In: Environmental Degradation: Causes and Remediation Strategies
DOI: 10.26832/aesa-2020-edcrs-011

CHAPTER [11]

Management and sustainable energy production using flower waste generated from temples

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ABSTRACT

Temples are considered as the house of deities. As being a part of their culture, people of Hindu religion pay visits to the temple before starting any auspicious occasion to get blessings of their Gods. Out of them, those who are immense believers of God are the daily visitors of temples. As a part of worship, flowers are essentially used. As a result, a huge amount of flower waste is generated from temples worldwide. The majorly offered flowers in temples include rose, marigold, jasmine, *Hibiscus*, etc. The flower waste generated from such activities causes harmful effects to many life forms, therefore, its management has become an emerging issue. As flower waste contains enough nutrient and lignocellulosic material, it can be used for a variety of purposes like bioenergy and biofuel production, compost preparation, conditioner for lawn dressing, eco-friendly incense sticks, soaps, rose water and other food products, etc. To achieve sustainable energy demands, low-cost bioenergy can be generated from floral waste. Energy from flower waste either might be in the form of biogas, biohydrogen, bioethanol, biocharcoal, or direct burning to get heat energy. This book chapter deals with a possible consequence that may arise as a result of improper flower waste disposal along with its possible utilization for low-cost bioenergy production and how waste flowers can be used as potential bioenergy material.

KEYWORDS

Bioenergy, Flower waste, Sustainable energy production, Temple waste

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Introduction

The varied climate of India allows the natural growth of a variety of floral species which are widely used in worshipping places for decoration on various occasions. Various religious rituals are performed in temples in which a variety of items including sweets, leaves, garlands, edible and non-edible fruits, flowers, etc. are offered to Gods (Samadhiya *et al*., 2017). The waste collected from the temple includes biodegradable and non-biodegradable materials out of which flower waste is segregated due to its biodegradable nature. A huge amount of flower waste is generated at religious places like temples, churches, dargahs because flowers are offered to Gods in almost all religions due to the religious beliefs which afterward are discarded (Yadav *et al*., 2015). As compared to kitchen waste management, floral waste lacks proper handling strategies (Jadhav *et al*., 2013). Improper disposal of floral waste in open landfills may result in various health hazards. After a few days of disposal, microorganisms act upon flower waste to degrade it thereby releasing harmful gases. These gases include methane (CH_4), carbon dioxide (CO_2), ammonia (NH_3) and others which create the foul smell and significant contribution to greenhouse emissions (Singh *et al*., 2017). Dumping of flower waste in water bodies results in a threat to aquatic environments. The aquatic organisms including fishes, diatoms, protozoans, molluscans plankton diversity are significantly affected by such waste disposal practices (Mahindrakar, 2018). On the other hand, pesticides and chemical fertilizers being used for flower cultivation alter the pH of water bodies resulting in health loss of aquatic bodies. Rotting flowers trigger algal growth in water bodies resulting in eutrophication on a large scale. Increased organic load of the water body by flower waste disposal may tend to grow harmful weeds and microbes which eventually depleting its oxygen levels (Makhania and Upadhyay, 2015). Besides this, nearby drains and water canals connected to such rivers may also get obstructed by flower waste disposal (Maity and Kumar, 2016). With the increase of the human population, the number of visitors is also increasing which consequentially contributing to the enormous amount of flower waste generated (Samadhiya *et al*., 2017).

To date, most of the holy cities of India including Haridwar, Kedarnath, Katra, Shirdi, Tirupati, Bhubaneswar, Patna, Gaya, Varanasi, etc. have insufficient flower waste disposal policy. Therefore, the management of flower wastes generated in Indian temples has become a cause of environmental pollution (Echavarria-Alvarez and Hormaza-Anaguano, 2014). It is estimated that nearly 40% of flowers from total production remain unsold and wasted in India and Srilanka. Dumping of flower waste on roadsides and open places gives filthy look to an area and distorts the image of an area especially the places that are regarded as important tourist destinations (Waghmode *et al*., 2018). As flower waste may have a significant content of lignocellulose, it may act as a good material to produce bioenergy like biogas, biohydrogen, bioethanol, biocharcoal, or

direct burning to get heat energy. There is a strong need to explore the potential of generated flower wastes from temples and their potential utilization as a feedstock of energy production. Therefore, this book chapter deals with a consequence that may arise as a result of improper flower waste disposal along with its possible utilization for low-cost bioenergy production while addressing how waste flowers can be converted into wealth.

