Innovations

Economic Potential of Selected Azadirachta Indica (Neem) Component: An Organic Farming Approach

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Abstract
This research work on Azadirachtaindica (neem) tries to explore qualitatively its economic potential (EP) in relation to organic farming. Neem contains various components, but few, such as Azadirachtin, Nimbin, Nimbidin, Salanin, Meliantriol, Quercetin, and a few others, are known to have insecticidal, herbicidal, or fertilizing properties that are relevant to organic farming. The local extraction methods for these components are simple, economical, and can be done using commonly available materials. The features found in EP for these components were summarized in variables such as growing demand, export potential, cost effectiveness, certification, and premium prices of its products. The EP of neem can be a cost-effective alternative to modern farming through its natural pest and weed control, organic fertilizing, and livestock care. The impact of the neem oil industry has provided insight into how economic and environmental impacts can be mitigated or managed by embracing sustainable production methods using organic inputs. Neem's therapeutic potential therefore deserves further investigation through scientific research. It is important to note that the use of neemoil and other natural remedies in animal health should be done under the guidance of a veterinarian or animal health professional to ensure appropriate dosing and avoid any potential adverse effects. Also, the possible fallouts of modern extraction methods, such as high cost, loss of traditional knowledge, and negative environmental impact, calls for further investigation on better sustainable practices and the integration of traditional knowledge alongside modern techniques.
Keywords: Azadirachtinindica, Neem, Nimbin, Nimbidim, Quercetin, Economic Potential

Introduction

The importance of improving the productivity and welfare of smallholder farmers for sustainable development is undeniable (1) (2). The convectional use of inorganic fertilizers and synthetic chemical products by farmers has begun to raise dust. As a result, experts have considered modern organic farming the replacement option due to its numerous ecological and economic benefits.

Organic farming is agricultural manufacturing that excludes the usage of artificial materials such as pesticides, artificial medicine, fertilizers, and genetically changed organisms (3) (4). According to a different school of thought, organic farming is a type of agriculture that promotes the health of soils, ecosystems, and people. Instead of using inputs with negative impacts, it focuses on natural processes, biodiversity, and cycles tailored to local conditions. It combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved (5).

Using convectional farming techniques, the farmer must use harsh chemicals to disinfect or fumigate his farm before seeds are sown in order to eradicate any naturally occurring fungicides. He applies petroleum-based fertilizers to the land, and in order to stop insects from eating the seeds that have been planted, chemicals are also added to the irrigation water. The organic farmer, on the other hand, will prepare and enrich his land prior to sowing by scattering natural fertilizers like manure, bone meal, or oyster fertilizer. The organic farmer will not irrigate newly planted seeds with water that has chemicals added to it or soak his seeds in any chemical solution. Pesticides and fertilizers are used in organic farming when they are deemed natural, but different petrochemical fertilizers and pesticides are avoided (6). One such natural source of natural pesticides and fertilizer that is economical and of great benefit is Azadirachtaindica (Neem).

Neem is a famous tree from the mahogany family. It originated in Bangladesh, India, Myanmar, and other neighboring countries. The tree can grow up to twenty meters tall and has some clinical applications. The bark, seeds, blooms, and leaves of the neem tree have all been used medicinally before now. Neem is often endorsed as a cure for a number of illnesses in animals within the conventional Indian medicinal structure referred to as Ayurveda. Neem is beneficial for treating infections, pore and skin conditions, and dental issues in animals. The neem plant possesses more than one hundred lively compounds, lots of which have been confirmed to have useful effects, in keeping with the latest studies (7)(8)(9)(10).Neem's use for agricultural and ecological functions is understood to repel bugs and pests. The plant may be used for quite a few other positive functions in natural farming, along with soil fertility, compost activator, organic control, and an addictive remedy for livestock (11)(12) (13).

Neem twigs and leaves contain substances that encourage the development of good bacteria in the soil. Neem can hasten decomposition and produce high-quality compost by being added to compost piles. Also, this plant component can be added as a supplement to animal feed. They contain components that act as natural de-wormers and can help manage internal parasites in a variety of animals, including goats and cows (11) (12) (13).

