RESEARCH PROPOSAL

Title of project:

Commercialization and Industrial Scale-up on the Production of NIPRD Essential Oil from *Eucalyptus citriodora* Plant

Executive Summary

The National Institute for Pharmaceutical Research & Development (NIPRD) in Abuja has proposed a comprehensive project aimed at the industrial scale production and subsequent commercialization of NIPRD OIL™, a 100% natural essential oil derived from *Eucalyptus citriodora* plant. Currently, NIPRD Pilot plant has an installed capacity that can produce about 448 liters of NIPRD OIL™ annually. However, with a range of 0.75 – 1.1% extraction yield, this project is estimated to generate a 10,000 USD/week revenue going by the current international market value for 100% natural *Eucalyptus* essential oil, after the proposed expansion is implemented. This initiative is driven by the need to diversify Nigeria's economy, reduce dependency on crude oil revenues, and tap into the growing global demand for natural and plant-derived products.

Project Overview The project focuses on the production, scale-up, and commercialization of *Eucalyptus* essential oil, leveraging Nigeria's favorable agroecological conditions for *Eucalyptus* cultivation. The essential oil, rich in 1,8-cineole (eucalyptol), has significant pharmacological applications, particularly in the health sector. It is known for its antimicrobial, anti-inflammatory, and expectorant properties, making it valuable in pharmaceuticals, respiratory treatments, and other medical applications.

Health Sector Benefits The commercialization of *Eucalyptus* essential oil presents numerous benefits to the health sector:

- **Respiratory Health**: *Eucalyptus* oil is widely used in the treatment of respiratory conditions such as asthma, bronchitis, and sinusitis. Its expectorant properties help in clearing mucus and improving breathing.

- **Antimicrobial Properties**: The essential oil's antimicrobial property makes it effective against a range of pathogens, including bacteria, viruses, and fungi. This makes it a valuable ingredient in antiseptics, disinfectants, and other healthcare products.
- **Anti-inflammatory Effects**: *Eucalyptus* oil's anti-inflammatory properties can help in reducing inflammation and musculoskeletal pain, making it useful in the treatment of conditions such as arthritis and lumbago.
- **Aromatherapy and Mental Health**: The essential oil is also used in aromatherapy to promote relaxation and mental well-being. It can help in reducing stress, anxiety, and mental fatigue.

Economic Potential - The global *Eucalyptus* oil market is projected to grow significantly, with estimates ranging from USD 159 million to USD 1.31 billion by 2025. Nigeria's current export of essential oils is minimal, highlighting a substantial opportunity for growth. Capturing even a small percentage of the global market could yield significant foreign exchange earnings, estimated between USD 1.6 million and USD 65.6 million annually.

Challenges and Solutions The project identifies several challenges, including low processing capacity, fragmented value chains, market access barriers, and data gaps. To address this, the proposal outlines a phased commercialization strategy:

- **Pilot & Demonstration**: strengthening of NIPRD's pilot production of NIPRD OIL™ to validate the ingenuity, agronomy, logistics, and distillation performance.
- **Aggregation & Capacity Building**: Form producer cooperatives in the states with significant *Eucalyptus* plantations, provide training, and establish collection centers.
- **Certification & Market Entry**: Obtain necessary certifications in addition to the already obtained trademark registration, ISO 9001 and ISO 17025 certifications, for the international market entry. This trademark registration is significant in that it has given the NIPRD OIL™ brand the needed legal shield and necessary megaphone for broader scale commercialization.
- **Scale-Up & Vertical Integration**: Expand distillation capacity, strengthen quality control, quality assurance procedures and invest in secondary processing for various applications.

Potential Benefits - The commercialization and Industrial scale-up of *Eucalyptus* oil is expected to provide multiple benefits:

- **Foreign Exchange Earnings**: Significant potential to increase Nigeria's non-oil export receipts.
- **Employment Creation**: Job opportunities in rural and peri-urban areas through the upstream strengthening of existing *Eucalyptus* plantations and establishment of new plantations and subsequent raw material collection and logistics hubs.
- **Value Addition**: Domestic processing to retain a larger share of export value and stimulate downstream manufacturing.

Conclusion The proposed project aims to establish a competitive *Eucalyptus* essential oil sector in Nigeria with NIPRD Oil^{TM} industrial scale production and commercialization project as the flagship, generate more foreign earnings for the economy and contribute to the nation's GDP, strengthen local content capacity into a global player level, strengthen and integrate local plantation holdings, enhance processing capacity, improving healthcare delivery and capacity and ensuring quality assurance. With targeted grant funding and strategic implementation on the objectives of this project, NIPRD can contribute significantly to one of the objectives of Mr. President's Renewed Hope Agenda, achieve meaningful foreign earnings, contribute to economic diversification, and significantly benefit the health sector.

1. BACKGROUND

Essential oils are volatile, natural base products, which are found in spices, aromatic and medicinal plants. The extraction of essential oils is well known from ages when pure essential oil and crude extract of essential oil-bearing plants, herbs and grasses were in use for various medicinal and fragrances, flavors, preservatives and insect repellants purposes, flavoring chemicals, aromatic in pharmaceutical products, food, perfume and industrial (Akuso *et al* 2019).

Eucalyptus (*Eucalyptus* spp.) is a fast-growing tree widely cultivated across tropical and subtropical regions because of its adaptability, rapid biomass accumulation, and multipurpose industrial uses. The leaves of selected species, such as *Eucalyptus globulus*, *E. camaldulensis* and *E. citriodora*, are a major source of *Eucalyptus* essential oil, which is rich in oxygenated monoterpenes, particularly 1,8-cineole (eucalyptol) as the major metabolite. This compound is responsible for its distinctive aroma and therapeutic value. *Eucalyptus* oil is widely utilized in pharmaceuticals, respiratory treatments, cosmetics, food flavoring, aromatherapy, and cleaning products due to its antimicrobial, anti-inflammatory, and expectorant properties (Vecchio, 2016; Chauhan *et al*., 2020). Species available in sizeable quantities are - *Eucalyptus camaldulensis, Eucalyptus citriodora, Eucalyptus grandis, Eucalyptus robusta, Eucalyptus torelliana.* Commercial *Eucalyptus* oil production is primarily carried out through steam distillation or hydro distillation of fresh or partially dried leaves. The production chain typically includes plantation establishment, leaf harvesting, transportation to distilleries, oil extraction, refining, quality testing, packaging, and marketing. Once plantations are established, *Eucalyptus* offers multiple harvest cycles annually, with relatively low input requirements. Importantly, oil yield and chemical composition vary by species, genotype, harvest season, and distillation methods, underscoring the importance of research and technology transfer (Salehi *et al*., 2018; FAO, 2011).

