Highly Successful Propagation of Persea americana Cuttings Using Aloe vera Gel as a Natural Rooting Hormone

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Research Article

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Posted Date: August 8th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10244693/v1

Additional Declarations: No competing interests reported.

Highly Successful Propagation of *Persea americana* Cuttings Using *Aloe vera* Gel as a Natural Rooting Hormone

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Abstract

Among major tropical fruit crops, avocado exhibits comparatively lower production volumes; however, it benefits from strong global demand and high export market value, which has stimulated the expansion of cultivated areas in both established and emerging production regions. Consequently, there is a growing need to develop efficient vegetative propagation techniques capable of shortening the juvenile phase of avocado plants while ensuring genetic uniformity, thereby enhancing production capacity and meeting increasing global demand. This study evaluates the efficacy of *Aloe vera* inner leaf gel as a novel, bio-organic biostimulant to promote sprouting and adventitious root initiation in avocado stem cuttings. Semi-hardwood cuttings (10–12 cm in length) were harvested from mature trees, treated at the basal end with freshly undiluted *Aloe vera* gel, and struck into a river sand medium. Untreated cuttings served as the control group. The organic *Aloe vera* treatment achieved a significant breakthrough, yielding a 100% sprouting, root initiation, and survival rate within six weeks. Conversely, the control group exhibited 0% sprouting, failed to initiate roots, and showed 100% basal necrosis during the same experimental period. These findings demonstrate that *Aloe vera* gel serves as a highly potent, sustainable, and accessible alternative to synthetic phytohormones, offering a scalable protocol for rapid clonal avocado nursery production.

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Introduction

The avocado tree (*Persea americana*) is a fruit-bearing species belonging to the Lauraceae family, cultivated not only for nutritional purposes but also for its numerous medicinal, phytochemical, and cosmetic applications (Hurtado-Fernández et al. 2018; Melgar et al. 2018; Pérez et al. 2015; Salgado 2020). In recent decades, avocado has become a flagship commodity in global agriculture due to the increasing demand associated with its high nutritional value and diverse industrial applications (FAO 2009, 2025). Recognized as one of the most nutrient-dense and energy-rich fruits, providing approximately 95.3-130.21 kcal per 100 g, avocado is widely consumed worldwide (Bhuyan 2019; Mooz 2012). Furthermore, to enhance its commercial value, avocado pulp is extensively processed by the food, cosmetic, and pharmaceutical industries (Melgar et al. 2018). As a result, the global value of avocado exports has steadily increased, making avocado one of the most profitable fruit crops and a commodity projected to surpass pineapple in economic importance by 2034 (FAO 2009, 2025).

Despite its economic importance, avocado cultivation faces significant propagation challenges. Several studies have reported that avocado seedlings generally require three to four years before reaching fruit-bearing maturity (COLEAD 2023). This juvenile period may be considerably longer when trees are propagated from seeds, requiring approximately five to thirteen years before fruit production begins (COLEAD 2023).

Aloe vera (*Aloe barbadensis* Miller) is a succulent plant belonging to the Asphodelaceae (formerly Liliaceae) family. Its thick triangular leaves contain a medicinal gel composed of approximately 99% water, as well as a yellow latex traditionally used for the treatment of skin disorders such as burns, cuts, insect bites, and eczema (Rajeswari 2012; Rath and Dutta 2025; Efterpi and Florou-Paneri 2010; Elseena et al. 2021). In addition, numerous studies have demonstrated the wound-healing, anti-inflammatory, antimicrobial, antidiabetic, anticancer, and antioxidant properties of *Aloe vera*, highlighting its potential in the management of gastrointestinal disorders, diabetes, ulcers, cancer, asthma, herpes, and HIV-related conditions (Dulmini et al. 2025; Kumar et al. 2010; Saxena and Bhatnagar 2006; Nandal and Bhardwaj 2012; Sharma and Kaur 2026; Padhi et al. 2024). Moreover, *Aloe vera* gel has been widely reported as an effective, edible, and biologically safe preservative coating for postharvest fruits and vegetables, including avocado and tomato fruits (Chuku 2010; Berihu and Zegeye 2022; Hayelom and Sasikumar 2020; Darmawati et al. 2019; Misir et al. 2014; Hasan et al. 2021; Buthane et al. 2025).