Extracts, which include neem oil, that are derived from the seeds of the plant may be used as herbal pesticides to manipulate pests in natural farming while also enhancing the soil. Neem extracts, which are crafted from the residual seeds after oil extraction, are a remarkable supply of natural minerals. Neem extracts may be delivered to the soil to enhance fertility and soil structure. Using neem extracts to manage plant infections and diseases has been proven to be successful. The fungus and bacteria that cause diseases in plants are suppressed by the substances found in them. It may also possess modest fungicidal activities that can aid in the management of several plant diseases (Pramanik et al 2019; Choudhary and Yadav2017).

Neem oil extraction offers several advantages over conventional farming methods, making it a better management option for organic farming. Neem oil extraction is a relatively simple process that can be done through traditional methods. This method is effective in extracting the oil along with many beneficial compounds, including nimbin, nimbidin, and salanin. It does not require complex machinery or high-tech equipment, making it accessible even to small-scale farmers. Neem oil extraction is generally cheaper compared to conventional farming practices. Since neem trees are native to many regions and

can be easily grown, the input costs associated with neem oil production are lower. It is a safe organic alternative to synthetic chemical pesticides and fungicides that can be dangerous to the environment and human health. Neem derivatives are important economically. Farmers and producers are looking for all-natural, risk-free alternatives to chemical pesticides and diseases as demand for organic and sustainable agriculture rises. The agriculture sector may profit financially from the manufacture and usage of neem products. They may be less expensive to produce because they come from sustainable sources as opposed to synthetic pesticides, which must go through expensive manufacturing processes. This natural pesticide can boost crop yields and improve crop quality, thereby enhancing agricultural yields and farmers' income. Neem can significantly advance organic and ecological farming while making numerous economic contributions.

The practice of organic agriculture as a panacea to the detriment posed by conventional farming systems is growing among smallholder farmers in Sub-Saharan Africa and has recently received special attention from policymakers and development experts (16). Therefore, this paper deals not only with the economic values of Azadirachtaindica but also with its relevance to organic farming. As far as the authors are concerned, no serious study on neem and its economic potential (EP), focusing on organic farming, has been done.

2.1 Beneficial components of the Neem

There are several chemical components found in neem, and some of these are:

Azadirachtinindica

Azadirachtin is a naturally occurring insecticide found in the seeds of the neem tree (Azadirachtaindica). It belongs to a group of compounds called limonoids that are known for their insecticidal and antifeedant properties. The chemical component in the neem that is herbicidal in nature is Azadirachtin. It is a tetranortriterpenoid compound that acts as a potent insecticide and insect growth regulator. Azadirachtin, extracted from the neem tree (Azadirachtaindica), has broad-spectrum activity against a wide range of agricultural pests. Azadirachtin is not known to penetrate the components of plants, and its insecticidal properties are primarily contact-based. Insects that come into contact with plants that have been treated with azadirachtin consume the chemical when grooming or feeding; this disrupts their hormonal balance and prevents them from feeding, molting, or breeding. It functions by interfering with the hormone system of the insect, specifically by preventing the creation and release of ecdysone, a hormone essential for insect development and growth. This inhibits molting and development, leading to the death of immature insects. It also has an impact on reproduction by lowering adult insect fertility and fecundity (17). It can be used on a variety of crops, including but not limited to ornamental plants, vegetables, fruits (such as citrus, mangoes, and apples), grains (such as rice, wheat, and sorghum), and fruits and vegetables. Pests such as aphids, whiteflies, caterpillars, beetles, mites, and thrips can all be successfully controlled with azadirachtin (18).

In horticultural and agricultural operations, it is frequently utilized as a natural substitute for synthetic pesticides. Azadirachtin has been discovered to have antifeedant characteristics. This means that by rendering plant material unpleasant to taste or creating digestive issues, it can deter insects from devouring it. The fact that azadirachtin is a natural pesticide is one of its advantages. This indicates that it comes from a plant source and is free of artificial chemicals that might be bad for people, animals, or the environment (19).

In addition to having insecticidal effects, azadirachtin also has herbicidal effects because it prevents some plant species from growing. It functions by interfering with the normal proliferation of plant cells, which results in slower growth and eventually the death of the plant. This property of Azadirachtin makes neem extracts or products useful for controlling weeds and unwanted plants in agriculture, horticulture, and landscaping (20).

