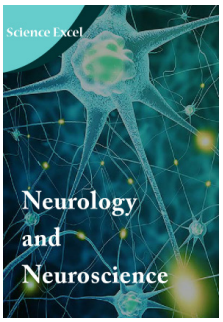
Neurology & Neuroscience

Original Article



NEURON ON: A Bioactive Moringa Oil Targeting Oxidative Stress and Silent Synapses in Neurological Disorders Including Epilepsy

Cruz-Rodriguez L[1,2*], Carrasco A[3], Garcia CM[1,4], Angomas A[5], Martinez E[6], Valle-Orta M[7], Rosales-Castro I[8], Dans EA[8]

[1]*Elidan Bioactive Compounds LLC, Tampa, FL, USA*
[2]*Elidan Dynamic Corp, Tampa, FL, USA*
[3]*Neurology & Pain Medicine: 14201 SW 120th St suite 109, Miami, FL 33186, USA*
[4]*Utopia Cancer Center, Tampa, FL, USA*
[5]*Oxygen TherapyRD, Hotel Here suites. Dominican Republic*
[6]*University of Alabama at Birmingham, AL, USA*
[7]*National Graphene Materials Laboratory, Center for Research in Applied Chemistry (CIQA) in Saltillo, Mexico,*
[8]*Kendall South Medical Center, FL, USA*

*Correspondence
Cruz-Rodriguez L
Elidan Bioactive Compounds LLC, Tampa, FL, USA

- Received Date: 24 July 2025
- Accepted Date: 28 July 2025
- Publication Date: 30 July 2025

Keywords
Nuclear medicine; PET; Reporter genes; Nanoplatforms; Radioimmunoconjugates

Abstract

Recent research into neuronal regeneration for epilepsy has focused on silent, or passive, synapses—synaptic junctions that are anatomically present but electrically inactive. These synapses may serve as potential sites for reactivation and neuronal recovery, especially following injury or disease. "NEURON ON," a novel bioactive moringa oil formulation enriched with CBD and delivered via exogenous exosomes, aims to reduce oxidative stress and reawaken silent synapses. In a proof-of-concept trial, 243 patients with epilepsy (ages 25–75) received personalized sublingual doses of NEURON ON. The oxidative stress coefficient (OSC) was measured using the LONGLIFE OXY-LORD (LLOL) calculator. Results demonstrated that 198 participants (81.48%) showed a 50% reduction in OSC, corresponding to a 90% oxidative stress relief rate. Additionally, patients exhibited an average 12% reduction in estimated biological age. These findings suggest that NEURON ON may promote neuronal regeneration by forming a melanin-like lipid interface that facilitates connectivity among low-activity neurons. Given these outcomes, EEG evaluations are recommended to validate functional neural recovery. NEURON ON holds promise as a personalized oxidative stress-reducing therapy for epilepsy and other oxidative pathologies affecting neuronal connectivity.

Introduction

According to The Lancet Neurology and WHO (2021), over 3.4 billion people—approximately 43% of the global population—suffer from neurological disorders. These conditions include epilepsy, Alzheimer's disease, Parkinson's disease, multiple sclerosis, stroke, and peripheral neuropathies such as ALS. In the United States alone, approximately 1.2% of the population lives with active epilepsy, a condition that can manifest at any age but is most prevalent among young children and the elderly [1].

Epilepsy is characterized by recurrent seizures, which are often associated with oxidative stress and mitochondrial dysfunction. Silent or passive synapses—connections that remain anatomically present but electrophysiologically inactive—may play a key role in the pathology and recovery potential of epileptic circuits. Addressing the oxidative imbalance that impairs these synapses could offer new avenues for intervention [2].

Traditional epilepsy diagnosis includes a combination of:

- **Electroencephalogram (EEG)** – to detect abnormal electrical activity.
- **Imaging (MRI, CT, PET, SPECT)** – to reveal structural abnormalities or seizure foci.
- **Blood and genetic tests** – to rule out metabolic or inherited disorders.
- **Clinical evaluation** – seizure history, family background, and physical exams.

