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TEMPLE WASTE UTILIZATION, ITS MANAGEMENT AND FUTURE PERSPECTIVES TO ATTAIN SUSTAINABLE MANAGEMENT

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Review Article

ABSTRACT

Management of "solid waste" is the big issue plaguing the universe and creating havoc to the environment. The generation of waste is increasing as a result of anthropogenic activities causing huge environmental pollution and global warming. Solid waste like kitchen waste, household waste, plastic waste, temple waste. possesses lots of pollutants like carbon. In the world, huge budget is spending to reduce and manage waste by opting landfill or incineration techniques. Temple waste coming out of temples is one of the main concerns, consisting of flowers, leaves, coconuts, grains, and fruits etc. majority of which are degradable. These ingredients are highly organic nature due to which temple waste also act as medium for the growth of microorganisms. The florets can be used in the preparation of many valuable and applicable products and in industries manufacturing perfumes, soaps, cosmetics, food etc. However, temple waste is usually thrown in running water or local water bodies causing water contamination and mortality of aquatic organisms. This review describes the hazards (environmental, human health, aquatic) caused by temple waste through various mechanisms illustrating contamination of water bodies and propagation of microbes, pests, rodents etc., as well as utilization of waste for conversion into useful products like manure, incense sticks, biochar, biofuel, pigments, papers and dyes. All these products have diverse applications in different industries thereby strengthening the concepts like "best out of waste" and "from the temple to the temple". This review paves the aspect of environmental conservation, reduction in pollution and solve energy crisis.

Keywords: Temple waste; pollution; compost; value added products.

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1. INTRODUCTION

The world is facing problem of waste due to increasing population, urbanization and industrialization. Efforts are made by the government, private agencies as well as NGOs to manage the organic remains at low and effective price and also in biodegradable and power relieving core which has magnetized ample consideration. Management of waste is the most controversial issue in the universalization area of research, a vogue that strives for consequence the most. Deterioration of environment due to pollution is a global issue and its potential to influence people's robustness is dreadful [1]. There is a close connection between Human and Environment in maintaining firmness of nature. Environment is deteriorating terribly because of excessive increase in the pollution as well as population and its unlimited expansion. Anthropogenic activities and other natural exertions are main causes of pollution [1]. Use of natural resources on large scale, urbanization and deforestation etc. are the primary sources of environmental pollution. However, destructibility of human to pollution is now appraised to be extra immoderate than afterwards presence of human [2]. Huge amount of waste is originating from various human activities [3]. Types and variety of waste increases with the increase in amount of waste [4]. Any substance or material which is unbeneficial to the manufacturer is considered as waste [5]. The production of waste is found in different forms and its description could be verified in different forms. There are few characteristics which can be used to identify the different types of waste which includes the manufacture cause, recycling capacity, physical states and its properties and the superiority of environmental influence [6-7].

Waste is usually classified in the three forms: solid waste, liquid waste and gaseous waste. Waste from household activities, waste from industries, waste from agricultural activities, waste from commercial activities, mining waste and temple waste are the major sources of waste. Solid waste is the waste which is generated from human actions and usually discarded and thrown away as unusable residue [8]. It also includes 'municipal solid waste (MSW)', 'electronic waste (EW)' and 'hazardous waste (HW)' [9]. Municipal solid waste or (MSW)is defined as the squander coming out of the household and commercial sources [10]. This waste primarily comprises of food, plastic, paper, garden waste, textiles, glass, and metals. Although, municipal waste can be indication of negative impression on the public health and environment if it is not coped properly [11]. Hence, municipal waste becomes one of the major causes of environmental pollution. Generally, activities like generation of solid waste, its transfer, transportation, treatment and disposal of solid waste are related with waste management. However, only four activities such as generation of waste, collection of waste, transport and disposal are coming under municipal solid waste management system. It is proven by [11] that management of waste is not a thoughtful matter till the people commence to live together in the societies. Because of increasing population, the power consumption by humans has increased on largescale; a large number of materials are produced to complete the demand of the customers which results into increased production of the waste [4]. Hence, appropriate scheming and controlling methods to manage wastes are mandatory. There are few practices of waste management such as reuse, recycling, composting, energy generation from burning of waste and land filling [12]. Most of these practices require lots of finance and labor. Now, waste management has drawn much attention towards managing waste at low cost in eco-friendly manner as well as energy frugality all over the world. Environmentalists are agonizing with the costs of solid waste management for environmental protection [13]. Moreover, temple waste is a kind of municipal solid waste that is considered to create several types of environmental pollution and health problems in comparison to other waste such as domestic waste, industrial waste, agricultural waste, etc. In many developing countries like India, worshipping is performed in temples, mosques and gurudwaras, which provide an exclusive share of flower waste towards the entire solid waste engender. Waste generated from temple is organic in nature which frames about 70% of entire solid waste [14].

Waste that comes out of temples is of diverse nature as pilgrims used to offer variety of flowers, leaves and other offerings in temples. The quantum of flower waste is increasing and has become decagonal for the period of precise events such as celebrations, festivals, religious ceremonies, etc. There are some chief florets such as Marigold, Chrysanthemum, China Rose, Jasmine, Rose etc. which are mainly proposed in various holy places. Flower waste usually does not find any consideration and continuously worsening the environment as well as water bodies. Temple waste is considered to be holy residue not to be mixed with other wastes and is thrown away in some reservoir or left untreated in open producing bad odour which acts as propagation area for disease causing microorganisms. Mixing of left out flowers in running water channels is creating critical environmental pollution and health issues [15]. Focusing towards the perilous effect of the inadequate dumping of wastes on the environment, suitable

Fig. 1. Collection, transportation and utilization of temple waste

operation and management is the need of hour. For the proper treatment of flower waste, it requires lots of biological management strategies that may be adopted due to its organic nature like vermicomposting in place of landfills, jettison or any other environmentally perilous waste management options [16-18]. This review describes the hazards (environmental, human health, aquatic) caused by temple waste through various mechanisms illustrating contamination of water bodies and propagation of microbes, pests, rodents etc., as well as utilization of waste for conversion into useful products like manure, incense sticks, biochar, biofuel, pigments, papers and dyes etc. Therefore, this review also paves the aspect of environmental conservation, reduction in pollution and solve energy crisis (Fig. 1).

In fact, the problem with floral waste management is associated with its sanctity or holiness and people refuses to mix and dispose floral waste with rest of solid waste. Temple waste contains lots of nutrients and other lignocellulosic materials, so it can be utilized for various purposes like compost preparation, biofuel and bio energy production, extraction of dyes and essential oils and also to produce valuable eco-friendly products like incense sticks, soaps etc[19].

2. PROBLEMS ASSOCIATED WITH TEMPLE WASTE

Temple waste and its mismanagement causes environmental pollution, water contamination and various health hazards (Fig. 2). The quantum of waste is increasing at very fast pace further raising concerns and forcing researchers to rethink on this aspect. Waste including Municipal solid wasteis getting managed by dumping it in landfills, however, in many developing countries; waste is hurled in open yet, causing the emission of different greenhouse gases responsible for global warming. There are several other methods like pyrolysis, gasification, anaerobic digestion, composting and biomethanation which are also used for resource resumption from waste in some of the advance countries.