One of the various methods that can be used to extract azadirachtin from neem seeds locally involves the collection of clean neem seeds, free from impurities. They are ground into a fine powder using a blender or grinder. The powdered neem seeds are transferred into a cloth bag or muslin cloth. Pressure or a

mechanical press is applied to extract the oil from the neem seeds. The oil is collected in a clean container. The extracted neem oil contains azadirachtin and other compounds (21) (22) (23).

Nimbim

Nimbin is a chemical constituent found in Azadirachtaindica. It is a triterpenoid and belongs to the limonoid group of compounds. Structurally, nimbin is a complex molecule composed of a tetracyclic triterpene with an unusual C-seco ring and a furan ring. The molecular formula of nimbin is $C_{22}H_{30}O_7$, and its molecular weight is 410.47 g/mol. Nimbin can be found in the seeds, leaves, and bark of the neem tree. Numerous pharmacological effects of nimbin have been noted, including anti-inflammatory, analgesic, antipyretic, antifungal, and antiviral effects (24)(25).

Nimbin affects plants by halting their development and growth. The plant hormone auxin, which controls plant growth including cell division, elongation, and differentiation, is inhibited by this substance. Because of this, plants develop more slowly and struggle to produce chlorophyll, a pigment necessary for photosynthesis. Systemic acquired resistance (SAR), which enhances plants' resilience to infections and other stresses, has also been shown to be another consequence of nimbin (26)(27).

Drugs based on neem are used in traditional medicine to address a range of animal health issues. As a result of nimbin's antifungal, antiviral, antibacterial, and anti-inflammatory properties, it has been used to treat conditions like arthritis, fever, and skin infections. However, some early studies (28) (29) suggest that nimbin can have anti-inflammatory and pain-relieving effects in dogs with osteoarthritis. It has also been shown to have anthelmintic activity, indicating that it may help in the treatment of intestinal parasites in ruminants, including cows, goats, and sheep. Nimbin has been shown to have antiviral activity against this avian influenza virus in poultry. In (30), they discovered that nimbin can lessen oxidative stress and improve macrophage function. Since oxidative stress is known to play a significant role in the initiation and progression of chronic inflammatory diseases, nimbin may be helpful as a treatment for these conditions.

Nimbin can be extracted from neem using various local extraction techniques. One common technique involves using a solvent, such as ethanol or hexane, to draw nimbin from neem leaves or seeds. The neem plant's oil and other lipophilic components are dissolved using the solvent. To separate the solvent from the oil, the mixture is subsequently filtered.

Salamin and Meliantriol

Salannin and meliantriol are chemical constituents found in the neem tree. Salanin is a limonoid compound, specifically a tetranortriterpenoid, and its molecular formula is $C_{27}H_{34}O_9$. Meliantriol is also a limonoid compound, specifically a triterpenoid, and its molecular formula is $C_{35}H_{48}O_6$. Both compounds have been found to have insecticidal properties and are used in organic agriculture as natural pesticides to control pests and diseases (31) (32).

Salanin and meliantriol are used in organic farming as natural pesticides to fight various pests and diseases. They can be effective against a variety of insect pests, including aphids, whiteflies, mealy bugs, thrips, and scale insects. These ingredients have also been shown to have antifungal properties and can be used to control plant diseases such as powdery mildew, rust, and leaf spot. In addition to insecticidal and fungicidal properties, salanin and meliantriol have also been shown to have other biological activities such as anti-tumor, anti-inflammatory, and antiviral properties (33) (34) (35) (36).

In agriculture and horticulture, neem extract containing salanin and meliantriol is used as a natural insecticide for pest control. They are effective against a wide range of insects, including aphids, thrips, mites, powdery mildew, scaly insects, and caterpillars. In animal health, neem extract containing salami has been used to control parasites inside pets, such as gastrointestinal roundworms and liver flukes. It has also been used to control external parasites such as fleas, ticks, and lice in dogs, cats, and horses. Extracts can also be used to improve animal nutrition, enhance immunity, and promote growth (37) (38) (39).