Eucalyptus tree has been widely introduced in Nigeria for shelterbelts, erosion control, poles, and fuelwood. However, industrial-scale processing of *Eucalyptus* leaves into essential oil remains underdeveloped. Nigeria's official trade statistics indicate that within the export of essential oils section, a category that includes *Eucalyptus* oil is minimal. In 2023, Nigeria's essential oil exports were valued at approximately US$176,000, which is negligible compared to the global market value (International Trade Centre, 2024). This low level of activity highlights the absence of a structured *Eucalyptus* oil industry, despite the presence of suitable agroecological conditions and

wide distribution of *Eucalyptus* plantations.
Several factors justify grant-supported investment in *Eucalyptus* oil production in Nigeria.
1. **Economic diversification and value addition.** Nigeria's economy is heavily dependent on crude oil revenues. There is urgent need to diversify into agro-processing and non-oil exports, which is in accordance with the Federal Ministry of Finance's advocacy. Developing *Eucalyptus* oil production could provide rural employment, generate foreign exchange, and stimulate industrial growth through local value addition (Oni & Yusuf, 2021).
2. **Growing global demand**. Demand for natural and plant-derived products is increasing globally, with the *Eucalyptus* oil market projected to grow steadily over the next decade. Market forecasts estimate that the global *Eucalyptus* oil industry could reach between US$159 million and US$1.31 billion by 2025, depending on methodology and scope. (Knowledge Sourcing Intelligence, 2022; Research and Markets, 2023).

Global *Eucalyptus* oil demand provides significant export opportunities. Using available market projections, Nigeria's potential foreign exchange earnings can be estimated as follows:
- If Nigeria captures 1% of the global *eucalyptus* oil market projected at US$1.31 billion by 2025, the country could earn approximately US$13.1 million annually.
- At a 5% market share, this would rise to US$65.6 million.
- Even under the more conservative projection of US$159 million by 2025, a 1–5% market share would yield between US$1.59 million and US$7.96 million annually (Knowledge Sourcing Intelligence, 2022; Research and Markets, 2023).

Thus the current poor earnings in this sector demonstrate both the underutilization of resources and the significant potential for expansion. With targeted grant funding to support technology acquisition, farmer integration, and certification, Nigeria can scale *eucalyptus* oil production to achieve meaningful foreign earnings.

3. **Agroecological suitability**. Nigeria's climate and soils favor eucalyptus cultivation. Integrating eucalyptus oil production into agroforestry and community forestry projects can also provide ecological benefits such as erosion control, carbon sequestration, and renewable energy from fuelwood (FAO, 2020).

4. **Pharmaceutical and Therapeutic Potential**. *Eucalyptus citriodora* oil contains high levels of citronellal, a compound with proven antimicrobial, anti-inflammatory, analgesic, and antioxidant properties (Nureni et al 2021). These attributes make it valuable in the formulation of topical

ointments, antiseptic creams, pain relief balms, and respiratory therapies. Its radical scavenging activity and phenolic content also support its use in natural drug development, aligning with global trends toward plant-based pharmaceuticals (Nureni et al 2021). In addition, given Nigeria's rich tradition of herbal medicine, eucalyptus oil offers a bridge between indigenous knowledge systems and modern pharmacology. Its incorporation into nutraceuticals and wellness products can expand local pharmaceutical innovation while preserving cultural heritage.

5. **Public Health Applications**. The oil is widely used in natural insect repellents, particularly against mosquitoes, which are vectors for diseases like malaria and dengue. Promoting its use in rural and urban communities could contribute to vector control strategies, reducing disease burden and healthcare costs. Additionally, its mood-enhancing and stress-reducing effects through aromatherapy support mental wellness initiatives.

Despite the potential, significant challenges exist:

- Low processing capacity. Nigeria lacks modern distillation plants and laboratories capable of producing pharmaceutical- or food-grade *Eucalyptus* oil that meets international standards (Ajayi *et al*., 2022).
- Fragmented value chains. Smallholders are not integrated into cohesive supply systems, limiting their ability to supply raw material consistently.
- Market access barriers. Export certification, phytosanitary compliance, and organic labeling all required in high-value markets are largely unavailable to Nigerian producers (Oni & Yusuf, 2021).
- Data gaps. There is little research on local yields and production economics of Nigerian *eucalyptus* oils, limiting investor confidence (Ajayi *et al*., 2022).

1.1 *Eucalyptus citriodora*

This is the species of choice for this project. *Eucalyptus citriodora* (Lemon-Scented Gum) is widely cultivated in several states across Nigeria, particularly in regions with suitable climatic conditions. Some of the states where the plantation is found in large quantities include Kaduna state, Oyo state, Ogun state, Ondo state, Ekiti state, and Osun state.

The yield of essential oil from *Eucalyptus* leaves via steam distillation can vary based on several factors, including the species of *Eucalyptus*, the condition of the leaves, and the specific distillation parameters used. Generally, the yield ranges from 0.5% to 3.85% by weight of the leaves. For

example, one study reported an optimum yield of 2.05% under specific conditions, while another found a yield of 0.52% with different parameters (Kidane M., 2016). In a study conducted by Muazu *et al* in 2019, daily production of the essential oil from five batches of *E. citriodora* dried leaves yielded 0.579 liters per 100kg. Total production cycle per batch was 120 minutes out of which 80 minutes were the actual extraction time with lag period of 37 minutes. The results further revealed that 66.7% of the oil was extracted in 40 minutes while 95.6% in 80 minutes. Sareriya *et al* 2024 that the optimum factors for the essential oil extraction included leaf size (0.02 m), extraction temperature (97.76 ℃), solid/solvent ratio (0.61), and extraction time (206 min), with temperature being crucial. The major oil components were 1–8 cineole (57.53–78.45%) and α-Pinene (15.27–27.83%). The oils are administered as an inhalation with steam and other preparations for relief of colds and influenza symptoms. Because of its refreshing odour and its efficiency in killing bacteria, the oil is also used as an antiseptic. It helps to treat lung infections and gastrointestinal ulcers.