But, still there are chances of improvement in these processes when it comes to the management of temple waste which is lying unnoticed in environment. Following hazards have been reported to occur due to temple waste:

2.1 Air Pollution by Burning of Incense

Burning incense to adore divinities is a daily spiritual tradition and also a part of everyday routine all over the world among all the religions [20]. In a report from Taiwan, approximately 15 Lakhs devotees used to visit more than "14,500 temples" across the country and burn incense sticks inside the temples (http://www.moi.gov.tw/stat/). India alone has more than 2 million Hindu temples apart from large number of mosques, gurudwaras and churches recorded during the 2001 census and the number is increasing at tremendous speed. Millions of devotees used to visit and worship at these religious places on daily basis and offer various items like flowers, fruits, leaves etc. The quantity of temple waste generation in

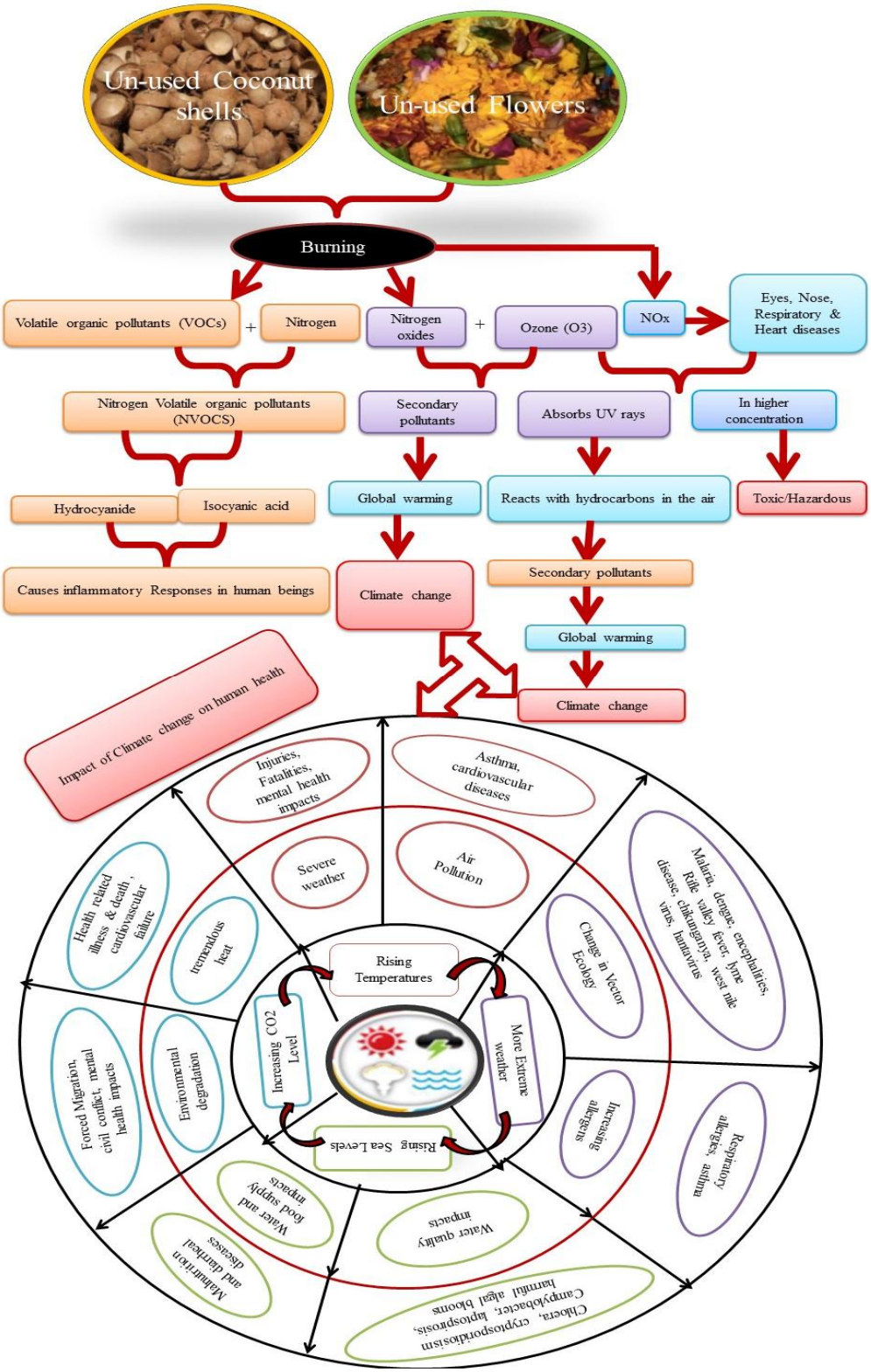

Fig. 2. Effects of temple waste on environment and human health

India is 300 MT/day [21]. Burning of incense and dhoopbatti is the most common practice among people. Burning of incense is considered as an abundant source of large number of particulate matters and carcinogenic polycyclic aromatic hydrocarbons (PAHs) [22-25]. Because carcinogenic polycyclic aromatic hydrocarbons have long, slow and incomplete process of combustion like nature, these practices generate uncontrolled smoke. It was showed in various studies that peoples who have exposed to such smoke develop higher risks for the incidence of acute respiratory symptoms like irritation in throat and upper respiratory tract [22, 26].The total PAHs and individual compound concentrations could be used to get best estimation about the health risk related with the burning of incense sticks in the temples. The concentration of these compounds could be compared to already present regulatory standards which are used for the protection of people's and worker's health with adequate safety margin. It was reported that the target yearly mean values of "Benzo[a]pyrene" are "0.7 to 1.3ngm^{-3}"in European countries [27] and the WHO risk estimate for PAHs in air based on lung cancer in coke-oven workers had led to a health-based guideline value of "0.1 ng m^{-3}" Benzo[a]pyrene for ambient air [28]. Related concentrations of PAHs have also been reported in some Taiwanese temples and these concentrations were found high to cause direct exposure to cancer causing PAHs in temples. It has been reported that exposure to these PAHs results in the higher risks of cancer [25, 29-31]. Hence, it is necessary to develop useful knowledge about protection of human health of temple workers. It is also required to develop a framework about an integrated risk assessment such as "probabilistic exposure model", "human respiratory tract model", and "incremental lifetime cancer risk model", to calculate temple workers exposed to airborne PAHs in temples.

2.2 Environmental Degradation and Human Health Hazards

Flower is an important part of worship as the word "pooja" signifies the fulfillment of prescribes customs and realization of divine. Several types of flowers are offered in the temple at different stages of devotion. Each year approx. "800,000,000 tons" of flower waste are thrown away in water channels in India [32]. The main cause of pollution by flower is the toxicity of pesticides and chemical which are used to grow flowers and then mix up with water bodies. Several sewers and waterways also get blocked with waste creating problem in community to a great extent. Industrial waste is always blamed to cause environmental and health hazards all the time, temple/floral waste never comes to the thoughts of most of people however, temple residues also significantly affect the health of environment and mankind.

