From Invasive Weed to Innovative Health: A Comprehensive Study of Lantana Camara Products and Market Potential

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***Abstract*—Lantana camara L. is one of the most aggressive invasive alien plant species distributed across tropical and subtropical regions of the world, including India, where it causes significant ecological, agricultural, and economic damage [1],[2]. Despite its invasive nature, Lantana camara has emerged as a promising bioresource due to its rich phytochemical composition and diverse industrial applications [3],[4]. The plant contains several bioactive constituents such as terpenoids, flavonoids, alkaloids, tannins, and essential oils that exhibit antimicrobial, antioxidant, insecticidal, and medicinal properties [5],[6]. These phytoconstituents make Lantana camara a valuable raw material for the development of herbal medicines, essential oils, insect repellents, bio-pesticides, compost, biochar, and biofuels [7][8]. The conversion of this invasive weed into marketable products offers a sustainable strategy for weed management while generating economic value [2],[9]. This review explores the ecological burden, phytochemical profile, product development potential, and commercial applications of Lantana camara [3],[5]. The study further evaluates the market potential of Lantana camara-based products in pharmaceutical, cosmetic, agricultural, and rural enterprise sectors [4],[9]. A SWOT analysis is included to assess its commercial viability and entrepreneurial scope [2]. The review concludes that Lantana camara can be transformed from an ecological threat into a sustainable economic resource through strategic utilization, innovation, and commercialization [8],[9]. review explores the ecological burden, phytochemical profile, product development potential, and commercial applications of Lantana camara [3],[5]. The study further evaluates the market potential of Lantana camara-based products in pharmaceutical, cosmetic, agricultural, and rural enterprise sectors [4],[9]. A SWOT analysis is included to assess its commercial viability and entrepreneurial scope [2]. The review concludes that Lantana camara can be transformed from an ecological threat into a sustainable economic resource through strategic utilization, innovation, and commercialization [8],[9].**

***Index Terms*—Lantana camara, invasive weed, value-added products, phytochemistry, essential oil, biochar, herbal products, market potential, rural entrepreneurship, sustainable utilization.**

I. INTRODUCTION

Invasive alien plant species are one of the major threats to global biodiversity, ecosystem stability, and agricultural productivity [1]. Among them, Lantana camara L. is considered one of the world's most problematic invasive weeds due to its rapid spread, allelopathic effects, and ecological adaptability [2],[6]. Lantana camara belongs to the family *Verbenaceae* and is native to tropical America, but it has now spread extensively across Asia, Africa, Australia, and India [3],[7]. In India, Lantana camara has invaded forests, grasslands, roadsides, agricultural fields, and wastelands, causing severe ecological and economic losses [2]. It is estimated that Lantana camara has invested millions of hectares of land in India, particularly in forest ecosystems and pasture lands [2]. The weed suppresses native vegetation, reduces biodiversity, alters nutrient cycling, and interferes with agricultural productivity through allelopathic interactions [6],[7].

The invasive success of Lantana camara is attributed to its high reproductive efficiency, seed dispersal capacity, tolerance to environmental stress, and release of allelochemicals [6],[7]. These allelochemicals inhibit seed germination and growth of neighboring

plant species, enabling Lantana camara to dominate large landscapes [6]. In addition, the plant forms dense thickets that are difficult to eradicate and can increase fire hazards in forest ecosystems [2]. Due to these ecological concerns, Lantana camara is often regarded as a harmful and destructive weed [1],[2].

However, recent scientific studies have highlighted the economic potential of Lantana camara as a valuable biomass resource [3],[5]. The plant contains a wide range of secondary metabolites, including triterpenoids, flavonoids, alkaloids, tannins, glycosides, and essential oils, which exhibit significant biological and industrial properties [3],[5]. These compounds possess antimicrobial, antioxidant, anti-inflammatory, insecticidal, antifungal, and wound-healing activities, making the plant useful in pharmaceutical and cosmetic industries [4],[5]. In addition to medicinal applications, Lantana camara biomass can be used for compost production, biochar, briquettes, natural dyes [2],[8].