Beyond its medicinal and preservative applications, the use of *Aloe vera* gel as a natural rooting and growth-promoting agent for plant cuttings has been extensively documented. Previous studies have demonstrated its effectiveness in the propagation of several plant species, including tea plants (*Lippia javanica* and *Camellia sinensis*), *Citrus aurantifolia*, *Syzygium jambos*, *Coleus* spp., *Populus* clones, *Aglaonema*, *Eucalyptus citriodora*, *Hylocereus* spp., Robusta coffee (*Coffea canephora*), *Vernonia amygdalina*, and *Jatropha integerrima* (Zhakata and Abduel 2021; Vidanapathirana et al. 2023; Mirihagalla and Fernando 2020; Sherif 2017; Shakirah et al. 2023; Hassan and Hendi 2021; Sujata et al. 2022; Rauben et al. 2024; Ehoniyotan et al. 2024; El-Zahra et al. 2025).

However, studies on the propagation of avocado through stem cuttings remain extremely limited. In 1964, Leal and Krezdorn were the first researchers to report a successful protocol for rooting avocado cuttings using indole-3-butyric acid (IBA) (Leal and Krezdorn 1964). Since then, several researchers have attempted to optimize and simplify avocado cutting propagation by modifying and improving existing methodologies (Barrientos-Priego et al. 1986; The

Division of Subtropical Agriculture 1960-1969). Despite these efforts, achieving rapid and efficient rooting of avocado stem cuttings remains a major challenge. Consequently, grafting is still considered the most reliable and widely adopted method for the commercial propagation of avocado trees.

This study aimed to evaluate to the first time the potential of *Aloe vera* gel as a natural rooting agent for enhancing the propagation of avocado stem cuttings in a river sand growth medium.

Materials and Methods

Study Site and Experimental Design

The experiment was conducted from May to June 2026 in LAFE-BALENG Village, Bafoussam, West Region of Cameroon (5°31′02″ N, 10°24′37″ E). The materials used in this study included 20 avocado cuttings, *Aloe vera* leaves, river sand, water, a sterile knife and saw, a basin, a watering can, recycled plastic bottles, and a portable E-1 TDS/EC meter.

Collection of Avocado Cuttings and *Aloe vera* Harvesting

Stem cuttings were collected from a 32-year-old avocado tree (Semil-34), and fresh leaves were harvested from a 3-year-old *Aloe vera* mother plant growing on a farm in LAFE-BALENG Village.

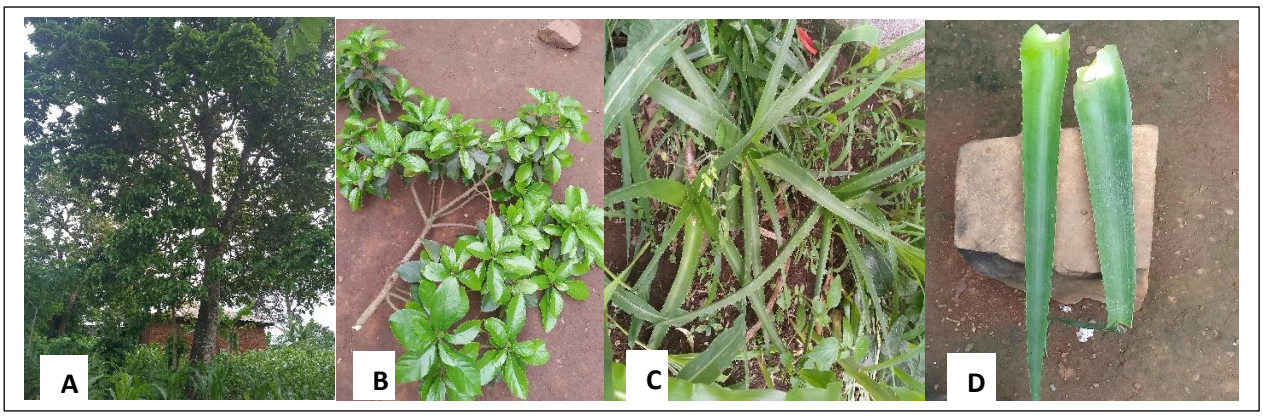

Fig. 1 Avocado mother tree (A); Avocado branch cut (B); *Aloe vera* mother tree (C); *Aloe vera* leaves (D)

Preparation of Cuttings Prior to Planting in River Sand

A vigorous and healthy branch was selected from the avocado tree and cut using a sterilized saw. Twenty leafless stem cuttings were subsequently prepared, each measuring 10–

13 cm in length and 0.5–1.5 cm in diameter. A 1-cm circular incision was made at the basal end of each cutting using a sterilized knife.