Beside the municipal waste, flower industry is also considered the potential cause of environmental deterioration ensuing from the excess use of water, pollution of the lake & the increasing population in the area, threaten its local species by pollution. Due to water pollution, many species of aquatic organisms are getting declined and fish catchers are also dwindling. The use of chemicals has also increased which have grown certain threat to labor force specially women and children. In year 2005, "World Health Organization" estimated about 36% of chemicals used by Floraverde plantations as extremely toxic [32]. Different economic activities in dairy farms as well as vegetable & flower market in Ghazipur, New Delhi (India) is generating approximately 8700 Kgs of residue/waste on daily basis. Most of the workers living in that area are migrants, and inhabits slum areas around the city, where hygiene facilities are poor. As a result, water bodies are further getting polluted as an outcome of anthropogenic activities like bathing, washing of clothes and utensils etc. [32]. One more factor which is considered important is picking/shifting of flowers. Transportation of flowers from one place to another generates a lot of pollution and harmful gases are emitted due to vehicular movement. Many wedding planners bought flowers either from organic florist or choose option to grow their own flowers. The main point of concern is what to do with the flowers after the wedding. Some wedding planners are making efforts to replant the flowers after the event to minimize the generation of waste and let the flowers to keep on growing afterwards. According to Flowerpetal.com, huge amount of floral organic waste is generated on single Valentine's Day in United States. The organic wastes thus generated, undergo different stages and broken down by the actions of bacteria and resulted in the formation of methane and some 9,000 metric tons of CO_2 emissions (Fig. 3).

2.3 Water Pollution and Damage to Aquatic Ecosystem

The whole world is facing problem of water both in terms of quality and quantity. In the whole universe there are many problems but water pollution is one of the main problem, affecting both developed & developing countries [33]. Heavy metals, acids, deposits, wastes released by animals and humans, synthetic &organic compounds get released in the water sources that causes the water pollution in developing countries [34]. The pollutants change the chemical nature of water due to which the quality of

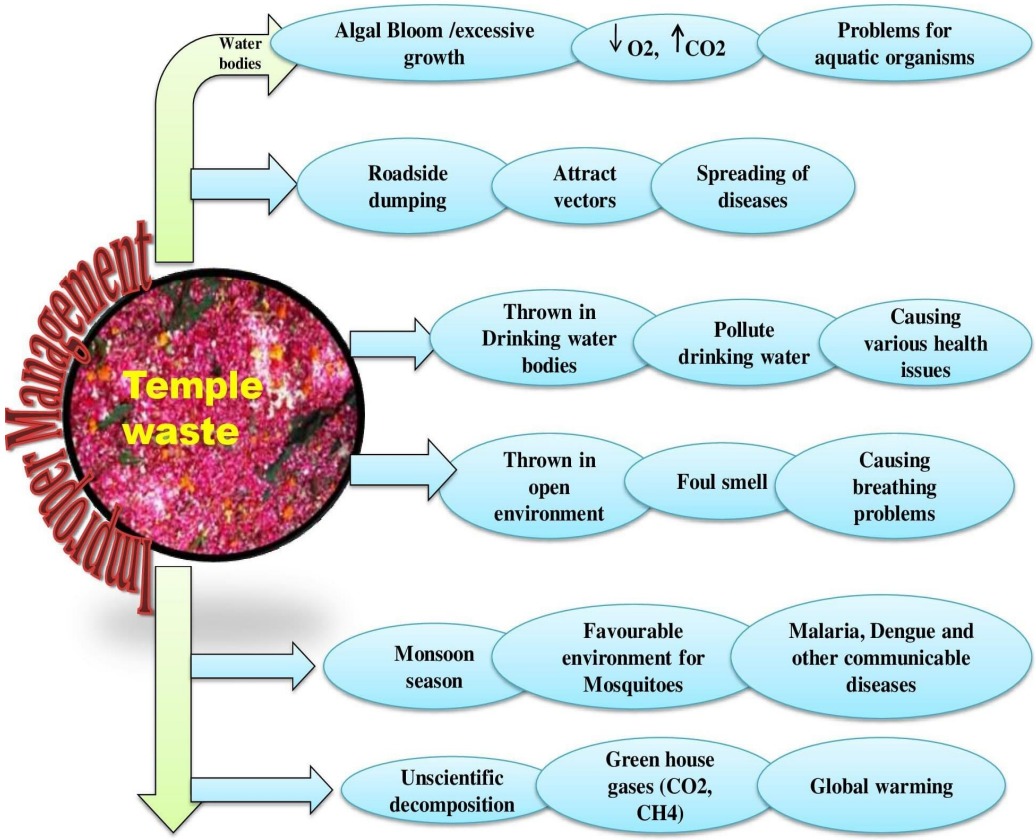

Fig. 3. Environmental and health issues due to improper management of temple waste

water is affected and disturbs the balance in the aquatic ecosystem. Floral offerings are always considered holy and sacred, usually thrown in running water channels or local water bodies such as rivers, ponds and lakes. This practice is most common and least eco-friendly and the amount of pollution caused by the flowers is immense.

India is a country of gods and goddesses and huge amount of flower waste is dumped in the Indian rivers each year [35]. There are several temples in the country, particularly those in the Ganga basin, which dump waste directly into the river without segregating it into biodegradable and non-biodegradable components. Although industrial runoff in Ganga is not only responsible for the pollution, temple waste hardly gets all the blame. Floral waste is said to account for 16 percent of the total pollution of the rivers [36]. High organic content present in flowers increases algal blooms and eutrophication in water bodies when floral waste starts decomposing. It may further disturb oxygen levels in the water bodies and cause marine life to die, finally resulting in the alteration of the ecosystem (Fig. 4).

3. MANAGEMENT AND UTILIZATION OF TEMPLE WASTE

Floral waste coming out of temples is emerging as serious threat to environment and mankind. Dehydrated or rotten flowers can be investigated as excess matter therefore thrown into dumping are and in different water bodies causing pollution in aquatic ecosystem and mortality of minor and major aquatic fauna and flora.

In some of the countries such as Sri Lanka and India, plenty of flowers are used in temple, producing floral-waste that carries leaves, stem, fruits, fibers and many other things. Approximately 40% flowers are getting wasted on daily basis because of one or another means leading to water or environmental pollution [37]. Majority of the people put the flowers (used in worship) in plastic bag or tossed into land water, it seems problematic conditions for all of us because of heat emissions and water contamination etc. A trashed waste may cause degradation of somatic aspects of land water and worsen its quality. When the floral material is dipped into water bodies, it makes water

contaminated and causes negative impact on our wellness. This throwing of floral waste in larger quantities causes bad smell or develops a place for mosquito production. Soil productivity may contaminate and worsen the cultured use of ground or earth. Burning of floral material may cause the discharge of poisonous gases which leads to air pollution and acid rain. The floral waste changes the water color, there is no proper use of it and also dangerous to the flora and fauna. Processing and recycling of floral waste is able to reduce the utilization of essential products [38]. Nowadays, such floral waste materials are utilized in research by several scientists and researchers for its better management and production of valuable products. Management of temple waste has become a challenge to temple authorities and environmentalists. Countries round the world are suffering with high environmental expense of solid waste management [13]. Efforts are being made to manage the floral waste at low cost in ecofriendly and energy redeemable manner which is getting great attention all over the world. Various techniques deployed for utilizing floral waste are as under:

3.1 Utilization of Floral Waste for Vermicomposting

Vermicomposting has become a better option for the conversion of floral waste into valuable organic fertilizer that can provide great benefits to environment as well as human health. Vermicomposting is a process in which different

