

Recycling Temple Waste into Organic Incense as Temple Environment Preservation in Bali Island

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ABSTRAK

Kegiatan upacara di tempat suci pura di Pulau Bali rata-rata menghasilkan sampah sekitar 2000 L/hari. Sebagai bagian yang sangat penting dari budaya Bali, sesajen yang terdiri dari bunga, daun, buah-buahan dan bambu disajikan di setiap upacara keagamaan. Pembuangan sampah pura yang tidak tepat berpotensi menimbulkan gangguan pada kehidupan manusia dan lingkungan, seperti air dan sanitasi, penumpukan sampah, peningkatan tingkat pencemaran, dan kesehatan manusia. Penelitian ini bertujuan untuk mendaur ulang sampah pura, khususnya sisa bunga menjadi dupa organik serta mengkaji alternatif lain dalam daur ulang sampah pura. Daur ulang sisa bunga menjadi dupa organik dilakukan dengan menggunakan tiga bahan campuran. Kajian literatur digunakan untuk menambah informasi alternatif daur ulang sampah pura dari penelitian sebelumnya. Hasil eksperimen menunjukkan bahwa sampah sisa bunga dapat didaur ulang menjadi dupa organik. Rasio campuran 1:2 untuk sisa bunga dan bubuk esensial memberikan hasil terbaik. Dupa organik yang terbentuk sangat kuat dan padat. Selain itu, aroma campuran yang dihasilkan lebih baik di antara yang lain. Sampah pura juga dapat didaur ulang menjadi beberapa produk berharga, seperti kompos, ekstrak warna minyak atsiri, bubuk warna, atau biogas. Diestimasi sebuah pura menghasilkan sekitar 200 kilogram sampah pura dalam satu hari upacara. Sekitar 40% dari sampah pura merupakan sisa bunga (berat basah) dengan kadar air sekitar 80%. Setelah melalui proses pengeringan, sisa bunga mencapai 16 kilogram. Diperkirakan sekitar 45 ton sampah pura dari 230 pura publik di Pulau Bali dapat didaur ulang setiap tahun melalui upaya daur ulang. Beberapa dampak yang ditimbulkan dari upaya daur ulang ini, seperti mengurangi sampah pura, menciptakan produk daur ulang yang dapat dipasarkan, dan meningkatkan keharmonisan antara budaya, lingkungan, dan masyarakat melalui pemberdayaan masyarakat.

Kata kunci: Upacara, dupa organik, daur ulang, sampah pura

ABSTRACT

Ceremonial's activities in Bali's Temple have produced about 2000 L/day of waste in average. As an integral part of Balinese culture, devotion offerings which consists of flowers, leaves, fruits and bamboo are presented at every ceremony. The improper disposal of temple waste potentially causes a stress on the basic services in human life, such as water and sanitation, waste accumulation, raising the level of pollution, and human health. The present study aims to leverage of temple waste, especially discarded flower into organic incense through recycling and find out the foreseen impact of this initiative to the environment. Processing discarded flower into organic incense was conducted in this research with three material mixtures ratio. A literature review was added to enhance the alternatives of discarded flowers recycling on previous research. It is found that discarded flower was successfully recycled into organic incense. The preliminary experiments showed that the ratio of 1:2 for discarded flowers and essential powder gave the best results. The incenses were very strong formed and solid. Additionally, the smell of best mixture was the best among others. Besides, temple waste can be recycled to some valuable products, such as vermicompost, dyes extraction, essential oil, color powder, or biogas. It assumed that a temple has produced around 200 kilograms of temple waste during a ceremonial day. About 40% of those was discarded flowers (wet weight) that 80% contains water. After the drying process, it has left 16 kilograms of dried discarded flowers. It estimated around 45 tons of discarded flowers from 230 public temples around Bali could be recycled every year through this recycling effort. Some impacts come up with following this initiative, such as reducing the temple waste, creating a marketable recycling product, and build up a harmony between the cultural, environment, and society through community empowerment.