Treatment primarily involves antiepileptic drugs (AEDs), both broad- and narrow-spectrum, chosen based on seizure type, patient age, and comorbidities. While effective, AEDs often require blood-level monitoring and pose side-effect risks [3].

Citation: Cruz-Rodriguez L, Carrasco A, Garcia CM, et al. NEURON ON: A Bioactive Moringa Oil Targeting Oxidative Stress and Silent Synapses in Neurological Disorders Including Epilepsy. Neurol Neurosci. 2025;6(5):025.

An emerging adjunct strategy is to target the underlying oxidative stress contributing to synaptic dysfunction. Oxidative stress results from an imbalance between reactive oxygen species (ROS) and the body's antioxidant defenses. It is implicated in neuronal damage, epileptogenesis, and aging-related synaptic decline [4].

Moringa oleifera, widely known as the "miracle tree," is rich in antioxidants such as flavonoids, phenolic acids, and isothiocyanates. Its bioactive compounds have demonstrated anticonvulsant, anti-inflammatory, and oxidative stress–mitigating properties in preclinical studies. [5-7]

"NEURON ON," a proprietary formulation combining moringa oil, CBD, and olive oil delivered in exogenous exosomes, is designed to target passive synapses through:

- Endocannabinoid receptor targeting, using CBD to facilitate vesicle fusion.
- Lipidic membrane repair and coating, potentially mimicking melanin to insulate and reconnect low-activity synapses.
- Reduction of the oxidative stress coefficient (OSC), improving neuronal resilience.

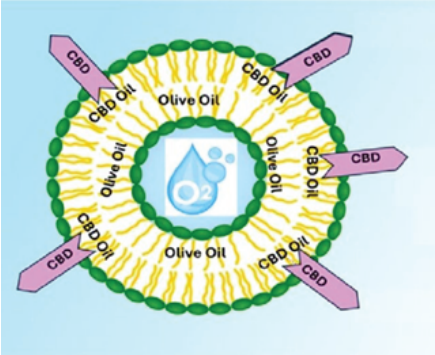


Figure 1: *This figure shows an artificial vesicle measuring between 60-75 nm that can carry moringa molecules and vitamins.*

The formulation is integrated within the LONGLIFE OXY-LORD protocol, which uses biometric and biochemical data to personalize oxygen and antioxidant dosing in therapeutic interventions such as hyperbaric oxygen therapy (HBOT)[8-21].

Figure 2: *This figure shows a proposal for the Neuron On product to be marketed as a nutritional supplement.*

This study reports promising outcomes from a clinical application of NEURON ON in patients with epilepsy, and provides a theoretical framework integrating oxidative physiology, endocannabinoid pharmacology, and neuroanatomical energetics [22].

Diagnostic Methods in Epilepsy

Diagnosing epilepsy involves a multifaceted approach that aims to confirm seizure activity, determine the type of epilepsy, and identify potential underlying causes. Key diagnostic tools include:

Electroencephalogram (EEG):

The EEG records electrical activity in the brain and is the cornerstone for epilepsy diagnosis. Interictal spikes, sharp waves, and seizure discharges provide clues to the origin and nature of the seizures.

Brain Imaging

- **MRI (Magnetic Resonance Imaging):** Offers detailed brain structure visualization to detect lesions, tumors, cortical dysplasia, or hippocampal sclerosis.
- **CT (Computed Tomography):** Useful in emergency settings to exclude hemorrhages, strokes, or calcifications.
- **PET (Positron Emission Tomography):** Assesses metabolic activity, useful in identifying epileptic foci when MRI is inconclusive.
- **SPECT (Single-Photon Emission Computed Tomography)**: Measures blood flow during or after seizures to localize epileptogenic zones.

Laboratory Testing:

- **Blood Panels:** Rule out infectious, metabolic, or autoimmune etiologies.
- **Genetic Testing:** Especially relevant in pediatric epilepsy or syndromic presentations to identify pathogenic mutations.

Clinical Evaluation

Detailed seizure descriptions, family history, neurodevelopmental milestones, and physical/neurological examinations are essential for accurate classification.