Different methods are used for the extraction of the essential oil such as solvent extraction, maceration, cold pressing, effleurage, super critical CO_2 extraction, microwave extraction, turbo distillation extraction, hydro distillation, and steam distillation. This project will employ the use of steam distillation method for the essential oil extraction. Steam distillation is a specialized method used to separate heat-sensitive substances—such as oils, resins, and hydrocarbons—that don't dissolve in water and might decompose at high temperatures. This technique allows these compounds to be distilled at much lower temperatures than their normal boiling points. For example, although some components in essential oils typically boil at temperatures around 200°C or more, thus they can be extracted out of the plant materials near 100°C when exposed to a jet of steam under normal atmospheric pressure. Fresh, or sometimes dried, botanical material is placed in the plant chamber of the still and the steam is allowed to pass through the herb material under pressure which softens the cells and allows the essential oil to escape in vapor form. The temperature of the steam must be high enough to vaporize the oil present, yet not so high that it destroys the plants or burns the essential oils. Besides the steam tiny droplets of essential oil evaporate and travel through a tube into the still's condensation chamber. Here essential oil vapors condense with the steam. The essential oil forms a film on the surface of the water. To separate the essential oil from the water, the film is then decanted or skimmed off the top. The remaining water, a byproduct of distillation, is called floral water, distillate, or hydrosol. It retains many of

the therapeutic properties of the plant, making it valuable in skin care for facial mists and toners (A solution containing chemicals that can change the color of a photographic print). In certain situations, floral water may be preferable to be pure essential oil, such as when treating a sensitive individual or a child, or when more diluted treatment is required. The advantage of Steam distillation is that it is a relatively cheaper process to operate, it aligns with the principles of green chemistry, and the properties of oils produced by this method are not altered. As steam reduces the boiling point of a particular component of the oil, it never decomposes in this method. This method, apart from being economical, is also relatively faster than other methods (Kumar, 2010)

1.2 Commercialization strategy of NIPRD Oil^{TM} (Eucalyptus oil)

This proposal presents a phased commercialization strategy designed to develop a competitive *eucalyptus* essential oil sector in Nigeria. The strategy prioritizes smallholder integration, good agricultural practices (GAP), good manufacturing practices (GMP), quality control, quality assurance, and market access and sustainability development. Grarry *et al*., in 1995, remarked that essential oils have relatively high sales value of approximately N13,000/kg as at then.

Phase A — Pilot & Demonstration: NIPRD has an ISO 9001 and ISO 17025 certified pilot plant for the extraction of *Eucalyptus* essential oil via steam distillation method. ISO 17025 is the international standard that specifies the general requirements for the competence of testing and calibration laboratories. This ensures that labs produce valid, reliable results and operate with impartiality and consistency. The present certified 500-liter capacity extractor produces 2 L/day of the essential oil, which equates to 10 liters in 5 working days. This project intends to double-up this present capacity to 4 liters per day production capacity of the essential oil, by acquiring a 1000 L capacity distiller, leverage on NIPRD's relationship with other local *Eucalyptus* supply zones to validate agronomy and logistics.

Phase B — Aggregation & Capacity Building: There will be need to initiate the raw material network or association across the producing states, provide training on best-harvest practices, grading and pre-processing, establish collection centers to aggregate leaf at scale before forwarding to NIPRD distilling facility.

Phase C — Technology & Quality Upgrade: There will be need to strength quality assessment testing procedures, chief of which is the GC–MS testing which are already available in NIPRD laboratories and adopt GMP-aligned packaging format that will appeal to the international market.

Other test scopes include optical rotation, refractive index, Specific gravity, HPLC-IR fingerprint analysis, TLC fingerprint analysis, acid value, ash value, Saponification value.

Phase D — Certification & Market Entry: In addition to the ISO/quality certifications, there is need to obtain phytosanitary documentation and pursue organic/sustainable sourcing labels for premium markets. NIPRD will initiate cooperation with NEPC to secure market linkages.

Phase E — Scale-Up & Vertical Integration: Expand distillation capacity; invest in secondary processing for cineole-rich fractions, formulation for pharmaceuticals and personal care, and brand development for retail and export channels.

1.3 Benefits to the Nigerian Economy

The commercialization of *eucalyptus* oil offers quantifiable economic benefits: foreign-exchange earnings, contribution to non-oil exports, employment creation, and industrial linkage effects.

- Foreign exchange potential: Industry estimates place the 2025 global eucalyptus oil market between ~US$159 million and US$1.31 billion. A conservative 1% market capture yields US$1.6–13.1 million annually; a 5% capture yields US$8–65.6 million (Research and Markets, 2025; Knowledge Sourcing, 2024).
- Contribution to non-oil exports: Nigeria increased non-oil export receipts substantially in 2024–25 (NEPC/NBS reporting non-oil export growth to multiple billions of naira and a national goal to reach higher non-oil FX inflows). Even modest eucalyptus export volumes would support diversification goals and incremental FX inflows (NBS, 2024; Reuters, 2025).
- Employment impacts: A processing hub with a 10 t/day plant typically requires 15–40 direct staff (operators, lab technicians, logistics), plus indirect jobs in farming, transport, and packing. Scaling to 10–20 such hubs could create several thousand rural and peri-urban jobs (FAO, 2011).
- Value retention: Domestic processing converts low-value raw biomass into high-value oil and derivatives, retaining a larger share of export value domestically and stimulating downstream manufacturing (Oni & Yusuf, 2021).