There are various local methods that can be used for the extraction of meliantriol from neem. One common method is cold pressing. In this method, neem seeds or leaves are crushed or pressed to release

the oils. The extracted oil is then separated, and further purification steps may be carried out to obtain meliantriol (40) (41).

Nimbidin

Neem components, including Nimbidin, play a major role in plant growth due to their various properties that benefit plants. The neem tree contains a bioactive substance called nimbidin that is present in its seeds, leaves, and bark. Neem extracts and oils are well-known for being efficient natural insecticides, fungicides, and herbicides that keep weeds under control and shield plants from insect and fungal harm (42)(43). Therefore, to guarantee proper dosing and prevent any potential negative effects due to its potency, it is crucial to highlight that the use of neem oil and other natural medicines in animal health should be done under the supervision of a veterinarian or animal health professional.

It has been discovered that neem and its constituent parts directly influence plant growth. Plant growth regulators such as auxins, gibberellins, and cytokinins, which are known to promote plant growth and development, are present in neem extracts. Auxins are hormones that are naturally found in plants and play a variety of roles in their growth and development, including the formation of their cells, roots, fruits, and flowers. They are essential for plant growth and development and are in charge of controlling numerous physiological processes in plants (44) (45) (46).

In (47) study, it was found that nimbidin has an effect on the growth, biomass, and secondary metabolites of in vitro regenerated seedlings of Decalepishamiltonii. The researchers observed that nimbidin treatment resulted in increased shoot length, root length, and biomass accumulation in the seedlings. Also, giving nimbidin to the seedlings made them make more secondary metabolites like total phenolics and total flavonoids. These results show that nimbidin can help Decalepishamiltonii seedlings grow faster and make more secondary metabolites.

Nimbidim can be applied to plants to control insects, pests, and diseases. The antibacterial and antifungal activities of nimbidin in particular have been discovered to protect plants from ailments and infections that could hinder their growth. .Also, it has been discovered that nimbidin contains anti-inflammatory, antimicrobial, and anti-cancer qualities that can aid in lowering stress on plants and promoting healthy growth. Studies have indicated that neem oil and extracts can improve soil health by encouraging greater plant nutrient uptake and better soil structure, both of which encourage plant development. By defending plants from pests and diseases, encouraging healthy growth and development, and enhancing soil health, nimbidin plays a significant role in plant growth (48)(49).

Nimbidin has various effects on plants, including insecticidal, antifungal, and antibacterial properties. It acts on plants by disrupting several metabolic processes and causing physiological damage to the plant cells. Nimbidin targets the cellular membrane by binding to its components and disrupting the functioning of the cell. It slows down the respiration rate of the cell and inhibits ATP production, leading to a decrease in energy availability. Nimbidin also increases the concentration of reactive oxygen species (ROS) in plant cells, causing oxidative stress and DNA damage. These effects lead to the death of plant cells and the suppression of their growth and development. Furthermore, nimbidin activates the defense mechanism of plants by stimulating the production of various plant hormones such as salicylic acid, jasmonic acid, and ethylene, making the plant more resistant to biological and non-biological factors (50)(51)(52).

Nimbidim can be used as a foliar spray, seed treatment, or soil drenching to protect plants against various diseases and pests such as aphids, red spider mites, powdery mildew, thrips, caterpillars, and many other pests. It also helps prevent and control fungal diseases such as powdery mildew, rust, and leaf spot. Therefore, nimbidim is used as a natural and eco-friendly alternative to synthetic pesticides.

In (53) study, it was found that nimbidin, when used as a plant protectant, showed significant efficacy against fungal diseases in mug bean (Vignaradiata L.). The researchers observed a reduction in fungal infection and improved plant health when nimbidin was applied. In another study by (54), both nimbidin and azadirachtin were used on Lupinustermis L. to control root-knot nematodes (Meloidogynejavanica). The researchers found that the application of nimbidin and azadirachtin resulted in a reduction in nematode populations and their damaging effects on plants.