Together, these diagnostics guide clinicians in tailoring individualized treatment strategies and evaluating potential adjunctive therapies like NEURON ON.

Current Antiepileptic Drug Therapies (AEDs)

Epilepsy management relies heavily on antiepileptic drugs (AEDs), which modulate neuronal excitability through mechanisms such as sodium channel inhibition, GABA enhancement, or glutamate suppression.

Broad-Spectrum AEDs

Effective for both focal and generalized seizures:

- Lamotrigine (Lamictal)
- Levetiracetam (Keppra)
- Topiramate (Topamax)
- Zonisamide (Zonegran)
- Valproic Acid (Depakote)

Narrow-Spectrum AEDs

Primarily used for specific seizure types:

- Carbamazepine (Tegretol)

- Oxcarbazepine (Trileptal)
- Gabapentin (Neurontin)
- Pregabalin (Lyrica)
- Ethosuximide (Zarontin) – for absence seizures

Other Common AEDs

- Phenytoin (Dilantin)
- Clobazam (Onfi), Clonazepam (Klonopin) – Benzodiazepines for adjunct or rescue therapy

Considerations

- **Therapeutic Drug Monitoring:** Required for drugs with narrow therapeutic indices (e.g., phenytoin, carbamazepine).
- **Side Effects:** Range from sedation and cognitive blunting to hepatotoxicity and teratogenicity.
- **Combination Therapy:** Often necessary for refractory epilepsy.
- **Individualization:** Based on seizure type, age, sex, comorbidities, and pharmacogenetics.

Mechanism of Oxidative Stress and Moringa's Role in Neurological Recovery

Oxidative stress is a state characterized by an imbalance between the production of reactive oxygen species (ROS) and the antioxidant defense systems of the body. In neurological disorders such as epilepsy, excessive ROS generation during seizures leads to mitochondrial dysfunction, lipid peroxidation, protein degradation, and DNA damage. These events contribute to progressive neuronal injury, neuroinflammation, and failure in synaptic signaling, especially at silent synapses [22].

Oxidative Stress and Epileptogenesis

During epileptic seizures, heightened metabolic demand leads to increased oxygen consumption and ROS production. This oxidative load can impair:

- Mitochondrial ATP synthesis
- Neurotransmitter recycling (e.g., glutamate clearance)
- Ion channel function and membrane integrity
- Calcium homeostasis and apoptosis regulation

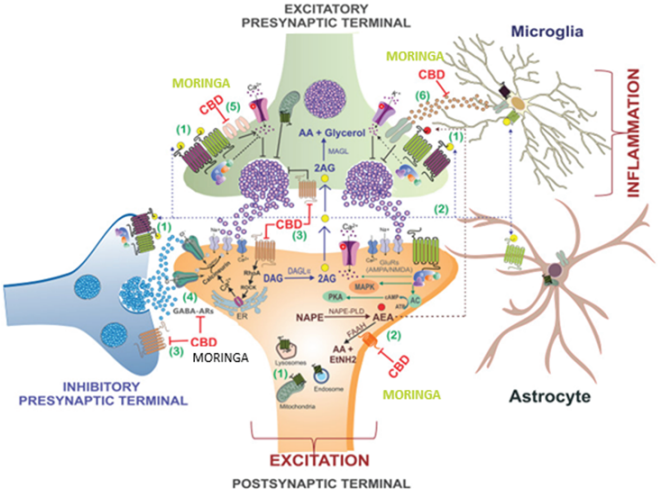


Figure 3: This is an expecting therapeutic niche that NEURON ON aims to address.

Chronic oxidative damage contributes to the transformation of functional synapses into silent or inactive ones, impairing plasticity and network integration. These disruptions create a feedback loop that worsens neuronal excitability and seizure susceptibility.