Keywords: Ceremonial, Organic incense, Recycling, Temple waste

Citation: Wijaya, I. M. W., Ranwella, K. B. I. S., Revollo, E. M., Widhiasih, L. K. S., Putra, P. E. D., Junanta, P. P. (Tahun). Recycling Temple Waste into Organic Incense as Temple Environment Preservation in Bali Island. *Jurnal Ilmu Lingkungan*, 19(2), 365-371, doi:10.14710/jil.19.2.365-371

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1. Background

Human and environment are closely interwoven in order to maintain the equilibrium of the nature. Natural resources exploration, in term of industrialization is carried out to fulfill the human needs. In other side, the rapid growth of population has an impact on the increase of pollution level that lead to environment deterioration (Soedjono et al., 2018; Yadav et al., 2015). Untreated waste generation is one of the issues that is indicating the environment degradation. Waste are generated from any activities and due to insufficient waste management facilities, it is ended up to the landfill.

Waste management problem also does exist in Bali island as one of the best tourism destinations in the world. Besides the domestic waste from the households and tourism source, Bali has a typical waste which is generated from ceremonial activities, called temple waste. Known as the Island of Gods, Bali is globally recognized as the Island of Thousand Temples in the world. Not only an important place of worship for the Hindus population, Balinese temple is also a local and national cultural icon that drives over six million tourists to the island each year. As almost 90% of Bali's population are majority Hindus, there is a lot of religious ceremonies are conducted regularly at the temples. In other side, temple is well known as a cultural icon of Bali Island, but unfortunately also become one of the landfill waste contributors.

Generally, the temple waste is directly disposed to the landfill without any treatment, such as waste recycling. According to the Green Temples Guide by The Alliance of Religions and Conservation (ARC) (ARC, n.d.), encountering a temple space that has taken care to be blessing and not burdening the earth, it can gives an inspiration to share the blessing to the communities and makes the connection between human and earth better.

As an integral part of Balinese culture, devotion offerings which consists of flowers, leaves, fruits and bamboo are presented at almost every ceremony. Worshiping is a way of living of Balinese community as part of three principles of the cause of happiness or *Tri Hita Karana*. Worshiping or *Parahyangan* is the good relationship between human and the God. Regularly, the Balinese pray and offer the offering to the deities, also on some holy days, such as full moon, dead moon, knowledge day ceremony, etc. The offerings mainly consist of flowers, leaves, fruits, coconut, and any other natural resources (A. R, 2013; Wahyu Wijaya, 2019; Yadav et al., 2015).

After the ceremonials, all of the offerings will be collected and carried out to the landfill. Sometimes, it is found that the temple waste is discarded into the water body or dumped in an open place. The improper disposal of temple waste potentially causes a stress on the basic services in human life, such as water and sanitation, waste accumulation, raising the level of pollution, and human health (Wijaya & Soedjono, 2018). The aftermath of these offerings brings about

monumental temple waste issue, as over 2.000 litres of temple are generated during each ceremonial day. According to the WHO, 36% of chemicals used in flower plantations are highly toxic and when dumped in landfill, it can release harm greenhouse gases that are 22 times more environmentally damaging than carbon dioxide.

Flower waste can be recycled to some valuable products, such as vermicompost, dyes extraction, essential oil, color powder, or biogas. The flower waste also can be recycled for making therapeutic incense, art and craft, handmade paper and any souvenirs (Khammee et al., 2019; A. Singh et al., 2013; Yadav et al., 2015). The present study was exercising the leverage of temple waste, especially discarded flower into organic incense through recycling and also other previous recycling initiatives.

2. Methods

The study was located at the Griya Anyar Tanah Kilap Temple in Denpasar City. It is one of the public temples in the city that usually has lot of visitors, especially Hindu's community. It has about 2,300 m² of area and classified into three zones, such as *Nista Mandala* area (common area), *Madya Mandala* area (ceremonial activities), and *Utama Mandala* area (the most sacred area). Each of area has been provided trash container to collect the temple waste. The location of Griya Anyar Tanah Kilap Temple can be shown in the Figure 1.