Fig. 2 Taking cuttings from the avocado branch (A); Harvested avocado cuttings (B); Basal end avocado cuttings incision (C); Basal end avocado cuttings measurement (D)

Ten cuttings were treated by coating their basal halves with fresh *Aloe vera* gel (Fig. 3) prior to planting, whereas the remaining ten cuttings served as untreated controls.

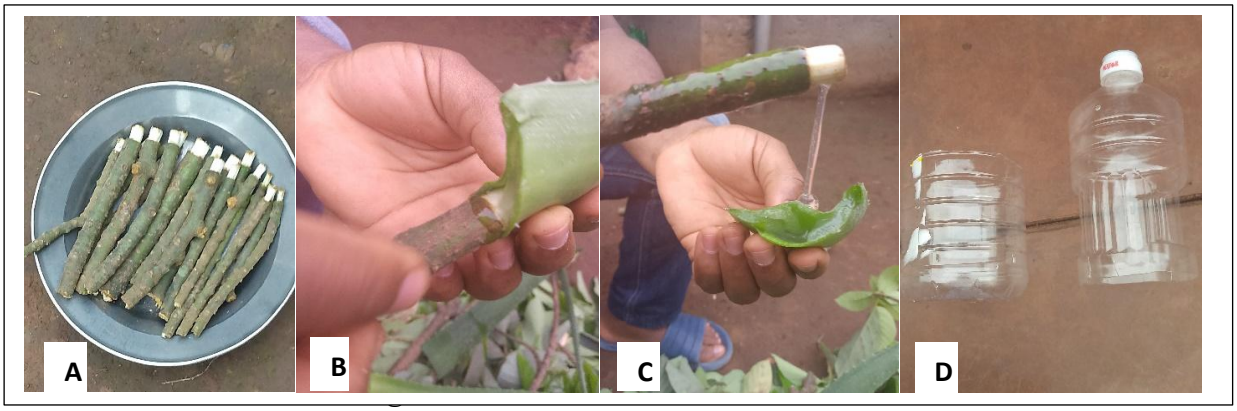

Fig. 3 Avocado cuttings after basal end incision (A); A cutting dipped in fresh *Aloe vera* leaf gel (B); Removed cutting from *Aloe vera* gel (C); Containers (D).

Establishment of Cuttings in River Sand

Water was added to the initially dry sand in plastic containers equipped with drainage holes until the substrate was thoroughly moistened. The two groups of cuttings were then gently inserted into the sand to a depth of approximately 3–4 cm, ensuring that the substrate provided adequate support to hold the cuttings in place (Fig. 4).

Fig. 4 Planting *Aloe*-treated cuttings into a sandy medium (A, B); Planting cuttings control in sand (C, D)

At the end of the experiment, ten containers were used and divided equally into two groups. Group A (five containers) contained cuttings treated with *Aloe vera* gel, with two cuttings per container. Group B (five containers) consisted of control cuttings without any *Aloe vera* treatment, also with two cuttings per container.

Establishment of the Experiment in a Greenhouse

The containers were sealed and placed in a warm, shaded environment with bright, indirect light to promote high humidity (greenhouse-like conditions) and prevent excessive desiccation of the cuttings (Fig. 5).

Fig. 5 Establishment of the Experiment in a Greenhouse.

Temperature and Humidity Control

A portable E-1 TDS/EC meter was used to monitor environmental conditions in the greenhouse-like setup on a daily basis (morning, afternoon, and evening). The containers were opened every three days to assess substrate moisture, prevent fungal growth, and apply light

irrigation using a watering can, while avoiding overwatering in order to maintain consistently moist conditions.