Generation of flower waste in religious places of India

India is a country of festivals with so many festivals celebrated throughout the year. In all religious places, the flowers are offered to devotees which afterward are discarded and becomes waste (Yadav *et al.*, 2015). Most of the festivals involve worshipping to God including Navratri (celebrated twice in a year) in which nine different forms of the Goddess (Durga) are worshipped. Temples are decorated with flowers of different kinds as well as flowers are offered to Goddess Durga at the time of puja (Yadav *et al.*, 2018). As offered flowers to God are considered as sacrosanct so they are not thrown with other waste generated in hotels, markets, etc. as it hurts the religious sentiments, therefore, are disposed in water bodies or left in open places (Barad and Upadhyay, 2016). The quality and quantity of flower waste generated vary from temple to temple. Gods are worshiped with their favorite flowers as mentioned in Vedas. Besides this, the number of flowers offered also varies from days to days. For example, in temples of Lord Shiva, the amount of flower waste generated is more on Monday and Saturday than other days of the week, Shivratri being Hindu festival generates quite a high amount of flower waste as compared to normal weekdays (Dwivedi *et al.*, 2019). Table 1 shows the status of flowers offered in some selected temples of Chennai as reported by (Perumal *et al.*, 2012). There are nearly 2 million temples in India out of which major temples are in most recognized holy cities including, Haridwar, Kedarnath, Katra, Shirdi, Tirupati, Bhubaneswar, Patna, Gaya, Varanasi, etc. (Ramachandara, 2012). Figure 1 shows some famous temples in India.

Composition of flower wastes

The composition of flower waste generated vary from place to place like in Dargahs the flower waste mostly consists of jasmine flowers, in Gurudwaras mainly marigold flowers are used and in case of temples marigold, lotus, rose, etc. (Elango and Govindasamy, 2018). Flower wastes are composed of high lignocellulose, cellulose, crude proteins, crude fibers, essential oils, nitrogen-bearing compounds, etc. Such components of flower waste can be utilized as a stock for bioenergy resources. *Chrysanthemum* flowers are a natural source of flavonoids, volatiles, myricetin and quercitrin (Wu *et al.*, 2010). Jasmine flowers contain essential oils, flavonoids,