1.4 Economic Sectors that Stand to Benefit

A mature *Eucalyptus* oil industry touches multiple sectors:

- *Agriculture and Agroforestry*: Nursery and plantation services, seedling production, and extension support.
- *Manufacturing and Processing*: Distillation equipment fabrication, plant operations, refining and packaging industries.
- *Healthcare and Pharmaceuticals*: Raw material supply for respiratory remedies, antiseptics, inhalants (Salvatori *et al*., 2023).
- *Cosmetics and Personal Care*: Ingredient supplies for fragrances, lotions, and organic product lines.
- *Food and Flavoring*: Natural flavor ingredients and potential roles in food preservation research (El Shiekh, 2024).
- *Environmental Services*: Agroforestry and carbon sequestration projects tied to plantation expansion and sustainable sourcing initiatives.

1.5 Global Emerging Trends on Use and Application

Key global trends that NIPRD Oil™ can leverage on:

- Medical & Respiratory Products: Increasing R&D into *eucalyptus* oil for respiratory relief, mucolytic formulations, and topical anti-inflammatory uses (El Shiekh, 2024; Salvatori *et al*., 2023).
- Cleaner Chemistry & Green Solvents: Eucalyptol is gaining interest as a green solvent in some industrial applications, offering higher-margin technical markets (Credence Research, 2025).
- Clean-label Consumer Demand: Growth of organic and naturally derived personal care segments in Europe and North America increases demand for certified eucalyptus oil (Fortune Business Insights, 2024).
- Agricultural Bioproducts: Research on essential oils like bio-pesticides and postharvest protectants is advancing; dedicated product development can open domestic and regional agri-input markets (Adeogun *et al*., 2025).

- Digital Traceability & Sustainability Claims: Buyers increasingly demand proof of sustainable sourcing and chain-of-custody; digital traceability and third-party sustainability certification add price premiums.

1.6 References

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1.7 Estimated budget of project: One hundred and eighty-four million, eight hundred and seventy-four thousand, eight hundred and fifty naira only (**N184,874,850.00**)

3 – 5 key words describing the project: NIPRD Oil^{TM} , Essential oil*, Eucalyptus citriodora,* species, scaled-up production, commercialization.

2. AIM OF THE PROJECT – Production, scale-up from pilot to industrial capacity, and commercialization of essential oil from *Eucalyptus citriodora* plant (NIPRD Oil^{TM}).

3. OBJECTIVES

- To re-establish and prove NIPRD's capacity on the production of essential oil from *Eucalyptus citriodora* plant.
- To re-demonstrate and revalidate the quality control procedures on the essential oil necessary for entry into the international markets.
- To demonstrate proof of capacity for sustainable raw material supply from the plantations.
- To upgrade present activities and equipment from Pilot stage to an Industrial capacity for larger production of NIPRD Oil^{TM}.
- To aggressively pursue the commercialization of the essential oil (NIPRD Oil^{TM}) in Nigeria and in the global markets to tap into the huge economic benefits of essential oil trade.

4. SCIENTIFIC HYPOTHESIS

- The yield and chemical composition of essential oil *from Eucalyptus citriodora* can be significantly optimized through controlled cultivation and steam distillation parameters.
- Scale-up of essential oil extraction from *E. citriodora* using steam distillation maintains chemical integrity and bioactivity of key compounds such as citronellal and citronellol.
- Commercial production of *E. citriodora* essential oil is economically viable with good foreign earning potentials, and sustainable in rural-urban agro-industrial settings.

5. RESEARCH QUESTIONS

- How does plant age or seasonal variation affect the quantity and quality of essential oil?

- What is the chemical profile of the essential oil (e.g., % citronellal, citronellol, limonene) using GC-MS and NMR techniques?
- How does the chemical composition vary with geographic origin or extraction method?
- What antimicrobial or antifungal properties does the oil exhibit, and how do these correlate with its chemical constituents?
- What is the cost-benefit analysis of producing essential oil at scale using locally fabricated distillation units?
- What are the projected ROI, payback period, and market demand for *E. citriodora* essential oil?
- What are the regulatory and quality standards required for commercialization in pharmaceutical, cosmetic, or food industries?

6. EXPECTED OUTCOMES FROM THE PROJECT

The expected outcomes reflect both technical achievements and socioeconomic impact.

Technical & Production Outcomes

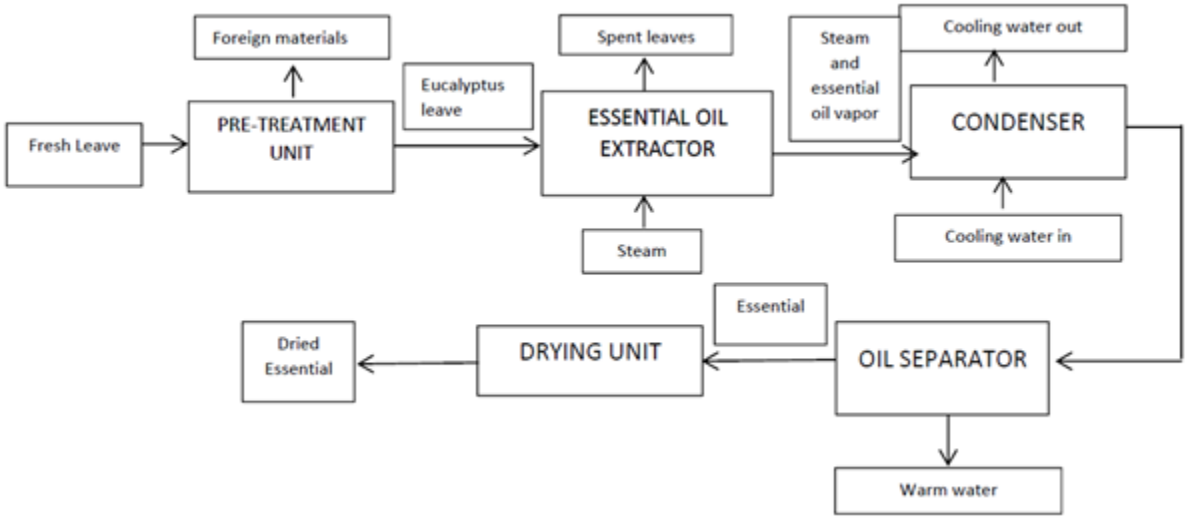
- Optimized extraction protocol for high-yield essential oil using scalable steam distillation method.
- Pilot-scale production data, including yield per batch, extraction time, and energy consumption.
- Standardized quality parameters for the essential oil (e.g., refractive index, specific gravity, acid value).
- Scale-up blueprint for transitioning from pilot to industrial production, including equipment specifications and process flow.
- Essential oil yield benchmarks based on leaf biomass and particle size studies.

