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## CONVERSION OF TEMPLE FLOWER WASTE INTO VALUE ADDED PRODUCT FOR SUSTAINABLE UTILIZATION – A REVIEW

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### ABSTRACT

India is a country with many distinct religions, where devotion is a way of life and people make numerous offerings to the gods, among which floral offerings are widespread. Because the flowers were given as an offering, they are not disposed of in usual manner. Instead, they are dumped in rivers or near forests, causing environmental issues. After serving their purpose, flowers, like other waste, end up in the garbage or are thrown into rivers, seas, or oceans, generating a variety of environmental hazards. Floral waste may be appropriately managed and turned into a variety of environmental issues. This waste may be appropriately managed and turned into various value-added products. Techniques like vermicomposting, composting, dye extraction, essential oil extraction, Holi colour preparation and biogas generation can be employed for a variety of purposes. Essential oils derived from discarded aromatic blossoms such as champak, roses, jasmines and others are in high demand for fragrances, toiletries, cosmetics and incense sticks. This not only allows for disposal, but it also helps in the production of useful items such as manure, natural dye, incense sticks, handcrafted paper and biogas. Floral dyes are used in the production of cosmetics because

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they are non-toxic, non-allergenic and non-carcinogenic. This review focuses on how floral waste collected from various temples can be utilized to produce useful products.

**Keywords: Floral waste, Vermicomposting, Essential oil extraction, Dyes, Fragrances, Cosmetics and Incense sticks**

## INTRODUCTION

The most debatable issue in the globalized field of research is waste management, a tendency that favours results [1]. Indian cities and towns, like those in other developing countries, are pressured by the environmental costs of solid waste management [2]. Overpopulation, urbanization, and land scarcity are just a few of the factors that are responsible for solid waste pileup. While domestic, organic, temple, and agricultural wastes such as rotten fruits, peels from vegetable processing, flower trimming, farm leftovers, and so on are biodegradable, their breakdown and nutrient leaching pose serious threat such as water and land pollution [1]. Floral waste is produced by a variety of causes, including temple waste, wedding ceremonies, hotels, and other cultural and religious ceremonies [3]. Because the flowers were given as an offering, they become sacred and that is the reason many people hesitate to throw them away. For hundreds of years the only method of disposing of these symbols of devotion has been to throw them into sacred bodies of water like the Ganges. Throwing flowers in oceans, rivers and other bodies of water pollutes the water and

harms the living organisms present that are present in them. The toxic pesticides and insecticides present on flowers gets washed away into the water which can cause a havoc in the sensitive ecosphere. Some flower merchants dump flower wastes in the street which might lead to outbreak of severe endemic diseases as the garbage attracts pests [4]. The situation worsens during the rainy season, when mosquitoes and flies breed on the trash. There is also a severe issue with the production of leachate from flower waste, which, when mixed with river or well water can cause various health problems [5]. When compared to kitchen waste breakdown, flower waste breakdown is a very slow process [6]. Therefore appropriate management and utilization of floral waste is very important for an environment friendly lifestyle. The harmful effects caused by disposing flower waste into water bodies can be mitigated by using these flowers to make beneficial products. Like using synthetic dyes in textile industry or festivals like holi can be very dangerous because they contain carcinogenic and allergic agents which may cause skin and eye irritations. Therefore flowers collected from temples can be

utilized to make natural dyes. In the same way we can use the floral waste to produce beneficial items like: vermicompost from the waste produced in the temple; using rose to make rose water; incense sticks, and essential oils can be extracted from these

flowers. Therefore this review paper highlights various methods that can be used to convert floral waste to riches. Different applications from temple flower waste is illustrated below in **Figure 1**.