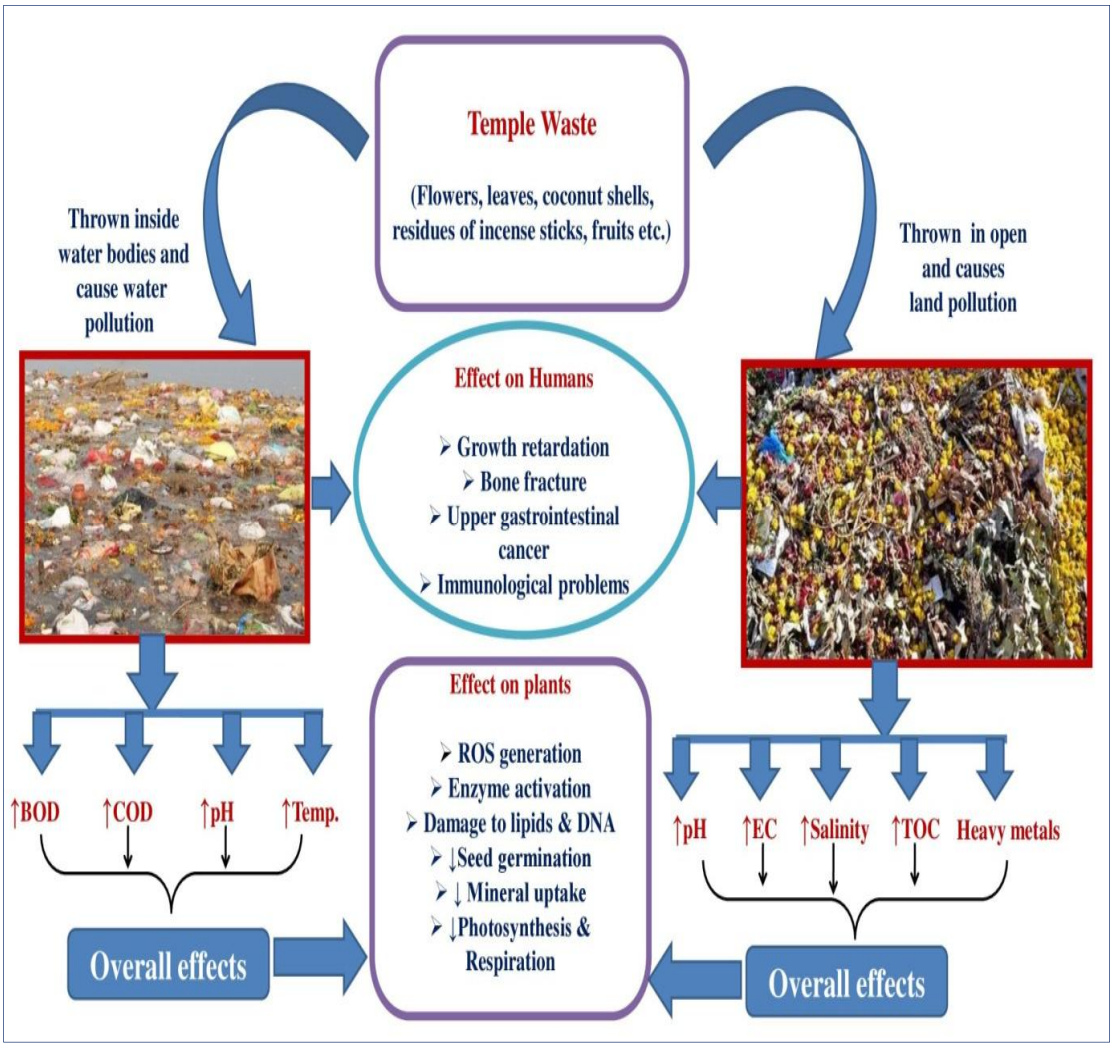

Fig. 4. Impact of temple waste on terrestrial and aquatic ecosystem

energy rich and complex organic substances are bio-oxidized and converted into steadied products with the help of earthworms and microorganisms, [39]. Thus, earthworms play highly significant role in breaking and changing biological activity of the biodegradable waste [40].

Aerobic composting converts the solid organic waste into nutrients rich manure [41-43]. Thus, transformation of "organic wastes" into vermicompost got significance only just due to harmless continuous breakdown of organic waste with the help of earthworms and microorganisms in mesothermic circumstances [40]. However, vermicomposting is acknowledged as ecological cause of micro as well as macronutrients, plant growth stimulating hormone, inhibition microbes and enzymes [41,44] that boost microbial population and grasp plant nutrients for prolonged period [45]. It also contains plant-growth hormones, like auxins, gibberellins, cytokinins [46] and humic acids [47] thus important for better growth of plants and yield of various crops [47]. These plant stimulating hormones are initiated by microbial activity such as bacteria, actinomycetes, fungi etc.[39]. Population of earthworms are doubled in favorable physical environment like high permeableness, oxygenate, irrigation, water stock capacity and activity of microbes which provide tremendous home environment for them to grow &increase [47,48,49]. Moreover, enormous microbial activities and strong nutrients holding capacity are also provided within these environmental conditions [50]. The floret vermicompost prepared by earthworms is dark black grainy in appearance indicating proper decomposition of flower waste which shows consumption of floral waste by earthworms. The consumption of organic waste is done by worms very hastily by the action of grinding gizzards and organic matter breakdown into finer particles [51]. Earthworms derive their nutrients from various microorganisms which flourish upon the waste material and also, they promote activity of microbes in waste [52]. In addition to that, there is no foul odour during the formation of compost due to the circulation of oxygen rich hemoglobin via the skin of the earthworms. Earthworm releases adequate amount of oxygen to oxidize foul odour produced by compounds like H_2S, mercaptans and skatole, etc. [53]. High proportion solidity is boosted due to porousness which further enhances the accessibility of nutrients for the growth of crop. This is because, during the process of vermicomposting, essential plant nutrients which are contained by organic waste, mainly N_2, P, K, Mg, Sand Ca are liberated and changes by microbial action in the such forms that are extremely solvable and obtainable to plants than those in the nurture compounds [54-55]. The moisture content varies in composting units which should be retained at 60%-70%. Likewise, temperature of vermicompost should not be more than 35^0C because exposing the earthworms to temperature more than 35^0C even for concise periods can destroy them. Hence, to avoid such problem particular management of the organic wastes should be done [56].

Lower concentration of carbon/nitrogen of substrate is due to loss of carbon over microbial exhalation and mineralization and instantaneous supplement of nitrogen by earthworms in the form of mucus and nitrogenous excretory material [57]. Therefore, the deficiency of carbon in organic waste lowers the repository capacity of micro and macro nutrients and also reduces the soil fertility. The amalgamation of vermicompost with floral waste has been revealed to raise organic carbon content in the soil.[58] reported an increase in the content of organic carbon up to 20.76% which showed that it has positive effect for the growth and yield of crops. Hence, the nitrogen content present in soil was also rose which indicated that the vermicompost might have quality which play a significant role in increasing nitrogen level of soil by using floral vermicompost. Due to presence of nitrogen fixing bacteria in the floral vermicompost, nitrogen content of soil increases [59]. The study also revealed that there was 18.25% phosphorus in organic vermicompost as P_2O_5. Additionally, it was recommended that the organic matter passed through the gut of earthworm's results in the conversion of phosphorus in such forms that are much bio-accessible to plants [60]. Specifying nutrients such as phosphorus & nitrogen and the mucus of intestinal layer expelled by earthworms are further consumed by the microorganisms for reproduction, robust soil remediation and also for fertility enhancement action. The subordinate nutrients like Ca, Mg &S that are essential in reduced amounts have also been reported in compost. Floral compost also comprises different plant hormones such as auxin, gibberellins and enzymes that are supposed to accelerate plant growth and oppose the growth of plant pathogens [61-62].