Commercialization & Economic Outcomes

- Market-ready product: Packaged essential oil with branding, registered trademark, labeling, and regulatory compliance.
- Business model outlining cost of production, pricing strategy, and profit margins.
- Economic viability report showing return on investment (ROI), payback period, and internal rate of return (IRR).

- Distribution and export strategy, targeting pharmaceutical, cosmetic, and aromatherapy sectors.
- Job creation metrics, especially in rural areas where *Eucalyptus citriodora* is cultivated.

7. METHODOLOGY



A summarized block diagram displaying the stepwise method for the extraction of pure *Eucalyptus* essential oil from *Eucalyptus citriodora* leaves.

Quality control analysis – These sets of analysis are part of the technical requirements in the ISO 17025 certification in which NIPRD has been certified. These sets of analyses enhance credibility and reputation of our NIPRD Oil^{TM} product. It provides a globally recognized seal of approval that demonstrates our lab's technical competence to the international markets, regulators, and other stakeholders. The following scopes of analysis will be adopted:

- Plant raw material morphological identification and authentication.
- Plant raw material taxonomical identification and authentication.
- Moisture content determination,
- Refractive index determination,
- Specific gravity,
- Ash value,
- Acid value,
- Viscosity test,

- Thin layer chromatography (TLC) fingerprint analysis,
- High Performance Liquid Chromatography (HPLC) fingerprint analysis,
- Gas Chromatography-Mass Spectrometry analysis,

Fig. 1. Picture of the proposed Industrial-scale 1000 liter capacity steam distillation equipment for the essential oil extraction.

7b. Previously published article from NIPRD

Research Article | Open Access
Volume 3 | Issue 2 | https://doi.org/10.17311/tas.2024.83.90

Chemical Composition Analysis of *Eucalyptus citriodora* Essential Oil Using GC-MS and NMR Spectroscopy

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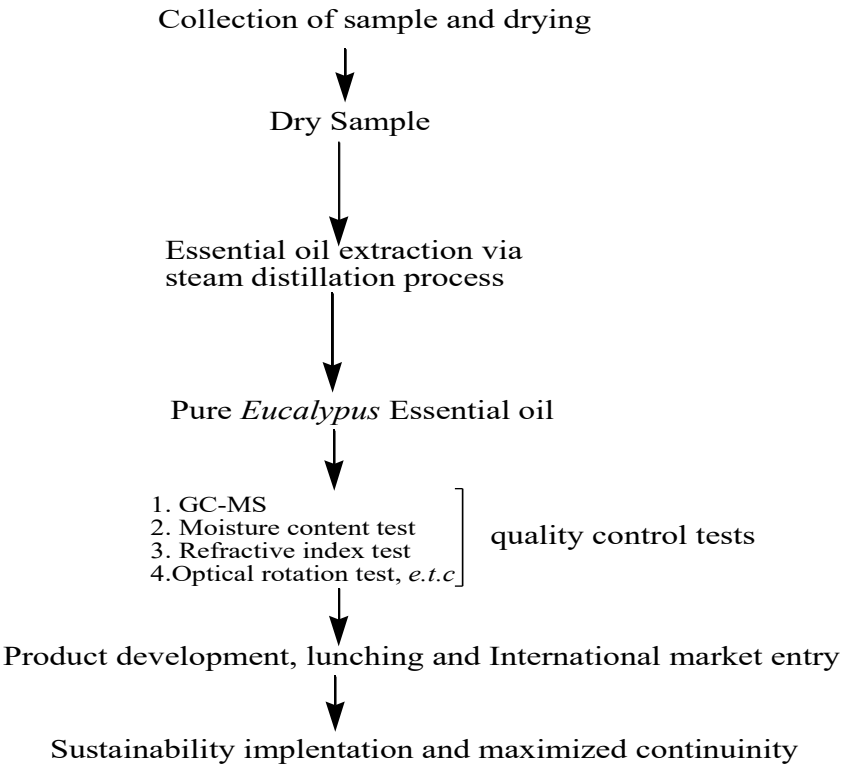
Received	Accepted	Published
20 Mar, 2024	26 Apr, 2024	30 Jun, 2024

8. RESEARCH DESIGN

Summary flow diagram of the entire process of the proposed project.