Recycling of discarded flowers into organic incense were conducted as one of the recycling initiatives for temple waste handling. Additionally, another temple waste recycling from previous research which were successfully attempted were explained. The recycling of discarded flowers into organic incense consists of some phases: waste collection, sorting, drying, grinding, incense material mixing, and incense making.

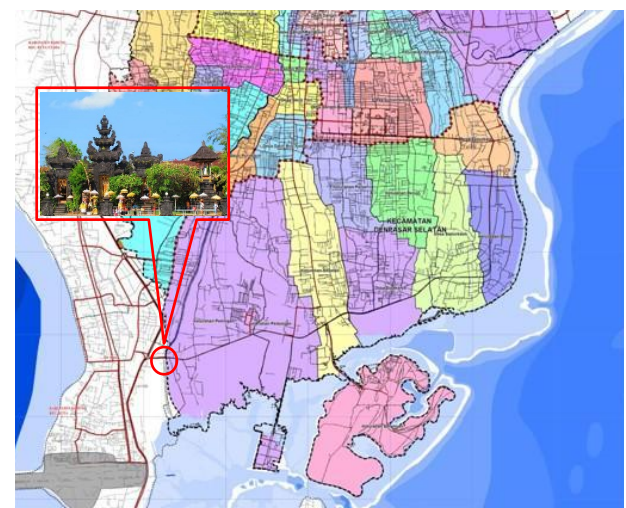


Figure 1 The location of Griya Anyar Tanah Kilap Temple in Denpasar City

The main materials of this incense are flower powder, sticky powder, essential powder, oil, and water. The temple waste was collected from a family temple that consist of 5 households for 7 days. The collection was conducted according to national standard for waste collection method (SNI 19-3964-1994, 1994) and held every morning to collect the whole waste of previous day. Afterwards, the temple waste was scaled and separated manually between the flowers, leaves, fruit or plastics. Discarded flowers are taken as the main material for the incense and dried up directly under the sunlight. It took 3-4 days drying to get dried flowers and ready to grind up. A grinding machine was used to grind the dried flower to get a fine flower powder.

The mixture of materials was used as the variable which followed the ratio of flower powder and essential powder. The mixture variable in this study was A (1:0,5), B (1:1), C (1:2). Sandalwood was used as the essential for this incense. Other variable such as sticky powder and oil was remain the same composition. Water is used to mix all of the materials and get easier to shape the incense. Oil was used as the fuel for the incense to get easier to be burnt. There were three parameters which this study was concerning on: structure of the incense, smell, and burning time. Other factors such as smoke and ash were assumed the same for all experiments.

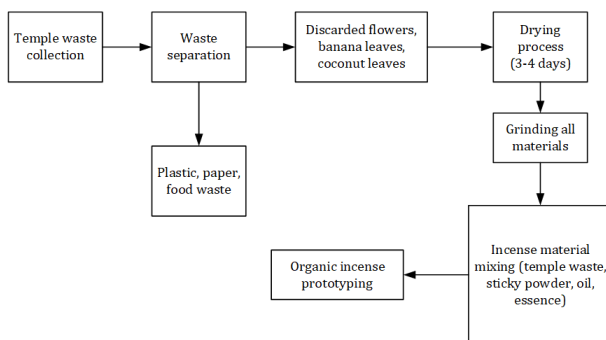


Figure 2 Discarded Flowers Recycling Process into Organic Incense



Figure 3 The discarded flowers are separated and dried up

3. Results and Discussion

3.1. Temple Waste Characteristic

Temple waste were generated largely during the worshipping, ceremonial or festival. Sometimes, the waste container was out of load and lot of waste were thrown away and dumped on the street. In general, all of temple waste would be disposed to the landfill directly. There is a need of proper handling system and environmentally friendly process for the temple waste. Since about 80% of the temple waste is biodegradable waste, a lot of ways were found to recycle it (A. R, 2013; Jain, 2016; P. Singh et al., 2017; Yadav et al., 2015). Another issue come up by the use of fertilizer in the flower plantation. It shown that production was generally increased by using more fertilizers, especially chemical fertilizer. The use of chemical fertilizer affect the soil condition, fertility, or hazardous impact (A. R, 2013). The temple waste was also disposed to the water body and have been created water pollution, regarding the use of chemical matter and it is harmless for the aquatic ecosystem. However, the flower waste has been contain those chemical matters (Ameen et al., 2018; Anvitha et al., 2015; Bogale, 2017).