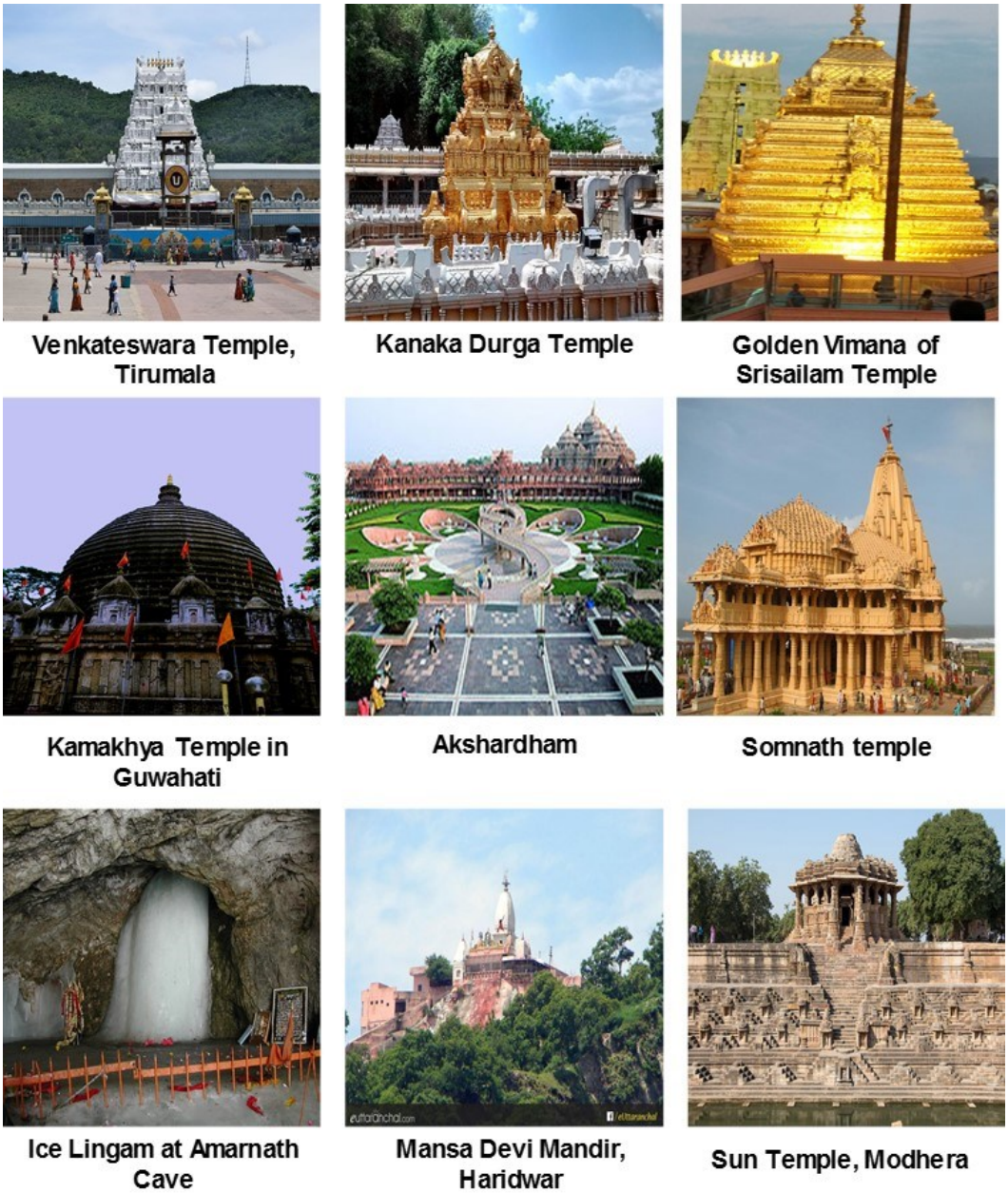

Figure 1. Some famous temples of India.

Table 1. Status of flowers offered in the selected temples of Chennai (Source: Perumal *et al.*, 2012).

Temple	Flowers	Quantity of wasted flowers (kg per day)	Quantity of flowers wasted (kg per day)
Ashtalakshmi, Besantnagar	Jasmine, marigold, rose	1000	200
Marudeeshwar, Thiruvanmiyu	Jasmine, rose, chrysanthemum	950	125
Kabaleeshwar, Mylapore	Rose, marigold, chrysanthemum	2500	800
Murugan, Vadapalani	Jasmine, marigold, rose	1500	400
Sri Parthasarathy, Light House	Rose, marigold, chrysanthemum	1200	400

phenolics, saponins, and steroids (Kunhachan *et al.*, 2012). Rose flowers are rich in riboflavin, sugars, tannins, pectin, mineral salts, salt of tartaric acid (Thakare *et al.*, 2017). *Hibiscus rosa-sinensis* contains essential oils, flavonoids, tannins, quinines, phenols, alkaloids, cardiac, protein, carbohydrates, reducing sugars and steroids (Al-Snafi, 2018). Thiophenes, flavonoids, carotenoids, phenolic compounds, and terpenoids are reported in most of the *Tagetes* species (Gupta and Vasudeva, 2012). Several alkaloids, flavonoids, and non-flavonoid compounds are found in lotus flower (Paudel and Panth, 2015).

