

Neem the Pool of Endless Potential – Industrial Prospective

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Abstract:

In Indian subcontinent neem tree (*Azadirachtin indica*) is known for centuries for its beneficial uses. It has made its unique place in the global market as it offers answers to the majority concerns faced by mankind. The main vast application tranche of neem extract are agriculture, animal products, health and personal care. Today, neem extracts are used in numerous herbal, Ayurveda, allopathic, Unani and Homoeopathic medicine and has become a cynosure of modern medicine to cure Dermatitis, Acne, Bacterial, Fungal infections and other skin related disorders. Neem also has demonstrated its effectiveness as antiviral, anti-fungal and anti-bacterial. It helps support a strong immune system and is used in blood purifying and in cases of inflammatory skin conditions. The neem leave alcoholic extract is useful against diabetes, as it found to have significant blood sugar lowering effect. The neem products has generator largest revenue in past year in local and international market. In this review, we focus on commercial relevance of neem products and how neem products can create platform for future industrial aspects.

Keywords —Neem market, industrial, extraction, Azadirachtin

I. INTRODUCTION:

Neem (*Azadirachtin indica*) has been appraise as having incredible beneficial properties form centuries. Since past hundreds of year, neem utilization began in ancient time in India and other neighbouring countries. Today's time the neem tree is regarded as national tree which is venerable as all aspects of it is known to have special helpful therapeutic value. Neem is the most versatile, multifarious trees of tropics, with vast and endless potential. It possesses maximum useful non-wood products (leaves, bark, flowers, fruits, seed, gum, oil and neem cake) than any other tree species, and also known to have antiallergenic, antidermatic, antifeedent, antifungal activities. Because of these activities neem has found enormous applications in the field of cosmetics, agriculture, pharmaceutical and neutraceuticals etc. The world neem conference held in 2020 has elevated neem as an “Industrial plant” (Kumar, 2003). Different sector industries including pharmaceuticals, cosmetics, textile

industries and agriculture, use neem by products and neem oil in there processes and products (Jattan et al., 1995). Neem cake (oil extracted neem kernels, is called cake) has been used for many centuries throughout Indian sub-continent as soil amendment which is effective efficiency enhancer of soil. Azadirachtin Technical powder, extracted from neem seed extract used in many industries is a manufacturing used products and used for making end products in many industries. The neem extract, neem oil and pure Azadirachtin are considered nontoxic to useful organisms such as earthworms, and safe for human consumption and environment (Khalid and Shad, 2002; Boeke et al., 2004). Today in market so many neem-based commercial product are available, different parts of Neem tree are being used quite extensively in manufacturing of soaps, skin creams/lotions, shampoos, toothpastes, beauty aids and toiletries (Khanna, 1992). The major player operating in the Indian neem market include

Patanjali, EID parry India Limited, P.J Morgan Pvt Limited, Agro extract limited, Ozone Biotech private limited and other. In this review, we summarize neem by-product market which is categorise in neem and seed extract (oil and cake) market which has made its space globally and how commercial relevance of neem products can create platform for future industrial aspects.

Neem chemical constituents:

The primary extracts of neem which contain a wide range of active chemicals are separated into two constituents: terpenoids and non-terpenoids. Nimbin, nimbidin, nimbinin, nimbidiol, salannol, 3-tigloylazadirachtol (Azadirachtin B) and 1-tigloyl-3-acetyl-1-hydroxymeliacarpin (Azadirachtin D) are some of the other bioactive compounds found in neem plant. These compounds are recognized to play a major role in key activity of neem (**Morgan, 2009; Melwita and Ju, 2010**). Neem extract, neem oil is becoming popular in organic agriculture. Azadirachtin the major active ingredient of neem plant exists in many forms (A-K) and it is made up of several isomers (**Rangiah and Gowda, 2019**). Apart from its insecticidal activities, Azadirachtin has ill effect on fungi, viruses, nematodes and protozoans (**Mordue, 2010**). The Table 1 shows the chemical constituents of neem tree and their commercial potential.