A massive amount of temple waste during the ceremonial urgently needs to be manage through waste management approach. The dumped temple waste causes adverse effect on the temple environment and river as well, such as smell, diseases vector, and pollution. In other hand, temple is a holy place for worshipping and have to be always clean and maintained (Samadhiya et al., 2017; P. Singh et al., 2017). According to the composition, the temple waste are consist of various flowers, leaves, coconuts, fruits, bamboo, foods, clothes and plastics (Samadhiya et al., 2017; Yadav et al., 2015). The use of plastic is still common nowadays as it used as packaging of the fruits and food. Also, some people use it to carry out their offering. In Bali, some temples apply regulation to avoid the plastic to enter the temple. They provide a place to collect the plastic which have been brought by the visitors.

According to the field survey at the Griya Anyar Tanah Kilap Temple, it has found the temple waste generation during a ceremonial day, in average was about 290.36 kg/day. The density of temple waste has measured with 63.5 kg/m³. The temple waste was consisted of leaves and discarded flowers at the most with 45.52% and 33.86% of the temple waste, respectively. Other waste such as food waste has contributed 10.78%, non-biodegradable waste such as plastic package was about 3.63% and other hard waste such as wood was about 9.72%. The ceremonial offering from the communities are usually made of coconut leaves, banana leaves, flowers and some foods. It has made the temple waste were contained mostly with leaves and flowers. Khalil and colleagues have analyzed if coconut leaves is mainly consisted of 32.8% of lignin, α -cellulose (20.5%) and 56% of holocellulose. The high content of lignin makes the

leaves are more robust and solid, compared to other leaves. Lignin provides plant tissue a compressive strength and stiffens the cell wall. It protects the carbohydrates from chemical and physical destruction (Khalil et al., 2006). Previous research from Lomeli-Ramirez found the composition of lignin and cellulose of green fibers from coconut were 35.46% and 29.96%, respectively (Lomeli-Ramirez et al., 2018).

A study from Yadav and colleagues (Yadav et al., 2018) shown that the generation of temple waste in 10 temples in Jaypur India. The total temple waste generation was ranged from 27 kgs to 300 kgs per day. Most of those temple wastes were confirmed 100% biodegradable. All temples have completely banned the use of plastic in their offering stuffs. Singh *et al.*, (A. Singh et al., 2013) has reported that tons of offering flowers were disposed in an open dump and released in the Ganges River. It generates foul odor as well as become the breeding center for disease causing microorganism and flies. The temple waste was consisted of *Aegle marmelos* leaves, *Datura stramonium*, *Tagetes erecta* and *Hibiscus rosa sinensis* flower.

3.2. Temple Waste Recycling into Organic Incense

The organic incense was made by mixing the dried discarded flowers powder, sticky powder, essential powder, oil and water. Dried discarded flower become the main material of this incense. Three experiments were conducted as a preliminary research to finding the possibility of making incense from discarded flowers.

The structure of the incense, smell, and burning time were examined during this study. Structure of was showing the strongness of the incense, not easy to break, and shaped well. The smell is an obligatory for the incense as it used to be aromatic fragrance. The use of natural sandalwood powder was expected to create the smell of the incense in this study. The burning time is also one of consideration of the use of incense. The common incense for worshipping can burn last 30-60 minutes, while the aromatic fragrance could be more. About 30-60 minutes was expected for the duration of this incense to be burnt.