Issues in management of flower waste

Management and handling of flower waste become difficult as compared to the kitchen and other municipal waste because religious sentiments of people are attached with the flowers that are offered to God which afterward becomes part of temple waste (Samadhiya *et al.*, 2017). Because of this, few religious places do not allow to even separate flower waste from temple waste and convert into useful products like making compost, etc. (Jadhav *et al.*, 2013). Mostly flower waste is disposed of in water bodies which result in their deterioration. Due to the decomposition of flower waste dissolved oxygen is depleted from water bodies hence, the death of fishes and other aquatic organisms (Mahindrakar, 2018). Besides this, dumping of flower waste causes landfill problems resulting in surface and groundwater contamination. Due to the biodegradable nature of flower waste, it creates a wrong assumption among people that flower waste degrades fast if it is dumped anywhere despite fast decomposition flower waste decomposes very slowly as compared to kitchen waste (Jadhav *et al.*, 2013).

Flower waste and bioenergy

Flower waste can be utilized in several ways to produce bioenergy (Figure 2).

Bioethanol

Bioethanol produced from flower waste can be blended with other fuels which increase its energy efficiency providing an eco-friendly approach of reduced carbon footprint (Waghmode *et al*., 2018). Through, saccharification of the reducing sugars obtained from the flower waste may give a promising yield of bioethanol and methanol. However, the pretreatment of flower waste should be optimized as per the composition of waste generated.

Biogas

Flower waste can also be used as raw material to produce biogas by using anaerobic digestion technology (Lakshmi and Vijayalakshmi, 2017). Methane is a potent greenhouse gas (Singh and Bajpai, 2011), by using flower waste for biogas production, it will help to solve three problems firstly reduced emission of methane in the atmosphere and secondly fulfillment of energy needs and lastly reduced soil pollution from decomposition of flower waste (Rashed and Torii, 2015). The biogas produced from flower waste can be used as a source of heat for cooking purposes or can be used in electricity production (Kulkarni and Ghanegaonkar, 2019). A recent report by Ranjitha *et al*. (2014) showed that flower waste has enormous potential to produce biogas. The amount of produced biogas per kg of the substrate from flower wastes in Kenya as reported by them is given in Table 2. Whereas the composition of biogas produced from flower waste is given in Table 3.

Other uses of flower waste

Other strategies for flower waste management are given below (Figure 2):

Vermicomposting: Being rich in organic matter flower waste can be converted into organic manure by using certain species of earthworm as an alternative to chemical fertilizer. Such ver-

Table 2. Amount of biogas (per kg substrate) produced from flower wastes in Kenya (Source: Ranjitha *et al*., 2014).

Substrate	Biogas (per kg of substrate)
African wattle	10.92
Roselle	5.18
Nile tulip flower	5.38
Silk tree mimosa	23.73
Sunset flower	2.73
Jasmine	6.07

Table 3. Analysis of biogas generation (volume) from flower waste (Source: Singh and Bajpai, 2011).

Months (year)	Methane (%)	Carbon dioxide (%)	Other gases (%)
December (2009)	43	50	7
January (2010)	44	50	6
February (2010)	50	44	6
March (2010)	50	43	7
April (2010)	52	42	6
May (2010)	54	40	6

Table 4. Physico-chemical characteristics of floral waste vermicompost (Source: Jain, 2016).

Parameters	Control (Soil)	Vermicompost (50:50)
Color	Dark Brown	Black
Odor	Odorless	Odorless
Moisture	20.50	22.80
Bulk Density(g/cm3)	0.88	0.89
pH	7.9	7.0
Conductivity (ms cm-1)	3.50	3.35
Organic Carbon	16.5	19.4
Total Nitrogen	0.90	2.0
C/N ratio	20.0	21.55
Total Phosphorus (P_2O_5)	2.57	2.0
Potassium (K_2O)	0.4	0.9
Calcium	4.4	5.9
Magnesium	0.2	0.3
Sulphur	0.40	0.50

micompost may be helpful to provide nutrient-conditioning to the soil (Sharma and Yadav, 2017). Due to the presence of a higher value of nitrogen-phosphorus-potassium in flower degradation material, it can also be used as NPK fertilizer. The microbial consortium can be prepared from flower waste in order to avoid the problems of flower waste generated (Jadhav *et al*., 2013). Table 4 provides characteristics of flower waste vermicompost as analyzed by in study of Jain (2016).