The utilization of Lantana camara for value-added product development presents a dual advantage [2],[8]. First, it helps in reducing the environmental burden caused by its uncontrolled spread [2]. Second, it creates economic opportunities through sustainable product development and rural entrepreneurship [8],[9]. This concept aligns with the modern circular bioeconomy model, where biological waste is converted into commercially useful products [9]. Thus, Lantana camara can be redefined not only as an invasive weed but also as a potential green resource for innovative wealth generation [8].

The present review aims to comprehensively examine the transformation of Lantana camara from an invasive ecological threat into a sustainable economic opportunity [2],[9]. The study focuses on its ecological impact, phytochemical profile, product development potential, and market opportunities [3],[5]. It also highlights the commercialization prospects of Lantana camara-derived products in different industrial sectors [4],[8]. This review may serve as a scientific foundation for future research, industrial innovation, and policy development in sustainable invasive weed management [2],[9].

Figure 1: Lantana camara

II. BOTANICAL PROFILE OF LANTANA CAMARA

Lantana camara L. is a perennial, aromatic, flowering shrub belonging to the family *Verbenaceae* and order Lamiales [3],[5]. The genus Lantana comprises nearly 133 accepted species, among which Lantana camara is the most widespread and economically significant species [5]. The plant is native to tropical and subtropical America but is now naturalized and invasive in more than 60 countries, including India [2],[5]. It was introduced into India as an ornamental plant during the colonial period and later spread aggressively into forests, grasslands, and agricultural fields [2].

Taxonomically, Lantana camara is classified under Kingdom Plantae, Division Magnoliophyta, Class Magnoliopsida, Order Lamiales, Family Verbenaceae, Genus Lantana, and Species Lantana camara L. [3],[5]. The taxonomy of Lantana camara is highly complex due to extensive hybridization, polyploidy, and morphological variability among populations [5]. This taxonomic complexity has resulted in the formation of several ecotypes and varieties with different flower colors, growth habits, and phytochemical compositions [5].

Morphologically, Lantana camara is a woody, straggling, evergreen shrub that usually grows up to 1–4 m in height, although under favorable conditions it may grow taller [2],[4]. The stem is quadrangular when young and becomes cylindrical and woody with age [2]. Mature stems are rough, branched, and often armed with small recurved prickles that aid in defense and spread [2],[4]. These prickles make manual removal difficult and contribute to its persistence in invaded habitats [2].

The leaves of Lantana camara are simple, opposite, ovate to elliptic, rough, and strongly aromatic due to the presence of volatile oils [3],[5]. The leaf surface is hairy and glandular, with serrated margins and prominent venation [3]. Leaves usually measure 2–10 cm in length and emit a pungent odor when crushed [2],[5]. This odor is associated with essential oil constituents such as caryophyllene, p-cymene, and linalool [3],[5].

The flowers of Lantana camara are small, tubular, and arranged in dense, axillary umbels [2],[3]. Each inflorescence contains numerous florets with vibrant colors such as yellow, orange, pink, red, and white, often changing color with age [2]. Flowering occurs throughout the year in tropical climates, with peak blooming during warm and humid seasons [2],[4]. The brightly colored flowers attract pollinators such as butterflies, bees, and birds, which contribute to its reproductive success [2].

The fruit of Lantana camara is a small, fleshy drupe that turns from green to dark purple or black upon ripening [2],[5]. Unripe fruits are toxic to livestock and humans due to the presence of pentacyclic triterpenoids known as lantadenes [5]. Birds consume ripe fruits and disperse seeds over long distances, facilitating rapid colonization [2],[6]. Seed dispersal by birds is one of the major reasons for its successful invasion in diverse ecosystems [2].

The root system of Lantana camara is strong, extensive, and capable of surviving drought and mechanical injury [2]. The plant regenerates rapidly from rootstock after cutting, burning, or grazing, making eradication difficult [2],[6]. Its ability to tolerate poor soils, drought, and disturbance contributes significantly to its invasive success [2],[6].