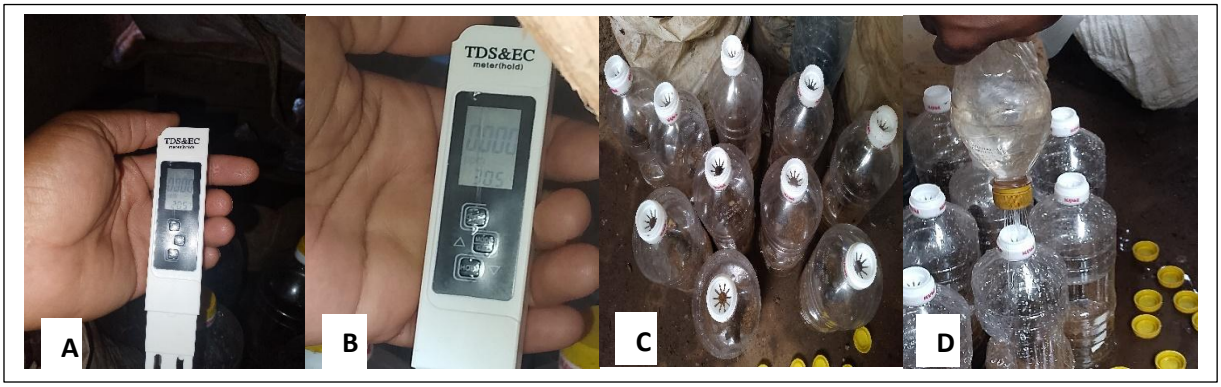

Fig. 6 Temperatures control (A (bottom), B (peak)); Open containers (C); Containers irrigation (D)

Results

The effectiveness of aloe vera gel as a natural sprouting and rooting hormone was evaluated based on parameters like the percentage of avocado stem cuttings that sprouted, survived and rooted over a 6-weeks period.

During the experiment, the temperature was stable in the range 20-30 °C (Fig. S1) with a bottom and peak respectively at 20.5 °C and 30.5 °C. This temperature range is in accordance with previous study on some cutting's propagation including avocado (Sujata et al. 2022; (Leal and Krezdorn, 1964; Barrientos-Priego et al. 1986; The Division of Subtropical Agriculture 1960-1969).

After one week, the two groups of avocado cutting show some good signs of progress by stilling healthy and firm, with its stems remaining green (Fig. S2). Progressively at week three, there was development of new small green shoots sprouting from the upper dormant buds of the cutting. 9 over 10 of the cuttings initially dipped in aloe vera gel sprouted (90 %) (Fig. S3) and the percentage of sprouting reached the value of 100 % at week number four (Fig. 7a; Fig. 7b) whereas no sign of change (no sprouting) was observed to all the cuttings steps control.

Fig. 7a Sprouting of avocado step cuttings dipped in *Aloe vera* gel.

Fig. 7b Sprouting of avocado step cuttings dipped in *Aloe vera gel*

We let the cutting grow in other to develop roots therefore it was a high development of the previous sprouts and their number on steps were in permanent increase week after week. After six weeks (42 days), the growth was significant, all the cutting prior dipped in *Aloe vera* gel before planting, developed multiple shoots and they were carefully removed from the sand to examine the roots. The basal end of these cutting showed good sign of root initiation (Fig. 8).

Fig. 8 Avocado step cuttings dipped in *Aloe vera* gel removed from the sand.

In contrast, the control group, which was untreated with *Aloe vera* gel, did not exhibit any observable growth in terms of buds, shorts sprouting or roots initiation during the entire experimental period and many of them died. This trend suggests a positive correlation between the natural *Aloe vera* gel hormone and the vigor of the avocado stem cutting growth for successful propagation. This may be also a confirmation that the river sand medium is not directly responsible of the avocado cutting's growth observe in this experiment.

Fig. 9 Avocado step cuttings control after 42 days.

Discussion

The results of this study strongly suggest that *Aloe vera gel*, used as a natural rooting biostimulant, positively influences the vegetative propagation of avocado cuttings by enhancing the development of new buds, sprouts and root growth. These findings support the hypothesis

that the bioactive compounds present in *Aloe vera* promote root and shoot formation in stem cuttings, thereby improving their propagation potential.

The gel of *Aloe vera* is documented to harbor a diverse array of over 75 phytoconstituents alongside vital nutrients, encompassing amino acids, complex glycans, antioxidants, essential minerals (such as calcium, zinc, and magnesium), and vitamins from the A, C, E, and B-complex groups (Rajeswari et al. 2012; Rath and Dutta, 2025; Azam et al. 2011). Pre-treatment of avocado stem cuttings via submersion in this gel prior to their establishment in a river sand substrate likely facilitated the uptake of these bioactive molecules by the plant tissues.