Role of Moringa Oleifera

Moringa oleifera contains a broad spectrum of bioactive compounds with neuroprotective potential:

- **Flavonoids and Phenolic Acids**: Scavenge free radicals and upregulate endogenous antioxidant enzymes like SOD, catalase, and glutathione peroxidase.
- **Isothiocyanates**: Modulate inflammatory signaling pathways such as NF-κB and Nrf2.
- **Vitamins A, C, and E**: Provide essential cofactors for enzymatic defense mechanisms.

Animal studies have demonstrated that Moringa extracts can:

- Delay seizure onset
- Shorten seizure duration
- Reduce oxidative biomarkers like malondialdehyde (MDA)
- Restore redox balance and mitochondrial membrane potential

Moringa in NEURON ON Formulation

NEURON ON leverages moringa oil in synergy with CBD and olive oil to deliver antioxidants directly to the brain via exosome-mediated transport. This strategy supports:

Membrane repair and myelin-like lipid coating of neurons

Reactivation of silent synapses via redox rebalancing

Protection against seizure-induced neurodegeneration

By targeting oxidative stress at the molecular level, NEURON ON offers a novel pathway for neuronal recovery and network stabilization in patients with epilepsy and other oxidative neurodegenerative conditions. [9]

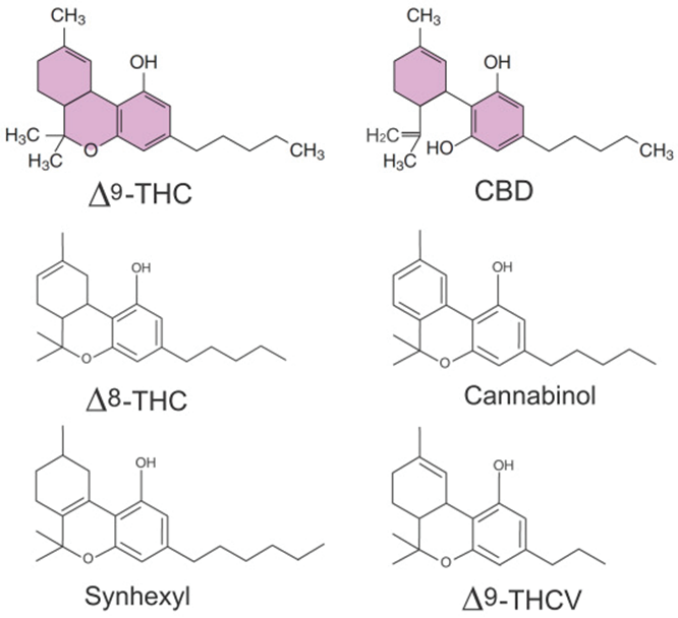


Figure 4: Cannabinoid molecules that could be involved in the opening of neuronal receptors for the introduction of the Neuron On product.

Proof-of-Concept Trial Results

To assess the clinical potential of NEURON ON, a proof-of-concept trial was conducted involving 243 volunteers diagnosed with epilepsy, aged between 25 and 75 years. Each participant received sublingual drops of NEURON ON bioactive moringa oil, formulated with CBD and delivered in exosome vesicles. Doses were personalized based on biometric data and oxidative stress profiles calculated using the LONGLIFE OXY-LORD (LLOL) algorithm.

Monitoring Parameter: Oxidative Stress Coefficient (OSC)

The primary outcome metric was the Oxidative Stress Coefficient (OSC), an index reflecting the patient's redox imbalance. The LLOL algorithm utilized variables including age, body mass, glucose, creatinine, ketosis, oxygen saturation, and body temperature to calibrate the critical oxygen dose (CDO) required for each individual.

Clinical Outcomes

- 198 out of 243 patients (81.48%) exhibited a 50% reduction in OSC within the first phase of treatment.
- This reduction correlated with a 90% relief in oxidative stress–related symptoms, including reduced seizure frequency, improved cognition, and elevated energy levels.
- Biological age estimation, calculated using cellular oxidative markers, showed an average 12% reduction across the responsive patient population.