Food products: Edible waste flowers such as roses and marigolds are rich in nutrient, therefore, can be used for making syrups, cakes, ice creams, cookies, jellies, jams, sweets, beverages, etc. by food industries (Waghmode *et al*., 2018).

Biochar: The woody part of flower waste can be converted into biochar through the process of slow pyrolysis (Bogale, 2017). Biochar can be further used as a material for absorption or adsorption of heavy metals and other harmful substances resulting in purification of wastewater (Waghmode *et al*., 2018).

Table 5. Composition of essential oil of Rosa damascene obtained from GC-MS analysis (Source: Perumal *et al*., 2012).

Peak area (%)	Components	Retention time (sec)
0.07	Benzaldehyde	3.189
27.19	Phenyl ethyl alcohol	4.775
0.15	Tetradecanol	5.394
1.44	Propanamide	5.452
0.01	Phenyl ethyl ester	5.703
3.12	Thiophene carboxylic ester	6.457
0.23	methyl 4-pentanyl acetyl ester	7.733
0.19	Hexadecanol	8.11
0.29	Ethyl amino 1- butyl cyclohexa benzene	9.091
0.08	Bromo propionate	9.097
0.55	2-2-dimethyl phenyl ethyl ester	10.595
0.19	Tricosene	11.243
0.36	Heptyle 2-phenyl ethyl ester	12.316
0.27	Isohexyl ester	12.452
0.10	8-methyl heptacosane	13.099
0.21	Eicosane	14.801
0.14	Pentatriacontene	16.068
3.17	Nonadecene	16.209
7.76	Hexadecane	16.744
0.72	Benzene propaonic ester	17.402
0.09	Eicosene	18.098
1.11	Phenyl Dodecanoic ester	18.562
0.17	Di phenyl ethyl ester	19.703
0.20	Octadecyl tri chloro ethyl ester	19.887
0.35	Heneicosanol	20.167
0.21	Chloropropronic ester	20.235
10.49	Heneicosane	20.316
0.11	Hexadecyleste	21.995
0.27	2Propyl tridecyl ester	22.682
0.54	Dodecanoic ester	23.29
1.15	Tricosane	23.629
1.89	Tetratetracontene	23.764
0.48	Cyclobutyl pentadecyl ester	25.379
0.21	Pentadecyl 2-phenyle ethyle tridecyle ester	26.655
3.03	Pentatriacontene	26.752
2.73	Chloropropionic ester	26.848
0.15	Benzene dicarboxylic ester	26.955
3.45	Tetra methyl trisilocendecanol	27.602

Table 5. continued...

0.23	Dimethyle benzaldehyde thiocarbamoyl hydrazon	27.718
0.70	Pthalic diphenyl ester	28.037
0.31	Hexacosane	28.124
0.19	Dibromoecosane	28.18
0.48	Octadecyle ester	28.88
0.39	Cyclotrisiloxane	29.495
0.22	Benzamine	29.536
0.39	Methoxyethyl ester	29.594
0.84	Hexadecane-l-ol acetate	29.72
0.61	Cyclobutane	30.068
0.44	Nonacosane	30.909
0.70	Cyclohexadiene	30.977
0.32	Trimethyl silyl ester	31.073
5.77	Phenyl ethyl tetradecyl ester	31.275
0.52	Thiophene	31.85
0.32	Hexadecyl 2-phenylethyl ester	32.6

Essential oil extraction: In India, around 300,000 metric tons of flowers are being utilized for various purposes like making garlands, decorations, pigments extraction, insecticides, and perfume ingredients. The flowers offered to deities are available as temple flower waste among which rose was found to be 50% so can be used for extraction of essential oils (Perumal *et al*., 2012). About 300 compounds are present in rose oil. Perumal *et al*. (2012) studied the composition of essential oil in *Rosa damascene* (Table 5).