A lot of studies have been carried out by various workers on quality of compost produced from different type of wastes. In general, compost produced from cow dung is abundantly used in crop fields, however compost generated from waste may also be utilized for its best use while recycling the earlier. Quality of compost obtained from different type of waste in terms of fertility as reported by various workers is as under: (Table 1).

[63] analyzed MSW compost and reported moisture (19.3%), density (0.67%), pH (8.4), Ec (0.38), TOC (16.13%), TN (1.71%), TP (1.67%), TK (0.88%) and

C:N (9.46%). In a study carried out by [64], compost prepared from temple waste was analyzed for nutritional parameters like pH (7.2), TOC (8.57%), TN (0.49%), TP (0.5%), TK (0.16%) and C:N (17.4%). As per FCO standards, values for different parameters are moisture (15-25%), density (0.7-0.9%), pH (6.5-7.5), EC (<4), TOC (16% min), TN (0.5%), TP (0.5% min), TK (1% min) and C:N (20% max).

The review concludes that C:N ratio which is considered most prominent characteristic of fertility was reported best in temple waste compost value being 17.4 almost similar to that of dung (16.89) as compared to 9.46 in MSW compost. Hence, temple waste may be utilized as organic manure after proper decomposition with the help of earthworms.

3.2 Biofuels, Bioethanol and Biogas Production

Fermentation biotechnologist uses various microbes as a tool to convert sugar into ethyl alcohol. The production of ethanol through submerged fermentation by using Mahua flower is of great commercial benefits [65]. Flowers that are abundantly offered in Indian temples may also prove significant source for the production of biogas [66].

Energy generated through floral waste may be utilized in similar manner as that of electric power or natural gas. Shri Mahakaleshwar temple, which comes under the "12 Jyotirlingas" in India, produces nearby 3tonnes of biodegradable waste which primarily contain flowers and coconut. [67] made an analysis about energy production from the temple waste. In this study, temple waste and kitchen waste were used for the production of bio gas as well as vermicast. In Mahakaleshwar, Mahakumbh occur after every 12 years, where lots of floral waste is generated. Efforts have been made to evolve a technique to engender energy from that waste. [66] conducted a study for production of fuel from mixture of floral and vegetable waste through anaerobic affliction. It was reported that biofuel was produced at the rate of 16.69g/kg in floral waste while 9.089g/kg in peat (vegetables) waste exhibiting the potential of floral waste in the production of energy.

3.4 Organic Acids, Dyes and Pigments

Floral waste can also be used in the preparation of various value-added products like acids, pigments and dyes etc. Sugarcane is the major source of oxalic acid in India. Mahua flowers are offered in many temples in India and have significant sugar quantity so these can also be used to form oxalic acid [68]. Temple waste mainly marigold or roses are considered for production of different stains [69]. Petals of saffron flower are used to forms stains in Pashmina shawl [70] and Hibiscus flower extract is used as organic stains [71]. The most important thing about these organic strains is that they do not cause any health hazards. *Tagetes erect L and Tagetes patula L* are used in production of patuletin stain that is used in various textile-industries [72]. *Tagetes* is also composed of various compounds like lutein carotenoid pigment that is used in food or textile industries [73]. Marigold extract is used in veterinary feed, but not in much quantity because of reduced knowledge about its protection and strength.

Table 1. Analysis of compost prepared from different type of wastes

Fertility Parameters	MSW Compost (Mandal et al 2014)	Temple Waste (Aruna et al 2016)	FCO Standard (Mandal et al 2014)	Dung (Bhat et al 2017)
Moisture (%dm)	19.3 ± 1.4	INA	15-25	INA
Bulk Density (g/cm^3)	0.67 ± 0.0	INA	0.7-0.9	INA
pH	8.4 ± 0.02	7.2	6.5-7.5	7.12 ± 0.05
EC (ds/m)	0.38 ± 0.07	INA	<4.0	2.82 ± 0.03
TOC (%dm)	16.13 ± 0.69	8.57	16 (min)	33.79 ± 0.36
TN (%dm)	1.71 ± 0.09	0.49	0.5 (min)	2.0 ± 0.03
TP(%dm)	1.67 ± 0.11	0.5	0.5 (min)	1.08 ± 0.05
TK(%dm)	0.88 ± 0.27	0.16	1 (min)	1.96 ± 0.06
C:N	9.46 ± 0.91	17.4	20 (max)	16.89 ± 0.43

INA: Information Not Available
EC: Electrical conductivity, TOC: Total organic carbon, TN: Total nitrogen, TP: Total phosphorous, TK: Total potassium, C: Carbon, N: Nitrogen