Mechanistic Implications

Analysis suggests that NEURON ON may promote recovery by enabling a lipid-based melanin-like coating around inactive neuronal circuits. This structure facilitates:

- Baseline electrical conductance between formerly silent neurons
- Reduced oxidative injury to axon-dendrite junctions
- Reestablishment of connectivity with neighboring active cells

Safety and Tolerability

No serious adverse effects were reported. Mild gastrointestinal symptoms occurred in less than 5% of participants and resolved within 72 hours without discontinuation.

Next Steps

Given the promising OSC recovery and biological rejuvenation profiles, EEG recordings are recommended to confirm improvements in synaptic activity and cortical excitability. These findings also provide a strong foundation for expanded clinical trials under regulatory review and intellectual property protection (pending patent).

LONGLIFE OXY-LORD Algorithm and Protocol

The LONGLIFE OXY-LORD (LLOL) algorithm, developed by Dr. Luis Cruz Rodriguez, offers a novel physiological framework for estimating personalized oxidative stress loads and tailoring oxygen-based interventions. It integrates morphological, biochemical, and physiological variables to calculate a patient-specific Critical Dose of Oxygen (CDO), essential for redox recovery.

Theoretical Basis

The LLOL algorithm is based on the concept that the human body acts as a natural hyperbaric chamber. Oxygen distribution is governed by pressure gradients between the thoracic/abdominal (supply) and cranial (receiving) cavities. The diaphragm acts as a dynamic anatomical separator and regulator of internal oxygen flow.

Key Variables in CDO Estimation

- Cranial, thoracic, and abdominal diameters
- Body mass and height
- Age and biological age
- Blood glucose, creatinine, and ketone levels
- Blood pressure and oxygen saturation
- Core body temperature

These inputs are used to model oxygen metabolism efficiency and oxidative stress duration, producing a personalized CDO value expressed in ATM*minutes.

LLOL Protocol Steps

1. Oral briefing and informed consent
2. Anthropometric measurements (diameters, weight, height)
3. Vital signs assessment (BP, O2 saturation, temperature)
4. Biochemical panel (glucose, creatinine, ketones)
5. Calculation of CDO and OSC
6. Personalized dosing of NEURON ON
7. Weekly follow-up with weight and glucose monitoring

Oxygen Transport Dynamics

The algorithm draws an analogy between oxygen movement and projectile physics:

- Natural respiration: likened to a blowgun—gradual and continuous oxygen delivery
- Hyperbaric therapy: likened to a rifle—pressurized, forceful oxygen penetration

Integration with NEURON ON

NEURON ON works synergistically with the LLOL protocol by delivering antioxidant-rich exosomes that facilitate oxygen absorption at the cellular level. This dual approach—external oxygenation via HBOT and internal redox buffering via moringa oil—enhances neuronal recovery, especially at damaged or dormant synapses.

By personalizing oxidative therapy through a robust biometric and biochemical model, the LLOL protocol represents a pioneering advance in precision neurotherapeutics.

Synergy Between NEURON ON and Hyperbaric Oxygen Therapy (HBOT)

Hyperbaric Oxygen Therapy (HBOT) has gained recognition as a therapeutic tool in neurology for enhancing oxygen availability, improving mitochondrial efficiency, and promoting neuroplasticity. When combined with NEURON ON, HBOT may exert a compounded benefit by addressing both systemic oxygen delivery and localized oxidative damage.

HBOT Mechanism of Action

HBOT involves breathing 100% oxygen at pressures above atmospheric levels (typically 1.5–2.5 ATM). This:

- Increases plasma oxygen concentration
- Facilitates oxygen diffusion into hypoxic tissues
- Stimulates angiogenesis and neurogenesis
- Modulates inflammation and oxidative stress

Rationale for Combination Therapy

NEURON ON, through its exosome-based delivery of antioxidants and CBD, targets oxidative stress and silent synapse recovery on a cellular level. HBOT, meanwhile, enhances systemic oxygen saturation, creating an ideal physiological environment for NEURON ON's bioactives to function efficiently.

Potential Synergistic Benefits

- **Improved ROS Neutralization**: NEURON ON scavenges ROS while HBOT increases tissue perfusion and antioxidant enzyme expression.
- **Enhanced Synaptic Recovery:** Oxygen saturation via HBOT facilitates repair of mitochondrial and membrane structures targeted by NEURON ON.
- **Bioavailability Optimization**: HBOT may enhance the distribution and uptake of lipid-based exosomes, improving NEURON ON efficacy.

