivak, M., … Zampini, C. (2019). Standard methods for *Apis mellifera* propolis research. *Journal of Apicultural Research*, *58*(2), 1–49. https://doi.org/10.1080/00218839.2016.1222661

Bankova, V., de Castro, S., & Marcucci, M. (2000). Propolis: Recent advances in chemistry and plant origin. *Apidologie*, *31*(1), 3–15. https://doi.org/10.1051/apido:2000102

Bankova, V., Popova, M., & Trusheva, B. (2006). Plant sources of propolis: An update from a chemist's point of view. *Natural Product Communications*, *1*(11), 1934578X0600101–1934578X0601028. https://doi.org/10.1177/1934578X0600101118

Dezmirean, D. S., Paşca, C., Moise, A. R., & Bobiş, O. (2020). Plant sources responsible for the chemical composition and main bioactive properties of poplar-type propolis. *Plants*, *10*(1), 22–22. https://doi.org/10.3390/plants10010022

Dongock, D. N., Tchoumboue, J., D'Albore, G. R., Youmbi, E., & Pinta, Y. J. (2007). Spectrum of melliferous plants used by *Apis mellifera adansonii* in the Sudano Guinean western highlands of Cameroon. *Grana*, *46*(2), 123–128. https://doi.org/10.1080/00173130701318459

Drescher, N., Klein, A.-M., Schmitt, T., & Leonhardt, S. D. (2019). A clue on bee glue: New insight into the sources and factors driving resin intake in honeybees (*Apis mellifera*). *PloS One*, *14*(2), e0210594. https://doi.org/10.1371/journal.pone.0210594

Ghisalberti, E. L. (1979). Propolis: A review. *Bee World*, *60*(2), 59–84. https://doi.org/10.1080/0005772X.1979.11097738

Greenaway, W., Scaysbrook, T., & Whatley, F. R. (1990). The composition and plant origin of propolis: A report of work at Oxford. *Bee World*, *71*(3), 107–118. https://doi.org/10.1080/0005772X.1990.11099047

Hlokoane, O. K., & Sello, M. (2021). Antimicrobial wound healing properties of indigenous medicinal plants of Lesotho and the pharmacist's role in minor wound care. *South African Pharmaceutical Journal*, *88*(1), 33a–33e.

Moteetee, A., & Van Wyk, B.-E. (2011). The medical ethnobotany of Lesotho: A review. *Bothalia*, *41*(1), 209–228. https://doi.org/10.4102/abc.v41i1.52

Mugomeri, E., Chatanga, P., Raditladi, T., Makara, M., & Tarirai, C. (2016). Ethnobotanical study and conservation status of

local medicinal plants: Towards a repository and monograph of herbal medicines in Lesotho. *African Journal of Traditional, Complementary and Alternative Medicines*, *13*(1), 143–156. https://doi.org/10.4314/ajtcam.v13i1.20

Nogueira, R. J. L., Danopoulos, P., Swikidisa, R., & Pinheiro, V. A. (2016). Evaluation of the antibacterial activity of green propolis extract and meadowsweet extract against Staphylococcus aureus bacteria: Importance in wound care compounding preparations. *International Journal of Pharmaceutical Compounding*, *20*(4), 333–337.

Park, Y. K., & Ikegaki, M. (1998). Preparation of water and ethanolic extracts of propolis and evaluation of the preparations. *Bioscience, Biotechnology, and Biochemistry*, *62*(11), 2230–2232. https://doi.org/10.1271/bbb.62.2230

Seleteng Kose, L., Moteetee, A., & Van Vuuren, S. (2015). Ethnobotanical survey of medicinal plants used in the Maseru district of Lesotho. *Journal of Ethnopharmacology*, *170*, 184–200. https://doi.org/10.1016/j.jep.2015.04.047

Wilson, M. B., Spivak, M., Hegeman, A. D., Rendahl, A., & Cohen, J. D. (2013). Metabolomics reveals the origins of antimicrobial plant resins collected by honey bees. *PloS One*, *8*(10), e77512. https://doi.org/10.1371/journal.pone.0077512

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