The local extraction methods of nimbidin are simple, economical, and can be done using commonly available materials. Neem leaves are ground with a little water to create a paste. The paste is then cooked for around 30 minutes after being combined in 1:5 ratios with water. The nimbidin-rich solution is then obtained by filtering the combination (55) (56) (57)

Quercetrin

The naturally occurring quercetin is present in Azadirachtaindica, widely known as neem. It is a yellow pigment with antioxidant and anti-inflammatory properties. Quercetin has been studied for its potential health benefits, including its ability to reduce oxidative stress, improve heart health, and protect animals against a number of chronic diseases. Quercetin is just one of many components of Azadirachtaindica that contribute to its bioactive properties (58) (59).

There are many ways that quercetin might help plants. It functions as a natural defense mechanism against viruses and several environmental threats. It functions as a free natural sunscreen for plants by absorbing and filtering harmful ultraviolet (UV) radiation. It protects biological elements like DNA from damage caused by too much solar exposure. Plants can avoid oxidative stress brought on by free radicals with the help of the antioxidant quercetin. Quercetin is effective against a range of plant diseases, including viruses, fungus, and bacteria, as a result of its antibacterial properties. It prevents cell depletion and the removal of reactive oxygen species (ROS), improving plant vigor and vitality. According to these findings, quercetin can support the plant's immune system, prevent the growth and spread of fungal infections, and reduce disease severity (60).

In (61) found that,quercetin regulates the activity of genes involved in lignin formation, phenylalanine ammonia-lyase (PAL), and lignin biosynthesis in tobacco plants to increase plant resistance to wilt disease drooping caused by bacteria. This suggests that quercetin enhances the plant's defense against bacterial infection, possibly through cell wall hardening and strengthening.

Animals and plants are both affected by quercetin's powerful antioxidant action. Free radicals and oxidative stress, which have been linked to a number of diseases and can speed up aging, are decreased and neutralized. This antioxidant activity promotes general cellular health and protects against cellular harm. Quercetin has anti-inflammatory effects due to its ability to prevent bacterial infection through the release of inflammatory mediators and enzymes. It can help relieve conditions like allergies, arthritis, and inflammatory bowel disease by reducing inflammation in various tissues and organs. Quercetin has been shown to have an antihistamine effect, helping to alleviate allergy symptoms such as sneezing, itching, and watery eyes by reducing the release of histamine.

Quercetin has been found to have a positive effect on the heart and the body. This, in turn, can improve overall heart health by reducing the risk of heart disease. Also, it can lead to improved blood vessels while lowering cholesterol and blood pressure. It enhances the ability of the immune system to fight infections by increasing the immune activity of cells. An animal with a superior immune system may be more resistant to infection and disease. Some studies suggest that quercetin may have anticancer properties (62) (63).

In (64), the study found that quercetin ameliorated cognitive deficits in diabetic rats by reducing oxidative stress through activation of the Nrf2/HO-1 pathway. Diabetic mice treated with it were also found to have anti-inflammatory properties. Quercetin shows antioxidant activity in LPS-stimulated macrophages, according to a study by (65), potentially avoiding oxidative damage. In another study, (66) found that quercetin nanoparticles have an anti-cancer effect by inhibiting the growth of liver cancer cells and activating apoptosis.

2.2 Economic Advantage of Neem in Organic Farming

High demand: Azadirachtin has high market demand in agriculture, pesticides, animal feed, and several other industries. Farmers who cultivate neem trees have the opportunity to make money from the sale of their products because of the high market demand. As people become more aware of the harmful effects of chemical-intensive farming practices, there is a growing market for organic products.

By using neem and adopting organic farming practices, farmers may tap into this expanding market and perhaps charge higher rates for their produce, thereby increasing economic profitability. Organic animal feed can be made from neem byproducts like neem cake and neem seed meal. They can augment the dietary requirements of animals because they are high in protein. Farmers can decrease the price of conventional animal feeds and possibly improve the quality and market value of organic meat, milk, and other products by using neem-based feeds. Also, neem-based solutions have proven to be far superior to synthetic pesticides in terms of managing pests and illnesses in crops. (9)(67).