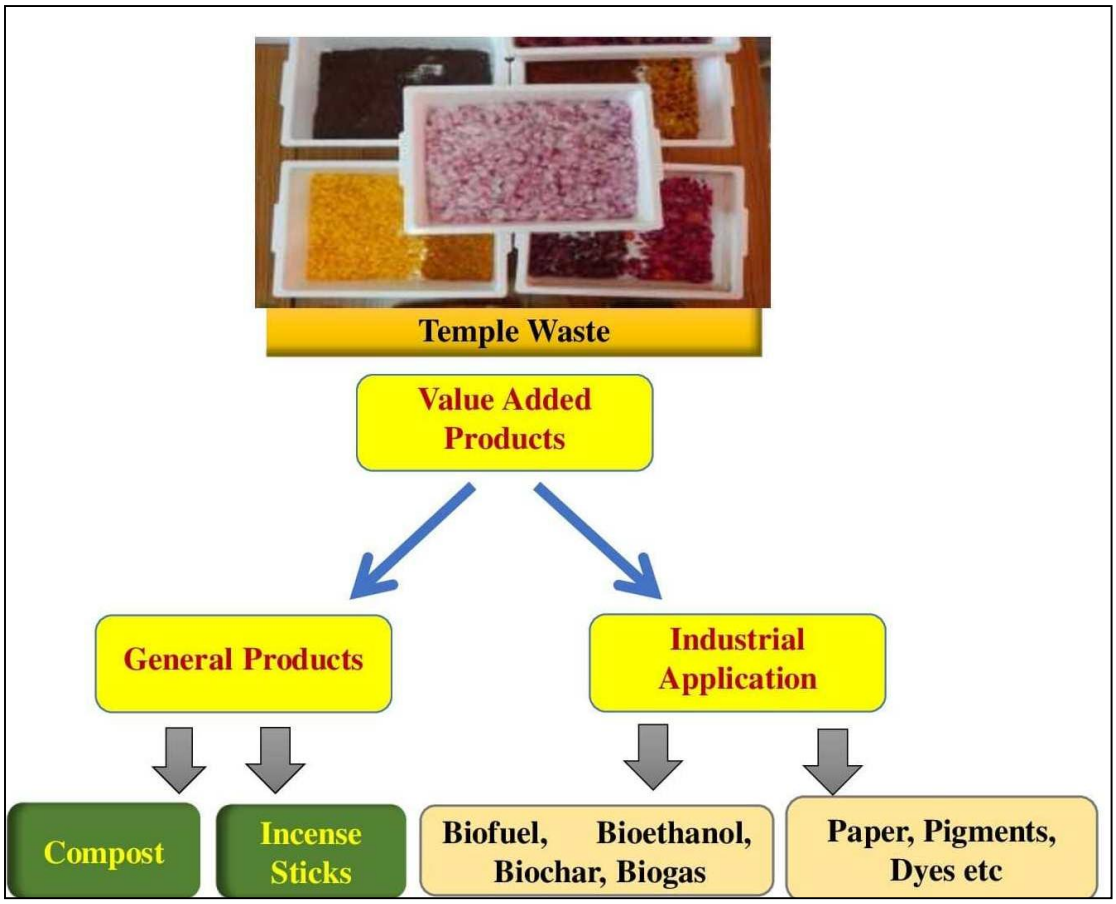

Fig. 5. Management and value addition of temple waste

Floral waste may also be used in the production of aromatic oils. Rosa species are the prominent flowers for the production of aromatic oils [74]. In India, huge floral material generated from temples can be used as stain in industries [75]. In marigold flower petals, usually carotenoids lutein or flavonoid patuletin pigments are present, which can be used in stain industries. Treating the material with metal sacrides appears to give better effects in the form of stain for cotton, wool or silk dye. [76] while evaluating floral waste reported that rose, marigold, chrysanthemum or Jasmine are common flowers offered in these temples and about 2350kg/day floral waste is generated out of temples. The extraction of some aromatic oils from waste flowers can be made through the process of steam distillation method. [73] isolated organic stains from Hibisicus or marigold floral waste, mixed with alum, or ferrous sulphate for staining cotton as well as silk fabric. According to the [15], about 1450 tones floral material is supposed to be generated in entire country (India) which includes Rose, jasmine, marigold, chrysanthemum, hyacinth, hibiscus or tuberose. They also suggested use of temple waste in the production of aromatic oils or stains by making use of C_2H_5OH, CH_3OH and $C_6H_{14}$for separation of stain from dry and crushed floral material.

3.5 Medicinal Value of Flowers

It has been reported in literature that floral plants or their parts are used in the treatment of many ailments since time immemorial [77]. The flowers of Madhuca species play an important role to treat bronchitis, it also helps in accumulation of breast milk in milching mothers [77]. The oil extracted from Marigold species mixed with olive oil can be used as valuable product for massage. Passiflora, a flower is promoted as dietary supplements, to reduce anxiety or restlessness. For the treatment of jaundice, respiratory disorders and gastrointestinal disorders, Lily flowers are used. Also, some times to cure high blood pressure, Rhododendron's juice is useful. Camomile's aromatic oils play an important role to prevent skin disease such as dermatitis and muscle pain. Rose is one of the main flowers offered in temples, extract of which may be used as rose water, attar and pankhuri or gulkand.

In many products like perfumes, creams and soaps, rose extract is used for odour, also in ointment or lotion. Gulkand is a valuable product mainly used as Tonic and having medicinal value for multiple sicknesses. *Arnica montana* flower has been utilized as herbal remedy [78] having many medicinal properties such as anti-septic, anti-inflammatory and analgesic. Saffron is well known for its anti-oxidant or anti-microbial uses. This anti-oxidant effect of carotenoids, betalain or anthocyanin pigments present in it, may be used to treat cancer [79-81].

3.6 Incense Sticks Using Floral Wastes

Improper disposal of flower waste may cause many health issues. To overcome these ill effect, various valuable products can be made by using flower waste. Incense sticks produces smoke contains particular matters, gas products and various organic compound that can cause many health issues. Therefore, herbal incense sticks can be made from flower petals taken from temples. Additionally, rose water, herbal colours, natural dyes etc. can also be made by using temple waste [82].

Incense sticks are the most common product which is produced out of temple waste strengthening the concept of "waste from the temples to the temples". Petals of Genda and rose are most commonly used in many Indian states like Uttrakhand, Madhya Pradesh etc. for the production of incense sticks and dhoopbatti [83].

Eco-friendly Incense sticks Nirmalya are manufactured from the floral disposals or floral waste procured from places of worship by employing and training women from a low-income background. The incense sticks manufactured in this way are eco-friendly and as a result are not harmful to humans. Now-a-days the manufacturers use coal as a raw material for the preparation of incense sticks because coal has carbon content which is essential for burning. In the ground state of coal, carbon is present and the organic content of dried flowers has carbon in the 3^+ oxidation state. For the purpose of burning, the required oxidation state is 4^+, and it has to be changed to 4^+. This process is easy and it requires low energy in case of flowers, also release of CO^2 from incense burning is decreased to a great amount and the resulted product is more energy efficient. Replacing coal with the flower waste may acts as potential waste management solution to the flower waste, it is more energy efficient and generates lesser carbon emissions (http://www.greenwaveindia.com/). In spiritual places such as temples, mosques, church, large number of incense sticks are used. After the burning of incense sticks, ash is left out which is in large quantum and has zero value. [84] reported that incense sticks ash can be used for remediation of Victoria Blue B (Basic Blue 26) dye from waste water.

3.7 Utilization of Coconut Shells

Coconut is one of the widely used offering by the devotees in the temples. After the removal of edible portion of coconut its shell is mainly thrown into the dustbins. Coconut shells are reused in many applications. For the construction of light weight concrete the coconut shells are used [85] (Fig. 6).

Due to the smooth surface of coconut shell on one side it shows better ability to work. It shows better resistance when compared to other conventional concrete. Fibers from the outer layer of coconut are also removed. These shells thrown into some water resources or other open areas and causing many problems to the environment. The use of coconut shell as an alternative in the construction industries opens new horizons. This will solve the problem of its disposal and its use in the construction industry lowers the cost of construction material. [86] analyzed the characteristics of concrete with coconut shell as complete alternative. A controlled concrete with usual accumulate and coconut shell concrete with 10-20% coarse accumulate replaced with coconut shell was prepared. Factors such as compressive potency, split tensile potency, water consumption & moisture migration were studies for various coconut shells replaced by concrete and regulated concrete. Hence, their study revealed that aggregates of coconut shell can be used instead of usual aggregate but functioning of coconut shell aggregate concrete is slight inferior than usual aggregate concrete.

A study was undertaken by [87] for the purpose to construct a concrete by exchanging "granite" with "coconut shell". They made 45 cubes and their compressive potency & feasibility were evaluated on 7^{th},14^{th} and 28^{th} days. The compressive potency of concrete was reported as decreased as the percentage substitution increased. Concrete made by 2.5%, 5%, 7.5%, 10% substitute achieved 28 days compressive potency of 19.71,19.53,19.08,18.91 respectively. Hence, it was concluded that coconut shell concrete can be used in fortified concrete manufacture and also, its utilization is cost-effective and eco-friendly. A study was done on the use of coconut shell instead of cement in concrete as cement releases large quantity of CO_2 [88]. The coconut shells were burnt in open air for about 3 hours. Later on, the obtained product was ignited in muffle furnace at 800° C for six hours for the production of ash from coconut shell. It was concluded that the ash hence obtained could be used as incomplete replacement of cement [88].