The plant reproduces through both sexual and vegetative methods [2]. Sexual reproduction occurs through prolific seed production, while vegetative propagation occurs through stem layering and coppicing [2],[6]. This dual reproductive strategy enables Lantana camara to establish persistent populations and spread rapidly in disturbed habitats [2].

Overall, the botanical adaptability of Lantana camara plays a major role in its invasive success and biomass productivity [2],[6]. These same biological characteristics also make it a suitable candidate for biomass utilization and commercial exploitation [2],[8]. Thus, understanding its botanical profile is essential for both weed management and industrial application [2].

III. PHYTOCHEMISTRY OF LANTANA CAMARA

The phytochemical profile of Lantana camara is one of the major reasons for its medicinal and industrial significance [3],[5]. The plant contains a wide range of primary and secondary metabolites distributed across leaves, flowers, stems, roots, and fruits [3]. These metabolites include alkaloids, flavonoids, terpenoids, tannins, glycosides, saponins, steroids, phenolic compounds, and essential oils [3],[5]. Many of these compounds exhibit pharmacological, pesticidal, and antioxidant activities, making Lantana camara a promising bioresource [4],[5].

Phytochemical investigations have shown that the leaves and flowers of Lantana camara are particularly rich in bioactive compounds [3],[5]. Among these, pentacyclic triterpenoids are the most widely studied class of phytochemicals in Lantana camara [5]. Important triterpenoids include lantadene A, lantadene B, lantanolic acid, camaric acid, and oleanolic acid [5],[6]. These compounds are responsible for both the toxic and therapeutic properties of the plant [5].

Lantadene A and lantadene B are major pentacyclic triterpenoids found in leaves and unripe fruits [5]. These compounds are hepatotoxic to grazing animals and are mainly responsible for lantana poisoning in livestock [1],[5]. However, in controlled concentrations, these compounds also exhibit antimicrobial, anti-inflammatory, and anticancer properties [5]. This dual toxic-pharmacological behavior makes them important targets for phytopharmaceutical research [5].

Flavonoids are another important class of compounds present in Lantana camara [3],[5]. Major flavonoids reported from the plant include quercetin, kaempferol, luteolin, and apigenin derivatives [5]. These compounds possess strong antioxidant, anti-inflammatory, and antimicrobial properties [4],[5]. Flavonoids contribute significantly to the medicinal value of Lantana camara extracts used in traditional and modern herbal preparations [3].

Phenolic compounds present in Lantana camara include caffeic acid, chlorogenic acid, ferulic acid, and gallic acid [5]. These phenolics are known for their antioxidant and free radical scavenging activities

[4],[5]. Their presence supports the use of Lantana camara in wound healing, anti-aging, and skin-protective formulations [4].

The plant also contains alkaloids, glycosides, and saponins in moderate amounts [3],[5]. These compounds contribute to antimicrobial, antifungal, and insecticidal activities [3],[9]. Saponins and glycosides are especially important in plant defense and may contribute to pesticidal applications [5],[9].

Essential oils obtained from leaves and flowers of Lantana camara are rich in volatile terpenes and sesquiterpenes [3],[5]. Major volatile constituents include β-caryophyllene, germacrene D, α-humulene, bicyclogermacrene, sabinene, limonene, α-pinene, and p-cymene [3],[5]. These essential oil components exhibit insecticidal, antimicrobial, antifungal, and aromatic properties [3],[9]. Due to these properties, Lantana camara essential oil is highly useful in perfumery, insect repellent, and herbal formulations [3],[9].

The composition of essential oils varies depending on geographical location, season, plant part, and extraction method [3],[5]. This chemical variability affects biological activity and product quality [5]. Therefore, standardization of extraction and formulation is essential for commercial utilization [4],[5].

Iridoid glycosides and phenylpropanoids are also reported in Lantana camara [5]. These compounds contribute to anti-inflammatory and antimicrobial actions [5]. In addition, tannins present in the leaves provide astringent and antimicrobial properties useful in topical formulations [3],[4].

The phytochemical richness of Lantana camara makes it suitable for multiple industrial applications [4],[5]. Its bioactive compounds support the development of herbal medicines, essential oils, cosmetics, insecticides, and agricultural formulations [4],[9]. Therefore, the phytochemical composition of Lantana camara is the scientific foundation for its transformation into value-added commercial products [4],[5].