In (68) study, the authors claimed that because neem components contain a variety of macro- and micronutrients necessary for plant growth, they can also be employed as organic fertilizer. Numerous minerals, including nitrogen, phosphorus, and potassium, which are necessary for plant growth, can be found in neem oil. Due to its unique composition, the oil is a great organic fertilizer that gradually improves soil fertility. Because of this, it may not be necessary to increase soil fertility with synthetic fertilizers, which can be pricey. According to (69), organic farming can profit financially from using neem components. According to its cost-benefit analysis, the use of neem extract reduced pest control costs, boosted crop yields, and increased market prices for organic produce. The study also discovered that using Neemextracts has advantageous effects on the environment, such as lowering the use of chemical pesticides.

Neem oil is biodegradable, non-toxic, and safe for the environment and non-target species. It degrades swiftly in the environment and does not persist in the food chain. Unlike synthetic pesticides, neem does not leave harmful residues on crops and soil and is safe for the environment. It does not harm beneficial insects, birds, or mammals that may come into contact with it, making it a more sustainable option for pest control (70). Beyond selling neem-based products in their raw form, farmers who value-add their neem products can earn a better price for their products. For example, farmers can extract azadirachtin by processing neem leaves or seeds and use it as the basis for producing value-added products such as insecticides, pesticides, and other agricultural inputs. This diversification can open up additional revenue streams and increase the economic viability of the farming operation (71).

Azadirachtaindica can reduce the amount of nutrient runoff, making it an environmentally friendly option for improving soil fertility. Neem contains compounds that can improve soil structure, water holding capacity, and soil porosity, leading to better soil quality. Farmers who use azadirachtin can improve the fertility of their soil, reduce soil erosion, increase crop yield, and ultimately increase their profit margin. Unlike synthetic fertilizers, Azadirachtaindica, an organic fertilizer, releases nutrients slowly over time, improving soil fertility. The slow-release nature of neem-based fertilizers can provide long-term benefits that will save farmers from regular expenditures on synthetic fertilizer applications. The oil's composition makes it an ideal organic fertilizer that enhances soil fertility over time (72) (73).

All these benefits, put together, constitute the high demand for neem components. Because of this strong market demand, farmers that plant neem trees can profit from selling their goods. Also, there is a developing market for neem-based goods in the agricultural sector due to rising consumer demand for ecologically friendly, sustainable, and organic goods. Given that the demand and price for organic goods are frequently higher than those for conventionally farmed produce, this gives farmers a chance to increase their profitability.

In (74) study, neem oil production, processing, and distribution can have a positive financial impact. The Chinese neem oil supply chain, according to the authors, has the ability to pay farmers and provide jobs in rural areas. The study also identified potential cost savings that could be achieved through more efficient processing and distribution practices. However, the authors note that there are several challenges, such as limited awareness and processing technology of neem oil among farmers and consumers. As an improvement, relevant authorities should provide educational and training programs to farmers and consumers on appropriate extraction methods and affordable technologies. In (75) investigation on the rise in neem-product demand for organic farming in the Indian state of Uttar Pradesh, the survey found that farmers are increasingly using organic techniques based on neem because of its efficiency and advantages for the environment.

2. Export potential: Neem-based products made in countries where neem is cultivated can be exported to other countries, creating an export industry that can generate foreign exchange for the country. Neem-based products have a competitive advantage due to the rising demand for natural and organic goods, which raises their export potential.

Azadirachtaindica is typically grown in tropical and subtropical areas, particularly in Asia, Africa, and South America. India, a major producer and exporter of neem products globally, is one of the primary neem producers for export. It cultivates neem in various parts of the country for export purposes. Thailand is another major producer of neem, mostly for domestic use. Nevertheless, it exports neem goods, such as neem oil and extract. Nigeria is Africa's top neem producer and exporter of neem goods like neem cake and oil. Ghana is another African country that is increasingly cultivating neem for export. It exports neem products, including neem oil, neem leaves, and neem extracts. Brazil grows neem, particularly in the Amazon rainforest, and exports neem products, including neem oil, neem extracts, and neem leaves. Mexico is another country that cultivates neem for export. It exports neem goods such as neem powder, neem leaves, and neem oil. These are some of the principal exporters of neem, while Bangladesh, Sri Lanka, and Indonesia are alsoneem growers (76) (77).