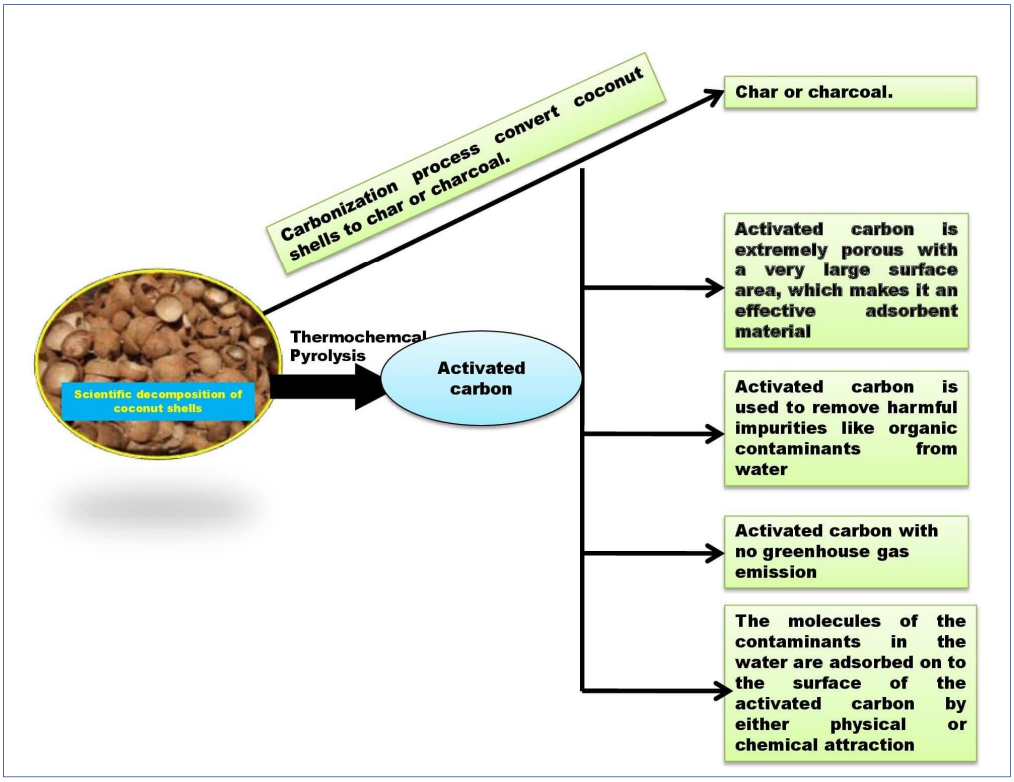

Fig. 6. Utilization of coconut shells in the preparation of value-added products

3.8 Handmade Paper Production

In the field of culture and industries, requirements for paper are one of the most essential needs of human beings. In the paper industry, cellulose and pulp of wood are generated from raw material of waste paper and the plants that contain cellulose. The conversion of these intermediates into paper is done by various mechanical and chemical processes. Cellulose being a natural polymer are the primary products that are used for the manufacturing of paper. The cell wall of the plants and trees are formed by cellulose. Cellulose is found abundantly in nature and has immense uses i.e. production of paper and cardboard etc. Wood is the primary raw material that is used in the paper and cardboard industry for making papers. About "350 million tons" papers are utilized annually around the world. In the year 2000, production of paper and cardboard was 51.0 million tons in Europe, and in the year 2020 it was assumed that it would be about 83.7 million tons and the increase in the utilization of paper is 47.7 million tons to 79.8 million tons annually [89]. The use of wood for making papers and cardboard is increasing day by day and due to this increase, there is decrease in the forest resources. And now, paper industry is choosing different alternative raw material for paper making. One of them is the use of floral waste and plant waste in pulp and paper production [90]. Temple waste contains flowers waste, coconut shells etc. It can also be utilized / reused in the form of ecofriendly paper thereby, strengthening 3R's (reduce, reuse or recycle) concept. Temple waste provide viable inception of organic matter for the manufacturing of paper after processing [91]. The use of floral waste for the manufacturing of paper shall eradicate deforestation, there shall control in the rate of global warming and habitat loss for forest animals shall be reduced, thus saving the forest animals. And while processing the leaves and these flowers also do not cause any hazards related to the health [92]. Now-a-days floral waste disposal is becoming a huge problem and manufacturing of paper from floral waste shall provide an approach to minimize the quantity of floral waste. For the paper production use of floral waste would also generate source of income for the temples and marriage halls. Paper made from floral waste is eco-friendly, cost-effective and biodegradable [93].

3.9 Biogas Generation

Large amountof floral waste is generated and available in prominent temples throughout the world. Floral waste is rarely used for products

manufacturing. Standard techniques of floral waste removal are used in water bodies or landfill which creates water, air and soil pollution. Due to these methods, it releases greenhouse gases into the atmosphere. Therefore, there is necessity to provide a solution regarding disposal or management of floral waste. Very less work has been done in the area of biogas production through floral waste. Recent literature shows that the alternative and effective technology of anaerobic digestion combines with waste management and production of biofuels [94]. Percentage of methane in the anaerobic digestion process varies from 50 to 70% which reduces environmental discharges and waste material. Methane gas helps to produce valuable biogas by anaerobic digestion process.

According to the "Kyoto Protocol", CH_4 is the major greenhouse gas with global warming potential 25 times more than the "carbon dioxide" potential. Due to this type of methane utilization is suitable for the fulfillment of energy needs and decrease methane emission [95]. In addition to decreased methane discharges, biogas technologies also have impact on environment, social and hygienic issues. Four different aspects of anaerobic digestion process are pretreatment, digestion, gas upgrading and digestive treatment [96]. In India, total production of biogas is 2.07 billion per year and total estimated production is 29 to 48 billion per year. To control the anaerobic digestion phenomenon, advance technologies are microbiology, biochemistry and engineering that helps to understand the phenomena in better way [97]. Different type of kitchen wastes and flower waste are used for production of biogas [98]. Crude or fresh flower waste cannot produce biogas. Calcium carbonate is used to carry out biogas production by alkaline chemical pretreatment, but the literature is limited regarding the anaerobic digestion of various types of waste materials.

[99] concluded that the biogas generation from the floral waste of Marigold, Datura, Ankra, Rose and bel leaves can be done in laboratory scale digesters of 1.5 L capacity at 30º temperature within 35 days. It describes the feasibility of biogas generation. The experiments were carried out without pre-treatment and also with treatments like drying, milling and chemical pretreatment by using sodium hydroxide. The results of findings indicated that the floral waste has a good biogas generation. Drying, mechanical pre-treatment and alkaline chemical pre-treatments are essential for biogas generation [99]. [100] studied the potential of biogas generation of different market waste materials in an anaerobic digester to recover a source of renewable energy. The highest methane production of 0.40 L/g of volatile solids is obtained from vegetables, fruits and flowers at 5% total solid contents. Another laboratory experimental investigation was carried out using one litre capacity anaerobic digester using vegetable wastes and flowers of jasmine, sunset flower, Roselle. African wattle, Nile tulip flower and silk tree mimosa was carried out by anaerobic digester. Biogas yielding of floral waste was reported more than the other waste [66]. [66] carried out the anaerobic digestion of floral waste by drying, mechanical and chemical pre-treatment (basic) technique for the generation of biogas. There is urgent need to explore user-friendly and cost-effective techniques for generating biogas from floral waste. However, viable production of biogas is carried out from floral waste.