The preliminary experiments showed that the ratio C with 1:2 for discarded flowers and essential powder, respectively gave the best results. All incenses were formed in cube and have brownish in color. The mixture A showed that the structure was good in well dried condition. The fine form of essential powders has helped the incense to get stronger. Unfortunately, this mixture gave less and very light smell than other two. It has created the smell of scorched. It might be because the smell of burnt essential powder was out of compete the burnt dried flowers. This experiment came up with around 5 minutes last for the burning time. It possibly happened because it has less essential powder which

literally wood powder that can become the fuel for the fire. All of the results are presented in Table 1.

The mixture B and C were showing similar result for the structure. The incenses were very strong formed and solid. In other side, the smell of mixture C was the best among others and apparently define the smell of sandalwood. It also showed up the longest burning time and was in the range of expected burning time 30 -60 minutes. Those results showed that dried discarded flowers were possibly used as organic material incense and could be improve to get better structure, smell and burning time.

As mentioned above, the impact of this project could be measured through the number of discarded flowers were used in making the incense. According to the best mixture (C), the composition of an incense unit was 3 grams of dried flowers, 6 grams of essential powder, 0,1 grams of sticky powder, and 1,5 mL of coconut oil. It assumed that a temple has produced around 200 kilograms of temple waste during a ceremonial day. About 40% of those was discarded flowers (wet weight) that 80% contains water. After the drying process, it has left 16 kilograms of dried discarded flowers. That number of dried discarded powders could be potentially produced about 5000 incense units that are marketable. It estimated around 45 tons of discarded flowers from 230 public temples around Bali could be recycled every year through this project. It is only from one ceremonial day, since Bali has lot of ceremonials and more temple waste are going to produce. This project is a form of circular economic initiative that connecting the temple ecosystem as cultural icon of Bali, environment preservation, and society awareness. By involving the society in this project, also can elevate the awareness and knowledge of Balinese community to their environment.

Table 1 The Results of Organic Incense Experiments

Ratio	Structure	Smell	Time (minutes)
A (1:0,5)	**	*	± 5
B (1:1)	***	*	± 18
C (1:2)	***	***	± 36

Note: * (poor), ** (good), *** (very good)



Figure 4 The prototype of organic incense from discarded flowers



Figure 4 The Organic Incense Making Process

3.3. The Other Alternatives Discarded Flowers Recycling

Some recycling techniques were conducted previously to reduce the amount flower waste in the environment. Other recycling was including vermicomposting, bioethanol, charcoal, etc. Jain (Jain, 2016) has been successfully applied vermicomposting by using discarded flowers. The research was conducted in Jaipur city (India) that has lot of temples and rituals. Furthermore, creating a huge amount of flower waste, which causes severe environmental pollution and health risk. Those waste were biologically managed by applying vermicomposting instead of disposal to landfill sites, open dumping or any other harmful waste management alternatives. Discarded flowers have complex organic substances that possibly bio-oxidized and transformed into stabilized products by combined the earthworms and microorganisms, hence earthworms play a considerable role by fragmenting and altering all biological activity of the waste. The study has proved that vermicomposting of floral waste with cow dung at 50:50 and 60:40 showed to be the most promising high value bio-fertilizer. This was not only increasing the plant growth, but also was cost effective and pollution free. Vermicompost technology could be successfully applied in temples as a solid waste management strategy with flower as the major organic waste.

An interesting finding was done by Khammee and colleagues (Khammee et al., 2019). By applying the concept of waste to energy, recycling of *Tagetas erecta*

into biofuel has been conducted. Those discarded flowers are the best lignobiomass sources for producing biofuels. It could be a rich source of sugars from the flower waste which can be potentially converted into bioethanol. Lignocellulosic biomass, such as agricultural residues (corn and wheat straw), wood and energy plant, is a new material for bioethanol fuel production. Following through a conceptual methodology, the research showed that Marigold flower wastes were potentially become the raw material for bioethanol production. Through an optimization of the pretreatment, saccharification and fermentation, it will improve the fermentation yield. It is also proved its potential and feasibility to use as a flower wastes biomass for bioethanol production.