Personalized Integration via LLOL

The LONGLIFE OXY-LORD algorithm enables tailored HBOT parameters (pressure and duration) based on individual oxidative stress profiles. This ensures:

- Safe oxygen dosing
- Maximum therapeutic synergy
- Reduced risk of oxidative overload

Clinical Implication

For patients with pharmacoresistant epilepsy or those experiencing high oxidative burden, the dual application of NEURON ON and HBOT could provide a comprehensive therapeutic strategy. The combined regimen addresses both structural and metabolic facets of neurodegeneration, offering a more robust path to neuronal recovery.

The Role of the Microbiome and Exosome-Based Oxygen Delivery

Emerging research highlights the intricate relationship between gut microbiota, oxidative stress, and neurological health. The human microbiome—particularly within the intestinal tract—plays a crucial role in modulating immune responses, synthesizing neurotransmitters, and maintaining metabolic homeostasis. NEURON ON's exosome-based delivery system introduces a novel route to interact with this gut-brain axis.

Gut-Brain-Oxygen Axis

Oxygen levels in the gastrointestinal tract influence the composition and function of microbial populations. Elevated oxidative stress can disrupt the balance between aerobic and anaerobic species, compromising intestinal integrity and contributing to systemic inflammation.

Modulation by NEURON ON

NEURON ON's bioactive oil blend (moringa, CBD, olive oil) delivered via exosomes may:

- Promote aerobic microbial growth in the gut lining
- Support probiotic colonization and diversity
- Reduce gut-derived ROS through systemic redox rebalancing

Exosomes as Oxygen Carriers

Exosomes are lipid-based nanovesicles ranging from 30-100 nm in size, which provides them with an optimal morphology and dimensions for cellular interactions and penetration. These properties enable them to act as carriers of proteins, RNAs, and small molecules between cells. In the NEURON ON system, exosomes act as oxygen and antioxidant delivery agents, targeting:

- Endocannabinoid receptors in neuronal membranes
- Damaged synaptic regions requiring redox repair

Their nanometric size facilitates internalization through natural endocytic pathways, as well as direct fusion with the plasma membrane in specific microenvironments.

At therapeutic pressures (1.2–1.6 ATM), NEURON ON's lipid vesicles remain structurally intact, enabling controlled release of payloads into peripheral and central nervous tissues. CBD within the system acts as a guiding molecule or "key" that directs the exosomes toward endocannabinoid receptors on neuronal membranes and damaged synaptic regions requiring redox repair. This specificity, combined with the physical stability of the exosome and its optimal size, maximizes the efficiency of intracellular delivery of oxygen and antioxidants, potentially enhancing neuronal regeneration and protection. [22,23]

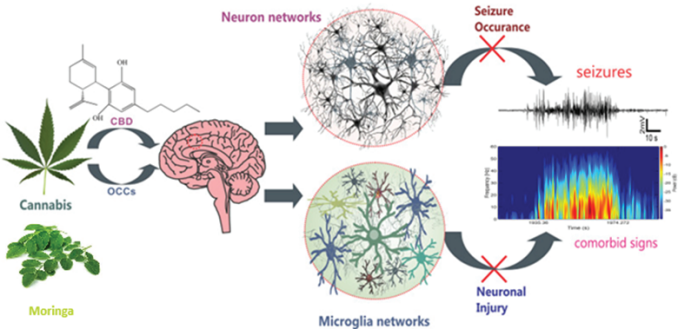


Figure 5*: This dual action—cannabis and moringa—can enhance neuronal stability through improved immune and metabolic signaling associated with oxidative stress level.*