Furthermore, salicylic acid—a major bioactive constituent of *Aloe vera*—serves as an elicitor of the plant's immune response by triggering systemic acquired resistance (SAR) within the cutting's vascular pathways. This hormonal activation potentially bolstered the defense mechanisms of the explants against phytopathogenic attacks, thereby mitigating the risk of premature tissue decay (El-Zahra et al. 2025; Azam et al. 2011).

Given that the longevity of plant cells and tissues hinges on their efficacy in suppressing programmed cell death (PCD)—a fundamental biological response regulated during development and under fluctuating biotic or abiotic stresses—the synergistic action of the salicylic acid and antioxidant agents present in *Aloe vera* appears pivotal in sustaining cell viability (Hamdeni et al. 2021; Srivastava 2023).

Additionally, these antioxidant properties may have obstructed autophagic pathways that drive vacuolar cell death and subsequent necrosis. This necrotic degradation is typically marked by an initial disruption of the plasma membrane coupled with protoplast shrinkage (Srivastava 2023; Kant et al. 2025).

Similar results in the propagation of cuttings have been reported in several plant species, including tea (Zhakata and Abduel 2021; Vidanapathirana et al. 2023), citrus (Mirihagalla and Fernando 2020), coffee (Rauben et al. 2024), and eucalyptus (Hassan and Hendi 2021), confirming the potential of *Aloe vera gel* to enhance both shoot emergence and root formation.

The absence of growth in the control group highlights the importance of exogenous growth-promoting substances in facilitating vegetative propagation through stem cuttings, particularly in the Lauraceae species such as *Persea americana* which are resistant to grow. Without such stimulatory agents, the cuttings may have experienced insufficient hormonal

activity or been unable to overcome the physiological constraints associated with dormancy and organogenesis (Shakirah et al. 2023).

To our knowledge, this study represents the first successful report of rapid and efficient sprouting and rooting initiation of leafless avocado cuttings collected directly from mature trees, with a high success rate. In contrast, Leal and Krezdorn required approximately five months to obtain a substantial number of rooted cuttings from juvenile avocado plants and up to seven months to achieve 90% rooting using indole-3-butyric acid (IBA) as a rooting hormone (Leal and Krezdorn 1964). Similar to earlier studies, the practical application of these methods was limited by low propagation efficiency and the extended time required for root development.

More recent approaches, such as the etiolation preconditioning of avocado rootstocks, have been explored to improve rooting performance (Li et al. 2024; García-Cabrera et al. 2025; Duman et al. 2020). However, the technical complexity of these methods which require equipment and facilities (Li et al. 2024), together with the need to further reduce propagation time and facilitate the large-scale production of commercial avocado cultivars, remains a significant challenge.

Conclusion

At the end of the present study, we successfully induced sprouting and rooting initiation in stem cuttings collected from a mature avocado tree for the first-time using *Aloe vera* gel in a river sand substrate, achieving a very high sprouting percentage within a relatively short period. This method is original, simple, eco-friendly, reproducible, and represents a promising solution to the challenges of prolonged rooting time and the large-scale propagation of commercial avocado cultivars that have limited the effectiveness of previous cutting propagation techniques. The technique offers an efficient vegetative propagation approach capable of reducing the juvenile phase of avocado plants while maintaining genetic uniformity, thereby enhancing production capacity and helping to meet the growing global demand for avocado. *Aloe vera* gel may therefore serve as a natural rooting biostimulant for avocado stem cuttings, promoting both root formation and shoot development. It can be considered a promising, low-cost, and environmentally sustainable alternative to synthetic rooting hormones.

Acknowledgements

André Désiré Siéwé gratefully acknowledges the University of Dschang's research grant committee and the Cameroonian Ministry of Higher Education special research allocation for

financial work supports. Additional Acknowledgements go to M. CHOUNDEU WHOMANDJO JOSEPH and Miss. ATSING FOWE ELVIRA for good collaboration and the free access they gave to collect avocado cutting and *Aloe vera* leaves in their farm.

Conflict of Interest The author declares no conflict of interest.

Data Availability Statement The data that support the findings of this study are included in the article/Supplementary Material; further inquiries can be directed to the corresponding author.

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