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Could alien invasive species be a solution to postharvest losses of fresh produce?

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Postharvest losses of fresh produce remain a serious challenge for the horticultural industry. Tons of fresh produce are lost each year because of postharvest diseases and physiological disorders. The lack of proper storage facilities and cheap postharvest treatments are the major disadvantages, especially for resource-limited producers. Wasted food releases significant amount of methane to the environment. Additionally, wasted food equates to lost energy, water and many other limited inputs (Mditshwa et al., 2023). Thus, reducing postharvest losses is one of the effective ways of fulfilling environmental stewardship.

Alien invasive species are undesired, noxious and highly aggressive plants. Just like postharvest losses, alien invasive species pose serious risks to the environment. For instance, they reduce the quality and value of arable land (Horsch and Lewis, 2009). Reduced water quality has also been reported after the invasion of alien plants (Chamier et al., 2012). In some instances, these species become dominant thereby suppressing and excluding native plants in the ecosystem (Didham et al., 2005). Moreover, change in fire regimes has been reported in environments with high population of alien invasive species (Brooks et al., 2004). However, alien invasive species may also have positive attributes that have sometimes been overlooked and could be explored for the benefit of the society. In their comprehensive systematic review on the possible roles of alien invasive species on human livelihood, Shackleton et al. (2019) indicated that 16% of invasive alien species can be categorized as desirable and weakly competitive due to various benefits they offer. These benefits include the providing food and fodder for animals as well as fuelwood and timber (Das and Duarah, 2013; Guild and Shackleton, 2018; Sipango et al., 2022).

In this opinion piece, we seek to establish the possibility of using alien invasive species as postharvest treatments. Tremendous amount of resources is used to combat alien invasive species, identifying those with potential postharvest applications could have a ripple effect on environmental health. This could simultaneously curtail the loss of fresh produce, water resources and ecosystem diversity. Significant research has been done on biochemical characterization of selected alien invasive species. In their article titled "novel chemistry of invasive exotic plants", Cappuccino and Arnason (2006) demonstrated that some alien invasive species contain key second compounds such as alliarinoside, catechin, sparteine, gallic acid and xanthoxylin. Most of these compounds possess antiviral, antifungal and antimicrobial properties. In fact, Máximo et al. (2020) gave a comprehensive review of biochemical attributes of various alien invasive species and their biological activities.

The pharmaceutical value of selected alien invasive species has been explored. Rural communities use some of these species to treat various ailments. Research has also produced empirical evidence about the biomedical efficacy of these species. For example, the antimicrobial activity of *Hakea salicifolia* against multiresistant strains of *Staphylococcus aureus* has been reported (Madureira et al., 2012). Similarly, crude extracts of *Phytolacca americana* are effective against *Porphyromonas gingivalis* and *Streptococcus mutans* which are known to cause inflammation and oral diseases (Patra et al., 2014).

Carpobrotus edulis is a succulent, ground creeping and year-round species that is native to the Cape Region of South Africa (Campoy et al., 2018). This succulent species has been reported as an alien invasive plants species that causes serious challenges in Portugal. Plant extracts of *C. edulis* have been reported to possess antioxidant and antimicrobial properties, they also have enzymatic inhibitory activities (Meddeb et al., 2017; Castaneda-Loaiza et al., 2020). Microbial contamination is the leading cause of postharvest losses in fresh produce. The stem-end-rot causing *Lasiodiplodia theobromae* and anthracnose causing *Colletotrichum gloeosporioides* are some of the prevalent postharvest pathogens. They are controlled using antimicrobial and biofungicidal treatments such as gaseous ozone (Bambalele et al., 2023) and edible coatings (Kubheka et al., 2020; Nkanzela et al., 2021). Enzymatic browning is one of the major quality issues during postharvest. Enzyme inhibiting treatments are often used to control this problem. However, most of these treatments are synthetic and very costly for an average farmer. Can extracts obtained from the alien invasive species such *C. edulis* be used to suppress enzymatic browning and pathogen activity at postharvest? Research must seek to address and answer this question! On face value, the biochemical attributes of *C. edulis* ticks all the boxes for postharvest treatments. However, it is imperative to note that opinion will not replace the existing control interventions that are already used to manage the infestations and minimize the negative impacts caused by *C. edulis*. The most implemented control management tools include hand removal, chemical control application and mulching (Lazzaro et al., 2020; Fos et al., 2021).

Due to their antimicrobial and antioxidant properties, alkylresorcinols (ARs) have been demonstrated to extend the shelf-life of various foods. Reduced lipid oxidation, pathogenic activity and longer shelf-life has been reported in low-moisture foods pre-treated with alkylresorcinol extracts before storage (Schmidt, 2023). Interestingly, some alien invasive species also possess ARs. *Hakea sericea*, which is highly invasive in various parts of the world, including Portugal and South Africa, possesses an alkylresorcinol derivative called 9-(3,5-dihydroxy-4-methylphenyl) nona-3(Z)-enoic acid (Luis et al., 2013). Methanolic extracts of AR have demonstrated antibacterial properties against foodborne pathogens such as *Bacillus cereus* and Listeria monocytogenes (Luis et al., 2013). Higher phenolic and flavonoid concentrations have also been founded in alien invasive species such as *H. sericea* (Luis et al., 2011). The application of *H. sericea* extracts on fresh produce could potentially boost the antioxidant activity against pathological and physiological disorders during storage. Although these are all fascinating facts about the alien invasive species, it is important to note that alien invasive species have the potential to disperse non-infested areas, become difficult to control and threaten native biodiversity (Rai and Singh, 2020).

While the pharmaceutical value of alien invasive species has been extensively explored, research on possible agricultural applications, particularly postharvest, is yet to take-off. Based on the evidence before us, it is our strong opinion that certain alien invasive species could be a solution to some postharvest diseases and disorders. Thus, it is highly recommended that their potential value as postharvest treatments of fresh produce should be investigated. Currently, alien invasive species are managed at an exorbitant cost for the national government. If proved to be effective against postharvest losses, the alien invasive species could become a raw material. Instead of being persistent pests, they can be extracted and transformed into highly valuable postharvest treatments.

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