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Bioeconomy gaps and opportunities in restored Atlantic forests

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Forest restoration faces persistent challenges for its financial viability due to high land opportunity costs and insufficient financial returns from restored areas, such as through payments for ecosystem services and timber production. A potential financial pathway is to develop non-timber forest products with bioeconomic potential. Here, we explore the bioeconomic potential of native tree species growing in different types of new wooded lands in Atlantic forests. First, we established 25 30 x 30 m plots in natural regeneration, degraded forest remnants, and actively managed areas (eucalyptus monoculture and active restoration) in the Paraíba Valley, southeastern Brazil, where we sampled all woody individuals with dbh ≥ 5 cm, totaling 284 native tree species. Then, we conducted a literature review and patent survey on the biotechnological potential of the species sampled. Based on this review and survey, we calculated the proportion of sampled species with patents and assessed the species used and general characteristics of patents registered among prominent companies in the market. We found 168 (70%) species with a biotechnological potential based on the presence/absence of articles reporting uses for medicine, cosmetics, food, and other market segments, such as bioinsecticides, bio fertilization, construction, and manufacturing. In the sampled areas, species offer varied potential for use,

with higher potential in spontaneous environments. *Araucaria angustifolia* was the most extensively studied species, with 246 research papers, followed by *Euterpe edulis* (205), *Baccharis dracunculifolia* (188), *Dodonaea viscosa* (170), *Cedrela odorata* (158), *Copaifera langsdorffii* (139) and *Hymenaea courbaril* (132). We found patents worldwide, distributed across more than 20 countries, for the sampled species. The medicinal use of leaf chemicals accounts for the largest use in our survey. Despite these numbers, we found that less than 5% of the investigated articles reported evaluations of final products, while most provided results from *in vitro*, *in vivo*, or chemical analytics descriptions. Most patents registered by companies are related to exotic and non-tree species, many associated with existing commodity chains, reinforcing the need to integrate bioeconomy and forest restoration agendas better.

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