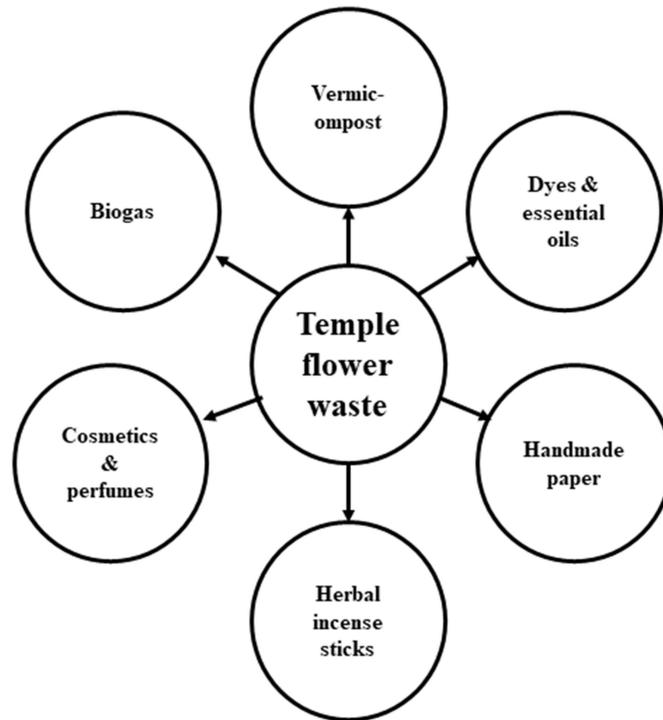


Figure 1: Various applications from temple flower waste

### Vermicomposting of flower waste

Vermicomposting is consistent with environmentally-sound principles that value resource preservation and sustainable practices, making it a viable option for the safe, clean, and cost-effective disposal of organic wastes [7]. Vermicompost is a superior soil additive formed from compost decomposed by earthworms [8]. It promotes soil fertility by containing nutrients such as phosphorus, nitrogen,

carbon, copper, iron, manganese, zinc, and other enzymes and plant growth hormones such as giberellins, auxins and cytokinins, as well as decreasing organic carbon, C/N ratio, and pH levels in the soil [9]. It acts as an excellent soil conditioner and nutrient rich organic fertilizer. The major benefit of vermicomposting is that it is an environmentally friendly solution, because it boosts plant growth, increases water retention and aeration capacity of soil and

also increases porosity and microbial activity in soil [10]. Kohli and Hussain (2016) combined 5 kg of floral waste and cow dung to make 2.75 kg of vermicompost. Earthworms were put in partially digested material with a moisture content of 60% in alternating thick layers of farm waste flower waste and cow dung. The C/N ratio of the resulting vermicompost was greater [11]. The pH

and temperature of temple waste and cow dung plays an important role in vermicomposting [12]. Kumar *et al* (2021) stated that *Trichoderma* plays a significant role in decomposition by promoting enzyme activity, which increases the pace of decomposition [13]. The following flow diagram depicts vermicompost production from flower waste (**Figure 2**).

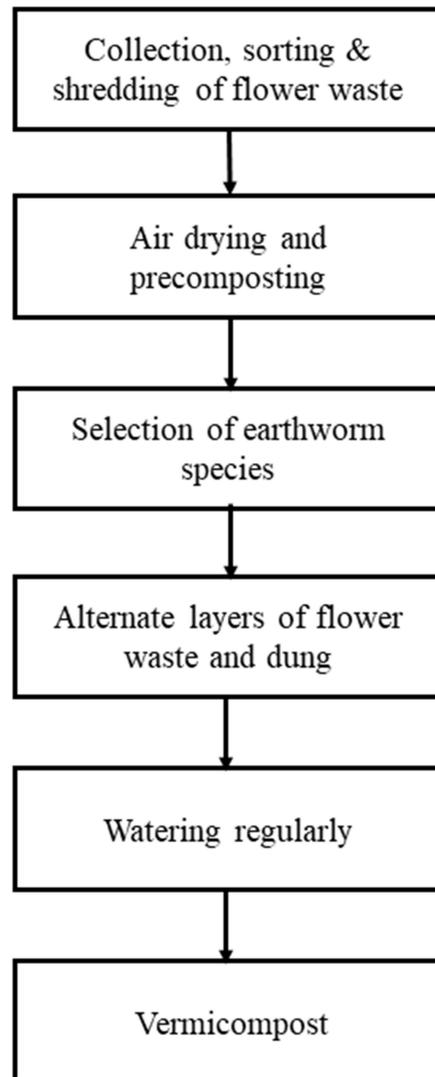


Figure 2: The production of vermicompost from flower waste [5]