Lantana camara with herbal combination and their application: [10,11,12,13,14]

Sr.No.	Category	Combination	Uses	Properties
1.	Face Wash	Neem+Tulsi + Lantana camara	Pimples, Acne Control	Antibacterial, Antiseptic, Anti-inflammatory
2.	Mosquito Repellent Cream	Citronella + Eucalyptus + Lantana camara	Mosquito Protection	Insecticidal, Mosquito Repellent
3.	Foot Powder	Turmeric + Neem+ Lantana camara	Fungal Infection	Anti-Fungal
4.	Pain Relief Oil	Ginger + Lantana camara + Garlic	Joint Pain, Swelling	Anti-inflammatory
5.	Wound Healing Spray	Aloe vera + Lantana camara	Cuts, Burns	_
6.	Hair Oil	Amla + Bhringra+ Lantana camara	Hair Growth	_
7.	Immunity Kadha	Tulsi + Ginger + Black Papper + Lantana camara	Cold, Cough	_
8.	Herbal cough syrup	Lantana camara + Ocimum tenuiflorum	Cold, Cough, skin infection	antimicrobial and antioxidant effects.
9.	Cooling Soap	Lantana camara + Mentha piperita	Foot infections Mosquito repellent	Anti-inflammatory.
10.	Hair Oil	Lantana camara + Lawsonia inermis	Dandruff Hair fall Scalp irritation	antimicrobial and antioxidant effects.

IV. VALUE-ADDED PRODUCTS FROM LANTANA CAMARA

The transformation of Lantana camara into value-added products represents one of the most practical strategies for converting an invasive weed into economic wealth [2],[9]. Due to its rich phytochemical profile, woody biomass, essential oil content, and rapid growth, Lantana camara can serve as a renewable raw material for multiple industrial and commercial applications [3],[5]. Scientific studies have demonstrated that different parts of the plant, including leaves, stems, roots, flowers, and fruits, can be utilized for producing medicinal, agricultural, cosmetic, domestic, and energy-related products [2],[8]. This wide product versatility makes Lantana Camara an important candidate for sustainable biomass valorization [8],[9].

4.1 Herbal Medicinal Products

Lantana camara has long been used in traditional medicine for the treatment of wounds, skin infections, fever, ulcers, eczema, respiratory disorders, and gastrointestinal problems [3],[5]. The leaves are commonly used in the form of poultices, decoctions, and extracts due to their antimicrobial, anti-inflammatory, and wound-healing properties [3],[4]. Phytochemicals such as flavonoids, tannins, triterpenoids, and phenolics contribute significantly to these therapeutic activities [4],[5].

Leaf extracts of Lantana camara have shown promising antibacterial activity against Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa, supporting their use in topical antiseptic products [4],[5]. Ethanolic and methanolic extracts also exhibit antifungal activity against Candida albicans and dermatophytic fungi, making them useful in herbal antifungal creams and lotions [4],[5]. Due to these biological activities, Lantana camara can be developed into herbal ointments, wound-healing gels, antimicrobial soaps, and medicated creams [4].

The pharmaceutical market for plant-based antimicrobial and wound-care products is expanding globally due to increasing consumer preference for natural remedies [4],[9]. This creates a promising opportunity for commercialization of Lantana camara-based herbal medicinal products [4].

4.2 Essential Oil and Aromatic Products

The essential oil extracted from leaves and flowers of Lantana camara is one of its most commercially valuable products [3],[5]. The oil contains bioactive volatile compounds such as β-caryophyllene, germacrene D, limonene, p-cymene, sabinene, and linalool, which exhibit antimicrobial, insecticidal, antifungal, and aromatic properties [3],[5].

Essential oil of Lantana camara has potential applications in perfumery, aromatherapy, room fresheners, deodorizing sprays, and herbal fragrances [3]. Its pleasant aromatic nature and biological activity make it suitable for personal care and household products [3],[4]. The increasing demand for natural essential oils in cosmetic and wellness industries enhances the market value of Lantana camara essential oil [4].