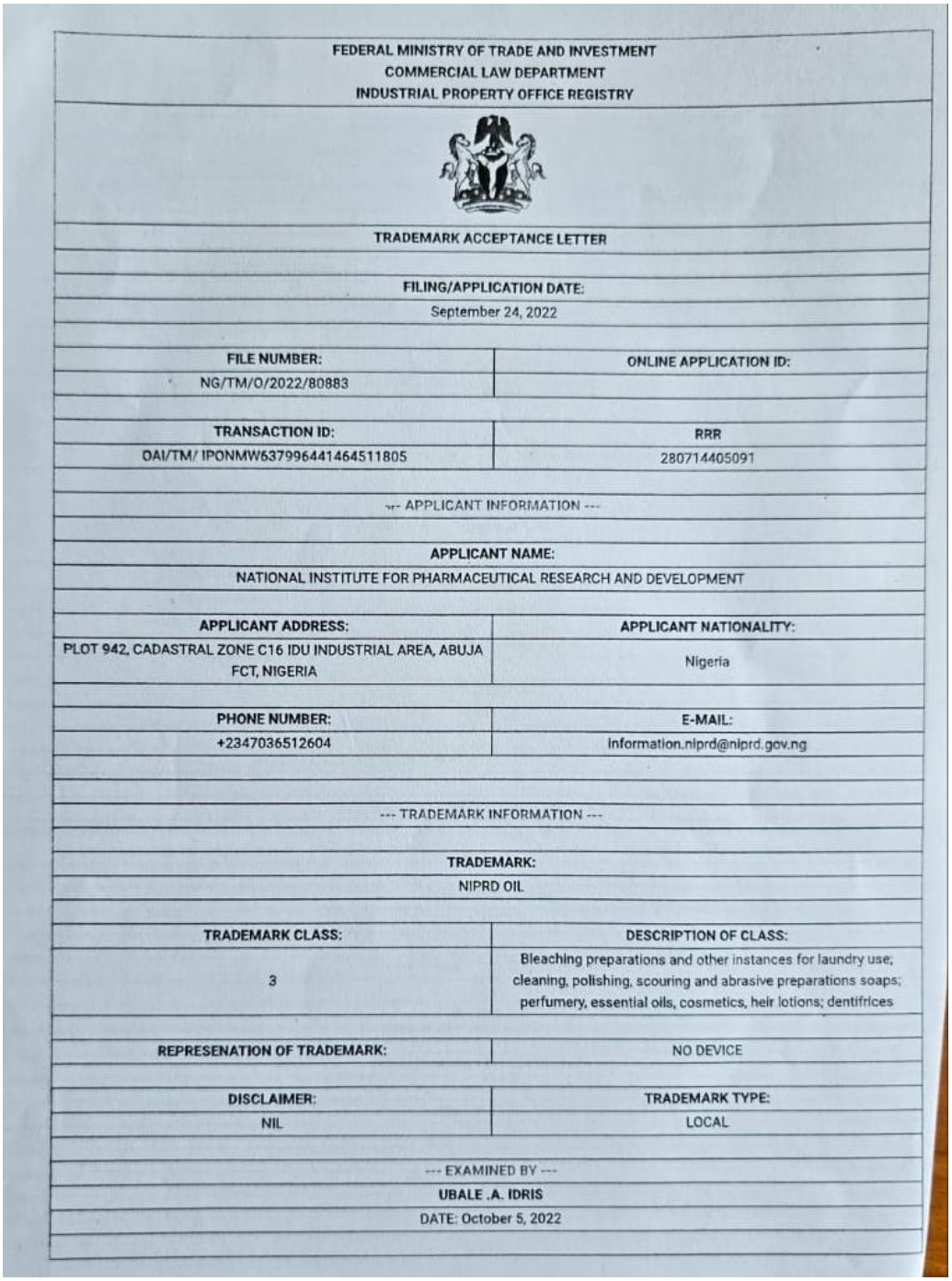
9. PROJECT TEAM MEMBERS

S/N	Name	Institution / Department	Expertise Coordination	Qualification	Contribution to Project
1.	Dr. Tiwalade Adelakun	Medicinal Chemistry and Quality Control department, NIPRD	Medicinal Chemistry and Quality control.	Ph.D	Principal Investigator
2.	Engr. Elias Amlabu	Medicinal Plant Research & Traditional Medicine department, NIPRD	Project engineer and Technical personnel.	Ph.D	Investigator
3.	Dr. Samuel Okhale	Medicinal Plant Research & Traditional Medicine department, NIPRD	Medicinal Plant Chemistry	Ph.D	Investigator
4.	Dr. Jemilat Ibrahim	Medicinal Plant Research & Traditional Medicine department, NIPRD	Ethnobotany and Plant	Ph.D	Investigator
5.	Dr. Nneka N. Ibekwe	Medicinal Chemistry and Quality Control department, NIPRD	Natural Product Chemistry.	Ph.D	Investigator
6.	Mrs. Mercy A. Ademola	Medicinal Chemistry and Quality Control department, NIPRD	Quality Control	B.Sc	Investigator
7.	Mr. Abdulakeem Olayanju	Medicinal Plant Research & Traditional Medicine department, NIPRD	Taxonomist and Species authentication	B.Sc	Plant species identification, authentication and plantation contact.

10. TRADEMARK REGISTRATION

Fig. 2. NIPRD Oil^{TM} registered package outlook.

Trademark acceptance letter from the Federal Ministry of Trade and Investment for the trademark registration of NIPRD OIL™



FEDERAL MINISTRY OF TRADE AND INVESTMENT
COMMERCIAL LAW DEPARTMENT
INDUSTRIAL PROPERTY OFFICE REGISTRY

TRADEMARK ACCEPTANCE LETTER

FILING/APPLICATION DATE:
September 24, 2022

FILE NUMBER:	ONLINE APPLICATION ID:
NG/TM/O/2022/80883	

TRANSACTION ID:	RRR
OAI/TM/ IPONMW637996441464511805	280714405091

--- APPLICANT INFORMATION ---

APPLICANT NAME:
NATIONAL INSTITUTE FOR PHARMACEUTICAL RESEARCH AND DEVELOPMENT

APPLICANT ADDRESS:	APPLICANT NATIONALITY:
PLOT 942, CADASTRAL ZONE C16 IDU INDUSTRIAL AREA, ABUJA FCT, NIGERIA	Nigeria

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--- TRADEMARK INFORMATION ---

TRADEMARK:
NIPRD OIL

TRADEMARK CLASS:	DESCRIPTION OF CLASS:
3	Bleaching preparations and other instances for laundry use; cleaning, polishing, scouring and abrasive preparations soaps; perfumery, essential oils, cosmetics, heir lotions; dentifrices

REPRESENATION OF TRADEMARK:	NO DEVICE

DISCLAIMER:	TRADEMARK TYPE:
NIL	LOCAL

--- EXAMINED BY ---
UBALE .A. IDRIS
DATE: October 5, 2022

This trademark registration is significant in that it has given the NIPRD OIL™ brand the needed legal shield and necessary megaphone for broader scale commercialization.

11. TIME SCHEDULE FOR THE RESEARCH PROJECT

The estimated time schedule to produce 5,000 bottles of 20ml capacity of NIPRD Oil™ is 10 weeks, thus after the proposed scale-up equipment must have been installed, the estimated time to double-up the production to 10,000 sets of 20ml bottle capacity of NIPRD Oil™ will still be 10 weeks. In addition to quality control procedures the estimate time is proposed to be 3 months' duration.