### Extraction of dyes and essential oils

The floral waste collected from various temples can be used for extraction of dyes, which are mainly utilized in textile industries for dyeing cotton, silk, wool and many other fabrics. Marigold flowers, which are a major source of carotenoid-leutin and flavonoid-patulinin, two colourants that have been extracted and used for dyeing, are mostly found in temple waste [1]. They come in various colours between yellow to orange red. Yadav *et al* (2019) has reported that use of different mordants showed many variations in dye colour. They used the yellow extract obtained from marigold flowers for dyeing and fixed the dye with different mordants such as ferrous sulfate, copper sulfate, potassium dichromate and stannous chloride [14]. Lachguer *et al* (2021) showed that saffron flower extract (SFE) has good thermal and pH stability and under acidic conditions it would be suitable for textile dyeing. They produced a range of colours from brown to green were obtained [15]. The pigment in safflower petals is roughly 30% yellow and 0.83 percent red. These pigments are commonly employed as stains, beverage and cosmetic additives, printing, dyeing and natural food colourants [16]. Singh *et al* (2016)

suggested that after colour extraction, the waste generated is a possible source for vermicomposting and can potentially be used as a fertilizer in agriculture which shows dual benefit from floral waste [1]. Marigold, rose, jasmine, chrysanthemum, hibiscus, and other flowers are commonly offered in temples. Extraction of essential oils from these flowers can have many applications. To extract food-grade essential oils, traditional processes like steam distillation and solvent expression are most typically utilized [17]. Essential oil derived from marigold flowers have antibacterial properties and can also act as an effective antioxidant. While jasmine oils can be used as food grade chemical solvents and in perfumery. Rose flowers can be used to extract essential oils and rose water. For millennia, people have utilized rose essential oil for a variety of reasons all around the world. Oktavianawati *et al* (2019) extracted essential oil from rose flowers by distillation and enfleurage. Their results suggests that enfleurage is a better method for obtaining high quality rose oil than distillation [18]. The process of dye extraction in explained with the help of flow chart shown in **Figure 3**.

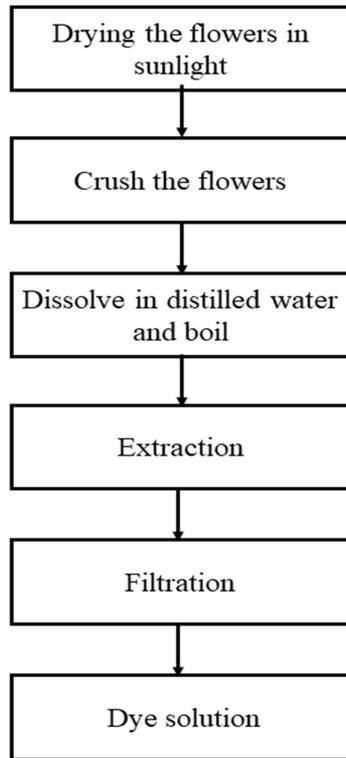


Figure 3: Process of dye extraction from flowers [19]

### Handmade paper production

Paper is one of the most extensively used products in our daily lives. Paper manufacture consumes 40 percent of all commercially cut timber on planet. The pulp and paper production is a major contributors of deforestation and is partly to blame for the extinction of some forest-dwelling wildlife. When chemicals used in paper manufacturing, such as dyes, inks, and bleach are discharged into the water supplies and neighbouring land after usage, they can be toxic to the environment. The pulp and paper industry consumes a large amount of water [20]. Temple flower waste can be used as a renewable source of raw

material for handmade paper production [21]. Handmade paper manufactured from floral waste does have the advantage of being completely free of wood, chemicals, and toxic by-products. These papers made from flowers can also be used to make lamps and lanterns which can be sold in tourist places as souvenirs [22]. In this way one can not only reduce solid waste from temples but also implement reuse, reduce and recycle by making handmade papers out of the waste [19]. The flow diagram representing the process of making handmade paper from flowers is shown in **Figure 4**.