Dye extraction: Colored pigments present in flowers give them characteristic color which attracts the eyes of the viewer. The pigments from colored flowers are extracted to further used in a variety of purposes like:

- For dyeing fabrics in the textile industry.
- Making colored candles.
- Food industry for making eggs, vegetables, etc. colored.
- Making colors in powdered form by using solar drier for drying flowers which can be used as Holi and Rangoli colors, being purely organic is safe to use (Kumar *et al*., 2016).

Medicinal uses: Some flowers from temple flower waste such as marigold, *Hibiscus rosa sinensis* have medicinal properties so can be utilized for the medicinal purpose that is mostly taken in the form of decoction (Voon *et al*., 2011).

***Essence*:** Essence can be extracted from flowers. These are kind of infusions made from flowers by boiling them, there is no physical part of the flower. Flower essence has wide utility it can be used in beauty products, shampoos, lotions, aromatherapy, etc. (Ali *et al*., 2015).

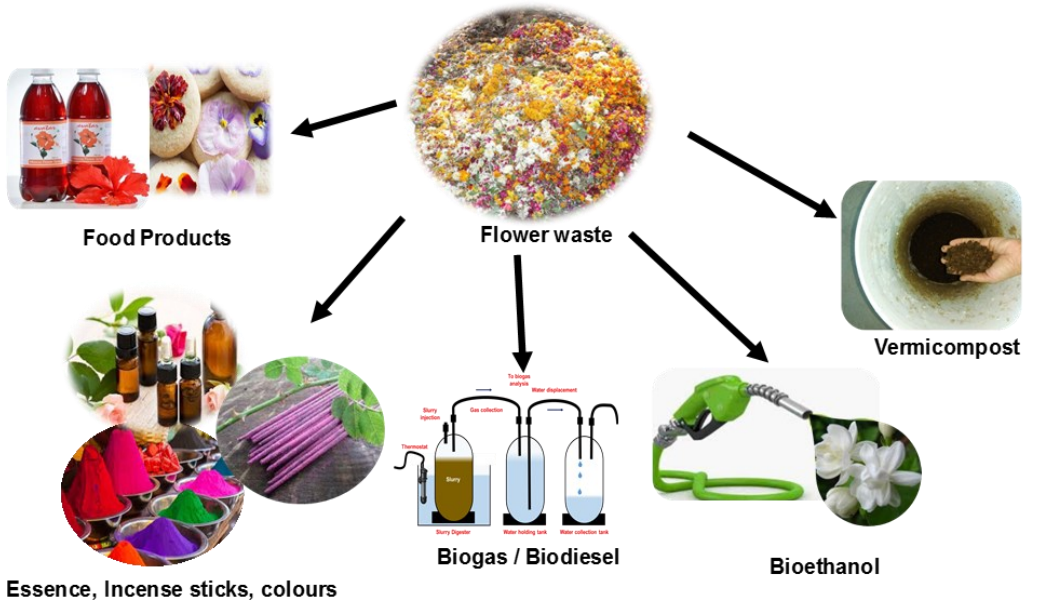

Figure 2. Use of flower waste feedstock as a resource for production of bioenergy and other useful materials.

Miscellaneous uses: Incense stick making and handmade paper production are being carried out by using waste flowers moreover dry flowers can be used for various art and craft activities. Some flowers can also be used as veterinary feed. Nowadays activated carbon is being prepared from temple flower waste which has a wide range of utility due to its adsorption properties (Elango and Govindasamy, 2018).

Conclusion and recommendations

This chapter deals with the problems of flower waste generated at religious places. Improper handling and disposal of flower waste cause serious problems affecting the soil, water and air quality of the nearby environment. However, flower waste is a good source of lignocellulose and organic matter, therefore, it can be used as a potential resource for bioenergy production and other useful products. By using flower waste, a significant amount of bioenergy can be produced, which may serve a dual purpose by helping in reducing the environmental problems and giving us eco-friendly energy at a low cost. Besides bioenergy production, many other compounds can also be extracted from flower waste which has great demand by industrial sectors. Thus, this book chapter emphasized on the utilization of flower waste generated from temples as a potential

resource for bioenergy production to meet future goals of sustainable energy production.