Detailed plan of activities:

Activities	Duration of Activity in Weeks
Collection of the plant material from the *Eucalyptus* plantation	Every 3 days
Steam distillation to obtain essential oil	5 hours daily production time (20 weeks)
Quality control procedures and validation	1 week
Packaging and release	Periodically throughout the project (1 week)

12. FACILITIES AND FUNDING

List of facilities available at NIPRD Pilot Plant and Laboratories

A bulk extractive distiller which is of 500 liters capacity for the extraction of essential oil from aromatic/medicinal plants. Its main features include:

- 500 liters capacity stainless steel Extractor. – this is the vessel where life steam knocks off the oil from the leaves at 100 degrees Celsius.
- 500 liters Reboiler - This is the kettle at the bottom of the distillation still. Fluid from which a distillate is expected to be recovered is fed into it and mild heat applied.
- Circulating/vacuum pumps - It is used to circulate fluid into/out of extractor to other parts of the plant. Vacuum pump creates vacuum pressure inside the Reboiler, distilling column, condenser, coil type cooler and VATs (receivers)

- Small/large overhead Condensers -
- 600 liters capacity solvent tank - For receiving extraction solvents.
- Distillation column packed with intertwined wire mesh - where reactant components separation takes place in gaseous mixture depending on their differences in boiling point.
- Reflux distributor - Device which takes draw off from the overhead condenser back into the column.
- Coil type cooler - cools product from the overhead condenser further towards ambient temperature.
- Glass VAT Receivers - Receives product from the coil type cooler.
- Miscella filters that runs from the extractor into the Reboiler for solvent recovery.

(i) A Bradlee boiler that can generate 500Kg/hr of wet steam. This is a diesel fired boiler with a 250 liters diesel tank and has a 1000 liters water feed tank.

(ii) Water cooling tower for the cooling of heated water in the overhead condensers. The cooled water is then recycled back into the condensers.

(iii) Borehole water supply. *This has been a challenge over time*.

(iv) Electric power supply. *This has been a challenge over time*.

13. ESTIMATED BUDGET

13.1 ***Cost of; procurement of items to facilitate the smooth running of the 500-litres capacity steam distillation equipment.***

S/No	Item Description	Quantity	Unit cost (N)	Amount (N)
1a.	30 KVA power diesel generator	1 complete set	18,000,000	18,000,000.00
1b.	12 mm electric cable	30 meters	255,000.00	255,000.00
1c.	Change over switch	1	160,000.00	160,000.00
1d.	Installation/logistics	1	585,000.00	585,000.00
2a.	Procurement of Cooling tower fan motor (2 KW).	1 set	400,000.00	400,000.00
2b.	Starter switch contactor for Fan electric motor	3	50,000.00	150,000.00
2c.	Three Phase electrical impreventer	3	25,000.00	75,000.00
3a.	Steam boiler: Burner contactor (100A)	2	80,000.00	160,000.00
3b.	2.5 mm electric cable	30 m	3,000.00	90,000.00
4a.	Stainless steel steam pipes – (16 lengths of 2")	16 lengths of 2" diameter	235,000.00 / length	3,760,000.00
4b.	Stainless steel water pipes – (8 lengths of 1 3/4")	8 lengths of 1 3/4"	215,000 / length	1,720,000.00
4c.	Stainless steel water pipes – (5 lengths of 1 1/2")	5 lengths of 1 1/2"	185,000 / length	925,000.00
4d.	Stainless steel water pipes - 11 lengths of 2"	11 lengths of 2"	235,000 / length	2,585,000.00
4e.	Workmanship for welding, alignment and installation		2,040,000.00	2,040,000.00
4f.	Pipe accessories and logistics cost		1,200,000.00	1,200,000.00

5.	Automatic Polarimeter for Optical Rotation. Model – Veidt INESA WXG-4	1 unit	800,000.00	800,000.00
6.	Digital Viscometer (10 - 100,000 mPa's) Specification - *Digital lab rotation viscosity meter ± 3% accuracy fluidity meter tester with 4 rotors and temperature probe (110-240v) NDJ-5S* *Features; Compact design, variable spindle/rotor speed, Data storage, Versatility, Accuracy and repeatability, Digital display, Temperature measurement, Integrated time, Spindle set.*	1 unit	1,200,000.00	1,200,000.00
7.	Tabletop digital refractometer (BRIX ABBE) Model name/number; BNWYA-2S/3S 0-100% Features. 1. Sapphire prism, temperature control, 8-inch color touch screen. 2. Brix: 0-100%, high resolution: Brix: 0.01%	1 unit	1,700,000.00	1,700,000.00
Estimated freight charges, insurance, tax on items to be imported:				950,000.00
			Subtotal	**36,855,000.00**

13.2 ***List of materials needed for the project***

S/No	Description of item	Quantity	Unit Cost (N)	Amount (N)
1	*Eucalyptus citriodora* leaves (twigs only)	22,000 kg	1,100.00 / kg	24,200,000.00
2	Packaging (20ml glass bottles with Aluminum screw lids, stickers and paper box)	10,000 units	1,500.00	15,000,000.00

3	Transport of plant materials to the facility for the 10 weeks duration	50 trips (440 Kg/ trip)	80,000.00	4,000,000.00
4	Labour for Ad-Hoc staff for the proposed 10 weeks duration	750 hrs.,	8334.00/hr	6,250,000.00
			Subtotal -	**49,450,000.00**

13.3 ***List of daily running costs for production during the proposed 10 weeks duration***

S/No	Description of item	Quantity	Unit Cost	Amount (N)
1	Diesel fuel for running generator (14.62L/hr)	8772 liters	1140.00/hr	10,000,000.00
2	Diesel fuel for running the steam generator boiler (12.5L/hr)	7500 liters	1140.00/hr	8,550,000.00
3	Charges for the use of water supplied	750 hrs.	4000/hr	3,000,000.00
			Subtotal	**21,550,000.00**

13.4 ***Cost of new 1000-liter capacity steam distillation equipment for the Industrial scale-up.***