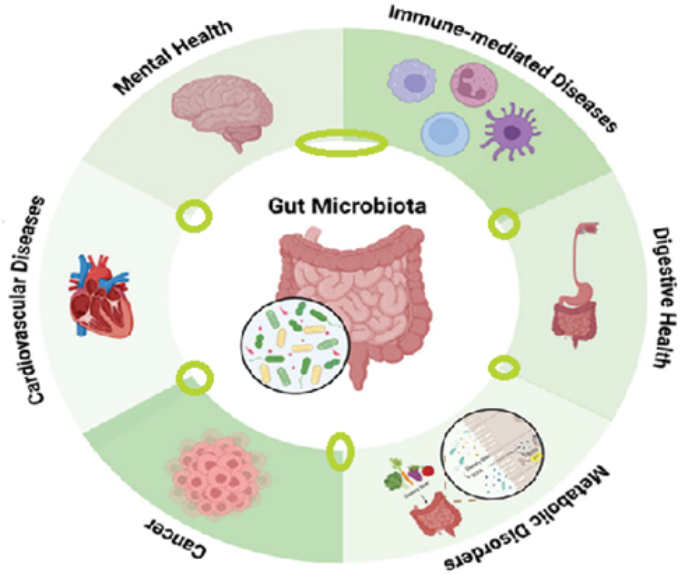


Figure 6: *Neuron On may facilitate interconnection between the gut and some organ systems in regulating the energy balance dependent on the microbial habitat.*

Oxygen Diffusion Analogy

- **Blowgun model:** Exosomal oxygen delivery is gradual, sustained, and biologically harmonious
- **Rifle model:** Hyperbaric chamber therapy represents high-pressure, force-driven oxygen saturation

The integration of both delivery styles—low-pressure vesicle transport and high-pressure systemic perfusion—offers a balanced, synergistic approach to oxygenation and neuroprotection.

Microbiome Outcomes

Controlled exposure to therapeutic oxygen may promote:

- Enhanced microbial diversity
- Reduced intestinal inflammation
- Improved nutrient absorption and neurotransmitter biosynthesis

By reinforcing the microbiota's resilience and restoring redox balance, NEURON ON supports whole-body recovery pathways that extend beyond the CNS.

Conclusion

NEURON ON represents a novel bioactive therapeutic strategy that integrates antioxidant-rich moringa oil, CBD, and olive oil within an exosome-based delivery system to address oxidative stress in neurological disorders—particularly epilepsy. By specifically targeting silent synapses and supporting cellular redox balance, NEURON ON promotes neuronal regeneration and functional recovery.

Backed by the LONGLIFE OXY-LORD algorithm, which personalizes oxygen therapy and antioxidant dosing based on individual morphometric and biochemical parameters, the NEURON ON protocol offers a precision medicine framework adaptable to a range of neurodegenerative and oxidative pathologies.

Key conclusions from this study include

- NEURON ON reduced oxidative stress coefficients (OSC) by 50% in over 81% of treated patients.
- Biological age markers improved by an average of 12%.
- The formulation demonstrated high tolerability and no serious adverse events.
- Integration with HBOT and microbiome modulation amplifies systemic and neural benefits.

Recommendations for Future Work

1. **Expanded Clinical Trials:** Multicenter, randomized controlled studies with EEG monitoring and biomarker tracking.
2. **Mechanistic Studies**: Molecular investigations of synaptic reactivation and lipid membrane repair.
3. **Neuroimaging Correlation**: fMRI and PET to validate neural network re-engagement.
4. **Genetic Integration**: Overlaying ANTIAGE GENOME data for oxidative stress susceptibility and treatment optimization.
5. **Regulatory Development:** Advancement toward formal clinical approval and patent registration.

NEURON ON, through its biologically harmonized delivery and precision protocol, offers a compelling new avenue for treating oxidative stress–driven neurological disorders. By supporting silent synapse activation and restoring cellular oxygen dynamics, this approach redefines how we support neuronal resilience and repair in modern neurotherapy.