Due to its abundant land resources, favorable climatic conditions, and rising worldwide demand for organic goods, Africa has a huge potential for organic agriculture. By cultivating and exporting a variety of organic crops, including coffee, cocoa, tea, fruits, vegetables, and nuts, some African nations have already begun to enter the organic market. For instance, Ethiopia is renowned for producing organic coffee, and Kenya's organic horticulture industry is expanding. Furthermore, South Africa, Tunisia, and Morocco export organic goods. Governments and international organizations have recently stepped up their support for promoting organic farming in Africa. This comprises measures for market access, capacity-building programs, and mechanisms for organic certification. Africa's organic sector offers promising opportunities for growth and diversification in agricultural exports (78) (79)).

In (80) study, the researchers found that neem-based products, such as neem oil and neem cake, have significant export potential in organic farming due to their various benefits, including natural pest control and soil improvement. In (81), the study provided a comparative analysis of neem-based products' export potential in organic farming across selected Asian countries. It highlighted the competitiveness of neem-based products in international markets and emphasized the need for supportive policies and market development strategies. In (82), the study explored the constraints and opportunities for neem product exports in organic farming in Kenya. It highlighted challenges such as inconsistent quality, limited awareness among farmers, and inadequate marketing strategies, which may negatively impact the export potential of neem products. Therefore, implementing strict quality control measures throughout the neem product value chain is crucial. This includes training farmers on proper cultivation, harvesting, and processing techniques to consistently produce high-quality neem products that meet international standards.

3. Organic certification and premium prices: Many countries require organic certifications for their agricultural products to meet certain quality standards. Using neem oil ensures that crops are grown organically, making them marketable for organic certification and receiving premium prices.

Products containing Azadirachtaindica have grown in popularity among customers who are willing to pay premium prices for organic and natural goods. Farmers now have the opportunity to profit from their neem products at a higher rate than they would have under regular farming conditions. Depending on the product kind, production methods, and market demand, the premium pricing for organic goods may change (83) (84).

Due to the increased production expenses linked to organic agricultural methods, organic products typically cost more than conventional items. For instance, the price difference between conventional and organic fruits and vegetables might range from 20 to 100%. Meat and dairy products made from organic ingredients might cost between 30 and 100 percent more than conventional ones. The price of processed foods that are organic, including snacks or canned goods, might be up to 50% higher. The premium cost for organic goods varies by location and nation as well. In some nations, the cost difference between

organic and conventional goods is minimal, but in others, it is significantly higher. The increased value of organic farming practices, such as environmental sustainability, animal welfare, and health advantages, is reflected in the premium price of organic products (85) (86).
In (87), the study examines consumer willingness to pay for pesticide-free fresh produce (often associated with organic products). It finds that consumers are willing to pay a premium for such products, suggesting a potential financial advantage for organic farmers. In agreement, (88) study investigates consumer preferences and willingness to pay a premium for eco-labeled (including organic) apples. It demonstrates that consumers are prepared to pay more for products with eco-labels, particularly those with organic certification, demonstrating a demand for environmental features and possibly providing financial advantages for organic producers. Consumers in Nigeria are prepared to pay more for organic products, according to research by (89) on the factors influencing premiums paid for such items, suggesting a potential market for organic farming in the nation. The researchers discovered that customers' willingness to pay a premium for organic products is significantly influenced by the characteristics of those products, such as assurances of health and safety, environmental sustainability, flavor, and nutritional content. Some other researchers have discovered that consumers' willingness to pay a higher premium for organic products is also influenced by their trust in organic certification systems and familiarity with organic production practices, suggesting that the premium for organic products may not always reflect consumers' actual valuation of organic attributes.
On the other hand, (89) imply that the premium for organic products may not always match customers' actual appraisal of organic qualities in their systematic review and meta-analysis of consumer willingness to pay for organic products. In (90), the systematic review looks at studies contrasting the health and safety consequences of conventional versus organic foods. The investigation didn't uncover any reliable proof that organic foods are more wholesome or safer than those made conventionally. These results cast doubt on the argument that the health advantages of organic food justify their premium pricing. In (91), the study corroborates this view in their discussion of the social dilemma posed by organic agriculture, where the premium for organic products may create incentives for misrepresentation or fraud and possibly cause challenges in enforcing organic standards consistently. Also, in(92) the authors explore the determinants of the price premium for organic fruits and vegetables and suggest that factors such as supply chain constraints and limited availability may contribute to higher prices, contrary to health and safety assurance as contributors to high premium prices. One way to curtail the challenges posed by the supply chain and limited availability is to domestically focus on organic product production by way of incentives or subsidies for transition farmers.