Acknowledgments

This work was academically supported by the Department of Zoology and Environmental Science, Gurukula Kangri Vishwavidyalaya, Haridwar, India. The Corresponding author (S.K) is grateful to her lab mates for their support and guidance at each step.

References

Ali, B., Wabel, A.A.N., Shams, S., Ahamad, A., Khan, S. A. and Anwar, F. (2015). Essential oils used in aromatherapy: A systemic review. *Asian Pacific Journal of Tropical Biomedicine,* 5(8): 1-11, https://doi.org/10.1016/j.apjtb.2015.05.007

Al-Snafi, A.E. (2018). Chemical constituents, pharmacological effects and therapeutic importance of *Hibiscus rosa-sinensis*- A review. *IOSR Journal of Pharmacy*, 8(7): 1-5.

Barad, G. and Upadhyay, A. (2016). Degradation of flower wastes: A review. *International Journal for Scientific Research & Development*, 4(4): 1-2.

Bogale, W. (2017). Preparation of charcoal using flower waste. *Journal of Power and Energy Engineering*, 5: 1-10, https://doi.org/10.4236/jpee.2017.52001

Dwivedi, A., Dubey, R.P.K., Singh, P.K. and Ohri, A. (2019). Scientific management of municipal solid waste in an academic campus – A case study of IIT(BHU). *Journal of Materials and Environmental Sciences*, 10(10): 1-9.

Echavarria-Alvarez, A.M. and Hormaza-Anaguano, A. (2014). Flower wastes as a low-cost adsorbent for the removal of acid blue 9. *Dyna*, 81(185): 1-7, https://doi.org/10.15446/dyna.v81n185.37234

Elango, G. and Govindasamy, R. (2018). Analysis and utilization of temple waste flowers in Coimbatore District. *Environmental Science and Pollution Research*, 25(11): 1- 7, https://doi.org/10.1007/s11356-018-1259-0

Gupta, P. and Vasudeva, N. (2012). Marigold -A potential ornamental plant drug. *Hamdard Medicus*, 55(1): 1-15. *International Journal of Engineering Technology Science and Research*, 2: 1-6.

Jadhav, A.R., Chitanand, M.P. and Shete, H.G. (2013). Flower waste degradation using microbial consortium. *IOSR Journal of Agriculture and Veterinary Science*, 3(5): 1-63.

Jain, N. (2016). Waste management of temple floral offerings by vermicomposting and its effect on soil and plant growth. *International Journal of Environmental & Agriculture Research*, 2(7): 1-6.

Kulkarni, M.B. and Ghanegaonkar, P.M. (2019). Methane enrichment of biogas produced from floral waste: A potential energy source for rural India. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 41(22): 1-12.

Kumar, P., Sachan, A.K. and Rawat, A. (2016). Utilization of temple flower waste in Varanasi for the generation of economic resources. *Journal of Environmental Sciences and Engineering*, 1(3): 1-8.

Kunhachan, P., Banchonglikitkul, C., Kajsongkram, T., Khayungarnnawee, A. and Wichet Leelamanit, W. (2012). Chemical composition, toxicity and vasodilatation effect of the flowers extract of *Jasminum sambac*. Hindawi Publishing Corporation, pp. 1-7, https://doi.org/10.1155/2012/471312

Lakshmi, C. and Vijayalakshmi, S. (2017). Studies on biogas production using withered flowers as a substrate. *Research Journal of Pharmacy and Technology*, 10(12): 1-4, https://doi.org/10.5958/0974-360X.2017.00773.9

Mahindrakar, A. (2018). Floral waste utilization. *International Journal of Pure and Applied Bioscience*, 6(2): 1-5.

Maity and Kumar P. (2016). Impact of waste flower on environment. *International Journal for Research in Applied Science & Engineering Technology*, 4(8): 1-2.