Steam distillation of Lantana camara leaves can yield essential oil suitable for commercial extraction [3]. This oil may also be incorporated into mosquito repellent sprays, herbal disinfectants, and natural preservatives [3],[9].

4.3 Natural Insect Repellents and Bio-Pesticides

One of the most promising applications of Lantana camara is in the production of natural insect repellents and botanical pesticides [9]. The plant contains volatile terpenes and secondary metabolites with strong insecticidal and larvicidal activities against agricultural and household pests [9].

Studies have shown that Lantana camara extracts and essential oils are effective against mosquitoes, aphids, termites, beetles, and stored grain pests [9]. Leaf extracts have demonstrated larvicidal activity against Aedes aegypti, Anopheles stephensi, and Culex quinquefasciatus, indicating strong potential in mosquito control products [9]. These findings support the development of herbal mosquito coils, repellent sprays, fumigants, and insecticidal formulations [9].

Botanical pesticides prepared from Lantana camara may provide an eco-friendly alternative to synthetic chemical pesticides [9]. Their biodegradability and low environmental persistence make them attractive for sustainable agriculture [9]. This sector has strong commercial value due to growing demand for organic and residue-free pest management products [9].

The use of Lantana camara compost in agriculture can reduce dependence on chemical fertilizers and support organic farming systems [8]. This product has strong

rural and agricultural market potential, especially in sustainable farming communities [8].

Activated carbon prepared from Lantana camara can also be used for adsorption of dyes, heavy metals, and industrial pollutants from wastewater [8]. This offers additional industrial value in environmental remediation and water treatment sectors [8].

4.4 Natural Dyes and Colorants

Extracts from flowers and leaves of Lantana camara can be used as natural dyes for textiles and handicrafts [2]. The pigments present in flowers provide yellow, orange, and reddish shades suitable for natural colorant applications [2].

The increasing demand for plant-based dyes in sustainable textile industries enhances the market scope of Lantana camara pigments [2]. These dyes may also be used in eco-friendly art and craft industries [2].

4.5 Cosmetic and Personal Care Products

Due to its antimicrobial, antioxidant, and aromatic properties, Lantana camara has significant potential in cosmetic and personal care formulations [4],[5]. Extracts and essential oils can be incorporated into herbal soaps, anti-acne creams, face cleansers, shampoos, deodorants, and skin-protective lotions [4]. Its antioxidant phenolics and flavonoids may help in anti-aging and skin protection formulations [4],[5]. This makes Lantana camara a promising raw material for herbal cosmetic industries [4].

Overall, the product diversity of Lantana camara demonstrates its strong industrial and entrepreneurial value [2],[4]. The development of value-added products from this invasive weed offers a sustainable pathway for environmental management, rural employment, and innovative wealth generation [2],[9].

V. MARKET POTENTIAL OF LANTANA CAMARA -BASED PRODUCTS

The market potential of Lantana camara-based products is increasing due to the global demand for sustainable, plant-based, and eco-friendly alternatives in pharmaceutical, agricultural, cosmetic, and energy sectors [4],[8]. The commercial value of Lantana camara lies in its dual advantage as a low-cost raw material and an environmentally beneficial biomass resource [2],[9]. Since Lantana camara grows abundantly in wastelands, forests, roadsides, and non-cultivable areas, it provides an inexpensive and readily available feedstock for industrial utilization [2]. This makes it economically attractive for small-scale enterprises, rural industries, and green start-up models [8].

The global herbal products market is expanding rapidly due to rising consumer preference for natural and plant-derived formulations [4]. Lantana camara extracts possess antimicrobial, antioxidant, anti-inflammatory, and wound-healing properties, making them suitable for herbal medicinal products and phytopharmaceutical formulations [4],[5]. These applications create commercial opportunities in herbal creams, antiseptic gels, wound-healing ointments, and therapeutic formulations [4]. The increasing demand for herbal therapeutics significantly improves the pharmaceutical market potential of Lantana camara [4],[5].