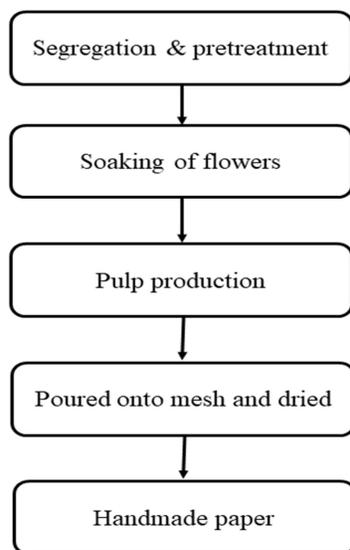


Figure 4: Paper production from flowers

### Non-toxic incense sticks

The incense sticks are used by millions of Hindus, Buddhists, and Christians to purify and freshen the air, as well as being an important part of their religious ceremonies. Generally, three or more sticks of incense are burned at the same time. When incense is burned, particulate matter (PM), gas products, and other organic compounds are released in the form of smoke. According to the EPA, incense smoke contains particulates that have been related to asthma, lung irritation, and even cancer. Incense burning also releases volatile organic chemicals like benzene, toluene, and xylenes, as well as aldehydes and polycyclic aromatic hydrocarbons (PAHs). Incense smoke contains a lot of particulate matter, which is a mixture of solid particles and liquid droplets

suspended in air [23]. Fine particles settle more efficiently in the lungs and extrapulmonary organs, thereby initiating inflammatory interactions with biological cells [24]. Furthermore, the enormous surface area per unit mass of these small particles makes them an ideal carrier for hazardous inorganic and organic substances, enhancing their toxicity [25]. Therefore, incense burning in enclosed spaces is a major public health concern [26]. Methods have been developed to make non-toxic incense sticks using flower waste as raw material. Incense sticks are made from flowers like Genda [5]. Saoji *et al* (2021) prepared incense sticks from Marigold flowers which were collected from Nasik during Navaratri festival [27]. The below figure explains the process of incense making as shown in **Figure 5**.

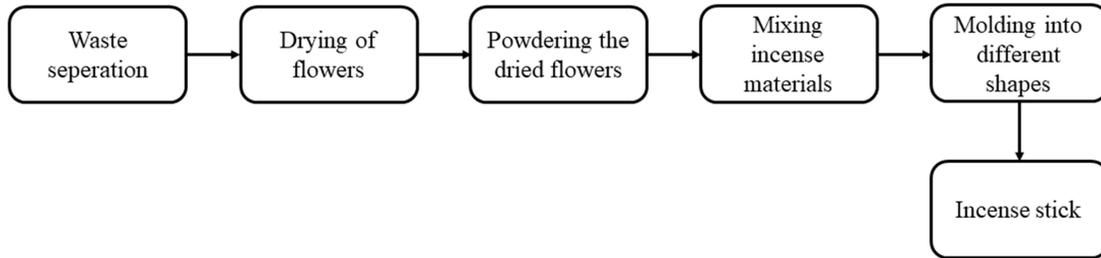


Figure 5: The process of making non-toxic incense sticks [28]

### Anaerobic digestion of flower waste: Biogas

The mixture of CO<sub>2</sub> and the combustible gas CH<sub>4</sub> produced by bacterial decomposition of organic materials under anaerobic conditions is known as biogas. It is a renewable fuel made from the decomposition of organic matter like kitchen waste and animal manure. Biogas can be used for a multitude of purposes, including vehicle fuel, heating, and energy production. The biogas production process takes place in a biogas plant, which is a technical facility consisting of anaerobic digesters. Anaerobic digestion is an innovative and efficient technique that combines biofuel production and sustainable waste management, according to some research [29]. Low-cost bioenergy can be generated from floral waste to meet long-term energy demands [30]. Singh and Bajpai (2011) made an experimental setup to produce biogas from flower waste with the help of gas chromatographer. Their process has been proved to be effective in reducing the pollution potential of flower waste. They produced biogas containing

methane content of 50% from flower waste collected in temples of Lucknow [31]. Various strategies, such as novel alkaline pre-treatment, solar digester heating, and co-digestion with food waste, result in increased biogas production from floral waste [29]. The use of floral waste in biogas production is beneficial since flowers provide a higher yield of biogas at a faster rate [5].