II. Commercial value of Neem by-products:

Neem is the only plant which has a potential to give complete out come in form of different by-products as all part of this herb bear valuable commercial value in market in almost every industrial sector whether agriculture, medical, nutraceuticals, cosmetics and pharmaceuticals.

a. Neem leaves and bark:

Neem leaves and bark contain various active compounds like ascorbic acid, amino acids, nimbolide and nimbin and polyphenolic compounds (e.g. quercetin and β -sitosterol) (**Alzohairy, 2016, Sarah et al., 2019**). It has anti-bacterial and anti-fungal quality has high market. In industries, across India neem is highly exploited, neem leaf powdered are employed in various cosmetics preparations such as face creams, nail polish, nail nourishing oils, shampoos, conditioners, toothpaste, face wash etc. (**Jattan et**

al., 1995). A new shampoo based on seed extract of neem was highly effective in compare with pyrethroid against head lice under in vitro conditions (**Heukelbach et al., 2006**). Neem based toothpaste (oral- health care) is widely used in India and European countries. Neem leaf and seeds Neem leaves are used as green leaf manure and in preparation of litter compost. Neem leaves are also used in store grains. Twigs of neem in early stage is used as is decomposed and used as organic green manure which is widely incorporated in tobacco and paddy fields. The neem bark contains approx. 12% tannins, a chemical required in leather industry. Neem bark and roots also have various medicinal properties. There are many active constituents of Neem which are still to be explored. Neem root control fleas and sucking pests when used in grinded form. Neem leaves have superb restorative properties as it is rich in rutin and bitter constituents. Neem leave and bark extract has great market value which is used in agriculture, personal care product, animal feed and pharmaceuticals.

b. Neem oil: Neem oil is gaining importance economically as it is the most commercially important product of neem.

Table 1: The chemical constituents of neem plant and their commercial potential

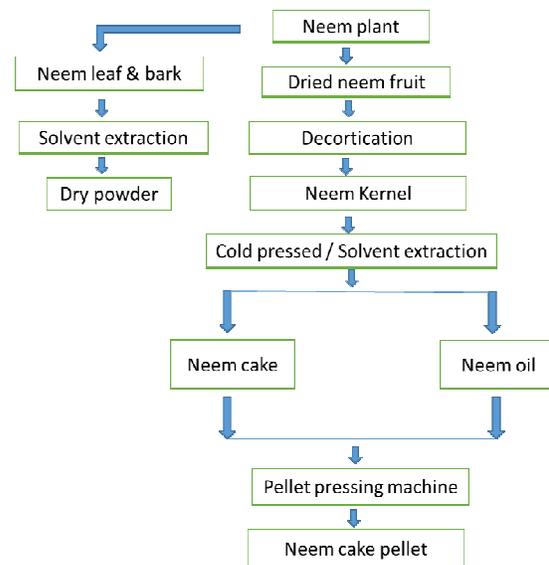
S.no.	Source	Chemical constituents	Biological activity	Commercial potential	Reference
1	Bark extract	Gallic acid, catechin and epicatechin	Antibacterial, Anti-cancer	Medicinal	T. Laxmi et. al (2015)
2	Bark extract	Margolon, Margolonone, isomargololone	Antibacterial	Therapeutic	Mohammad A. Alzohairy(2016)
3	Bark extract	Polysaccharide GIA, GIB	Antitumor	Therapeutic	Girish K. (2008)
4	Bark extract	Polysaccharide G2A, G3A	Anti-inflammatory	Medicinal	Ojha V.K (2016)
5	Bark extract	NB-2 Peptidoglucon	Immunomodulatory	Therapeutic	Pankaj et. al (2011)
6	Leaf extract	Cyclic Trisulphide and Cyclic terasulphide	Antifungal	Plant protection	TomarLokeshwar et al. (2011)
7	Leaf extract	Polysaccharides	Anti-inflammatory	Therapeutic	Kusumharjai et. al. (2013)
8	Leaf extract	Rutin and Bitter	Antioxidant and anti-inflammatory	Medicinal	Garimapandey et. al. (2014)
9	Seed oil	Azadirachtin	Antimalarial	Pesticide, Medicine, cosmetic	Sengottayan et. al (2005)
10	Seed oil	Nimbin	Spermicidal	Pesticide, Medicine	Bhattacharyya et. al (2005)
11	Seed oil	Nimbidin	Anti-pyretic, Anti-arthretic	Commercial Pesticide, Medicine	Khillar and Srivastava (2003)
12	Seed oil	Nimbolide	Anti-malarial, Antibacterial	Commercial Pesticide, Medicine	Udeinya (1993)
13	Seed oil	Gedunin	Anti-malarial, Antibacterial, antifungal	Commercial Pesticide, Medicine	Rochanakji et.al (1985)
14	Seed oil	Mahmoodin	Antibacterial	Commercial Pesticide, Medicine	Jones et. al (1994)
15	Seed oil	Sodium nimbidate	Anti-inflammatory	Commercial Pesticide, Medicine	Chattopadhyay (1998)
16	Seed oil	Salanin	Anti-malarial, Antibacterial, antifungal	Commercial Pesticide, Medicine	Uko and Kamalu, 2001; Lale, 2002
17	Neem Cake	Seed constituents , NPK	Soil amendments	Soil manure, Animal fodder, Fertilizer	Manish et. al. (2019)