3.10 Biochar

Biochar is an extremely carbon carbonaceous and soil ameliorant that have elevated marginal area along with micro andmacro-nutrients on the surface. Also, it is a nutrient retaining enhancer and also lessens global climate change [93]. In various fields like industrial and non-industrial, it is used as adsorbents in the form of activated carbon, silica and alumina has been used for several purposes. Globally, activated carbon is used by various researchers for diversity of fields including food and chemical industries, wastewater treatment, solvent recovery, air pollution control, and hydrometallurgy for the recovery of gold and silver due to its regeneration and reusability" [101]. Activated carbon is a non-graphite form of black carbonic substance which is dense, flavorless, and microcrystalline with an absorptive structure [102-103]. Also, it has been considered as an exclusive and universal acknowledged adsorbent because of its excellent surface area, microporous structure, high adsorption capacity, and high degree of surface reactivity [104-106]. The requirement for activated carbon is rising gradually because it has inclusive range of use by means of environmental acquiescence in many countries [107]. However, activated carbon is a purifying material and is an outcome of valuable carbonaceous substances of carbonization process. At the present time, agrarian products and bio-mass can be used as raw materials to produce activated carbon. Usually, Bio-mass is a discarded matter and end-products of industrial activities, and it is a primary source for manufacture of activated carbon. Temple waste flowers are also a kind of bio-mass materials which are low-cost and can be available easily. Eco-friendly bioabsorbents have developed by some researchers by using flower waste for removal of toxic colorants and toxic metals existing in aqueous medium [83] (Fig. 7).

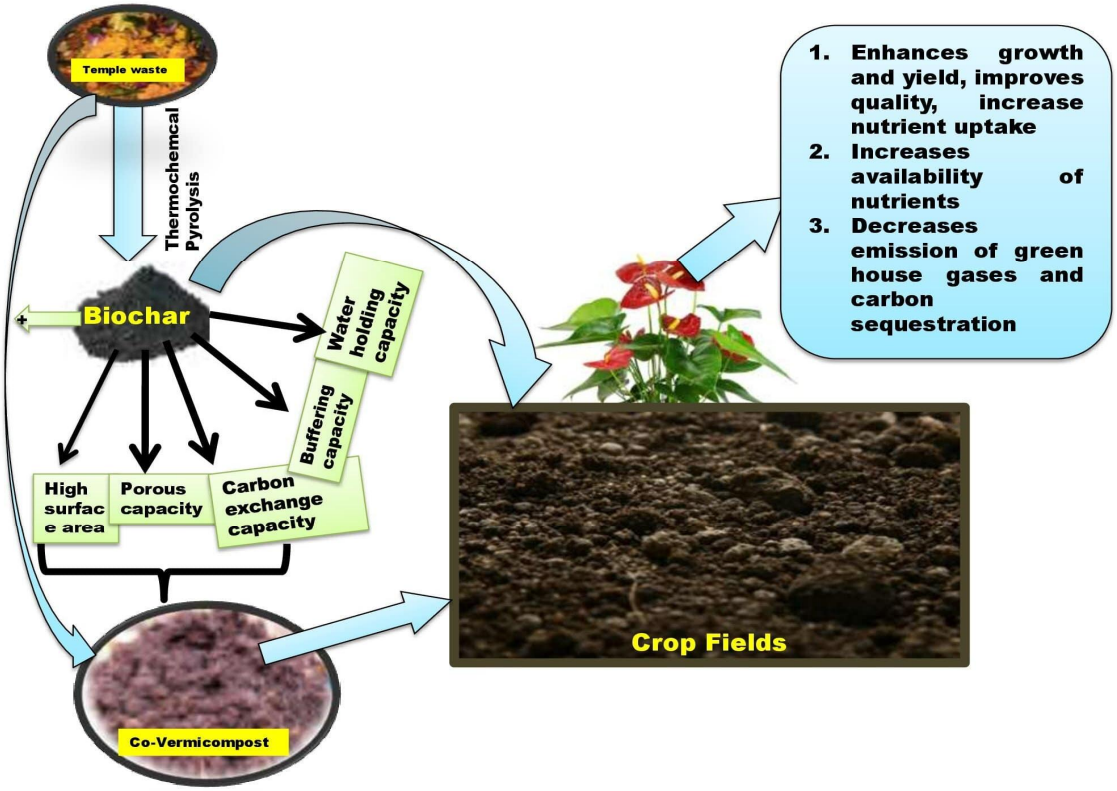

Fig. 7. Effect of biochar prepared from temple waste on agriculture

Coconut shell may be used as base materials for the manufacturing of activated carbon. Therefore, activated carbon was produced from coconut shell by following few steps. Recently, lead which is present in aqueous solution has been removed by using the saffron flower's waste as green bioabsorbent[108]. For the removal of methylene blue dye from aqueous medium, [109] has produced the biochar from the flower wastes. About, 42 percent and 36 percent biochar adsorbents were attained at a temperature of 350ºC and 500ºC, likewise. Therefore, it is practicable to transfer flower waste into biochar by pyrolysis process. Moreover, it can be used as an effectual adsorbent that can eliminate various pollutants including heavy metals, synthetic dye and other organic pollutants from waste water [109] and soil quality improver as well [110]. Previous studies suggested that temple waste flower as an activated carbon can be reused as an eco-friendly alternative to reduce the environmental pollution caused by this floral waste [101].

4. FUTURE PERSPECTIVES

Temple waste is one of the main problems emerging in 21st century. Lots of budget is being allocated for clean missions, green technologies, river cleaning and environmental conservation. In India, Namami Gange mission has been launched by the government to clean holy river Ganga and its tributaries (www.nmcg.nic.in). Scientific management of temple waste can play a significant role in keeping the water channels clean as most of the residue and left out material is thrown in running water cannels. Many solutions have been proposed to recycle/reuse temple waste; however, these solutions and practices are yet to be followed on ground. Except few cases, majority of studies are limited to laboratories, whereas, requirement is to shift the technologies from lab to land. Composting of temple waste with the help of worms, preparation of incense sticks, extraction of pigments are the few options available with temples authorities, however, these also require scientific suggestions for which provisions are yet to be made. Separate budget should be allocated for management of floral waste at site and temple authorities should follow and apply scientific techniques so that nothing should be thrown in rivers and other water bodies.

Management of floral waste is a big challenge in the countries like India where religious ethics and myths may hamper the process. Researchers and environmentalists have lots of things to do on this serious issue right from creating awareness among

poojaris, temple authorities, other bureaucrats and finding more easy methods for recycling temple waste so that it may be managed within the temple premises. Efforts should be made to formulate and manufacture value added products from floral offerings to support the concept of 3R's. Pilot scale studies are to be carried out in large temples and waste collection and recovery/decomposition units should be established under proper guidance of experts.

5. CONCLUSION

Increasing population, urbanization and anthropogenic activities leads to generation of more and more waste. This waste reaches the environment through one or another route. The waste coming from temples is also one of the major contributor of pollution. Therefore, proper management of temple waste and conversion of floral waste into valuable products may prove helpful in protecting the nature that may further lead to sustainable environment.

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COMPETING INTEREST

The authors declare that they have no known competing interests or personal relationships that could have appeared to affect the work reported in this paper.

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