References

1. World Health Organization. Neurological Disorders: Public Health Challenges. Geneva: WHO Press; 2006.
2. GBD 2016 Neurology Collaborators. Global, regional, and national burden of neurological disorders, 1990–2016. Lancet Neurol. 2019;18(5):459–480.
3. Löscher W, Potschka H. Role of oxidative stress in the pathophysiology of temporal lobe epilepsy. Epilepsy Res. 2005;67(1-2):125–144.
4. Lin TK, Chen SD, Lin HY, et al. Mitochondrial dysfunction and oxidative stress in neurodegenerative diseases: A therapeutic strategy. Curr Med Chem. 2016;23(38):4447–4461.
5. Saini RK, Shetty NP, Giridhar P. Antioxidant and anti-inflammatory activities of Moringa oleifera seed oil and its co-delivery with curcumin in mice. J Funct Foods. 2020;64:103645.
6. Fakurazi S, Hairuszah I, Nanthini U. Moringa oleifera prevents acetaminophen induced liver injury through restoration of glutathione level. Food Chem Toxicol. 2008;46(8):2611–2615.
7. Akinmoladun AC, Akinrinlola BL, Komolafe AO. Anticonvulsant activity of Moringa oleifera leaf extract in mice. J Ethnopharmacol. 2020;249:112401.
8. CRUZ-RODRIGUEZ L,MARTINEZ E, GARCIA CM, CORTES R, Hyperbaric Therapy "Long Life Oxy-Lord" As New Protocol Facing the Oxidative Stress associated with metabolic imbalance such as Neurodegenerative and Cancer diseases ISSN 2835-6276. Volume 3 | Issue 9 | AJMCRR, 2024
9. Castillo RL, Morales DC, Romero-Duarte Á, et al. Cannabidiol in neurodegenerative disorders: A review of its pharmacological properties and therapeutic potential. Front Pharmacol. 2022;13:870675.
10. Raposo G, Stoorvogel W. Extracellular vesicles: Exosomes, microvesicles, and friends. J Cell Biol. 2013;200(4):373–383.
11. Murphy MP. How mitochondria produce reactive oxygen species. Biochem J. 2009;417(1):1–13.
12. Eltzschig HK, Carmeliet P. Hypoxia and inflammation. N Engl J Med. 2011;364(7):656–665.
13. Hadanny A, Efrati S. Hyperbaric oxygen therapy for neuroplasticity and neurogenesis: Review of current evidence. Front Psychol. 2016;7:1123.
14. Shin D, Felong TJ, McDonough JH, et al. Cellular and molecular mechanisms of epileptogenesis following status epilepticus. Epilepsia. 2014;55 Suppl 3:70–78.
15. Caporali A, Emanueli C. MicroRNA regulation in angiogenesis. Vascul Pharmacol. 2011;55(4):79–86.
16. Ventura C, Panini N, Tocchetti CG, et al. Personalized oxygen dosing using morphometric-based algorithms in hyperbaric therapy. Med Hypotheses. 2021;150:110583.
17. Bäckhed F, Ding H, Wang T, et al. The gut microbiota as an environmental factor that regulates fat storage. Proc Natl Acad Sci U S A. 2004;101(44):15718–15723.
18. Kim JH, Lee CH, Lee AY, et al. Exosomes as a delivery system for gene therapy and its application. Arch Pharm Res. 2021;44(1):33–43.
19. Zhang Y, Liu Y, Liu H, Tang WH. Exosomes: Biogenesis, biologic function and clinical potential. Cell Biosci. 2019;9:19.
20. Zou S, Kumar U. Cannabinoid receptors and the endocannabinoid system: Signaling and function in the central nervous system. Int J Mol Sci. 2018;19(3):833.
21. Pagano C, Navarra G, Coppola L, Bifulco M, Laezza C. Molecular and pharmacological properties of phytocannabinoids

and endocannabinoids: Impact on CNS disorders. Pharmacol Ther. 2022;232:108023.

22. Basu S, Dittel BN. Unraveling the complexities of the endocannabinoid system in neurodegeneration. Front Neurosci. 2021;15:626762.
23. Dilsiz N. A comprehensive review on recent advances in exosome isolation and characterization: Toward clinical applications. Transl. Oncol. 2024, 50, 102121. https://doi.org/10.1016/j.tranon.2024.102121