S/No	Description of item	Quantity	Unit Cost (N)	Amount (N)
1.	Steam distillation apparatus (SD-1000L) *Features:* *Distillation kettle (1000L capacity)* *Re-distillation pipe* *hydrosol mixing tank* *multi-stage high-efficiency condensation tower* *secondary oil-water separator,* *top fragrance condensing device,* *gas steam boiler and other related pipelines.*	1 unit	35,775,000.00	35,775,000.00
	Estimated freight charges, insurance, tax on items to be imported:			15,550,000.00
	Contingency expenses (10 %)			5,132,500.00
			Subtotal	**56,457,500.00**

13.5 ***List and cost of glassware needed for the project***

S/N	Item description	Quantity	Unit Price (Naira)	Amount (Naira)
1.	TLC glass plates GF 254 (5cm x 10cm) / plate, 40 plates/pack. (Qingdao HaiYang Chemical Company, China)	10 cartons	7000 /pack 70,000 / carton	700,000.00
2.	TLC glass tanks – (10 x 20 cm) / set	4 sets	30,145.00	120,580.00
3.	Glass rod 8 x 500mm	10 sets	180.50	1,805.00
4.	Forceps – 30cm, 20cm long	15 pcs	210.00	3,150.00
5.	Glass pipettes – 15cm long	500 pcs	90.50	45,250.00
	30cm long	500 pcs	120.00	60,000.00
6.	Glass pipettes rubber fillers (2ml)	20 pcs	90.00	1,800.00
7.	Glass Separating funnel	250 ml (5pcs)	2,500.00	12,500.00
		500 ml (5pcs)	5,200.00	26,000.00
		1 liter (10pcs)	7,000.00	70,000.00
		3 liters (2 pcs)	10,000.00	20,000.00
		5 liters (2 pcs)	15,000.00	30000.00
8.	Glass pycnometer	50ml (5pcs)	8000.00	40,000.00
		25ml (5pcs)	5000.00	25,000.00
		10ml (5pcs)	3000.00	15,000.00
9.	Glass round bottom flasks (various sizes)	10ml (50pcs),	950.50	47,525.00
		25ml (20pcs),	1000.00	20,000.00
		50ml (20pcs),	1500.00	30,000.00
		250ml (20pcs),	2500.00	2,500.00
		500ml (10pcs),	4000.00	80,000.00
		1L (10pcs),	6000.00	6,000.00
		2L (10pcs)	8000.00	80,000.00
10.	Glass round bottom flasks connector mouth	29/24 (3 sets)	5,000.00	15,000.00
		29/19 (3 sets)	5,000.00	15,000.00
11.	Glass measuring cylinders	5ml (30pcs)	1,011.00	30,330.00
		10ml (20pcs)	1,013.00	20,260.00
		250ml (20pcs),	1197.00	23,940.00
		500ml (10pcs),	33,277.00	332,770.00
		1L (10pcs),	21,408.00	214,080.00
		2L (10pcs)	71,677.00	716,770.00

12.	Glass beakers	5ml (30pcs)	6,062.00	181,860.00
		10ml (20pcs)	6,029.00	120,580.00
		250ml (20pcs),	11,759.00	235,180.00
		500ml (10pcs),	14,518.00	145,180.00
		1L (10pcs),	29,996.00	299,960.00
		3L (10 pcs)	35,000.00	350,000.00
		5L (10pcs)	40,000.00	400,000.00
13.	Melting point Capillary tubes	40 pks	5,000.00	20,000.00
14.	Glass desiccator (30cm diameter) with desiccant	1 set	40,000.00	40,000.00
15.	Densitometer for volatile oil	1 set	35,800.00	35,800.00
	Estimated freight charges, insurance, tax for items to be imported:			950,000.00
			Subtotal -	**6,426,550.00**

13.6 ***List and cost of solvents needed for the project***

16.	Methanol (HPLC grade) by Sigma-Aldrich	2.5L (12pcs)	40,000	480,000.00
17.	Hexane (Analar grade 99%) by Sigma-Aldrich	2.5L (12pcs)	40,000	480,000.00
18.	Standard distilled water by Sigma-Aldrich	2.5L (12pcs)	30,000	360,000.00
			Subtotal -	**1,320,000.00**

13.7 ***List and cost of chemicals needed for the project***

19.	Sodium Sulphate pentahydrate salt (99% Sigma-Aldrich or BDC)	20 x 500g	30,000.00	600,000.00
20.	1,8-Cineole (99% Reference standard) CAS number - 470-82-6	2 x 100 mg	700,000.00	1,400,000.00
21.	Alpha-pinene (99% Reference standard) CAS number - 80-56-8	2 x 100 mg	510,000.00	1,020,000.00
22.	Camphene (99% Reference standard)	2 x 100 mg	490,000.00	980,000.00

	CAS number – 79-92-5			
23.	*p*-cymene (99% Reference standard) CAS number – 99-87-6	2 x 100 mg	310,000.00	620,000.00
24.	Silica Gel			
	60-80 micron	10 cartons	45,000/carton	450,000.00
	100-200 micron	10 cartons	45,000/carton	450,000.00
	300-400 micron	10 cartons	55,000/carton	550,000.00
25.	Sephadex LH-20			
	a. 100g (China)	2 pack x 100g	200,000.00	400,000.00
	b. 500g (China)	3 pack x 500g	900,000.00	2,700,000.00
26.	5ml syringe	10 boxes	10,000.00	100,000.00
27.	Parafilm roll – (10cm x 38 cm roll)	2 sets	32,900.00	65,800.00
	Estimated freight charges, insurance, tax for items to be imported:			350,000.00
			Sub-total:	**9,685,800.00**

13.8 ***Literature, documentation, information***

S/N	Item description	Quantity	Unit Cost (N)	Amount (N)
1.	Stationeries for results, reports and filing (3 cartons of A-4 paper)	3 ctns	10,000.00	30,000.00
2.	3-in-1 Hp Lazer-jet black & white Printer (A4 paper size)	1 unit	2,500,000.00	2,500,000.00
3.	Toners cartridges for the Hp printer	3 sets	200,000.00	600,000.00
			Sub-total:	**3,130,000.00**
			Grand Total:	**184,874,850.00**

Grand Total - One hundred and eighty-four million, eight hundred and seventy-four thousand, eight hundred and fifty naira only (N184,874,850.00)