### Holi colours

Holi, often known as the “Celebration of Colours,” is a popular ancient Indian festival. People play with colours with their friends and relatives on the day of Holi. Traditional Holi colours for Gulal included spring flowers, berries, spices, and other plants, while wet colours included hibiscus flowers for red, henna for green, and turmeric powder for yellow. Recently, cheap artificial bright and vibrant Holi colours have begun to appear in markets, which contain chemical solvents and harmful chemicals such as metal oxides, acids, mica, glass powder, silica, asbestos, and chalk [32]. Mica dust is frequently used as a sparkling element in dry powders, but

it can cause many skin microtraumas and infection susceptibility [33]. PM10 particles are present in Holi colours which can cause pro-inflammatory responses [34]. Garg *et al* (2019) showed that these synthetic colours cause ocular toxicity involving surface epithelium and the superficial stroma. They observed that conjunctival tear, cornea epithelial defect, stromal haze, etc were mostly reported injuries in holi festival [35]. Roy *et al* (2019) with the help of people facing mental health challenges made natural holi colours from discarded flowers [36].

Colours were produced from waste flowers from local flower markets by the Chemical Engineering Department of Jadavpur, University in Kolkata in collaboration with ‘Moromi,’ an NGO. For extraction of colourful dyes, they employed common flowers such as marigold, china rose, butterfly pea, and others [37]. Thus, using flower waste to produce natural Holi colours helps in keeping the environment clean and safe. The following is the list of flowers that can be used for extraction of various Holi colours shown in **Table 1**.

**Table 1: Flowers that can be used to make different Holi colours [32]**

Colour	Name of the flower
Red	Hibiscus
Orange	Orange marigold
Blue	Indigo flower & Hayacinth flower
Yellow	Yellow marigold
Pink/Violet	Pink flower of kanchan

### **Flowers as raw material for perfume production**

Perfume is a fragrant product made by skilfully combining specific odoriferous components in the right amounts. The name comes from the Latin word *per fumum*, which means “through smoke”. Perfumes were used in some of the earliest human civilizations, according to ancient literature and archaeological findings. Many natural and synthetic ingredients have been used to manufacture perfumes for use on skin and clothing, in cleaning and cosmetics, and in

the air. These natural odorants require the use of a variety of extraction procedures to extract the aromatics from the raw materials. Essential oils are the product of the extraction. Each essential oil is supposed to have three notes based on its volatility, or velocity of diffusion into the air [38]. The three notes are namely, Top notes which are extremely volatile and should only last a few minutes; Middle notes indicate the perfume’s body, which is noticeable several hours after application; Base notes have the lowest volatility and

last for almost 8 hours after application, they also serve as perfume fixatives by lowering the volatility of the top and middle notes [39]. Cold expression, solvent extraction, enfleurage, and steam distillation are the main processes used to extract these oils from various plant sources [17]. Using flower waste from temples to make perfumes is a great step towards reducing solid waste pollution. Waithaka *et al* (2016) performed an experiment in which it was proved that flowers higher yields of essential oils compared to leaves. They also showed that, a mixture of methanol and formaldehyde gave the highest quality of perfumes [40]. Though perfumes are used to provide a pleasant odour, certain odorants also have antibacterial characteristics or other secondary benefits, such as insect repellent activity [41].

## CONCLUSION

This study offers a unique way for temple waste management. The review discusses how floral waste is managed by using it to create various applications like vermicompost, biogas, dyes, incense sticks, handmade paper, perfumes, and so on. This also suggests that temple waste could not only be safely disposed of in an environmentally appropriate manner but could also be used to make a variety of products. The beneficial products obtained from flower waste namely, vermicompost

which acts like as excellent soil conditioner and nutrient rich organic fertilizer; dyes which are mainly utilized in textile industries and the use of natural dyes reduces skin rashes; paper from flower waste would eradicate deforestation, global warming would be managed, and loss of habitat for wild animals would be limited, resulting in the conservation of wild animals. The biofuels and bioethanol obtained from temple waste have potential to alleviate the energy crisis. The waste can thus become riches. More research into the conversion of waste flowers into riches is needed. It will shed light on how to reduce the volume of temple waste, which would eventually result in increased revenue for temples. As a result, temple administrators, pilgrims, and waste handlers should be made aware of the need to embrace such unique ideas to reduce temple waste to achieve a clean environment and self-sufficiency.

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