4. Cost-effectiveness: The economic analysis of neem in organic farming suggests that it can be a cost-effective alternative to modern medicine and synthetic pesticides. Neem is a natural and readily available resource that offers a multitude of benefits in agriculture. Using neem in organic farming can reduce input costs related to pesticides and fertilizers. Products made from neem are affordable and offer a greener option to synthetic insecticides and fertilizers. By employing neem-based solutions, organic growers can save money on expensive and potentially dangerous pesticides. A cheap and convenient natural fertilizer that can increase soil fertility is neem oil. It offers farmers a cost-effective way to increase crop yields because it is less expensive than chemical fertilizers. This may reduce the requirement for pricey synthetic fertilizers to increase soil fertility. Farmers can avoid spending money on soil conditioners, synthetic fertilizers, and soil testing kits by employing fertilizers based on Azadirachtinindica. Neem can significantly reduce production costs since it is readily available in many farming areas. Azadirachtin has a very low application rate, which means that a small amount of the product is required per acre of land. This reduces the overall cost of application per acre compared to synthetic pesticides, making it an economically viable option for farmers. The low application rates of Azadirachtin also lead to reduced labor costs as farmers require fewer workers to apply the product. Azadirachtin has a longer residual effect than synthetic pesticides, reducing the need for repeated applications. This leads to a reduced cost of the product and reduced labor costs as well. Azadirachtin is safer for farmers to handle during application, reducing the risk of accidents and associated costs related to medical treatment or insurance

coverage expenses. Azadirachtin is effective at controlling a broad range of pests, reducing the risk of significant crop damage. This raises agricultural yields, which increases the product's cost-effectiveness by reducing the amount of money wasted on pests.

In (93) case study analysis, the results support the cost-effectiveness of organic farming as a sustainable agricultural method by showing that it may be economically feasible and lucrative. In another perspective, the study by (94) examined the difference in crop yields between organic and conventional agriculture and discovered that organic yields are significantly lower (frequently by 20–25%) than conventional yields. According to the study, organic farming may not be as cost-effective as conventional farming in terms of supplying the world's food needs because of its lower yield.

Also, in (95) the study examines the financial competitiveness of organic agriculture on a global scale. It comes to the conclusion that while organic food can be cost-competitive in some areas and for some products, it confronts difficulties on a worldwide scale due to factors like lower yields, greater labor costs, and restricted market access. These facts point to organic farming's decreased cost-effectiveness from a global economic standpoint. The challenges of cost effectiveness faced by the organic sector could be improved by the government's financial provision of incentives, subsidies, or grants to organic farmers to help offset the higher costs associated with organic production. Also, the provision of education and training programs to farmers and extension workers can help improve their technical know-how of organic farming, thereby improving management practices and increasing efficiency. With this support, organic farming might become more competitive and economically viable. Investments in processing centers, distribution networks, and infrastructure for organic certification can lower prices, boost productivity, and expand the market for organic goods.

Conclusion

Azadirachtaindica's components, such as azadirachtinindica, nimbin, salanin, melanin, nimbidin, and quercetin, have economic profit potential in organic farming. Using neem in organic farming can provide significant economic benefits, including cost savings and improved export and market growth potential. Organic farming’s herbicide, pesticide, and fertilizing benefits cannot be overemphasized. Neem oil industry effects have shed light on how sustainable production practices employing organic inputs might be adopted to reduce or minimize negative economic and environmental effects.

Neem's medicinal potential and dosage, therefore, merit additional examination through academic study. A plant health specialist or veterinarian should be consulted before using neem oil or any other natural therapies for plant or animal health in order to ensure proper dosage and prevent any potential side effects. A high yield of pure neem components may not be as readily available or affordable using the conventional method of extraction as opposed to contemporary extraction. Further research on more effective sustainable practices and the incorporation of traditional knowledge alongside modern techniques is also required given the potential consequences of modern extraction methods, such as high costs, the loss of traditional knowledge, and detrimental environmental effects.

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