In composition, it is much like other vegetable oils, composed primarily of triglycerides in which oleic oil is high in concentrations (**Anderson and Hemdrie, 1971**). Neem oil has dormant active constituent Azadirachtin, due to which oil has insecticidal and medicinal properties. Different concentration of Azadirachtin 150 ppm, 300 ppm, 1500 ppm of Neem oil are in demand in fertilizer and cosmetic industries. Urea sold in India should be 100% neem oil coated confirmed by Ministry of Chemicals and Fertilizers in 2015. Various methods are employed for extracting the neem oil from neem kernels. These range from simple to complex techniques depending on the resources available. To obtain neem oil, extraction is done mainly using different types of technologies which include mechanical pressing and solvent extraction. The neem seeds are first decorticated and the kernels are separate out. The kernels are then pressed in expellers or in electrical operated wooden presses (khachighanis). It is generally dark greenish brown, bitter, and smelly. In India mechanical process is mainly used and recover 45-55% oil form the neem kernels. A large scale industry in India extracts the oil left out in the seed cake using solvent (**Anderson et al., 1971**). This hexane extracted oil goes into certain soaps and consumer products and has a good commercial market status. India's exported neem oil is mostly used by soap manufacturing industries. Although much of it goes to small-scale specialty soaps, large-scale producers also use it, mainly because it is cheap. Generally, the crude oil is used to produce coarse laundry soaps and used as lubricants oil to grease cart wheels(**Bringi& Thakur, 1963**).

c. Neem cake: Neem cake is resourceful and has plenty of usage. It may be utilized as animals feed, compost and regular pesticide. It help in providing nitrogen to soil and block the nitrification procedure, when blended with urea, before using in fields. It is pure, clean and good soil conditioner which add Organic matter (natural macro and micro nutrient) to soil. Neem Seed Powder is widely used in India for various crop fertilize paddy, cotton and sugarcane. It contains good quantity of Azadirachtin and others limonoids which protect

plant parts from wide range of insects. It also acts as a natural manure with pesticide properties. Neem cake (khel) and neem chilka has a good amount of bitter content so can be used in form of Neem dry extract for various herbal products. Neem manure is attaining popularity as it is affluent in sulphur, potassium, calcium, nitrogen and increases the amount of Nitrogen, Potassium and Phosphorous in soil (**Mitra, 1963**). In agricultural industry whether in Asian or western countries like USA, UK and Australia, the neem organic fertilizer is gaining admiration. The processing of neem leaf and fruit in industries is mentioned in Figure 1.

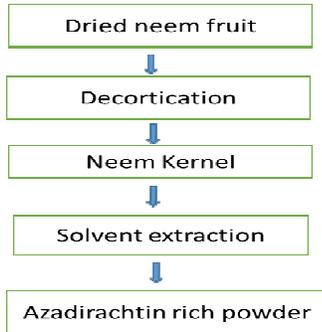
Figure 1: Neem leaf and fruit processing in herbal and fertilizer Industries.



d. Neem technical powder: The neem seed contains > 40 % Azadirachtin, supplemented with more than 100 concentrated bio active limonoids. Azadirachtin as Technical powder is most vigorous tetranotriterpenoid. It is yellowish coloured powder that contains Azadirachtin (A&B) and its isomers that are key active component of Neem and possesses powerful insecticidal properties. Azadirachtin Technical is manufacturing use product (MUP). In different industries it is used for making end products. The actives are less hydrophilic but extremely soluble in organic solvents like alcohols, ketones and hydrocarbon

(Schmutterer and Singh, 1995). The extraction of Azadirachtin rich powder by neem fruit in industries is brief in Figure 2.