Bogale (Bogale, 2017) has another approach in recycling the discarded flowers in Ethiopia. Ethiopia is the second largest flower exporter in Africa. The flower waste was converted into biochar through pyrolysis process. Biochar is defined as carbon-rich product obtained when biomass is heated in a closed container with little or no available air through a process called pyrolysis. It has been used for so long since it mitigates climate change and used for sustainable waste management (Lehmann, n.d.). The result showed that 10 kilograms of biochar is generated by using 18 kilograms of flower waste with a conversion efficiency of 55.5% and approximately 310.8 kilograms of biochar can be generated daily. Based on the result, the measured value of lower heating value of the produced biochar was 26.54 MJ/kg and approximately 392.2 kg of firewood was

replaced daily. Thus, by adopting this innovative technology and producing biochar, the amount of flower waste was reduced from direct disposal to the landfill, energy is recovered from flower waste, income will be generated from the selling of the biochar and the energy problems of the society would be solved and finally environmental impact of the flower waste is reduced.

Temple waste disposal have to be managed safely to prevent the environmental pollution around the temple area. Most of the temple waste are thrown away directly into water bodies. The organic matter contained in the temple waste are released and increase the algal blooms and eutrophication in water, which can deplete the oxygen levels in the water bodies (Halappa, 2020). Since it has high composition of biodegradable waste (leaves and discarded flowers), makes the temple waste is potentially transform into another valuable product through recycling initiatives. Improper temple waste disposal can damage and deteriorate the environment quality. There are some types of disposals and treatment options in handling temple waste. A land treatment can be use as a waste disposal by making a contact with the soil. It encourages the environment capacity of the soil to return any substances from the waste material. Volatilization is also used for waste disposal. It is effective to remove the volatile compounds from soil by heating it up the soil to between 100 and 500°C. Recycling is a modern approach to transform the temple waste into value-added product, such as compost, vermicompost, dyes, incense, biocoal, biofuels, biosurfactans, papers, etc (Waghmode et al., 2018).

3.4. The Strategies in Preserving Temple Environment

Balinese Temple is known as one of the cultural icons of Bali Island. Unfortunately, it is also the contributor of landfill waste. The regular ceremonial activities in Bali Island will keep going and produce temple waste. Consequently, amount of waste generated in the temple need to be well managed, otherwise decrease the cleanliness and holiness of the temple. As a sustainable effort in preserving temple environment in Bali Island, the practice of waste management has to be improved. The strategies of temple waste management practice are as follows:

1. Increasing the awareness of the temple community regarding the important of waste management in their own temple.
2. Cooperation with local government and temple's organization in making temple regulation addressing waste handling. Also, installing the information board about waste handling.
3. Providing waste bins to improve the temple waste separation. The waste separation can be on organic and inorganic waste.
4. Training of the community in waste management, including collection, separation, recycling, and disposal.

5. Empowering the local community in recycling the organic waste into some recycled and marketable product, such as compost, organic incense, biocoal, etc
6. Cooperating with the government and private sectors in developing the recycling facilities and marketing of the product

4. Conclusion

Temple waste is an urgent issue in the temple environment in Bali Island due to insufficient waste management. Discarded flower as a component of temple waste were examined to be recycled into organic incense and potentially become an initiative to reduce the temple waste. It is showed that the ratio of 1:2 for discarded flowers and essential powder gave the best results. The incenses were very strong formed and solid. Additionally, the smell of best mixture was the best among others and apparently define the smell of sandalwood. It estimated around 45 tons of discarded flowers from 230 public temples around Bali could be recycled every year through this recycling effort. Some impacts come up with following this initiative, such as reducing the temple waste, creating a marketable recycling product, and build up a harmony between the cultural. Some impacts come up following this initiative, such as reducing the temple waste, creating a marketable recycling product, and build up a harmony between the cultural, environment, and society. Many other initiatives have been previously conducted and supporting the temple waste management

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