Makhania, M. and Upadhyay, A. (2015). Study of flower waste composting to generate organic nutrients. *International Journal of Innovative and Emerging Research in Engineering*, 2(2): 1-5.

Paudel, K.R. and Panth, N. (2015). Phytochemical profile and biological activity of *Nelumbo nucifera*. Hindawi, pp. 1-16.

Perumal, K., Sambanda, T. and Savitha, J. (2012). Characterization of essential oil from offered temple flower *Rosa damascena* mill. *Asian Journal of Experimental Biology and Science,* 3: 1-5.

Ramachandara, S.K. (2012). Vastu-Silpa Kosha, Encyclopedia of Hindu Temple architecture and Vastu by S.K. Ramachandara Rao (Ed.), Delhi, Devine Books, (Lala Murari Lal Chharia Oriental series), Volume 3, pp. 485.

Ranjitha, J., Vijayalakshmi, S.,Vijayakumar, P. and Ralph, N.(2014). Production of biogas from flowers and vegetable wastes using anaerobic digestion. *International Journal of Research in Engineering and Technology*, 3: 1-5.

Rashed, M. and Torii, S. (2015). Removal of hydrogen sulfide (H_2S) from biogas using zero-valent iron. *Journal of Clean Energy Technol*ogy 3(6): 1-5, https://doi.org/10.7763/jocet.2015.v3.236

Samadhiya, H., Gupta, R.B. and Agrawal, O.P. (2017). Disposal and management of temple waste: Current status and possibility of vermicomposting. *International Journal of Advanced Research and Development*, 2(4): 1-8.

Sharma, D. and Yadav, K. D. (2016). Bioconversion of flowers waste: Composing using dry leaves as bulking agent. *Environmental Engineering Research*, 22(3): 1-8, https://doi.org/10.4491/eer.2016.126

Singh, P. and Bajpai, U. (2011). Anaerobic digestion of flower waste for methane production: An alternative energy source. *Environmental Progress & Sustainable Energy*, 1-5, https://doi.org/10.1002/ep.10589

Thakare, P.A., Deshbhratar, K. and Suryawanshi, M.N. (2017). A brief review on therapeutic effects of – "ornamental plant" rose. *International Journal of Ayurveda and Pharma Research*, 5(12): 1-7.

Voon, H.C., Bhat, R. and Rusul, G. (2011). Flower extracts and their essential oils as potential antimicrobial agents for food uses and pharmaceutical applications. *Comprehensive Reviews in Food Science and Food Safety*, 11(1): 1-22, https://doi.org/10.1111/j.1541-4337.2011.00169.x

Waghmode, M.S., Gunjal, A.B., Nawani, N.N. and Patil, N.N. (2018). Management of floral waste by conversion to value-added products and their other applications. *Springer,* 9(1): 1-11, https://doi.org/10.1007/s12649-016-9763-2

Wu, L.Y., Gao, H.Z., Wang, X.L., Ye, J.H., Lu, J.L. and Liang, Y.R. (2010). Analysis of chemical composition of *Chrysanthemum indicum* flowers by GC/MS and HPLC. *Journal of Medicinal Plants Research*, 4(5): 1-6.

Yadav, I., Juneja, S.K. and Chauhan, S. (2015). Temple waste utilization and management. *International Journal of Engineering Technology Science and Research*, 2: 1-6.

Yadav, I., Singh, S., Juneja, S.K. and Chauhan, S. (2018). Quantification of the temple waste of Jaipur city. Recent Trends in Agriculture, Food Science, Forestry, Horticulture, Aquaculture, Animal Sciences, Biodiversity, Ecological Sciences and Climate Change, pp. 1-3.

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Cite this chapter as: Kumar, V., Kumari, S. and Kumar, P. (2020). Management and sustainable energy production using flower waste generated from temples. In: Environmental Degradation: Causes and Remediation Strategies, Volume 1, Eds. Kumar, V., Singh, J. and Kumar, P., pp. 154-165, https://doi.org/10.26832/aesa-2020-edcrs-011