Figure 2: Extraction of Azadirachtin Technical powder in industries.



III. Market potential of Neem :

Three broad application segments of the neem by product market include health, personal care, animal products and agriculture, where agriculture holds the largest market size. On the basis of product types available, the neem extract market is categorized into leaf extract, bark extract and seed extract, where seed extract (Neem oil, Azadirachtin technical powder and neem cake) has been the largest revenue generator in past recent years. India is a major neem extract market, where several Ayurvedic and herbal companies including Baidyanath, Dabur, Hamdard, Himalaya, Patanjali, Vicco and Zandu are the key users of neem extract. The consumption of fertilizer-based neem extract products is the highest of the total consumption of neem extract in the agriculture sector market. In India, neem extract also find application as organic pesticide, where 300 PPM and 1,500 PPM are consider the most preferred concentrations. Now a days, demand of neem extract for applications in personal care is higher. With a vast access to neem plantation in the country and rising public awareness regarding the advantages offered by neem extracts in livestock feeding and agriculture, India in near future is expected to hold a recognizable position in the neem extract market. The neem product market world-wide, will be observing a constant continues growth in coming

years, due to large neem extract use in by products production as well as growing interest towards healthier, organic and safe goods globally. The market is expected to observe higher growth on account of rising demand from various furnish industries including personal care, pharmaceutical, animal feed, and agriculture. Moreover, with rising consumer perception about health well-being using neem particularly in developed and developing countries, is predicted to enhance the market extension over the anticipated period. Usage of chemical pesticides and fertilizers used in agriculture live harmful impact on our ecosystem. This makes neem-based products ideal for uses in our daily household. Bhutan is a vital exporter of neem oil extract to the neighbouring countries include India, Sri Lanka, Pakistan and China apart from the European Countries and USA. Export of neem product from Bhutan to India can be justified by the rising demand of the natural product in India and a current shift to Ayurveda herbal medicine which requires neem extract. With growing interest in organic and natural products world-wide the national and international market of neem product is flourishing. The majority of the neem extract market is currently based in the Asia-Pacific, with significant demand from countries especially like United States, Spain and Italy owing to strike regulations towards farming of chemically harvested fruits and vegetables. The major factors driving the global neem market are the cost-effective and safe applications in organic agriculture and herbal products. The demand for these products has been increasing globally owing to their effective efficiency and null side effects. Moreover, leading companies in herbal products manufacturing have been increasingly using neem extract for fairness creams, shampoo, body wash, body lotions, hand wash, hand creams to cope with the rising demand for organic products around the world. The medicinal, agriculture and pharmaceutical properties of these neem products are likely to escalate market growth.

IV. CONCLUSION:

Due to extraordinary properties of Neem tree, its processing can be a valuable project for an

entrepreneurs to invest upon. Neem in overall manufacturing process from Neem leaf extract, bark extract, Neem fruit, Neem oil to Neem khel, it gives 100% out come in form of different by-products as all part of this herb bear valuable commercial value in local and global market. There has been an evident shift all over the world from synthetic chemical products to non-synthetic organic ones. This is largely because of the wide spread awareness of the side effects of these synthetic chemical products not only on plants and soil but also on other living organisms. This is a great opportunity for neem products manufacturers to cash in on the growing popularity of natural or herbal products. Although, neem products cannot completely replace synthetic insecticides in insect pest control, however, their availability and reduced health hazards on the applicator and the ecosystem is greatly minimized. This is a good opportunity for manufacturers and exporters to produce quality bio agricultural and natural organic products. Scientists and experts from different nations are working utterly in exploring the other benefits and properties of Neem tree to formulate and develop new antibiotics. Neem overall a wonderful cure for diseases and provides overall well-being of human. Listing all the plants on this planet that have proved useful for mankind, a few are distinguished by their confound versatility. Among these, the Neem tree has deemed its place as one of the most supreme one.

V. AUTHORS' CONTRIBUTION:

All authors contributed equally to all stages of preparation of this manuscript and all approved final version of manuscript.

VI. CONFLICT OF INTEREST:

No conflicts of interest.

VII. ACKNOWLEDGEMENT:

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