How controlled inoculation of sap tubing with Pseudomonadota strains may influence maple syrup quality

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Maple syrup production begins each spring when sap flows through plastic tubing networks, and this sap is naturally colonized by a diverse community of microorganisms. Over the last decades, microbiological surveys have shown that certain bacterial groups, notably members of the genera Pseudomonas and related taxa, dominate in maple sap across regions, seasons, and collection systems (Filteau et al., 2010; Lagacé et al., 2004).

Such persistent colonization is not anecdotal: a 2022 metataxonomic study of sap communities identified hundreds of bacterial and fungal taxa, with Pseudomonas, Rahnella, Janthinobacterium, Leuconostoc and others recurrently present (N'guyen et al., 2022). The biochemical activity of these microbes such as invertase and other activities generating other metabolites, can influence sap chemistry and affect the development of color, aroma and flavor in the final syrup via Maillard reactions and related pathways (Lagacé et al. 2004; Garcia et al., 2020).

Given this background, Centre ACER has conducted a research project to evaluate a new approach for quality control of maple sap.'

The study recently published in Canadian Journal of Microbiology and available in open access consisted in the inoculation of the sap collection system with three Pseudomonadota strains and to assess the microbial and organoleptic quality of maple sap and syrup (Gagnon et al., 2025). This work represents a significant step: rather than simply characterizing microbial communities, the study tested whether an intentional inoculation of selected bacterial strains into tubing systems can steer microbial succession and influence syrup quality.

Inthe experiment, three bacterial strains, two from the genus Pseudomonas (one being the reference strain P. fluorescens ATCC 17926 and one isolated by Centre ACER [MSB2019]) and one identified as Janthinobacterium lividum by Filteau et al. (2011), were chosen for their capacity to form biofilms on plastic tubing. Over two sugaring seasons in Centre ACER's experimental sugarbush, these strains were introduced into sections of the sap collection system, with untreated sections used as controls. Sap and resulting syrup were collected periodically,

and analyzed for microbiological composition, physicochemical parameters (pH, °Brix, conductivity, sugars, organic acids), and sensory properties of the syrup (Gagnon et al., 2025).

The main findings were instructive. The inoculated systems yielded maple sap with higher numbers of bacteria associated with the inoculated genera, at least for the beginning of the season. Systems inoculated with Pseudomonas sp. MSB2019 corresponded with significantly higher maple flavour and overall flavour-intensity scores in the syrup after the second flow season. Importantly, inoculation did not alter sap yield nor dramatically increase microbial load; nor did it produce consistent off-flavors (e.g., "buddy," "fermented," "ropy," etc.) that would impair syrup quality.

These observations support three conclusions. First, the microbiota of maple sap collection systems is resilient, but not immutable: targeted inocula can transiently reshape community structure. Second, such reshaping can have measurable, although modest, effects on sensory attributes, potentially enhancing desirable flavor intensity without compromising safety or yield. Third, this opens the door to a more controlled microbiological management of syrup production, similar to practices in fermented food industries though underlining that effects remain subtle under the tested conditions.

That said, the study's results also highlight limitations: the introduced strains generally did not establish permanent dominance, and their impact on flavor, while statistically detectable, remains limited. Further research will be needed to assess long-term stability, strain persistence, interactions with sap origin (tree health, soil, climate), and scalability for commercial production. Such a promising process should however be approved by regulatory authorities before being used in maple syrup production.

In a broader context, this work demonstrates the emerging recognition that maple syrup is not solely defined by tree biology and boiling practices, but by a microbial effect intimately linked to production systems. As we deepen our understanding of sap microbiomes and their functional roles, the possibility emerges of steering those microbial communities toward better syrup quality, joining tradition with microbiological insight.

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