The essential oil and aromatic product market also offers strong commercial prospects for Lantana camara [3],[4]. The global essential oil industry has shown consistent growth due to increased demand in aromatherapy, perfumery, personal care, and wellness products [4]. Lantana camara essential oil can be positioned as a niche product in herbal fragrance, deodorant, disinfectant, and insect repellent markets [3],[9]. Its multipurpose aromatic and antimicrobial properties improve its commercial competitiveness in the natural wellness sector [4].

The rising demand for organic farming inputs has increased the need for botanical pesticides, natural insect repellents, and organic fertilizers [8]. Lantana camara-derived bio-pesticides and mosquito repellents have strong commercial value in sustainable agriculture and public health pest management [9]. Similarly, compost and biochar derived from Lantana camara offer viable opportunities in organic farming and soil improvement industries [8].

The renewable energy market further strengthens the economic potential of Lantana camara [2],[8]. Biomass briquettes and solid fuels prepared from Lantana camara can serve as sustainable alternatives to firewood, charcoal, and fossil-based fuels [2]. This is particularly relevant in rural and semi-urban regions where low-cost renewable fuel solutions are needed [2]. The growing emphasis on bioenergy and carbon-neutral fuels supports the market growth of Lantana camara-based biomass products [8].

The cosmetic and personal care industry also presents strong commercial scope for Lantana camara [4]. The demand for herbal soaps, natural face cleansers, anti-acne creams, deodorants, and skin-care products is increasing globally [4]. Due to its antimicrobial and antioxidant properties, Lantana camara extracts can serve as active ingredients in herbal cosmetic formulations [4],[5]. This expands its market value in the cosmeceutical and personal care sectors [4].

Overall, the market potential of Lantana camara is broad and multi-sectoral [2],[4]. Its low input cost, high product diversity, and eco-friendly image make it commercially attractive for sustainable business development [8],[9]. Therefore, Lantana camara has strong potential to support bioeconomy-driven enterprises and green commercialization models [8].

VI. CONCLUSION

Lantana camara is widely recognized as one of the most destructive invasive alien plant species due to its rapid spread, allelopathic behavior, and ecological dominance [1],[2]. Its invasion has caused serious ecological, agricultural, and economic challenges in many tropical and subtropical regions, particularly in India [2],[6]. Despite these negative impacts, Lantana camara possesses significant phytochemical richness and biomass potential that can be harnessed for productive and sustainable use [3],[5].

The plant contains a wide range of bioactive compounds such as triterpenoids, flavonoids, alkaloids, phenolics, tannins, and essential oils, which provide medicinal, , antioxidant, and industrial value [4],[5]. These phytoconstituents support the development of herbal medicines, wound-healing products, insect repellents, botanical pesticides, and cosmetic formulations [4],[9]. In addition, its abundant woody biomass can be effectively utilized for compost, biochar, activated carbon, briquettes, handicrafts, paper pulp, and natural dyes [2],[8]. Such applications demonstrate that Lantana camara is not merely an ecological burden but also a promising renewable bioresource [8],[9].

The conversion of Lantana camara into value-added products provides a dual benefit by supporting invasive weed management and generating economic returns [2],[8]. This approach aligns with the principles of sustainable development, circular bioeconomy, and waste-to-wealth innovation [8]. Its low-cost availability, multipurpose utility, and commercial adaptability make it suitable for rural entrepreneurship, green product industries, and decentralized biomass enterprises [2],[4].

The market analysis indicates that Lantana camara has strong commercial potential in pharmaceutical, agricultural, cosmetic, energy, and handicraft sectors [4],[8]. However, successful commercialization requires scientific standardization, toxicity evaluation, quality control, and regulatory support [5],[8]. Strategic investment in research, product development, pilot-scale processing, and industrial collaboration will be necessary to unlock its full economic potential [4],[8].

In conclusion, Lantana camara represents a unique opportunity to transform an invasive ecological threat into a sustainable economic resource [8],[9]. With proper scientific validation, innovation, and commercialization, this invasive weed can be redefined as a valuable green raw material for future bioeconomy-driven industries [8]. Thus, Lantana camara truly exemplifies the concept of converting “invasive weed into innovative wealth” [8],[9].

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